Essays in Microfinance:

Theory and Evidence on Sequential Lending

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I confirm that the work presented in this essay is my own and the work of other persons is appropriately acknowledged.

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Abstract

The dissertation explores mechanisms by which a lender can use timings of loans to engender peer monitoring and increase lending efficiency, when lending to a group of jointly liable impoverished individuals. We show that by disbursing the loans in a sequence (restricting the number of loans per period), the lender can finance a greater range of projects and allow poorer individuals to join the groups.

Sequential lending entails lending to one borrower per period with the proviso that the second borrower's loan is contingent on first borrower's repayment. Simultaneous lending lets the borrowers make the decisions on their respective tasks simultaneously, requiring the lender to incentivise tasks collectively. Sequential lending separates the decisions on the task temporally and tasks are incentivised individually. Conversely, the lender's capital is less productive in sequential as compared to simultaneous lending. We show that if monitoring technology is sufficiently efficient, a greater range of projects are feasible under sequential lending.

In a case-study of a Microfinance Institution in India, we found evidence of sequential lending. The lender restricted the number of group members that could borrow simultaneously, giving non-borrowers incentives to monitor the borrowers. We found significant income heterogeneity within the groups with wealthier members obtaining a higher proportion of loans.

We build a stylised model based on the case-study. We show that the lender can engender negative assortative matching (wealthy pairing-up with poorer individuals) by restricting credit to the group. By requiring that the borrower and the non-borrower acquire a stake in the borrower's project, the lender determines the wealth-threshold for joining the group. Restricting credit creates intra-group competi-

tion for loans. The wealthy pair-up with poorer individuals to curtail the competition for loans within the group. By forbidding the group members to borrow simultaneously, the lender is able to lower the wealth-threshold for joining the group.

To mamma and papa

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Introduction

Overview

The objective of this dissertation is to explore the mechanisms by which a lender can engender peer monitoring when lending to a group of jointly liable impoverished individuals. We examine how disbursing the loans in sequence (or restricting the number of loans per period) to a group can help the lender save on the economic rents left to the borrowers given that saving on economic rents can potentially allow the lender to (a) finance a greater range of projects and (b) lower the wealth threshold required for participating in group lending.

The poor lack wealth which can be put up as collateral for a loan. Thus, from the lender's perspective, lending to the poor individuals for investment projects is expensive in terms of rents. Their limited ability to bear liability in case of an unsuccessful outcome restricts the lender's ability to incentivise their effort by punishing failure. Thus, the lender has to incentivise individual borrower's effort through rents. The lender is unable to finance some less productive yet socially viable projects because of these rents.

The group lending literature suggests that this problem can be partially alleviated if the loans are disbursed to groups of individuals who can be held jointly liable for each other's outcome. An individual borrower's incentive for effort is sharper when she is part of a jointly liable group. With joint liability, the lender can punish a borrower for her peer's failure, which may induce *cooperation* and lead to *information sharing* amongst the group members.

Put simply, with joint liability, it is cheaper, in terms of the rents, to satisfy a group's collective incentive compatibility constraint[1] than it is to satisfy an individual's incentive compatibility constraint.[2] Of course, this only holds when the borrowers in a group can influence each other's action.

In these essays, we assume that the agents can influence each other's effort choice by monitoring each other. There are private benefits associated with insufficient (low) effort which a peer can curtail by monitoring.[3] Consequently, the lender can influence the borrower's effort choice either directly through the rents he offers her or indirectly by engendering peer monitoring.

If it is costly for the group members to influence each other's effort through monitoring, the borrowers will also have to be compensated for the cost incurred while monitoring. The lender has to ensure that each borrower's two tasks, monitoring and effort, are incentivised and the group's collective incentive compatibility condition is satisfied.

The group's collective incentive compatibility condition is also the condition that ensures that the group does not collude. On one hand, this condition encourages the group to take all decisions cooperatively. On the other hand, it ensures that the group does not benefit additionally from colluding. The rents that satisfy the group's collective incentive compatibility condition can be called the *collusion rents.*

In the first essay we show that in terms of rents, satisfying the group's col-

[1]This is the incentive compatibility condition of the group where the group is presumed to be a single entity. Alternatively, it is a group that can perfectly collude.

[2]This is, if the joint liability payments are high enough.

[3]Specifying monitoring in this way is the reduced form of a much richer interaction between the agents.

lective incentive compatibility condition is more expensive than incentivising the borrowers to undertake the two tasks (monitoring each other and exerting sufficient effort on their project respective projects). That is, the collusion rents are higher than the rents that incentivise the two tasks.

If lender disburses the loans simultaneously to the group, the borrowers make their respective decisions on monitoring and effort simultaneously. It is the simultaneity of the decisions on the two tasks that requires the lender to compensate the group collectively. In effect, the group can obtain collusion rents even if it does not possess the ability to collude or possess limited ability to collude. Conversely, if the decisions are temporally separated, the group would no longer be able to retain collusion rents and the lender would have to just incentivise the two tasks.

We show that the lender can lower the rents the borrowers retain by lending sequentially to the group. Lending sequentially to a group of two would entail lending initially to a randomly chosen group member i. j, the remaining member of the group, gets the loan only if i's project succeeds. With this mechanism, the lender would only have to incentivise the two tasks individually and the group's collective incentive compatibility condition would remain slack.

In terms of the lender's ability to finance low productivity projects, the picture is mixed. The disadvantage of sequential group lending is that it punishes the whole group for i's (first borrower's) project failure. This lowers the productivity of the lender's capital. We show that if the monitoring technology is sufficiently efficient, a greater range of low productivity projects are feasible under the sequential as compared to simultaneous group lending mechanism. The rents that lender saves by employing the sequential mechanism decreases as the monitoring technology becomes more inefficient. Consequently, if the monitoring technology is sufficiently inefficient, a greater range of low productivity projects are feasible under the simultaneous as compared to the sequential mechanism.

In sequential lending mechanism, the lender is able to exploit the borrower's inability of side contract across time period to lower rents allocated to them. If the borrowers possessed unlimited ability to collude, the rents allocated to the borrower would be identical under simultaneous and sequential lending mechanisms. Sequential lending mechanism only works if the borrowers in the group are not able to side contract over action across time. This could be the reason why, in practice, members are barred from grouping with their relatives by the lender.

The second essay is a case study of a Microfinance Institution (MfI) working in Haryana in India. We examine the group lending mechanism used by this particular MfI and analyse how the mechanism solves the information problems associated with lending to the poor. The MfI allows 15 to 20 members in each group. 54 group members from 5 different groups were interviewed for this case study. The study found that

(a) the group members made a fixed contribution each month to the group's saving pot,

(b) the group members could borrow internally (from the group's saving pot) as well as externally (from an external credit source)[4],

(c) the lender induced sequential lending in the group by restricting the number of members in a group that could borrow simultaneously at a given point in time,

[4]The MfI arranges the external loans for the group. Under the rules of the Self Help Group Linkage Programme, India's national microfinance programme, the MfI is not allowed to lend directly to the groups or act as a financial institution.

(d) the group had significant income heterogeneity within it and the wealthier members of the group obtained a high proportion of the loans[5] given to the group and

(e) about half the members of each group had chosen not to borrow even though other members had borrowed more than once.

The case study thus finds evidence of the MfI in India lending sequentially within the groups. Further, the case study suggests that, by restricting simultaneous lending in this particular mechanism, the lender is able to engender peer monitoring by partitioning the group between borrowers and non-borrowers using their wealth. The non-borrowers are given explicit incentives to monitor the borrower. This is done by allowing internal lending within the group, which effectively makes the non-borrower an equity investor in the borrower's project.

In the third essay, we build a stylised model based on this case study. We assume that the borrowers have varying amounts of cash wealth at their disposal. A group is endogenously formed for only one period and consists of two borrowers. The lender offers the group a contract where only one member from the group can borrow. The group contract specifies the amounts the borrower and the non-borrower have to invest in the borrower's project and their respective payoffs. The lender lends the remaining capital for the borrower's project to the group. The group contract in effect specifies the wealth thresholds for becoming a borrower or a non-borrower in the group.

The optimal contract is characterised by the non-borrower's return on her equity investment. The lender is able to engender optimal amount of monitoring by ensuring that the non-borrower's return compensates her for the opportunity cost of capital and the costs incurred whilst monitoring.

[5]in terms of value

Restricting the credit creates intra-group competition for the loans in the group. The essay shows that by restricting the credit, the lender can engender negative assortative matching, i. e. the relatively wealthy agents[6] pairing up with poorer agents[7] to form groups. For the relatively wealthy, grouping with a poor agent eliminates the intra-competition for loans.

This group lending mechanism gives the poor an opportunity to enrich themselves by allowing them to earn a higher than market return on their cash wealth. Thus, prohibiting the group members from borrowing simultaneously enables the lender to lower the wealth threshold of participating in the group.

The essay further shows that as the opportunity cost of capital in the economy decreases, the wealth threshold for the non-borrower increases while the gap in the borrower's and non-borrower's wealth threshold closes. We define the optimal cost of capital, in this context, as the one which allows the poorest borrower to join the group as a non-borrower and graduate on to becoming a borrower in one loan cycle.

From the perspective of the government thus, subsiding the cost of capital is only warranted if the market cost of capital is higher than the optimal cost of capital. If the market cost of capital is lower, then subsidising the cost of capital harms the interests of the poor.

The following section discusses the related literature in group lending.

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[6]Relatively wealthy agents are the ones that have wealth greater than the borrower's wealth threshold.

[7]Poorer agents are the ones that have wealth that lies between the borrower's and non-borrower's wealth thresholds.

Related Literature

A recurrent theme in the moral hazard literature on group lending has been that joint liability induces the borrowers in a group to effectively collude, i.e. behave cooperatively. Consequently, if the group's collective incentive compatibility condition is satisfied, the borrowers choose effort cooperatively, which is beneficial to the lender, who, in turn, passes it on to the borrowers. (Stiglitz (1990), Varian (1990) and Ghatak and Guinnane (1999)). Thus, any gains in lending efficiency, i. e. lowering of the borrower's rents, can potentially benefit the borrower's themselves.

With joint liability, the risk each group member faces on her own in group lending is higher than in individual lending. Stiglitz (1990) shows that joint liability induces members to monitor each other in the group. The overall risk reduction of the group due to peer monitoring outweighs the increased individual risk imposed by joint liability leading to increased lending efficiency.

Stiglitz (1990) assumes that the borrowers are able to observe each other's actions and collude on actions without incurring any costs. Ghatak and Guinnane (1999) show that if social sanctions are sufficiently effective or peer monitoring is sufficiently inexpensive, the group members can collude, i, e. contract on effort amongst themselves leading to increased lending efficiency.

Laffont and Rey (2003) argue that "lending efficiency is enhanced when entrepreneurs mutually observe their efforts but reduced when they collude." Their nuanced argument is that gains in the lending efficiency come from information sharing amongst the borrowers and not collusion per se. Thus, if observing and influencing effort choice within the group costs less than the rents that satisfy the group's collective incentive compatibility condition, then the rents group members are obtaining are collusion rents.

Monitoring, by itself, is an unobservable task. When the groups are encouraged to collude, they internalise the cost of monitoring. (Stiglitz (1990), Varian (1990) and Ghatak and Guinnane (1999)) If the lender instead sets out to explicitly encourage the agents to monitor, he can only do so through rents. Consequently, in a standard delegated monitoring model with wealth less borrower and monitor, where the monitor can influence the borrower's effort choice by monitoring, the lender incentivises effort and monitoring by allocating rents to the borrower and the monitor. Conning (1996) and Conning (2000) show that in group lending, only the more expensive of the two rents have to be paid, leading to gains in lending efficiency.

Unfortunately, one of the rents turns out to be collusion rents. The group can only be induced to take on monitoring if the group's collective incentive compatibility constraint is satisfied. Monitoring can only be induced if the borrowers are paid out the collusion rents. The intuition for this result is that in a group, the lender cannot incentivise two separate tasks with one instrument (in this case rent) without allowing the group to collude. The essays in this dissertation suggest that the lender can use time as an additional instrument. That is, the lender can use timing of the loans to incentivise the two tasks, without allowing the group to collude amongst themselves.

An alternative way to engender peer monitoring would be restrict the loans to only one member per group and allow the group members to borrow from each other. In a setup reminiscent of the delegated monitoring case, Banerjee et al. (1994) analyse the process by which peer monitoring is engendered in cooperatives, where the members are allowed to borrow both internally (from other group members) and externally. If a borrower's project is partly financed by her peer, it gives the peer the incentive to monitor the borrower. The peer monitors to safeguard the returns from her equity investment in the borrower's project. In the third essay, we use this framework to analyse endogenous group formation and examine whether it allows the lender to lower the wealth threshold for joining a group.

Chapter 1

Sequential Group Lending with Moral Hazard

1.1 Introduction

In this chapter we compare sequential and simultaneous group lending mechanisms. In simultaneous group lending, all the borrowers in the group receive their loans simultaneously. Conversely, in sequential group lending, the loans are disbursed sequentially within the group with the proviso that the second borrower obtains the loan only if the first borrower's project succeeds.

In simultaneous group lending, the borrowers make their decisions on their respective tasks simultaneously. Consequently, the lender has to incentivise their actions collective by satisfying the group's collective incentive compatibility condition. Lending sequentially allows the lender to temporally separate the borrower's decision on their respective tasks. As a result, the lender incentivises' the borrower's tasks individually and not collectively, leaving the group's collective incentive compatibility condition slack. Consequently, the lender is able to lower the rents allocated to the borrowers by lending sequentially.

The disadvantage of lending sequentially is that punishing the whole group for the first borrower's project failure lowers the productivity of lender's capital. Consequently, we show that for a sufficiently efficient monitoring technology, the lender is able to finance a greater range of projects with sequential as compared to simultaneous group lending.

In practice, Grameen Bank (Bangladesh) follows the sequential group lending model where borrowers receive their credit sequentially. Banco Solidario (Bolivia) and ACCION affiliated microfinance organisations allocate credit within the groups simultaneously

Varian (1990) explores the benefits of sequential lending in a setup with heterogeneous borrowers, i.e. ones with high and low productivity. The critical assumption in the paper is that, given requisite incentives, the high productivity borrower can school the low productivity borrower and turn her into a high productivity borrower.

The paper shows that when lending to a group of randomly selected borrowers, the lender prefers to lend sequentially, as it increases his profits. He offers the second period borrower a contract only after observing the output of the first period borrower. If the first period borrower is the low type, schooling her helps the second borrower get a favourable contract.

Lending sequentially increases the lender's profit in two ways. First, the first period production signal helps him in sorting out the borrower's type more effectively. Second, the information transmission increases the number of high productivity borrowers. The result of the paper, of course, rests on the assumption of perfect information transmission within groups.

In a recent contribution, Roy Chowdhury (2005) finds that in a costly monitoring setup, group lending with joint liability does not necessarily alleviate the moral hazard problem.

There is strategic complementarity between the monitoring levels of the two borrowers in the group, i.e. monitoring by one borrower encourages the other borrower to monitor and vice versa. Roy Chowdhury (2005) finds that this strategic complementarity leads to both borrowers choosing to not monitor when borrower obtain credit simultaneously. Lending sequentially enhances the incentives for peer monitoring and results in positive levels of monitoring.

The no-monitoring result in simultaneous group lending in Roy Chowdhury (2005) are driven by the assumption[1] that the interest rate the lender charges the borrower is exogenously determined. Consequently, with insufficient rents, simultaneous group lending is infeasible. (Roy Chowdhury, 2005, Proposition 2, page 423) Of course, simultaneous group lending has shown to be viable in practice in Banco Solidario (Bolivia) and ACCION affiliated microfinance organizations among others. As discussed above, simultaneous group lending is feasible if the group can be encouraged to cooperate. This is achieved by satisfying the group's collective incentive compatibility condition.

In this chapter we show that simultaneous group lending is feasible if the lender is free to vary the interest rate charged (and determine the borrower's payoffs). If the borrowers can influence each other's effort decision through monitoring, the lender will induce positive levels of monitoring in simultaneous group lending by allocating appropriate rents to the borrowers. This allows us to compare the cost (in terms of rents) of implementing the two lending mechanisms. We find that that the borrowers retain lower rents in sequential group lending.

[1] Roy Chowdhury (2005) follows Besley and Coate (1995) in assuming that the interest rate charged by the lender is exogenously given.

1.2 Model

There are two agents B_1 and B_2. Each of them has access to a project requiring a lump-sum investment of 1 unit of capital. The project produces an uncertain and observable outcome x, valued at $\bar{x}$ when it succeeds (s) and 0 when it fails (f).

1.2.1 Agents

The agents are risk neutral, with zero reservation wage and no wealth. Agents may choose to pursue the aforementioned project with a high (H) or low (L) effort e, which is unobservable. With a high (low) effort, $\bar{x}$ is realised with a probability π^h (π^l) and 0 with $1 - \pi^h$ $(1 - \pi^l)$. $(\pi^h > \pi^l)$

By exerting low effort, agents obtain private benefits of value B from the project which is non-pecuniary and non-transferable amongst the agents. The private benefits can be curtailed by monitoring, which is undertaken at a non-pecuniary cost c to the agent monitoring.

The agents are able to monitor and curtail each other's private benefits. The extent of monitoring is observable to the agents but unobservable to the lender. We impose the following assumption on the monitoring function B(c).

Assumption 1 (Monitoring function $B(c)$).

i. $B(0) > 0$

ii. $B(c)$ *is continuous and at least once differentiable* $\forall\ c \geqslant 0$

iii. $B_c(c) < 0\ \ \forall\ c \geqslant 0$

1.2.2 The Lender

The *lender* is risk-neutral. He is not able to monitor the agents and can only punish them through their payoffs. The lender can costlessly observe the initial capital invested in the project and the output from the project. We assume that the lender has the ability to enforce the contracts once the project outcome is realised.

The lender has access to capital at ρ, the opportunity cost of capital. The lender faces competition and is unable to earn any rents on the funds he lends, thus making zero profit.

1.2.3 The Agent's Payoff

In individual lending, the borrower borrows 1 unit of capital once she accepts the contract offered by the lender. The lender may choose to delegate the task of monitoring to another agent. The lender makes the borrower's and the monitor's payoff, b_i and w_i respectively, contingent on i, the borrower's project outcome.

In group lending, the lender finances the projects of the group members B_1 and B_2 once they accept the group contract offered by the lender. We assume that both borrowers want to undertake identical projects and the lender offers them symmetrical contracts. The lender makes the borrower's payoff b_{ij} contingent on i and j, the outcomes of B_1 and B_2's projects, respectively, in the group contract.

In a joint liability group contract a borrower's payoff is affected by her peer's project outcome. ($b_{is} \neq b_{if}$) The lender can punish a borrower for her peer's project failure by ensuring that $b_{is} \geqslant b_{if}$ for $i = \{s, f\}$ with at least one strict inequality.

1.3 Individual Lending

In individual lending, the individual borrower undertakes a project by borrowing 1 unit of capital from the lender if she accepts the contract (b_s, b_f).

1.3.1 First-Best

The perfect information case, where the lender can observe the borrower's effort level, is examined as a benchmark. The lender offers the borrower a contract (b_s, b_f) that solves the following problem:

$$\begin{aligned} \max_{b_i} E\left[x \mid H\right] &- E[b_i \mid H] \\ E\left[b_i \mid H\right] &\geqslant 0 \qquad (1.1) \\ b_i &\geqslant 0; \quad i = s, f \qquad (1.2) \end{aligned}$$

The borrower's participation constraint (1.1) binds and the limited liability constraint (1.2) binds in state f. The lender offers the borrowers a contract where $b_s = b_f = 0$. If the borrower accepts the contract, she is able to undertake the project. Using the lender's feasibility condition given below, we find that the lender can finance all the socially viable projects. notation?

x_s v $\bar{x}$

$$E[x \mid H] \geqslant E[b_i \mid H] + \rho \qquad (1.3)$$

$$x_s \geqslant \frac{\rho}{\pi^h}$$

Define x_s

1.3.2 Second-Best

With incomplete information, borrower's effort is unobservable to the lender. The lender needs to give the borrower incentive to exert high effort by rewarding her sufficiently if her project succeeds.

$$E[b_i \mid H] \geqslant E[b_i \mid L] + B(0) \tag{1.4}$$

The incentive compatibility constraint above ensures that the borrower is not worse off by exerting high effort. With no monitoring, the private benefits are at their maximal value, $B(0)$.

The Optimal Contract without Delegated Monitoring

The lender offers the borrower a contract (b_s, b_f) that solves the following problem:

$$\max_{b_i} E\left[x \mid H\right] - E[b_i \mid H]$$

subject to the borrower's participation constraint (1.1), limited liability constraint (1.2) and incentive compatibility constraint (1.4).

The lender offers the borrower a contract $\left(\frac{B(0)}{\Delta\pi}, 0\right)$ where $\Delta\pi = \pi^h - \pi^l$. The contract ensures that the incentive compatibility constraint (1.4) binds and the limited liability constraint (1.2) binds only for state f.

$$E[b_i \mid H] = \pi^h \frac{B(0)}{\Delta\pi} > 0 \tag{1.5}$$

The borrower is left with a positive expected rent leaving her participation constraint slack.

The lender is unable to punish the borrower when the projects fails because of the limited liability constraint. The borrower gets the requisite incentive for high effort through higher payoffs when the project succeeds. This allows the borrower to retain a strictly positive limited liability rent. (Laffont and Martimort, 2002, page 119) Using the lender's feasibility constraint (1.3) we get the set of feasible projects.

Confusing x_s | $\bar{x}$

$$x^s \geq \frac{\rho}{\pi^h} + \frac{B(0)}{\Delta\pi} \tag{1.6}$$

Lemma 1. *With imperfect information, the lender is unable to finance some socially viable projects.*

The lender is not able to finance projects $\bar{x} \in \left[\frac{\rho}{\pi^h}, \frac{\rho}{\pi^h} + \frac{B(0)}{\Delta\pi}\right)$.

Delegated Monitoring

Group lending is plagued with the possibility of collusion between the borrowers in the group. Understanding how collusion is prevented in the delegated monitoring model helps us better understand how it can be prevented in group lending.

Like the effort level, the lender cannot observe the task of monitoring. If the lender delegates the task of monitoring, he makes the monitor's payoff contingent on the borrower's project outcome. This gives the monitor the requisite incentive to influence the borrower's effort choice by monitoring her and curtailing her private benefits B. This particular lending mechanism is partially akin to joint liability in group lending, where the two borrower's project outcomes affect each other's payoffs.

The borrower's and monitor's contracts work in conjunction with each other. The borrower's contract aims to influence her effort choice directly through her payoff. The lender is also able to influence the borrower's effort choice indirectly through the monitor's contract.

The lender's problem is solved in Appendix 1.7.1. We find that the borrower's and monitor's incentive compatibility constraints bind in the optimal contract. Their respective participation constraints remain slack and their limited liability constraints bind only in the state f. The lender offers the borrower a contract $\left(\frac{B(c_{dm})}{\Delta\pi}, 0\right)$ and the monitor a contract $\left(\frac{c_{dm}}{\Delta\pi}, 0\right)$, where $c_{dm} = \min\left[B^{-1}(0), B_c{}^{-1}(-1)\right]$.

Consequently, delegating the task of monitoring is feasible only if $B_c(0) < -1$. The condition ensures that the benefit of curtailing the borrower's private benefit initially is not overwhelmed by the payoff allocated to the monitor. The lender induces monitoring till, either the marginal benefit from inducing additional monitoring at the margin is matched by the cost of inducing it or the private benefits are driven down to zero. The borrower and the monitor retain the following expected rent respectively.

$$E[b_i \mid H] = \pi^h \frac{B(c_{dm})}{\Delta\pi}$$
$$E[w_i \mid H] - c = \pi^l \frac{c_{dm}}{\Delta\pi}$$

Collusion

We examine whether the borrower and the monitor benefit from colluding, if they could fully side-contract amongst themselves. Collusion would entail the borrower exerting low effort and the monitor not monitoring.

Proposition 1. *If the borrower's private benefits are non-pecuniary and non-transferable, the borrower and the monitor would not collude, even if they could fully side contract amongst themselves.*

Let's assume that agents can fully side-contract amongst themselves costlessly. Agents would choose monitoring intensity and effort level together in order to maximise their collective payoffs. Thus, the no-collusion condition for the borrowers given below compares the expected surplus from not-colluding with the expected surplus from colluding.

$$E[b_i \mid H] + E[w_i \mid H] - c \geqslant E[b_i \mid L] + E[w_i \mid L]$$

Using the monitor's and the borrower's contracts from section 1.3.2, we find that the no-collusion condition is always satisfied given that $\frac{B(c_{dm})}{\Delta\pi} \geqslant 0$. By not monitoring, the monitor lowers her expected surplus by a greater amount than the amount she saves in cost of monitoring. Consequently, the borrower and the monitor do not benefit from colluding. Conversely, if the private benefits were transferable, the borrower and the monitor would prefer to collude. In this case, the no-collusion condition is given by

$$E[b_i \mid H] + E[w_i \mid H] - c \geqslant E[b_i \mid L] + E[w_i \mid L] + B(0)$$

Using the contracts from section 1.3.2, we find that the no-collusion condition is never satisfied given that $B(c) < B(0)$.

1.4 Group Lending

Limited liability restricts the lender's ability to use the payoffs to punish a borrower when her project fails. Conversely, joint-liability allows the lender the use of payoffs to punish a successful borrower if her peer's project fails. Consequently, a lender can use a joint-liability group-contract to give each borrower an explicit incentive to influence her peer's effort decision by monitoring her and thus reducing the likelihood of the peer's project failing.

A groups consists of two borrowers, B_1 and B_2, seeking loans from the lender that would enable them to undertake their respective projects. We compare a group lending mechanism where borrowers borrow simultaneously with the one where they borrow sequentially.

1.4.1 Simultaneous Group Lending

The lender offers the borrowers a joint liability group contract. If they accept the contract, the borrowers obtain loans for their respective projects simultaneously.

With costless monitoring, the lender has to leave each borrower a smaller rent in group lending as compared to individual lending. That is because the group's collective incentive compatibility condition gets satisfied with lower rents as compared to an individual's incentive compatibility condition in this case. (Armendáriz de Aghion and Morduch, 2005, page 97)

We show below that with costly monitoring, the lender has to leave sufficient rents to satisfy both

(1) the individual borrower's incentive compatibility condition associated with effort when her peer exerts high effort and both borrower's monitor each other

(2) the group's collective incentive compatibility condition.

With costly monitoring, satisfying (2) requires simultaneously incentivizing both the tasks, namely effort and monitoring. It should also be noted that in the case of costless monitoring, (1) is always satisfied if (2) is satisfied.

The lender can distinguish between the four states of the world, once the outcome of the projects are realised. These states $\{ij\}$ are:

ss B_1 and B_2's projects succeed

sf B_1's project succeeds and B_2's project fails

fs B_1's project fails and B_2's project succeeds

ff B_1 and B_2's projects fail

The game is played in two stages. The agents simultaneously choose their monitoring intensities and their effort choices in the first and second stage respectively. They choose a pair of monitoring intensities (c_1, c_2) in the first stage where c_k is the monitoring intensity chosen by B_k. A given pair of monitoring intensities (c_1, c_2) then determines the payoff structure of the subgame $\xi(c_1, c_2)$ in effort decisions, in the second stage.

Let b_{ij} denote the borrower's pecuniary payoff in state ij. The timing of the game is as follows:

t=0 The lender offers B_1 and B_2 an identical contract $(b_{ss}, b_{sf}, b_{fs}, b_{ff})$.
If they accept the contract, the game continues. Otherwise, it terminates.

t=1 B_1 and B_2 choose their respective monitoring intensities c_1 and c_2 simultaneously.

t=2 B_1 and B_2 choose their respective effort levels e_1 and e_2 simultaneously.

t=3 B_1 and B_2's project outcome is realised.
Both borrowers gets payoffs b_{ij} depending on the state ij.

The limited liability constraint ensures that the borrower's payoffs in the contract are non-negative.

$$b_{ij} \geqslant 0 \quad \text{for } i, j = \{s, f\} \tag{1.7}$$

Symmetry requires that

$$b_{sf} = b_{fs} \tag{1.8}$$

Assumption 2. *The project returns are statistically independent.*

So, for instance, if B_1 exerts high effort and B_2 exerts low effort, the likelihood of state ss is $\pi^l \pi^h$.

From the lender's perspective, the desired outcome of the game is one where both borrowers choose to exert high effort on their respective projects. ss and ff are the two most informative states for the lender. If ss occurs, the two agents are most likely to have undertaken requisite monitoring to induce high effort from their respective peer. If ff occurs, the vice versa is true. Consequently, the lender should reward ss and punish ff to the maximum extent possible.

The limited liability constraint (1.7) binds for ff leaving $b_{ff} = 0$. The lender can choose to allocate rewards among payoffs associated with rest of the states. Increasing b_{ss} sharpens the incentive for the borrowers to make the desired outcome more likely. Given that the borrowers are risk neutral, it is optimal for the lender to reward only ss and leave no reward for any other states. Thus, the lender offers each agent a contract $(b_{ss}, 0, 0, 0)$.

We show in the Appendix 1.8.1 that if the following two conditions are met, the lender's desired outcome is the pure strategy subgame perfect nash equilibrium (SPNE) of the game.

The first condition is B_1's (and symmetrically B_2's) incentive compatibility constraint for effort level in the subgame $\xi(c, c)$ where $c \geqslant 0$.[2]

$$E(b_{ij} \mid HH) - c \;\; \geqslant \;\; E(b_{ij} \mid LH) + B(c)$$

Once the borrowers have decided on their monitoring intensities c, and B_2 (B_1) has chosen to exert high effort, this condition ensures that B_1 (B_2) is no worse off exerting high effort as compared to exerting low effort. This

[2] $E(b_{ij} \mid LH) = \pi^l \pi^h b_{ss}$ is the expected payoff borrower B_1 (and by symmetry B_2) gets when B_1 (B_2) exerts low effort and B_2 (B_1) exerts high effort. See Assumption 2.

condition is satisfied if

$$b_{ss} \geqslant \frac{B(c)}{\pi^h \Delta\pi} \qquad \text{(Condition 1)}$$

Thus, monitoring makes inducing high effort cheaper for the lender. The second condition is the group's collective incentive compatibility condition which ensures that the borrowers should not prefer the outcome where both borrowers do not monitor and exert low effort over the outcome where both monitor with intensity $c > 0$ and exert high effort.

$$E(b_{ij} \mid HH) - c \geqslant E(b_{ij} \mid LL) + B(0) \qquad (1.9)$$

Thats is, by undertaking requisite monitoring and exerting high effort, the agents are no worse off than they would have been if they had not monitored at all and exerted low effort. This condition is satisfied if

$$b_{ss} \geqslant \frac{B(0) + c}{\pi^{h^2} - \pi^{l^2}} \qquad \text{(Condition 2)}$$

It should be noted, the payoff required to satisfy the condition 2 increases with c. Thus, the greater the monitoring intensity the lender wants to induce, the more expensive it is to satisfy the group's collective incentive compatibility condition. We should also note that not allocating the borrowers sufficient rents to satisfy condition 2 is what made simultaneous group lending infeasible in Roy Chowdhury (2005, Proposition 2, page 423). With these two conditions satisfied, simultaneous group lending would always be feasible.

It is striking that the payoffs that satisfy Condition 2 depend on $B(0)$, the private benefits with of without monitoring and not on $B(c)$, the private benefits after monitoring. Although, within a group, monitoring makes incentivizing the individual effort cheaper at the margin (Condition 1), it makes satisfying both tasks collectively more expensive (Condition 2).

We can summarise with the following proposition.

Proposition 2. *Simultaneous group lending is feasible if the borrowers are allocated rents which satisfy condition 1 and 2.*

The lender's problem follows:

$$\max_{b_{ij}} \; E\left[x \mid H\right] - E[b_{ij} \mid H]$$

$$\text{subject to} \quad b_{ss} \geqslant \frac{1}{\pi^h \Delta\pi} \max\left[\, B(c), \alpha\big(B(0) + c\big)\right] \tag{1.10}$$

where $\alpha = \frac{\pi^h}{\pi^h + \pi^l}$. To minimise the rents that the borrowers retain, the lender induces monitoring intensity c_{sim} defined by

$$B(c_{sim}) = \alpha\big(B(0) + c_{sim}\big) \tag{1.11}$$

The borrower's expected payoff is given by

$$E(b_{ij} \mid HH) = \frac{\alpha\pi^h}{\Delta\pi}\big(B(0) + c_{sim}\big) \tag{1.12}$$

The lender's feasibility condition $E[x_i \mid HH] \geqslant \rho + E[b_i \mid HH]$ gives us the set of project that can be financed under simultaneous group lending.

$$\bar{x} \geqslant \bar{x} \geqslant \frac{\rho}{\pi^h} + \frac{1}{\Delta\pi} B(c_{sim})$$

1.4.2 Sequential Group Lending

The lender allocates credit sequentially. Only one borrower gets the loan from the lender in the first period. The remaining borrower in the group gets the loan only if the first borrower succeeds.

The lender randomly chooses a borrower in the group to lend to first. Lets call the first borrower B_1. In sequential group lending, her peer B_2 can only borrow if B_1's project succeeds. As before, B_1 gets punished for the failure of her peer's project. Additionally, with sequential group lending, B_2 is denied the opportunity to borrow if her peer's project fails. The agents share the burden of failure equally as their payoffs are symmetric and the first period borrower is chosen randomly.

In sequential group lending, the borrowers alternate between the task of pursuing their project and monitoring their peer. When B_1 undertakes the project, she is monitored by B_2. Subsequently, their roles are reversed if B_1's project succeeds. The lender can distinguish between the following three states:

f	B_1's projects fails
sf	B_1's projects succeeds and B_2's project fails
ss	B_1 and B_2's project succeeds

The lender offers the borrowers a contract with outcome-contingent payoffs (b_{ss}, b_{sf}, b_f). If B_1's project fails, both borrowers receive b_f and the game terminates. Conversely, if her project succeeds, B_2 gets the loan. If B_2's project succeeds (fails), both agents get a symmetrical payoff of b_{ss} (b_{sf}) and the game terminates. The timing of the game is as follows:

t=0 The lender offers B_1 and B_2 an identical contract (b_{ss}, b_{sf}, b_f).

If they accept the contract, the game continues. Otherwise, it terminates.

t=1 B_2 chooses c_2, the intensity with which she monitors B_1.

t=2 B_1 chooses e_1, the effort level for her project.

t=3 B_1's project outcome is realised.

If B_1's project fails, both agents get b_f. The game terminates.

If B_1's project succeeds, the game continues.

t=4 B_1 chooses c_1, the intensity with which she monitors B_2.

t=5 B_2 chooses e_2, the effort level for her project.

t=6 B_2's project outcome is realised.

If B_2's project fails, both agents get b_{sf}. The game terminates.

If B_2's project succeeds, both agents get b_{ss}. The game terminates.

The limited liability constraint ensures that all payoffs are non-negative.

$$b_{ij} \geqslant 0 \quad \forall\, i, j$$
$$b_f \geqslant 0$$

Again, the lender's desired outcome is one where both borrowers choose to exert high effort on their respective projects. In Appendix 2, we show that the desired outcome is the SPNE of the game if the following condition is met.

$$b_{ss} \geqslant \frac{1}{\pi^h \Delta\pi} \max\left[B(c), c\right] \qquad \text{(Condition 3)}$$

The condition states that the payoff should be high enough to induce the borrowers to monitor with intensity c and exert high effort on their projects. If condition 3 is satisfied, the game will have a SPNE where both borrowers will exert high effort for their respective projects.

Proposition 3. *Sequential group lending is feasible if the borrowers are allocated rents which satisfy condition 3.*

In sequential group lending, the lender only needs to satisfy the individual's incentive compatibility condition associated with monitoring and effort. Unlike simultaneous group lending, the lender does not have to satisfy the group's collective incentive compatibility condition.

In simultaneous group lending, allowing the group to make the decisions on the tasks simultaneously meant that both tasks had to be incentivzed simultaneously. By separating the decision temporally, the lender only has to incentivise the tasks individually at each stage.

For instance, by monitoring at $t = 1$, B_2 reduces the likelihood of getting a payoff of $b_f = 0$ if the game terminates prematurely. Similarly, by monitoring at $t = 4$, B_1 reduces the likelihood of B_2's project failing and her bearing the brunt of joint liability by receiving payoff $b_{sf} = 0$. Consequently, b_{ss} just has to compensates them both for resources expended in monitoring. Similarly, both borrowers would exert high effort if b_{ss} covered their opportunity cost of high effort.

In the following section, we show that incentivizing the task individually is cheaper in terms of rents than incentivizing both tasks simultaneously.

The lender's problem follows:

$$\max_{b_{ij}} \; E\left[x \mid H\right] - E[b_{ij} \mid H]$$
$$\text{subject to Condition 3}$$

To minimise the rents that the borrowers retain, the lender would like to induce monitoring intensity c_{seq} defined by

$$B(c_{seq}) = c_{seq} \tag{1.13}$$

The borrower's expected payoff is given by

$$E[b_{ij} \mid HH] = \frac{\pi^h}{\Delta\pi} c_{seq}. \tag{1.14}$$

Punishing the group if the first borrower's project fails is expensive for the lender. The lender expects to pay the group more per unit capital lent in sequential as opposed to simultaneous group lending.[3] Consequently, from the lender's perspective, his capital is less productive in sequential group lending. Using the lender break-even condition, we find the set of all projects feasible under sequential group lending.

$$\bar{x} \geqslant \frac{\rho}{\pi^h} + \frac{2}{(1+\pi^h)\Delta\pi} B(c_{seq})$$

1.4.3 Comparing Economic Rents

From Figure 1.1 it is clear that for all monitoring functions with the property $B_c c < 0 \; \forall \; c \geqslant 0$, we would have $c_{sim} < c_{seq}$ and $B(c_{sim}) > B(c_{seq})$.[4] The lender would induce more monitoring in sequential as opposed to simultaneous group lending if monitoring reduces the borrower's private benefits.

In both simultaneous and sequential group lending, effort gets incentivised along the segment ED in Figure 1.1. Incentivizing monitoring is more expen-

[3]In simultaneous group lending, the lender lends 2 units of capital and expects to get an output of $2\pi^h x$. In sequential group lending, the lender expects to lend $(1+\pi^h)$ units of capital and get an output valued at $\pi^h(1+\pi^h)x$. He pays the borrowers $2b_{ss}$ with probability ${\pi^h}^2$ in both cases. Consequently, the lender pays the borrower b_{ss} and $\frac{2}{1+\pi^h} b_{ss}$ per unit of capital lent in simultaneous and sequential group lending respectively.

[4]AB and OC intersect at $c = \frac{\pi^h}{\pi^l} B(0)$ which is at a height greater than $B(0)$.

sive in simultaneous group lending. This is because to incentivise monitoring, the lender has to satisfy the group's collective incentive compatibility condition along the segment AB. In contrast, in sequential group lending, the tasks need to be incentivised individually. Monitoring gets incentivised along segment OC.

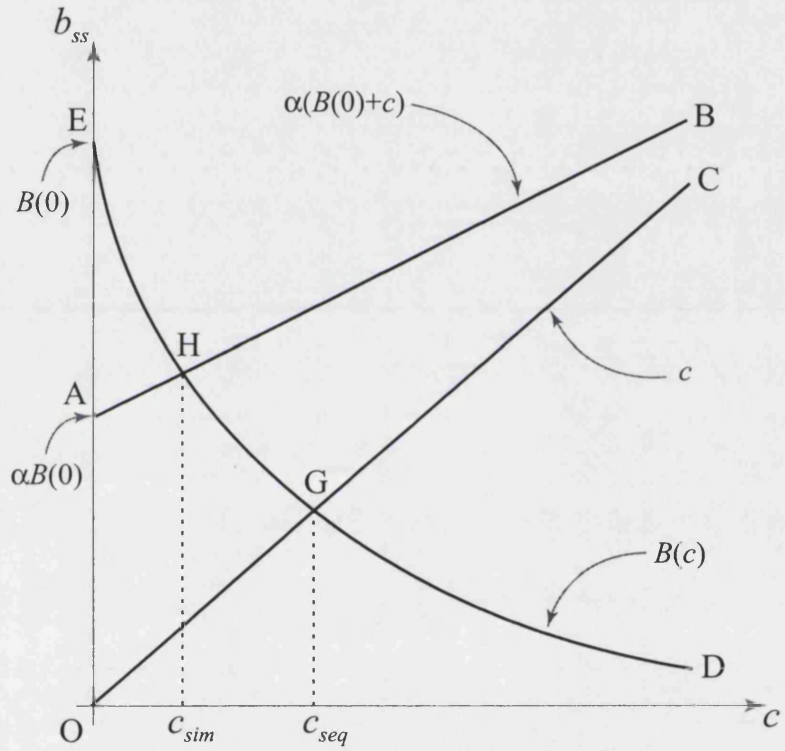


Figure 1.1: Monitoring Intensities in Group Lending

High effort would be implemented in simultaneous and sequential group lending if the payoffs were above the segments EHB and EGC respectively. The lender's problem gets solved at H in simultaneous and at G in sequential group lending. Consequently, the borrower's payoff is higher in simultaneous as compared to sequential group lending. The corollary to proposition 3 follows.

Corollary 1. *In sequential group lending, the group's collective incentive compatibility condition is slack.*

The group's collective incentive compatibility condition gets satisfied at H in Figure 1.1. The lender offers the borrower a contract at G. It is clear that the group's collective incentive compatibility condition is slack at G.

1.4.4 Collusion

Colluding does not require any side-contracting ability in the simultaneous group lending. The borrowers take their monitoring and effort decisions simultaneously and consequently incur the cost of monitoring and obtain private benefits, simultaneously.

Conversely, colluding in sequential group lending is not trivial given that the decision on actions are separated temporally. The borrowers incur their monitoring costs and obtain private benefits at different points in time. Thus, to collude, they need to be able to sign and enforce contracts across time. For instance, by not monitoring, B_1 (B_2) saves on monitoring costs at $t = 4$ ($t = 1$) and B_2 (B_1) obtains the private benefits from low effort at $t = 5$ ($t = 2$). The subgame(s) of the sequential group lending game is (are) almost identical to the delegated monitoring case we analysed above.

In group lending, the group's incentive compatibility condition (1.9) is also the no-collusion condition. Given that in the simultaneous group lending, the borrowers do not need any ability to side contract to be able to coordinate on the no-monitoring low-effort equilibrium, the lender has to ensure that (1.9) is always satisfied. Otherwise, simultaneous group lending is not feasible.

Conversely, as we know from corollary 1, the group's collective incentive compatibility condition is slack in sequential group lending and the borrowers would benefit from colluding i.e. coordinating on the no-monitoring low-effort equilibrium.

Given that monitoring costs and private benefits are non-pecuniary, the borrowers would collude if either (a) the non-pecuniary costs and benefits were transferable amongst them or (b) if they had the ability to sign and enforce side contract across time. Consequently, the lender is able to exploit the group's inability to fully side-contract over time in sequential group lending to lower the borrower's rents.

1.5 Group lending with varying efficiency of Monitoring Technology

In this section we examine the effect of varying the efficiency of the monitoring technology. We introduce a parameter β which measures the efficiency of the monitoring technology. Higher values of β are associated with greater efficiency of the monitoring technology. We impose the following additional assumption on the monitoring function $B(c, \beta)$.

Assumption 3 (Monitoring function $B(c, \beta)$).

i. $B(0, \beta) = B_0 > 0 \ \forall \beta \geqslant 0$

ii. $B(c, \beta)$ *is continuous and at least once differentiable* $\forall \beta, c \geqslant 0$

iii. $B_c(c, \beta) < 0, \quad B_\beta(c, \beta) < 0 \ \forall \beta, c \geqslant 0$

For any given β, $\bar{x}_{sim}$ and $\bar{x}_{seq}$, the least productive projects financed under simultaneous and sequential group lending respectively, are given by

$$\bar{x}_{sim} = \frac{\rho}{\pi^h} + \frac{1}{\Delta\pi}\left[B(c_{sim}, \beta)\right] \tag{1.15}$$

$$\bar{x}_{seq} = \frac{\rho}{\pi^h} + \frac{2}{(1+\pi^h)\Delta\pi}\left[B(c_{sim}, \beta)\right] \tag{1.16}$$

where c_{sim} and c_{seq} are defined by (1.11) and (1.13) respectively.

Proposition 4. *As the monitoring technology becomes more efficient, a greater range of projects is feasible under both group lending mechanisms.*

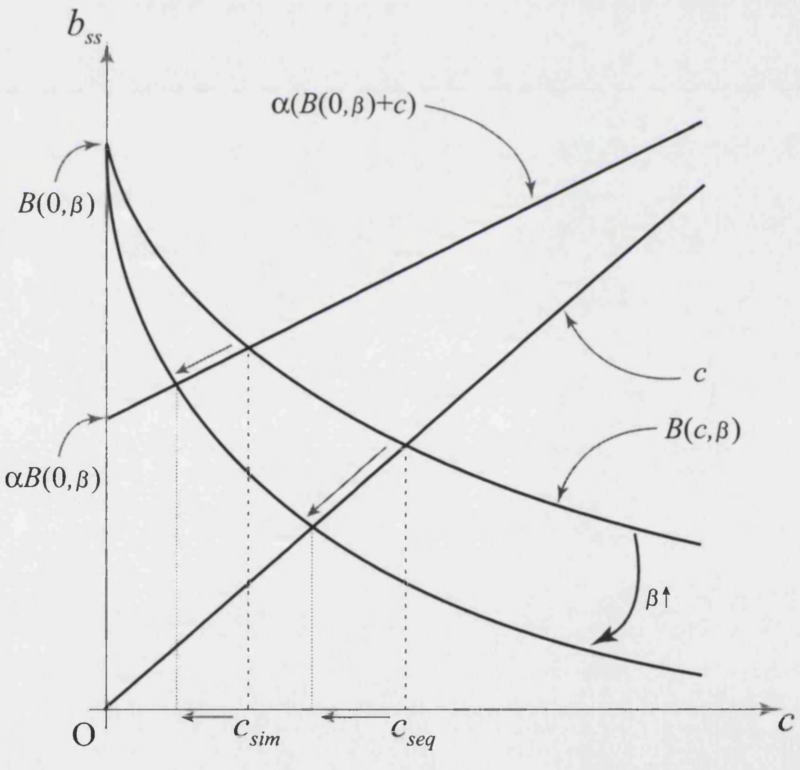


Figure 1.2: c_{sim} and c_{seq} as Monitoring Efficiency Varies

We see the effects of a more efficient monitoring technology on the borrower's payoff in Figure 1.2. In Appendix 1.9.1, we show that as monitoring technology becomes more efficient (β increases), the borrowers in both group lending mechanism get lower rents. $\bar{x}_{sim}$ and $\bar{x}_{seq}$ decrease as the lender is able to finance lower productivity projects.

Proposition 5. *With an extremely efficient monitoring technology ($\beta \rightarrow \infty$), some socially viable projects are not feasible with simultaneous group lending, whereas all socially viable projects are feasible under sequential group lending.*

In Appendix 1.9.2, we show as $\beta \rightarrow \infty$, $\bar{x}_{sim} \rightarrow \frac{\rho}{\pi^h} + \frac{\alpha B(0)}{\Delta\pi}$ and $\bar{x}_{seq} \rightarrow \frac{\rho}{\pi^h}$. Consequently, $\bar{x} \in \left[\frac{\rho}{\pi^h}, \frac{\rho}{\pi^h} + \frac{\alpha B(0)}{\Delta\pi}\right)$ is the set of socially viable projects that are not feasible in simultaneous group lending because of the rents allocated to the borrowers to satisfy the group's collective incentive compatibility condition (1.9).

1.5.1 Linear Monitoring Technology

Further, with a linear monitoring technology of the form $B(c,\beta) = B(0) - \beta \cdot c$, we can find the conditions under which sequential group lending finances a greater range of projects than simultaneous group lending.

Proposition 6. *When monitoring technology is linear, we can show that if the monitoring technology is sufficiently efficient, a greater range of projects get financed with sequential as compared to simultaneous group lending.*

In Appendix 1.9.3, we show that if $\beta \geqslant -\left(2 - \frac{k}{\alpha}\right) + \sqrt{\left(2 - \frac{k}{\alpha}\right)^2 + 4(k-1)} > 0$, then $\bar{x}_{sim} \geqslant \bar{x}_{seq}$. (where $k = \frac{2}{1+\pi^h}$). That is, with a sufficiently high β, a greater range of projects are feasible with sequential group lending as compared to sequential group lending. This is because even though the borrower's rents are lower in sequential group lending, punishing the group when B_1's project fails implies that the lender pays more per unit capital lent to the group, thus lowering his capital's productivity. Thus, for low values of β, the difference in the borrower's rents are overwhelmed by the difference in the productivity of the lender's capital.

1.6 Conclusion

We compare the sequential lending mechanism with the simultaneous lending mechanism. In the simultaneous group lending mechanism, the lender has to leave the borrowers sufficient rents to satisfy the group's collective incentive compatibility. Given that the borrowers make their monitoring and effort choices simultaneously, the lender has to incentivise the group's decisions on the two tasks, monitoring and effort, collectively.

Alternatively, the loans could be disbursed sequentially within the group with the proviso that the second borrower gets the loan only if the first borrower succeeds. With sequential group lending, the borrower's effort and monitoring decisions are temporally separated. We show that in this case, the lender does not have to satisfy the group's collective incentive compatibility condition. Thus, once the decisions are temporally separated, only the more expensive of the two tasks has to be incentivised.

Satisfying the group's collective incentive compatibility condition requires that the lender leaves the borrowers higher rents in the simultaneous as opposed to sequential group lending. Thus, the advantage of lending sequentially in the group is that the lender has to allocate lower rents to the borrowers. Conversely, the disadvantage is that punishing the group for the first borrower's project failure is expensive. It lowers the productivity of the lender's capital.

We find that for sufficiently efficient monitoring technology, a greater range of projects are feasible under sequential group lending. With a sufficiently efficient monitoring technology, the difference in the productivity of capital is overwhelmed by the difference in the borrower rents in the two group lending mechanisms. Consequently, some socially viable projects that are infeasible under simultaneous group lending are feasible under sequential group lending.

Conversely, if the monitoring technology is not sufficiently efficient, a greater range of projects are feasible under simultaneous group lending. The difference in the borrower's rents under the two group lending mechanism decreases as the monitoring technology becomes less efficient.

Further, the borrower's ability to collude through side contracting is irrelevant in simultaneous group lending. If the group's collective incentive compatibility condition is satisfied, the group does not benefit from colluding. In sequential group lending, the group's collective incentive compatibility condition remains slack. If the borrowers have an unlimited ability to side contract, they would benefit from colluding in this case. Consequently, the lender actually exploits the group's inability to side contract across time to lower the rents left to the borrowers in sequential group lending.

Appendix

1.7 Individual Lending

1.7.1 Individual Lending with Delegated Monitoring

The lender offers the borrower a contract (b_s, b_f) and the monitor a contract (w_s, w_f) which solves the following problem:

$$\max_{b_i, w_i} E\left[x_i \mid H\right] - E[b_i \mid H] - E[w_i \mid H]$$

$$
\begin{aligned}
\text{subject to} \quad E\left[b_i \mid H\right] &\geqslant 0 & (1.17)\\
E[b_i \mid H] &\geqslant E[b_i \mid L] + B(0) & (1.18)\\
b_i &\geqslant 0; \quad i = s, f & (1.19)\\
E[w_i \mid H] - c &\geqslant 0 & (1.20)\\
E[w_i \mid H] - c &\geqslant E[w_i \mid L] & (1.21)\\
w_i &\geqslant 0; \quad i = s, f & (1.22)
\end{aligned}
$$

where (1.17) and (1.20) are the participation constraints, (1.18) and (1.21), the incentive compatibility constraints and (1.19) and (1.22), the limited liability constraints of the borrower and the monitor respectively.

In the optimal contract, the borrower's and monitor's incentive compatibility constraints bind. Their respective participation constraints remain slack and their limited liability constraints bind only in the state f.

$$
\begin{aligned}
\Delta\pi(b_s - b_f) &= B(0) & (1.23)\\
\Delta\pi(w_s - w_f) &= c & (1.24)\\
w_f = w_s &= 0; \quad i = s, f & (1.25)
\end{aligned}
$$

The lender offers the borrower a contract (b_s^*, b_f^*) and the monitor a contract (w_s^*, w_f^*).

$$
\begin{aligned}
b_s^* &= \frac{B(c_{dm})}{\Delta\pi}; \quad b_f^* = 0 & (1.26)\\
w_s^* &= \frac{c_{dm}}{\Delta\pi}; \quad w_s^* = 0 & (1.27)
\end{aligned}
$$

where $c_{dm} = \min\left[B^{-1}(0), {B_c}^{-1}(-1)\right]$.

1.8 Group Lending

1.8.1 Simultaneous Group Lending

For a subgame $\xi(c_1, c_2)$, B_1 and B_2's respective payoffs from exerting effort e_1 and e_2 respectively are given by

$$\Pi_1[e_1, e_2, c_1, c_2] = E(b_{ij} \mid e_1, e_2) - c_1 + \left[\frac{\pi^h - \pi_1}{\pi^h - \pi^l}\right] B(c_2)$$
$$\Pi_2[e_1, e_2, c_1, c_2] = E(b_{ij} \mid e_1, e_2) - c_2 + \left[\frac{\pi^h - \pi_2}{\pi^h - \pi^l}\right] B(c_1)$$

where $\pi_k = \pi^h$ if $e_k = H$ and $\pi_k = \pi^l$ if $e_k = L$.

For ease of exposition, we use $\bar{e_1}\bar{e_2}(\bar{c_1}, \bar{c_2})$ as a shorthand notation to refer to a particular outcome where B_1 and B_1 choose effort levels $e_1 = \bar{e_1}$ and $e_2 = \bar{e_2}$ respectively in the subgame $\xi(\bar{c_1}, \bar{c_2})$. Thus, for instance, $LH(\bar{c_1}, \bar{c_2})$ refers to a situation where B_1 and B_2 choose $c_1 = \bar{c_2}$ and $c_2 = \bar{c_2}$ at $t = 1$ and choose $e_1 = L$ and $e_2 = H$ at $t = 2$ respectively. Given our assumption of statistical independence of the projects, the likelihood of state ss, given the above effort levels, is $\pi^l\pi^h$.

Of the game described in Section § 1.4.1, we analyse the subgames $\xi(c, c)$, $\xi(c, 0)$, $\xi(0, c)$ and $\xi(0, 0)$. In the subgame $\xi(c, c)$, B_1 does not deviate from $HH(c, c)$ if

$$\Pi_1[H, H, c, c] \geqslant \Pi_1[L, H, c, c]$$
$$b_{ss} \geqslant \frac{B(c)}{\pi^h \Delta\pi} \qquad \text{(Condition 1)}$$

B_1 does not deviate from $LL(c,c)$ if

$$\Pi_1[L,L,c,c] \geqslant \Pi_1[H,L,c,c]$$
$$\frac{B(c)}{\pi^l \Delta\pi} \geqslant b_{ss} \tag{1.28}$$

In subgame $\xi(c,c)$, $HH(c,c)$ and $LL(c,c)$ are Nash Equilibriums if (Condition 1) and (1.28) satisfied. The borrowers would coordinate on $HH(c,c)$ if

$$\Pi_1[H,H,c,c] \geqslant \Pi_1[L,L,c,c]$$
$$b_{ss} \geqslant \frac{B(c)}{\pi^{h2} - \pi^{l2}} \tag{1.29}$$

In the subgame $\xi(c,0)$, B_1 does not deviate from $HH(c,0)$ if

$$\Pi_1[H,H,c,0] \geqslant \Pi_1[L,H,c,0]$$
$$b_{ss} \geqslant \frac{B(0)}{\pi^h \Delta\pi}$$

B_1 does not deviate from $LL(c,0)$ if

$$\Pi_1[L,L,c,0] \geqslant \Pi_1[H,L,c,0]$$
$$\frac{B(0)}{\pi^l \Delta\pi} \geqslant b_{ss}$$

B_2 does not deviate from $HH(c,0)$ if

$$\Pi_2[H,H,c,0] \geqslant \Pi_1[L,H,c,0]$$
$$b_{ss} \geqslant \frac{B(c)}{\pi^h \Delta\pi}$$

B_2 does not deviate from $LL(c,0)$ if

$$\Pi_2[L,L,c,0] \geqslant \Pi_1[H,L,c,0]$$
$$\frac{B(c)}{\pi^l \Delta\pi} \geqslant b_{ss}$$

Thus, in the subgame $\xi(c,0)$, $LL(c,0)$ is the only Nash Equilibrium if the following condition is met

$$b_{ss} < \frac{B(0)}{\pi^h \Delta\pi} \tag{1.30}$$

By symmetry, (1.30) would also ensure that $LL(0,c)$ is the only Nash Equilibrium in the subgame $\xi(0,c)$.

In the subgame $\xi(0,0)$, B_1 does not deviate from $HH(0,0)$ if

$$\Pi_1[H,H,0,0] \geqslant \Pi_1[L,H,0,0]$$
$$b_{ss} \geqslant \frac{B(0)}{\pi^h \Delta\pi}$$

B_1 does not deviate from $LL(0,0)$ if

$$\Pi_1[L,L,0,0] \geqslant \Pi_1[H,L,0,0]$$
$$\frac{B(0)}{\pi^l \Delta\pi} \geqslant b_{ss}$$

In the subgame $\xi(0,0)$, $LL(0,0)$ is the only Nash Equilibrium if (1.30) is satisfied.

Moving up the game tree, c would be the best response to c if

$$\Pi_1[H,H,c,c] \geqslant \max\Big(\Pi_1[L,L,c,0],\ \Pi_1[L,L,0,c]\Big)$$

The condition given above would be satisfied if the following two condition are satisfied.

$$\begin{aligned} \Pi_1[H, H, c, c] &\geqslant \Pi_1[L, L, c, 0] \\ b_{ss} &\geqslant \frac{B(0)}{\pi^{h^2} - \pi^{l^2}} \end{aligned} \tag{1.31}$$

$$\begin{aligned} \Pi_1[H, H, c, c] &\geqslant \Pi_1[L, L, 0, c] \\ b_{ss} &\geqslant \frac{B(c) + c}{\pi^{h^2} - \pi^{l^2}} \end{aligned} \tag{1.32}$$

This leaves us with $HH(c, c)$ and $LL(0, 0)$. The borrower's would prefer $HH(c, c)$ over $LL(0, 0)$ if

$$\begin{aligned} \Pi_1[H, H, c, c] &\geqslant \Pi_1[L, L, 0, 0] \\ b_{ss} &\geqslant \frac{B(0) + c}{\pi^2 - \pi^{l^2}} \end{aligned} \tag{Condition 2}$$

Condition 1, together with (1.28) and (1.30) give us a range for b_{ss}. Condition 1 gives us the lower bound for the range. The upper bound of the range is given by either (1.28) or (1.30). Given that the lender's objective is to minimise the borrower's payoffs, he would ignore the upper bound. Further, if Condition 2 is satisfied, then (1.29), (1.31) and (1.32) would also be satisfied.

Consequently, if Condition 1 and Condition 2 are satisfied, the desired outcome is the SPNE of the game.

1.8.2 Sequential Group Lending

B_1 and B_2's respective final payoffs are:

$$\Pi_1[e_1, e_2, c_1, c_2] = \pi_1[\pi_2 s_{ss} + (1-\pi_2)s_{sf}] - c_1 + (1-\pi_1)s_f + \left[\frac{\pi^h - \pi_1}{\pi^h - \pi^l}\right] B(c_2)$$
$$\Pi_2[e_1, e_2, c_1, c_2] = \pi_1[\pi_2 s_{ss} + (1-\pi_2)s_{sf}] - c_2 + (1-\pi_1)s_f + \left[\frac{\pi^h - \pi_1}{\pi^h - \pi^l}\right] B(c_1)$$

where $\pi_k = \pi^h$ if $e_k = H$ and $\pi_k = \pi^l$ if $e_k = L$. In the subgame $\xi(c_2, e_1)$, B_2 chooses high effort level ($e_2 = H$) at $t = 5$ and B_1 chooses positive monitoring intensity ($c_1 >$)0 at $t = 4$ if the following conditions hold:

$$\Pi_2[\pi_1, H, c_1, c_2] \geqslant \Pi_2[\pi_1, L, c_1, c_2] \tag{1.33}$$
$$\Pi_2[\pi_1, H, 0, c_2] \leqslant \Pi_2[\pi_1, L, 0, c_2] \tag{1.34}$$
$$\Pi_1[\pi_1, H, c_1, c_2] \geqslant \Pi_1[\pi_1, L, 0, c_2] \tag{1.35}$$

If (1.33) and (1.35) are satisfied but (1.34) is not satisfied, B_2 would choose high effort at $t = 5$ in spite of B_1 choosing monitoring intensity $c_1 = 0$ at $t = 4$. Thus, it makes (1.34) irrelevant.

(1.33) and gives us the following condition.

$$s_{ss} - s_{sf} \geqslant \frac{B(c_1)}{\pi_1 \Delta\pi} \tag{1.36}$$

(1.35) gives us

$$s_{ss} - s_{sf} \geqslant \frac{c_1}{\pi_1 \Delta\pi} \tag{1.37}$$

(1.36) and (1.37) can be summarised as:

$$s_{ss} - s_{sf} \geqslant \frac{1}{\pi_1 \Delta\pi} \max\left[B(c_1), c_1\right]$$

For the lender, ss is the most informative state. Rewarding the agent in state sf, when B_2's project fails is unnecessary. The lender can let the limited liability condition bind for s_{sf} and set is to zero. The above condition can be restated as

$$s_{ss} \geqslant \frac{1}{\pi_1 \Delta\pi} \max\left[B(c_1), c_1\right] \tag{1.38}$$

B_1 chooses high effort level ($e_1 = H$) at $t = 2$ and B_2 chooses positive monitoring intensity ($c_2 > 0$) at $t = 1$, if the following conditions hold:

$$\Pi_1[H, H, c_1, c_2] \geqslant \Pi_1[L, H, c_1, c_2] \tag{1.39}$$

$$\Pi_1[H, H, c_1, 0] \leqslant \Pi_1[L, H, c_1, 0] \tag{1.40}$$

$$\Pi_2[H, H, c_1, c_2] \geqslant \Pi_2[L, L, 0, 0] \tag{1.41}$$

Again, if (1.39) and (1.41) are satisfied but (1.40) is not satisfied, B_1 would choose high effort at $t = 2$ in spite of B_2 choosing monitoring intensity $c_2 = 0$ at $t = 1$. Thus, it makes (1.40) irrelevant.

(1.39) gives us

$$\pi_2 s_{ss} + (1 - \pi_2) s_{sf} - s_f \geqslant \frac{B(c_2)}{\Delta\pi} \tag{1.42}$$

(1.41) gives us

$$\pi_2 s_{ss} - (1 - \pi_2)s_{sf} - s_f \geqslant \frac{c_2}{\Delta\pi} \tag{1.43}$$

(1.42) and (1.43) give us

$$\pi^h s_{ss} + (1 - \pi^h)s_{sf} - s_f \geqslant \frac{1}{\Delta\pi} \max\left[B(c_2), c_2\right]()$$

Again, ss is the most informative state. Rewarding the borrowers in state sf and f is unnecessary. The lender can let the limited liability condition bind for s_{sf} and s_f and set them to zero. The above condition can be restated as

$$s_{ss} \geqslant \frac{1}{\pi^h \Delta\pi} \max\left[B(c_2), c_2\right] \tag{1.44}$$

(1.38) and (1.44) give us

$$s_{ss} \geqslant \frac{1}{\pi^h \Delta\pi} \max\left[B(c), c\right] \tag{Condition 3}$$

If this condition holds, it ensures that the game would have a SPNE in which both borrowers would monitor their respective peers with sufficient intensity to ensure that both borrowers in turn exert high effort.

1.9 Varying Efficiency of Monitoring

1.9.1 Least Productive Project Financed

c_{sim} and c_{seq} are defined by $B(c_{sim}, \beta) = \alpha\big(B(0) + c_{sim}\big)$ and $B(c_{seq}, \beta) = c_{seq}$ and respectively. From these conditions we can obtain that rate at which c_{sim} and c_{seq} change as β changes.

$$\frac{dc_{sim}}{d\beta} = \frac{B_\beta(c_{sim})}{\alpha - B_c(c_{sim})} \leqslant 0 \tag{1.45}$$

$$\frac{dc_{seq}}{d\beta} = \frac{B_\beta(c_{seq})}{1 - B_c(c_{seq})} \leqslant 0 \tag{1.46}$$

We can find the rate at which $\bar{x}_{sim}$ and $\bar{x}_{seq}$ change by substituting $\frac{dc_{sim}}{d\beta}$ and $\frac{dc_{seq}}{d\beta}$ from the above expressions.

$$\frac{d\bar{x}_{sim}}{d\beta} = \frac{\alpha}{\Delta\pi}\left[\frac{B_\beta(c_{sim})}{\alpha - B_c(c_{sim})}\right] \leqslant 0 \tag{1.47}$$

$$\frac{d\bar{x}_{seq}}{d\beta} = \frac{2}{\Delta\pi(\pi^h + 1)}\left[\frac{B_\beta(c_{seq})}{1 - B_c(c_{seq})}\right] \leqslant 0 \tag{1.48}$$

As monitoring technology become more efficient (β increases), a greater range of projects get financed under both simultaneous and sequential group lending.

1.9.2 Simultaneous and Sequential Group Lending with an Extremely Efficient Monitoring Technology

The monitoring technology become extremely efficient as $\beta \longrightarrow 0$.

$$\lim_{\beta \to \infty} c_{sim} = 0 \tag{1.49}$$

$$\lim_{\beta \to \infty} c_{seq} = 0 \tag{1.50}$$

With an extremely efficient monitoring technology, the lender induces negligible amounts of monitoring in the group members.

$$\lim_{\beta \to \infty} B(c_{sim}, \beta) = \alpha B(0) \tag{1.51}$$

$$\lim_{\beta \to \infty} B(c_{seq}, \beta) = 0 \tag{1.52}$$

In sequential group lending the borrower's private benefits are driven down to almost 0 where as in simultaneous group lending, they remain positive due to the scope for collusion amongst the borrowers.

$$\lim_{\beta \to \infty} \bar{x}_{sim} = \frac{\rho}{\pi^h} + \frac{\alpha B(0)}{\Delta \pi} \tag{1.53}$$

$$\lim_{\beta \to \infty} \bar{x}_{seq} = \frac{\rho}{\pi^h} \tag{1.54}$$

With borrowers retaining almost no rents in sequential group lending, all socially viable projects are feasible. In simultaneous group lending, due to the rents that borrowers retain, some projects namely $\bar{x} \in \left[\frac{\rho}{\pi^h}, \frac{\rho}{\pi^h} + \frac{\alpha B(0)}{\Delta \pi}\right)$ are not feasible.

1.9.3 Linear Monitoring Technology

With the linear monitoring technology, $B(c, \beta) = B(0) - \beta c$, we can find the values of c_{sim} and c_{sim}.

$$c_{sim} = \left[\frac{1-\alpha}{\beta+\alpha}\right] B(0) \; ; \; c_{seq} = \left[\frac{1}{1+\beta}\right] B(0)$$

We look for conditions under which greater range of projects are financed under sequential group lending.

$$\bar{x}_{sim} \geqslant \bar{x}_{seq}$$
$$\alpha\big(B(0) + c_{sim}\big) \geqslant k \cdot c_{seq} \quad \text{where } k = \frac{2}{1+\pi^h}$$

Substituting the values of c_{sim} and c_{seq} gives us following condition in terms of β.

$$\beta^2 + (2 - \frac{k}{\alpha})\beta - (k-1) \geqslant 0$$

Using the positive root of the quadratic equation, we find that the above condition is met when

$$\Rightarrow \qquad \beta \geqslant -\left(2 - \frac{k}{\alpha}\right) + \sqrt{\left(2 - \frac{k}{\alpha}\right)^2 + 4(k-1)} > 0$$

The right hand side is always positive since $k > 1$.

Chapter 2

The Casestudy

2.1 Introduction

In this chapter, we document a variation of the simple group lending mechanism used by a Microfinance Institution (MfI) in the Indian state of Haryana. We look at the distinctive features of this group lending mechanism. The objective of the exercise is to understand how the particular group lending mechanism helps the MfI solve the information problems associated with lending to the poor.

The MfI in Haryana works under the guidelines of the Self Help Group (SHG) Linkage Programme, India's decade old national microfinance programme. The SHG Linkage Programme was designed to encourage MfIs to enter and fill the gaps in the rural financial markets across the country.

2.2 Background

2.2.1 Rural Banking in India

The nationalisation of India's fourteen major commercial banks in 1969 paved way for what came to be know as the social and development banking. The objective was to increase rural access to banking services and target credit at some specific activities and certain disadvantaged groups. The Reserve Bank of India (RBI) pursued these objectives by imposing ceilings on interest rates and setting specific targets for expansion of rural branches and sectoral allocation of credit.

In 1991, this policy was reversed after the Narsimhan Committee Report suggested "phasing out the directed credit programmes, deregulating the interest rates and revoking the branch licensing policy." (Narasimhan, 1991). It was felt that by encumbering the banking sector with social objectives, the state was restricting the banking sector from competing in the global economy.

India started the slow but steady process of dismantling its social and development banking policies. By some accounts, the policy had enjoyed some success since its inception in the late 1970s. "Between bank nationalization in 1969 and the onset of financial liberalization in 1990, bank branches were opened in over 30,000 rural locations which had no prior presence of commercial banks" and the "Indian rural branch expansion programme significantly lowered rural poverty." (Burgess and Pande, 2004)

The 1990s saw a contracting rural banking network in line with the recommendation of the Narsimhan Committee Report. To compensate for this, there was a need to find a new method of disbursing credit to the rural poor, which would be compatible with the spirit of deregulation.

2.2.2 The Self Help Group Linkage Programme

The Self Help Group (SHG) Linkage Programme initiated by the National Bank of Agriculture and Rural Development (NABARD) emerged as a solution. The pre-existing rural banking network was incorporated in the programme. The programme adhered closely to the principle espoused by other microfinance programmes, namely making financial services available to the poor.

Since 1999, India has seen a phenomenal rise in the number of self help groups being formed and subsequently linked to the conventional banking network under this programme. There has been a ten fold increase between 1999 and 2004 in the number of groups that have been linked by the SHG programme. (Table 2.1)

Table 2.1: Growth of Self Help Group Linkage Programme in India

	Self Help Groups			Loans to Self Help Groups*		
Year	Number	Growth	Cumm.	Amount	Growth	Cumm.
1992-1999	32,995		32,995	570		570
1999-2000	81,780	148%	114,775	1360	138%	1,930
2000-2001	149,050	82%	263,825	2880	112%	4,810
2001-2002	197,653	33%	461,478	5450	89%	10,260
2002-2003	255,882	29%	717,360	10,220	87%	20,490
2003-2004	361,731	41%	1079,091	18,550	81%	39,040

Source: Government of India, Economic Survey, 2003-04

*Figures in Rs. million; £1.00 = Rs. 79;

2.3 The Fieldwork

The objective of the fieldwork was to analyse how the SHG group lending mechanism solves the information problems associated with providing financial services to the poor. With this objective in mind, we studied the group

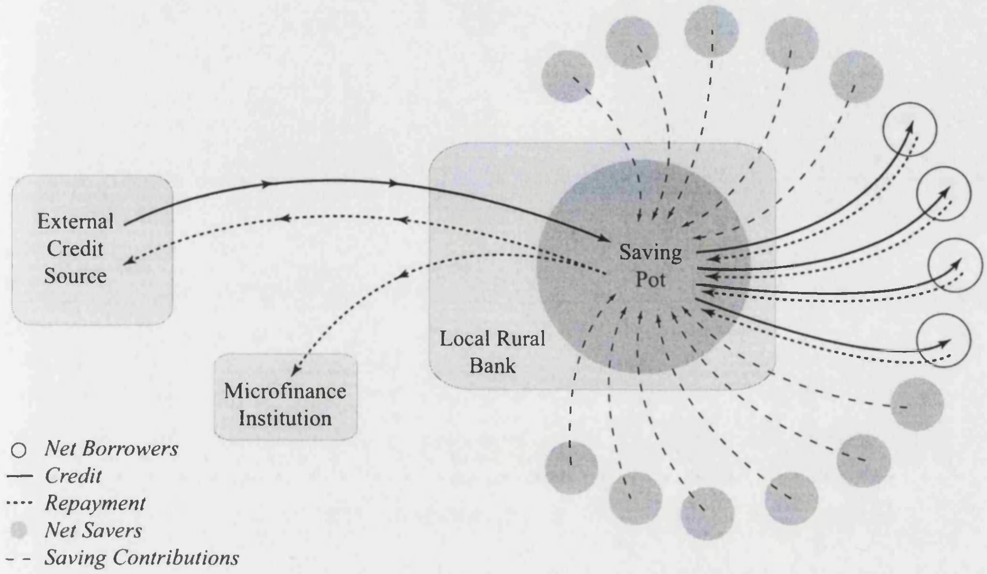


Figure 2.1: Flow of Funds

lending mechanism used by a particular MfI working under the guidelines of the SHG Linkage programme guidelines.

The fieldwork for this study took place in August 2004 in the *tehsil* of Hathin[1] in the Indian state of Haryana. We interviewed 54 members from 5 self help group in the area. These self help groups had been formed by Society of Promotion of Youth and Masses (SPYM), a New Delhi based MfI working in the area for the last eight years. In that period, they have formed 300 groups in the area and have a presence in all 84 villages of Hathin. SPYM works with women-only groups and so all our interviewees were women. The groups we interviewed were about 18 months old. We set out the precise group lending mechanism used by SPYM in detail below.

[1]The *tehsil* of Hathin is part of district Faridabad. For the purpose of administration, a state is divided into districts which is divided further into *tehsil*.

2.3.1 The Group Lending Mechanism

In accordance with the SHG Linkage Programme guidelines, the MfI encourages individuals to form a group of 15 to 20 members. Once the group is formed, the members contribute a fixed amount every month to the group's saving pot. The group opens an account in the local rural bank and the contributions to the saving pot are deposited each month in this account.

The guidelines suggest that there is moratorium on borrowing from the saving pot for the first five months during which the saving pot is allowed to accumulate. After this period, the members petition the group for loans and the group decides who gets to borrow first from the saving pot. Since the borrower is borrowing from the members of the group, we will henceforth refer to this kind of loan as the internal loan and interest rate charged on the loan as the internal interest rate. The loan has to be fully repayed back in 10 installments over a 10 month period. The interest earned on the internal loan is shared equally amongst the group members.

Two months after the first internal loan, the group can lend its savings to a second borrower from the group. For each loan, the members petition the group and the group as a whole decides who gets the loan. The group is encouraged to keep detailed accounts of the savings contributions and the loan repayments each month. These accounts, in conjunction with the group's bank account activity, starts the process of creating a credit history for the group.

If the group is able to enforce timely repayment on the first two internal loans, the MfI arranges an external loan for the group from either one of the numerous subsidised government lending programmes or a public bank. We refer to the interest rate charged on the external loan as the external interest rate.

The external loan is made to the group as a whole. The group then allocates it to a borrower in the group. Each subsequent external loan is approved on the basis of the group's repayment history on the internal and external loans. Like the internal loan, the external loan has to be fully repayed in 10 installments over a 10 month period. Though, for a external loan, a direct debit is setup for repayment of the loan at the time the loan is disbursed. Every month, the rural bank automatically deducts the installments on all outstanding external loans from the group's account. It is the responsibility of the group to ensure that the borrowers deposit their installment in the group's account. If the borrowers fail to do so, the group's saving pot get depleted.

The rules of the SHG Linkage Programme explicitly forbid the MfI from engaging in financial intermediation. The group's saving has to be deposited in the local rural bank and any external loan has to be transacted exclusively through the local rural bank. The MfI's remuneration for forming the groups and linking it to the external sources of credit is tied to repayment of the external loans. Part of the interest payment on the external loan made by the borrower goes to the MfI.

2.3.2 The Group Contract

The MfI proposes the following three elements of the group contract at the time of group formation.

1. The amount each group member is required to save each month

2. The length of the repayment period for the internal and external loans

3. The internal interest rate charged on the internal loans

The group is formed if the group members agree to these three elements of the group contract as proposed by the MfI. The MfI has no control on external interest rate as it is determined by the external source of credit, i.e. the public bank or government in the case of a subsidised lending programme.

2.3.3 Terms of the Loan

In each of the 10 monthly installments, a borrower is required to repay back one tenth of the principal along with the interest accrued on the principal owed hitherto. For a loan amount of L, the installment due in month t would be $\left[\frac{1}{10} + \frac{10-(t-1)}{10} \cdot \frac{r}{12}\right] L$ where r is the yearly interest rate charged on the loan.

The interest rate varies according to the source of the credit. In our study, we found that the groups were able to obtain external loans at 18% per cent per annum. The group's internal funds were lent out to its members at 24% per annum.

On an external loan of Rs. 10,000 (£ 125.00),[2] the first month's installment would be Rs. 1,150 (£ 14.375). Each subsequent installment would be Rs. 15 (18.75 pence) less, till the loan is paid off in the tenth month. On an internal loan of same amount, the first month's installment would be Rs. 1,200 (£ 15.00) and each subsequent installment would be Rs. 20 (25 pence) less, till the loan is paid off in the tenth month.

The group member's monthly contribution to the saving pot varied from group to group. In our sample this varied from Rs. 200 (£ 2.50) to Rs. 100 (£ 1.25). To put these amounts in context, the poorest group members in our sample were agricultural labourers, whose daily wage was approximately Rs. 100.

[2] This was the mode and median of the loans in our study, £1 = Rs. 80

The primary sources of external credit were the Rashtriya Mahila Kosh (RMK), the National Minorities Development Finance Corporation (NMDFC) and the the public banks. Part of the interest payment on the external loans was retained by the MfI. Depending on the source of the loan, the MfI's margin on the external loans varied between 6% and 10%.

2.3.4 Saver's Premium

It is notable that the interest rate charged on the internal loans was considerably higher than the interest rates charged on external loans. This is in line with the findings in Chavan and Ramakumar (2005). They find that the internal interest rate is always higher than external interest for the SHG groups across India. Studies like Harper (1998), Harper (2002), Gaiha (2001), Puhazhendi and Satyasai (2000) and Puhazhendi and Badatya (2002), which have looked at the SHG group across India, have come to a similar conclusion.

Whilst analysing the internal structure of a cooperative, where members of the cooperative borrow both internally and externally, Banerjee et al. (1994) shows that a premium needs to be paid on the internally borrowed funds. The premium ensures that the net saver's have an incentive to participate in the cooperative. It compensates the net savers for monitoring the net borrowers and bearing the liability for the net borrowers failure to repay.

2.3.5 Potential Investment Projects

In the interviews, most of the group members said that they had joined the group with the objective of buying a buffalo. There are a number of privately owned dairies in the area which source their milk from the villages in Hathin. Consequently, investing in a buffalo was perceived to be a safe investment as there was a well established market for its produce.

A buffalo could cost anywhere between Rs. 5,000 to Rs. 15,000. The more expensive the buffalo, the more milk it produced per day. The milk could be sold to the local dairy at anywhere between Rs. 4 to Rs. 6 per litre. All the group members that reported borrowing for investment purposes, claimed to have bought a buffalo.

2.3.6 Borrower's Stake in the Project

Lets take a typical example of a borrower taking an external loan of Rs. 10,000 to buy a buffalo of that amount. At 18% per annum, the borrower is required to repay Rs. 1150 after the first month. Given a buffalo's typical milk production, which the borrower sells at Rs. 5 per litre, the borrower can expect to have a surplus of Rs. 30 per day. The borrower would have a shortfall of Rs. 400 in the first month and a shortfall of Rs. 265 in the tenth month. Thus, the borrower cannot expect to repay the loan just using the proceeds from the investment project.

Assuming that the borrower is able to earn 24% (the internal interest rate) on her savings at all points in time, the borrower would require to have savings of at least Rs. 3008.71 to start with in order to stick to the repayment schedule of the loan. Thus, shortening the repayment period forces the borrower to use her savings to repay the loan. To make repayments on time, the borrowers require sufficient initial savings to start with. That is, unless they plan on defaulting on their installments.

2.4 Solving the Information Problems

This section discusses the way in which the SHG group lending mechanism solves the information problems associated with lending to the poor.

2.4.1 Enforcing Joint Liability

The SHG mechanism is able to impose full and immediate joint liability on the group members. If a particular borrower fails to repay on time, the group members and in particular the members that do not have any outstanding loans, are penalised, fully and immediately. At any given point in time, the non-borrowers effectively cover for the late payment by the borrowers in the group. The MfI is thus able to impose joint liability by restricting the number of members that can borrow at point in time in the group.

In conventional groups, where all members borrow simultaneously, imposing joint liability on the group members is not trivial. It has been argued that the MfI imposes joint liability by threatening to barr the group's and its individual member's access to future credit in response to an individual member's delinquency. Ghatak and Guinnane (1999, pg. 214) illustrate this with an example from the Grameen Bank. "All borrowers accept the threat that if their group does not fully repay its loans, then all members are cut off from future credit from this lender."

SPYM's accounts showed that 97% of the groups had made timely repayment. In the 3% of case, there were delays in repayment but no default. There has never been any reported instance of a late payment in the 5 groups we studied.

2.4.2 Active Screening

The MfI assigns a Community Development Officer (CDO) to each group. The CDO attends the weekly meetings of the group and clarifies any doubts the group members may have. Attending the weekly meeting gives the CDO an opportunity to observe how the group functions. For an outside observer, observing the weekly group meeting can convey important information about the group's social cohesion and it's ability to administer itself. This and other relevant information collated by the CDO helps the MfI assess the group's ability to enforce timely repayments on external loans.

Hoff and Stiglitz (1990) classify this kind of screening as *active screening* as it "entails lenders (a) expending resources in actively screening applicants (groups) ... and (b) limiting the range of their lending activity to members of a particular kinship group, residents of a given region or individuals with whom they trade." This kind of screening is distinct from the *passive screening* mechanism which works though the design of contracts (interest rate, loan size and extent of joint liability) and encourages the borrowers or groups to self select.

Given that the MfI is not the financial intermediary, it does not have full control on the terms of contract it offers the groups. The external interest rate is set either by the government lending agencies like the RMK and NMFDC at the national level or by the respective public banks. Consequently, the MfI is constrained in its ability to screen the groups passively and relies more on active screening.

I was able to observe the MfI's cost associated with active screening. I frequently accompanied the CDOs in their visits to group meetings. The CDO would observe the weekly meeting, interrupting only to clarify rules regarding accounting and saving. The CDOs tended to address the meeting at the end, to impress upon the group that their access to future credit hinges on their ability to efficiently self govern.

As Hoff and Stiglitz (1990) suggests in (b) above, the MfI, by tying-in the groups with a mandatory saving scheme, encourages the formation of the group on which it intends to concentrate its future lending activity.

It is well documented that the MfI, as an outsider, has a disadvantage in terms of cost of acquiring local information, as compared to the various participants in the local informal markets. With the SHG mechanism, the MfI is able to economise on the resources expended in screening actively. The CDO is able to gather information about the group and its members merely by attending successive weekly meetings and examining the accounts maintained by the group. Consequently, the SHG mechanism allows the MfI to acquire information about the group inexpensively and allows the groups to exhibit their ability to administer themselves as a financial entity before any funds are lent to them.

2.4.3 Peer Monitoring and Auditing

The SHG mechanism is able to induce peer monitoring by restricting the number of borrowers that borrow simultaneously in the group.

Sequential Lending

There is a moratorium on lending for approximately the first five months. Once the lending starts, credit is allocated sequentially within the group and the group decides the sequence in which the borrowers get credit.

All group members that do not have outstanding loans have incentives to monitor the present borrower(s). Their saving is jeopardised if the current borrower(s) do not repay on time or default. Further, for the borrowers waiting for credit in the near future, the incentive to monitor and audit are even stronger. They would like to ensure that they get a chance to borrow.

In our study we found that at any given point in time there are always group members that have no loans outstanding. (See Table 2.2) With joint liability, the threat of losing their accumulated savings gives the peers incentives to monitor the borrower. It ensures that the loaned funds are used judiciously and the repayments are made on time.

Table 2.2: Number of Group Members with Outstanding Loans

Month	Group 1	Group 2	Group 3	Group 4	Group 5
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	1
4	0	0	1	0	3
5	0	1	1	0	5
6	1	1	1	0	5
7	1	1	1	3	5
8	2	2	1	3	5
9	2	5	1	4	5
10	2	5	1	5	5
11	3	6	3	5	5
12	4	7	5	5	5
13	7	8	5	6	5
14	9	8	4	6	4
15	9	8	4	8	3
16	10	7	4	8	4
17	9	8	6	8	4
18	10	9	6	7	5
Total Membership	16	17	17	17	16

At any given point in time, these incentives are sharper for a non-borrower i as compared to a member j who has an outstanding loan. j has comparatively less to lose if another borrower defaults and the group collapses. By strategically defaulting, j may lose access to future credit but also escapes the current repayment obligations. Conversely, i would loose part of her saving as well as access to future credit. Thus, the non-borrower member i has sharper incentives to monitor and audit her peers than the borrower j.

Restricting the number of simultaneous borrowers in the group induces a greater amount of aggregate monitoring in the group. The tight repayment schedule implies that the borrowers require sufficient cash wealth to be able to borrow in the first place. Consequently, only members of the groups that have sufficient cash wealth can petition the group to borrow. Table 2.4.3 shows us that after 18 months almost a third of each group has not yet borrowed.

Table 2.3: No. of Non-borrowing Members in the Group
(after 18 months of group formation)

Group	Members	
	Total	Not Borrowed Yet
Group 1	16	5
Group 2	17	7
Group 3	17	7
Group 4	17	7
Group 5	16	6

Restricting the number of simultaneous borrowers creates a intra-group demand for credit. Consequently, this gives the relatively well off[3] incentive to group with the poor in an effort to reduce the demand for credit within the group. Table 2.4 gives us an idea of the extent of income heterogeneity in the groups.

Table 2.4: Income Heterogeneity in the Group
(*after 18 months of group formation*)

Group	Wealthiest Member's Income†	Poorest Member's Income†
Group 1	Rs. 36,000	Rs. 15,000
Group 2	Rs. 72,000	Rs. 18,000
Group 3	Rs. 110,000	Rs. 10,000
Group 4	Rs. 60,000	Rs. 10,000
Group 5*	Rs. 76,000	Rs. 24,000

†Annual income in Rupees where £1 = Rs. 80

[3]Individuals that have sufficient initial cash wealth to borrow in the group but not enough cash wealth to borrow individually

Table 2.5 shows us that the wealthy members in each group receive disproportionate amounts of loans in each group. The only exception is group 5 where the richest two members of the group had already borrowed extensively from another group.[4]

Table 2.5: Wealthy Member's Borrowing as a Proportion of Total Borrowing
(*after 18 months of group formation*)

Group	Borrowing			
	Total†	2 Wealthiest Member's Proportion	4 Wealthiest Member's Proportion	6 Wealthiest Member's Proportion
Group 1	107,800	43.56%	52.50%	54.29%
Group 2	99,000	13.64%	21.72%	44.45%
Group 3	135,500	52.03%	59.41%	66.79%
Group 4	28,000	27.94%	38.23%	44.70%
Group 5*	65,000	1.73%	32.03%	49.35%

† in Rupees where £1 = Rs. 80
* Group 5's wealthy members had borrowed extensively from another older group.

2.5 Conclusions

The objective of this exercise was to examine the group lending mechanism used by the SHG Linkage Programme. We were also able to analyse how the SHG mechanism solves the information problems associated with lending to the poor. We examined how implementing full and immediate joint liability and restricting the number of simultaneous borrowers in a group enhances the SHG mechanism's ability to screen the group and give the group members incentive to peer monitor. Along with giving the poor access to credit, the mechanism also allows the poor to obtain a premium on their savings.

[4]This was the only instance we observed of the individuals being members of more than one group simultaneously.

Chapter 3

An Analysis of Saving Opportunities in Group Lending

3.1 Introduction

The paper examines the long held view in microfinance that subsidising the cost of capital is an effective way of helping the poorest. We show that subsidising the cost of capital harms the ability of the poorest to join the groups in a group lending microfinance programmes.

Too strong given the specific nature of the model and subsidy.

We have a standard moral hazard environment with costly monitoring in which the lender influences the borrower's effort choice by requiring her to partly self-finance her project. The lender can use wealth to engender peer monitoring by lending to jointly liable groups. We show that in doing so, the lender unwittingly provides incentives for the relatively wealthier (yet still poor) to group with the poorest. The poorest become equity investors (savers) in the relatively-wealthy borrower's project, giving them explicit incentive to monitor the borrower. We analyse how the wealth thresholds to participate in the group as savers and borrowers vary with the cost of capital.

The optimal cost of capital, in this case, is the one which allows the poorest to join the group as equity investors (savers) and graduate on to become borrowers (with a positive probability) in one loan cycle. If the government can influence the cost of capital, they should aim for this rate.

In a seminal paper, Ghatak (1999) has shown that in an adverse-selection framework with joint liability there is positive assortative matching amongst the borrowers in a group. That is, the borrowers flock together with their own type. The safe-type group with the safe-type and the risky-type with the risky-type of borrowers. The lender can screen the borrowers by varying the interest rate and the degree of joint liability of the loan contract. We show that wealth could be another relevant dimension in group formation and that there could be negative assortative matching in this dimension, that is, the relatively wealthy individuals group with the poor individuals.

The microfinance literature has hitherto mainly focussed on mechanisms that allow the wealth-deprived (collateral-less) individuals to borrow in a group. The liability they bear for each other within the group compensates for their lack of ownership of stock assets that can serve as collateral. The literature, with the exception of Banerjee et al. (1994), has ignored the implication of offering saving opportunities within the group mechanism. Whilst analysing the internal structure of a cooperative, where members of the cooperative borrow both internally and externally, Banerjee et al. (1994) shows if the funds are borrowed internally, a premium needs to be paid on the internally borrowed funds.

Armendáriz de Aghion and Morduch (2005, pp.172) highlight the changing attitudes towards offering saving opportunities when they write that "microfinance practitioner and policymakers are coming around to the view that facilitating savings may often be more important than finding better ways to lend to low income customers, especially for the most impoverished households ... the two are complementary ..."

In our model, the lender decides on three aspects of the contract that he offers the group. First, he sets out the extent to which the borrower is required to self finance her project. Second, he sets out the extent to which the project should be co-financed by the peer. Third, he sets out the rate of return the peer gets on her capital, used for co-financing the project. This, in turn, determines the amount of capital the lender would lend to the group. We assume that the market for loanable funds is competitive. Even though the lender specifies the rate of return on the capital he lends, it is effectively bounded by his zero profit condition.

We show that the relatively wealthy agents prefer to group with poorer agents. This is because of two reasons. First, the lender creates intra-group competition for credit by allowing only one group member to borrow. Without this restriction, all group members would be net borrowers and the lender would not be able to induce peer monitoring in this way. Second, given that some cash wealth is required to be able to borrow, when the (relatively) wealthy group with poor, there is less competition in the group for credit.

The poorest join the group to participate as savers. In return, they obtain higher than market returns on their equity investment (savings) in the borrower's project. (Banerjee et al., 1994) Thus, the premium or higher than market return compensates the poor equity investors for their monitoring activities.

Further, we analyse how the mechanism's ability to reach the poorest varies with the cost of capital. We find that as the cost of credit is lowered through subsidy, the minimum wealth required to be a borrower is reduced. Conversely, with subsidy, the minimum wealth required to be a saver is higher. Consequently, subsidy closes the gap between the wealth required to be a saver and a borrower.

More and more poor individuals get excluded from participating in group lending as the cost of capital is lowered. Though, it increases the chances of the ones already participating in group lending to graduate on to becoming borrowers. We solve for the cost of capital at which the group lending mechanism can reach the poorest and concurrently ensure that all current period savers become borrowers (with a definite probability) in one loan cycle. Thus, at this optimal cost of capital, the premium is high enough that the poor savers can enrich themselves sufficiently to be able to borrow in one loan cycle.

If the policymakers have the ability to influence the cost of credit, they should aim for this optimal rate. Thus, subsidy only helps the poor in this group lending mechanism if the cost of credit in the market is higher than the optimal rate. Conversely, if the market cost of credit is lower than the optimal rate, subsidy harms the interest of the poor.

3.2 Model

There are two agents. Each agent has access to an identical project which requires a lump-sum investment of 1 unit of capital. The project produces an uncertain and observable outcome x, valued at $\bar{x}$ when it succeeds (s) and 0 when it fails (f).

3.2.1 Agents

Each agent k is risk neutral, with zero reservation wage income and w_k cash wealth. Agents have no collateralizable wealth. ($w_k < 1 \; \forall \; k$)

Agents may choose to pursue the project with a *high* (H) or *low* (L) effort, which is unobservable to everyone. With a high (low) effort, $\bar{x}$ is realised with probability π^h (π^l) and 0 with $1 - \pi^h$ ($1 - \pi^l$). ($\pi^h > \pi^l$)

By exerting low effort, agents obtain a private benefit of value B from the project which is non-pecuniary and non-transferable amongst the agents. The private benefits can be curtailed by monitoring, which is undertaken at cost c to the monitor. The cost of monitoring is non-pecuniary.

The only connection that agents have amongst themselves is their ability to monitor each other and curtail each other's private benefits. The agents can observe the monitoring amongst themselves but it is unobservable to the lender. We impose the following assumptions on the monitoring function $B(c)$.

Assumption 4 (Monitoring function).

i. $B(0) > 0$

ii. $B(c)$ *is continuous and twice differentiable*

iii. $B'(c) < 0, \;\; B''(c) > 0;$

3.2.2 Lender

The *lender* is risk-neutral. The lender does not have the ability to monitor or punish the agents in any way, except through their payoffs. The lender can costlessly observe the initial capital invested in the project as well as the output from the project.

$$\delta = \frac{\rho}{\pi_h}$$

$$\pi_h\left(\bar{x} - \frac{\rho}{\pi_h}(1 - w_b)\right) \geq \rho w_b$$

$$\pi_h \bar{x} - \rho + \rho w_b \geq \rho w_b$$

$$\pi_h \bar{x} - \rho \geq 0$$

$$\bar{x} \geq \frac{\rho}{\pi_h}$$

3.2.3 Cost of Capital

The opportunity cost of capital for everyone in the area is ρ. The lender has access to capital at ρ and the agents can obtain a return of ρ on their savings. The lender faces competition and is unable to earn any rents on his lending. Thus, the lender makes zero profit.

3.3 Individual Lending

In this section, we examine the case where an individual borrower undertakes a project by investing 1 unit of capital. The lender lends her $(1 - w_b)$ and requires that she invest w_b of her own cash wealth in the project.

3.3.1 First-Best

As a benchmark, we look at the perfect information case, where the lender can observe the borrower's effort. The lender will be willing to lend $(1 - w_b)$ at interest rate r, if it solves the following problem:

$$\max_{w_b} \ \pi^h r(1 - w_b)$$
$$E\left[b_i \mid H\right] \geqslant \rho w_b \tag{3.1}$$

where ρ is the opportunity cost of capital and b_i the borrowers payoff in state $i = \{s, f\}$. If the project succeeds, the borrower repays the lender $r(1 - w_b)$, and keeps the rest of the output $\bar{x}$ for herself. If the project fails, she gets 0. Thus, $b_s = \bar{x} - r(1 - w_b)$; $b_f = 0$. The borrower's expected pecuniary payoff with effort level j is $E\left[b_i \mid j\right] = \pi^j[\bar{x} - r(1 - w_b)]$. The participation constraint (3.1) gives us the minimum wealth required for borrowing.

$$w_b \geqslant -\left[\frac{\bar{x}-r}{r-\frac{\rho}{\pi^h}}\right]$$

We assume that the lender, due to the competition he faces, is unable to obtain an ex ante return on the capital he lends, over and above his opportunity cost of capital. Thus, the lender's zero profit condition (L-ZPC) is satisfied if $\pi^h r(1-w_b)=\rho(1-w_b)$ giving us

$$r=\frac{\rho}{\pi^h}. \tag{L-ZPC}$$

At this interest rate, all the borrowers, irrespective of their wealth, can borrow. In the first-best world, where effort is observable, there is no minimum wealth required for borrowing from the lender if $\bar{x} \geqslant \frac{\rho}{\pi^h}$, that is the project is socially viable.

3.3.2 Unobservable Effort

In the first-best world, there is no tension between r and w_b because effort is observable and thus contractible. The tension between r and w_b emerges when the effort is unobservable and thus needs to be incentivised.

With unobservable effort, increasing r reduces the borrower's incentive for high effort.[1] This can be compensated by increasing w_b, the borrower's stake in her own project. Thus, given r, there is a minimum w_b required for the contract to be *incentive compatible.* Further, the minimum stake w_b required by the lender increases with r.

[1]Increasing r reduces the borrower's expected pecuniary payoff from high effort ($\pi^h[\bar{x}-r(1-w_b)]$) more than from the low effort ($\pi^l[\bar{x}-r(1-w_b)]$), given that $\pi^h>\pi^l$. This reduces her incentive to pursue the project with high effort and lose $B(0)$, the private benefits associated with low effort.

ATP ↑, wb ↓ ✓

wb ↑ ✓

P ↑

The lender's zero profit condition requires that $r = \frac{\rho}{\pi^h}$. Consequently, the minimum w_b required for borrowing increases with ρ, the cost of capital.

3.3.3 Borrower's Incentive Compatibility Constraint

We add the borrower's incentive compatibility constraint to the lender's problem from the previous section.

$$E[\, b_i \mid H\,] \geqslant E[\, b_i \mid L\,] + B(0) \tag{3.2}$$

The condition ensures that the borrower has the incentive to pursue the project with high effort. The borrower's incentive compatibility constraint (3.2) can be written as

$$\Delta\pi\bar{x} - B(0) \geqslant \Delta\pi r(1 - w_b) \tag{3.3}$$

where $\Delta\pi = \pi^h - \pi^l$. The LHS is the net social gain and the RHS is the increase in the lender's expected payoff, from the borrower's high effort.

The borrower keeps whatever is left of the output after repaying the lender. Consequently, the borrower's incentive for high effort is maintained if the lender does not extract more than the net social gain accruing to the borrower by exerting high effort. Using the lender's zero profit condition, we obtain

$$w_b \geqslant 1 - \frac{1}{\left(\frac{\rho}{\pi^h}\right)} \left[\frac{\Delta\pi\bar{x} - B(0)}{\Delta\pi}\right]$$

The RHS is the lower bound on the borrower's wealth for a given ρ, the cost of capital.[2]

[2]Thus, individual lending is feasible if the project is sufficiently productive, namely

3.3.4 Contract

The lender's objective function is decreasing in w_b. In order to align the borrower's incentive in his favour, the lender offers the borrower a contract (r, w_b^I), requiring the borrower to invest at least w_b^I of her own cash wealth in the project where

$$w_b^I = 1 - \frac{1}{\left(\frac{\rho}{\pi^h}\right)} \left[\frac{\Delta\pi\bar{x} - B(0)}{\Delta\pi}\right] \tag{3.4}$$

We know from the lender's objective function that he would like to lend as

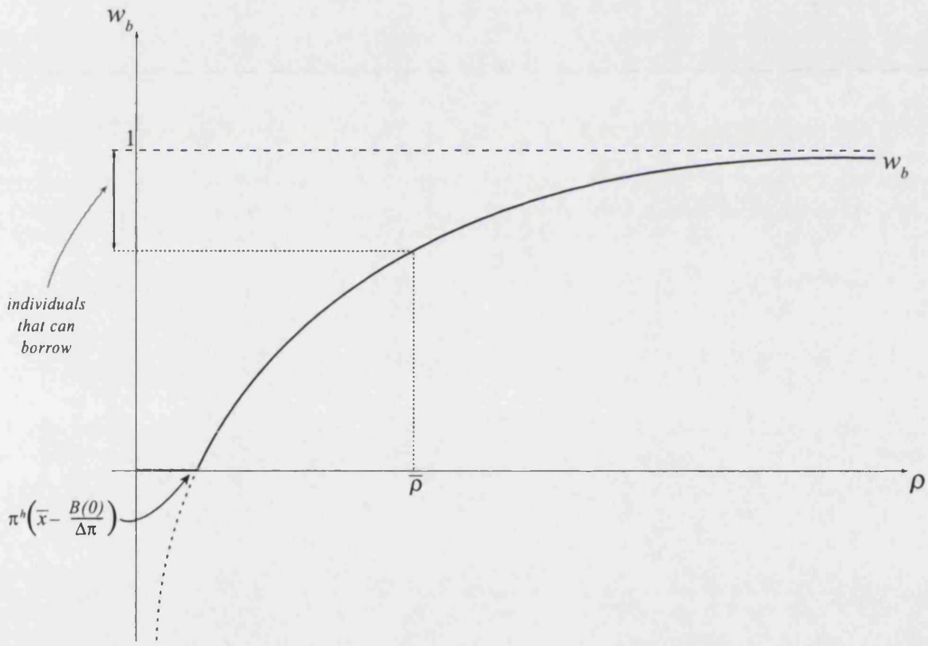


Figure 3.1: Minimum Wealth Required to Borrow in Individual lending

much as he can to the borrowers and would not let the borrowers invest more than that specified by (3.4).

Lemma 2. *An agent with wealth greater than w_b^I will accept the lender's*

$\bar{x} \geqslant \frac{B(0)}{\Delta\pi}$.

contract if her project is socially viable.

Any agent k with cash wealth $w_k (\geqslant w_b^I)$ will accept the contract (r, w_b^I) offered by the lender if

$$\rho\,(\,w_k - w_b^I\,) + \pi^h[\,\bar{x} - r(1 - w_b^I)\,] \geqslant \rho w_k$$

The above condition is satisfied for $\bar{x} \geqslant \frac{\rho}{\pi^h}$.

Proposition 7. *w_b^I, the minimum wealth required to borrow from the lender increases with ρ the cost of capital and decreases with $\bar{x}$, the productivity of the project.* and productivity of "effort".

We can see from Figure 3.1 that as ρ increases, the borrower's repayment obligation to the lender increases, lowering her incentive for high effort. This is compensated by requiring her to have a greater stake in her own project. Similarly, we can see that the wealth required to borrow is increaseing in $\bar{x}$, the productivity of the project.

3.4 Group Lending

A group is endogenously formed and consists of two agents, a borrower and a saver (non-borrower). The borrower is the agent that undertakes the project, and the saver the agent that co-finances the project. The lender allows only one member of the group to borrow and the group disbands once the project outcome is realised.

We assume that the combined cash wealth of the borrower and the saver is less than the initial capital required for the project. The agents form a group with the purpose of borrowing capital from the lender to enable the borrower to undertake her project.

3.4.1 The Mechanism

The lender specifies the amount of wealth the borrower and the saver are required to invest in the project and their respective payoffs in the contract. The borrower invests w_b and the saver invests w_s in the project. The group borrows $1 - (w_s + w_b)$, the rest of the capital required for the project, from the lender.

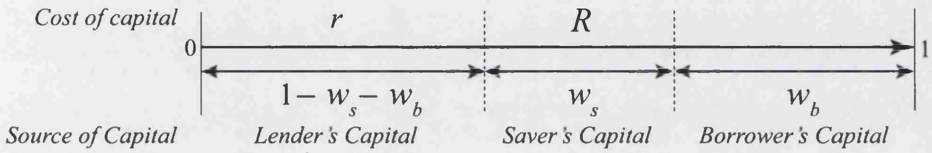


Figure 3.2: Source and Cost of Capital in Group Lending

If the project succeeds, the saver gets a payoff

why no equity-style return?

$$s_s = Rw_s$$

and the lender gets a payoff

$$l_s = r(1 - w_s - w_b).$$

The borrower's payoff is

$$b_s = \bar{x} - Rw_s - r(1 - w_s - w_b).$$

That is, the saver gets a return R on her capital w_s and the lender gets a return r on his capital $(1 - w_s - w_b)$. The borrower is the residual claimant of the output. Conversely, if the project fails, everyone gets 0.

$$s_f = l_f = b_f = 0$$

$\left(\bar{x} - r(1-w_5-w_6)\right)\frac{w_5}{w_5+w_6}$

Timing

The timing is as follows:

t=1 The Lender offers a group-contract.

> *The saver and borrower get contracts* (w_s^*, R) *and* (w_b^*, r) *respectively.*

t=2 The agents self-select into the roles of the *saver* and the *borrower.* Subsequently, they pair up to form a group.

t=3 The group borrows $(1 - w_b^* - w_s^*)$ from the lender.

> *The Borrower invests* 1 *unit of capital into the project.*

t=4 The saver chooses her monitoring intensity c.

t=5 The borrower chooses her effort level.

t=6 The project outcome is realised.

> *If the project succeeds, the output* $\bar{x}$ *gets distributed as follows. The saver and the lender get* Rw_s^* *and* $r(1 - (w_s^* + w_b^*)$ *respectively and the borrower keeps whatever remains. If the project fails, everyone gets* 0.

The borrower's and monitor's contracts work in conjunction with each other. The borrower's contract aims to influence her effort choice directly through her payoff. The lender is also able to influence the borrower's effort choice indirectly through the saver's contract. The saver's contract gives the saver incentives to monitor the borrower and curtail her private benefits. An optimal contract ensures that the borrower pursues her project with high effort.

3.4.2 The Constraints

The borrower and saver's participation and incentive compatibility constraints are examined below.

Borrower

The borrower's participation constraint (B-PC) is given by

$$\pi^h [\bar{x} - r(1 - w_s - w_b) - Rw_s] \geqslant \rho w_b \tag{B-PC}$$

The condition ensures that the borrower's return from exerting high effort should not be less than the opportunity cost of her cash wealth w_b invested in the project. The borrower's incentive compatibility constraint (B-ICC) is given by

$$\begin{aligned} &\pi^h [\bar{x} - r(1 - w_s - w_b) - Rw_s] \\ &\qquad \geqslant \pi^l [\bar{x} - r(1 - w_s - w_b) - Rw_s] + B(c) \end{aligned} \tag{B-ICC}$$

The condition ensures that the borrower has the requisite incentive to pursue the project with a high effort.

Saver

The saver's participation constraint (S-PC) is given by

$$\pi^h Rw_s - c \geqslant \rho w_s \tag{S-PC}$$

The condition ensures that the saver's returns from participating in the group and monitoring with intensity c are not less then her returns from investing

Lender

↓

r, $1-(w_s+w_b)$ w

↓

Int MFI

↓

R, w_s, w_b $(w = w_s + w_b)$

w_s in a safe asset. The saver's incentive compatibility constraint (S-ICC) is given by

$$\pi^h R w_s - c \geqslant \pi^l R w_s \tag{S-ICC}$$

C is continuous

The condition ensures that the saver's return from inducing the borrower to exert high effort on her project by monitoring with intensity c is not less than the returns from monitoring with 0 intensity.

3.4.3 Discussion

Borrower's Decision

Given the contracts (R, w_s) and (r, w_b) that the lender offers the group, the borrower exerts high effort if the following condition is met.

$$\Delta\pi[\bar{x} - r(1 - w_s - w_b) - R w_s] \geqslant B(c) \tag{B-ICC}$$

The gain in the borrower's payoff from a high effort should at least compensate her for the lost private benefit $B(c)$. This condition can be rewritten as

$$w_b \geqslant 1 - \frac{1}{r}\left[\bar{x} - \frac{B(c)}{\Delta\pi}\right] + \left(\frac{R}{r} - 1\right) w_s \tag{B-ICC}$$

Given the saver's contract (R, w_s), the borrower's incentive compatibility constraint gives us the the lower bound on w_b, the minimum wealth required for borrowing. Using the lender's zero profit condition, the borrower's participation constraint can be rewritten as

$$\pi^h (\bar{x} - r) \geqslant (R - r)\, w_s \tag{B-PC}$$

π^h p

The condition restricts the total premium that the saver gets can get on her savings w_s, thus effectively restricting the contracts the saver can be offered.

Saver's Decision

There are two relevant ranges for R. For $R \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right)$, the saver's participation constraint binds and the incentive compatibility constraint remains slack. For $R > \frac{\rho}{\pi^l}$, the saver's incentive compatibility constraint binds and the participation constraint remains slack. This holds true for all $c > 0$. (S-PC) and (S-ICC) always intersect and bind at $R = \frac{\rho}{\pi^l}$.

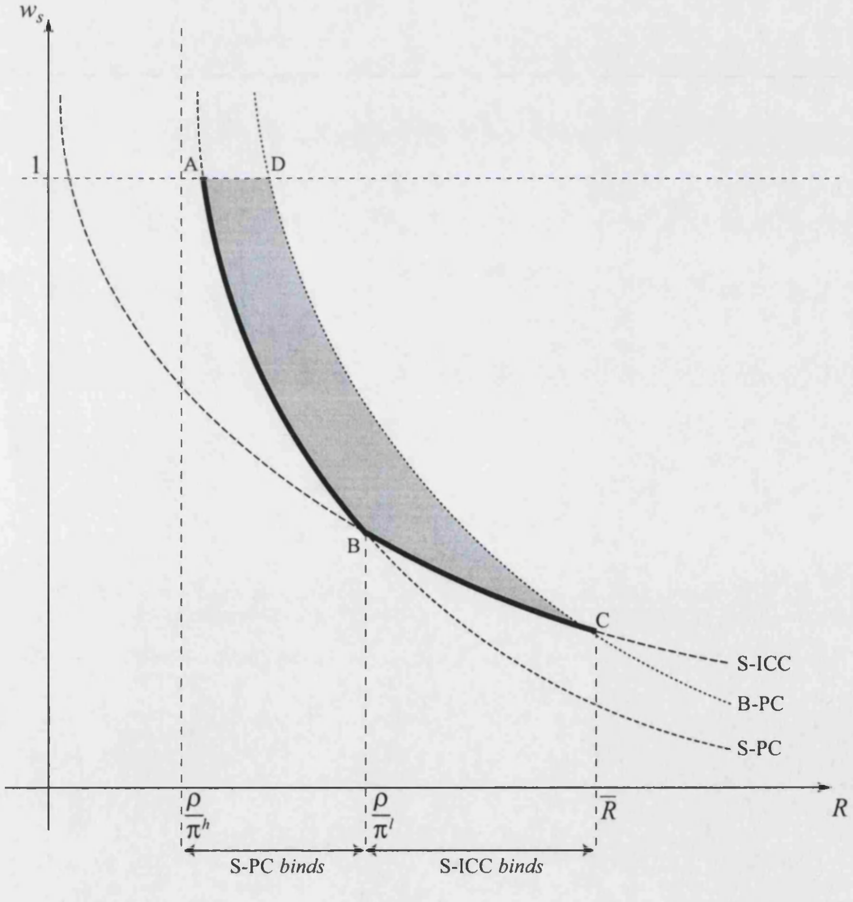


Figure 3.3: Borrower's and Saver's Constraints for a given c

Figure 3.3 shows the saver's participation and incentive compatibility constraint for a positive value of c. The saver's participation and incentive compatibility constraints are violated to the left of the curves. The borrower's participation constraint is violated to the right of the curve.

As discussed above, the borrower's participation constraint serves to restrict the saver's contract. Thus, any contract which is to the left of the (B-PC) in figure 3.3 will satisfy the borrower's participation constraint. A saver's contract in the area ABCD will satisfy the saver's incentive compatibility and participation constraint as well as the borrower's participation constraint.

Given an contract (R, w_s), the saver will choose her monitoring intensity that would make her participation constraint bind if $R \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right]$ and make her incentive compatibility constraint bind if $R \geqslant \frac{\rho}{\pi^l}$. The borrower would choose high effort if her incentive compatibility constraint is satisfied and the saver's contract satisfies her participation constraint. A detailed discussion follows in Appendix 3.7.

We can also deduce from Figure 3.3 that for all values of c, if the saver's contract is on the segment AB, the saver's participation constraint binds and the saver gets no rent. The borrower gets positive rents given that her participation is slack.

As R increases, the saver's contract moves along the segment BC. The saver's rents are increasing in the distance between the saver's contract and saver's participation constraint. Concurrently, the borrower's rent decreases as the distance between the saver's contract and the borrower's participation constraint decreases.

3.4.4 Lender's Problem

The lender would like to maximise the capital lent to the group (and minimise the collective group capital invested in the project) whilst concurrently ensuring that the borrower exerts high effort. There is the obvious tension between lender's maximising his objective function and giving the group a sufficient collective stake in the project so that the borrower exerts high effort. The lender's problem is

$$\max\ \phi = \pi^h r(1 - w_s - w_b)$$

subject to the lender's zero profit condition, the saver's and the borrower's participation and incentive compatibility constraints. By substituting binding the constraints, i.e. (S-PC), (S-ICC), (B-ICC) and (L-ZPC), into the lender's objective function, the lender's problem can be written as

$$\min_{R,c}\ w_b\big(R, c, w_s(R,c)\big) + w_s\big(R, c\big)$$

The lender's problem is solved in Appendix 3.8. The following set of propositions summarise the results that follow.

Lemma 3. *For projects $\bar{x} \geqslant \frac{\rho + c^*}{\pi^h}$, the lender induces the saver to monitor with intensity c^* by setting $R = R^*$ where $R^* = \frac{\rho}{\pi^l}$, $B'(c^*) = -1$.*

The proof is given in Appendix 3.8.

The saver gets a contract (R^*, w_s^*) where

$$R^* = \frac{\rho}{\pi^l},\ \ w_s^* = \frac{\pi^l}{\rho}\frac{c^*}{\Delta\pi}. \tag{3.5}$$

The borrower gets a contract (r, w_b^*) where

$$r = \frac{\rho}{\pi^h}, \quad w_b^* = 1 - \frac{\pi^h}{\rho}\Big[\bar{x} - \frac{B(c^*)}{\Delta\pi} - \frac{c^*}{\pi^h}\Big]. \tag{3.6}$$

From the Figure 3.3 and the discussion in the preceding section, it should be clear that with this contract, the borrower would get a positive rent and the saver no rent. We show this in Appendix 3.8.3.

Lemma 4. *Group lending is only feasible if $\rho > \tilde{\rho}$ where*

$$\tilde{\rho} = \pi^h \left[\bar{x} - \frac{B(c^*)}{\Delta\pi} - c^* \left(1 - \frac{\pi^l}{\Delta\pi}\right)\right]$$

For $\rho \leqslant \tilde{\rho}$, the wealth threshold to be a borrower is less than the wealth threshold to be a saver, $w_s^* \geqslant w_b^*$. In Appendix 3.8.3, we show that the borrower gets all the rent and saver gets no rent from the above given contract. It follows that all agents with wealth in the range $[w_b^*, 1)$ would choose to be a borrower and no agent would choose to be a saver in the group. Consequently, groups would not be formed and the lender would have to revert to individual lending.

Group lending only works if $\rho > \tilde{\rho}$. In this range, the wealth threshhold for borrowers is always greater than the wealth threshold for savers, that is $w_s^* < w_b^*$. Wealth is able to sort agents in their roles as borrower and saver. Agents with wealth in the range $[w_s^*, w_b^*)$ have choice but becomes savers in the group. Agents with wealth in the range $[w_b^*, 1)$ are eligible to be both borrower and saver in the group. They choose to be borrowers in the group as only in this role they can retain rents.

Proposition 8. *The minimum collective group wealth required to borrow in group lending is lower than in individual lending.*

The minimum wealth required to borrow in individual lending and group lending is given by (3.4) and (3.6) respectively. Given that $B(0) \geqslant B(c^*)+c^*$, $w_b^I \geqslant w_b^*$ always hold.

3.4.5 Group Formation

Proposition 9 (Negative Assortative Matching). *If $\rho > \tilde{\rho}$, an agent with enough wealth to be a borrower will always prefer to pair up with an agent who has enough wealth to be a saver but not enough to be a borrower and vice versa.*

Let's assume that agents k_1 and k_2 have enough cash wealth to be borrowers, that is $w_{k_1}, w_{k_2} \in [w_b^*, 1)$. Agents n_1 and n_2 have cash wealth to be savers but not borrower, that is $w_{n_1}, w_{n_2} \in [w_s^*, w_b^*)$.

For agent k_1, paring up with agent n_1 (and similarly agent n_2) will ensure that she would be able to borrow in the group. Agent k_1's expected payoff from this pairing is

$$\rho(w_{k_1} - w_b^*) + E[b_i \mid H] \tag{3.7}$$

For agent k_1, pairing up with agent k_2 would imply that she would have to compete with agent k_2 to become the borrower in the group. We assume that if agents in the group compete for the role of the borrower, the role is allocated randomly to an agent. The other agent has to take on the role of the saver. Agent k_1's expected payoff from pairing with agent k_2 is given by

$$\frac{1}{2}\left[\rho(w_{k_1} - w_b^*) + E[b_i \mid H]\right] + \frac{1}{2}\left[\rho(w_{k_1} - w_s^*) + E[s_i \mid H] - c^*\right] \tag{3.8}$$

Comparing (3.7) with (3.8), agent k_1 would prefer to pair up with agent

n_1 over agent k_2 if the following condition holds

$$\pi^h \left(\bar{x} - \frac{\rho}{\pi^h}\right) - c^* \geqslant 0$$

The condition always holds for projects $\bar{x} \in \left[\frac{c^*+\rho}{\pi^h}, \infty\right)$. Similarly, agent n_1 would prefer to pair up with an agent k_1 (and similarly agent k_2) over agent n_2 if the following condition holds.

$$\left[\rho(w_{n_1} - w_s^*) + E[s_i \mid H] - c^*\right] \geqslant \rho w_{n_2} \tag{3.9}$$

Agent n_1's final payoff from pairing up with agent k_1 is given by the LHS. Her payoff from pairing with agent n_2 is given by the RHS. Given that (3.9) holds with an equality, agent n_1 is indifferent between the two choices.

3.5 Interest Rate Policy

In this section we examine the role of the interest rate policy. We analyse the cost and benefits of influencing the cost of capital in terms of its effect on outreach, i. e. its ability to reach the poorest.

The government intervenes in this market by either augmenting or decreasing the supply of loanable funds.[3] This lowers the cost of capital or decrease ρ in the particular market. We assume that the policymaker's ability to influence ρ is limited. She can influence ρ by a small amount, δ in either direction.

[3]Given the competition amongst the lenders, if a particular lender gets his funds at a subsidised cost, he would just end up retaining the subsidy in the form of rents for himself. He would have no incentive to pass on the benefits of the subsidy to the agents participating in the group.

Minimum cash wealth required to access the services offered by the microfinance institution is $w_s^*(\rho)$ if $\tilde{\rho} < \rho$. If $\rho \leqslant \tilde{\rho}$, the minimum cash wealth required is $w_b^I(\rho)$.

3.5.1 Subsidising the Cost Of Capital

We examine the effect of subsidising the cost capital on the wealth required to participate in the group as a saver and as a borrower.

Proposition 10. *Subsidising the cost of capital decreases the wealth required to participate in the group as a borrower. Conversely, it increases the wealth required to participate in the group as a saver.*

Differentiating w_s^* and w_b^* with respect to ρ allows us to examine the effect of subsidising the cost of capital on the group lending contract.

$$\frac{dw_s^*}{d\rho} = -\left[\frac{\pi^l}{\Delta\pi}\frac{c^*}{\rho^2}\right] < 0$$
$$\frac{dw_b^*}{d\rho} = \frac{\pi^h}{\rho^2}\left[\bar{x} - \frac{B(c^*)}{\Delta\pi} - \frac{c^*}{\pi^h}\right] > 0$$

Thus, decreasing ρ or subsidising the cost of capital decreases w_b^*, which in turns allows poorer agents to become borrowers in the group. Conversely, decreasing ρ increases w_s^*. This implies that the minimum cash wealth required to participate in the group as a saver has increased. Overall, $(w_s^* + w_b^*)$, the collective group wealth required increases with ρ.

$$\frac{d\left(w_s^* + w_b^*\right)}{d\rho} = \frac{\pi^h}{\rho^2}\left[\bar{x} - \frac{B(c^*)}{\Delta\pi} - \frac{c^*}{\Delta\pi}\right] > 0$$

With increasing ρ, the policymaker gets a greater depth of outreach. At the same time, some agents who could have borrowed at the lower ρ are not be able to borrow now and are relegated to the role of a saver.

Lemma 5. *There exists a $\hat{\rho}$ such that for all $\rho \in (\tilde{\rho}, \hat{\rho}]$ the savers are able to accumulate enough wealth to able to borrow in the next period, if the current project succeeds.*

?

If the current projects succeeds, the savers of this period can accumulate enough cash wealth to borrow in the next period if the following condition is met.

$$w_s^* R^* \geqslant w_b^* \tag{3.10}$$

This holds for values of ρ that satisfy the following constraint

$$\rho \leqslant \frac{\pi^h \left[\bar{x} - \frac{B(c^*)}{\Delta \pi} - \frac{c^*}{\pi^h} \right]}{1 - \frac{c^*}{\Delta \pi}} = \hat{\rho}$$

$\hat{\rho}$ is the optimal ρ for allowing the poorest agents to escape the poverty trap. It maximises depth of outreach subject to the constraint (3.10).

With $\rho = \hat{\rho}$, the poorest agents with sufficient wealth to be savers in this period can hope to become borrowers with probability π^h in the next period. This would start a process by which a proportion π^h of all savers in this period would become borrowers in the next period and pair up with agents aspiring to be savers. This process would be particularly helpful if wealth distribution is skewed and the relatively wealthy agents with cash wealth $w_k \geqslant w_b^*$ are in short supply.

As ρ increases, depth of outreach increases. Conversely, the gap between w_s^* and w_b^* also increases with ρ making it more difficult for the poorest in the group to bridge the gap. We summarise with a proposition.

Proposition 11. *At the optimal cost of capital $\hat{\rho}$, the group lending pro-*

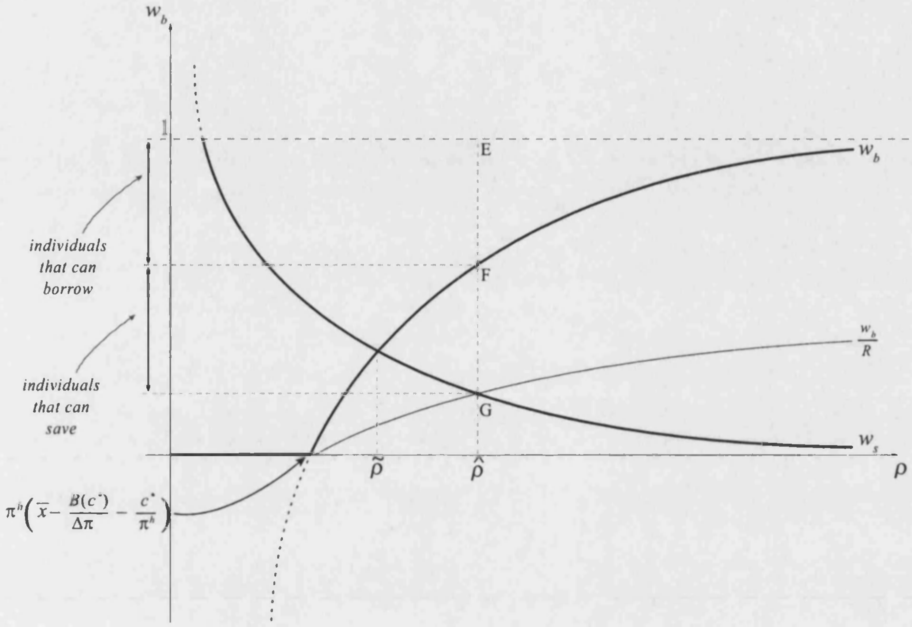


Figure 3.4: Reaching the Poor with the Interest Rate Policy

gramme can concurrently reach the poorest agents and, with probability π^h, *enrich them sufficiently at the end of the period so that they borrow next period.*

If ρ in the market is greater than $\hat{\rho}$, then subsidy is warranted. Conversely, if ρ in the market is less than $\hat{\rho}$, curtailing the supply of loanable funds and driving up the cost of capital towards $\hat{\rho}$ would increase the outreach.

3.6 Conclusion

We analysed the use of wealth to engender peer monitoring when lending to the poor. All the agents have some cash wealth and no collateralizable assets. The lender encourages the poor individuals to form groups of two. He restricts the credit to each group, allowing only one member from each group to borrow. The group decides which group member gets the credit.

The lender requires that the borrower in the group partly self-finances her project with her own cash wealth. This helps the lender align the borrower's incentives with his own. The lender can further reduce the cost of aligning the borrower's incentives with his own by inducing peer monitoring. He does that by requiring that the non-borrower member of the group makes an equity investment in the borrower's project. The equity investment gives the non-borrower the incentive to influence the borrower's effort decision by monitoring the borrower. She receives a higher than market return on her equity investment to compensate her for the cost of monitoring. Thus, the non-borrower member is in effect a saver in the group.

The lender offers the group a contract where he specifies the stake the borrower and the saver are required to have in the project along with their respective payoffs. We found that the borrower's wealth threshold is set higher by the lender than the saver's wealth threshold.

By restricting the credit to a group, the lender can induce the individuals to group across wealth levels. With intra-group competition for the loan, the individuals wealthy enough to be borrowers would choose to group with individuals who are wealthy enough to be savers but not wealthy enough to be borrowers. This is because it would ensure that the poor individuals do not compete for loans in the group.

We showed that if the cost of capital is subsidised or lowered, the borrower's wealth threshold decreases with it and the saver's wealth threshold increases with it. The borrower's interest burden decreases with the cost of capital. The lender can thus reduce the stake that the borrower is required to have in her project. Conversely, the saver's premium on the equity investment decreases with the cost of capital. To compensate the saver for the cost of monitoring, the lender has to increase the saver's stake in the project.

Thus, subsidy actually limits the ability of the SHG mechanism to reach the poorest. On the other hand, subsidy also closes the gap between the wealth required to be a saver and the wealth required to be a borrower. Closing the gap is helpful in letting the current savers become borrowers in the near future. That is, the time a saver can expect to take to accumulate enough wealth to be a borrower decreases with the cost of capital.

We found that there was an optimal cost of capital, at which, the wealth required to be a saver was minimised subject to the constraint that the savers could transform themselves into borrowers in one period with a definite probability. Thus, if the policymakers have an ability to influence the cost of capital, they should try to push the cost of capital towards this optimal rate.

Subsidy only helps the poorest if the cost of capital is above this rate. Conversely, if the cost of capital is below the optimal rate, subsidy would harm the interest of the poorest by excluding them from the group lending mechanism.

Appendix

3.7 Group Lending: Saver's Contract

The saver's participation constraint and the incentive compatibility constraint can be written as

$$w_s (R - r) \geqslant \frac{c}{\pi^h} \tag{S-PC}$$

$$Rw_s \geqslant \frac{c}{\Delta\pi} \tag{S-ICC}$$

The borrower's participation constraint can be written as

$$\bar{x} - r \geqslant (R - r)\, w_s \tag{B-PC}$$

The three curves (S-PC), (S-ICC) and (B-PC) give us the area ABCD in Figure 3.3. A saver's contract in the area ABCD would satisfy the three constraints given above. It may be noted that the area ABCD starts contracting if either c or ρ increases or $\bar{x}$ decreases.

3.7.1 Maximum Feasible Monitoring

For the area ABCD to exist, we need to ensure that (B-PC) is not to the left of (S-PC). It translates into the following condition.

$$(\bar{x} - r) \geqslant w_s\,(R - r) \geqslant \frac{c}{\pi^h}$$

The borrower's participation constraint gives us the first inequality and the saver's participation constraint gives us the second inequality from the left. From this we get an upper bound on the monitoring intensity c.

Lemma 6. *The maximum monitoring that can be induced for a project is given by the following inequality.*

$$c \leqslant \pi^h(\bar{x} - r)$$

3.7.2 Existence of $\bar{R}$

For the sake of completeness, we look at conditions under which $\bar{R}$ exists. $\bar{R}$ is defined by the intersection of the (B-PC) and (S-ICC). But they do not necessarily intersect. If they intersect, it just means that the borrower's rent can be driven down to zero.

$$\bar{R} = \begin{cases} \dfrac{r}{1 - \left[\frac{(\bar{x}-r)}{\frac{c}{\Delta\pi}}\right]} & \text{if } c > \Delta\pi(\bar{x} - r), \\ \nexists & \text{if } c \leqslant \Delta\pi(\bar{x} - r). \end{cases} \tag{3.11}$$

(3.11) implies that $\bar{R}$ exists only for a low-productivity high-monitoring combination. Given a project's productivity $\bar{x}$, a monitoring intensity $c < \Delta\pi(\bar{x} - r)$ can be induced without driving the borrower's rent to zero. For higher monitoring intensity $c \geqslant \Delta\pi(\bar{x} - r)$, the maximum return the saver can be given on her capital is given by $\bar{R}$.

To summarise, the set of all the saver's contracts (R, w_s) that satisfy (S-PC),(S-ICC) and (B-PC) are given by

$$w_s \geqslant \max\left[\frac{c}{\pi^h(R-r)}, \frac{c}{\Delta\pi R}\right] \begin{cases} \forall R \in \left(\frac{\rho}{\pi^h}, \bar{R}\right] & \text{if } c \in \Big(\Delta\pi(\bar{x} - r)\,,\, \pi^h(\bar{x} - r)\Big] \\ \forall R \in \left(\frac{\rho}{\pi^h}, \infty\right) & \text{if } c \in \Big(0\,,\, \Delta\pi(\bar{x} - r)\Big] \end{cases}$$

where $\bar{R}$ is given by (3.11).

3.8 Group Lending: Lender's problem

Proof for Proposition 3. The lender's problem is

$$\max_{R,c} \quad \pi^h r\Big(1 - (w_s + w_b)\Big)$$

$$\text{subject to} \quad \pi^h\left[\bar{x} - r(1 - w_s - w_b) - Rw_s\right] \geqslant \rho w_b \tag{B-PC}$$

$$\pi^h[\bar{x} - r(1 - w_s - w_b) - Rw_s] \geqslant$$
$$\pi^l[\bar{x} - r(1 - w_s - w_b) - Rw_s] + B(c) \tag{B-ICC}$$

$$\pi^h Rw_s - c \geqslant \rho w_s \tag{S-PC}$$

$$\pi^h Rw_s - c \geqslant \pi^l Rw_s \tag{S-ICC}$$

$$r = \frac{\rho}{\pi^h} \tag{L-ZPC}$$

Using (L-ZPC) and Lemma 6, we can summarise (S-PC), (S-ICC), (B-PC) with[4]

$$w_s \geqslant \max\left[\frac{c}{(\pi^h R - \rho)}, \frac{c}{\Delta\pi R}\right] \quad \forall\, c \leqslant \pi^h(\bar{x} - \frac{\rho}{\pi^h}) \tag{3.12}$$

Using (L-ZPC), the (B-ICC) can be written as

$$w_b \geqslant 1 - \frac{1}{(\frac{\rho}{\pi^h})}\left[\bar{x} - \frac{B(c)}{\Delta\pi}\right] + \frac{1}{(\frac{\rho}{\pi^h})}\left(R - \frac{\rho}{\pi^h}\right) w_s \tag{3.13}$$

By substituting (3.12) and (3.13), the lender's objective function can be written as a function of R and c.

[4]There are two relevant ranges for R. The (S-PC) binds and (S-ICC) is slack if $R \in (\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l})$. The (S-ICC) binds and (S-PC) is slack if $R > \frac{\rho}{\pi^l}$. At $R = \frac{\rho}{\pi^l}$ both constraints bind. The (B-PC) is satisfied if $c \leqslant \pi^h(\bar{x} - \frac{\rho}{\pi^h})$.

$$
\phi = \pi^h r\Big[1 - \big\{w_b\big(R, c, w_s(R,c)\big) + w_s(R,c)\big\}\Big]
$$

$$
= \begin{cases} \pi^h \bar{x} - \pi^h \left(\dfrac{B(c)}{\Delta\pi} + \dfrac{c}{\pi^h - \frac{\rho}{R}} \right) & \text{for } R \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right] \\ \pi^h \bar{x} - \pi^h \left(\dfrac{B(c) + c}{\Delta\pi} \right) & \text{for } \quad R \geqslant \frac{\rho}{\pi^l} \end{cases} \tag{3.14}
$$

For $R \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right]$, we find that

$$
\frac{\partial \phi}{\partial R} = \frac{\pi^h \rho c}{(\pi^h R - \rho)^2} > 0 \qquad \forall\, c > 0
$$

$$
\frac{\partial \phi}{\partial c} = -\pi^h \left(\frac{B'(c)}{\Delta\pi} + \frac{1}{\pi^h - \dfrac{\rho}{R}} \right) \begin{cases} > 0 & \text{if } \; B'(c) < -\left[\dfrac{\pi^h - \pi^l}{\pi^h - \dfrac{\rho}{R}} \right] \\ \leqslant 0 & \text{if } \; B'(c) \geqslant -\left[\dfrac{\pi^h - \pi^l}{\pi^h - \dfrac{\rho}{R}} \right] \end{cases}
$$

$$
\begin{aligned}
\frac{\partial \phi^2}{\partial c^2} &= -\pi^h \left(\frac{B''(c)}{\Delta\pi} \right) < 0 \\
\frac{\partial \phi^2}{\partial c\, \partial R} &= -\pi^h \left(\frac{\rho}{\pi^h R - \rho} \right) < 0
\end{aligned}
$$

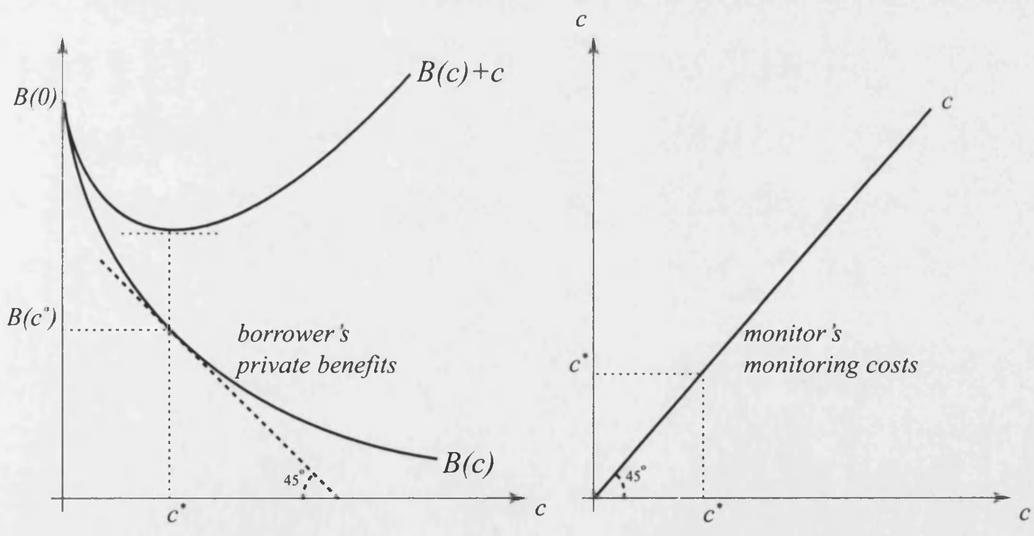
For $R \geqslant \frac{\rho}{\pi^l}$, we find that

$$\frac{d\phi}{dc} = 0 \quad \Rightarrow \quad B'(c) = -1$$

$$\frac{d^2\phi}{dc^2} = \frac{\pi^h}{\Delta\pi} B''(c) < 0$$

The optimal c as a function of R is given by the following function

$$B'(c) = \max \left[-\left(\frac{\pi^h - \pi^l}{\pi^h - \dfrac{\rho}{R}} \right), -1 \right] \tag{3.15}$$



Consequently, the lender's objective function, $\phi = \pi^h r \left[1 - \left(w_s + w_b\right)\right]$, is maximised if the following set of conditions are met.

$$
\begin{aligned}
R &\geqslant \frac{\rho}{\pi^l} & &\forall\, \bar{x} \in \left[\, \tfrac{\rho+c^*}{\pi^h} \,,\, \infty \right) \quad \text{where } B'(c^*) = -1 \\
R &= \frac{\rho}{\pi^h + \dfrac{\Delta\pi}{B'(\tilde{c})}} & &\forall\, \bar{x} \in \left(\, \tfrac{\rho}{\pi^h} \,,\, \tfrac{c^*+\rho}{\pi^h} \right) \quad \text{where } \tilde{c} = \pi^h \bar{x} - \rho
\end{aligned} \tag{3.16}
$$

3.8.1 The Optimal Contract

For projects with $\bar{x} \in \left[\, \frac{\rho+c^*}{\pi^h} \,,\, \infty \right)$, the lender induces monitoring c^* by setting $R = R^* = \frac{\rho}{\pi^l}$. The saver would be offered a contract $(\, R^* \,, {w_s}^* \,)$ and the borrower would be offered a contract $(\, r \,, {w_b}^* \,)$ where

$$
\begin{aligned}
R^* &= \frac{\rho}{\pi^l} \\
{w_s}^* &= \frac{1}{R^*} \frac{c^*}{\Delta\pi} \\
r &= \frac{\rho}{\pi^h} \\
{w_b}^* &= 1 - \frac{1}{\left(\frac{\rho}{\pi^h}\right)} \left[\bar{x} - \frac{B(c^*)}{\Delta\pi} - \frac{c^*}{\pi^h} \right]
\end{aligned} \tag{3.17}
$$

3.8.2 Low Productivity Projects

For projects with $\bar{x} \in \left(\, \frac{\rho}{\pi^h} \,,\, \frac{c^*+\rho}{\pi^h} \right)$ the lender induces monitoring $\tilde{c} < c^*$ by setting $R = \tilde{R} < R^*$ where is $\tilde{c} = \pi^h(\bar{x} - r)$. (See Section 3.7.1) Thus, the saver would be offered a contract $(\, \tilde{R} \,, \tilde{w_s} \,)$ and the borrower would be offered a contract $(r, \tilde{w_b})$ where

$$\begin{aligned}
\tilde{R} &= \frac{\rho}{\pi^h + \dfrac{\Delta\pi}{B'(\tilde{c})}} \\
\tilde{w_s} &= \frac{1}{\tilde{R}}\frac{\tilde{c}}{\Delta\pi} \\
r &= \frac{\rho}{\pi^h} \\
\tilde{w_b} &= 1 - \frac{1}{\left(\frac{\rho}{\pi^h}\right)}\left[\bar{x} - \frac{B(\tilde{c})}{\Delta\pi} + \frac{\tilde{c}}{\pi^h}\cdot\frac{1}{B'(\tilde{c})}\right]
\end{aligned} \tag{3.18}$$

For projects $\bar{x} \in \left(\frac{\rho}{\pi^h}, \frac{c^*+\rho}{\pi^h}\right)$, the lender is not able to induce monitoring intensity c^*. This is because the saver's contract (R^*, w_s^*), which is required to induce the saver to monitor with intensity c^* would not satisfy the borrower's participation contract.

Let's suppose that for a project $\bar{x} \in \left(\frac{\rho}{\pi^h}, \frac{c^*+\rho}{\pi^h}\right)$ the lender tries to induce the saver to monitor with intensity c^* by offering her a contract $(R^*, {w_s}^*)$. The contract would satisfy the borrower's participation constraint if

$$\begin{aligned}
& \bar{x} - \frac{\rho}{\pi^h} \geqslant \left(R^* - \frac{\rho}{\pi^h}\right) {w_s}^* \\
\Rightarrow \qquad & \bar{x} \geqslant \frac{c^* + \rho}{\pi^h}
\end{aligned}$$

Thus contradicting the initial assumption about the project.

3.8.3 Economic Rents

Economic rents obtained by the borrower in group lending are given by

$$\begin{aligned} E[b_i \mid H] - \rho w_b = & \ \pi^h \left[\bar{x} - r(1 - w_s - w_b) - R w_s\right] - \rho w_b \\ = & \ \pi^h \left[\bar{x} - r - (R - r) w_s\right] \end{aligned} \tag{3.19}$$

Economic rents obtained by the saver in group lending are given by

$$\begin{aligned} E[s_i \mid H] - \rho w_s - c = & \ \pi^h R w_s - c - \rho w_s \\ = & \begin{cases} = 0 & \forall\, R \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right] \\ \geqslant 0 & \forall\, R \geqslant \frac{\rho}{\pi^l} \end{cases} \end{aligned} \tag{3.20}$$

Using (3.19) and (3.20), the total rents obtained by the saver and the borrower are given by

$$\begin{aligned} & E[b_i \mid H] - \rho w_b + E[s_i \mid H] - \rho w_s - c \\ & \qquad = \begin{cases} \pi^h[\bar{x} - r - (R - r) w_s] & \forall\, R \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right] \\ \pi^h(\bar{x} - r) - c & \forall\, R \geqslant \frac{\rho}{\pi^l} \end{cases} \end{aligned}$$

For the optimal contract (r, w_b^*) and (R, w_s^*) given by (3.17) in the previous section, the rents are given by

$$E[b_i \mid H] - \rho w_b^* = \pi^h(\bar{x} - r) - c^*$$

$$E[s_i \mid H] - \rho w_s^* - c^* = 0$$

For the optimal contract $(r, \tilde{w}_b)$ and $(R, \tilde{w}_s)$ given by (3.18) in the previous section, the rents are given by

$$E[b_i \mid H] - \rho\tilde{w}_b = \pi^h(\bar{x} - r) - \tilde{c}$$

$$E[s_i \mid H] - \rho\tilde{w}_s - \tilde{c} = 0$$

The borrower gets all the rent and the saver gets zero rent with the optimal contract.

Conclusion

We analysed the mechanisms by which a lender can engender peer monitoring when lending to a group of individuals who are jointly liable for each other's project outcomes.

When lending to a group of wealth less individuals, where all borrowers obtain their loans simultaneously, the lender has to allocate the group members rents that satisfy their collective incentive compatibility condition. Alternatively, the lender can lend sequentially within group with the proviso that second borrower's loan is contingent on the first borrower successfully repaying the loan. Lending sequentially allows the lender to incentivise the borrowers' tasks individually and not collectively, allowing him to leave the group's collective incentive compatibility condition slack. Consequently, by lending sequentially, the lender is able to reduce the borrower's rents and thus increase the lending efficiency.

In sequential lending, the lender punishes the whole group if the first borrower's project fails, thus reducing his capital's productivity. We were able to show that for a sufficiently efficient monitoring technology, the lender is able to finance a greater range of projects under sequential as compared to simultaneous group lending.

Using a case study approach, we examined the group lending mechanism used by a particular Microfinance Institution (MfI) working in Haryana, India. We found evidence of the MfI lending sequentially to the group members, i. e. restricting the numbers of members that can borrow simultaneously at a given point in time. Further, restricting the number of members that can borrow simultaneously is useful in partitioning the group between borrowers and non-borrowers. By allowing the members to borrow internally, i. e. from the group's accumulated savings, the MfI effectively makes the non-borrowers equity investors in the borrowers' investment projects. This gives the non-borrowers an explicit incentive to monitor the borrowers. The case study found that there was significant income heterogeneity within the groups and the wealthier members of the group obtained a high proportion of the loans given to the group. Further, one in three members in each group had not even borrowed once, even though the other members had borrowed more than once.

We built a stylised model based on the case study, in which the lender lends to individuals (in a group) with varying amount of cash wealth at their disposal. We showed that the lender can engender negative assortative matching, i. e. relatively wealthy individuals grouping with poorer individuals, by restricting the credit to the group. The lender allows only one borrower in a two member group to borrow and specifies the stakes the borrower and the non-borrower are required to have in the borrower's project. In doing so, the lender decides on the borrower's and non-borrower's wealth thresholds for joining the group.

Restricting credit to the group creates intra-group competition for loans in the group. Thus, the wealthy eliminate the competition within the group by grouping with poorer individuals whose wealth is below the borrower's threshold. Consequently, not allowing the group members to borrow simultaneously allows the lender to lower the wealth threshold for participating in the group.

Further, we were able to show that as cost of capital is lowered, the non-borrower's threshold increases and the borrower's threshold decreases, thus closing the gap between the two thresholds. We define the optimal cost of capital, in this case, as the one which allows the poorest borrower to join the group as a non-borrower and graduate on to becoming a borrower within one loan cycle. Thus, the subsidising the cost of capital is only warranted if the market cost of capital is above the optimal cost of capital.

The essays have allowed us to examine the significance of timing of the loans in group lending. Determining the sequence of the loans to a group has the potential of improving the efficiency of lending to groups. We were also able to find evidence of a Microfinance Institution in India sequencing loans to its groups.

We were able to show theoretically that when lending to a group of individuals with no wealth, the lender can finance a greater range of projects if he lends sequentially. Similarly, when lending to a group of individuals with varying amounts of cash wealth, by restricting credit to the group, the lender can provide incentives for the relatively wealthy to group with the poorer individuals and thus lower the wealth threshold for the joining the group.

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