Microfinance Spillovers: a Model of Competition in Informal Credit Markets with an Application to Indian Villages*

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Abstract

Despite widespread interest in the development of microfinance, spillover effects on the non-using population and redistributive issues remain largely unexplored. In a two-sector model of lending with adverse selection, I study the general-equilibrium consequences of introducing group-lending in local credit markets. I show that those depend crucially on the size of the microfinance sector relative to the risk composition of the borrower pool. I characterize the conditions under which composition externalities trigger an increase in the equilibrium interest rate charged by moneylenders, which adversely affects borrowers' welfare outside the microfinance sector. The model's setting and main predictions are then shown to be consistent with first-hand panel data recording eight years of credit transactions at the household level, for a sample of Indian villages that displays extensive time and space variation in the size of the microfinance sector.

Keywords: Microfinance, Joint liability, Informal credit market, Moneylenders, Adverse selection, Competition, General Equilibrium effects.
JEL Classification Numbers: D82, G21, O16

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1 Introduction

From the 80s onwards, microfinance institutions (MFIs) have spread out around the world, reaching more than 200 million poor families by 2010 (Maes and Reed, 2012). An extensive theoretical literature has explained how innovative contractual structures and organizational forms - especially group lending - have enabled the delivery of small and uncollateralized loans, while mitigating the well-known adverse selection and moral hazard problems that traditionally plague informal credit markets (e.g. Stiglitz, 1990; Besley and Coate, 1995; Ghatak, 1999, 2000; Ghatak and Guinnane, 1999).

However, by mostly focusing on the problem of single lenders trying to tap excess demand, the existing literature has not yet quite explored a key issue regarding the development of microfinance, namely its general-equilibrium effects on the informal credit market and the welfare of the non-using population. As a matter of fact, MFIs do not operate in an empty space but instead enter pre-existing local credit systems. Although imperfect in most cases, those informal markets are very important for many people's welfare. For instance, the last All-India Debt and Investment Survey estimated that informal finance accounted for 43% of outstanding loan amounts of Indian rural households (NSSO, 2005). Another recent survey by the Reserve Bank of India found that between 1995 and 2006, while the outreach of MFIs was booming to about 40 millions borrowers, the number of registered moneylenders increased by 56% and the number of unlicensed lenders was believed to have made similar gains (RBI, 2007). In other words, MFIs do not appear to simply replace incumbent lenders but rather to increasingly coexist with them in local credit markets.[1] In fact, this coexistence is largely natural and is likely to persist because of important complementary features between the two types of lenders. Intuitive reasons for the continued (or indeed increasing) prevalence of moneylenders include: the existence of constraints on microfinance lending (e.g. limited funds, selection of specific borrowers or projects), confidentiality issues, round-the-clock availability and speed of processing, flexibility in loan use and repayment, lender-of-last-resort and double-dipping phenomena. It thus seems crucial to understand how informal lenders adapt to the presence of MFIs and what can be the general-equilibrium consequences.

MFIs seem desirable because they potentially supply credit to otherwise-constrained households. They can also supply credit to households borrowing from moneylenders, which helps limit the market power of the latter. Nevertheless, in this paper, I argue that, because group-lending MFIs are likely to attract the safest investment projects, they can worsen the informational problems that cause traditional lenders to charge high interest rates and exclude some creditworthy borrowers. This seems to be in line with the puzzling conclusion of the above-cited RBI's study: "In the [177] districts surveyed, and where the presence of MFIs / SHGs [Self-Help Groups] was significant, the incidence of money lending by traditional moneylenders has come down. However, this has not prompted moneylenders to reduce their interest rates. This could be because MFIs do not have a sufficiently large network (RBI, 2007)." Although reliable data and identification strategies on the matter are scarce, Mallick (2012), Kaboski and Townsend (2012) and Berg et al. (2013) report similar evidence for Bangladesh and Thailand, while trying to address endogeneity issues seriously: following MFIs' entry, the average interest rates

[1] Other studies providing evidence about the coexistence of microfinance and informal lenders include Coleman (1999); Zeller et al. (2001); Jain and Mansuri (2003). To some extent, these facts go against the rationale behind the early policy interventions in credit market and the motivation of the first proponents of microfinance, which were mostly trying to tame exploitative moneylenders.

charged by informal lenders do not decrease and tend to increase. The first paper does not analyze the evolution of the demand for informal loans, but suggests that microfinance might actually have increased the demand for moneylenders' credit, either because of rigid repayment schedules imposed by MFIs or the small size of MFIs' loans with respect to indivisible investment projects. Kaboski and Townsend (2012) explain that the fact that they do not find any significant effect on the informal credit market might reflect the existence of credit constraints.[2] Berg et al. (2013) perform a careful analysis of the demand for informal credit in Bangladesh and show that it goes down with the penetration of microfinance. They suggest that their findings are consistent with a model where MFIs draw away better borrowers from the moneylender and/or where fixed costs are important in informal lending. Yet, having only village-level data, they are not able to test these mechanisms. By contrast, the present paper provides new evidence from Indian household panel data, while developing a full-fledged theoretical framework able to explain the observed facts.

I present a model of horizontal competition between zero-profit MFIs that lend limited funds using joint-liability contracts and traditional moneylenders who use standard individual loans.[3] Over a nontrivial region of parameters, MFIs are shown to decrease the demand for informal credit, increase the equilibrium interest rate charged by moneylenders, and potentially decrease the coverage of creditworthy borrowers. This scenario happens when traditional moneylenders are serving (some) safe borrowers in the absence of MFIs, and the latter do not have enough funds to supply the entire population of safe borrowers - a realistic situation.

The implication of the model is that policy makers and practitioners need to be aware of potential negative general-equilibrium effects that need to be taken into account beyond any direct impact derived from the entry of MFIs in local credit markets. Ultimately, it is the understanding of the local market conditions that will determine the anticipated impact of microfinance. In the last section of the paper, I use first-hand data from a unique panel household survey to assess the relevance of the model. The database includes all credit transactions made over nine years by a random sample of Indian households, living in villages that experience important variation in the size of the microfinance sector over space and across time. The detailed micro data allows me to test accross mechanisms, while controlling for important unobserved heterogeneity thanks to the panel structure. First, I show that microfinance clients have a safer risk profile and form groups that are more homogenous than other households in their village. Second, they borrow from moneylenders, more than other households before the entry of MFIs and in a largely reduced way afterwards. Third, controlling for villages' fixed characteristics, time fixed effects and village-level income shocks, I find that moneylenders charge higher interest rates in villages where some SHGs are present than where there are none. Fourth, in line with the theory, I find that the relation reverses when the SHG coverage becomes large, leading to an inverted-U shaped pattern, and that it is much stronger in less risky villages. Taken together, those facts provide strong support for the theoretical predictions of the model with competition among informal lenders.

The theoretical contribution of this paper relates to different connected strands of

[2]They find a positive and insignificant effect of microfinance on informal interest rates and a negative and insignificant effect on the reliance on informal lenders.

[3]The model in this paper explicitly uses joint liability, though the conclusions would apply to a wider set of microfinance mechanisms that imply some sort of borrower selection, such as peer screening, peer pressure or frequent repayment.

the literature on microfinance and informal financial markets. First, I build on earlier works in microfinance contract theory, and especially the papers by Ghatak (1999, 2000). In his seminal 1999 paper, Ghatak shows that joint-liability credit contracts typically lead to positive assortative matching at the group formation stage, which in turn implies lower implicit costs for safe borrowers and higher welfare. Ghatak (2000) shows that a joint-liability bank maximizing the utility of borrowers can improve repayment rates and welfare with respect to individual liability contracts, by offering discriminating contracts in which the extent of joint liability varies. In addition, he shows that this optimal separating contract can be implemented in a decentralized setting as a competitive equilibrium, and argues that the introduction of joint-liability would therefore break any preexisting pooling equilibrium with individual liability. Yet, as I briefly discussed earlier, this is not what is typically observed in reality: moneylenders often keep operating alongside microfinance, possibly supplying credit to microfinance clients themselves. By contrast, the present paper introduces an informal credit market alongside the microfinance sector and studies a game of decentralized competition between MFIs and strategic moneylenders. In such a setting, I predict that the equilibrium interest rate on the informal credit market might increase, decrease or stay unchanged following the emergence or the expansion of the microfinance sector, depending on the size of the latter, the risk composition of the borrower pool and the competitiveness of the informal market. Another important difference is that I impose that MFIs offer incentive-compatible contracts and follow a zero-profit rule, with the consequence that discriminating joint-liability contracts are actually not feasible in my model (which seems to be in line with what happens in practice).

Second, I share some similarities with existing papers that study the interaction between (semi-) formal and informal financial sectors. For instance, Hoff and Stiglitz (1998) show that, if a subsidy to the formal sector induces new entry, it can increase the marginal cost of lending and result in higher interest rates charged by informal moneylenders, because of negative enforcement externalities or lower scale economies. Bose (1998) reaches a similar conclusion, using a mechanism which is closer to the one discussed in this paper: if some lenders can discriminate between safe and risky borrowers while others cannot, an increase of the credit supply by the former can worsen the composition of the pool of the latter. However, in contrast to this paper, Bose (1998) deals with the vertical interaction between formal and informal sectors and looks at the effect of a public subsidy to the formal sector. Besides, it provides no justification for the assumption that one part of the informal sector is informed about borrowers' type and another is not. In this paper, all lenders have the same information and the type of debt contract that they use leads to an endogenous selection of borrowers. Jain (1999) and Andersen and Malchow-Møller (2006) are models of horizontal strategic interaction between (semi-)formal lenders with lower opportunity cost of capital and informal lenders with better information about borrowers. In those models, banks or MFIs can ration credit in order to force borrowers to resort to the informal sector for the remainder of the loan and thereby benefit from the screening of borrowers by moneylenders. Jain and Mansuri (2003) use a similar setting but introduce moral hazard. In their model, MFIs seek to benefit from the monitoring advantage of moneylenders by forcing borrowers to multiple-borrow. As a consequence, microfinance can raise the demand for informal loans and hence the interest rate in that sector. Mookherjee and Motta (2013) study the effect of joint-liability in a similar context with adverse selection. In their model, borrowers have non-collaterizable wealth, project returns as well as outside options are increasing in wealth levels and wealth and riskiness are uncorrelated. They assume that informal lenders have private knowledge of risk types and can make borrower-specific debt contracts. On the other hand, the MFI has a cost advantage but lacks such information. In this setting, informal lenders use their private information to behave monopolistically in their own wealth segment of the pool of safe borrower and break-even on the pool of risky borrowers. The MFI that enters such a market attracts all risky borrowers because of its cost advantage and might attract some rich safe borrowers. The presence of microfinance thus typically decreases the average interest rate of the informal credit market, though it can increase it if monopolistic interest rates are decreasing in wealth or if the MFI assigns a higher welfare weight to poor borrowers. Though I partly share the motivation and conclusion of the two previous papers, I propose a fundamentally different mechanism, which offers a better fit of the empirical evidence presented at the end of the paper. In particular, MFIs in this context are shown to decrease the demand for informal loans, to attract the relatively safe population and to propose a unique contract to all borrowers.

Third, this paper also contributes to the literature on the impact of microfinance in general, and the potential spillover effects on the non-using population in particular. Focusing on credit, this paper provides a clear theoretical framework to think about how the introduction of new services in the form of microfinance can affect traditional institutions that evolved to fulfill important economic roles. In doing so, I add to an emerging literature that explores indirect effects of policy interventions on non-users (e.g. Angelucci and De Giorgi, 2009; Flory, 2012). By identifying an important channel through which non-users might be affected by the entry of microlenders, namely the strategic adaptation by incumbent informal lenders, I suggest a careful appraisal of empirical studies that try to assess the impact of microfinance, as inappropriate comparison groups may strongly bias estimates and a failure to take into account such externalities would deliver a very partial picture.

The remainder of the paper is as follows. Section 2 presents the model in the case of competitive credit markets. I start with the basic features of the model, which hold throughout the paper. I present the problems of stand-alone moneylenders and MFIs, and derive the conditions under which inefficient separating equilibria may arise in such a setup. I then study a competition game between the two types of lenders sharing a given informal credit market. In appendix B, I introduce market power and analyze a similar competition game between a not-for-profit MFI and a monopolistic moneylender. In the second part of the paper, section 3 puts the model to an empirical test using first-hand panel data about financial transactions in Indian villages. Finally, I conclude.

2 The model

2.1 Basic setup

I use a simple one-period model of a rural credit market with adverse selection (à la Ghatak, 2000). The market is populated by N risk-neutral households. Each household is endowed with a risky investment project which requires one unit of capital and one unit of labour. Their utility function U is assumed to be continuous and linearly increasing in income ($U' > 0$, $U'' = 0$). It is assumed that households lack capital and have to borrow the amount required to start the project. They will do so if the expected net benefit from investing is greater than the opportunity cost of labour $\bar{u} > 0$, which is the net rate of remuneration that the household would get if not committed to any investment project (e.g. wage rate).

Households are indexed into two groups, safe (s) and risky (r), of size N_s and N_r respectively.[4] Let $\pi = \frac{N_s}{N}$ and $(1-\pi) = \frac{N_r}{N}$, with $\pi \in (0,1)$. While the proportions of safe and risky borrowers are common knowledge, the risk of each individual project is unknown to lenders (or the screening technology is prohibitively expensive), which forces them to charge a common interest rate to all borrowers. I do not assume any difference in the information structure faced by different lenders, who will only differ according to their debt contract. Indeed, the relative information held by the different lenders is very context-dependent. Hence, I prefer to remain as general as possible by avoiding to impose any exogenous advantage on one side or the other (which would amount to assuming away adverse selection). Moreover, in the context of the empirical application presented in section 3, MFIs take the form village associations that have certainly no less information than traditional lenders.[5]

I denote by p_i the probability of success of the project of type i, with $i \in \{r, s\}$ and $0 < p_r < p_s < 1$. If successful, projects yield a gross return R_i and zero otherwise. The project returns of different borrowers are assumed to be uncorrelated (for the effect of correlated types, see Laffont 2003 or Ahlin and Townsend 2007). Moreover, I make the common assumptions in the literature that expected returns are equal for both types of households - i.e. heterogeneity is in the second moment of the distribution only - and that all investment projects are socially efficient - i.e. their expected return is greater than the opportunity cost of the capital and labour used up in the project:

$$E(R_i) = p_s R_s = p_r R_r = \bar{R} > 1 \text{ and } \bar{R} > \gamma + \bar{u}, \tag{EC}$$

where $\gamma > 1$ is the gross cost per unit lent (including bank's interest rate if moneylenders refinance in the formal sector or if they forego deposits). I do not introduce fixed costs in lending in order to abstract from this particular source of negative externalities following new market entry, which has nothing specific to microfinance. Assumption (EC) means that, in a welfare-maximizing situation, all households should get funds. However, in the presence of imperfect information, underinvestment might result in equilibrium (Stiglitz and Weiss, 1981).

There is no (ex post) moral hazard in the model, such that successful borrowers always repay.[6] In case of failure, I assume limited liability in the sense that borrowers cannot repay their loan nor the interest rate due - it is assumed that borrowers cannot

[4]Risk types should be interpreted in terms of riskiness of projects - and not riskiness of borrowers - as the same borrowers might behave differently in front of different lenders (e.g. MFI members, being forced to limit the riskiness of their group borrowing might apply to moneylenders in order to finance riskier projects).

[5]If one wants to think about a particular situation in which MFIs are external to the village or the local market, it might make sense to assume that traditional lenders have an information advantage, as for instance in Jain and Mansuri (2003) and Mookherjee and Motta (2013). In that situation, the results of the present model can hold or be reversed, depending on how accurate is the moneylenders' knowledge about the risk profile of borrowers. At the extreme, if moneylenders have perfect information while MFIs have none, it is easy to foresee that safe borrowers will always prefer borrowing individually.

[6]This is obviously the case if success is perfectly observed (though actual returns are private) and repayment is enforceable, or if ex-post state verification is costless. Yet, Gale and Hellwig (1985) showed that, in the case of one-period debt contracts with sufficiently costly state verification, in equilibrium, lenders pay that cost whenever borrowers default, which leads to the same conclusion. Furthermore, in the rural setting that I have in mind, social sanctions and/or repeated interactions will also contribute to the enforceability of contracts.

pledge any collateral, for simplicity and also because it is likely to actually best describe the situation of most poor households around the world.[7] Together, limited liability and absence of collateral imply that most instruments used by conventional lenders to address information problems are not available.

Lenders follow a zero-profit rule, which can be viewed as a reduced form of a profit maximization problem under perfect competition or Bertrand competition (with all lenders facing the same technology and free entry). Alternatively, it could be the rule followed by not-for-profit institutions (e.g. NGO), in particular as far as microfinance is concerned. Hence lenders simply react to the composition of the pool of borrowers by charging a price that allows them to break-even according to their lending technology. In appendix B, I present an extension of the model that allows for lenders' market power.

2.2 Equilibrium of the credit market under individual and joint liability

As a useful building block, this section derives the problem of stand-alone lenders using individual or group lending. The timing of the lending game is as follows. First, risk-neutral lenders make price offers based on their rational expectations about the riskiness of borrowers as well as the distribution of the states of nature, and market competition determines the equilibrium interest rate. Second, borrowers observe the market interest rate and decide whether to borrow or not. Third, households who borrowed invest, Nature decides the outcome, and repayment is made according to the debt contract if projects are successful. Households who did not borrow enjoy the reservation income $\bar{u}$.

Proposition 1 *The individual-lending market is at an efficient pooling equilibrium if* $\bar{R} - \bar{u} \geq \frac{p_s}{\bar{p}}\gamma$*, and at an inefficient separating equilibrium (adverse selection) otherwise.*

Proof. See appendix A.1. ■

As is clear from the above proposition, adverse selection is more likely the higher the cost of capital, the probability of failure and the proportion of risky borrowers in the population, because those factors increase the break-even interest rate. It is less likely the higher the riskiness of safe borrowers, as safe borrowers expect to pay less often and the interest rate only partially reflects their own riskiness. Finally, the larger the difference between the expected return from investment and the safe wage option, the higher the probability that safe households apply for a loan at equilibrium. This, in turn, will be determined by factors like the size, fragmentation and competition of local markets for goods and services, or the education of households - all of which are left outside this model (but will be controlled for in the empirical analysis).

I now turn to the problem of a lender that lends to groups that are collectively responsible for repayment under a joint-liability contract. That is, although loans are still individual and every borrower is still responsible for paying back her own loan, successful group members have to pay an extra cost if their partners default. As is well known, this is a scheme that is widely used by microfinance institutions around the world in order to mitigate information asymmetries.[8] Formally, I define a joint-liability debt

[7] Often, traditional moneylenders accept as collateral goods or services that have little or no economic value but whose role is to induce higher willingness to repay (given the positive value they have for borrowers). In this model without moral hazard, collateral is therefore not a crucial matter.

[8] Most microfinance programmes in the world make use of some form of group-lending schemes, such as compulsory group meetings, regular public repayments or explicit joint liability. In recent years,

contract as a contract (r^J, c), where r^J is the equilibrium gross interest rate given joint liability and $c > 0$ is the gross compensation that a successful group member has to pay in case her partner fails to repay her loan.[9]

For simplicity, I model groups of two, which is a standard assumption in the literature that can be generalized (see Ghatak, 1999; Ahlin, 2012). More importantly, either because borrowers know each other well within a tight-knit village allowing repeated interactions or because they can signal each other's type by means of side payments, borrowers who are asked to form groups voluntarily in order to access a loan will pair up with same types. Indeed, pairing with risky individuals increases expected costs of borrowing, and it does increasingly so the safer the borrower. In this context, it is easy to show that there is no mutually beneficial way for risky and safe borrowers to group together, and homogenous groups represent the only stable outcome of the pairing game (Ghatak, 1999).[10]

For the contract to be feasible ex-post, it needs to satisfy the following condition:

$$r^J + c \leq R_s \tag{FC}$$

i.e. the realized payoff in case of individual success is enough to honour the debt contract in all states. In addition, I impose the following incentive-compatibility condition:

$$c \leq r^J \tag{IC}$$

i.e. the total repayment due can never exceed twice the individual-liability component. Condition (IC) means that the lender cannot require a compensation that is larger than the defaulting partner's due. It is key to avoiding the situation where the successful partners of failing borrowers prefer to declare their partner to be successful, which would lead to a break down of the joint-liability contract (unless success and failure are perfectly and freely observable). It also ensures that the gross interest rate is always greater than one. Not surprisingly, it is in line with what group-lending programmes do in practice - and in particular with the empirical application in the second part of the paper.

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a growing number of MFIs have been turning to individual liability (e.g. Grameen II and ASA in Bangladesh and BancoSol in Bolivia). However, most of them still use groups to disburse and collect loans, which implies that some peer screening, monitoring or enforcement is still present (constituting some form of 'implicit' joint liability). Moreover, this trend is by no means universal. For instance, BRAC, the largest NGO in the world, still uses explicit group lending. In India, Self-Help Groups (SHGs), which form the object of the empirical exercice in the second part of the paper, adhere fairly strictly to the joint-liability contract and represent 73% of the microfinance sector (Srinivasan, 2009). Worldwide, it is estimated that only 7% of microfinance loans are made to individuals (MIFA, 2008). In any case, as explained by Besley and Coate (1995), the reason why group liability works is probably not so much because of the formal structure of liability but because, after being together for a while, people start to value their relations with other members.

[9]In practice, there are differences in the way how MFIs enforce joint liability contracts. They might require the group to pay a predetermined penalty in case of one member's default, in which case the interpretation of c is literal. Alternatively, they might deny future credit to all group members until the loan of the defaulting partner is repaid, or simply have some form of automatic debt mutualization (as in Indian SHGs). In those cases, the term c can be interpreted as the net present discounted value of the cost of sacrificing consumption.

[10]Note that Guttman (2008) shows that this property does not necessarily hold if borrowers are denied future access to credit in case the group defaults (dynamic framework) and if side payments are possible. The little empirical evidence available about the nature of group formation in real-life joint-liability contracts points towards assortative matching (e.g. Ahlin, 2009; Baland et al., 2011). I myself provide direct evidence in favor of assortative matching in Indian SHGs in section 3.

Lemma 1 *Condition* (IC) *is a sufficient condition for* $r^J > 1$. *Moreover, it is also a sufficient condition for condition* (FC) *whenever* $\gamma \leq \bar{u}$.

Proof. See appendix A.2. ■

In the setting of this paper, an important consequence of condition (IC) is that the amount of joint liability cannot be used as an independent screening device:

Lemma 2 *Given* (IC)*, zero-profit microfinance lenders cannot charge a compensation that is high enough to deter risky borrowers from applying to a pooling joint-liability contract:* $U_r(r^{J,P}, c) > U_r(r^{I,S})$, $\forall c$.

Proof. See appendix A.3. ■

As a result, discriminating contracts à la Ghatak (2000) are not feasible and the choice of c will have no influence on the composition of the borrower pool.[11] Hence, the analysis that follows treats c as given and the results hold true for any joint-liability level satisfying (IC).

Proposition 2 *The market for joint-liability loans is at an efficient pooling equilibrium if* $\bar{R} - \bar{u} \geq \frac{p_s}{\bar{p}} \left(\gamma - c(1-\pi)p_r(p_s - p_r)\right)$*, and at an inefficient separating equilibrium otherwise.*

Proof. See appendix A.4. ■

As is obvious from proposition 2, the range of parameters - π, p_i - that gives rise to pooling equilibria increases with respect to the individual-lending case. The group-lending contract limits the likelihood of adverse selection by allowing lenders to implicitly charge a lower interest rate for safe borrowers - thereby relaxing their participation constraint.[12] Yet, it is unable to completely avoid the possibility of excluding worthy safe borrowers. The likelihood of adverse selection decreases with the importance of joint liability. As before, it increases with the cost of capital, the proportion of risky borrowers in the population and their riskiness, as well as the probability of success of safe borrowers.

2.3 Equilibrium of the credit market with moneylenders and microfinance

In this section, I consider the following situation. In a given geographical area, capital-constrained households have the opportunity to take up individual loans from traditional moneylenders (hereafter ML) or from a group-lending institution (hereafter MFI). I thus

[11] Condition (IC) was not satisfied by the optimal joint-liability contract in Ghatak (2000). Gangopadhyay et al. (2005) revisit the previous paper and show that the optimal sorting contract can be recovered under (IC), if MFIs are allowed to make positive profits and to offer multiple contracts. However, it happens over a much smaller region of parameters and the first-best level of welfare cannot be achieved anymore. Note that, besides the fact that it is necessary for the contract to make sense, condition (IC) actually goes against the main mechanism of this paper, because it complicates the sorting of borrowers across lenders.

[12] In the special case in which potential borrowers do not know each other and cannot get any information on the others' risk characteristics, groups are formed randomly and group lending does not offer any improvement upon individual lending. Using the present framework, it is easy to show that lower interest charges are indeed exactly compensated for by expected joint liability payments. However, this conclusion might not hold in the presence of correlation between entrepreneurs' returns (see Laffont, 2003).

analyze a competition game between the two types of lenders described in the previous section.

Given that being the only clients of ML represents the worst and the best situation for risky and safe borrowers respectively, it is easy to check that this game does not admit any pure-strategy Nash equilibrium if lenders have illimited funds. Using mixed strategies, it can be shown that all borrowers behave in the same way, such that the relative riskiness of borrower pools does not change and the market equilibrium is not affected. Interestingly, once capacity constraints are introduced, the picture looks very different and pure-strategy Nash equilibria exist. I impose that MFI does not have enough funds to serve the entire market, i.e. it can serve maximum $N^{max} < N$ borrowers. Limited fund availability (which depends, say, on the amount of savings from members or on funds from donors or the public sector) is one potential justification, given the often high take-up rates and the general lack of profitability of the sector (Armendáriz and Morduch, 2010). Yet, the assumption that the microfinance sector cannot serve all borrowers can be viewed as a reduced form for the existence of entry barriers or any other reason that explains why some people keep borrowing from traditional lenders. Those can stem from the difficulty of organizing such schemes for lenders, or, as far as borrowers are concerned, from a lower-than-average risk aversion, too high economic or psychological costs of attending meetings, a lack of social connections, or inadequate rigid rules about loan access, use and repayment.[13] Let $0 < \alpha < 1$ be the importance of the 'capacity constraint' of MFI - i.e. $\alpha = \frac{N^{max}}{N}$. In order to simplify the exposition, the individual-lending market is assumed to have no financing constraint. That is, though borrowers might have to compete to get funds from their preferred source, the entire population would be served in a complete-information setting (i.e. there is no a priori inefficiency). Note that, given the absence of fixed costs in lending, this simple capital constraint does not modify the results derived in the previous section.

The timing of events is as follows. First, both lenders announce the terms of their debt contract, which satisfy zero-profit, incentive-compatibility and feasibility constraints based on their rational expectations of market parameters. Second, borrowers decide whether to borrow or not and apply to their preferred source of credit. Third, applicants who could not get credit can decide to borrow from the other lender. [14] Fourth, as before, investment takes place, Nature decides about the realizations and lenders get reimbursed according to contract terms.

From the previous sections, we know that safe borrowers always (weakly) prefer borrowing in groups, while risky borrowers always prefer a pooling individual contract to any joint-liability contract. As a consequence, safe borrowers will always turn to MFI in the first place, and the decisions of risky borrowers will determine market equilibrium. According to the parameter values, three market configurations are thus possible: safe borrowers can be served by (1) no lender, (2) MFI only or (3) both lenders. I will discuss

[13]It is easy to think of a model in which heterogenous agents would split across the two sectors according to their individual characteristics. Yet, this would require additional assumptions regarding the correlation between those and risk characteristics, and would unnecessarily complexify the setting of this paper.

[14]This timing thus allows borrowers to reoptimize once they learn the outcome of the first application to their preferred source, ensuring full incentive compatibility. Another possibility would be to assume that borrowers commit to the investment when they decide to borrow in the first period, based on their expectation about getting credit from both sources. This second setup would ease our results, because constrained safe borrowers would be more likely to borrow from ML (thus relaxing condition (1)), though it is arguably less realistic.

the optimal choice of risky borrowers in each situation, as well as the resulting impact of MFI's entry on the informal credit market along price, quantity and welfare dimensions. Table 1 summarizes the results in the different cases.

Table 1: Lenders' expected market shares and impact of MFI's entry in competitive credit markets

	Contract of MFI	
Contract of ML	Separating	Pooling
Separating	1. *shares:* $[(0, max\{^{(1-\pi)}/_2, 1-\pi-\alpha\}); (0, min\{^{(1-\pi)}/_2, \alpha\})]$ *impact:* 0	2. *shares:* $[(0, (1-\pi)(1-\alpha)); (\pi\alpha, (1-\pi)\alpha)]$ *impact:* Δ^+ coverage and welfare
Pooling	(impossible)	3.A. if $\alpha \geq \pi$ or conditions (1) or (2) not satisfied: *shares:* $[(\pi(1-\alpha), (1-\pi)(1-\alpha)); (\pi\alpha, (1-\pi)\alpha)]$ *impact:* Δ^+ welfare 3.B. if conditions (1) and (2) are satisfied: *shares:* $[(\pi-\alpha, 1-\pi); (\alpha, 0)]$ *impact:* Δ^+ informal interest rate

Note: '*shares*' reads as follows: [(expected safe borrowers served by ML, expected risky borrowers served by ML) ; (expected safe borrowers served by MFI, expected risky borrowers served by MFI)], where the number of borrowers is scaled by the market size N.

First, if the expected returns from investment are too low, capital costs are too high or the population is too risky, MFI cannot offer a pooling equilibrium either, and the two lenders compete exclusively for risky borrowers (*case 1*). Both lenders expect to serve a scaled-down pool of risky borrowers, implying that MFI and ML still break-even at $r^{I,S}$ and $r^{J,S}$ respectively. In that situation, risky borrowers are indifferent between the two lending contracts, as the lower interest rate is exactly compensated by the expected extra joint liability payments in the group contract: $U_r(r^{J,S}) = U_r(r^{I,S}) = \bar{R} - \gamma$. As a consequence, the two lenders share the population of risky borrowers according to their availability of funds. Compared to the situation in which ML serves the market alone, MFI has no effect on coverage since safe borrowers are still excluded, nor on the informal interest rate since the composition of ML's pool is unaffected. MFI does not affect welfare.

In *case 2*, a separating equilibrium exists in the moneylending market, while group-lending is able to achieve a pooling equilibrium. In that situation, MFI can potentially limit credit rationing and attract unserved safe investors back to the market. Yet, it also attracts risky borrowers, who prefer borrowing in groups at a pooling equilibrium to borrowing individually at a separating equilibrium (see appendix A.3). As a consequence, MFI lends its funds equally to the two sub-populations at the interest rate $r^{J,P}$. Unserved safe borrowers stay excluded because ML is unable to serve them without incurring losses, by definition of the separating equilibrium situation. Unserved risky borrowers borrow from ML at rate $r^{I,S}$. Hence, MFI has no effect on the informal interest rate but increases coverage by serving some safe borrowers who would be excluded under individual-lending. Note however that it is never able to supply the entire population of safe borrowers who are rationed, even if it has enough funds to do so. MFI increases welfare in the Pareto sense, as it makes some safe and some risky borrowers better off without reducing the utility of any other agent.

Finally, the most interesting situation arises when a pooling equilibrium is feasible in the market of individual loans (*case 3*). From the previous section, we know that risky borrowers prefer borrowing individually if they share the market with safe borrowers. However, this might not hold true when the two lenders are present in the market, depending on how many safe borrowers actually stop borrowing individually. Table 2 provides the strategy space of risky borrowers after MFI's entry, when the informal credit market is at a pooling equilibrium before MFI's entry.

Table 2: Market configurations and strategy set of risky borrowers

	$\alpha \geq \pi$	$\alpha < \pi$	
Source of credit		$U_s(r^{I,P\alpha}) < \bar{u}$	$U_s(r^{I,P\alpha}) \geq \bar{u}$
MFI	**(A)**	**(A)**	(A)
ML	(D)	(C)	**(B)**

Notes: cases are presented in decreasing order w.r.t. $\frac{\alpha}{\pi}$ from left to right; optimal strategy is in bold font.

If risky types choose to borrow from MFI (situation A), they share its funds with safe borrowers, and the unserved borrowers of both types go to ML. Hence, the average expected utility of risky and safe borrowers are respectively

$$\bar{R} - p_r r^{I,P} - p_r\alpha\left(r^{J,P} + (1-p_r)c - r^{I,P}\right) = \bar{R} - \tfrac{p_r}{\bar{p}}(\gamma + \alpha c\pi p_s(p_s - p_r)) \text{ and}$$
$$\bar{R} - p_s r^{I,P} - p_s\alpha\left(r^{J,P} + (1-p_s)c - r^{I,P}\right) = \bar{R} - \tfrac{p_s}{\bar{p}}(\gamma + \alpha c(1-\pi)p_r(p_r - p_s)).$$

If risky types choose to borrow from ML, different situations can arise depending on the size of α and the market parameters. If $\alpha \geq \pi$ (situation D), MFI serves all safe borrowers and risky borrowers are at a separating equilibrium. If $\alpha < \pi$, safe borrowers who do not manage to get credit from MFI can turn to ML as a second choice. If they do, they will face an interest rate s.t.

$$(\pi - \alpha)p_s r^{I,P\alpha} + (1-\pi)p_r r^{I,P\alpha} = \gamma(1-\alpha) \iff r^{I,P\alpha} = \gamma\frac{1-\alpha}{\bar{p} - \alpha p_s}.$$

That is, ML have to increase its interest rate due to the lower proportion of safe types in its pool of borrowers. As a result, constrained safe individuals borrow from ML if

$$U_s(r^{I,P\alpha}) \geq \bar{u} \iff \bar{R} - \bar{u} \geq \gamma\frac{p_s(1-\alpha)}{\bar{p} - \alpha p_s}. \quad (1)$$

If MFI's capacity increases, ML's borrower pool becomes riskier, $r^{I,P\alpha}$ increases and unserved safe borrowers are less likely to go to ML (at the limit, when α comes close to zero, the above condition boils down to proposition 1 and is always satisfied). By a symmetric argument, condition (1) is more likely to be satisfied the higher the proportion of safe borrowers. If the condition holds true (situation B), the average expected utility of risky and safe borrowers are, respectively,

$$\bar{R} - p_r r^{I,P\alpha} = \bar{R} - \gamma\tfrac{(1-\alpha)p_r}{\bar{p} - \alpha p_s} \text{ and}$$
$$\bar{R} - p_s r^{I,P\alpha} - p_s\alpha\left(r^{J,SS} + (1-p_s)c - r^{I,P\alpha}\right) = \bar{R} - \gamma\tfrac{p_s(1-2\alpha)+\alpha\bar{p}}{\bar{p} - \alpha p_s},$$

where $r^{J,SS} = \frac{\gamma}{p_s} - (1-p_s)c$ is the break-even interest rate when MFI's pool is composed only of safe borrowers. By contrast, if condition (1) fails (situation C), part of the safe borrowers remain unserved, and the average expected utility of risky and safe borrowers are, respectively,

$$\bar{R} - p_r r^{I,S} = \bar{R} - \gamma \text{ and}$$
$$\alpha\left[\bar{R} - p_s\left(r^{J,SS} + (1-p_s)c\right)\right] + (1-\alpha)\bar{u} = \alpha(\bar{R} - \gamma) + (1-\alpha)\bar{u}.$$

The optimal strategy for risky borrowers, and hence the market equilibria, are determined by backward induction. It is quite easy to see that risky types are always better off borrowing from MFI, except in situation B. Indeed, if safe borrowers who are not served by MFI are able to derive a positive utility from borrowing individually, then risky types can achieve their preferred situation, taking individual loans and benefiting from the implicit subsidy of safe types (albeit reduced as compared to section 2.2). Formally, it is optimal for risky types to borrow individually if

$$\bar{R} - \alpha p_r\left(r^{J,P} + (1-p_r)c\right) - (1-\alpha)p_r r^{I,P} \leq \bar{R} - p_r r^{I,P\alpha}$$
$$\iff \gamma\frac{1-\pi}{\bar{p} - \alpha p_s} \leq c\pi p_s \tag{2}$$

The above condition can always be satisfied for high enough π and low enough α. In fact, it is easy to check that it can never be satisfied if $\alpha \geq \pi$. Moreover, the higher the c, the less attractive is the joint-liability contract for risky borrowers and the less binding is the condition (but, given (IC), c is never high enough to guarantee the satisfaction of (2) independently of the other parameters). Interestingly, MFI is able to completely screen out risky borrowers in this situation (contrary to the stand-alone case in section 2.2). Finally, note that, though conditions (1) and (2) are both binding, they go in the same direction and are likely to be satisfied together, especially for low α (see the graphical representation of the area of joint realization in appendix C).

Conclusion 1 The impact of microfinance in competitive credit markets

1. *In very risky environments, microfinance cannot solve adverse selection and both sectors compete for risky borrowers. The entry of microfinance does not change the equilibrium of the informal credit market nor the welfare of borrowers.*

2. *When safe borrowers can borrow from microfinance but are excluded from the informal market (risky environments), microfinance increases the efficiency of the market and improves welfare in the Pareto sense - though it is unable to completely solve the rationing of safe borrowers.*

3. *When safe borrowers can access individual loans prior to MFI's entry (less risky environments):*

   A. *If MFI's fund availability is large relative to the safe population, all borrowers prefer borrowing from MFI, the informal interest rate remains at the pre-entry level. Microfinance is welfare-improving.*

   B. *If the proportion of safe borrowers is relatively high and the capacity of the microfinance sector is relatively low, microfinance triggers an increase in the informal interest rate. The overall welfare effect is then ambiguous: some safe borrowers gain, but all others lose.*

That is, this simple model of competitive informal lending speaks to the empirical puzzle of the introduction: the introduction of microfinance can lead to an *increase* in the equilibrium interest rate charged by incumbent moneylenders, if the average riskiness of the population is not too high and the capacity of the microfinance sector is low relative to the proportion of safe borrowers in the population. Appendix C provides a simulation of the theoretical model, which displays the interest rate charged by the two types of lenders when standing alone or when sharing the market, for varying capacities of the microfinance sector.

3 Empirical test using data on financial transactions in Indian villages

This section presents an empirical validation exercice. My aim is not to make strong causal claims but instead to check if the data are consistent with the main assumptions and predictions of the model developed in this paper, by contrast to alternative mechanisms present in the literature. I exploit an original panel database that records all loans taken by a sample of rural Indian households over an eight-year period. The data come from a Living Standard Measurement Survey that was administered in villages of the state of Jharkhand (Eastern India), with the objective to document the long-run changes experienced by households with and without access to village MFIs called Self-Help Groups (SHGs).[15]

Bank-linked SHGs represent the dominant model of microfinance in India, which has been promoted by the National Bank for Agriculture and Rural Development since 1992. SHGs are informal village associations of 10-15 women, which are engaged in a variety of collective activities out of which savings and credit are the most important. At every weekly or bi-weekly meeting, each woman contributes the agreed savings (usually 5 or 10 rupees, $\sim$ USD 0.5-1 monthly) and the regular repayments on the loan(s) she has taken from the group. New loans can then be requested and disbursed out of the group's pool of accumulated savings, interest revenues and external credit that SHGs can jointly take out from commercial banks. Loans can be requested for all purposes and without any predetermined fixed order. Though formally loans are individual, SHG lending entails important peer screening and joint-liability features: only group members can access SHG loans, the group collectively decides on whether to grant a loan, repayment is public and, in case of problems and if group pressure fails to recover the due payment, losses are eventually absorbed by the common pool of savings. The interest rate on SHG loans is usually 2% monthly, which allows groups to roughly break even.[16] Finally, at the end of the year, the group decides to redistribute part of the group's savings and interest revenues by paying a dividend to each member in proportion to the personal savings.

From the spring of 2002, an Indian NGO called PRADAN started to encourage the formation of such groups in about 40 villages of Jharkhand, one of the poorest and most remote states of India. During the summer of that same year, the survey team randomly

[15] The data were collected between 2002 and 2009 by a team of researchers including myself. More details about the survey and the broader research project can be found in Demont 2014.

[16] An independent study estimated that the average return on assets of Indian SHGs (after adjusting for loan loss provisions) is around 9%. Deducting all NGOs' subsidies, SHGs break even on average, with an adjusted ROA of 0%. The study concludes that "The Indian SHG model can work sustainably in well-managed programmes. Compared to other microfinance approaches, the SHG model seems to be producing more rapid outreach and lower cost" (CGAP, 2007).

selected 24 villages out of the list of villages that had been visited by the NGO (stratified by the four socio-ecological clusters composing Jharkhand in order to be representative of the entire state), and interviewed in each village a random sample of 6 households among those who had just decided to participate in the SHG programme (but did not receive any benefits as groups were not yet functioning) and 18 nonmember households. In 2004, for the second wave of the panel, we decided to add 12 member households in each village in order to get a balanced sample of members and nonmembers. In addition, we selected 12 control villages from the same districts and with similar socio-economic profile than the selected SHG villages, in which we interviewed a random sample of 18 nonmember households. In total, the sample is thus constituted of 1,080 different households from 36 villages, who have been followed for up to seven years. The selected SHG and control villages appear very similar, and we fail to detect any significant difference on a range of key observable characteristics (see descriptive statistics in appendix D). Nevertheless, the econometric analysis will be within-village in order to control for potential unobserved village heterogeneity.

Four rounds of detailed data were collected between 2002 and 2009 about, among other things, households' characteristics and credit transactions over that period. Households were asked details about all the actual loans that they had taken during the two years preceding the interview date, allowing me to reconstruct the credit history of all households present in the sample for up to 8 years. For each loan, the effective monthly interest rate is computed using the amount borrowed, the total amount (to be) repaid and the duration.[17] In the analysis that follows, I focus on loans made by traditional lenders, i.e. loans with positive interest rates from professional moneylenders or pawnbrokers, cash-rich local traders, landlords / employers and neighbors (excluding friends and relatives).[18]

These data and empirical context are particularly well-suited to test the theoretical model of this paper, for several reasons. First, the detailed micro data about both microfinance coverage and households' credit behavior and characteristics, as well as the long time span covered by the panel, are exceptional features in order to study the evolution of informal credit conditions. In particular, household data from treated and untreated villages are needed to discriminate across theoretical mechanisms, and sufficiently long panel data, including the pre-intervention period, are key to observing sufficient evolution and controlling for unobserved heterogeneity. To my knowledge, this paper represents the first attempt to exploit substantial time and space variation at the

[17]For pending loans, if such effective rate cannot be computed because one of these data is missing (e.g. the respondent could not give any agreed duration), I use the stated ("explicit") interest rate. Econometric results are robust to the exclusion of those observations.

[18]As a matter of fact, the definition of moneylender is rather elastic. In the words of Bell (1990): "The lender has several guises, which reflect what anthropologists call the multiplex nature of rural life. The same individual may lend to cultivators and labourers. If he has land and cultivates part of it, those of his tenants and labourers who borrow from him will think of him as a landlord, while other owner-cultivators will think of him as a cultivator who pursues moneylending on the side. In certain areas of India, some of the borrowers may be his relatives and regard themselves as such in their dealings with him. Similarly, the village shopkeeper often lends to his customers in the lean season and may engage in commodity trading on a small scale at harvest time." Clearly-identified professional moneylenders were actually not present in all villages: in 2009, 73% of the villages reported to not have any, 8% to have one or two, 15% to have several and 4% to have many of them. When not present in t he village, professional moneylenders could be found within 5km in 50% of the cases, and within 10km in 90% of the cases. As a robustness check, I replicate all econometric results on the reduced sample of professional lenders only, who were clearly identified as such by borrowers in the survey.

micro level to study the issue. Second, I argue that the surveyed villages can be thought of as self-contained credit markets. As a general rule, informal lending within the village is much more common than across-village lending and, in particular, the villages in the sample are very isolated: only 20% of the sample villages have an asphalted road reaching them and the nearest market is more than 5 km away on average. Moreover, given that SHG members can belong to and take loans from only one group, the SHG coverage of a village's population accurately represents the size of the microfinance sector in the village (the α parameter of the model). Third, in line with the model, the lending decisions by informal lenders and SHGs are overwhelmingly dichotomous and partial funding of projects is extremely rare. In the data, less than 4% of the households who borrowed from moneylenders got a smaller amount than what they asked for, while the figure is under 1% for SHG borrowers. Fourth, SHG groups are formed based on neighborhood, personal affinities and members' anticipated discipline in terms of savings and loan repayment, hence displaying assortative matching properties. Indeed, table 3 shows that SHG groups are more homogenous than the rest of the village to which they belong, along several key stable socio-economic characteristics as well as their borrowing behavior before joining SHGs. [19]

Table 3: Assortative matching: homogeneity of SHGs and their village

	Village	SHGs Diff. vs. village	P-value[a]
Tribal identity fractionalization (2)	0.22	-0.09	0.07*
Tribe or caste fractionalization (91)	0.57	-0.13	0.03**
Language fractionalization (25)	0.40	-0.10	0.05**
Religion fractionalization (6)	0.33	-0.07	0.22
Land ownership category fractionalization (4)[b]	0.58	-0.08	0.01**
Loan purpose fractionalization (6)[c,d]	0.61	-0.03	0.39
Std dev. of interest rate paid on loans[d]	4.19	-1.17	0.02**
Std dev. of total amount borrowed	5,241	-1,543	0.29
Std dev. of log total amount borrowed (if>0)	3.52	-0.45	0.11
Std dev. of avg. amount borrowed	4,460	-1,386	0.30

The (ethno-linguistic) fractionalization indexes give the probability that two randomly-drawn individuals belong to different groups: $f = 1 - \sum_{i=1}^{n} s_i^2$, where s_i refers to the sample share of the ith group (the number of groups is indicated in parentheses). Rows 1 to 4 correspond to stable demographic characteristics and use 2004 data in order to include the full sample of SHG members (837 observations); the last 6 rows use 2002 data (573 observations). [a] T-test for equal means, correcting standard errors for village clustering (** and * indicate significance at the 95 and 90 percent levels respectively). [b] Categories: landless, small (land owned $\leq 25^{th}$ percentile of the land distribution in the district-year), intermediate (between 25^{th} and 50^{th} percentiles) and big ($\geq 75^{th}$ percentile). [c] Categories: agriculture / business, consumption, health, family / social, education, other. [d] Loan-level data.

Fifth, it is well documented that information asymmetries are very prevalent in traditional credit markets, leading in particular to the difficulty for local lenders to screen borrowers' projects according to their riskiness (Bolnick, 1992; Gine and Klonner, 2006; Rai and Klonner, 2007; Karlan and Zinman, 2009; Collins et al., 2009). In the data, as much as 41% of all loans from traditional lenders are overdue by at least three months. I also observe that, though traditional lenders are usually lending money to a range of borrowers with different characteristics, there is little variation in the interest rate within a village in any given year.[20] As for SHGs, they form tightly-knit groups of women meeting

[19]Baland et al. (2011) provide an extensive study of the same SHGs and reach a similar conclusion.

[20]The average standard deviation of the interest rate charged by informal lenders in any village-year is 2.65, against 3.00 and 3.29 for the average standard deviation across time in any given village and

regularly and knowing well each other, thereby enjoying at least as much information as local moneylenders. Interestingly, their proportion of overdue loans is significantly lower, at 29%.

Finally, table 4 clearly shows that traditional lenders represent an important source of credit in Indian villages. In particular, before SHGs start operating, more than half of the members have taken such credit in the course of the two years preceding the baseline survey, for an average value slightly above 1,000 INR per household. Once they access SHG credit, members reduce their borrowing from traditional lenders dramatically, but do not give up entirely. Looking at the entire village, moneylenders certainly keep playing an important role after the entry of microfinance, remaining the source of about one loan out of 5. Hence, despite the lower demand, moneylenders do not appear to be driven out of business by SHGs, which is consistent with the model's assumption of limited capacity of the microfinance sector. As a matter of fact, when there are some SHGs in the village, the proportion of member households with respect to the total village population varies between 4 and 75% in the data (29% on average). Interestingly, for members, the increase in SHG credit more than compensates the drop in moneylenders'. There is no evidence of crowding out of other credit sources (but rather the contrary), as on average total credit increases by more than the net increase in SHG credit and becomes higher than the village average. This observation is thus consistent with the existence of credit constraints in the informal market, though SHG participation might also have generated new demand. Moreover, when they continue to borrow from moneylenders, members take out loans that are on average almost twice as large as before. That might indicate that members' profile changes after the opening of SHGs, as they now turn to moneylenders only for larger and riskier needs that cannot be funded within SHGs. In any case, the simple fact that members leave en masse the borrower pool of moneylenders is likely to imply an important modification of the latter. In table 5, I compare the baseline risk profile of future SHG members and other households from the same village, in order to analyze the nature of the composition effect created by the apparition of SHGs. In the absence of one obvious statistics to measure riskiness, I look at key indicators of both revealed riskiness (credit outcomes) and underlying riskiness (socio-economic profile). First, future SHG members appear less constrained than other households on informal credit markets. Over a two-year period, they are 20% more likely to borrow and take twice as many loans from moneylenders. Yet, they do not appear significantly more indebted than other households and they do not pay a different interest rate (which is consistent with the model). Second, future member households have fewer elder members, are less likely to have benefited from an IAY grant for home building or improvement[21], are more likely to have a head who has a school diploma and is more economically active, and they are less likely to fall below a consumption-based consumption poverty line (determined as the 25th percentile of the distribution of consumption of the entire population), all of which point at a lower risk profile. Taken together, the observations from tables 4 and 5 therefore indicate that the borrower pool of traditional lenders is likely to get modified towards an increased riskiness after SHGs' entry, which corresponds to the main mechanism underlying the

across villages in any given year, respectively. Another indication is that SHG members do not pay a statistically different interest rate than nonmembers. Note that such a situation might stem not only from a lack of information about borrowers, but also from other factors like the importance of customs and perceived fairness in villages.

[21]The Indira Awaas Yojna scheme has been running since 1986 and provides financial assistance for construction or upgradation of dwelling units to below-poverty-line rural households, based on a poverty ranking done by local municipal councils.

spillover effects in the model.

Table 4: Borrowing behavior before and after the start of SHGs

	(Future) SHG members			Entire village
	Before	After	P-value[a]	After
In last two years...		Diff. vs. before		
Probability to borrow from any source	0.69	+0.22	0.00***	0.62
Probability to borrow from moneylender	0.54	-0.48	0.00***	0.11
Probability to borrow from SHG	0	+0.81	0.00***	0.28
Total amount borrowed from any source (INR)	2,293	+1,927	0.00***	2,568
Total amount borrowed from moneylender (INR)	1,437	-1,220	0.00***	313
Total amount from SHG (INR)	0	+2,277	0.00***	745
Average amount borrowed from any source (INR)	1,904	+88	0.84	2,700
Average amount borrowed from moneylender (INR)	1,501	+1,839	0.01**	2,329
Number of household-rounds	*143*	*1,383*	*1,526*	*2,542*

Observations are reweighted to account for the sampling probabilities of members and nonmembers. [a] T-test for equal means, based on standard errors robust to heteroskedasticity and village-year clustering (*** and ** indicate significance at the 99 and 95 percent levels respectively).

Table 5: Composition effect: riskiness and poverty profile of future SHG members at baseline

	Nonmember households	SHG households Diff. vs. other hh. in village	p-value[a]
A. Participation to the informal credit market (in the two years before the baseline survey)			
Probability to borrow from moneylenders	0.32	+ 0.20	0.00***
Number of loans from moneylenders	0.47	+ 0.37	0.00***
Number of loans from moneylenders if > 0	1.47	+ 0.11	0.27
Total credit from moneylenders if > 0 (INR)	2,670	+ 360	0.63
Avg. amount borrowed from moneylenders (INR)	1901	- 164	0.64
Avg. monthly interest rate paid to moneylenders (%)	8.62	+ 0.05	0.93
Total credit from any source if > 0 (INR)	4,260	- 490	0.33
Avg. monthly interest rate paid to any lender if > 0 (%)	7.84	- 0.01	0.98
B. Key socio-economic variables			
Number of productive members (15-50)	3.1	+ 0.01	0.97
Number of young children (0-14)	2.3	+ 0.2	0.35
Number of elderly members (>50)	0.84	- 0.22	0.04**
Landless	0.14	- 0.01	0.68
Land owned (acres)	1.55	+ 0.52	0.27
BPL	0.61	- 0.05	0.47
IAY	0.19	- 0.12	0.00***
Head has no or less than primary education	0.65	- 0.08	0.08*
Head's main occupation is farming	0.28	+ 0.01	0.85
Head is unemployed	0.16	- 0.12	0.00***
Agregate per-capita consumption < 25^{th} percentile	0.23	- 0.08	0.05**
Number of households	*428*	*143*	*571*

Observations are reweighted to account for the sampling probabilities of members and nonmembers. [a] T-test for equal means, based on standard errors robust to heteroskedasticity and village clustering (***, ** and * indicate significance at the 99, 95 and 90 percent levels respectively).

Taken together, the previous observations tend to validate the assumptions of the model and indicate that the third case, in which moneylenders give credit to safe borrowers before the entry of microfinance, is the most relevant one on average. I now proceed to check the main predictions of the model against these data, by estimating an empirical analog to the theoretical simulation presented at the end of the model. In particular, my aim is to test if an intermediate-size microfinance sector in a not-too-risky village can lead to a significant increase in the informal interest rate, as compared to a situation without any SHG (see conclusions 1 and 2). To do so, I regress by ordinary least squares the following fixed-effects model, for each loan i that was taken from an informal lender by household h in village v at time t:

$$INT_{ihvt} = \alpha + C'_{vt}\beta + \gamma Amount_i + H'_h\delta + \theta Shock_{vt} + \lambda_t + \nu_v + \epsilon_{ivt}$$

where INT is the monthly interest rate and C is a vector of dummies indicating that the SHG coverage of the village population is weakly smaller than respectively the 25th, 50h, 75th and 100th percentile of the coverage distribution (no SHG in the village being the base category).[22] *Amount* is the (log) amount borrowed and is used as default control throughout, in order to be consistent with the theoretical model that abstracts from loan size and fixed costs considerations. H is a vector of socio-economic characteristics of household h that could influence the interest rate, including SHG membership, land ownership, scheduled caste identity, age structure, as well as the origin, education, age and main occupation of the household head. *Shock* is an indicator for income shocks at the village-year level that controls for a potentially important source of time-varying village heterogeneity. [23] Finally, λ_t are time fixed effects and ν_v are village fixed effects controlling for time-invariant unobserved village heterogeneity and temporary shocks affecting the entire sample. Standard errors are clustered at the village-year level (i.e. the level of variation of SHG coverage), to control for heteroskedasticity and potential correlation of errors within village-years. Observations are weighted in order to control for the oversampling of SHG members and to be representative of the village population from which they are drawn.

Table 6 presents the estimates of the coverage coefficients, for different vectors of controls. In column 1, the simplest specification shows that the relationship between SHG coverage and moneylenders' interest rates is significantly positive and follows an inverse-U shape. As compared with the absence of microfinance, a coverage between 18 and 30% of the village population (i.e. between the 25^{th} and 50^{th} percentile of the coverage distribution) is associated with a significant increase in the interest rate of about 2.2 percentage points. This is a sizeable amount, corresponding to a semi-elasticity of 30% and approximately equal to one standard deviation. However, as coverage increases, the interest rate progressively returns to its no-microfinance level, leading to an inverted-U shaped relation. Indeed, the F-tests at the bottom of the table indicate that the coefficient attached to an intermediate size of the microfinance sector ($\mathbf{1}_{p25p50}$) is significantly larger than the coefficients attached respectivly to small ($\mathbf{1}_{0p25}$) and large ($\mathbf{1}_{p75p100}$) sizes,

[22]Given that SHGs are fairly homogenous credit institutions, I proxy the capacity of the microfinance sector by the proportion of the village population who are SHG members. Coverage varies between 0 et 75% in the data. I use this dummy specification in order to assume no functional form regarding the relation between the SHG coverage and the interest rate charged by moneylenders (it turns out that the relation is essentially quadratic).

[23]The vast majority of the people living in the survey area are small landholders, living out of a subsistence agriculture characterized by small marketable surpluses and little investments in infrastructure or inputs. In particular, the cultivation of rain-fed rice represents the main source of alimentation and income of the households in the sample. As a consequence, the abundance of rain has a large positive impact on households' welfare and resources (e.g. Asada and Matsumoto, 2009). I construct a continuous variable measuring the relative quality of the monsoon in the district during the year before loans were taken: $Shock_{vt} = \frac{Monsoon_{vt} - \overline{M}_v}{\sigma_v}$, where $\overline{M}_v$ and σ_v are respectively the average and the standard deviation of the monsoon level in each district and are computed over a ten-year period encompassing all surveys and preceding years (1998-2008), excluding the current year. Rainfall data come from the Global Precipitation Archive (Matsuura and Willmott, 2009). The nine districts present in the sample being spread across the different agro-climatic zones of the state, the variable captures important variation between villages and across years. As shown in Demont (2014), it is strongly correlated with income levels and access to traditional credit sources in the sample villages.

which confirms the nonlinearity. This estimated relationship is thus consistent with the theoretical model: a progressive increase in informal interest rates as the microfinance sector gets larger, and a return to the no-MFI situation when the capacity of the sector becomes too large and the latter attracts all borrowers. According to the model, this increase in the interest rate is driven by an increase in the average riskiness of the borrower pool of moneylenders, but not by individual risk characteristics (which are unobservable to lenders). In column 2, I check that the relation is indeed robust to the inclusion of a range of household characteristics.

Coverage naturally tends to increase over time, as the SHG programme unravels and new groups get created out of imitation (mean coverage in round 1, 2, 3 and 4 is respectively 0, 18, 23 and 23%). Yet, the process is very slow-moving and sinuous. There are several instances of groups going defunct over the sample period, which can happen for a series of complex reasons both internal and external to the groups, such as naxalite activism (2 villages), corrupt or incompetent accountants (1 village), disengagement of the NGO's local team (1 village), internal conflicts (for an extensive study of SHGs' life span, see Baland et al. 2008). Hence, reverse causality between the evolution of SHG coverage and informal interest rates is unlikely to be a big concern, especially given the inverse-U shaped relationship. However, the occurrence of major shocks at the village-level could potentially influence both the presence of SHGs and the informal interest rates. Yet, controlling for rain shocks - which represent the most important source of village-level income shocks in the villages of the survey area - only slighltly decreases the magnitude of the coefficients and does not modify the estimated relationship (column 3).

Yet, according to the model, the pattern should be true only for villages with a relatively safe profile, i.e. in which traditional lenders are serving safe borrowers before the development of a microfinance sector and the latter cannot supply funds to the entire safe pool (case 3.B in model). Hence, columns 4 to 6 focus on 'relatively safe' villages, using different methods to classify villages. First, I use two different proxies for villages' direct average riskiness, which are reasonably objective and exogenous. In column 4, I classify villages according to the proportion of the village population that is from scheduled castes (SC), using data from the 2001 Indian census (i.e. before the start of the SHG programme). SC households being traditionally the most vulnerable and suffering from extensive social and economic discrimination in the Indian rural society, it is reasonable to consider that a village concentrating many SC households represents a poorer and riskier environment. I classify as 'safe' the villages where the proportion of SC households is lower than the median proportion observed in the sample. The second measure (in columns 5) is the 1998-2008 average annual monsoon level in the district, which I compute using the same data presented above. As already explained, the monsoon quality is a very important determinant of those villages' resources and development. I thus classify as 'safe' the villages that receive more rain than the median average annual rainfall level observed in the data. Interestingly, for both measures, the median interest rate is lower in safe villages (8.3 and 8.4%) than in the other villages (10 and 9.3%). Even more interestingly, I observe that the increase in the interest rate associated with a positive SHG coverage is mostly driven by safe villages. In those villages, the increase is not only more likely but also larger (between 5 and 7 percentages points), which is exactly what the theory predicts. By contrast, in risky villages, there is no significant relationship between SHG coverage and informal interest rates, and the F-tests indicate that the coverage coefficients are not significantly different from each other (see the two first columns of table 10 in appendix). My second strategy, even closer to the theory, consists in trying to classify villages according to the baseline equilibrium of their informal credit market. That is, I look at their indirect riskiness revealed by the lending policy of their traditional lenders before the entry of SHGs. I compute the proportion of the population that did not take any loan from a moneylender in the two years preceding the first survey (2002 in SHG villages and 2004 in non-SHG villages), and classify as safe the villages in which this proportion is below median (62%). In other words, according to this definition, less than 40% of the population in risky villages borrow from moneylenders at baseline, which indicates that the informal market is probably at a separating equilibrium. Almost by definition, we have much less observations of loans from moneylenders in those villages. Moreover, this classification exercise should be considered as tentative because we only observe a sample of each village' population. Nevertheless, in column 6, we find once again that the significant inverse-U shaped relationship is only true in safe villages, which were more likely to be at a pooling equilibrium initially (compare with column 3 of table 10).

Table 6: Moneylenders' interest rates and SHG presence

	All villages			Relatively safe villages		
SHG coverage	(1)	(2)	(3)	(4)	(5)	(6)
(0,p25]	0.418	0.485	0.619	4.820*	0.819	1.342**
	(1.045)	(1.002)	(0.916)	(2.739)	(1.478)	(0.639)
(p25,p50]	2.220*	2.519**	2.193**	6.892**	4.634***	2.170***
	(1.124)	(1.183)	(1.108)	(2.899)	(1.535)	(0.799)
(p50,p75]	0.613	0.874	0.654	4.736*	0.142	0.732
	(1.069)	(1.055)	(1.066)	(2.674)	(1.273)	(0.917)
(p75,p100]	-0.847	-0.311	0.303	1.791	1.914	0.492
	(1.018)	(1.072)	(1.013)	(2.046)	(1.486)	(0.845)
Amount borrowed	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	No	Yes	Yes	Yes	Yes	Yes
Rain shock	No	No	Yes	Yes	Yes	Yes
Village and year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1000	973	973	443	450	756
Adjusted R^2	0.210	0.214	0.227	0.186	0.191	0.293
p-value: $F(1_{p25p50} = 1_{0p25})$	0.0220	0.0189	0.0508	0.0736	0.0017	0.191
p-value: $F(1_{p25p50} = 1_{p50p75})$	0.0866	0.102	0.114	0.126	0.0002	0.139
p-value: $F(1_{p25p50} = 1_{p75p100})$	0.00076	0.0024	0.0201	0.0269	0.0768	0.0554

Observations weighted to correct for sampling probabilities; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Standard errors clustered at the village-year level in parentheses.

Finally, I perform three robustness checks (results are displayed in columns 4 to 6 of table 10 in appendix). In the interest of space, I report only estimates for safe villages, which is te relevant set of villages as we have seen above (we use the average monsoon level to classify villages - the alternative definition using the proportion of SC households delivers similar results). First, I check the robustness of the results when dropping one member village (Haldipokhar) that could introduce some bias or at least noise in the estimates because (i) it had a lot of SHGs that were actually not working properly (all ten groups that were created in 2002-03 had closed by 2008) and (ii) it is a very large 'village' that includes a semi-urban market centre. As a consequence, it is likely to present different dynamics as well as coverage statistics that are less meaningful. The magnitude of the effect actually increases when the village is excluded from the sample, though the significance decreases slightly. Second, I replicate the previous analysis by focusing on clearly-identified professional moneylenders. The estimation on the whole sample delivers an effect of roughly identical size and significance as in the main table. Third, I restrict the analysis to such observations for which I can compute effective interest rate (i.e. dropping stated explicit rates). Again, this does not significantly alter the main results.

To conclude, the data appears to be consistent with the mechanisms highlighted in the theoretical model, in particular with the possible increase in the equilibrium interest rate of relatively-safe informal credit markets as a response to the apparition of a microfinance sector of intermediate size. By contrast, the above results are hard to reconcile with the other mechanisms present in the literature. First, they cannot be explained by a demand effect. Indeed, if SHGs contribute to the development of their clients and push them into indivisible investments (e.g. Buera et al., 2012; Banerjee et al., 2013) or force clients to multiple borrow (Jain, 1999; Jain and Mansuri, 2003), they could increase the demand for credit from moneylenders. However, I observe in the data that SHG clients actually take a lot *fewer* loans from moneylenders after joining the group (see table 4). Moreover, a demand argument cannot explain the nonlinear relation that I estimate, since more groups should increase the demand even further. Second, the nonlinearity also rules out an explanation à la Hoff and Stiglitz (1998), whereby the increase in interest rates could be caused by an increase in the marginal cost of lending due to existence of fixed costs in screening and enforcement, or by a reduction in the borrowers' incentives to repay. Note that, in addition, I do not find support for the existence of market power, which is at the basis of Hoff and Stiglitz's theoretical argument. One the one hand, the amount of transactions and the low standard deviation in the interest rates observed in any village-year suggest that the local credit markets under study should not be monopolistic. On the other hand, the econometric results, in particular the magnitude of the estimated effect of SHG coverage, the continuity of the estimated relation and the fact that I do not observe any decrease in the total number of borrowers being served as a consequence of a larger SHG presence, do not support the monopolistic version of the model. Third, contrary to the theoretical argument of Mookherjee and Motta (2013), I find that SHG members have a relatively safer profile than other households in their village, and informal lenders do not seem to be able to discriminate and offer different contracts to different borrowers within any village-year. Moreover, in the context of this study, important differences in the outside options available to different households from a given village seem highly unlikely. For instance, the sample distribution of the daily wage received on casual labor activities is characterized by a low dispersion around the mean in all villages (standard deviation of 18.5 for a mean of 58.3).

4 Conclusion

We know little about the redistributive aspects of the dramatic expansion of the microfinance sector that has occurred over the last decades. This paper focuses on one important channel through which microfinance institutions (MFIs) can affect the non-using population, namely local credit markets. It has often been thought that the main effect is to decrease the power of local moneylenders. Yet, because MFIs usually deliver different products and use different contracts, they are likely to attract specific types of clients. In this paper, I analyze both theoretically and empirically when and how MFIs are likely to modify the equilibrium of informal credit markets.

I use a standard adverse selection model, with moneylenders supplying individual loans and MFIs lending limited funds to jointly-liable groups of borrowers. When local credit markets are competitive, group lending institutions always increase the utility of safe borrowers and attract a share of constrained safe borrowers, if any, back to the market. Yet, even if MFIs have enough funds to do so, they are never able to entirely solve inefficient credit rationing. Moreover, as part of the pool of safe borrowers who borrowed from moneylenders stop doing so once they get access to MFIs' credit, the riskiness of the moneylenders' pool of borrowers increases. As a consequence, I show that informal lenders might have to raise their interest rate in order to avoid making losses in expected terms. However, this only happens if the overall borrower pool is not too risky and the size of the microfinance sector is not too large. When the moneylender has market power, it can choose to serve all borrowers or to focus on risky ones. Depending on its optimal strategy, the entry of a zero-profit MFI can force the monopolist to cut its interest rate, or, on the contrary, to give up supplying credit to safe borrowers and raise its interest rate. The first case happens if the population is very risky and the microfinance sector is very large, while the second case happens if the overall borrower pool is not too risky and the microfinance sector has an intermediate capacity. Moreover, in the second case, microfinance decreases total credit supply, implying a unambiguous reduction in market efficiency and potentially in overall welfare.

As a consequence, my model highlights the fact that the development of microfinance does not always relax local credit constraints (the effect traditionally emphasized) and can trigger an increase in the equilibrium informal interest rate, especially if the local credit market that it enters is reasonably competitive and if the borrower pool is not too risky. In that situation, microfinance has adverse distributional consequences: it increases the welfare of its direct users, but hurts the other borrowers with no access to microfinance (e.g. because they are too safe or, to the contrary, because they are perceived as too risky by their fellow villagers, because they are lacking social connections to set up a group, or simply because MFIs cannot supply the entire market due to limited funds).

Using first-hand data from a panel household survey in villages of Northeast India, I present empirical evidence supporting the assumptions of the model and its main predictions. I observe that microfinance clients tend to have a safer profile than other households in their village and to borrow extensively from moneylenders before the entry of MFIs. Contrary to what a simple competition argument would predict, I find that moneylenders charge higher interest rates in villages where some group-lending institutions are present than where there are none. Moreover, the relation between informal interest rates and MFI coverage appears to be inverse-U shaped, as informal interest rates in villages with high coverage return to no-microfinance levels. Finally, I find that the increase in interest rate occurs especially in relatively safe villages. Taken together, those facts provide strong support for the theoretical predictions of the model, and especially its competitive-market version. To my knowledge, this paper is the first to use micro data to distinguish between alternatives mechanisms present in the literature and to quantify the effect.

I believe that this potential general-equilibrium effect from the introduction of group lending is very relevant, given the limited outreach of formal financial services and the consequent importance of informal moneylenders, as well as the high interest rates and degree of asymmetric information that are often reported in rural credit markets. Moreover, the effects emphasized in this paper can materialize not only as some initial MFIs enter informal markets, but also each time the sector increases its lending due to a subsidy, additional funds or the entry of a new microlender.

The results presented in this paper have also important implications for the broader evaluation literature. They imply that the average treatment effect on the treated might mechanically overestimate the impact of microfinance if the control group comes from the same village or local market environment. More importantly, if controls are outside the local environment, it is crucial to take into account indirect effects on nonmembers in the analysis in order to provide a complete picture of the impact of microfinance. As this model makes clear, there exist potentially important negative externalities and redistributive effects, which would be interesting to quantify (e.g. designing randomized experiments that are able to quantify those equilibrium effects).

The theoretical model presented in this paper could be extended along several lines. One of them would be the introduction of moral hazard issues by assuming imperfect monitoring by the lenders. Other studies have shown that group lending can also attenuate moral hazard (e.g. Banerjee et al., 1994; Ghatak and Guinnane, 1999). Therefore, there are good reasons to expect similar results. In such a context, one could also introduce enforcement externalities between competing institutions. Finally, other competition frameworks could be envisaged. For instance, both moneylenders and MFIs could be for-profit and enjoy market power, implying a two-sided strategic interaction between lenders. However, though this is a much-debated recent evolution of the microfinance industry, for-profit MFIs are still far from being the majority. Moreover, the empirical application presented in the paper seals with MFIs that, although being financially sustainable on average, are clearly not for-profit.

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A Model: details and proofs

A.1 Proposition 1

The game is solved by backwards induction. Would-be borrowers compute their net individual expected payoff from investment as:

$$U_i(r^I) = p_i(R_i - r^I),$$

where r^I is the equilibrium gross interest rate (I stands for individual liability), and borrow if $U_i(r^I) \geq \bar{u}$. Since $p_s R_s = p_r R_r = \bar{R}$ and $p_s > p_r$, expected payoff is always larger for risky households, because they have to repay less often than safe borrowers and are thus implicitly subsidized by the latter.

Moneylenders break even by equalizing the average expected repayment from the loans extended to borrowers with the average opportunity cost of capital (zero-profit constraint, or ZPC). If they expect to serve the entire population, i.e. $U_s(r^I) \geq \bar{u}$, the *pooling equilibrium* interest rate is given by

$$\pi p_s r^{I,P} + (1-\pi) p_r r^{I,P} = \gamma \iff r^{I,P} = \frac{\gamma}{\bar{p}} > 1,$$

where $\bar{p} = \pi p_s + (1-\pi) p_r$ is the average probability of success in the population.

Given (EC), it is easy to check that risky households always borrow at rate $r^{I,P}$, while this is not true for safe borrowers. If the latter are not able to derive a positive expected payoff from investment, the market is at a *separating equilibrium*: lenders supply only risky borrowers and break-even at $r^{I,S} = \frac{\gamma}{p_r}$.

Proof. Safe borrowers are excluded from the market whenever $U_s(r^{I,P}) = p_s(R_s - r^{I,P}) < \bar{u} \iff \frac{p_s}{\bar{p}}\gamma > \bar{R} - \bar{u}$. Anticipating the higher riskiness of their borrower pool, lenders then charge $r^{I,S}$. At that rate, risky borrowers always borrow since $U_r(r^{I,S}) = \bar{R} - \gamma > \bar{u}$. That situation is inefficient given (EC): there is *adverse selection.* ■

A.2 Lemma 1

First, I show that the incentive-compatibility condition (IC) implies that $r^{J,P} > 1$.

Proof.

$$c \leq r^{J,P} \iff c \leq \frac{\gamma}{2\bar{p} - \pi p_s^2 - (1-\pi) p_r^2} \equiv c^{max}.$$

Let us define $C \equiv 2\bar{p} - \pi p_s^2 - (1-\pi)p_r^2$ and note that $C < 1$. Indeed, $C = 2\pi p_s + 2(1-\pi)p_r - \pi p_s^2 - (1-\pi)p_r^2 = \pi(2p_s - p_s^2) + (1-\pi)(2p_r - p_r^2) < 1$, given that the two expressions in parentheses are lower than one.

$$r^{J,P} > 1 \iff \frac{\gamma}{\bar{p}} - \frac{c}{\bar{p}}(\bar{p} - \pi p_s^2 - (1-\pi)p_r^2) > 1 \iff c < \frac{\gamma - \bar{p}}{\bar{p} - \pi p_s^2 - (1-\pi)p_r^2},$$

which is a weaker requirement given that

$$\frac{\gamma - \bar{p}}{\bar{p} - \pi p_s^2 - (1-\pi)p_r^2} > \frac{\gamma}{2\bar{p} - \pi p_s^2 - (1-\pi)p_r^2} \iff \bar{p}(\gamma - C) > 0 \iff \gamma > C,$$

which is always verified given $\gamma > 1$ and $C < 1$. ■

Second, I show that condition (IC) usually implies that any successful borrower can repay for its defaulting partner.

Proof.

$$r^{J,P} + c \leq R_s \iff \frac{\gamma}{\bar{p}} - \frac{c}{\bar{p}}(\bar{p} - \pi p_s^2 - (1-\pi)p_r^2) + c \leq R_s \iff c \leq \frac{\bar{p}R_s - \gamma}{\pi p_s^2 + (1-\pi)p_r^2}$$

Therefore, a sufficient condition for the contract to be feasible is

$$\frac{\bar{p}R_s - \gamma}{\pi p_s^2 + (1-\pi)p_r^2} \geq \frac{\gamma}{2\bar{p} - \pi p_s^2 - (1-\pi)p_r^2} \iff CR_s \geq 2\gamma.$$

Given $\bar{p} < C < 1$, $CR_s \approx \bar{R}$ and a sufficient condition for the previous condition to be satisfied is $\gamma \leq \bar{u}$ (given (EC)). ■

A.3 Lemma 2

At a pooling equilibrium, the joint-liability contract gives the following utility levels to safe and risky borrowers:

$$U_s(r^{J,P}, c) = \bar{R} - \frac{p_s}{\bar{p}}\gamma + \frac{p_s}{\bar{p}}c(1-\pi)p_r(p_s - p_r) \text{ and } U_r(r^{J,P}, c) = \bar{R} - \frac{p_r}{\bar{p}}\gamma + \frac{p_r}{\bar{p}}c\pi p_s(p_r - p_s).$$

Given that $\frac{\partial U_s}{\partial c} > 0$ and $\frac{\partial U_r}{\partial c} < 0$, it is enough to check that $U_r(r^{J,P}, c) > U_s(r^{J,P}, c)$ at

$$c = c^{max} = r^{J,P} = \frac{\gamma}{2\bar{p} - \pi p_s^2 - (1-\pi)p_r^2}.$$

After some algebra, I have that $U_r(r^{J,P}, c^{max}) > U_s(r^{J,P}, c^{max})$ iff

$$\bar{R} - \gamma\frac{p_r(2-p_r)}{2\bar{p} - \pi p_s^2 - (1-\pi)p_r^2} > \bar{R} - \gamma\frac{p_s(2-p_s)}{2\bar{p} - \pi p_s^2 - (1-\pi)p_r^2} \iff p_s(2-p_s) > p_r(2-p_r),$$

which is always satisfied given $0 < p_r < p_s < 1$.

In other terms, the single crossing point between the utility functions of safe and risky borrowers, $U_r(r^{J,P}, c) = U_s(r^{J,P}, c) \iff c = \frac{\gamma}{p_s p_r}$, is to the right of c^{max} (see figure 1). A direct corollary of the previous observation is that MFI can never set a c high enough to screen borrowers: for risky borrowers, the benefit of being subsidized by safe borrowers at a pooling equilibrium is always larger than the joint liability cost. Indeed,

$$U_r(r^{J,P}, c) > U_r(r^{I,S}, c) \iff \bar{R} - \frac{p_r}{\bar{p}}\gamma + \frac{p_r}{\bar{p}}c\pi p_s(p_r - p_s) > \bar{R} - \gamma$$
$$\iff \gamma\left(1 - \frac{p_r}{\bar{p}}\right) + \frac{p_r}{\bar{p}}c\pi p_s(p_r - p_s) > 0 \iff c < \frac{\gamma}{p_s p_r}.$$

A.4 Proposition 2

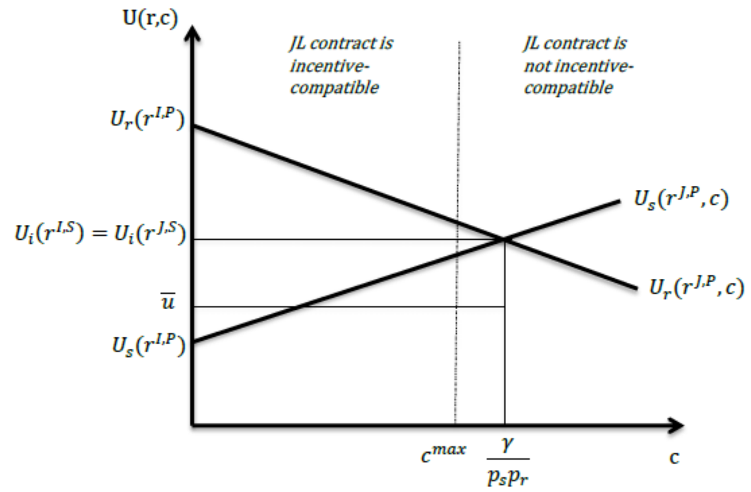
The expected utility from investment with joint liability is expressed as:

$$U_i(r^J, c) = p_i(R_i - r^J - (1-p_i)c).$$

Lenders expecting to supply the entire population face homogenous groups (S,S) and (R,R) with probability π and $(1-\pi)$ respectively. Zero profit in a pooling equilibrium therefore requires

$$\left[p_s r^{J,P} + (1-p_s)p_s c\right]\pi + \left[p_r r^{J,P} + (1-p_r)p_r c\right](1-\pi) = \gamma,$$

Figure 1: Utility functions of safe and risky borrowers under joint liability



which determines the pooling equilibrium relation between individual and joint liability:

$$r^{J,P}(c) = \frac{\gamma}{\bar{p}} - \frac{c}{\bar{p}}\left(\bar{p} - \pi p_s^2 - (1-\pi)p_r^2\right) > 1.$$

The introduction of joint liability allows a reduction in the interest rate because it increases the expected repayment for the lender (insurance effect). Importantly, borrowers now face an extra cost in case their partner defaults, which is expected to be higher for risky borrowers because their partner defaults more often than in safe borrower groups. That is, although the explicit contract terms are the same for every borrower in the market, lenders are able to implicitly charge a lower interest rate to safe borrowers and a higher interest rate to risky borrowers. It is easy to check that the utility of safe borrowers is linearly increasing in c, which explains why MFIs can potentially attract back to the market the safe borrowers who were excluded in the previous section (if any). By contrast, the utility of risky borrowers is linearly *decreasing* in c: risky borrowers prefer the individual contract (if a pooling equilibrium exists). Note however that the expected overall payments by risky borrowers are still always lower, such that $r^{J,P}$ is decreasing in π and p_i. Moreover, given the incentive-compatibility constraint (IC), the utility of risky borrowers is still always higher than for safe individuals, and any potential separating equilibrium involves risky individuals only. In that situation, lenders face homogenous groups of risky individuals and the break-even interest rate is $r^{J,S}(c) = \frac{\gamma}{p_r} - (1-p_r)c$. Again, it is easy to see that this rate is lower than in the individual-lending case. One can also show that $r^{J,S} > r^{J,P}$: lenders, being only partially insured against default, still expect higher default rates from risky borrowers overall.

Proof. A separating equilibrium happens if $U_s(r^{J,P}) = \bar{R} - p_s(r^{J,P} + (1-p_s)c) < \bar{u} \iff \bar{R} - \frac{p_s}{\bar{p}}(\gamma) + c\frac{p_s}{\bar{p}}(\bar{p} - \pi p_s^2 - (1-\pi)p_r^2 - \bar{p}(1-p_s)) < \bar{u} \iff \bar{R} - \bar{u} < \frac{p_s}{\bar{p}}(\gamma - c(1-\pi)p_r(p_s - p_r))$. The utility of risky borrowers at a separating equilibrium is: $U_r(r^{J,S}) = \bar{R} - \gamma > \bar{u}$, so that risky borrowers always apply. ■

B Market power

In this section, I study non-competitive informal credit markets, in order to I allow for another commonly-cited benefit of microfinance, i.e. increasing competition on the local credit market.[24]

B.1 Equilibrium with a monopolistic moneylender only

The monopolist chooses the interest rate that maximizes its profit, taking into account the downward-sloping step demand and repayment functions:

$$\max_r \ \Pi = D(r)p(r)r - \gamma D(r) \text{ s.t. } \Pi \geq 0, \text{ where}$$

$$D(r) = \begin{cases} 1 \\ (1-\pi) \\ 0 \end{cases} \text{and } p(r) = \begin{cases} \bar{p} \\ p_r \\ - \end{cases} \text{if } \begin{cases} r \leq r_s^{I,\max} \\ r_s^{I,\max} < r \leq r_r^{I,\max} \\ r > r_r^{I,\max}. \end{cases}$$

The above problem accepts two possible strategies: either to offer a high interest rate contract that is accepted by risky households only (regime 1) or to offer a low interest rate contract that is accepted by both types (regime 2) - not supplying anything can never be profit maximizing given (EC). If the monopolist focuses on risky types, then it is optimal to set the interest rate at risky borrowers' reservation level such that $p_r(R_r - r_r^{I,\max}) = \bar{u}$, which leads to the equilibrium interest rate $r_r^{I,\max} = \frac{\bar{R}-\bar{u}}{p_r}$ and a profit equal to $\Pi(r_r^{I,\max}) = (1-\pi)\left(\bar{R} - \bar{u} - \gamma\right)$ - which is always positive given (EC). Whereas if it targets both types of households, it is optimal to set the interest rate at safe borrowers' reservation level $r_s^{I,\max} = \frac{\bar{R}-\bar{u}}{p_s}$, yielding a lender's profit $\Pi(r_s^{I,\max}) = \frac{\bar{p}}{p_s}(\bar{R}-\bar{u})-\gamma$. Regime 1 has the virtue that the lender can extract all the surplus from risky types. Yet, regime 2 allows supplying a larger and safer population.

Proposition 3 *The monopolistic lender serves the entire market (regime 2) if* $\pi\gamma \leq (\bar{R} - \bar{u})(\frac{\bar{p}}{p_s} - 1 + \pi)$ *and serves only risky borrowers (regime 1) otherwise.*

Proof. Regime 2 yields a higher profit than regime 1 if $\Pi(r_s^{I,\max}) \geq \Pi(r_r^{I,\max}) \iff (\bar{R} - \bar{u})\frac{\bar{p}}{p_s} - \gamma \geq (1-\pi)(\bar{R} - \bar{u}) - (1-\pi)\gamma \iff (\bar{R} - \bar{u})(\frac{\bar{p}}{p_s} - (1-\pi)) \geq \gamma\pi.$ ■

That is, it is sometimes optimal for the monopolist to refrain from charging the maximum interest rate in order to keep safe borrowers in the pool. Its choice depends on the success probabilities and the proportion of risk types in the population. If the relative success probability of risky individuals increases (meaning that both types become more equal), so does the likelihood of regime 2. On the contrary, if the cost of capital and the proportion of risky borrowers in the population increase, a separating equilibrium is more likely to happen. Finally, recalling the threshold of section 2.2, it is easy to check that a monopolist always rations credit more than a competitive lender.

[24]Evidence regarding the extent of informal lenders' market power is naturally mixed, as it is by definition context-specific. Empirical studies have been describing informal finance as competitive (e.g. Ghate et al., 1992; Banerjee and Duflo, 2010), monopolistically competitive (e.g. Aleem, 1990), and monopolistic (e.g. Bolnick, 1992). Yet, a consensus exists that monopoly rents alone cannot explain the high interest rates observed in informal credit markets.

In regime 1, the utility of all borrowers is equal to $\bar{u}$. In regime 2, the utility of borrowers is given by

$$U_i(r_s^{I,\max}) = p_i\left(R_i - \frac{\bar{R}-\bar{u}}{p_s}\right),$$

such that the moneylender extracts all surplus from safe borrowers ($U_s(r_s^{I,\max}) = \bar{u}$) and leaves a positive surplus to risky borrowers ($U_r(r_s^{I,\max}) = \bar{R} - p_r\frac{\bar{R}-\bar{u}}{p_s} > \bar{u}$).

B.2 Equilibrium with a monopolistic moneylender and microfinance

I now analyze a competition game between the monopolistic lender (ML) described above and a not-for-profit microfinance sector (MFI) that offers group-lending contracts as described in section 2.2.[25] As before, I assume that MFI has a financing capacity equal to $0 < \alpha < 1$ and that ML has no financing constraint.

The timing of events is similar to the previous section. First, both lenders announce simultaneously the terms of their debt contract that satisfy their respective objective function as well as the incentive-compatibility and feasibility constraints. Second, borrowers decide whether and from whom to borrow.[26] Third, unserved borrowers can decide to borrow from the other lender. Fourth, investment takes place, Nature decides about the realizations and lenders get reimbursed according to contract terms.

Table 7 summarizes the different scenarios, as a function of the contracts offered by the stand-alone ML and MFI. When MFI is at a separating equilibrium (*case 1*), the two lenders are competing for exactly the same pool of risky borrowers. As a consequence, if $\alpha \geq (1-\pi)$, ML has no choice but to cut its profits to zero and charge $r^{I,S}$ in order to make risky borrowers indifferent between the two contracts. That is, by contrast with the previous section, I find that the entry of MFI can *decrease* the informal interest rate when the informal market is not competitive. However, if $\alpha < (1-\pi)$, ML still finds it optimal to supply the unserved risky borrowers at rate $r_r^{I,\max}$, while making positive profits. In both cases, microfinance improves borrowers' welfare in the Pareto sense (but decreases ML's profits). It has no effect on coverage and the credit market is inefficient.

When MFI is at a pooling equilibrium, the strategy space of ML also gets modified along several dimensions. First, at rate $r_s^{I,\max}$ (regime 2), it can never expect to serve the entire pool of safe borrowers, but at most a fraction $(1-\alpha)$ of them. Likewise, at rate $r_r^{I,\max}$ (regime 1), ML can only expect to supply a fraction $(1-\alpha)$ of the risky pool. Let us consider a third alternative, namely the level of interest rate that would be low enough to just leave risky borrowers indifferent between borrowing individually or in group:

$$U_r(r_r^{I,ind}) = U_r(r^{J,P}, c) \iff r_r^{I,ind} = \frac{1}{\bar{p}}\left(\gamma + c\pi p_s(p_s - p_r)\right).$$

This rate can never be profit maximizing. Indeed, if $r_r^{I,ind} > r_s^{I,\max}$, it would lead to negative profits since even a zero-profit ML cannot prevent risky borrowers from switching

[25] I model the two sectors as independent because the monopolist always makes more profit by supplying individual loans than by joining the microfinance sector. On the other hand, a for-profit microfinance institution could have an incentive to enter the individual-lending sector. Though this certainly has some empirical relevance, I leave it for future research.

[26] Without loss of generality, I assume the following tie-breaking rule: when individuals are indifferent between borrowing individually or in groups, they choose the first option.

Table 7: Lenders' expected market shares and impact of MFI's entry in monopolistic credit markets

Contract of ML \ Contract of MFI	Separating	Pooling
Regime 1	1. *shares:* $[(0, max\{(1-\pi)/2, 1-\pi-\alpha\}); (0, min\{(1-\pi)/2, \alpha\})]$ *impact:* Δ^+ welfare, Δ^- interest if $\alpha \geq 1-\pi$	2. *shares:* $[(0, (1-\pi)(1-\alpha)); (\pi\alpha, (1-\pi)\alpha)]$ *impact:* Δ^+ coverage and welfare
Regime 2	(impossible)	3.A. If $\alpha \geq \pi$ or conditions (3) or (4) not satisfied: *shares:* $[(\pi(1-\alpha), (1-\pi)(1-\alpha)); (\pi\alpha, (1-\pi)\alpha)]$ *impact:* Δ^+ welfare 3.B. If $\alpha < \pi$ and conditions (3) and (4) satisfied: *shares:* $[(0, (1-\pi)(1-\alpha)); (\pi\alpha, (1-\pi)\alpha)]$ *impact:* Δ^+informal interest rate, Δ^- coverage

Note: '*shares*' reads as follows: [(expected safe borrowers served by ML, expected risky borrowers served by ML) ; (expected safe borrowers served by MFI,expected risky borrowers served by MFI)], where the number of borrowers is scaled by the market size N. Regime 1 and 2 refer to the optimal choice of the stand-alone ML given by proposition 3.

to MFI when its borrower pool comprises no safe borrower. For the same reason, $r_r^{I,ind}$ generates negative profits whenever $\alpha \geq \pi$. Furthermore, if $r_r^{I,ind} < r_s^{I,\max}$, it is always dominated by regime 2, which provides a higher interest rate and probability of repayment (as safe borrowers who are being crowded out of MFI by risky ones turn to ML) for the same market share (everyone not served by MFI). As a consequence, the optimal strategy involves, as before, charging either $r_s^{I,\max}$ or $r_r^{I,\max}$. When facing the competition of pooling-equilibrium MFI, the problem of the monopolist can thus be reexpressed as:

$$\max_r \ \Pi = D(r)p(r)r - \gamma D(r) \text{ s.t. } \Pi \geq 0, \text{ where}$$

$$D(r) = \begin{cases} (1-\alpha) \\ (1-\alpha) \\ (1-\alpha)(1-\pi) \\ 0 \end{cases} \text{ and } p(r) = \begin{cases} \frac{\bar{p}-\alpha p_s}{1-\alpha} \\ \bar{p} \\ p_r \\ - \end{cases} \text{ if } \begin{cases} r \leq r_s^{I,\max} \leq r_r^{I,ind} \text{ and } \alpha < \pi \\ r_r^{I,ind} < r \leq r_s^{I,\max} \\ r_s^{I,\max} < r \leq r_r^{I,\max} \\ r > r_r^{I,\max}. \end{cases}$$

Whenever the stand-alone ML is choosing regime 1 (*case 2*), this remains the optimal strategy after MFI's entry. Indeed, when $r_r^{I,ind} < r_s^{I,\max}$, the relative profits of regime 1 and 2 do not change and ML's optimal choice is still given by proposition 3. When $r_r^{I,ind} \geq r_s^{I,\max}$ and $\alpha < \pi$, in regime 2 risky types prefer borrowing individually while a share a safe types leaves the pool. As a consequence, regime 2 becomes relatively less attractive than before and regime 1 is still necessarily profit-maximizing. In both cases, all borrowers apply to MFI and the unserved risky borrowers subsequently turn to ML. Microfinance increases borrowers' welfare by making some safe and risky borrowers better off without making any worse off (except of course the monopolist moneylender). It increases coverage and efficiency by attracting some safe borrowers back to the market, though its impact is suboptimal due to the inability to screen out risky borrowers.

When ML chooses regime 2 when alone (*case 3*), it could be optimal to switch instead to regime 1 after MFI's entry, depending on the financing capacity of the microfinance sector. Table 8 provides the strategy space of ML after MFI's entry, when the optimal pre-entry decision is to serve all borrowers.

If ML maintains regime 2 in presence of MFI, different situations can arise, depending on the size of α and the composition of the borrower pool. First, if $\alpha \geq \pi$, $r_s^{I,\max}$

Table 8: Market configurations and strategy set of ML

New regime	$\alpha \geq \pi$	$\alpha < \pi$	
choice of ML		$r_s^{I,\max} \leq r_r^{I,ind}$	$r_s^{I,\max} > r_r^{I,ind}$
2	**(A)**	(C)	**(A)**
1	(B)	**(B)**	(B)

Notes: cases are presented in decreasing order w.r.t. $\frac{\alpha}{\pi}$ from left to right; optimal strategy is in bold font.

is necessarily greater than $r_r^{I,ind}$ (since risky borrowers prefer borrowing in group at a pooling equilibrium than alone at a separating equilibrium even when ML makes zero profit) and both types of borrowers are better off borrowing from MFI. ML then gets a profit of

$$\Pi(A) = (1-\alpha)\left(\frac{\bar{p}}{p_s}(\bar{R}-\bar{u}) - \gamma\right).$$

If $\alpha < \pi$, risky types may prefer borrowing from ML or not, depending on whether the following condition holds:

$$r_s^{I,\max} \leq r_r^{I,ind} \iff \gamma + c\pi p_s(p_s - p_r) \geq \frac{\bar{p}}{p_s}(\bar{R}-\bar{u}). \tag{3}$$

All else being equal, risky types are more likely to prefer borrowing individually if the proportion of safe types in the population is not too high, because a bigger number of safe borrowers implies a larger 'subsidy' when borrowing from MFI (while ML's rate does not depend on π). Condition (3) is also more likely if $\frac{p_s}{p_r}$ is high, because a high p_s decreases the interest rate of ML, while a low p_r decreases the probability that risky borrowers end up repaying their obligations and increases the implicit interest rate they would face if borrowing from MFI.

If risky borrowers prefer borrowing individually (situation C), ML's profit is

$$\Pi(C) = (1-\alpha)\left(\frac{(\bar{R}-\bar{u})}{p_s}\frac{(\bar{p}-\alpha p_s)}{(1-\alpha)} - \gamma\right) = \frac{\bar{p}-\alpha p_s}{p_s}(\bar{R}-\bar{u}) - (1-\alpha)\gamma$$

and MFI serves only safe borrowers at the interest rate $r^{J,SS}$, while we are back to situation A if risky borrowers prefer going to MFI.

Instead, if ML chooses to focus on risky borrowers after MFI's entry (situation B), then both types of borrowers are better off borrowing from MFI, and ML gets a profit of

$$\Pi(B) = (1-\alpha)(1-\pi)(\bar{R}-\bar{u}-\gamma).$$

Market equilibrium is determined by backward induction. Because ML would optimally choose to serve all borrowers if alone in the market, it is clear that $\Pi(A) > \Pi(B)$, given that all borrowers prefer MFI and ML thus serves a scaled-down population of unchanged riskiness. However, in situation C, ML might prefer to focus on risky borrowers because regime 2 would only attract part of the safe borrowers and thus becomes less interesting than in the absence of MFI. The formal condition is:

$$\Pi(B) > \Pi(C) \iff (\bar{R}-\bar{u})\left((1-\pi)(1-\alpha) - \frac{(1-\pi)p_r + (\pi-\alpha)p_s}{p_s}\right)$$
$$+\gamma\pi(1-\alpha) > 0 \iff \pi\gamma > (\bar{R}-\bar{u})\frac{\pi p_s(2-\alpha) + (1-\pi)p_r - p_s}{(1-\alpha)p_s}. \quad (4)$$

The likelihood of the above condition being realized increases with α. It decreases with π and with $\frac{p_s}{p_r}$, both of which go in the same direction as (3). Note that there is always a nonempty intersection between the region of satisfaction of condition 4 and proposition 3, such that situation C always exists. Indeed, if $\alpha = 0$, condition 4 is equivalent to proposition 3 and, as α increases, it accepts a larger and larger proportion of safe borrowers, such that the area of joint satisfaction widens (see the simulation in appendix C).

Moreover, if ML decides to switch to regime 1 as a result of the increased riskiness of its borrower pool, the coverage of borrowers necessarily goes down, as a share $(\pi - \alpha)$ of the safe borrowers, who would be served by ML in the absence of MFI, loses access to credit. In other words, even though more funds become available on the market, less borrowers end up being served because of the increased severity of the informational problems facing moneylenders. Finally, I show below that the average interest rate in the entire economy can increase as well, leading to an unambiguous reduction of the average borrowers' welfare.

The following conclusion summarizes the results obtained in this section.

Conclusion 2 The impact of microfinance in monopolistic credit markets

1. *In very risky environments, both lenders compete for risky borrowers, which causes ML to cut its interest rate if MFI's funds are large enough to serve the entire population of risky borrowers. Microfinance is welfare-improving.*

2. *When safe borrowers can borrow from microfinance but are excluded from the individual-lending market (risky environments), microfinance increases the efficiency of the market and the welfare of borrowers - without being able to completely solve the rationing of safe borrowers.*

3. *When safe borrowers can access individual loans prior to MFI's entry (less risky environments):*

   A. *If MFI has enough funds to serve the entire safe population ($\alpha \geq \pi$) or to the contrary if its financing capacity is very low ($\alpha << \pi$), microfinance has no effect on the residual interest rate and is welfare-improving.*

   B. *If MFI has an intermediate capacity ($\alpha < \pi$), microfinance increases the residual interest rate, decreases the coverage and the efficiency of the overall credit market and has an ambiguous effect on borrowers' welfare.*

That is, the introduction of market power for individual lenders does not modify the main insights of the previous section: microfinance can increase the equilibrium interest rate of the informal market by increasing the riskiness of the borrower pool. However, there are important differences with the perfect-competition case. First, the set of necessary conditions to get an increase of the equilibrium informal interest rate is more demanding (see the simulations in appendix C). Second, when the informal interest rate does increase, the consequences are more serious, because it involves a discrete jump to a higher level and a decrease of the total credit supply. Third, the relation between the interest rate and MFI's capacity is flat in this case. Fourth, the shift to the higher-interest regime does not happen for small α, but for intermediate MFI's capacity. Finally, I find that microfinance can also potentially *decrease* the informal interest rate, if the borrower pool is very risky or the expected returns of investing are too low with respect to capital costs. Appendix C provides a graphical summary of the results obtained in the different cases, using the same parameter values as in the previous section.

B.3 MFI can increase the average interest rate in monopolistic informal credit markets

In situation B of section B.2, ML charges $r_s^{I,\max} = \frac{\bar{R}-\bar{u}}{p_s}$ when standing alone in the market. After MFI's entry, if ML chooses to switch to regime 1, the average interest rate in the economy becomes:

$$\left(r_r^{I,max}(N_r-(1-\pi)N^{max})+r^{J,P}N^{max}\right)\frac{1}{N-(1-\pi)N^{max}}$$
$$=\frac{\bar{R}-\bar{u}}{p_r}\frac{(1-\pi)(1-\alpha)}{1-\pi+\alpha\pi}+\left(\frac{\gamma}{\bar{p}}-\frac{c}{\bar{p}}(\bar{p}-\pi p_s^2-(1-\pi)p_r^2)\right)\frac{\alpha}{1-\pi+\alpha\pi}.$$

Hence, the average interest rate in the economy increases if

$$(\bar{R}-\bar{u})\left(\frac{p_s(1-\alpha)+\alpha\pi(p_s-p_r)-\bar{p}}{p_r p_s}\right)+\left(\frac{\gamma}{\bar{p}}-\frac{c}{\bar{p}}(\bar{p}-\pi p_s^2-(1-\pi)p_r^2)\right)\alpha>0$$

which is not guaranteed but can happen. For instance, a sufficient condition is $p_s(1-\alpha)+\alpha\pi(p_s-p_r)-\bar{p}\geq 0 \iff p_s(1-\alpha+\alpha\pi-\pi)\geq p_r(1+\alpha\pi-\pi)$, which is always satisfied for low enough α and/or high enough $\frac{p_s}{p_r}$.

C Numerical simulation of the theoretical model

All simulations are performed using the following parameter values (expressed in annual terms), which are economically sensible, satisfy conditions (EC) and (IC), and deliver average interest rates that are roughly in line with those observed in the data: $\gamma = 1.2$ (i.e. a 20% opportunity cost of capital for lenders), $p_s = 0.9, p_r = 0.5, u = 0.1$ (i.e. a 10% opportunity cost of labour for borrowers), $c = 1$ (i.e. if one of the two partners defaults, MFI is able to recover its capital), $\bar{R} = 1.6$ (i.e. an expected return on investment of 60%, which corresponds to the order of magnitude estimated by de Mel et al. 2008).

I start by plotting the area of joint satisfaction of the conditions that are necessary to get an increase in the equilibrium interest rate of the informal market. I reformulate each of the conditions in terms of π and α, which are the two main parameters of interests of the model and which are observed in the empirical application.

1. Model with perfect competition
   (a) Condition 1: $\alpha \leq \pi\frac{(\bar{R}-\bar{u})(p_s-p_r)}{p_s(\bar{R}-\bar{u}-\gamma)}+\frac{(\bar{R}-\bar{u})p_r-\gamma p_s}{p_s(\bar{R}-\bar{u}-\gamma)}$
   (b) Condition 2: $\alpha \leq \frac{\bar{p}}{p_s}-\frac{(1-\pi)\gamma}{c\pi p_s^2}$

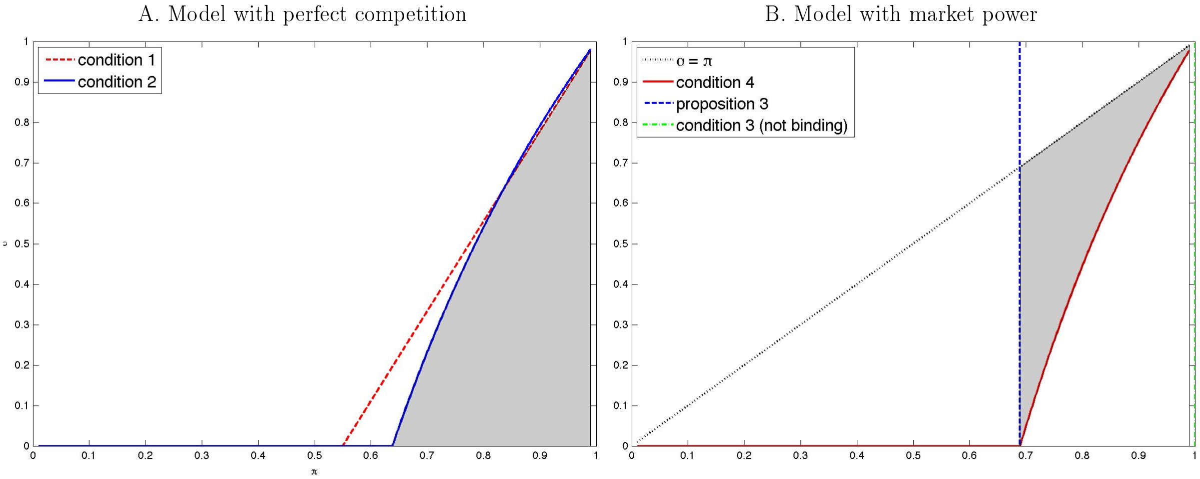
2. Model with market power

   (a) $\alpha < \pi$

   (b) Proposition 3: $\pi \geq \frac{(\bar{R}-\bar{u})(p_s-p_r)}{(\bar{R}-\bar{u})(2p_s-p_r)-\gamma p_s}$

   (c) Condition 3: $\pi \leq \frac{p_r(\bar{R}-\bar{u})-p_s\gamma}{(p_s-p_r)(cp_s^2-\bar{R}+\bar{u})}$

   (d) Condition 4: $\alpha \leq \frac{(\bar{R}-\bar{u})\frac{\bar{p}-p_s(1-\pi)}{\pi p_s}-\gamma}{\bar{R}-\bar{u}-\gamma}$



Note: shaded area indicates the region of parameters where the conditions are jointly satisfied.

I then plot the predictions of the model, in terms of the equilibrium interest rate prevailing in the two sectors and the coverage of borrowers, as a function of the capacity of the microfinance sector and for different levels of the average riskiness of the population. Solid and dash-dot lines represent the baseline scenario, when the market is composed of only MF or MFI respectively, while dashed and dotted lines relate to markets with both sectors (showing respectively ML's and average conditions).

The first row displays the competitive version. In very risky villages, both types of lenders serve risky borrowers equally and safe borrowers remain excluded from the market. At intermediate riskiness levels, MFI is able to serve safe borrowers (while ML is still at a separating equilibrium) and ends up attracting the entire population. Coverage increases, but stays incomplete as long as $\alpha < 1$. Finally, in relatively safe villages, the two lenders are able to supply safe borrowers when operating on independent markets. In mixed market, MFI siphons off safe borrowers and forces the equilibrium informal interest rate up (proportionally to the size of the MFI sector). When MFI's capacity becomes too large, it eventually attracts all borrowers and hence does not change the composition of the borrower pool or the interest rate of moneylenders. The model thus predicts a non-linear, inverted-U shaped, relation between the informal interest rate and MFI's capacity.

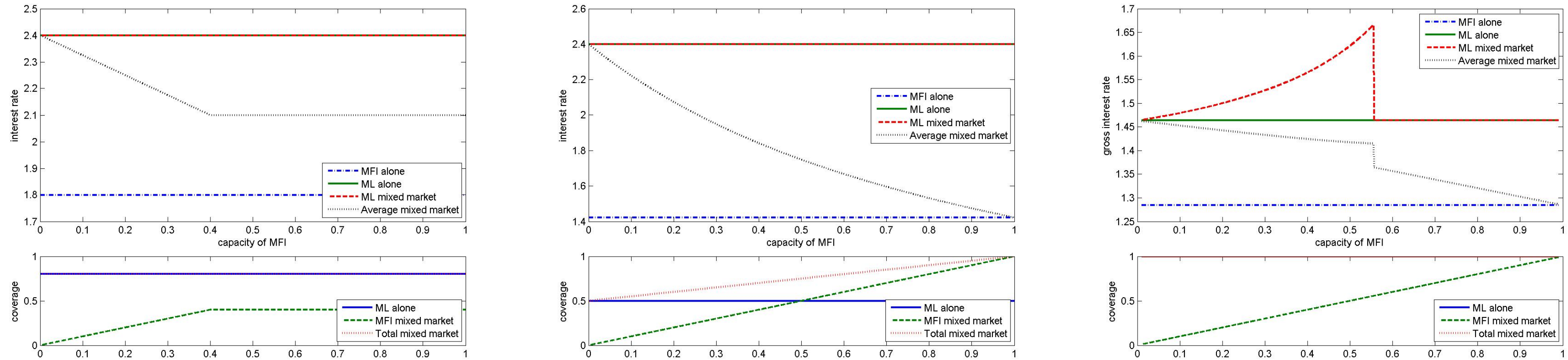
Market power increases the interest rate and the likelihood of credit rationing. Yet, when few risky borrowers are present in the market, it is optimal for the monopolist to serve all borrowers. In mixed markets, however, the monopolist can find it optimal to switch back to regime 1 and charge the maximum rate of interest. This happens for intermediate capacity levels of the microfinance sector. Coverage of borrowers decreases, since MFI does not have enough funds to make up for the newly-excluded safe borrowers. On the contrary, in very risky populations, MFI can trigger a decrease in ML's rate if it has a large financing capacity ($\alpha > 1 - \pi$).

$Case\ 1$: $\pi = 0.2$ ($\bar{p} = 0.58$)

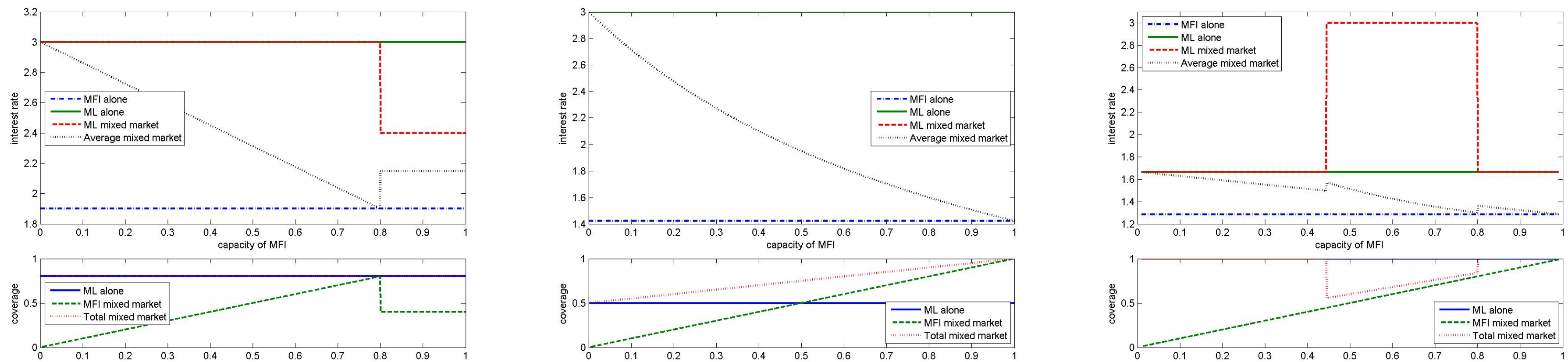
$Case\ 2$: $\pi = 0.5$ ($\bar{p} = 0.7$)

$Case\ 3$: $\pi = 0.8$ ($\bar{p} = 0.82$)

A. Model with perfect competition



B. Model with market power



D Empirical appendix

Table 9: Baseline characteristics of SHG and control villages

	SHG villages	control villages
Population (#households)†	219 (51.6)	189 (31.7)
SC population (%)†	10.2 (2.6)	11.5 (3.1)
ST population (%)†	44.6 (7.8)	42.7 (10.3)
Landless population (%)†	30.8 (4.7)	22.9 (7.4)
Illiterate population (%)†	63.1 (2.1)	66.6 (2.3)
Female illiterate population (%)†	76.0 (2.2)	78.3 (2.1)
Farming population (%)†	36.4 (4.7)	41.6 (9.0)
Working gender-parity index†	0.50 (0.06)	0.52 (0.13)
Unemployment (%)†	36.0 (4.4)	34.4 (8.4)
Asphalted road reaching village (%)§	18.6 (6.6)	22.7 (7.1)
Distance to bank (km)§	6.8 (1.0)	8.0 (2.3)
Distance to primary health center (km)§	5.5 (0.75)	4.5 (0.69)
Distance to market (km)§	5.3 (0.65)	5.4 (0.70)
Distance to bus stop (km)§	3.4 (0.52)	3.3 (1.00)
Schools in village (#)§	2.0 (0.23)	1.7 (0.24)

Std errors in parentheses. † Census of India 2001. § Own village survey.

Table 10: Moneylenders' interest rates and SHG presence: risky villages and robustness

	Relatively risky villages			Relatively safe villages: robustness		
	high SC prop.	few rain	low baseline borr.	w/o Hald.	only prof. ML	only effect. rates
SHG coverage	(1)	(2)	(3)	(4)	(5)	(6)
(0,p25]	-0.191	1.137	1.981	2.993	0.153	-1.539
	(0.409)	(0.989)	(1.347)	(2.556)	(1.858)	(1.451)
(p25,p50]	-0.0264	0.427	0.413	6.962**	4.534***	3.694**
	(1.002)	(1.008)	(2.255)	(2.714)	(1.644)	(1.636)
(p50,p75]	0.389	1.580	-0.0493	2.097	-0.461	-0.123
	(1.000)	(1.344)	(1.037)	(2.315)	(1.468)	(1.546)
(p75,p100]	-0.570	-0.899	-0.610	3.720	1.855	1.667
	(0.919)	(1.133)	(2.111)	(2.433)	(1.377)	(1.318)
Amount borrowed	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes
Rain shock	Yes	Yes	Yes	Yes	Yes	Yes
Village and year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	530	523	194	431	352	390
Adjusted R^2	0.294	0.322	0.146	0.208	0.276	0.224
p-value: $F(1_{p25p50} = 1_{0p25})$	0.862	0.0267	0.445	0.00281	0.00314	0.000
p-value: $F(1_{p25p50} = 1_{p50p75})$	0.695	0.203	0.851	0.000	0.000	0.00169
p-value: $F(1_{p25p50} = 1_{p75p100})$	0.552	0.0455	0.721	0.0389	0.0434	0.0878

Obs. weighted to correct for sampling probabilities. Std errors clustered at the village-year level in parentheses. ** $p < 0.05$, *** $p < 0.01$.