Microfinance, Subsidies and Dynamic Incentives

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Abstract

In this paper we develop a two period model of a credit market to study the interaction between a monopolistic moneylender and a subsidized microfinance institution. We assume that lenders face a moral hazard problem that is diminished as agents are able to take increased equity positions in their production projects. In this setting, we identify a range of subsidy levels for which the behavior of the moneylender complements the poverty reduction mission of the microfinance institution. We also explain why a policy of offering subsidized loans in the second period to agents who are poor due to a project failure in the prior period, does not distort agents' incentives to work hard and save in the first period. By varying the subsidy level available to the microfinance institution we discover that for small subsidies the moneylender may be better off with the microfinance institution in the market, and that when subsidies are excessive this can harm the poverty reduction mission of the microfinance institution.

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1. Introduction

The paucity of credit as one of the primary bottlenecks of the developmental process has been widely acknowledged in previous studies. Theoretical papers such as Galor and Zeira (1993), Banerjee and Newman (1994) and Mookherjee and Ray (2003) find that in a variety of different settings, imperfections in the credit market prevent the poor from making the critical investments that lead to higher income and growth. Motivated in part by these types of findings, a great deal of effort has been directed towards closing perceived funding gaps. Such efforts are manifested in a broad range of activities, from subsidizing small business loans to reforming the legal and judicial structures governing credit transactions. One approach in particular that has received a growing amount attention in academic and policy circles alike is the role of microfinance.[1]

Inspired by the remarkable achievements of institutions such as the Grameen Bank, the microfinance model has been studied and replicated throughout the developing world.[2] The enthusiasm associated with this has led to assertions that ultimately microfinance institutions (MFI's henceforth) will be able to grow without the constraints imposed by donor budgets. These assertions have been challenged by Morduch (2000) as wrong headed. Morduch points out that nearly all MFIs receive subsidies in one form or another, and before such assertions can be made, it is important to conduct further research on the benefits and costs of donor subsidized microfinance programs. One part of this research is the study of the interaction between subsidized MFI lending and private, profit oriented lenders. The aim of our paper is to highlight the analytics governing this type of interaction.

As a framework, we use a two period model of a credit market where identical agents apply costly effort to risky production projects. Project capital is supplied by lenders, who face a moral hazard problem associated with the agent's choice of effort. We assume that all agents begin with zero wealth,[3] but that over time agents can invest retained earnings and this reduces the need for external financing. Within this framework, we assume that unless an agent can acquire an adequate equity stake in his project, external financing of the project is unprofitable from the lender's standpoint. In this type of setting there is always a subset of the population that the market denies loans simply because they are too poor.

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[1] See Morduch (1999b) for a survey of microfinance institutions.
[2] For discussion on the Grameen Bank model, see Yunus (2003).
[3] Thus in our model agents have no collateral to offer, as is common in a lot of low-income communities.

The paper begins by considering a benchmark case where a moneylender has a monopoly over the credit market for the two periods. Faced with an initial loss on first period lending operations, we illustrate how a monopolist may be able to recover these losses through second period loans to agents capable of taking equity positions in their projects. We then look at a second case, in which an incumbent moneylender is joined by a subsidized MFI. In contrast to the moneylender, who seeks to maximize profit, the MFI's objective is to reduce poverty by providing production loans. We formalize this notion by defining a poverty line and assigning the MFI a weighted poverty gap as its objective function.[4]

Like the other players in the game, the MFI behaves strategically. In the second period, with the moneylender focused on agents who have some self-finance capability, we show it is optimal for the MFI to lend to agents that cannot obtain market loans. Since this policy effectively directs subsidized loans towards agents that had project failures in the first period, the policy winds up reducing the agent's incentive to work hard in the first period. However, we find that the lending policy also gives successful agents an option to consume their net earnings and apply for the MFI loan rather than save earnings for reinvestment to attract financing from the moneylender. This option gives the successful agents more bargaining power in dealing with the moneylender. To attract the successful agents the moneylender is forced to lower his interest rate. Consequently, the MFI's lending policy raises the payoff to the agent conditional of a first period failure as well as a success, implying that the agent's incentive to work hard in the first period actually does not change. While in equilibrium the successful agents don't actually borrow from the MFI, the presence of the MFI shifts the distribution of bargaining power between the lender and the borrower. This result is in the same vein as Ghosh, Mookherjee and Ray (2001), who claim that social policies that empower the borrower through strengthening his bargaining position are likely to increase effort levels and efficiency.

The link we establish between the MFI's policy of lending to the poor and the interest rate the moneylender charges the less poor, turns out to have several interesting implications regarding optimal subsidy level. First, we demonstrate a positive relationship between the size of the subsidy and the degree of outreach the MFI achieves in terms of distributing loans to the poor. As the subsidy increases, outreach widens, improving the expected payoff to the agent

[4] Our motivation for assigning the MFI a poverty minimizing objective function is due to the fact that an MFI typically adopts some metric of social welfare, one being to minimize poverty (See Morduch (2000)). In some cases minimizing poverty implies maximizing the number of clients (as in McIntosh and Wydick (2005)) or alternatively, a cross between maximizing profit and client numbers (as in Jain and Mansuri (2005)).

who applies for an MFI loan. Since this is associated with downward pressure on the interest rate charged by the moneylender, eventually the subsidy can grow to a point where the moneylender cannot afford to offer loans. Expanding outreach beyond this point then begins to distort the incentive of the agent to work hard and save, which in turn, lowers the effectiveness of the MFI's policy with regard to poverty minimization. In this respect, we uncover some rather interesting relationships between the size of the subsidy and variables such as agent effort and the level of poverty in the economy. Related to this, we find that when the MFI subsidy is small, a monopolist moneylender may actually prefer to have the MFI in the market rather than not.[5]

Our model abstracts entirely from the group aspect characterizing some microlending programs. Given that our main focus is on how subsidies impact the relationship between different types of lending institutions, we have chosen to avoid joint liability in order to keep lender-client contracting as simple as possible. Another reason is that there is a rather extensive literature that already exists on joint liability schemes.[6] Also, not all MFIs rely on group lending technology and even when group lending is used in practice, there tends to be quite a bit of disagreement among researchers about its significance and impact.[7]

Our model contributes to the existing microfinance literature on several fronts. First, in an empirical study of the Grameen Bank, Morduch (1999a) argues that much of the success of microfinance has been crucially dependent on the role of continuing subsidies, which tends to contradict the 'win-win' proposition made by the proponents of CGAP.[8] In a recent cross country study by Cull et. al (2007), where the financial institutions are united by claiming strong commitments to achieving self-sufficiency, the authors find that the average share of funding made up of subsidy exceeds 20%. In our model, we offer explicit justification for the role of subsidies in financing the lending policies of an MFI. Using this framework, we then uncover some rather interesting relationships between subsidy size and the impact the MFI has on poverty. We identify a range of subsidy levels that are effective in combating poverty, and find that excessive subsidies can lead a number of problems. Thus, part of our research offers a

[5] A few papers have pointed out potential perverse effects from introducing subsidized credit. For example Hoff and Stiglitz (1998) show that loss of scale economies in the lending process can lead to an increase in interest rates, and Bose (1998) finds that if borrowers are heterogeneous in risk and lenders are asymmetrically informed, cheap credit may wind up increasing interest rates. To our knowledge, none of these papers look at subsidized credit in a dynamic setting, which is the main focus of our work.

[6] See, for example, Stiglitz (1990), Ghatak (1999) and Ghatak and Guinnane (1999) for some key papers in this literature.

[7] For example, see Morduch (1999b).

[8] The Consultative Group to Assist the Poor (CGAP), is a consortium of 33 public and private development agencies working together to expand access to financial services for the poor.

perspective on the debate about why many of the subsidized microfinance projects in the 1960s and 1970s were failures.[9] This emphasizes the importance of a point made previously- any consideration of government regulation of credit markets must pay the closest attention to the precise structure of the market, and the role that various types of lenders play in that market.

Second, in a recent article by McIntosh and Wydick (2005), a point is made that in the absence of competition, an MFI can use the profit it earns on wealthier, less risky borrowers to subsidize lending to less wealthy, riskier borrowers. Since this ability to cross subsidize is diminished under competition, poor borrowers can be made worse off as competition intensifies.[10] As a contrast to the negative effects of competition on the MFI mission, our paper uses a different framework to illuminate potential complementarities between the MFI and the moneylender.[11]

Third, in an overlapping generations model with credit market imperfections, Ghatak et al. (2001) show that agents who work hard and save enjoy later advantages over those who must rely on external finance. In this context, the authors argue that public policy aimed at reducing imperfections in the credit market can negatively influence the dynamic incentives for young agents to work hard and save. While the authors don't explicitly consider microfinance, one might interpret their results to suggest that such intervention may reduce the incentive of the poor to work hard and save because failure to do so will be cushioned with subsidized loans. In our paper, we find a somewhat different result. In particular, if the availability of subsidized loans improves the terms that successful agents negotiate with the private lender, then the negative dynamic incentives will be mitigated.

Lastly, in a similar vein to Conning (1999), our work offers insight into the discussion on popular topics such as lending outreach and the impact MFI loans have on poverty. Given a poverty gap as an explicit objective function, we show for example that using a subsidy to maximize client outreach may be optimal only up to a certain point. We also find that even when an MFI focuses its lending on poor agents who are excluded from obtaining market loans, this can have an important impact on the market interest rate.

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[9] Morduch (2000) attributes excessive subsidies as one of the main reasons for the failures.

[10] One potential constraint on cross subsidization in a dynamic setting is that if agents anticipate future rent extraction, this may generate moral hazard. Padilla and Pagano (1997) make this point, and suggest that to alleviate the problem, an incumbent lender may optimally choose to share information in order to invite more competition. Also see Padilla and Pagano (2000). Jain and Mansuri (2005) find that this incentive to share information is robust to a setting where lenders have non-standard objective functions.

[11] See also Jain (1999) and Jain and Mansuri (2003).

The paper is organized in the following manner. Section 2 describes the two period model and the timing to the game. Section 3 analyzes the equilibrium where the only lender in the market is a monopolistic moneylender. A MFI institution and its objective function is introduced in Section 4. Section 5 examines the interaction between the MFI and the profit oriented moneylender. Finally Section 6 concludes with a summary of our results and some discussion on a few testable implications.

2. The Economy

2.1. Agents and Lenders

Consider a two period model with a large population of N identical risk neutral agents and a single moneylender. Every agent owns a risky one period production project in both periods. The project requires an investment of \$1 in capital and generates a revenue of $R > 1$ if successful and 0 if unsuccessful. The probability of project success is $p_t(e_t) = e_t$, where $e_t \in [0,1]$ denotes the effort level chosen by the agent in period t. The agent's disutility of effort is given as $g(e_t) = \frac{d}{\eta + 1} e^{\eta+1}$, where $d > 0$ and $\eta > 1$.

An agent's wealth at the start of period t is denoted $w_t \geq 0$. We assume that $w_1 = 0$ for all agents. Thus, to invest in the first period the agent requires a \$1 loan from the moneylender. The moneylender offers one period loan contracts characterized by limited liability. In particular, a loan contract specifies a loan size L_t and an interest rate r_t, where the agent is obligated to repay $\min\{(1+r_t)L_t, R\}$ in the event of project success and 0 otherwise. The moneylender has access to an unlimited supply of capital at a fixed interest rate, which we normalize to zero. At the start of $t = 2$, an agent's wealth w_2 is equal to the net revenue from the previous period. Hence, $w_2 = R - (1 + r_1)(L_1 = 1)$ if the agent was successful with his first period project and $w_2 = 0$ otherwise.

2.2. Timing

At the beginning of each period, the moneylender offers loan contracts (r_t, L_t) to the agents. Agents observe contract offers and then select a pair (c_t, s_t) where c_t denotes consumption and s_t denotes savings, such that $c_t + s_t = w_t$ and $c_t, s_t \geq 0$. Any $c_t > 0$ is immediately consumed and any $s_t > 0$ is allocated as investment to production project. Thus, to be eligible for a loan contract (r_t, L_t) offered by the moneylender, the agent must choose an appropriate pair (c_t, s_t) such that $L_t = 1 - s_t$. After agents select loan contracts, agents choose effort and finally, project outcomes are realized.

2.3. A Benchmark

To establish a benchmark, consider a one-period version of the model where the agent finances the project using his own wealth. In this case, the agent faces the following one-period problem: Choose e to maximize $eR - 1 - \frac{d}{\eta+1} e^{\eta+1}$. The optimal level of effort is $e = \left[\frac{R}{d}\right]^{\frac{1}{\eta}}$ and if we plug this effort into the agent's one period expected payoff we have

$$\frac{\eta}{\eta+1} d^{\frac{-1}{\eta}} R^{\frac{\eta+1}{\eta}} - 1. \tag{1}$$

With this benchmark in mind, we introduce the following assumptions for our model.

Assumption A1. $R < d$

Assumption A2. $R < \eta + 1$

Assumption A3. $1 < \frac{\eta}{\eta+1} d^{\frac{-1}{\eta}} R^{\frac{\eta+1}{\eta}}$

Assumption A4. $\frac{\eta}{\eta+1} d^{\frac{-1}{\eta}} R^{\frac{\eta+1}{\eta}} < (\eta+1)^{\frac{1}{\eta}}$

Given that the probability of the project's success is defined as the agent's effort e, Assumption A1 ensures that this variable will never exceed one. We use Assumption A2 to keep the analysis interesting, in that it implies the agent cannot accumulate sufficient wealth in the first period to make lenders irrelevant in the second period. To make the investment project worthwhile, Assumption A3 states that the agent's expected payoff as described in equation (1) is positive. Finally, we use Assumption A4 to narrow the focus of our analysis to a case where lenders face a significant moral hazard problem. In particular, this assumption ensures that there is always a group of agents that are unprofitable from the lender's standpoint simply because they are too poor.

3. A Monopolist Moneylender

In this section, assume that the only lender in the market is a monopolist moneylender. Working backwards through the game, if the agent accepts a loan contract (r_2, L_2) in $t = 2$, his second period expected payoff from the investment project is

$$u_2(e_2) = e_2[R - (1 + r_2)L_2] - \frac{d}{\eta + 1} e_2^{\eta+1}. \tag{2}$$

To maximize $u_2(e_2)$, the agent selects effort

$$e_2^*(r_2, L_2) = d^{\frac{-1}{\eta}} [R - (1 + r_2)L_2]^{\frac{1}{\eta}}. \tag{3}$$

Anticipating this level of effort, the moneylender's expected profit on the loan (r_2, L_2) is

$$\pi_2(r_2, L_2) = e_2^*(r_2, L_2)(1 + r_2)L_2 - L_2. \tag{4}$$

Maximizing $\pi_2(r_2, L_2)$ with respect to r_2, we get $r^m(s_2) \equiv \dfrac{\eta R}{(\eta + 1)(1 - s_2)} - 1$.

If the agent is unsuccessful in his first period investment project, then $w_2 = 0$. This agent then requires a loan size of $L_2 = 1$, since $s_2 = 0$. However, one can easily confirm that Assumption A4 implies that $\pi_2(r^m(0), 1) < 0$. This means that if an agent does not succeed in his first period investment project, the moneylender will not issue him a second period loan. Thus, agents who are unlucky in the first period are then denied external funding in the following period.

Agents with a success in the previous period are capable of self-financing part of their second period project, as they can invest $s_2 \leq w_2$. Faced with a contract $(r_2, L_2 = 1 - s_2)$ this agent can always turn down the lender's offer and simply consume the equivalent of s_2. Thus, to persuade the agent to borrow the moneylender must offer a contract such that $u_2\left(e_2^*(r_2, L_2)\right) \geq s_2$. Evaluating this participation constraint at the rate $r^m(s_2)$, one can confirm that the constraint holds as long as $s_2 \leq \hat{s}$, where

$$\hat{s} \equiv \frac{\eta}{\eta+1} d^{\frac{-1}{\eta}} \left(\frac{R}{\eta+1}\right)^{\frac{\eta+1}{\eta}}. \text{[12]} \tag{5}$$

At higher values where $s_2 \geq \hat{s}$ the agent's participation constraint binds at the interest rate

$$r^*(s_2) \equiv \frac{1}{1-s_2}\left[R - \left(\frac{\eta+1}{\eta} s_2 d^{\frac{1}{\eta}}\right)^{\frac{\eta}{\eta+1}}\right] - 1. \tag{6}$$

Comparing the rate $r^*(s_2)$ with the unconstrained rate $r^m(s_2)$, one can confirm that the two rates are equal when $s_2 = \hat{s}$. For values of s_2 that exceed $\hat{s}$ we find the following.

Lemma 1. $r^*(s_2) < r^m(s_2)$ *for* $s_2 \in (\hat{s}, 1)$.

Proof. *See appendix.*

At low values of s_2 the agent's participation constraint does not bind at the moneylender's profit maximizing rate $r^m(s_2)$. However, at higher values of s_2 the moneylender

[12] Assumption A4 ensures that $\hat{s}$ is less than one.

is forced to lower the interest rate to $r^*(s_2)$ in order to make it worthwhile for the agent to take out the loan. Once we have calculated these interest rates, the moneylender's problem is reduced to finding the loan size that maximizes expected profit. The solution is summarized in the following lemma.

***Lemma 2**. The moneylender's profit $\pi_2(r_2, L_2)$ is maximized subject to $u_2(e_2^*(r_2, L_2)) \geq s_2$ at $L_2 = 1 - w_2$, where $r_2 = r^*(w_2)$ for $w_2 \in [\hat{s}, 1)$ and $r_2 = r^m(w_2)$ for $w_2 < \hat{s}$.*

***Proof.** See appendix.*

We find that in order to minimize the moral hazard problem, the moneylender offers a loan such that the agent must maximize his equity position in the project. Turning now to the first period problem, faced with a loan contract (r_1, L_1) the agent chooses e_1 to maximize

$$e_1[R - (1 + r_1)L_1 - s_2] - \frac{d}{\eta + 1} e_1^{\eta+1} + e_1 u_2(e_2^*(r_2, L_2)) + (1 - e_1)0 . \tag{7}$$

When $r_2 = r^*(s_2)$ this objective function reduces to

$$e_1[R - (1 + r_1)L_1] - \frac{d}{\eta + 1} e_1^{\eta+1} . \tag{8}$$

This objective function is maximized at $e_1^*(r_1, L_1 | s_2 \geq \hat{s})$, which is identical to $e_2^*(r_2, L_2)$ as derived in equation (3). Hence, we find that the agent's first period effort is independent of second period payoffs.

Since the first period loan size must be $L_1 = 1$, the moneylender's problem in $t = 1$ boils down to selecting an interest rate r_1. If r_1 is low such that $r_1 \leq R - 2$ (i.e., $R - (1 + r_1) \geq 1$), then the agent's first period net-revenue is at least 1 and the agent does not require a second period loan. In this case the moneylender's payoff in the game will be equal to his first period profit. Let us denote the moneylender's maximum profit over the closed domain $r_1 \leq R - 2$ as Π_1. The more interesting case is where $r_1 > R-2$, implying the agent's net-revenue is less than one. From our earlier discussion, we know that over a subset of the domain $r_1 > R-2$, where $r_1 \in (R-2, R-1-\hat{s}]$, the moneylender's expected profit on a single agent is

$$\Pi(r_1) = e_1^*(r_1,1|s_2 \geq \hat{s})(1+r_1) - 1 + e_1^*(r_1,1|s_2 \geq \hat{s})\{e_2^*(r^*(w_2),L_2)(1+r^*(s_2))L_2 - L_2\}. \tag{9}$$

Define $r_1^* \equiv \arg\max \Pi(r_1)$ over the domain $r_1 \in (R-2, R-1-\hat{s}]$.

***Proposition 1**. If $\Pi(r_1^*) \geq \max\{0, \Pi_1\}$, then in equilibrium*

(a.) the moneylender offers the contract $(r_1^*,1)$ in $t=1$ and agents choose effort $e_1^*(r_1, L_1|s_2 \geq \hat{s})$,

(b.) and in $t=2$ the moneylender offers the contract $(r^*(w_2),1-w_2)$ to agents with a first period success, and agents choose effort $e_2^*(r_2, L_2)$.

***Proof**. See appendix.*

In the equilibrium described above, the moneylender offers loans to all agents in the first period and in the second period, limits his lending to agents with positive wealth. It turns out that on each of these first period loans, the moneylender takes an expected loss. The reason is that the agent's first period effort is independent of payoffs in $t=2$. Hence, lending to an agent in period one is equivalent to lending to an agent with zero wealth in period two, which given Assumption A4 is unprofitable. The incentive for a moneylender to offer unprofitable loans in $t=1$ comes from the monopoly the lender has on the market, which allows him to make positive second period profit on agents who save and re-invest their net-revenue from the first period. The condition $\Pi(r_1^*) \geq \max\{0, \Pi_1\}$ in the above Proposition ensures that the second period expected profits outweigh the first period expected loss.[13] Agents that are unlucky in the first period fail to accumulate any wealth and consequently, are denied loans in $t=2$.

[13] When this condition is violated because profits are negative, the moneylender will not offer loans even though he has a monopoly on the credit market. In this event it is rather obvious how MFI entry can reduce poverty. Thus by assuming the condition holds, we are making it more difficult for ourselves to prove that MFI entry is beneficial.

4. The Microfinance Institution

The other type of lender we consider is a microfinance institution (MFI). The general objective of the MFI is to reduce poverty through the distribution of production loans. Like the other players in the game, the MFI behaves strategically. In each period the MFI selects a lending policy. A lending policy describes a subset M of the population and for each $j \in M$, a specific loan contract $\left(r_t^j, L_t^j\right)$. The objective of the MFI in period t is to select a lending policy to minimize poverty in the current period. To define poverty in the economy, we use an exogenous poverty line $\bar{y} > 0$. Given a profile of strategies for all lenders and agents, we can calculate an equilibrium expected income y_t^j for agent j in period t, for all $j \in N$.[14] The (expected) poverty level in equilibrium is then defined as $\sum_{y_t^j < \bar{y}} \left(\bar{y} - y_t^j\right)^\alpha$, where $\alpha \geq 1$.[15] We assume that the objective of the MFI in period t is to select a lending policy to minimize $\sum_{y_t^j < \bar{y}} \left(\bar{y} - y_t^j\right)^\alpha$.

As with the moneylender, we assume the MFI has unlimited access to capital at a fixed interest rate of zero. However, unlike the moneylender, the MFI is endowed with a subsidy Z_t at the start of each period. The MFI uses this subsidy by allocating a non-negative portion of the subsidy to each loan contract it issues. In particular we assume that the MFI is constrained to selecting a lending policy such that $e_t^j(1+r_t^j)L_t^j - L_t^j + Z_t^j \geq 0$ for all $j \in M$, where $Z_t^j \geq 0$ is the subsidy allocated to loan contract (r_t^j, L_t^j) and $\sum_{j \in M} Z_t^j \leq Z_t$.

As is well known, the weight α on the poverty gap determines the degree to which the measure depends on relative inequality below the poverty line. As α rises, the poorest of the poor have the dominant influence on the level of poverty in the economy. In our paper, we adopt a measure where α is sufficiently high, though short of a "Rawlsian" measure where $\alpha \to \infty$. Under this weighting, the MFI's priority is to raise the expected income of the poorest agents, but can still benefit if the less poor also experience an increase in expected income.

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[14] Expected income does not include disutility of effort.

[15] This weighted poverty gap belongs to the class of measures from Foster, Greer and Thorbecke (1984).

5. The MFI and a Moneylender

We now consider a credit market with one moneylender and one MFI.[16] As in the previous section, we assume lenders cannot specify an agent's effort level as part of the loan contract. As is usual in such models, we start with the second period and solve backwards from there. At the risk of reiteration, let us review the basic timing of the game again. In the first period lenders offer loan contracts to the agents. Since $w_1 = 0$ all agents have zero self-finance, so the next relevant move is for agents to accept loans and exert effort. After project outcomes are realized, each agent is assigned a second period wealth level w_2. At the start of the second period, both lenders offer loan contracts. Agents select a pair (c_2, s_2) and then choose a loan contract. After $t = 2$ project outcomes are realized the game concludes.

5.1. Second Period MFI Loan

In the second period, the MFI selects a lending policy to minimize poverty in $t = 2$. In general, the MFI's optimal lending policy will depend on the strategy chosen by the moneylender. Consider the scenario described in Section 3, where the moneylender makes loans to agents in period 2 who had a success in the previous period. In this context, suppose that the MFI offers second period loans where $L_2 = 1$. From our earlier analysis, we know that in order to maximize the expected profit on such a loan, the lender should charge the interest rate $r^m(0)$. Since these borrowers have zero equity in their projects, the interest rate $r^m(0)$ winds up minimizing the MFI's expected loss per loan. Hence, to finance these loans the MFI requires a positive per loan subsidy of exactly $z_2^m \equiv -\pi_2(r^m(0),1)$. The fact that these second period loans must be subsidized is exactly why the moneylender never lends to these agents in $t = 2$.

Lemma 3. *Given a subsidy Z_2, in order to minimize poverty over a large set of agents with zero wealth, the optimal contract for the MFI to offer is $(r^m(0), L_2 = 1)$.*

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[16] Given that our primary objective is to illuminate the interaction between profit based lending and poverty minimization based lending, we have limited our study to a case where there is only one lender of each type.

This result follows from the fact that agents with zero wealth earn a positive income at the monopoly interest rate. The reason the rate $r^m(0)$ leaves the agent with positive net-revenue is to induce the agent to apply costly effort. Thus by charging this profit maximizing interest rate, the MFI simultaneously ensures that each borrower makes a positive expected income and that the MFI minimizes the subsidy per loan. Such a loan contract allows the MFI to then maximize the number of loans issued over the target population.

Whether all the agents in the target group will actually be able to get a loan depends on the number of agents in the group and the size of the second period subsidy Z_2. That is, suppose that exactly B agents select the MFI loan in $t = 2$. For a given Z_2, if it is the case that $Z_2 \geq z_2^m B$, then the MFI can afford to issue a loan to every applicant. However, if $Z_2 < z_2^m B$, then the MFI loans must be rationed. In case of the latter, we assume each agent receives an MFI loan with equal probability, namely $Z_2(z_2^m B)^{-1}$. We denote this probability as θ. The variable θ can be interpreted as the measure of *outreach* for a given lending policy.

5.2. The MFI and the Moneylender's Second Period Offer

We now look at the second period behavior of the moneylender. As described in the previous section, consider an MFI lending policy in which the MFI uses its subsidy to offer the loan contract $(r^m(0),1)$ to any agent with zero self-finance. Note that this policy targets all agents with $w_2 = 0$, as well as any agents with $w_2 > 0$ that then elect to consume their entire first period earnings. Hence, agents with positive wealth now have an option where they can consume their wealth and apply for an MFI loan. Consequently, if the moneylender offers a loan $L_2 = 1 - s_2$ where $s_2 > 0$, he must charge an interest rate that persuades agents with $w_2 > 0$ to not take the alternative. The alternative in this case is to consume the equivalent of s_2 and apply for an MFI loan, which generates the agent a second period expected payoff of

$$s_2 + \theta u_2\left(e_2^*\left(r^m(0),1\right)\right). \tag{10}$$

In order to attract successful agents in the second period, the moneylender must match this outside option. The moneylender must charge an interest rate r_2 such that

$$u_2\left(e_2^*\left(r_2, 1-s_2\right)\right) \geq s_2 + \theta u_2\left(e_2^*\left(r^m(0), 1\right)\right). \tag{11}$$

This inequality binds at the interest rate

$$r^{**}(s_2) = \frac{R - \left[\frac{(\eta+1)}{\eta} d^{\frac{1}{\eta}} s_2 + \theta\left(\frac{R}{\eta+1}\right)^{\frac{\eta+1}{\eta}}\right]^{\frac{\eta}{\eta+1}}}{1-s_2} - 1 \tag{12}$$

If we compare this interest rate with the second period rate the moneylender charged in the absence of the MFI as is given in equation (6), we find the following:

Lemma 4. $r^{**}(s_2) < r^*(s_2)$ *for* $\theta > 0$, *and if* $\theta = 0$, $r^{**}(s_2) = r^*(s_2)$.

As the MFI's outreach θ increases, this puts downward pressure on the interest rate the moneylender must charge to attract borrowers. This pressure originates from the choice of the MFI to make his second period loans available to basically anyone who does not get a loan from the moneylender. The availability of the MFI loans gives the successful agents an option to consume their first period net-earnings and take out an MFI loan. This option raises the bargaining power of the successful agents when they negotiate with the moneylender. To persuade agent to re-invest their net-earnings, the moneylender is forced to lower the interest rate he charges. As long as this rate is not too low, the moneylender can still make a profit. In this scenario agents with positive wealth are catered to by the moneylender and agents with no wealth are issued subsidized loans by the MFI. Note that the lending policy not only raises the expected incomes of agents with zero wealth but also those agents borrowing from the moneylender, which is relevant to the MFI as long as the expected incomes of these agents are below the poverty line.

5.3. Second Period Equilibrium Behavior

From the previous analysis we know that when successful agents hold wealth $w_2 \in [\hat{s},1)$, the interest rate offered by the moneylender depends on the level of outreach of the MFI. If $Z_2 = 0$, then $\theta = 0$ and the moneylender charges $r^{**}(s_2) = r^*(s_2)$. However, as Z_2 increases, θ increases and the moneylender must lower his interest rate. As this rate falls, so does the moneylender's second period expected profit.[17] This raises the question of how much outreach is compatible with profitable lending by the moneylender.

To answer this question we can identify a critical value of outreach, call it $\overline{\theta}(s_2)$ which maps each s_2 to a specific level of outreach. First of all, note that this question is only relevant if the moneylender's expected profit starts out positive at the interest rate $r^*(s_2)$, where outreach $\theta = 0$. Thus, for each $s_2 \in [\hat{s},1)$ if $\pi_2(r^*(s_2),1-s_2) < 0$, set the critical outreach at $\overline{\theta}(s_2) = 0$. For $s_2 \in [\hat{s},1)$ where $\pi_2(r^{**}(s_2),1-s_2) > 0$ at $\theta = 1$, set $\overline{\theta}(s_2) = 1$, otherwise let $\overline{\theta}(s_2)$ be the θ where $\pi_2(r^{**}(s_2),1-s_2) = 0$. Under this mapping, for any given $s_2 \in [\hat{s},1)$, the critical outreach $\overline{\theta}(s_2)$ indicates the maximum level of outreach that is compatible with profitable lending by the moneylender. In $t = 2$, as long as the MFI maintains an outreach $\theta < \overline{\theta}(s_2)$, the moneylender can make positive expected profit by issuing loans to agents with positive wealth.

Instead of looking at the cutoff level of outreach we can alternatively talk in terms of the second period subsidy. On each $t = 2$ loan the MFI distributes, the required subsidy is $z_2^m = -\pi_2(r^m(0),1)$, as calculated earlier. Thus given a subsidy of Z_2, the MFI can afford to issue $Z_2(z_2^m)^{-1}$ loans. If the number of agents that apply for an MFI loan is B, then given Z_2 we have an outreach of exactly $\theta = \dfrac{Z_2}{Bz_2^m}$. Observe that at $Z_2 = 0$, outreach is $\theta = 0$, and as Z_2 increases, outreach θ grows until eventually, we find a subsidy level where $\theta = \overline{\theta}(s_2)$. We denote this critical subsidy level as $\overline{Z}_2(s_2, B)$. Hence, if $Z_2 < \overline{Z}_2(s_2, B)$, the moneylender's expected profit $\pi_2(r_2, L_2)$ is positive at the interest rate $r^{**}(s_2)$.

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[17] This follows because the moneylender's profit function is strictly concave.

Proposition 2. *For* $Z_2 \le \bar{Z}_2(s_2, B)$*, the MFI offers loans of size* $L_2 = 1$ *to all agents with a first period credit history. For* $Z_2 > \bar{Z}_2(s_2, B)$*, the MFI offers loans of size* $L_2 = 1$ *to all agents with a first period credit history until* $\theta = \bar{\theta}(s_2)$*, after which it uses additional subsidy to lend to agents with no credit history.*

Proof. *See appendix.*

The reason the MFI targets new clients with subsidy dollars in excess of $\bar{Z}_2(s_2, B)$ is to keep its lending policy compatible with the profitable operations of the moneylender. If the MFI deviates by using subsidy to achieve an outreach exceeding $\bar{\theta}$, the MFI winds up effectively undercutting the moneylender. In doing so, the MFI lending policy encourages at least some agents with positive wealth to stop self-financing their projects and instead, to consume their wealth and apply for subsidized loans. This generates a situation where the MFI is using subsidy dollars to ration loans to a set of agents, of which now some are agents that otherwise could be earning income by accessing loans from the private market. Such an outcome is inconsistent with the priority of the MFI to focus on the poorest of the poor. It is exactly this sort of non-optimal use of excessive subsidies that we spoke of in the introduction as being detrimental towards the mission of poverty minimization.

5.4. First Period Effort in the Presence of the MFI

We now analyze the first period of the game assuming that both the MFI and moneylender are active in the second period. In general, the agent's optimal first period behavior will depend on which contracts are offered in the first period by the two different lenders. In this section we focus our attention on the case where $r_1 \in (R-2, R-1-\hat{s}]$, implying that in $t = 2$ agents either hold wealth $w_2 = 0$ or $w_2 \in [\hat{s}, 1)$, as analyzed in Section 3. Given this first period interest rate, from our previous discussion we know that in $t = 2$ the MFI offers $(r^m(0), 1)$ with an outreach of θ, and the moneylender finds it profitable to offer $(r^{**}(w_2), 1 - w_2)$. Anticipating these second period offers, the agent's expected payoff in the game is

$$e_1\left[R-(1+r_1)-s_2\right]-\frac{d}{\eta+1}e_1^{\eta+1}+e_1u_2\left(e_2^*\left(r^{**}(s_2),1-s_2\right)\right)+(1-e_1)\theta u_2\left(e_2^*\left(r^m(0),1\right)\right) \tag{13}$$

Given the definition of the interest rate $r^{**}(s_2)$, the agent's payoff collapses to

$$e_1\left[R-(1+r_1)\right]-\frac{d}{\eta+1}e_1^{\eta+1}+\theta u_2\left(e_2^*\left(r^m(0),1\right)\right). \tag{14}$$

Similar to what we found in Section 3, one can see here that the agent's second period contingent incomes have absolutely no impact on the agent's choice of first period effort. Faced with this expected payoff function, the agent's optimal level of effort is simply $e_1^*\left(r_1, L_1 \middle| s_2 \geq \hat{s}\right)$, as was defined earlier in Section 3.

Proposition 3*. If the moneylender offers* $r^{**}(s_2)$ *in* $t=2$ *given an MFI outreach of* θ*, the MFI's second period lending policy has no impact on the agent's first period choice of effort. The agent's effort is identical to what his effort would be in the absence of the MFI.*

In this result we find that the MFI's policy of offering subsidized loans to agents that fail has no negative implications on the agent's first period incentive to work hard. The reason for this is that the MFI outreach winds up influencing the bargaining power of agents that obtain loans from the moneylender. Any negative influence on the agent's incentive to apply first period effort due to the availability of subsidized loans in $t=2$ is negated by the downward pressure the outreach puts on the moneylender's interest rate. Thus while the agent's conditional payoff ex post of a project failure rises as MFI outreach increases, so does the conditional payoff ex post of a project success. This result offers an interesting contrast to Ghatak et al. (2001), who find that policies aimed at alleviating credit constraints can have negative consequences regarding an agent's incentive to work hard and save. The discrepancy in the results can be traced back to the credit market. As opposed to Ghatak et al., who consider a competitive credit market, we focus on a monopoly. The implication is that as the subsidy increases, the rate charged by the monopolist moneylender falls, which neutralizes any negative influence on first period effort.

5.5. Moneylender and MFI Interaction

In this section we examine players' strategies over two periods when both a moneylender and an MFI are present. Given that we already have a description of second period behavior where both lenders are active, the remaining question is who offers the first period loan. To answer this question we can describe what sort of contract a poverty minimizing MFI will offer agents with zero wealth in $t=1$. Given this first period lending policy, we then look at alternative strategies facing the moneylender. In particular, we calculate the moneylender's payoffs when he allows the MFI to offer the first period loan and contrast this with the moneylender's payoff when he makes the first period offer instead of the MFI.

To begin with, suppose the MFI offers the first period loan contract $(r^m(0),1)$ to M agents. Note that at this interest rate, successful agents will earn a net revenue $R(\eta+1)^{-1}$, which given assumptions A2 and A4, implies that $w_2 \in (\hat{s},1)$. Consequently, after first period investments, the set of M agents can be partitioned according to whether each agent has $w_2 \in (\hat{s},1)$ or $w_2 = 0$.

From our earlier discussion, we know that this distribution of wealth supports second period equilibrium behavior where all agents with $w_2 \in [\hat{s},1)$ accept contract $(r^{**}(w_2),1-w_2)$ from the moneylender, and fraction θ of the agents with $w_2 = 0$ borrow from the MFI under the contract $(r^m(0),1)$. When an agent is offered the loan contract $(r^m(0),1)$ from the MFI in $t=1$ and anticipates the second period offers described above, his optimal effort is $e_1^*(r^m(0),1 | s_2 \geq \hat{s})$. Hence, if the MFI offers this agent a first period loan, then in $t=1$ the moneylender calculates an expected payoff on this agent of

$$\Pi_2(\theta) \equiv e_1^*(r^m(0),1 | s_2 \geq \hat{s})\left[e_2^*(r^{**}(s_2),1-s_2)(1+r^{**}(s_2))-1\right](1-s_2)\,, \tag{15}$$

where $s_2 = R-(1+r^m(0))$. The payoff here is based on the profit the moneylender earns from a $t=2$ loan to the agent if the agent is successful with the first period MFI loan.

The alternative strategy facing the moneylender is to offer the first period loan instead of the MFI. As before, consider an MFI strategy to offer $(r^m(0),1)$ to M agents in $t=1$. Suppose the moneylender selects $C \leq M$ of these agents and offers each of them the contract $(r_1(C),1)$, where $r_1(C) < r^m(0)$. Then the agents who take the MFI loan exert effort $e_1^*\left(r^m(0),1 \middle| s_2 \geq \hat{s}\right)$ and the agents who take the moneylender's loan exert effort $e_1^*\left(r_1(C),1 \middle| s_2 \geq \hat{s}\right)$, assuming $r_1(C) > R-2$. The number of agents who are then unsuccessful in their first period project is

$$D \equiv (M-C)(1-e_1^*\left(r^m(0),1 \middle| s_2 \geq \hat{s}\right)) + C(1-e_1^*\left(r_1(C),1 \middle| s_2 \geq \hat{s}\right)). \qquad (16)$$

These D agents have wealth $w_2 = 0$. Given D and a subsidy Z_2, the MFI has an outreach of $\theta(C) \equiv Z_2 (z_2^m D)^{-1}$ in the second period. Consequently, if the moneylender lends to these C agents using contract $(r_1(C),1)$, then in $t=1$ the moneylender calculates an expected payoff per agent of

$$\Pi(r_1(C);\theta(C)) \equiv e_1^*\left(r_1(C),1 \middle| s_2 \geq \hat{s}\right)(1+r_1(C)) - 1 + e_1^*\left(r_1(C),1 \middle| s_2 \geq \hat{s}\right)\left[e_2^*\left(r^{**}(s_2),1-s_2\right)(1+r^{**}(s_2)) - 1\right](1-s_2)$$

where $s_2 = R-(1+r_1(C))$.

In comparing these two payoffs to the moneylender, one finds that the moneylender takes a loss on any first period loan. Recall that this was also true in Section 3. This by itself suggests that the moneylender should prefer to let the MFI take care of first period lending. However, one can see that the MFI offers a different first period rate than the moneylender and this rate impacts second period wealth, which in turn impacts the lender's second period profit. Thus when the MFI issues the first period loan, the moneylender loses the ability to influence the equity positions agents hold in their second period projects. The implication is that when the MFI issues the loan in $t=1$ instead of the moneylender, the moneylender's profit per agent in the second period is relatively less.

Lemma 5*. If* $\Pi_2(\theta) > \Pi(r_1(C);\theta(C))$ *for all* $C \leq M$ *, then the moneylender's profit is higher when the MFI distributes the first period loans to the* M *agents.*

In light of this finding, an interesting exercise is to contrast the payoffs to the moneylender under alternative assumptions about whether the MFI is present in the credit market or not. In the absence of an MFI, the moneylender's equilibrium payoff is $\Pi(r_1^*)$, as described in Proposition 1. In contrast, with an MFI present, consider the moneylender's equilibrium payoff of $\Pi_2(\theta)$.

In comparing these two payoffs, some of the tradeoffs discussed earlier apply here as well. By letting the MFI issue the first period loan the moneylender avoids a first period loss. However, with an MFI active in $t = 1$, the moneylender no longer controls the equity position of the agents. In addition, the fact that an MFI is present means that the moneylender faces second period pressure to lower the interest rate. As pointed out in Lemma 4, because of the MFI's second period lending policy, the moneylender offers a lower rate and this implies lower profit. The degree to which the moneylender will have to lower his rate depends on the size of the second period subsidy. Hence, we can establish a link between the size of the second period subsidy and how well the moneylender does in the presence of an MFI.

Proposition 4*. If* $\Pi_2(\theta = 0) > \Pi(r_1^*)$ *then there exists a* $\overline{\overline{Z_2}}$ *such that for all* $Z_2 < \overline{\overline{Z_2}}$*, the moneylender's two period expected payoff is higher when an MFI is present than when no MFI is present.*

Proof*. See appendix.*

This result offers some interesting insight on the question of how a monopolistic moneylender might respond to the entry of a subsidized MFI. In a setting where poor agents lack sufficient equity to make lending profitable, a moneylender faces a negative return on his initial distribution of loans. If an MFI enters and offers first period loans to these agents this clearly represents an increase in the moneylender's first period profit, in that it minimize first period losses. In the process of lending to the poor in the first period, the MFI creates a subset of profitable agents that the moneylender can then cater to in the second period. Under this scenario the moneylender takes in a positive profit in the second period without having to incur the concomitant loss in the first period.

As is pointed out in Proposition 4, we can have a range of second period subsidy levels for which the moneylender earns a higher expected profit from having an active MFI in the market. In a sense, one might argue that it is the donor's subsidy level which determines the harmonious relationship between the monopolistic moneylender and the MFI. This is relevant given some of the recent controversies over the tension between the interactions of the MFI and private lenders.[18] We also calculate a critical upper bound on the subsidy level, above which excessive subsidies will trigger a decrease in the incentives for agents to work hard and save income. This issue is relevant to Morduch's (1999a) argument, in which he claims that excessive subsidies have led to the failure of many previous microfinance programs. Our paper provides one explanation for why such an assertion could be true. By limiting the subsidy levels available to the MFI, the behavior of moneylender and the MFI are complementary, in that the loans provided by the money lender work in fashion with the MFI's mission of poverty alleviation.

6. Conclusion

This paper builds a dynamic model of the interaction between a monopolist lender and an MFI in order to examine a number of key policy issues regarding subsidized lending and poverty alleviation. We find that using an MFI to allocate credit subsidies to the poor can work in tandem with a monopolistic moneylender, with each institution maximizing its own respective objective function. In particular, distributing subsidized loans to poor unlucky agents does not necessarily distort effort or savings decisions, nor does it imply that agents borrowing capital in the private market will stop doing so. Thus, there is no necessary discord between these institutions as has been often proclaimed in recent policy debates. In fact, we offer an explanation for how a private lender with a monopoly over a credit market will actually prefer to have a poverty minimizing MFI enter and offer subsidized loans. We do find however that the impact the MFI has on variables such as borrower's effort and moneylender's profit is sensitive to the subsidy size and lending policy adopted by the MFI. For example, intervention accompanied with high subsidies can make a private lender worse off, and thus, generate conflict between the two lenders.

Our paper offers a few explanations for certain empirical regularities pertaining to subsidies and the failure of MFI institutions in the past, as pointed out in a number of influential

[18] See Aug 19th 2006 article "Microsharks" in The Economist.

studies. Apart from having policy implications we believe that our results have several testable implications. For one, the analytics of our theoretical model imply that MFI penetration in markets catered to by a single moneylender should generate a reduction in the interest rate, even when MFI loans are exclusively distributed to agents who otherwise, would not obtain loans. Whether there is evidence of this is an interesting question, which to our knowledge has not been explored. Secondly, our model implies that for cases where donor subsidies are high and MFI outreach is excessive, poverty alleviation efforts can be less than optimal due to perverse incentives. One approach to verifying this claim might be to examine the relationship between the subsidy level and poverty and how it varies in different regions. Finally, if loan default can be taken as a proxy for lower effort, one might be able to track default rates before and after an MFI is introduced, or alternatively as the subsidy level changes. This line of research could be used to determine whether the data supports our explanation for how the results of Ghatak et. al (2001) can be mitigated.

Appendix

Proof of Lemma 1. Take the partial derivative of each interest rate with respect to s_2:

$$\frac{\partial r^m(s_2)}{\partial s_2}=\frac{1}{(1-s_2)^2}\left[\frac{\eta}{\eta+1}R\right] \tag{18}$$

$$\frac{\partial r^*(s_2)}{\partial s_2}=\frac{1}{(1-s_2)^2}\left[R-\left(\frac{\eta+1}{\eta}s_2 d^{\frac{1}{\eta}}\right)^{\frac{\eta}{\eta+1}}\right]-\frac{1}{(1-s_2)}d^{\frac{1}{\eta}}\left(\frac{\eta+1}{\eta}s_2 d^{\frac{1}{\eta}}\right)^{\frac{-1}{\eta+1}} \tag{19}$$

Recall that at $s_2=\hat{s}$, $r^m(s_2)=r^*(s_2)$. Evaluating the derivatives at $s_2=\hat{s}$ we have:

$$\frac{\partial r^m(\hat{s})}{\partial s_2}=\frac{1}{(1-\hat{s})^2}\left[\frac{\eta}{\eta+1}R\right] \tag{20}$$

$$\frac{\partial r^*(\hat{s})}{\partial s_2}=\frac{1}{(1-\hat{s})^2}\left[\frac{\eta}{\eta+1}R\right]-\frac{1}{(1-\hat{s})}d^{\frac{1}{\eta}}\left(\frac{\eta+1}{\eta}\hat{s}d^{\frac{1}{\eta}}\right)^{\frac{-1}{\eta+1}} \tag{21}$$

Clearly, $\frac{\partial r^m(\hat{s})}{\partial s_2}>\frac{\partial r^*(\hat{s})}{\partial s_2}$. It then follows, looking at the general partial derivatives that as s increases, $\frac{\partial r^m}{\partial s_2}>\frac{\partial r^*}{\partial s_2}$ at each $s_2\in(\hat{s},1)$. QED

Proof of Lemma 2. For large loan sizes where $s_2<\hat{s}$, if we plug $r^m(s_2)$ into $\pi_2(r_2,L_2)$, we have

$$\pi_2\left(r^m(s_2),L_2\right)=\eta d^{\frac{-1}{\eta}}\left(\frac{R}{\eta+1}\right)^{\frac{\eta+1}{\eta}}-1+s_2. \tag{22}$$

Recall that due to Assumption A4, this profit is negative at $s_2=0$. However, as is clear from above, $\pi_2\left(r^m(s_2),L_2\right)$ increases linearly with s_2. Thus, for $s_2\le\hat{s}$, $\pi_2\left(r^m(s_2),L_2\right)$ is highest at $s_2=\hat{s}$. At smaller loan sizes, where $s_2>\hat{s}$, if we plug the interest rate $r^*(s_2)$ into $\pi_2(r_2,L_2)$, we have

$$\pi_2\left(r^*(s_2),L_2\right)=Rd^{\frac{-1}{\eta}}\left[\frac{\eta+1}{\eta}s_2 d^{\frac{1}{\eta}}\right]^{\frac{1}{\eta+1}}-\frac{1}{\eta}s_2-1. \tag{23}$$

Since $r^m(s_2)$ and $r^*(s_2)$ are the identical at $s_2 = \hat{s}$, it follows that $\pi_2(r^m(s_2), L_2) = \pi_2(r^*(s_2), L_2)$ at $s_2 = \hat{s}$.

The question now is what happens to the moneylender's profit for $s_2 > \hat{s}$. Taking the derivative of $\pi_2(r^*(s_2), L_2)$ with respect to s_2, we have

$$\frac{\partial \pi(r^*(s_2), L_2)}{\partial s_2} = \frac{R}{\eta}\left[\frac{(\eta+1)}{\eta} s_2 d^{\frac{1}{\eta}}\right]^{\frac{-\eta}{\eta+1}} - \frac{1}{\eta}. \tag{24}$$

Evaluating the sign of this partial as $s_2 \to 1$, one finds that the expression is positive due to Assumption A3. Furthermore, one can easily confirm that the second derivative is negative for all $s_2 > \hat{s}$, implying that equation profit is strictly concave with respect to s_2. It then follows for all values $s_2 \in [\hat{s}, 1)$, as s_2 increases so does the moneylender's expected profit. QED

Proof of Proposition 1. The second period equilibrium behavior follows directly from Lemma 2. In the first period the question is whether the moneylender will offer $r_1 \in (R-2, R-1-\hat{s}]$. In general $r_1 \leq R-2$ or $r_1 \in (R-2, R-1]$. For $r_1 \leq R-2$, the moneylender makes a payoff based on first period profit only, which is denoted Π_1. The other possible domain for r_1 is $r_1 \in (R-2, R-1]$, which can be partitioned into two subsets around the point $R-1-\hat{s}$. If the moneylender offers $r_1 \in (R-1-\hat{s}, R-1]$, then in $t=2$ the moneylender offers $r^m(s_2)$ to all successful agents. Anticipating this offer, the agent's first period problem is

Choose e_1 to maximize $e_1[R-(1+r_1)-s_2] - \frac{d}{\eta+1} e_1^{\eta+1} + e_1 u_2(e_2^*(r^m(s_2), 1-s_2)) + (1-e_1)0$.

Since $s_2 < \hat{s}$, it follows that $s_2 < u_2(e_2^*(r^m(s_2), 1-s_2))$. Thus, the agent's optimal first period effort is

$$e_1^*(r_1, L_1 | s_2 < \hat{s}) \equiv d^{\frac{-1}{\eta}}\left[R-(1+r_1)-s_2+\frac{\eta}{\eta+1} d^{\frac{-1}{\eta}}\left(\frac{R}{\eta+1}\right)^{\frac{\eta+1}{\eta}}\right]^{\frac{1}{\eta}}. \tag{25}$$

For $r_1 \in (R-1-\hat{s}, R-1]$, given optimal first period effort, the moneylender's expected payoff on a given agent is then

$$\Pi(r_1) = e_1^*(r_1,1|\, s_2 < \hat{s})(1+r_1) - 1 + e_1^*(r_1,1|\, s_2 < \hat{s})[e_2^*(r^m(s_2),1-s_2)(1+r_2^m(s_2)) - 1](1-s_2)\,, \qquad (26)$$

where $s_2 = R-(1+r_1)$. If one takes the first derivative of $\Pi(r_1)$ over this domain, one can confirm that $\Pi'(r_1) = 0$. This implies that over this region of first period interest rates, the moneylender's profit is constant. Thus, to maximize the moneylender's profit over the set $r_1 \in (R-2, R-1]$, it is sufficient to find the rate that maximizes profit over the subset $r_1 \in (R-2, R-1-\hat{s}]$. QED

Proof of Proposition 2. (i) First consider the case where $Z_2 \le \overline{Z}_2(s_2, B)$. The question is whether the MFI can reduce expected poverty in $t = 2$ by deviating and issuing loans to agents with no credit history. For a sufficiently high weight α on the objective function, the MFI has a priority to lend to the poorest agents first. At the start of $t = 2$ agents with credit histories can be partitioned according to whether they had a success or failure. Since $Z_2 \le \overline{Z}_2(s, B)_2$, it is profitable for the moneylender to issue second period loans to agents with a success. These agents, if successful then earn a net income of

$$[R-(1+r^{**}(s_2))(1-s_2)] = \left[\frac{(\eta+1)}{\eta} s_2 d^{\frac{1}{\eta}} + \theta\left(\frac{R}{\eta+1}\right)^{\frac{\eta+1}{\eta}}\right]^{\frac{\eta}{\eta+1}}. \qquad (27)$$

Recall that in the absence of the MFI, when the moneylender offers these same agents the rate $r^*(s_2)$ the net income is

$$[R-(1+r^*(s_2))(1-s_2)] = \left(\frac{\eta+1}{\eta} s_2 d^{\frac{1}{\eta}}\right)^{\frac{\eta}{\eta+1}}. \qquad (28)$$

Thus the gain in net income among successful clients of the moneylender is

$$\left[\frac{(\eta+1)}{\eta} s_2 d^{\frac{1}{\eta}} + \theta\left(\frac{R}{\eta+1}\right)^{\frac{\eta+1}{\eta}}\right]^{\frac{\eta}{\eta+1}} - \left(\frac{\eta+1}{\eta} s_2 d^{\frac{1}{\eta}}\right)^{\frac{\eta}{\eta+1}}. \qquad (29)$$

Of course, agents borrowing from the MFI also have a positive expected income. In particular, each agent who borrows under the contract $(r^m(0),1)$ and is successful earns a net income

$$R-(1+r^m(0))1=\frac{\eta}{\eta+1}d^{\frac{-1}{\eta}}\left(\frac{R}{\eta+1}\right)^{\frac{\eta+1}{\eta}}. \tag{30}$$

If the MFI deviates by extending a loan to an agent with no credit history, this new borrower has exactly the same expected income as the previous agent with a credit history. However, now the agents borrowing from the moneylender experience a fall in their expected income due to the lack of bargaining power. Hence, the MFI has no incentive to deviate and target agents without credit histories.

(ii) Next we consider the case where $Z_2 > \overline{Z}_2(s_2, B)$. In equilibrium, the MFI allocates subsidy to unsuccessful agents with credit histories until $\theta = \overline{\theta}(s_2)$, after which it uses the subsidy to offer loans to the agents from the population with no credit history. Then consider a deviation where the MFI uses subsidy levels above $\overline{Z}_2(s_2, B)$ to further finance loans to agents with credit histories rather than new agents. As the MFI raises outreach above $\overline{\theta}$ the moneylender will not lower his rate since the moneylender just breaks even at $\overline{\theta}$.[19] Consequently, if an agent deviates and applies for an MFI loan, his individual expected payoff will exceed the payoff he gets by staying with the moneylender. Hence, one or more agents deviate by consuming their savings and applying for an MFI loan. This then reduces the MFI's effective outreach since the number of applicants rises, which in turn eliminates the incentive for any additional agents to deviate and pursue an MFI loan.

Notice that by not deviating, the MFI uses additional subsidy to finance a loan to an agent with no credit history, i.e, an agent with zero wealth. In contrast, by deviating the MFI uses the additional subsidy to randomly allocate a loan to a set of agents, some of whom have zero wealth and others who have positive wealth and previously borrowed from the moneylender. Thus the deviation leads to an outcome where the MFI is allocating subsidy to agents that prior to the deviation were earning a positive expected income. Given the weight α on the objective function, poverty increases after the deviation as the MFI is now catering to the less poor. QED

[19] Notice that this implies that regardless of what the MFI does with additional subsidy above $\overline{Z}$, there is no additional reduction in poverty attributed to a decrease in the moneylender's interest rate.

Proof of Proposition 4. The profit that the moneylender derives in the absence of the MFI is given by $\Pi\left(r_1^*\right)$. On the other hand the profit that the moneylender derives in the presence of the MFI is $\Pi_2(\theta)$. At $Z_2 = 0$ when outreach is $\theta = 0$, assume $\Pi_2(\theta = 0) > \Pi\left(r_1^*\right)$. Let us denote the difference $[\Pi_2(\theta)$-$\Pi\left(r_1^*\right)]=$ $\phi(\theta)$. When $\theta = 0$ the moneylender's payoff is higher when an MFI is present, although the MFI of course is not lending in $t = 2$. As θ increases, this forces the moneylender to lower his second period rate and thus due to the concavity of the profit function the profit level of the moneylender falls. At $\theta = 1$, there are two possible cases; either $\Pi_2(\theta = 1) \leq \Pi(r_1^*)$ or not. Suppose it is true that $\Pi_2(\theta = 1) \leq \Pi(r_1^*)$. It then follows from the Intermediate Value Theorem that there exists a θ where $\theta \in (0,1]$, such that $\phi(\theta) = 0$; that is, $\Pi_2(\theta) = \Pi(r_1^*)$. This implies that starting at an outreach of zero there is a range of outreach levels for which the moneylender's profit $\Pi_2(\theta)$ exceeds what his profit would be in the absence of the MFI, namely $\Pi(r_1^*)$. Since outreach values can be mapped back to a specific Z_2, we can denote this critical subsidy level as $\overline{\overline{Z_2}}$. Finally, observe that if alternatively, it is true that at an outreach of $\theta = 1$, $\Pi_2(\theta = 1) > \Pi(r_1^*)$ obviously the moneylender is better off for a range of subsidy levels Z_2. QED

References

(1) Banerjee, A.V. and A. Newman (1993), "Occupational Choice and the Process of Development," *Journal of Political Economy* 101: 274-298.

(2) Bose, P., (1998) "Formal-Informal Sector Interaction in Rural Credit Markets," *Journal of Development Economics* 56: 265-280.

(3) Conning, J., (1999), "Outreach, Sustainability and Leverage in Monitored and Peer-monitored lending," *Journal of Development Economics* 60: 51-77.

(4) Cull, R., Demirguc-Kunt, A., and J. Morduch, (2007), "Financial Performance and Outreach: A Global Analysis of lending Microbanks," *Economic Journal* 117 (February): F107-F133.

(5) Foster, J., Greer, J., and E. Thorbecke, (1984), "A Class of Decomposable Poverty measures," *Econometrica* 52: 761-766.

(6) Galor, O., and J. Zeira, (1993), "Income Distribution and Macroeconomics", *Review of. Economic Studies* 60(1) :35-52.

(7) Ghatak, M., (1999), "Group Lending, Local Information, and Peer Selection," *Journal of Development Economics* 60 (1): 27-50.

(8) Ghatak, M., and T., Guinnane (1999), "The Economics of Lending with Joint Liability: Theory and Practice," *Journal of Development Economics* 60 (1): 27-50.

(9) Ghatak, M., M. Morelli and T. Sjostrom, (2001), "Occupational Choice and Dynamic Incentives," *Review of Economic Studies* 68: 781-810.

(10) Ghosh, P., D. Mookherjee and D. Ray, (2001), "Credit Rationing in Developing Countries: An Overview of the Theory," in *Readings in the Theory of Economic Development*, ed., by D. Mookherjee and D. Ray, Blackwell Publishers.

(11) Hoff, K., and J. Stiglitz, (1998), "Moneylenders and Bankers: Price Increasing Subsidies in a Monopolistically Competitive Market," *Journal of Development Economics* 55: 485-518.

(12) Jain, S., (1999), "Symbiosis versus Crowding-out: The Interaction of Formal and Informal Credit Markets in Developing Countries," *Journal of Development Economics*, 59(2): 419-444.

(13) Jain, S., and G. Mansuri, (2003), "A little at a Time: the use of Regularly Scheduled Repayments in Microfinance Programs," *Journal of Development Economics*, 72 (1): 253-279.

(14) Jain, S., and G. Mansuri, (2005), "Information Sharing Among Competing Microfinance providers"?, Working paper, University of Virginia.

(15) McIntosh, C., and B. Wydick., (2005), "Competition and Microfinance", *Journal of Development Economics*, 78: 271-298.

(16) Mookerjee, D. and D. Ray, (2003), "Persistent Inequality," *Review of Economic Studies,* 70: 369-393.

(17) Morduch, J., (1999a), "The Role of Subsidies in Microfinance: Evidence from the Grameen Moneylender," *Journal of Development Economics*, 60: 229-248.

(18) Morduch, J., (1999b), "The Microfinance Promise," *Journal of Economic Literature*, 37 (4): 1569-1614.

(19) Morduch, J., (2000), "The Microfinance Schism," *World Development*, 28 (4): 617-629.

(20) Padilla, J.A., and M. Pagano., (1997), "Endogenous Communication Among Lenders and Entrepreneurial Incentives," *Review of Financial Studies*, Spring 10 (1): 205-236.

(21) Padilla, J.A., and M. Pagano., (2000), "Sharing Default Information as a Borrower Disciplining Device," *European Economic Review*, 44: 1951-1980.

(22) Stiglitz, J., (1990), "Peer Monitoring and Credit Markets," *World Bank Economic Review* 4(3): 351-366.

(23) Yunus, M., (2003), *Moneylenderer to the Poor: Microlending and the Battle Against World Poverty*, Public Affairs, Perseus Book Group, New York, NY.