The Impact of Microfinance on the Informal Credit Market: An Adverse Selection Model

Timothée Demont *

FNRS research fellow, CRED, Namur University

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Abstract

This paper looks at 'the other side' of the much-celebrated microfinance revolution, namely its potential impact on the conditions of access to credit for non-members (the *residual market*), along price and quantity dimensions. It uses a standard adverse selection framework to show the advantage of group lending as a single innovative lending technology, and then to assess how the apparition of this new type of lenders might change the equilibria on rural credit markets, taking into account the reaction of traditional lenders. We find that two antagonist effects on the interest rate can coexist: a standard *competition effect* and a more subtle *composition effect*. While the former tends to lower the residual market rate, the latter raises the cost of borrowing outside microfinance institutions (MFIs) due to a worsening of the pool of borrowers. The relative weights of the two effects depend on the market structure, the risk heterogeneity of the population and the actual distance between lending technologies. Moreover, the model predicts that microfinance can increase, but also decrease, the coverage of the population's creditworthy borrowers. Those arguably less intuitive impacts of microfinance, which have been overlooked until now, are important given the nearly-universal coexistence of MFIs and traditional lenders in developing countries. Moreover, they are not only theoretically likely, but seem to match the empirical facts presented in the paper. Our paper is thus a contribution in the understanding of the redistributive implications of the microfinance revolution that has been occurring in the last years.

Keywords: Microfinance, Moneylenders, Adverse selection, Horizontal interaction, Composition effect.
JEL Classification Numbers: D82, G21, L1, O12, O16

1 Introduction

Individuals and organizations engaged in promoting economic development are usually concerned not only with generating aggregate growth in developing countries, but also with ensuring that the beneficiaries of this growth include the poorest fringes of the population (a so-called 'inclusive' growth). One widely-acknowledged obstacle to achieving this goal has been the extreme difficulty for rural households to acquire the capital needed to finance their productive investments and other needs (e.g. Banerjee and Newman 1994, Mookherjee and Ray 2003).

Indeed, given asymmetric information problems (pre- and post-lending), high-risk environments and the presence of important transaction costs, banks are usually absent of the rural world in developing countries. There, credit-constrained households rely on informal moneylenders (e.g. landlords, local traders, small businessmen), who typically have more information on borrowers and accept as collateral goods or services that a bank would not. However, it has usually been observed that they charge high interest rate and that they fail to serve all potential borrowers (e.g. Basu 1989, Aleem 1990, Robinson

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2001, Banerjee 2003, Armendáriz and Morduch 2005). From the 80's on however, microfinance institutions (MFIs) have spread out around the world, exploiting new contractual structures and organisational forms to supply small, uncollateralized and cheap loans to poor people.

Today, most microfinance programmes make use of some form of group-lending schemes, such as peer selection and monitoring, regular public repayments and joint liability. This paper explicitly uses joint liability, though it applies to any mechanism that implies some peer screening, monitoring or enforcement.[1] Under joint liability, individual borrowers have to form groups to apply and all group members are held collectively responsible for the repayment of each other's debt. Several authors have proposed various explanations for the new opportunities that this mechanism might offer (e.g. Ghatak and Guinanne 1999, or Guttman 2006 for a good review). We focus on the role of joint liability as instrument to allow better discrimination between entrepreneurs of different risk types and thereby to limit the risk of adverse selection. In this context, joint liability can be seen as a collateral substitute, which is particularly important in developing countries, both for borrowers (who often lack tangible assets and/or credible credit history) and lenders (who often lack due protection of property rights and effective enforcement mechanisms).

There exists some evidence that group lending - and joint liability in particular - have allowed microfinance to expand outreach and increase repayment performances (see e.g. Khandker et al. 1995, Ahlin and Townsend 2002, Armendáriz and Morduch 2005, Kritikos and Vigenina 2005, Karlan 2007). However, the existing literature (e.g. Stiglitz 1990, Ghatak 1999,2000, Besley and Coate 1995), by focusing on the problem of single lenders trying to tap excess demand, has not yet quite explored an important issue regarding the development of microfinance, namely its impact on the residual informal credit market and on the welfare of non participants. Intuitively, MFIs are desirable because they potentially supply credit to otherwise-constrained households. They can also supply credit to households borrowing from moneylenders, which helps limiting the market power of the latter. Yet, in this paper, we argue that MFIs, if they select the safest projects, are also likely to worsen the information problems that cause traditional lenders to charge high interest rates. Indeed, MFIs will adversely affect the average probability of repayment to incumbent lenders whenever (i) they select the safest borrowers away from incumbent lenders due to their specific contract features such as group lending with self-selection of members - this is actually what the following model makes explicitly use of, or (ii) microfinance clients finance only risky projects through traditional lenders, or (iii) we observe multiple lending, with traditional loans taken to repay MFIs' loans. As a result, MFIs may change the structure of rural credit markets in unintended ways, possibly raising interest rates or decreasing coverage, and ultimately hurting some poor borrowers.

This is an empirically highly-relevant question. Across the world, MFIs are far from providing credit to all poor borrowers and we often observe a coexistence of MFIs and traditional lenders in developing countries. For instance, a recent survey by the Reserve Bank of India found that between 1995 and 2006, while the number 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. As a consequence, while it is evaluated that the MFI sector is delivering credit to about 10% of the Indian poor, informal finance accounts for about 40% of outstanding loan amounts of rural households (RBI 2007 and Microfinance India 2007). Potential important reasons for the continued (indeed increasing) prevalence of moneylenders are: confidentiality, round-the-clock availability and speed of processing, flexibility in loan use, lender-of-last-resort nature (RBI 2007). Those reasons hints at a complementarity between micro- and informal finance. For instance, Andra Pradesh, the State with the highest concentration of Self-Help Groups, MFIs and Banks in India, also reports the highest proportion of rural non-institutional debt (73%) and the highest proportion of rural moneylender debt (57%) (NSSO 2005). In this context, the present paper is thus concerned with the redistributive aspect of the microfinance revolution. It aims at studying the (horizontal) interaction between MFIs and other providers of rural financial services as well as its consequences for poor borrowers.[2]

The most-closely related papers in the literature are focusing on formal-informal sector interaction. For instance, Hoff and Stiglitz (1997) show that subsidizing the formal sector can result in higher interest

[1]In recent years, a growing number of MFIs have been turning to individual liability (e.g. Grameen II and ASA in Bangladesh, BancoSol in Bolivia). However, most of them still use groups to disburse and collect loans (in order to reduce transaction costs), which implies that some peer screening, monitoring or enforcement is still present. Moreover, this trend is by no means universal: in India, for example, Self-Help Groups, which adhere fairly strictly to the joint-liability contract, represent 73 per cent of the microfinance sector (Srinivasan 2009) and 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 not because of the formal structure of liability but because, after being together for a while, people start to value their relationships with other members.

[2]We do not study competition between moneylenders or between MFIs themselves - for a model of competition in microfinance markets, see e.g. McIntosh and Wydick 2005.

rates charged by informal moneylenders, e.g. because a subsidy induces new entry and thus weaker repayment incentives for borrowers. Bose (1998) reaches the same conclusion using a mechanism which is very close to the one discussed in our paper: if some lenders can discriminate between safe and risky borrowers while others cannot, an increase in the supply of credit of the former can worsen the composition of the pool of borrowers of the latter, thus worsening the terms of credit to some borrowers. 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. More importantly, it gives no justification regarding the fact that one part of the informal sector is informed about borrowers' type and another is not - while this is endogenously determined by the lending technologies in our model.

In Jain (1999), borrowers can take loans from both the formal and informal sectors, as in our model. The formal sector is monopolistic and decides strategically on the interest rate and the amount of the loan. Subsequently, borrowers turn to the perfectly competitive informal sector for residual financing if needed. He shows that the bank can exploit the informational advantage held by the informal lenders by offering two different types of contracts: a full funding contract at a high interest rate, and a partial funding contract at a lower rate. Indeed, since risky borrowers are being discriminated in the informal market, they will accept a higher interest rate in exchange for full funding in the formal sector. If we share the horizontal-interaction feature of Jain (1999), we do not impose any hierarchy between lenders and focus on a purely informal (or rural) setting, in which no lender has some information or cost advantage over the others. Moreover, lenders decide only on interest rates in our model.[3] Note that Andersen and Malchow-Møller (2006) show that Jain's insights go through if both formal and informal sectors operate under imperfect competition and behave strategically.

Jain and Mansuri (2003) and Gosh and Van Tassel (2007) study the interaction between the informal and the microfinance sector, both using a moral hazard framework. Jain and Mansuri (2003) argue that the use of regularly scheduled repayments by MFIs force borrowers to take loans from informal lenders in order to repay microfinance loans. The rationale of the system is that MFIs can thereby benefit from the monitoring advantage of better-informed moneylenders. As a consequence, microfinance can expand the volume of informal lending and may also raise the interest rate in the informal sector. Note that in Jain and Mansuri there is no group aspect involved in MFI's loans.

Gosh and Van Tassel (2007 have a very different framework. They develop a two-period model of a credit market supplied by a monopolistic moneylender and a subsidized microfinance institution, in presence of moral hazard and dynamic incentives. In their setting, credit is only profitable for lenders in the second period, once borrowers have acquired enough wealth to cofinance their investment. Microfinance increases the bargaining power of borrowers and decreases the moneylender's interest rate. However, if subsidy and microfinance outreach increase too far, the moneylender cannot afford to offer loans anymore, and borrowers' incentives to work hard and to save drop.

Finally, Madestam (2009) constructs a model in which individuals can borrow from banks, who have unlimited funds but face moral hazard at investment stage, and informal lenders, who can control the opportunistic behavior of borrowers but are capital constrained. He finds that access to informal finance raises investment, disciplines borrowers and facilitates banks' rent extraction (given that informal lenders channel bank funds). The disciplinary effect dominates if banks are competitive, leading to an expanded overall credit provision. By contrast, informal finance serves primarily as an instrument of rent extraction if the bank is a monopolist, leading to an increase in the interest rate and a lower access to bank funds for poor borrowers. Although no formal finance is present in our paper and we use an adverse selection framework, we share some similarities with the paper of Madestam. First, we find that the impact of the lenders with information advantage depends on the market power of the other sector. Moreover, our model could easily be extended to a framework similar to Madestam's, in which MFIs would act as an outside option for borrowers (decreasing their reliance on banks and moneylenders). At the same time, MFIs can often be thought of channeling bank funds (e.g. bank-linked SHGs in India, which are the object of the empirical work presented in this paper) and so are likely to impact also on the formal interest rate, an issue which is left for further research.

The remaining of the paper is as follows. First, section 2 motivates our research question with a quick overview of the empirical literature on asymmetric information problems of rural credit markets. It also presents some evidence from two original sets of surveys in central India on the idea that the entry of MFIs in a traditional credit market might change it in important ways, and not always in the

[3] Introducing two-dimensional contracts would be an interesting extension of our model, even though we know little real-world evidence about extensive variation in the contract terms proposed by traditional lenders within local credit markets (also see Casini 2008 for a more extensive discussion on this issue). Moreover, Jain's separating-equilibrium mechanism is not feasible in our setting, given e.g. the general preference of safe borrowers for borrowing in groups - see section 6.

sense a reduction of the cost of borrowing. Then, section 3 presents the basic features of our model, which will hold throughout the paper. Section 4 develops the benchmark individual-lending case with perfect competition. We derive the conditions under which inefficient separating equilibria arise. Section 5 introduces the group lending technology. We show that, if assortative matching occurs at the group formation stage, joint liability lowers the probability of adverse selection, and increases efficiency and repayment rates. In section 6, we study the interaction between the two types of lenders, and assess the effects on the different segments of the market that are predicted by our model. Facing the presence of MFIs operating group lending, traditional lenders have to increase their interest rate as soon as MFIs attract some borrowers away from them. This happens if safe types can borrow individually, i.e. if moneylenders are at a pooling equilibrium. Provided MFIs have enough funds to serve the entire population of borrowers, moneylenders can even be driven out of the market. Furthermore, as a result of microfinance, coverage of borrowers may increase - if safe types are excluded from the individual-lending market - or stay unchanged. In section 7, we look at the effect of market power and analyze a competition game between a not-for-profit MFI and a monopolist moneylender. We show that the MFI presence can have two opposite impacts on the monopolist's equilibrium interest rate according to the initial situation: it can either force a decrease of the interest rate in case both lenders are in a separating-equilibrium situation (competition effect), or foster an increase in the interest rate in case the stand-alone monopolist offers credit to safe borrowers at equilibrium (composition effect). The composition effect is happening whenever joint-liability payments in the MFI's contract are high and the average success probability of the population is high (i.e. the risk heterogeneity of the population and/or the proportion of risky borrowers are not too high). Furthermore, our model predicts that microfinance can lower the coverage of borrowers, in case a stand-alone moneylender would serve safe borrowers and the MFI has not enough funds to serve the entire safe population. Finally, we conclude.

2 Some facts about rural credit markets

The basic axiom of the paper is the existence of information asymmetries in traditional credit markets, which imply the impossibility for moneylenders (be them professional or not) to screen borrowers according to their riskiness. To quote Bolnick (1992) about an informal moneylender in Malawi:

> *Even with this network [of informal investigators], Mr. C is often unable to judge who is a good risk and who is a bad risk, in part because a person's behavior can change. One who formerly was a reliable customer may now have more children to feed, or business problems, or obligations to the extended family. It is difficult, he said, to trust anyone. (p. 61)*

A number of recent papers provide solid empirical evidence on the existence and impacts of asymmetric information - and in particular adverse selection - in developing credit markets (e.g. Karlan and Zinman 2009, Klonner and Rai 2009 or Giné and Klonner 2005). The model of this paper translates this fact into interest rates and show how the latter evolve according to different lending technologies and market configurations. To our knowledge, there exists very few evidence regarding the actual interest-rate behavior of lenders and especially its evolution following market modifications. The only (unpublished) study we could find that investigates the issue presents a pattern consistent with the mechanisms of our model: using village-level data from Bangladesh, Mallick (2009) finds that greater MFI penetration is associated with higher average moneylender interest rates. However, he fails to explain this seemingly counterintuitive result. A recent survey by the Reserve Bank of India points to the same apparent puzzle (though in a milder version):

> *In the [177] districts surveyed, and where the presence of MFI-SHGs 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, p. 38)*

Below we display some illustrative first-hand data regarding interest rates charged by traditional lenders and the riskiness of moneylenders' business. The data come from two sets of household surveys that were collected between 2002 and 2009 in villages of central India, in which a large NGO has been organizing women in Self-Help Groups (SHGs).[4]

[4]Those are informal village associations, which are engaged in a variety of collective activities out of which saving and credit are the most important. At every meeting, each woman contributes the agreed weekly savings and the interest (and possibly part of the principal) on the loan she has taken, if any. Members who don't have a loan yet can require one to

Table 1 A and B displays self-reported interest rate data from the first set of surveys, which was realised in 2007 in the states of Orissa, Chhattisgarh and Jharkhand, India. We report the average answers of non microfinance users who were asked about the interest rate charged by different lenders, when they required small loans (doctor visits, daily consumption, etc.) or bigger loans (durables, business-related expenses, etc.). We focus on loans made by raditional lenders, i.e. loans with positive interest rates from professional moneylenders, traders, landlords / employers and other neighbors (outside relatives). Finally, we distinguish between villages without any SHG, with some SHGs (between one and three) and with many SHGs (more than three). For both sizes of loans, we observe a significantly higher interest rate when there are some microfinance presence in the village than when there is none (p-value of 0.00).

Nevertheless, villages with SHGs need not be comparable to villages without SHG because they were selected by the NGO at the first place and because groups are likely to have been formed and to be actually working where the need was important (or where villagers had a high intrinsic motivation etc.). This is why table 1 C rather compares a given set of (selected) treated villages - i.e. villages with microfinance presence - across the number of groups present in the village. It uses data from the second set of surveys, which forms a longitudinal database of SHG members and nonmembers who have been followed from prior to the start of any SHG up to seven years after the opening of SHG(s) - between 2002 and 2009. In those surveys, interviewed households were asked about actual loans that they had been taking in the two years preceding the interview date. When loans have been fully repaid, we use the amounts borrowed, repaid and the actual duration to reconstruct the implicit interest rate of the loans, while we use contract information (either the explicit rate or the amounts borrowed, to be paid and the planned duration) when loans are still pending. Panel C below aggregates data over the years for the same set of treated villages and compares the average interest rates charged by the same types of traditional lenders as in panels A and B in villages without, with some and with many SHG(s).[5] Results are comparable to those observed in the first two panels: interest rates are on average higher when some SHGs are operating than when there are none. Yet, a non-monotonic relationship now seems to emerge: the interest rate charged by traditional lenders is on average lower when there are more than three groups than when there are one to three group(s). Anticipating the results of our model, this could be consistent with the fact that the competition effect dominates the composition effect when a lot of MFIs are operating.

Table 1: Interest rates by SHGs' presence

# groups	mean (% monthly)	std dev.	N
A. Small loans (self-reported)			
0	6.8	2.9	793
1-3	7.2	2.6	278
>3	7.4	2.9	289
B. Big loans (self-reported)			
0	7.0	2.9	696
1-3	7.7	2.5	241
>3	7.6	2.9	253
C. Actual contracts (longitudinal)			
0	8.3	3.1	353
1-3	9.5	7.8	160
>3	8.1	6.0	136

Data for panels A and B come from a survey by Baland et al. (2008) and data for panel C come from a survey described in Demont (2010). Though the broad area and the partner NGO are the same, the two surveys concern mainly different villages.

the group. Loans are individual but they have to be agreed on by the group and repayment is public. Moreover, there is a strong peer pressure ensuring due repayment, especially on bank loans, for which the group is jointly responsible. Bank-linked SHG is the dominant model in Indian microfinance, which has been promoted by the National Bank for Agriculture and Rural Development (NABARD) since 1992. More information about the surveys and their context can be found in Baland et. al (2008) and Demont (2010).

[5] Since those are all treated villages, no SHG refers to baseline data, i.e. before the start of SHGs' operation, or to villages that lost all SHGs over time. The last case actually concerns only one village, the exclusion of which doesn't change the nature of reported figures.

The last panel of the table 1, if it solves the selection problem due to non-random program placement, might suffer from another issue due to the pooling of different dates. Indeed, no SHG (mostly) refers to first-period data - before any SHG started to operate - and villages are more likely to have more groups as time passes. This can be a problem if there exists a time trend in interest rates, since the difference in the rates charged by traditional lenders in villages with many SHGs might then reflect this trend instead of the effect of the high presence of MFIs. To address this issue, we now take advantage of the panel dimension of the second database to control for time and location formally.[6] To account for a market-wide trend, we add data on control villages, where no SHG has ever been created and which were chosen to be as comparable as possible to member villages. Finally, we also control for whether the borrower is a member of SHG or not to distinguish between members and nonmembers in treated villages. Table 2 presents the result of the following simple econometric regression performed at the loan level:

$$INT_{i,t} = \alpha + \beta SHG13_{i,t} + \gamma SHG4_{i,t} + \delta Member_{i,t} + \mu_t T_t + \nu_i V_i + \epsilon_{i,t}$$

where INT is the interest rate charged by the traditional lender in loan i and time t, SHG13 is a dummy indicating that the village has got between one and three SHGs, SHG4 is a dummy indicating that the village has got more than three SHGs, Member is a dummy indicating that the borrower is an active SHG member, T is a time fixed effect and V is a village fixed effect. In table 2, we see that, once the time trend and the fixed characteristics of location are controlled for, we still find the pattern we identified above: a limited number of SHGs increase the interest rate charged by traditional lenders in the village, while villages with many SHGs are not statistically different from villages without SHG. Moreover, SHG members don't pay lower interest rates on average (but if anything higher). That could mean that lenders don't really discriminate between borrowers within villages, or that SHG users turn to traditional lenders to finance riskier (or larger) loans than from SHGs.

Table 2: Interest rates and SHGs' presence: OLS fixed-effect regression

Variables	I	II
$SHG13$	3.41* (1.92)	3.16^{+} (1.95)
$SHG4$	1.90 (2.01)	1.32 (2.32)
$Member$		1.56 (1.94)
T_t	yes	yes
V_i	yes	yes
R^2	0.11	0.12
N	785	785

Village clustered standard errors in parentheses. * denotes significance at the 10% and + at the 15% level.

As a matter of fact, the patterns presented above might be explained by many different causes. Table 3 provides some insights into the mechanisms. Members dramatically reduce their borrowing from traditional lenders once SHGs start operating. When they still borrow, they take larger loans, which are aimed at financing less productive investments and more consumption or social expenses. In fact, the comparison with the behavior of nonmembers suggests that members might well be the riskiest of the moneylender's borrowers. All this indicates that the borrower pool of traditional lenders is indeed likely to be modified upon MFIs' entry, and most probably towards an increased riskiness.

Overall, the above evidence is an interesting indication that competition may not be the main force at work in rural credit markets facing MFIs' entry, and that the job of traditional lenders is likely to become riskier. The model that follows contributes to explaining how (and when) the equilibrium interest rate of traditional lenders can rise (and the coverage may fall) as a result of the entry of MFIs in the market, taking into account the selection of good risks by MFIs.

[6] Surveys were conducted every two years from 2002, except for the last one that was carried after three years.

Table 3: Borrowing behavior of members and nonmembers before and after MFIs' entry

	Members		Nonmembers	
	Before	After	Before	After
Loans from trad. lenders in 2 years (#)	1.9	0.1	1.8	0.8
Average amount borrowed from trad. lenders (INR)	2890	3774	2706	2749
Loans for agriculture/business from trad. lenders in 2 years (% all loans)	21.1	15.8	26.6	25.6
Loans for family/social expenses from trad. lenders in 2 years (% all loans)	43.9	53.5	38.9	42.0
N[a]	165	3498	353	1167

[a] Lines 2 to 4 are computed using actual loans from traditional lenders: 123 before and 101 after for members, and 226 before and 348 after for nonmembers.

3 Setup of the model

We use a simple one-period model of a rural credit market with adverse selection (à la Ghatak 2000). The market is populated by a continuum of size 1 of risk-neutral households. Each household is endowed with a risky investment project which requires K units of capital and supplies inelastically one unit of labour. Their utility function U is assumed to be continuous and linearly increasing in income ($U' > 0$, $U'' = 0$). The opportunity cost of labour is $\bar{u}$ per unit, which may be viewed as an alternative income that the household would be able to produce if not committed to any project (e.g. wage work). By assumption, households lack the capital required to enter the project, such that they have to finance their investment through borrowing by means of a debt contract.

Projects once started yield either a high gross return R_i^h or fail and yield a low gross return R_i^l, which is normalized to be 0 in the rest of the paper (henceforth R_i without any superscript will refer to R_i^h). Households are indexed into two groups, safe (s) and risky (r)[7], and the risk characteristic of each household is unknown to lenders (screening technology is prohibitively expensive). The proportions of safe and risky households in the population are π and $(1-\pi)$ respectively, and are common knowledge. The term p_i represents the probability of success of the project of type i ($i = r, s$), with $1 \geq p_s > p_r \geq 0$. We make the common assumption in the literature since Stiglitz and Weiss (1981) that $R_s < R_r$ and expected returns are equal for both types of households: $E(R_i) = p_s R_s = p_r R_r = \bar{R} > 1$. The project returns of different borrowers are assumed to be uncorrelated (for the effect of correlated types, see Laffont 2000). We assume throughout that the investment projects of both types of household are socially profitable, in the sense that their expected return ($\bar{R}K$) is greater than the opportunity cost of the capital and labour used up in the project. This means that, in a welfare-maximizing situation, all households should get funds (which of course would be the case in a situation with complete information).

There is no (ex post) moral hazard in the model: although actual returns are unknown to lenders, success is perfectly observed and repayment is enforceable.[8] In case of failure, we assume limited liability in the sense that borrowers cannot repay their loan nor the interest rate due - it is assumed that borrowers do not pledge any collaterisable wealth, for simplicity and also because it is likely to actually best describe the situation of most poor households around the world.[9] Together, limited liability and absence of collateral imply that most instruments used by conventional lenders to address information problems are not available. In this context, joint liability lending can be viewed as a 'simple mechanism that exploits local information to screen borrowers' (Ghatak 2000).

Finally, note that there will be no standard credit rationing in our basic model because lenders have access to an infinitely elastic supply of funds at a constant cost (contrary to Stiglitz and Weiss 1981). However, due to information problems, the equilibrium interest rate might be too high for some creditworthy individuals to borrow. That is, *access* to credit might be rationed. Moreover, when we look

[7] 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. SHG members, being forced to limit the riskiness of their group borrowing might apply to moneylenders in order to finance riskier projects).

[8] This is obviously the case if ex-post state verification is costless. Nevertheless, Gale and Hellwig (1985) showed that, in one-period optimal debt contracts with (sufficiently) costly state verification, lenders pay that cost whenever borrowers default, which leads to the same conclusion as in our simple model (i.e. successful borrowers always repay). This result derives from the fact that, in the presence of limited liability, borrowers always have the incentive to declare realised returns as low as possible, and lenders impose a penalty in case of false reporting. Finally, in the rural setting that we have in mind, social sanctions and/or repeated interactions will also contribute to the enforceability of contracts - even if those aspects are not present in our model.

[9] 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 our model without moral hazard, collateral is therefore not a crucial matter.

at how different lenders share a single market (sections 6 and 7.2), we do introduce the possibility of lenders not satisfying the entire demand due to fund limitation, in order to draw interesting conclusions.

Throughout, traditional lenders - who lend individually - are referred to as 'moneylenders', whereas 'MFIs' are operating joint lending. We call 'mixed market' a market with the two types of lending institutions, and 'residual market' the market supplied by traditional moneylenders - or the share of a mixed market that is not served by MFIs.

4 Equilibrium with individual lending

In the basic version of the model, both borrowers and lenders are price-takers. We model individual lending as the following sequence of events. First, lenders compete and the market determines the equilibrium price of funds.[10] Second, borrowers observe the market rate r and decide whether to borrow at this rate or not.[11] Third, households who borrowed invest, Nature decides the outcome, and repayment is made according to the debt contract. Households who did not borrow enjoy the reservation income $\bar{u}$.

Since the risk characteristics of households are private information, discrimination is not feasible in the absence of collateral, and lenders charge a unique nominal interest rate. As it is well-known, two different equilibria can arise in this situation. If the break-even interest rate is low enough to attract all risk types, we have a pooling equilibrium: all creditworthy households have access to funds. This is the first-best equilibrium, which maximizes overall welfare. If the break-even interest rate is too high for some households to expect a positive net utility from borrowing, we have a separating equilibrium: only a subset of risky borrowers has access to credit (*adverse selection*). A separating equilibrium is inefficient because, due to the information asymmetry, it leaves worthy entrepreneurs without the funds required to start their project and we observe underinvestment (given our assumptions, it would always be socially efficient to extend loans to all borrowers).

Let us first derive the problem of moneylenders expecting to serve the entire population. At equilibrium, they break even by equalizing the expected repayment from the loans extended to borrower with the opportunity cost of capital ('zero-profit constraint', or ZPC):

$$\pi p_s K r^{I,P} + (1-\pi) p_r K r^{I,P} = \gamma K \tag{1}$$

where the superscript I and P stand for individual lending and pooling equilibrium respectively, $r^{I,P}$ is the gross interest rate (principal plus net interest rate) and $\gamma > 1$ is the gross cost per unit lent (including bank's interest rate if moneylenders refinance in the formal sector or if they forego deposits). Above, we imposed that the investment of both types of household is socially profitable. Given the cost structure in (1), this condition can be written as:

$$\bar{R}K > \gamma K + \bar{u} \tag{2}$$

Would-be borrowers compute their net individual payoff from investment as:

$$U_i^{I,P} = p_i K(R_i - r^{I,P}). \tag{3}$$

Note that, 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 implicitely subsidized by the latter.

At a pooling equilibrium, the solution to (1) is

$$r^{I,P} = \frac{\gamma}{\bar{p}} > 1 \tag{4}$$

where $\bar{p} = \pi p_s + (1-\pi) p_r$ is the average individual probability of success of households. Intuitively, the break-even interest rate decreases with the proportion of safe individuals π and the probabilities of success p_i. Given (2), it is easy to check that risky households always borrow at this rate. On the contrary, if $r^{I,P}$ is too high, safe borrowers might not able to derive a positive expected payoff from

[10] The zero-profit constraint that we use can be seen as a reduced form of a profit maximization problem under perfect competition or Bertrand competition (with all lenders facing the same technology). Alternatively, it could be derived from utility maximization problem of altruistic moneylenders (e.g. not-for-profit institutions).

[11] As a tie-breaking rule, we assume that, if borrowers are indifferent between borrowing and enjoying the reservation income, they choose the first option and carry out their investment ('appetite for entrepreneurship').

investment. We then observe a separating equilibrium (S) and moneylenders break-even if

$$(1-\pi)p_r K r^{I,S} = \gamma(1-\pi)K \iff r^{I,S} = \frac{\gamma}{p_r} > 1. \tag{5}$$

That is, when lenders anticipate that safe borrowers don't apply at $r^{I,P}$, the equilibrium interest rate increases due to the higher probability of default in their pool of borrowers. We can now assess the conditions of existence of the two different equilibria that we have characterized.

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

Proof. Given (3), safe borrowers will be excluded from the market whenever $U_s^{I,P} = p_s K(R_s - r^{I,P}) < \bar{u} \iff \frac{p_s}{\bar{p}}\gamma K > \bar{R}K - \bar{u}$. Anticipating the higher riskiness of their borrower pool, lenders then charge $r^{I,S}$. At that rate, risky borrowers choose to borrow since $\bar{R}K - \gamma K > \bar{u}$ given (2). That situation is inefficient because safe types are excluded although they have socially valuable projects. ■

As a conclusion, the likelihood of adverse selection increases with the cost of capital (because safe borrowers expect to bear it more often than risky borrowers), the proportion of risky borrowers in the population and their effective riskiness. It decreases with the riskiness of safe borrowers, because safe borrowers then anticipate to pay less often the interest rate that reflects only partially their own riskiness (appendix A.1 works out the derivatives). Finally, the higher the difference between safe wage and expected return from investment 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 state of local markets for goods and services, and the education of households - all of which are left outside this model.

5 Equilibrium with group lending

We now turn to the problem of a lender that lends to groups that are collectively responsible for repayment (joint liability). That is, although loans are still individual and every borrower is still responsible for paying back her own loan, successful group members have in addition to pay for (part of) the obligations of defaulting partners. As is well known, this is a scheme that is widely used by microfinance institutions around the world in order to mitigate information asymmetries.Formally, we define a joint-liability debt contract as a contract (r^J, c), where $r^J > 1$ is the interest rate and $c > 0$ is the per-unit indemnisation that a successful group member has to pay if her mate cannot repay her loan.[12]

We model group lending as the following game. First, the (unsubsidized) risk-neutral lenders ('MFIs') choose joint-liability contracts that satisfy zero expected profit and credibility constraints (see below).[13] Second, borrowers who agree on those terms form groups and take up a loan. Third, as before, investment takes place, Nature decides about the realizations and lenders get reimbursed according to contract terms. To simplify analysis, we assume borrowers have to form groups of two, which is a standard assumption in the literature (see e.g. Ghatak 1999 or Laffont and N'Guessan 2000).

Either because borrowers know well each other whithin a tightly-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 typically pair up with same types. Intuitively, this is because borrowers expecting their project to be successful will want to avoid having to repay for defaulting peer as much as possible. In other words, 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 (e.g. Ghatak and Guinanne 1999).[14]

[12] In practice, there are differences in the way how microfinance institutions enforce joint liability contracts. Sometimes, they require the group to pay a fixed penalty in case of one member's default. In this case, the interpretation of c is litteral. However, the form of joint liability for defaults in actual group-lending programmes often takes the form of denying future credit to all group members in case of default by one member, until the loan is repaid. Usually, the defaulting members pay back their obligations to other group members (Huppi and Feder 1990), but with a delay. In our static framework, the term c can then be interpreted as the net present discounted value of the cost of sacrificing consumption during the 'grace period' in order to pay joint liability for a partner. Note that this cost exists precisely because of the credit market imperfection (Gangopadhyay et al. 2005).

[13] If MFIs are subsidized, the effect presented in the model would be reinforced since they would enjoy lower cost of lending and hence increase their supply of funds to safe individuals).

[14] Note that Sadoulet (1999) and Guttman (2008) show that this property does not necessarily hold if borrowers are denied future access to credit in case of group's default (dynamic framework) and if side payments are possible.

Given assortative matching at the group formation stage, MFIs contemplating lending to the entire population face homogenous groups (S,S) and (R,R) with probability π and $(1-\pi)$ respectively, so that the ZPC writes:

$$\left[p_s K r^{J,P} + (1-p_s)p_s K c\right]\pi + \left[p_r K r^{J,P} + (1-p_r)p_r K c\right](1-\pi) = \gamma K \tag{6}$$

where the superscript J stands for joint liability. Note that, for simplicity, we implicitly focus on the set of feasible joint-liability payments, which successful borrowers can always pay for (given limited liability): $r^{J,P} + c \leq R_s$. [15].

We impose the additional constraint that the amount of joint liability is never greater than the amount of individual liability, s.t. the contract is incentive-compatible ex-post[16]:

$$c \leq r^{J,P}. \tag{7}$$

The net individual payoff from investment to borrowers is then:

$$U_i^{J,P} = p_i K(R_i - r^{J,P} - (1-p_i)c) \tag{8}$$

Under joint liability, risky borrowers still anticipate a lower probability of repayment than safe borrowers. However, they now bear an additional cost because their partner defaults more often than in safe borrowers' groups. That is, although the explicit rate is the same for every borrower in the market, MFIs are able to implicitly charge a lower interest rate to safe borrowers and a higher interest rate to risky borrowers. Yet, we show in appendix A.2 that the utility of risky borrowers is still always higher than for safe individuals.

At a pooling equilibrium, the equilibrium interest rate is:

$$r^{J,P} = \frac{\gamma}{\bar{p}} - \frac{c}{\bar{p}}(\bar{p} - \pi p_s^2 - (1-\pi)p_r^2) > 1 \tag{9}$$

and the range of joint-liability payments that satisfy our assumptions is:

$$0 < c \leq \frac{\gamma}{2\bar{p} - \pi p_s^2 - (1-\pi)p_r^2}.$$

Note that the last condition is actually sufficient to ensure that the joint-liability contract is feasible ($r^{J,P} > 1$), which is proved in appendix A.3.

As is obvious from (9), the joint liability technology allows a reduction in interest rate because it decreases the probability for the lender not to be reimbursed ('insurance effect'). Even though risky borrowers expect to pay more of those insurance payments than safe borrowers, their overall payments are lower in expected terms and $r^{J,P}$ is still decreasing in π and p_i (formal proof in appendix A.1).

At a separating equilibrium, MFI de facto faces homogenous groups of risky individuals, and the break-even interest rate is

$$\left[p_r K r^{J,S} + (1-p_r)p_r K c\right](1-\pi) = \gamma(1-\pi)K \iff r^{J,S} = \frac{\gamma}{p_r} - (1-p_r)c > 1 \tag{10}$$

Again, it is easy to see that this rate is lower than in the individual-lending case. One can also show that $r^{J,S} > r^{J,P}$: although lenders are partially insured against default thanks to joint liability, this obviously happens only if one member is successful, s.t. lenders still expect higher default rates from risky borrowers overall - see appendix A.4 for a formal proof.

[15] This condition is not needed to get our results but eases their presentation because it ensures that an equilibrium on the group lending market always exists, s.t. mixed markets can indeed be discussed. Moreover, it is typically implied by conditions (7) and (2) - but not always, e.g. if success probability of risky borrowers is very low (see appendix A.3 for a formal discussion).

[16] Taking an amount of joint liability lower than the amount of individual liability seems to make sense, in order to avoid e.g. that successful partners of failing borrowers prefer to declare their partner to be successful (see Gangopadhyay et al. 2005). Not surprisingly, this seems to be in line with what group-lending programmes do in practice anyway. It implies that an increase (decrease) in the probabilities of success will result in an decrease (increase) in the interest rate charged by MFIs, as the higher (lower) expected repayment will dominate the lower (higher) joint-liability payments (see appendix A.1 for a formal exposition). In our model, a direct consequence is that risky borrowers will be better off at a joint pooling equilibrium than at an individual separating equilibrium, which is shown in section 6. Finally, assumption (7) ensures that the joint-liability contract in our model is feasible, in the sense that the gross interest rate is always greater than unity (also see appendix A.3).

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

Proof. Given that the utility of risky borrowers is always higher than for safe individuals (see appendix A.2), a separating equilibrium will still involve risky individuals only. It will happen if $U_s^{J,P} = \bar{R}K - p_s K(r^{J,P} - (1-p_s)c) < \bar{u} \iff \bar{R}K - \frac{p_s}{\bar{p}}(\gamma K) + cK\frac{p_s}{\bar{p}}(\bar{p} - \pi p_s^2 - (1-\pi)p_r^2 - \bar{p}(1-p_s)) < \bar{u} \iff \bar{R}K - \bar{u} < \frac{p_s}{\bar{p}}(\gamma K - cK(1-\pi)p_r(p_s - p_r))$. Finally, the utility of risky borrowers at a separating equilibrium is: $U_r^{J,S} = \bar{R}K - \gamma K > \bar{u}$ (given 2), so that risky borrowers always apply. ■

As is obvious from proposition 2, the range of parameters - π, p_i - which gives rise to pooling equilibria increases with respect to the individual-lending case (see appendix B for a graphical illustration). That is, the group-lending technology limits adverse selection by allowing lenders to implicitly charge a lower interest rate for safe borrowers - thereby relaxing their participation constraint.[17] However, it is unable to avoid completely the exclusion of worthy safe borrowers. As previously, the likelihood of adverse selection increases with the cost of capital, the proportion of risky borrowers in the population and their riskiness. However, in contrast to the individual-lending case, the probability of success of safe borrowers reduces the likelihood of their exclusion because it decreases the expected amount of joint-liability payments besides the interest rate itself (see appendix A.1).

6 Equilibrium in the mixed market

From the discussion of the two previous sections, we can summarize borrowers' preferences as follows.

Lemma 1 *If such loans are available, safe borrowers always prefer borrowing in groups (from MFIs). If a pooling equilibrium exists under individual lending, risky borrowers prefer borrowing from moneylenders, whereas they prefer borrowing from MFIs in case of a separating equilibrium in the individual-lending market.*

Proof. We distinguish 3 possible cases.

1. If $\bar{R}K - \bar{u} \geq \frac{p_s}{\bar{p}}\gamma K$, we have pooling equilibria both with group lending and individual lending.

   In this case, we have that $U_s^{J,P} > U_s^{I,P}$ iff $\bar{R}K - \frac{p_s}{\bar{p}}\gamma K + cK\frac{p_s}{\bar{p}}(\bar{p}p_s - \pi p_s^2 - (1-\pi)p_r^2) > \bar{R}K - \frac{p_s}{\bar{p}}\gamma K \iff cK\frac{p_s}{\bar{p}}(1-\pi)p_r(p_s - p_r) > 0$, which is always satisfied. Conversely, we have that $U_r^{J,P} < U_r^{I,P}$ iff $\bar{R}K - \frac{p_r}{\bar{p}}\gamma K + cK\frac{p_r}{\bar{p}}(\bar{p}p_r - \pi p_s^2 - (1-\pi)p_r^2) < \bar{R}K - \frac{p_r}{\bar{p}}\gamma K \iff cK\frac{p_r}{\bar{p}}\pi p_s(p_r - p_s) < 0$, which is always the case (whatever the specific contract terms $(r^{J,P}, c)$).

2. If $\frac{p_s}{\bar{p}}(\gamma K - cK(1-\pi)p_r(p_s - p_r) \leq \bar{R}K - \bar{u} < \frac{p_s}{\bar{p}}\gamma K$, a pooling equilibrium is feasible under group lending but not under individual lending.

   In that case, safe borrowers are obviously better off borrowing at MFI. As for risky borrowers, we have that $U_r^{J,P} > U_r^{I,S}$ iff $\bar{R}K - \frac{p_r}{\bar{p}}K(\gamma - c(\bar{p} - \pi p_s^2 - (1-\pi)p_r^2)) - p_r(1-p_r)cK > \bar{R}K - \gamma K \iff \gamma K(1 - \frac{p_r}{\bar{p}}) + \frac{p_r}{\bar{p}}cK\pi p_s(p_r - p_s) > 0 \iff \gamma > p_r p_s c$, which is satisfied given (7) - appendix A.1.2 shows this. Hence risky borrowers prefer group lending over individual lending because the lower interest rate outweighs the extra expected joint-liability payments.

3. Finally, if $\bar{R}K - \bar{u} < \frac{p_s}{\bar{p}}(\gamma K - cK(1-\pi)p_r(p_s - p_r)$, we have a separating equilibrium even under group lending, and the lower interest rate is exactly compensated by the expected extra joint liability payments for risky borrowers: $U_r^{J,S} = U_r^{I,S} = \bar{R}K - \gamma K$, such that borrowers are indifferent between borrowing in groups or individually.

■

Now consider the following situation. In a given geographical area, capital-constrained households have the opportunity to take up individual loans from traditional moneylenders (ML) or to participate in group loans organized by a group-lending institution (MFI). In that situation (and given risk neutrality), each lender has to guarantee at least the same utility level to borrowers than its competitors - or exit the

[17] In the special case in which potential borrowers don't 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. Indeed, using our model, it is easy to show that lower interest charges are then exactly compensated by expected joint liability payments (see also Laffont and N'Guessan 2000). However, this conclusion might not hold in the presence of correlation between entrepreneurs' returns (see Laffont 2000).

market. Specifically, every mixed-market equilibrium has to satisfy the following sets of participation and incentive-compatibility constraints.

$$
\begin{array}{ll}
U_i^L \geq \bar{u} & \forall i = r, s \text{ and } L = I, J \text{ s.t. agent i borrows a positive amount from lender L} \\
U_i^I > U_i^J \ (U_i^J > U_i^I) & \forall i = r, s \text{ s.t. agent i borrows primarily from ML (MFI)} \\
U_i^I = U_i^J & \forall i = r, s \text{ s.t. agent i borrows equally from both lenders}
\end{array}
$$

Yet, a direct consequence of lemma 1 is that, given its better lending technology, MFI attracts all types of borrowers as soon as it is in a pooling equilibrium situation, thus pushing ML out of business. This is because, in mixed markets, only separating equilibria can de facto be sustained under individual lending, in which even risky borrowers prefer to borrow in groups. In order to have non trivial - and more realistic - solutions, we relax the hypothesis of infinite supply of funds and impose a (simple) constraint on fund availability to MFI. Let $0 < \alpha < \pi < 1$ be the financing capacity of MFI (which depends, say, on the amount of savings from members or on external funding sources). The individual-lending market has no financing constraint. That is, though borrowers might have to compete to get funds from their prefered 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 constraint does not modify any of the results that we derived earlier. For instance, MFI's ZPC when serving all borrowers is $\left(p_s \alpha K r^J + (1-p_s) p_s \alpha K c\right) \pi + \left(p_r \alpha K r^J + (1-p_r) p_r \alpha K c\right)(1-\pi) = \gamma \alpha K$, which is identical to (6).

Let us now discuss the different possible market configurations, along quantity and price dimensions. Table 4 summarizes each lender's pool of borrowers and the impact of MFI's entry in the credit market. Starting in the upper-left cell and rotating clockwise, we find the following situations.

1. If capital cost or risky borrowers' riskiness and size in the population are so high that MFI cannot offer a pooling equilibrium either, MFI and ML compete exclusively for risky borrowers. The presence of the other lender in the market does not change their respective ZPC since both lenders expect to serve a scaled-down pool of unchanged riskiness. Therefore, MFI and ML still break-even at $r^{I,S}$ and $r^{J,S}$ respectively. From lemma 1, we know that risky borrowers are indifferent between the two lending technologies in that situation. 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 residual interest rate since the composition of ML's pool is unaffected.

2. If a separating equilibrium exists in the ML's market and group-lending is able to achieve a pooling equilibrium, MFI can potentially limit credit rationing and attract unserved safe investors back to the market. Yet, in that situation, we know from lemma 1 that it also attracts the risky borrowers who prefer borrowing in groups than borrowing individually. 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 making losses: $(1-\alpha)(1-\pi)p_r K r^{I,P} < \gamma(1-\alpha)K$ given the separating equilibrium situation (see proposition 1). Unserved risky borrowers borrow from ML at $r^{I,S}$. Hence, MFI has no effect on the residual interest rate but increases coverage by serving some safe borrowers who would be excluded under individual-lending. Note that MFI also increases welfare in the Pareto sense since it makes (some) risky borrowers better off without reducing the utility of any other agent.

3. If a pooling equilibrium exists in the market of individual loans, lemma 1 tells that safe borrowers prefer borrowing in groups and risky borrowers prefer borrowing individually. Hence, MFI's presence affects the pooling equilibrium of the individual-lending market. Since ML expects to serve a lower fraction of safe borrowers, its break-even interest rate increases to satisfy the new ZPC:

$$(1-\alpha)\pi p_s K r^{I,P\alpha} + (1-\pi)p_r K r^{I,P\alpha} < \gamma(1-\alpha\pi)K \iff r^{I,P\alpha} = \frac{\gamma(1-\alpha\pi)}{\bar{p} - \alpha\pi p_s}. \tag{11}$$

Unserved safe borrowers borrow from ML if the following participation constraint is satisfied:

$$U_s^{I,P\alpha} = \bar{R}K - p_s \frac{\gamma K(1-\alpha\pi)}{\bar{p} - \alpha\pi p_s} > \bar{u}. \tag{12}$$

We then need to check the incentive-compatibility constraint of risky borrowers. Risky agents prefer borrowing individually at the (modified) pooling equilibrium than borrowing in group at the (standard) pooling equilibrium if:

$$U_r^{I,P\alpha} = \bar{R}K - p_r \frac{\gamma K(1-\alpha\pi)}{\bar{p}-\alpha\pi p_s} > U_r^{J,P} \iff c > \frac{\alpha\pi(p_s-\bar{p})}{(\bar{p}-\alpha\pi p_s)\pi p_s(p_s-p_r)}\gamma. \tag{13}$$

In that case, MFI serves safe borrowers up to its financing capacity and ML serves unserved safe borrowers and all risky borrowers at rate $r^{I,P\alpha}$. The residual interest rate increases with respect to the stand-alone situation and coverage is unchanged. If condition (13) is not satisfied, both lenders serves all borrowers and the composition of their respective pools does not change. Hence, residual interest rate and coverage remain unaffected by MFI's presence in the market.

Finally, if the participation constraint (12) is not satisfied, ML is de facto at a separating equilibrium and increases its interest rate to $r^{I,S}$ in order to break-even. In that case, we know from lemma 1 that risky borrowers prefer borrowing in groups. Hence, MFI serves all borrowers up to its financing constraint at rate $r^{J,P}$ and ML serves unserved risky borrowers at rate $r^{I,S}$. The residual interest rate increases and coverage decreases because some safe borrowers become excluded while they would have been served in MFI's absence.

Table 4: Lenders' expected clients and MFI's impacts in mixed competitive markets

IL \MFI			separating	pooling
separating			*clients:* $[(0,(1-\alpha)(1-\pi));$ $(0,\alpha(1-\pi))]$ *impact:* 0	*clients:* $[(0,(1-\alpha)(1-\pi));(\alpha\pi,\alpha(1-\pi))]$ *impact:* Δ^+ coverage
pooling	cond.(12) KO		impossible	*clients:* $[(0,(1-\alpha)(1-\pi));(\alpha\pi,\alpha(1-\pi))]$ *impact:* Δ^+ interest and Δ^- coverage
	cond.(12) OK	cond.(13) OK		*clients:* $[((1-\alpha)\pi,(1-\pi));(\alpha,0)]$ *impact:* Δ^+interest
		cond.(13) KO		*clients:* $[((1-\alpha)\pi,(1-\alpha)(1-\pi));$ $(\alpha\pi,\alpha(1-\pi))]$ *impact:* 0

Note: '*clients*' is to be read 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)].

This completes the first part of our model. Before turning to the market power case, let us state the main messages of our discussion so far.

Conclusion 1 Coverage
If MFI achieves pooling equilibria, they attract safe borrowers away from ML, which can lead to an increase or a decrease in the coverage of borrowers by the credit market.
Coverage increases *if individual lending excludes safe borrowers (separating equilibrium). But coverage* decreases *if a pooling equilibrium is feasible under individual lending when ML is alone and impossible when MFI is present in the market.*

Conclusion 2 Residual interest rate
If MFIs achieve pooling equilibria, they attract safe borrowers away from ML. As a result, if ML is serving all borrowers when alone in the market (pooling equilibrium), it has to increase *interest rate, except if risky borrowers also prefer to borrow from MFI in the mixed market situation.*

An illustration is given in appendix B, which displays the interest rate charged by the two types of lenders when standing alone (solid lines) or when sharing the market (small-dot line), for a varying proportion of safe borrowers in the population.

7 Market power

In this section, we relax one of the major assumptions of the previous analysis, namely that moneylenders follow a zero-profit rule.[18] We then answer to the same question as before regarding the consequence of the entry of a group-lending institution (MFI) in the market. We first present the individual decision problem of a monopolist individual lender (ML), and then analyze the competition with a not-for-profit MFI.

Henceforth, we assume the following tie-breaking rule: when borrowers are indifferent between supplying their labour externally and carrying out their own investment, they choose the second option.

7.1 Individual lending under monopoly

The monopolist maximizes profit:

$$\max_r \Pi = D(r)p(r)r^{ML} - \gamma D(r) \text{ s.t. } \Pi \geq 0 \tag{14}$$

where

$$D(r) = \begin{cases} K & \text{if } r \leq r_s^{I,\max} \\ (1-\pi)K & \text{if } r \leq r_r^{I,\max} \\ 0 & \text{if } r > r_r^{I,\max} \end{cases}$$

is the (non linear) demand function and

$$p(r) = \begin{cases} \bar{p} & \text{if } r \leq r_s^{I,\max} \\ p_r & \text{if } r \leq r_r^{I,\max} \\ 0 & \text{if } r > r_r^{I,\max} \end{cases}$$

Facing this problem, the monopoly lender has 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 of entrepreneurs (regime 2) - not supplying anything can never be profit maximizing given the efficiency assumption.

If it serves only risky, then it is optimal to set $r_r^{I,\max}$ s.t. $p_r(R_r K - r_r^{I,\max} K) = \bar{u}$, which leads to the equilibrium interest rate $r_r^{I,\max} = \frac{\bar{R}K - \bar{u}}{p_r K}$ and a profit equal to $\Pi^{ML,1} = (1-\pi)\left[\bar{R}K - \bar{u} - \gamma K\right]$ (which is always positive given 2). Whereas if it serves both types of households, it is optimal to set $r_s^{I,\max} = \frac{\bar{R}K - \bar{u}}{p_s K}$, yielding a lender's profit $\Pi^{ML,2} = \frac{\bar{p}}{p_s}(\bar{R}K - \bar{u}) - \gamma K$ (which can be negative).

Regime 1 has the virtue that the lender can extract all the surplus from risky types. Yet, the expected losses from financing only risky borrowers might be so high that regime 2 is actually more profitable. We derive the following proposition:

Proposition 3 *The monopolist enjoying monopoly power serves the entire market (regime 2) if* $\pi\gamma K < (\bar{R}K - \bar{u})(\frac{\bar{p}}{p_s} - 1 + \pi)$, *and serves only risky borrowers (regime 1) otherwise.*

Proof. We have that regime 1 yields a higher profit than regime 2 iff $\Pi(regime1) > \Pi(regime2) \iff (1-\pi)(\bar{R}K - \bar{u} - \gamma K) > \frac{\bar{p}}{p_s}(\bar{R}K - \bar{u}) - \gamma K \iff (\bar{R}K - \bar{u})(1 - \pi - \frac{\bar{p}}{p_s}) + \pi\gamma K > 0.$ ■

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 a pooling equilibrium. To 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 4, it is easy to check that a monopolist always rations credit more often than a competitive moneylender would do.

Under regime 1, utility of all borrowers is equal to ū. In the pooling equilibrium (regime 2), the utility of borrowers is given by

$$U_i^{ML,2} = p_i K(R_i - \frac{\bar{R}K - \bar{u}}{p_s}) \tag{15}$$

such that the moneylender extracts all surplus from safe borrowers ($U_s^{ML,2} = \bar{u}$) and leaves a positive surplus to risky borrowers ($U_r^{ML,2} = \bar{R}K - p_r\frac{\bar{R}K - \bar{u}}{p_s} > \bar{u}$).

[18] Evidence about the extent of moneylenders' market power is actually not clear-cut. Informal Þnance has been documented as competitive (Adams et al. 1984, Banerjee 2003), monopolistically competitive (Aleem 1990), and as a monopoly (Bhaduri 1977, Bolnick 1992).

7.2 Equilibrium in the mixed market: competition monopolistic moneylender (ML) vs. not-for-profit MFI

As before, we consider the situation in which ML is facing the presence of a lender (MFI) who uses the group-lending technology such as described in section 5. We still assume that MFI has a financing capacity equal to $0 < \alpha < \pi < 1$ and that ML has no financing constraint. From lemma 1, we know that safe borrowers always prefer borrowing in groups than individually (even if the lender makes zero profit), so ML cannot prevent them from leaving his pool. That is, ML has no choice but to focus on risky borrowers. The interest rate it is able to set depends on the nature of the equilibrium in the group-lending market and the MFI's financing capacity. Let us review the different scenarios, which are summarized in table 5 below.

1. When the stand-alone ML chooses regime 1 and the MFI is at a separating equilibrium (because of high capital costs or high proportion of risky borrowers), the two lenders are perfectly competing for the same pool of risky borrowers. Then, if $\alpha \geq (1-\pi)$, ML has no choice but to cut its profits to zero and charge $r^{I,S}$ such that risky borrowers are indifferent between the two lending technologies (see lemma 1). However, if $\alpha < (1-\pi)$, ML can still make profits by serving the unserved risky at rate $r_r^{I,\max}$. Microfinance is welfare-improving in this last case. Yet, in any situation, microfinance has no effect on coverage and the credit market is inefficient.

2. When the stand-alone ML chooses regime 1 and the MFI is at a pooling equilibrium, lemma 1 indicates that ML cannot prevent risky borrowers from switching to MFI. That is, both types of borrowers apply at MFI and the only effect of MFI is to scale down the size of the borrower pool. Since the expected relative riskiness of its pool doesn't change, ML still focuses on risky borrowers and charges the same interest rate $r_r^{I,\max}$. As a result, MFI increases welfare by making (some) safe borrowers better-off without making other agents worse-off. MFI increases coverage by attracting some safe borrowers back to the market, though its impact is suboptimal compared to if it could serve exclusively safe borrowers.

3. In case ML chooses regime 2 when standing alone, MFI is necessarily in a pooling situation. We know that safe borrowers are unambiguously better-off at MFI. Yet, ML can hope to attract risky clients if it leaves them at least the utility they get when borrowing at MFI:

$$U_r^{ML,MFI} \geq U_r^{J,P} \iff \bar{R}K - p_r r^{ML,MFI} K \geq \bar{R}K - \frac{p_r}{\bar{p}}\gamma K + cK\frac{p_r}{\bar{p}}(\bar{p}p_r - \pi p_s^2 - (1-\pi)p_r^2) > \bar{u}$$
$$\iff r^{ML,MFI} \leq \frac{\gamma}{\bar{p}} - \frac{c}{\bar{p}}(\bar{p}p_r - \pi p_s^2 - (1-\pi)p_r^2).$$

   Note that $r_r^{I,\max} > r^{ML,MFI}$, which indicates that (i) ML has to leave some surplus to risky borrowers, and (ii) risky will always accept this contract. Besides, $r^{ML,MFI}$ can be lower or greater than $r_s^{I,\max}$, indicating that, when ML adopts regime 2, risky borrowers might or might not prefer borrowing at MFI. Ceteris paribus, risky types will be better off borrowing at MFI if the amount of joint liability is low and if risk heterogeneity among the population is high - see appendix A.5. Importantly, since we know that the stand-alone ML is more likely to choose regime 2 the more homogenous are the risk types in the population, it is also likely that risky types prefer borrowing individually than in groups.

   Yet, $r^{ML,MFI}$ is never an equilibrium rate. Indeed, if $r^{ML,MFI} > r_s^{I,\max}$, safe borrowers who are not served by the MFI cannot borrow from ML, who then serves only risky borrowers. However, we know from lemma 1 that, when only risky types are borrowing, ensuring them the same utility as when they borrow at MFI would require ML to make negative profits. Hence, ML has the same two options as in the standard case - but with different demand function and repayment probabilities. The first option is to increase the interest rate to $r_r^{I,\max}$, and serve the fraction of the risky population who cannot get funds from the MFI (at that rate, risky types are better off borrowing at MFI so that they will share MFI's funds with safe types). In this case, the demand function is $(1-\alpha)(1-\pi)K$ and the repayment probability is p_r.The second option is to decrease the interest rate to $r_s^{I,\max}$, and serve the entire risky population (who is now better off at ML given $r^{ML,MFI} > r_s^{I,\max}$) and $(\pi-\alpha)$ safe borrowers. In that case, the demand function is $(1-\alpha)K$ and the repayment probability becomes $(\pi-\alpha)p_s + (1-\pi+\alpha)p_r$. Option 2 gives a higher profit than option 1 iff:

$$\alpha < \pi \text{ and } ((\pi-\alpha)p_s + (1-\pi+\alpha)p_r)\frac{\bar{R}K-\bar{u}}{p_sK}(1-\alpha)K - \gamma(1-\alpha)K > (1-\pi)(\bar{R}K-\bar{u}-\gamma K)$$
$$\iff (1-\alpha)((\bar{R}K-\bar{u})(\pi-\alpha+(1-\pi+\alpha)\frac{p_r}{p_s}) - \gamma K) > (1-\pi)(\bar{R}K-\bar{u}-\gamma K)$$

which is never satisfied. That is, whenever $r^{ML,MFI} > r_s^{I,\max}$, ML chooses option 1, i.e. it increases interest rate and focuses on risky borrowers who cannot get funds from MFI. Moreover, given $\alpha < \pi$, the presence of MFI decreases coverage by excluding some safe borrowers who would have been served by the stand-alone ML. To the contrary, if $r^{ML,MFI} < r_s^{I,\max}$, risky borrowers prefer borrowing at MFI and proposition 3 holds true (cf. case 2). Given that he was choosing regime 2 when being alone in the market, he will still serve the entire population that is not served by MFI at rate $r_s^{I,\max}$. In this case, the MFI's presence has no effect on interest rate nor coverage, but increases welfare.

Table 5: Expected clients of the monopolist individual lender and impacts of MFI in mixed markets

IL \MFI	separating	pooling
regime 1	*clients:* $[(0,(1-\alpha)(1-\pi));(0,\alpha(1-\pi))]$ *impact:* Δ^-interest if $\alpha \geq 1-\pi$	*clients:* $[(0,(1-\alpha)(1-\pi));(\alpha\pi,\alpha(1-\pi))]$ *impact:* Δ^+coverage
regime 2	impossible	*clients:* $[(0,(1-\alpha)(1-\pi));(\alpha\pi,\alpha(1-\pi))]$ *impact:* Δ^+interest and Δ^-coverage

Notes: '*clients*' is to be read 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)]. Regimes 1 and 2 refer to the choice of the stand-alone ML, such as defined in proposition 3. Pooling and separating equilibria depend on whether the constraint of participation to group lending of safe borrowers is respectively satisfied or not, such as defined in proposition 2.

Hence we see that the entry of an MFI on a monopolistic credit market can have very different impacts on interest rates and coverage, according to the initial situation of the market and the availability of funds of the MFI. It can go from a pure composition effect that increases interest rate and possibly decreases coverage - if the monopolist was serving safe borrowers and risky types prefer borrowing individually than in groups to start with, to a pure competition effect that decreases the interest rate on the residual market - if the MFI cannot attract safe borrowers (separating equilibrium) and has enough funds to serve the entire risky population. In all intermediate cases, the MFI has no impact on the interest rate of the residual market but increases welfare. Regarding the likeliness of the composition and the competition cases, we can combine the predictions of sections 5 and 7 in order to sate the following.

Conclusion 3 Coverage
When facing the competition of a (not-for-profit) lender using group lending, a profit-maximizing moneylender has no choice but to focus on risky borrowers. This will increase *credit coverage if the stand-alone moneylender rations credit access (regime 1). But coverage* decreases *if the stand-alone moneylender does serve safe borrowers (regime 2) and microfinance does not have enough funds to serve the entire population of safe borrowers.*

Conclusion 4 Residual interest rate
When facing the competition of a (not-for-profit) lender using group lending, a profit-maximizing moneylender has no choice but to focus on risky borrowers. This can have two antagonist effects on the interest rate of the residual market.

1. *A competition effect, which drives the interest rate* down. *This happens if, other things being equal, capital cost is high or the average success probability in the population is low (i.e. if the population contains a lot of very risky types), s.t. safe borrowers are excluded from the credit market whatever the lending technology, and if the MFI has enough funds to serve the entire population of risky borrowers, s.t. it competes exactly for the same pool of borrowers with the monopolist.*

2. *A composition effect, which drives the interest rate* up. *This happens if, other things being equal, the average success probability in the population is high (i.e. risk heterogeneity of the population or*

the proportion of risky types are low), s.t. safe types are always able to borrow whatever the lending technology, and if the amount of joint liability is important, s.t. the MFI brings a real difference with respect to individual lending. Under these circumstances, the monopolist can charge a higher interest rate because of the selection away of good types by the MFI (though making a lower profit than when standing alone in the market).

Appendix B gives a summary of the results obtained in the different cases presented in the model, by means of a simulation.

8 Conclusion

There is no doubt that microfinance has managed expanding access to finance in poor areas worldwide. One of the distinctive feature that allowed this success is the practice of group lending, which is to be found in most microfinance programmes (such as, to name only the most famous, the Grameen Bank in Bangladesh, BancoSol in Bolivia, FINCA in Peru, NABARD in India or Bank Kredit Desa in Indonesia). However, while focusing on direct stakeholders, the existing literature has not yet touched the redistributive aspects of the microfinance revolution. Given the almost-universal coexistence of MFIs and traditional lenders in developing countries, it is important to analyse how they modify equilibria on rural credit markets and how they affect the access to credit of non participants. Once we take a market-wide view, it is indeed not clear that microfinance can be welfare-improving. In fact, field observations as the ones presented in this paper indicate that informal lenders can charge higher interest rates when MFIs are present in the same market than when they stand alone. This work is thus a contribution to the issue.

We used an adverse selection model, with moneylenders supplying individual loans and MFIs operating joint liability schemes. In the standard version of the model, lenders are in a competitive environment and make zero profit. In this case, it was shown that, if there is assortative matching at the group formation stage, group lending institutions considerably modify the market. Since they always increase utility of safe borrowers, MFIs increase welfare and efficiency by attracting constrained safe borrowers back to the market, if any. Yet, safe borrowers who already borrowed from moneylenders will switch to MFI upon its opening, leading to an increase in the riskiness of the moneylenders' pool of borrowers. As a consequence, informal lenders have to raise the interest rate of the residual market in order to avoid making losses in expected terms. Moreover, microfinance can decrease coverage in that case, if it does not have enough funds to serve the entire safe population. Finally, provided MFIs have enough funds, we have also shown the theoretical possibility that MFIs attract all types borrowers, leaving moneylenders out of business. However, this last result is driven from the simple structure of the model, mainly the two types of borrowers and the constant capital cost.

When lenders have market power, they can choose to serve all borrowers or only risky ones, depending on which strategy gives them the highest profit. Once a zero-profit, group-lending institution settles in the market, a monopolist individual lender can attract risky individuals only. As a result, depending on the choice he was making in the pre-entry situation, the impact of the MFI's entry can be to force the monopolist to cut its interest rate (competition effect), or to give up supplying credit to relatively safe borrowers and raising its interest rate (composition effect). We showed that the second effect dominates the former, meaning that the impact of MFIs' entry is to increase the interest rate of the individual-lending market, if the joint liability payments asked by the MFI are relatively high (i.e. the two lending technologies are well-differentiated), and if capital cost, the risk heterogeneity in the population and the proportion of risky borrowers are not too high (leading the monopolist to serve all risk types in the first place). Moreover, microfinance can decrease coverage if the moneylender serves safe borrowers in the monopoly equilibrium and if the microfinance sector does not have enough funds to serve the entire population of safe borrowers.

Therefore, our model predicts that, in a real world setting with a continuum of risk types and limited funds, the likely effect of the development of microlenders using group-lending schemes is indeed to relax the credit constraint on relatively safe individuals (which is the classical effect emphasized in the literature), but also potentially to raise the interest rate and to decrease the coverage of the cream-skimmed residual market. The second effect will in fact arise if moneylenders have limited market power (such that the competition effect is weak) and/or if they optimally choose to serve relatively safe borrowers in a stand-alone situation (such that the quality of their pool of borrowers is adversely affected by the MFI). This means that poor borrowers who cannot access microfinance (e.g. because they are too safe or to the contrary because there are perceived as too risky by their fellows, because they are lacking social connections to set up a group, or simply because MFIs cannot supply the entire market due to limited funds) might well be hurt be its apparition. Finally, the effects that we emphasized in this paper - though our exposition framed them in a market-entry setting - are not one-shot events. In a mixed market, as soon as MFI sector increases lending (due to a subsidy, increased funds, or the entry of a new microlender), the individual-lending sector will experience the kind of composition effect that we highlighted in the paper, which is likely to generate a rise in interest rates on traditional credit markets (as in Bose 1998) or a reduction in credit coverage.

This neglected potential impact of microfinance is of big importance given the limited outreach of basic financial services in rural environments and the high interest rates that are often reported in traditional credit markets. It surely deserves serious empirical attention in the future. Interestingly, the different pieces of evidence presented in this paper indicate that the presence of MFIs in rural credit market does not lead to cheaper credit for non members but rather the contrary. Moreover, there seems to be a nonlinear effect of the number of such MFIs, which may be a consequence of the mechanisms put forward in the model.

Further research could generalize the model to continuous risk types. Also, one could introduce the possibility for MFIs to screen borrowers by varying the sizes of individual and joint liabilities (see Ghatak 2000). However, this should surely strengthen the composition effect of the present model given the further increase (decrease) of the utility of good (bad) types under joint lending that it would bring. In the same line, moral hazard issues could be studied as well by assuming imperfect monitoring of the lenders. Other studies have showed 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: the quality of the pool of borrowers in the residual market worsens, leading to interest rate increases in order to cover anticipated losses. By contrast, turning to a dynamic framework, in which borrowers and lenders would have repeated interactions, could affect the nature of group formation and hence the selection of good risks by MFIs. Furthermore, other competition frameworks could be envisaged, such as the competition between competitive moneylenders and a for-profit MFI (as this is a much-debated recent evolution of microcredit). Finally, the interaction with the formal sector, though less relevant in some low financial depth environments, is certainly an important issue to explore. As shown by Madestam (2009), if MFIs channel bank funds, they can can contribute to higher rent extraction from banks.

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A Mathematical appendix

A.1 Derivatives

This section provides the formal expressions for the variation of the various interest rates and adverse-selection thresholds in the text with respect to the risk parameters π and p_i.

A.1.1 Individual lending

Derivatives of the interest rate are obvious. Derivatives of the adverse selection threshold $A^I \equiv \frac{p_s}{\bar{p}}\gamma K$ are as follows.

1. $\frac{\partial A^I}{\partial \pi} = -\frac{p_s}{\bar{p}^2}\gamma K \frac{\partial \bar{p}}{\partial \pi} < 0$, given $\frac{\partial \bar{p}}{\partial \pi} > 0$.

2. $\frac{\partial A^I}{\partial p_s} = -\frac{p_s}{\bar{p}^2}\gamma K \frac{\partial \bar{p}}{\partial p_s} + \frac{\gamma K}{\bar{p}} > 0$.

   Indeed, using the fact that $\frac{\partial \bar{p}}{\partial p_s} = \pi$, $\frac{\gamma K}{\bar{p}}(1 - \frac{p_s}{\bar{p}}\frac{\partial \bar{p}}{\partial p_s}) > 0 \iff \frac{p_s}{\bar{p}}\frac{\partial \bar{p}}{\partial p_s} < 1 \iff (1-\pi)\frac{p_r}{p_s} > 0$, which is always true.

3. $\frac{\partial A^I}{\partial p_r} = -\frac{p_s}{\bar{p}^2}\gamma K \frac{\partial \bar{p}}{\partial p_r} < 0$, given $\frac{\partial \bar{p}}{\partial p_r} > 0$.

A.1.2 Group lending

Derivatives of the interest rate $r^{J,P} = \frac{\gamma}{\bar{p}} - \frac{c}{\bar{p}}(\bar{p} - \pi p_s^2 - (1-\pi)p_r^2)$ and the adverse selection threshold $A^J \equiv \frac{p_s}{\bar{p}}(\gamma K - cK(1-\pi)p_r(p_s - p_r))$ are as follows.

1. $\frac{\partial r^{J,P}}{\partial \pi} = -\frac{\gamma}{\bar{p}^2}\frac{\partial \bar{p}}{\partial \pi} - c\pi \frac{p_s^2}{\bar{p}^2}\frac{\partial \bar{p}}{\partial \pi} + c\frac{p_s^2}{\bar{p}} - c(1-\pi)\frac{p_r^2}{\bar{p}^2}\frac{\partial \bar{p}}{\partial \pi} - c\frac{p_r^2}{\bar{p}} < 0$.

   Indeed, using the fact that $\frac{\partial \bar{p}}{\partial \pi} = p_s - p_r$, $\frac{c}{\bar{p}}(p_s^2 - p_r^2) - \frac{\partial \bar{p}}{\partial \pi}\frac{1}{\bar{p}^2}(\gamma + cp_s^2\pi + cp_r^2(1-\pi) < 0 \iff (p_s - p_r)\left(\frac{c}{\bar{p}}(p_s + p_r) - \frac{\gamma}{\bar{p}^2} - \frac{c}{\bar{p}^2}(\pi p_s^2 - (1-\pi)p_r^2)\right) < 0$. Using (7), a sufficient condition for this is $\gamma\frac{\bar{p}(p_s+p_r) - \pi p_s^2 - (1-\pi)p_r^2}{2\bar{p} - \pi p_s^2 - (1-\pi)p_r^2} < \gamma$, which is always true.

2. $\frac{\partial r^{J,P}}{\partial p_s} = -\frac{\gamma}{\bar{p}^2}\frac{\partial \bar{p}}{\partial p_s} - c\pi\frac{p_s^2}{\bar{p}^2}\frac{\partial \bar{p}}{\partial p_s} + 2c\pi\frac{p_s}{\bar{p}} - c(1-\pi)\frac{p_r^2}{\bar{p}^2}\frac{\partial \bar{p}}{\partial p_s} < 0$.

   Indeed, replacing $\frac{\partial \bar{p}}{\partial p_s}$ by its value, we have $\frac{\pi}{\bar{p}^2}\left(c(\pi p_s^2 + 2(1-\pi)p_s p_r - (1-\pi)p_r^2) - \gamma\right) < 0$, which is always true given that the sufficient condition $\gamma\frac{\pi p_s^2 + 2(1-\pi)p_s p_r - (1-\pi)p_r^2}{2\bar{p} - \pi p_s^2 - (1-\pi)p_r^2} < \gamma \iff \pi p_s^2 + 2(1-\pi)p_s p_r < 2\bar{p} - \pi p_s^2$ is satisfied.

3. $\frac{\partial r^{J,P}}{\partial p_r} = -\frac{\gamma}{\bar{p}^2}\frac{\partial \bar{p}}{\partial p_r} - c\pi\frac{p_s^2}{\bar{p}^2}\frac{\partial \bar{p}}{\partial p_r} - c(1-\pi)\frac{p_r^2}{\bar{p}^2}\frac{\partial \bar{p}}{\partial p_r} + 2c(1-\pi)\frac{p_r}{\bar{p}} < 0$, by a symmetrical reasoning.

   Substituting $\frac{\partial \bar{p}}{\partial p_r}$ and using (7), we have that $\frac{1-\pi}{\bar{p}^2}\left(2c\pi p_s p_r + 2c(1-\pi)p_r^2 - c\pi p_s^2 - c(1-\pi)p_r^2 - \gamma\right) < 0 \iff c(2\pi p_s p_r - \pi p_s^2 + p_r^2 - \pi p_r^2) < \gamma \iff 2\pi p_s p_r + 2(1-\pi)p_r^2 - 2\bar{p} < 0 \iff \pi p_s(2p_r - 2) + (1-\pi)p_r(2p_r - 2) < 0 \iff 2\bar{p}(p_r - 1) < 0$.

4. $\frac{\partial A^J}{\partial \pi} = -\frac{p_s}{\bar{p}^2}\gamma K\frac{\partial \bar{p}}{\partial \pi} + cK(1-\pi)\frac{p_s}{\bar{p}^2}p_r(p_s - p_r)\frac{\partial \bar{p}}{\partial \pi} + cK\frac{p_s}{\bar{p}}p_r(p_s - p_r) < 0$.

   Indeed, replacing $\frac{\partial \bar{p}}{\partial \pi}$ by its value, $\frac{p_s - p_r}{\bar{p}}K\left(cp_s p_r + c(p_s - p_r)p_r(1-\pi)\frac{p_s}{\bar{p}} - \frac{p_s}{\bar{p}}\gamma\right) < 0 \iff c\left(\bar{p}p_r + (1-\pi)p_r(p_s - p_r)\right) < \gamma \iff cp_s p_r < \gamma$. Once again, given (7), it is sufficient to check that the following condition holds: $p_s p_r < 2\bar{p} - \pi p_s^2 - (1-\pi)p_r^2 \iff (\pi p_s(2 - p_s) + (1-\pi)p_r(2 - p_r)) - p_s p_r > 0$, which is always satisfied - the first term being larger than $\bar{p}$ and the second term being lower than $\bar{p}$.

5. $\frac{\partial A^J}{\partial p_s} = -\frac{p_s}{\bar{p}^2}\gamma K\frac{\partial \bar{p}}{\partial p_s} + cK(1-\pi)\frac{p_s}{\bar{p}^2}p_r(p_s - p_r)\frac{\partial \bar{p}}{\partial p_s} - cK(1-\pi)\frac{p_r}{\bar{p}}(2p_s - p_r) < 0$.

   Replacing $\frac{\partial \bar{p}}{\partial p_s}$ by its value, we have $-\pi\frac{p_s}{\bar{p}^2}\gamma K + \frac{cK(1-\pi)}{\bar{p}}\left(\frac{p_s p_r}{\bar{p}}(p_s - p_r)\pi - p_r(2p_s - p_r)\right) < 0 \iff \frac{cK(1-\pi)}{\bar{p}^2}\left((1-\pi)p_r^2(p_r - 2p_s) - \pi p_s^2 p_r\right) < 0$, which is always the case.

6. $\frac{\partial A^J}{\partial p_r} = -\frac{p_s}{\bar{p}^2}\gamma K\frac{\partial \bar{p}}{\partial p_r} + cK(1-\pi)\frac{p_s}{\bar{p}^2}p_r(p_s - p_r)\frac{\partial \bar{p}}{\partial p_r} - cK(1-\pi)\frac{p_s}{\bar{p}}(p_s - 2p_r) < 0$.

   Substituting $\frac{\partial A^J}{\partial p_r}$ and using (7), we have that $\frac{p_s}{\bar{p}^2}\gamma K(1-\pi) + cK(1-\pi)\frac{p_s}{\bar{p}}((1-\pi)\frac{p_r}{\bar{p}}(p_s - p_r) - p_s + 2p_r) < 0 \iff \frac{p_s}{\bar{p}^2}K(1-\pi)\left(c((1-\pi)p_r^2 + \pi p_s(2p_r - p_s)) - \gamma\right) < 0 \iff 2(1-\pi)p_r^2 + 2\pi p_s(p_r - 1) - 2(1-\pi)p_r < 0 \iff 2\bar{p}(p_r - 1) < 0$.

A.2 Risky borrowers are better off than safe borrowers under group lending

Given (8),

$$U_r^J > U_s^J \iff \bar{R}K - p_r r^J K - p_r(1-p_r)cK > \bar{R}K - p_s r^J K - p_s(1-p_s)cK$$
$$\iff (p_r - p_s)r^J + (p_r(1-p_r) - p_s(1-p_s))\, c < 0$$

Given that $c < r^J$, a sufficient condition is:

$$p_r - p_r^2 - p_s + p_s^2 < p_s - p_r \iff (p_s - p_r)(p_s + p_r - 2) < 0$$

which is always true.

A.3 Feasibility of joint-liability contract

We first show that condition (7), $c \leq r^{J,P}$, is sufficient to ensure that $r^{J,P} > 1$.

Let us derive the following useful result:

$$C \equiv 2\bar{p} - \pi p_s^2 - (1-\pi)p_r^2 < 1.$$

Given that $0 \leq p_r < p_s \leq 1$, the function C is increasing in π. Indeed, $\frac{\partial C}{\partial \pi} = 2p_s - 2p_r - p_s^2 + p_r^2 > 0 \iff p_s + p_r < 2$. Therefore, it is sufficient to check that $C < 1$ for $\pi = 1$, i.e. at the maximum of C: we have that $2p_s - p_s^2 < 1 \iff p_s^2 - 2p_s + 1 > 0$, which is satisfied for any $p_s < 1$. We now turn to our main point:

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

We can check that this condition is implied by $c \leq r^{J,P} \iff c \leq \frac{\gamma}{2\bar{p} - \pi p_s^2 - (1-\pi)p_r^2}$ because

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

given $\gamma > 1$ and $C < 1$, i.e. the unity condition is less restrictive than condition (7) and $c \leq r^{J,P} \Rightarrow r^{J,P} > 1$.

Second, we show that the same condition (7) usually implies that any successful borrower can always repay for its defaulting partner. Indeed, we have that

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

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

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

Given the condition (2) that both projects are socially profitable, which links R_s, p_s and γ, the above will be satisfied unless p_r is very low.

A.4 Proof of $r^{J,S} > r^{J,P}$

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

which has been shown to be true in A.1.2.

A.5 $r^{ML,MFI}$ can be lower or greater than $r_s^{I,\max}$

We show that $r^{ML,MFI}$ can be lower or greater than $r_s^{I,\max}$, or equivalently that $U_r^{ML,2} \lesseqgtr U_r^{J,P}$.

$$r^{ML,MFI} > r_s^{I,\max} \iff U_r^{ML,2} > U_r^{J,P} \iff$$
$$\bar{R}K - \frac{p_r}{p_s}(\bar{R}K - \bar{u}) > \bar{R}K - \frac{p_r}{\bar{p}}K(\gamma - c(\bar{p} - \pi p_s^2 - (1-\pi)p_r^2)) - p_r(1-p_r)cK$$
$$\iff \bar{R}K - \bar{u} < \frac{p_s}{\bar{p}}\gamma K - \frac{p_s}{\bar{p}}cK(\bar{p}p_r - \pi p_s^2 - (1-\pi)p_r^2).$$

Using the fact that MFI is at a pooling equilibrium, we have $cK \geq \frac{\gamma K - \frac{\bar{p}}{p_s}(\bar{R}K - \bar{u})}{(1-\pi)p_r(p_s - p_r)}$, s.t. a sufficient condition for the above inequality to hold is:

$$\left(1 - \frac{\pi p_s}{(1-\pi)p_r}\right)\left(\bar{R}K - \bar{u} - \gamma K\frac{p_s}{\bar{p}}\right) < 0 \iff \begin{array}{l} \bar{R}K - \bar{u} - \gamma K\frac{p_s}{\bar{p}} > 0 \text{ and } \frac{p_s}{p_r} > \frac{1-\pi}{\pi} \\ \bar{R}K - \bar{u} - \gamma K\frac{p_s}{\bar{p}} < 0 \text{ and } \frac{p_s}{p_r} < \frac{1-\pi}{\pi} \end{array}$$

Finally, given that the stand-alone ML was choosing regime 2, we have that $\frac{\bar{p}}{p_s} - 1 + \pi > 0 \iff (1-\pi)p_r > (1-2\pi)p_s$, s.t. the above sufficient condition is likely to be often satisfied. For instance, as soon as $\pi < \frac{1}{3}$, $\frac{p_s}{p_r} < \frac{1-\pi}{\pi}$ whatever the values of p_s and p_r.

B Summary: simulation

The figure presents a simulation with the following parameter values: $\gamma = 1.5, K = 1, p_s = 0.9, p_r = 0.5$, and a varying proportion of safe (and hence risky) borrowers in the population. It summarizes the major findings of our model. The two solid lines represent the benchmark perfect-competition situation of sections 4 and 5. The first part of the curves (with high interest rate and zero slope) is the separating-equilibrium region, while the second part (with low interest rate and negative slope) is the pooling-equilibrium zone. One can see easily that group lending - the lowest line in the graph - allows both a reduction in the interest rate and an increase in the likelihood of a pooling equilibrium. In mixed markets, traditional lenders can lend to risky individuals only (across the whole distribution of parameters, see the small-dot line). That is, in the region of pooling equilibrium in individual lending (for $(1-\pi) < 0.6$ in our simulation), the presence of MFI leads to a higher interest rate in the individual-loan market. The dashed and the big-dot lines that lie highest on the graph represent the market-power case (section 7). The monopolist increases the interest rate and the credit rationing (the flat curve reflects the full rent appropriation by the monopolist). Yet, when few risky borrowers are present in the market, it is optimal for him to serve all borrowers (for $(1-\pi) < 0.4$ in our simulation). When it faces the competition of the MFI, it has to decrease its interest rate in the region in which MFI serves only risky borrowers (leftwards). The monopolist is then forced to make zero profit (competition effect). However, in the MFI's pooling-equilibrium region, the monopolist focuses on risky borrowers and charge the maximum rate of interest. That is, if the monopolist was serving all borrowers prior to MFI's entry (regime 2), the presence of the latter actually leads to an increase in the interest rate of the former (composition effect).

Figure 1: Interest rates across regimes and compositions of borrower pool