Does Subsidising the Cost of Capital Really Help the Poorest?

Does Subsidising the Cost of Capital Really Help the Poorest? An Analysis of Saving Opportunities in Group Lending

Kumar Aniket*

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Abstract

This paper shows that subsidising the cost of capital restricts the ability of the poorest to participate in the group lending mechanisms that offer opportunities to save. We document the group lending mechanism used by a typical microfinance lender in Haryana, India. We found that the groups have significant income heterogeneity within them. Individuals can participate in the group either as a borrower or a saver. The lender requires that the borrower partly self-finance's their project with their own cash wealth. Consequently, a borrower requires a minimum amount of cash wealth to borrow. The poorest participate in the group by co-financing the borrower's project with their meagre savings. In return, they obtain higher than market returns on their savings. Subsidising the cost of capital reduces the cash wealth required to participate in the group as a borrower. Conversely, it increases the cash wealth required to participate as a saver, thus curtailing the opportunity for the poorest to enrich themselves.

Keywords: Group Lending, Microfinance, Savings, Outreach
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*Economics Department, University of Edinburgh, Edinburgh EH8 9JY, UK
Email: `Kumar.Aniket@ed.ac.uk` URL: `http://www.aniket.co.uk/`

1 Introduction

In this paper, we challenge the long held view in microfinance that subsidising the cost of capital is the most effective way of helping the poorest. We find the conditions under which subsidising the cost of capital may harm the interest of the poorest.

The microfinance literature has hitherto mainly focussed on *mechanisms* that allow the wealth-deprived (collateral-less) individuals to borrow in *groups*. 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*.

Armendáriz de Aghion and Morduch (2005, pp.172) highlights the changing attitudes toward 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 . . . "

Whilst analysing the internal structure of a cooperative, where members of the cooperative borrow both internally and externally, Banerjee et al. (1994) show that a premium needs to be paid on the internally borrowed funds. The net savers in the *group-mechanism* are thus compensated for monitoring the net borrower's actions and bearing the liability for the net borrower's failure to repay. Using this as a starting point, we analyse the effect of offering saving opportunities within the *group-mechanism* on the *depth of outreach* achieved by the mechanism.

Depth of outreach is the mechanism's ability to reach the poor. It depends on the poorest person who is able to participate in the mechanism. The poorer this person is, the greater the depth of outreach of the mechanism. We differ in our approach from Banerjee et al. (1994), in that, our objective is to evaluate the efficacy of the *group mechanisms* that offer saving opportunities, in terms of their *depth of outreach*.

Using the data collected for the paper, we model the group-mechanism used by Society for Promotion of Youth and Masses (SPYM), a typical microfinance lender in Haryana, India. The microfinance lender is part of the Self-Help Group (SHG) Linkage Programme, India's new national microfinance programme.

The programme is quite unlike the operations of the large-scale microfinance lenders like BancoSol or Grameen Bank. Any small-scale microfinance lender across the country can join the programme. The programme is envisaged as a decentralised network of small-scale lenders with access to preferential credit lines from the banking industry in the country. Using this network of local lenders throughout the country, the aim of the programme is the "provision of thrift, credit and other financial services . . . to the poor in rural, semi-urban or urban areas, enabling them to raise their income levels and improve [their] living standards." (NABARD, 2000)

There has been a long tradition of 'social and development banking' in India. Under its guise, the policymakers specify the proportion of credit the banks in the country are required to direct towards 'targeted' areas. By increasing or decreasing this proportion, the policymakers can effectively augment or curtail the supply of loanable funds to the 'targeted' areas.

Table 1: Group Leaders Proportion of Total Borrowing

(after 18 months of group formation)

Name of Group	No. of Members	No. not borrowed	Total Borrowing	Average per Borrower	Group Leaders' Borrowing	Group Leaders' Proportion
Sahil	17	7	135,500	16,938	70,500	52.03%
Poornima	16	5	107,800	9,800	30,000	27.83%
Rahim	17	9	28,000	3,500	7,500	26.79%
Shrikant	17	7	99,000	9,000	10,500	10.16%
Chahat[1]	16	6	65,000	5,458	2,000	1.16%

1 Chahat's group leader were member of multiple groups and had borrowed from other groups.

The overarching aim of the SHG linkage programme is to funnel this 'targeted' credit to groups, through the local microfinance lenders. The local lenders get access to capital from the banks, which they then lend on to the groups. The policy of targeted credit implies that the profitable sectors of the banking industry in India effectively cross-subsidises the 'targeted' areas. The question the paper addresses is whether this cross-subsidisation enhances or deters the depth of outreach of the SHG Linkage Programme.

In our study of SPYM's groups, we found three salient features. These features are typical of the group-mechanism used by the microfinance lenders in the SHG programme.

Firstly, the group members save a fixed amount every month which is lent internally. Thus, the SHG mechanism offers its members opportunities to save. A borrower pays 24% per annum for borrowing internally in the group. On the other hand, the lender lends externally sourced funds to the group members at 18% per anuum. Chavan and Ramakumar (2005)

Table 2: Demographics

	All Members	Members excl. Group Leaders	Group Leaders only
Sample Size	58	44	14
Household income	34,038	**31,525**	**41,769**
	(21,855)	(21,181)	(22,935)
(per capita)	5,928	**5,430**	**7,460**
	(4,200)	(3,998)	(4,597)
Household Size	6.44	6.51	6.21
	(2.41)	(2.48)	(2.22)

standard errors in brackets, income in Rs. per annum

quote numerous sources like Harper (1998), Harper (2002), Gaiha (2001), Puhazhendi and Satyasai (2000) and Puhazhendi and Badatya (2002) which show that premium on internal capital is a regular feature of such groups.

The lender decides on the amount each member saves per month as well as the returns they get on their savings. In this way, the lender is able to give the net savers in the group the requisite incentives to monitor the net borrowers in the group. Each of the five SPYM groups which we studied, had a significant proportion of net savers. Column 2 in Table 1 shows us that, even after 18 months, a little less than half the members in each group had not borrowed at all.

Second, the microfinance lender decides on the repayment schedule of the loan. The lender requires that the borrowers pay back the principal in ten equal installments. This implies that the interest payment is very high to start with and decreases with time.[1] The repayment schedule is too tightly structured to allow the borrowers to use only the returns from the project for repayment. From our calculations in endnote 1, it is clear that the borrower needs to finance a significant part of the repayment from her own cash wealth.

Jain and Mansuri (2003) suggest that the widespread use of these tightly structured repayment schedules is to encourage the borrowers to repay by borrowing from the informal sector. According to them, this allows the microfinance institutions to incorporate the superior monitoring technology of the informal sector in monitoring the borrowers. In our study, we did not find any evidence that the group members were actively borrowing from the local moneylender once they had joined the group. In our sample of the 58, only 7 interviewees reported to have borrowed from the moneylender in the recent past.

The hypothesis in this paper is that extracting the early repayment of the loan is akin to requiring the borrower to partly self-invest in her own project. This allows the lender to align the borrower's interest with her own. Thus, a borrower requires some cash wealth to be able to borrow.

The more tightly structured the repayment schedule, the greater the portion of the project that is self financed by the borrower and therefore the greater the cash wealth required to borrow. In our model, the lender decides on the cash wealth the borrower is required to self-invest in her project in order to borrow from the lender.

This matches the inference from Table 1 that the group leaders, whose income levels are significantly higher than the rest of the group (see Table 2), dominate the credit in at least three of the five groups. Given that very few interviewees reported owning any assets at all, we can take income levels as a proxy for wealth, which is held mainly in form of cash wealth.

The third salient feature was that there was significant income or wealth heterogeneity within the groups. Every group had two group leaders who had initiated the group. As mentioned above, without exception, these were also the members with the highest income levels in the group. Further, these relatively wealthy group leaders dominated the credit in the group. (See table 1). In a seminal paper, Ghatak (1999) has shown in an adverse-selection framework that with joint liability, the borrowers flock together with their own type. The safe-type group with the safe-type and the risky-type with the risk-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 observed a new dimension that influenced group formation in the SPYM groups. Heterogenous groups were formed as the relatively wealthy individuals grouped with the poorer individuals. Using the first two salient features discussed above, the paper models the SHG mechanism in an attempt to explain the heterogenous group formation.

We show that the relatively wealthy agents prefer to group with poorer agents. This is because of two reasons. Firstly, the supply of credit is not entirely elastic in the group. Second, given the tightly structured repayment schedule, the borrowers require some cash wealth to be able to borrow. Thus, when the relatively wealth borrowers group with poorer borrowers, there is less competition in the group for credit. The poorest join the group to participate just as savers.

Further, we analyse how the mechanism's depth of outreach 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.

We find that there is an optimal cost of capital, at which, the poorest saver in the group-mechanism has a definite probability of becoming a borrower in the next period. This is possible if the saver can accumulate the requisite wealth in one period.

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 if the cost of credit in the market is higher than this optimal rate. Conversely, if the market cost of credit is lower than the optimal rate, subsidy can decrease the depth of outreach.

The paper proceeds as follows. Section 2 presents the model. We analyse individual lending in Section 3 and group lending mechanism in Section 4. Section 5 examines the interest rate policy, followed by the conclusions in Section 6.

2 Model

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_i, valued at $\bar{x}$ when it succeeds (s) and 0 when it fails (f).

2.1 Environment

2.1.1 Agents

Each agent k is risk neutral, with zero reservation utility and w_k cash wealth, which cannot be used as collateral. 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 except themselves. With a high (low) effort, $\bar{x}$ is realised with probability π^h (π^l) and 0 with $1 - \pi^h$ $(1 - \pi^l)$. $(\pi^h > \pi^l)$

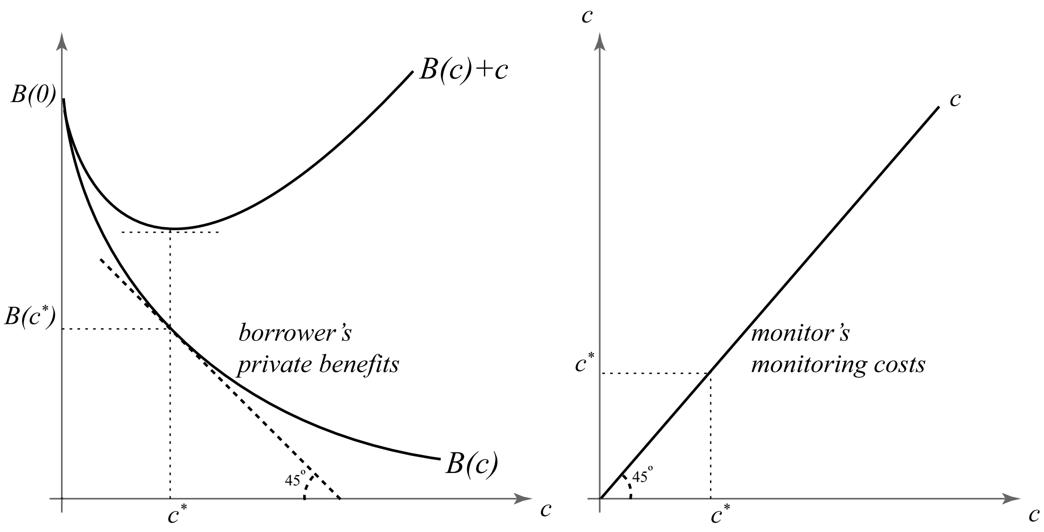
By exerting a low effort, agents obtain a private benefit of value B from the project which is non-pecuniary and non-transferable amongst the agents. The private benefits can be curtailed by monitoring, which is undertaken at cost c to the monitor.

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

Assumption 1 (Monitoring function)**.**

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

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



2.1.2 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.

2.1.3 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.

2.1.4 Agent's Payoff

The lender requires all loans be partly financed by another agent, who is a peer of the first agent. Thus, agents form groups of two to borrow from the lender. We call the agent undertaking the project the *borrower*. The agent co-financing the project is called the *saver*.

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

In a group contract, the saver is required to finance the borrower's project with w_s. The borrower is required to self-invest w_b in the project. The group borrows the rest of the capital $(1 - w_s - w_b)$ from the lender.

If the project succeeds, the saver and lender get returns of R and r on their capital. The borrower keeps the rest of the output.

Let s_i be the saver's pecuniary payoff in state $i = \{s, f\}$.

$$s_s = Rw_s$$
$$s_f = 0$$

If the project succeeds, the savers gets Rw_s and if it fails she gets nothing.

Let l_i be the lender's payoff in state i.

$$l_s = r(1 - w_s - w_b)$$
$$l_f = 0$$

The lender gets $r(1 - w_s - w_b)$ if the project succeeds and nothing if it fails. Let b_i be the borrower's pecuniary payoff in state i.

$$\begin{aligned} b_s &= \bar{x} - s_s - l_s \\ &= \bar{x} - Rw_s - r(1 - w_s - w_b) \\ b_f &= 0 \end{aligned}$$

If the project succeeds, the borrower gets to keep whatever is left after paying the saver and the lender. If the project fails, the output is zero and no one gets anything.

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.

3.1 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 $(1 - \boldsymbol{w_b})$

at interest rate r, if it solves the following problem:

$$\max_{\boldsymbol{w_b}} \; \pi^h r(1 - \boldsymbol{w_b})$$

$$E\left[b_i \mid H\right] \geqslant \rho \boldsymbol{w_b} \tag{1}$$

$$b_i \geqslant 0; \quad i = s, f \tag{2}$$

where ρ is the borrower's and the lender's 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 fail, 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

$$E\left[b_i \mid j\right] = \pi^j[\bar{x} - r(1 - \boldsymbol{w_b})] \tag{3}$$

The participation constraint (1) gives us the minimum wealth required for borrowing.

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

This does not bind for $r \in [\frac{\rho}{\pi^h}, \bar{x}]$ if $\bar{x} \geqslant \frac{\rho}{\pi^h}$. It implies that even borrowers with no wealth ($w_b = 0$) can borrow from the lender if they have a socially viable project.

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

$$\pi^h r(1 - w_b) = \rho(1 - w_b)$$

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

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

$$\boldsymbol{w_b} \geqslant 0 \tag{4}$$

if the project is socially viable, that is $\bar{x} \geqslant \frac{\rho}{\pi^h}$.

Proposition 1. *If effort is observable and the project is socially viable, there is no minimum wealth required to borrow from the lender.*

3.2 Unobservable Effort

In the first-best world, there is no tension between r and w_b because the effort is observable and does not need to be incentivized. The tension between r and w_b emerges when the effort is unobservable and thus needs to be incentivized.

With unobservable effort, increasing r reduces the borrower's incentive for high effort.[2] 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.

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.

3.2.1 Borrower's Incentive Compatibility Constraint

We examine the case where the effort is unobservable. As mentioned earlier, the lender is unable to monitor the borrower. We add the borrower's incentive compatibility constraint to the lender's problem from the previous section.

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

which, using (3), can be written as

$$\pi^h[\, \bar{x} - r(1 - \boldsymbol{w_b}) \,] \geqslant \pi^l[\, \bar{x} - r(1 - \boldsymbol{w_b}) \,] + B(0) \tag{5}$$

The borrower's return from pursuing the project with high effort is given by LHS and low effort by RHS. The RHS includes private benefits $B(0)$ associated with exerting low effort on the project. The condition ensures that the borrower has the incentive to pursue the project with high effort.

As in the previous section, the participation constraint is satisfied for all $r \in [\frac{\rho}{\pi^h}, \bar{x}]$. The borrower's incentive compatibility constraint (5) can be written as

$$\Delta\pi\bar{x} - B(0) \geqslant \Delta\pi r(1 - \boldsymbol{w_b}) \tag{6}$$

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, according to (6), 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.

The lender can extract the expected net social gain accruing to the borrower by setting the right combination of r and w_b. He can do this by setting either a large enough r, or a small enough w_b, that turns (6) into an equality. Given that the lender is bound by the zero profit condition, he can only set small enough w_b that turns (6) into an equality.

Thus, from the borrower's incentive compatibility condition we get the minimum wealth required to borrow.

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

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

3.2.2 Contract

The lender's objective function is decreasing in w_b. Conversely, the borrower's incentive compatibility condition gives us the minimum wealth required to borrow. In order to align the borrower's incentive in his favour, the lender requires the borrower to invest at least w_b of her own cash wealth in the project. The lender thus offers the borrower a contract $(r, \boldsymbol{w_b^I})$ where

$$\begin{aligned} r &= \frac{\rho}{\pi^h} \\ \boldsymbol{w_b^I} &= 1 - \frac{1}{\left(\frac{\rho}{\pi^h}\right)}\left[\frac{\Delta\pi\bar{x} - B(0)}{\Delta\pi}\right] \end{aligned} \tag{7}$$

The lender offers the individual borrowers a contract where they are required to self-invest a specified amount of cash wealth into their project. We know from the lender's objective function that he would like to lend as much as he can to the borrowers and would not let the borrowers invest more than that specified by (7).

Proposition 2. *The minimum wealth required to borrow from the lender increases with the cost of capital and decreases with the productivity of the project.*

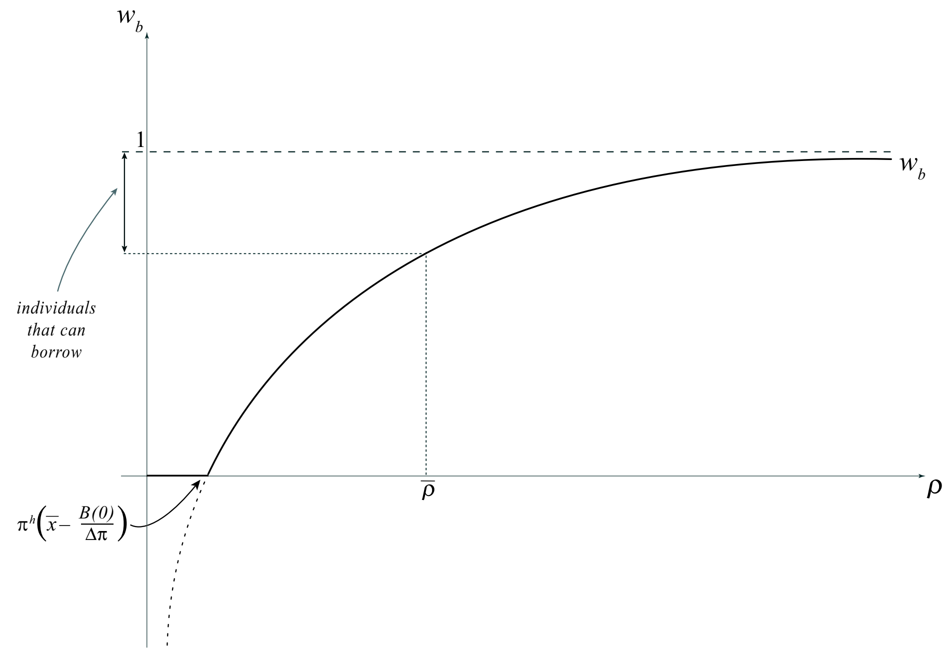


Figure 1: Individual Lending: Minimum Wealth Required

Figure 1 gives us the minimum wealth required to borrow from the lender (w_b), for a given ρ. 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, given ρ, the larger the net social gain, $\Delta\pi\bar{x} - B(0)$, the lower the wealth required to borrow.

Proposition 3. *An agent with wealth greater than the wealth required to borrow will accept the lender's contract if her project is socially viable.*

Any agent k with cash wealth $w_k \geqslant \boldsymbol{w_b}$ will accept the contract $(r, \boldsymbol{w_b})$

offered by the lender if

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

The LHS gives us the return an agent k, with cash wealth w_k, gets from accepting the contract $(r, \boldsymbol{w_b})$. The RHS gives us her returns from refusing the contract. With $r = \frac{\rho}{\pi^h}$, the above condition is reduced to one which requires the project to be socially viable.

$$\bar{x} \geqslant \frac{\rho}{\pi^h}$$

3.2.3 Economic Rents

The borrower's economic rent is given by

$$E[b_i \mid H] - \rho w_b = \pi^h \left[\bar{x} - \frac{\rho}{\pi^h}\right]$$

The borrower gets an economic rent due the lender's inability to punish her through her payoff if the project fails. The economic rents decreases in the cost of capital ρ and increase in the project productivity, $\bar{x}$.

4 Group Lending

A *group* consists of two agents, a *saver* and a *borrower*. The borrower is the agent that undertakes the project, and the saver, the agent that partly co-finance's the project.

The combined cash wealth of the borrower and the saver is less than the initial capital required for the project. The group is formed with the purpose of borrowing the rest of the capital from the lender to enable the borrower to undertake her project. The lender finances just one project per period per group. The group is disbanded after the project concludes.

4.1 The Mechanism

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

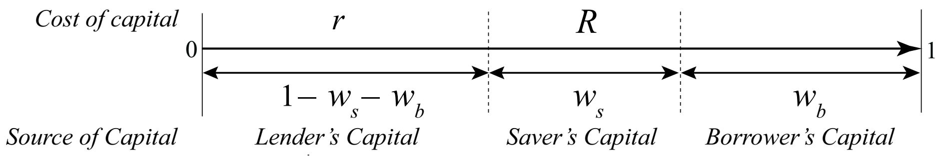


Figure 2: Group Lending: Source and Cost of Capital

If the project succeeds, the savers gets a return R on her capital. The lender gets a return r on his capital and the borrower keep the rest. Conversely, if the project fails, everyone gets 0.

4.1.1 Timing

The timing is as follows:

t=1 The *Lender* offers the group a group-contract.

- The saver gets a contract $(\boldsymbol{w_s}, \boldsymbol{R})$ and the borrower gets a contract $(\boldsymbol{w_b}, r)$.

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 $(1 - \boldsymbol{w_b} - \boldsymbol{w_s})$ 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:

$$\begin{aligned} \text{Saver: } & s_s = \boldsymbol{R w_s} \\ \text{Lender: } & l_s = r\Big(1 - (\boldsymbol{w_s} + \boldsymbol{w_b})\Big) \\ \text{Borrower: } & b_s = \bar{x} - l_s - s_s \end{aligned}$$

- If the project **fails**, the output is 0. Everyone gets 0

$$s_f = l_f = b_f = 0$$

4.1.2 Final Expected Payoffs

The borrower's final expected payoffs is

$$E[\, b_i \mid \boldsymbol{j}\,] + \left[\frac{\pi^h - \pi^{\boldsymbol{j}}}{\pi^h - \pi^l}\right] B(c) = \\ \pi^{\boldsymbol{j}}\big[\, \bar{x} - r(1 - w_s - w_b) - R w_s \,\big] + \left[\frac{\pi^h - \pi^{\boldsymbol{j}}}{\pi^h - \pi^l}\right] B(c)$$

where $i = \{s, f\}$ indicates the success or the failure of the project and $\boldsymbol{j} = \{H, L\}$ indicates the effort level the borrower exerts for the project. The final expected payoffs of the saver is

$$E[\, s_i \mid \boldsymbol{j}\,] - c = \pi^{\boldsymbol{j}} R w_s - c$$

where c is the intensity with which the saver monitors the borrower. The final expected payoffs of the lender is

$$E[\, l_i \mid \boldsymbol{j}\,] = (\pi^{\boldsymbol{j}} r - \rho)\, [\, 1 - w_b - w_s\,]$$

An optimal contract gives the saver the incentive to monitor the borrower with an intensity which is sufficient to induce the borrower to pursue the project with a high effort level.

4.2 The Constraints

Due to competition, the lender faces the following zero profit condition

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

We examine the borrower and saver's participation and incentive compatibility constraint below.

4.2.1 Borrower

The borrower's participation constraint is given by

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

The condition ensures that the borrower's return from exerting high effort level should not be less than the opportunity cost of her cash wealth w_b

invested in the project. The borrower's incentive compatibility constraint is given by

$$\pi^h \left[\bar{x} - r(1 - \boldsymbol{w_s} - \boldsymbol{w_b}) - \boldsymbol{R}\boldsymbol{w_s}\right] \geqslant \pi^l \left[\bar{x} - r(1 - \boldsymbol{w_s} - \boldsymbol{w_b}) - \boldsymbol{R}\boldsymbol{w_s}\right] + B(c) \qquad \text{(B-ICC)}$$

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

4.2.2 Saver

The saver's participation constraint is given by

$$\pi^h \boldsymbol{R}\boldsymbol{w_s} - c \geqslant \rho \boldsymbol{w_s} \qquad \text{(S-PC)}$$

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

The saver's incentive compatibility constraint is given by

$$\pi^h \boldsymbol{R}\boldsymbol{w_s} - c \geqslant \pi^l \boldsymbol{R}\boldsymbol{w_s} \qquad \text{(S-ICC)}$$

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.

4.3 Discussion

4.3.1 Borrower's Decision

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

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

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

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

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

$$\pi^h\left(\bar{x} - \frac{\rho}{\pi^h}\right) \geqslant \left(\boldsymbol{R} - \frac{\rho}{\pi^h}\right)\boldsymbol{w_s} \qquad \text{(B-PC)}$$

The RHS is the premium that the saver gets on her saving w_s. The condition restricts the total premium that the saver obtains and thus effectively restricts the range of the saver's contract $(\boldsymbol{R}, \boldsymbol{w_s})$.

4.3.2 Saver's Decision

There are two relevant ranges for $\boldsymbol{R}$, the return the saver gets on her capital. In the first range, $\boldsymbol{R} \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right]$, the saver's participation constraint binds and her incentive compatibility constraint remains slack. Thus, in this range, a saver's contract $(\boldsymbol{R}, \boldsymbol{w_s})$ that satisfies the saver's participation constraint always satisfies her incentive compatibility constraint. Conversely, a contract that satisfies the saver's incentive compatibility constraint does not necessarily satisfy her participation constraint.

In the second range, $R \geqslant \frac{\rho}{\pi^l}$, the saver's incentive compatibility constraint binds and her participation constraint remains slack. In this range, a contract that satisfies the saver's incentive compatibility constraint always satisfies her participation constraint, though vice versa is not true. It is important to note that this holds for all $c > 0$. (For details see the Appendix A.)

The saver's participation and incentive compatibility are drawn for a positive value of c in Figure 3. A saver's contract $(\boldsymbol{R}, \boldsymbol{w_s})$ which is to the right of the (S-PC) will satisfy the saver's participation constraint. Similarly, a saver's contract which is to the right of (S-ICC) will satisfy the saver's incentive compatibility constraint. As c, the intensity of the monitoring increases, both curves shift right, though they still continue to intersect at $\boldsymbol{R} = \frac{\rho}{\pi^l}$.

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 will satisfy the borrower's participation constraint.

A saver's contract $(\boldsymbol{R}, \boldsymbol{w_s})$ in the area ABCD will satisfy the saver's incentive compatibility and participation constraint as well as the borrower's participation constraint.

An optimal contract from the lender would give the saver the incentive to monitor the borrower with a intensity that is sufficient to induce the borrower to exert a high effort on the project. Thus, given an optimal contract $(\boldsymbol{R}, \boldsymbol{w_s})$, the saver will choose her monitoring intensity. If R is in the *first range*,

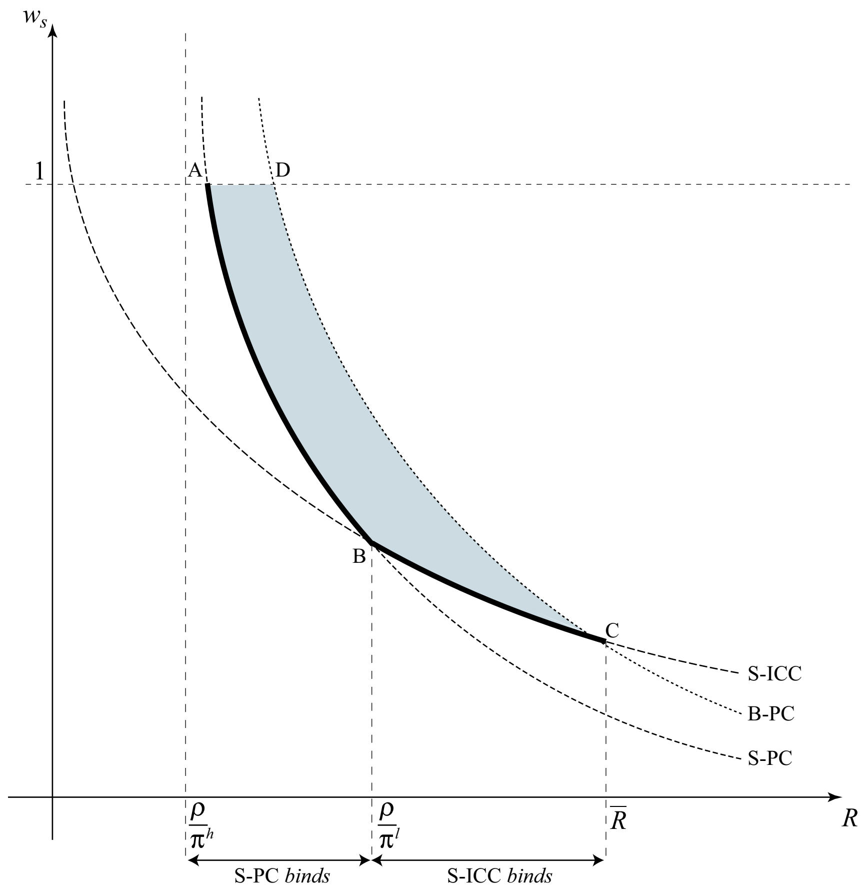


Figure 3: Borrower's and Saver's Constraints

she would choose a monitoring intensity that would make her participation constraint bind. If R is in the *second range*, she would choose a monitoring intensity that would make her incentive compatibility constraint bind. A detailed discussion follows in Appendix A.

4.4 Lender's Problem

The lender's problem is

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

subject to his zero profit condition, the saver's and the borrower's participation and incentive compatibility constraint.

The saver's participation constraint binds in the first range, namely $\boldsymbol{R} \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right]$ and her incentive compatibility constraint binds in the second range, $\boldsymbol{R} \geqslant \frac{\rho}{\pi^l}$. In Appendix A we show that if $c \leqslant \pi^h \bar{x} - \rho$, the borrower's incentive compatibility constraint will bind and her participation constraint will be slack.[3] Substituting (S-PC), (S-ICC), (B-ICC) and (L-ZPC) into the lender's objective function, the lender's problem can be written as

$$\max_{\boldsymbol{R}, c}\ \phi\left(\boldsymbol{R},\, c\right) \;=\; \pi^h r\Big[1 - \Big(\boldsymbol{w_b}\left(\boldsymbol{R}, \boldsymbol{w_s}, c\right) + \boldsymbol{w_s}\left(\boldsymbol{R}, c\right)\Big)\Big]$$

Thus, the lender maximises his expected payoff by choosing a optimum $\boldsymbol{R}$ and c. Given the optimum values for $\boldsymbol{R}$ and c, $\boldsymbol{w_s}$ and $\boldsymbol{w_b}$ can be obtained from the respective saver's and borrower's constraints that bind for the saver and the borrower.

In Appendix B, we show that the lender's objective function $\phi\left(\boldsymbol{R}, c\right)$ is increasing with R in the first range, namely $\boldsymbol{R} \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right]$. Conversely, in the second range, $\boldsymbol{R} \geqslant \frac{\rho}{\pi^l}$, the lender's objective function is independent of R. Further, for a given $\boldsymbol{R}$, the lender's objective function is maximised if the lender induces the saver to monitor with intensity c given by

$$B'(c) = \max\left[-\left(\frac{\pi^h - \pi^l}{\pi^h - \dfrac{\rho}{\boldsymbol{R}}}\right),\ -1\right] \tag{8}$$

The function gives us the optimal value of c that the lender would like to induce, for a given $\boldsymbol{R}$, in order to maximise his objective function $\phi(\boldsymbol{R}, c)$.

According to (8), the optimal c that the lender would like to induce increases with R in the first range, namely $\boldsymbol{R} \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right]$.

In the second range, $\boldsymbol{R} \geqslant \frac{\rho}{\pi^l}$, the lender would like to induce the saver to monitor with intensity c^* defined by $B(c^*) = -1$. The optimal c in this range is independent of R.

Given that (8) is continuous, the lender's objective function is maximised (unconditionally) if the contracts he offers the group meets the following conditions.

$$\boldsymbol{R} \geqslant \frac{\rho}{\pi^l} \tag{9}$$

$$B'(c^*) = -1 \tag{10}$$

$$\bar{x} \geqslant \frac{\rho}{\pi^h} + \frac{c^*}{\pi^h}\left[\frac{\boldsymbol{R} - \frac{\rho}{\pi^h}}{\Delta\pi\boldsymbol{R}}\right] \tag{11}$$

The lender can lend to a group with a project which satisfies (11) by offering the saver a contract that would induce her to monitor with intensity c^* defined by (10). Further, he would have to offer her a $\boldsymbol{R}$ in the second range.

As we discussed above, the value of $\boldsymbol{R}$ does not influence the lender's objective function in the second range. Thus, by setting $\boldsymbol{R}$ at its lowest value in the second range, $\boldsymbol{R} = \frac{\rho}{\pi^l}$, the lender can lend to all groups with projects that meet the following condition

$$\bar{x} \geqslant \frac{c^* + \rho}{\pi^h}$$

For projects $\bar{x} \in \left[\frac{c^*+\rho}{\pi^h}, \infty\right)$, the lender can induce the saver to monitor with intensity c^* by offering her a contract $(\boldsymbol{R}^*, \boldsymbol{w_s^*})$ where

$$\begin{aligned} \boldsymbol{R}^* &= \frac{\rho}{\pi^l} \\ \boldsymbol{w_s^*} &= \frac{1}{\boldsymbol{R}^*}\frac{c^*}{\Delta\pi} \end{aligned} \tag{12}$$

He offers the borrower a contract $(r, \boldsymbol{w_b^*})$ where

$$\begin{aligned} r &= \frac{\rho}{\pi^h} \\ \boldsymbol{w_b^*} &= 1 - \frac{1}{\left(\frac{\rho}{\pi^h}\right)}\left[\bar{x} - \frac{B(c^*)}{\Delta\pi} - \frac{c^*}{\pi^h}\right] \end{aligned} \tag{13}$$

We summarise this with the following proposition.

Proposition 4. *For projects with $\bar{x} \in \left[\frac{\rho+c^*}{\pi^h}, \infty\right)$, the lender induces the saver to monitor with intensity c^* by setting $\boldsymbol{R} = \boldsymbol{R}^* = \frac{\rho}{\pi^l}$.*

The proof is in Appendix B.

Proposition 5. *The minimum wealth required to borrow in group lending is lower than in individual lending.*

In individual lending, the minimum wealth required to borrow is given by

$$\boldsymbol{w_b^I} = 1 - \frac{1}{\left(\frac{\rho}{\pi^h}\right)}\left[\bar{x} - \frac{B(0)}{\Delta\pi}\right] \tag{14}$$

In group lending, the minimum wealth required to borrow is given by

$$\boldsymbol{w_b^*} = 1 - \frac{1}{\left(\frac{\rho}{\pi^h}\right)}\left[\bar{x} - \frac{B(c^*)}{\Delta\pi} - \frac{c^*}{\pi^h}\right] \tag{15}$$

where $B(c^*) = -1$. Comparing (14) with (15), we get

$$\boldsymbol{w_b^I} \geqslant \boldsymbol{w_b^*}$$

given that $B(0) \geqslant B(c^*) + c^*$.

4.5 Group Formation

Proposition 6. *An agent with enough wealth to be a borrower in the group will always prefer to pair up with an agent who has enough wealth to be a saver but not a borrower and vice versa.*

Agent k with cash wealth $w_k \geqslant \boldsymbol{w_b^*}$ will always prefer to pair up with an agent n whose cash wealth w_n is in the range $[\boldsymbol{w_s^*}, \boldsymbol{w_b^*})$.

If agent k with cash wealth $w_k \geqslant \boldsymbol{w_b^*}$ pairs-up with agent n with cash wealth $w_n \in (\boldsymbol{w_s^*}, \boldsymbol{w_b^*})$, she can be sure that she would be able to borrow from the lender. Thus, her payoff from this pairing is given by

$$\rho(w_k - \boldsymbol{w_b^*}) + E[b_i \mid H] \tag{16}$$

Pairing up with an agent h with cash wealth $w_h \geqslant \boldsymbol{w_b^*}$, would imply that she would have to compete with agent n to become the borrower in the group. If it is randomly decided which agent in the group gets to borrow, agent k could get the role of a borrower or a saver in the group with equal probability. Agent k's payoff from pairing with Agent h is given by

$$\frac{1}{2}\Big[\rho(w_k - \boldsymbol{w_b^*}) + E[b_i \mid H]\Big] + \frac{1}{2}\Big[\rho(w_k - \boldsymbol{w_s^*}) + E[s_i \mid H] - c^*\Big] \tag{17}$$

In Appendix B.2, we show that for the optimal contract $(r, \boldsymbol{w_b^*})$ and $(\boldsymbol{R}, \boldsymbol{w_s^*})$ given by (12) and (13), the borrower's and the saver's rents are given by

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

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

Comparing (16) with (17), agent k would prefer to pair up with agent n over agent h if the following condition holds

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

The condition always holds for projects $\bar{x} \in \left[\frac{c^*+\rho}{\pi^h} \, , \, \infty \right)$.

Similarly an agent n with wealth $w_n \in [\, \boldsymbol{w_s^*} , \boldsymbol{w_b^*} \,)$ would prefer to pair up with an agent k with wealth $w_k \geqslant \boldsymbol{w_b^*}$ over another agent l with wealth $w_l \in [\, \boldsymbol{w_s^*} , \boldsymbol{w_b^*} \,)$ if the following condition holds.

$$\left[\rho(w_n - \boldsymbol{w_s^*}) + E[s_i \mid H] - c^* \right] \geqslant \rho w_n \tag{18}$$

Agent n's final payoff from pairing up with agent k with wealth $(w_k \geqslant \boldsymbol{w_b^*})$ is given by the LHS and agent l with wealth $(w_l \ngeqslant \boldsymbol{w_b^*})$ is given by the RHS. Given that (18) holds with an equality, it leaves agent n indifferent between the two choices.

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 the depth of the outreach or the ability of the group-lending mechanism to reach the poorest.

Given the competition amongst the lenders, if a particular lender gets funds at a subsidised cost, he would just end up retaining the subsidy in the form of rents for himself. He would not have any incentive to pass on the benefits of the subsidy to the agents participating in the group.

Consequently, the only way in which the policymaker can intervene in this market is by augmenting the supply of loanable funds. This would have the effect of lowering the cost of capital or decreasing 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.

The policy maker cares about the *depth of outreach* or the ability of the group-lending mechanism to reach the wealth deprived. Her objective is to minimise the amount of cash wealth required by an agent to access the financial services offered by the group-lending mechanism. A agent k with wealth w_k can participate in the group lending mechanism if $w_k \geqslant \min(\boldsymbol{w_s^*} + \boldsymbol{w_b^*})$.

Definition 1 (Depth of Outreach)**.** *The depth of outreach is measured by*

$$min\,(\boldsymbol{w_s^*} + \boldsymbol{w_b^*})$$

.

The depth of outreach increases as $min(\boldsymbol{w_s^*} + \boldsymbol{w_b^*})$ decreases.

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 7. *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.*

Given the cost of capital ρ, the minimum wealth required to be a borrower in a group is given by

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

The minimum wealth required to be a saver in the group is given by

$$\boldsymbol{w_s^*} = \frac{\pi^l}{\rho} \frac{c^*}{\Delta\pi}$$

To examine the effect of subsidising the cost of capital on the group lending contract, we look at the first derivatives of $\boldsymbol{w_s^*}$ and $\boldsymbol{w_b^*}$ with respect to ρ.

$$\frac{d\boldsymbol{w_s^*}}{d\rho} = -\left[\frac{\pi^l}{\Delta\pi} \frac{c^*}{\rho^2}\right] < 0$$

Thus, decreasing ρ or subsidising the cost of capital decreases $\boldsymbol{w_b^*}$, which in turns allows poorer agents to become borrowers in the group.

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

Conversely, decreasing ρ increases $\boldsymbol{w_s^*}$. This implies that the minimum cash wealth required to participate in the group as a saver has increased.

Overall, $(\boldsymbol{w_s^*} + \boldsymbol{w_b^*})$, the combined group's wealth required by the lender increases with ρ.

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

As ρ increases, the increase in $\boldsymbol{w_b^*}$ is greater than the decrease in $\boldsymbol{w_s^*}$. With increasing ρ, the policymaker gets a greater depth of outreach. At the same time, some agents that could have borrowed at the lower ρ would not be able to borrow now. They would have to participate as savers.

Proposition 8. *There exists a $\hat{\rho}$, such for $\rho \leqslant \hat{\rho}$, the savers are able to accumulate enough wealth to be 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.

$$\boldsymbol{w_s^*}\boldsymbol{R}^* \geqslant \boldsymbol{w_b^*} \tag{19}$$

This holds for all 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 (19).

With $\rho = \hat{\rho}$, the poorest agents with sufficient wealth to be savers in this period can hope to become borrowers with the probability π^h in the next period. This would start a process by which π^h proportion 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 $w_k \geqslant \boldsymbol{w_b^*}$ are in short supply.

Thus, on one hand, as ρ increases, depth of outreach increases. On the other hand, with a increasing ρ, the gap between $\boldsymbol{w_s^*}$ and $\boldsymbol{w_b^*}$ also increases making it more difficult for the poorest in the groups to bridge the gap.

Thus, if ρ in the market is greater than $\hat{\rho}$, then subsidy is warranted. Conversely, if ρ in the market is less than $\hat{\rho}$, the policymaker should curtail the supply of funds and drive up the cost of capital towards $\hat{\rho}$.

6 Conclusion

We documented the group lending mechanism of a typical microfinance lender in India's SHG Linkage Programme. All the agents are poor and have no collateralizable assets. Given their inability to bear any liability for failure, the mechanism requires that the borrower partly self-finance's the project with her own cash wealth. This helps the lender align the borrower's incentive with his own. A borrower requires certain cash wealth to be able to borrow.

The lender specifies the cash wealth required to participate in the group as either a saver or a borrower. The poorest take on the role of savers in the group. Agents with sufficient wealth to borrow take on the role of borrowers in the group.

By allowing saving opportunities and restricting the number of borrowers per group per period, the mechanism gives the agents an incentive to group across wealth levels. We showed that the relatively wealthy agents, who have sufficient wealth to borrow, prefer to pair up with the relatively poor agents. This is because the poorest agents, with insufficient wealth to borrow, will not compete for the loans in the group.

The lender gives the savers the requisite incentives to monitor the borrower. The monitoring by the saver induces the borrower to exert a high effort level on her project. Even though the savers get zero rents, the mechanism allows the saver to get a premium on her savings in return for her monitoring effort. Thus, if the project succeeds, the savers are able to increase their cash wealth.

We showed that if the cost of capital is subsidised or lowered, the wealth required to be a borrower decreases with it and the wealth required to become a saver increases with it. Thus, subsidy actually limits the ability of the 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 the next period's borrowers.

We found that there was an optimal cost of capital where 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 policymaker's have an ability to influence the cost of capital, they should try to push the cost of capital towards this optimal rate. Thus, to answer the question in the title, 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.

A Group Lending: Saver's Contract

A.1 Saver's Constraints

Saver's participation constraint and the incentive compatibility constraint are

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

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

These constraints can be written as

$$\boldsymbol{w_s}\left(\boldsymbol{R} - \frac{\rho}{\pi^h}\right) \geqslant \frac{c}{\pi^h} \tag{S-PC}$$

$$\boldsymbol{R}\boldsymbol{w_s} \geqslant \frac{c}{\Delta\pi} \tag{S-ICC}$$

For the saver's constraints, there are two relevant ranges for R. In the *first range*, $R \in (\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l})$, the saver's participation constraint binds and the incentive compatibility constraint is slack. This is because a saver's contract $(\boldsymbol{R}, \boldsymbol{w_s})$ that satisfies the participation constraint always satisfies the incentive compatibility constraint in this range, but not vice-versa.

In the *second range*, $R \geqslant \frac{\rho}{\pi^l}$, the saver's incentive compatibility constraint binds and the saver's participation constraint is slack. Again, this is because a saver's contract $(\boldsymbol{R}, \boldsymbol{w_s})$ that satisfies the incentive compatibility constraint always satisfies the participation constraint in this range, but not vice-versa.

As c increases, the curves (S-PC) and (S-ICC) in figure 3 shift towards the right. It is important to note that for all $c > 0$ the two curves continue to intersect at $R = \frac{\rho}{\pi^l}$. This implies that the two ranges do not depend on c. Further, the saver's participation constraint binds on the *first range* and her incentive compatibility constraint binds on the *second range* for any $c > 0$.

The range $R \in (0, \frac{\rho}{\pi^h}]$ is irrelevant. In this range the saver's participation cannot be satisfied for any non-negative combination of $\boldsymbol{R}$ and $\boldsymbol{w_s}$.

In the *first range*, the saver does not get any rents given that her participation constraint binds. Her contract $(\boldsymbol{R}, \boldsymbol{w_s})$ is always on the her participation constraint. In the *second range*, her rent increases with R.

As we can see from Figure 3, the saver gets no rent along the segment AB in the first range. As R increases in the second range along the segment BC, the saver moves away from her participation constraint. As she moves away, her rent starts increasing. The saver's rent increases as the distance between the saver's contract and her participation constraint increases.

A.2 Borrower's Participation Constraint

The borrower's participation constraint is given by

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

which can be written as

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

This condition restricts the range of the saver's contract. In figure 3, all contracts to the left of the curve B-PC satisfy the borrower's participation constraint.

Thus the three curves (S-PC), (S-ICC) and (B-PC) give us the area ABCD in figure 3. A saver's contract in this area would satisfy the three constraints. It may be noted that the area ABCD starts contracting if either c or ρ increase. Similarly, the area contracts if $\bar{x}$ decreases.

For the area ABCD to exist, we need a condition that ensures that (B-PC) is not on the left of (S-PC). We also need to find conditions under which the (S-ICC) and (B-PC) intersect.

A.2.1 Existence of $\bar{R}$

As the saver's contract $(\boldsymbol{R}, \boldsymbol{w_s})$ moves down the segment BC in figure 3, the saver's rent increases. Concomitantly, the borrower's rent decreases. At C, the borrower gets no rent and the saver ends up getting all the rent. Consequently, any $R > \bar{R}$ will not satisfy the borrower's participation constraint.

$\bar{R}$ is defined by the intersection of the borrower's participation constraint and the saver's incentive compatibility constraint.

$$\bar{R} = \begin{cases} \dfrac{r}{1 - \left[\frac{(\bar{x}-r)}{\frac{c}{\Delta\pi}}\right]} & \text{if } \; c > \Delta\pi(\bar{x} - r), \\ \nexists & \text{if } \; c \leqslant \Delta\pi(\bar{x} - r). \end{cases} \tag{20}$$

(20) 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 $\bar{R}$.

A.2.2 Maximum Monitoring

We derive the upper bound on the monitoring intensity c from the borrower's and the saver's participation constraint.

$$(\bar{x} - r) \geqslant \boldsymbol{w_s}\left(\boldsymbol{R} - \frac{\rho}{\pi^h}\right) \geqslant \frac{c}{\pi^h}$$

The borrower's participation constraint gives us the first inequality and the saver's participation constraint gives us the second inequality. The maximum monitoring that can be induced for a project is given by the following inequality.

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

To summarise, the set of all the saver's contracts $(\boldsymbol{R}, \boldsymbol{w_s})$ which satisfies the saver's participation and incentive compatibility constraint along with the borrower's participation constraint are given by

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

where $\bar{R}$ is given by (20).

B Group Lending: Lender's problem

Proof for Proposition 4.

The lender's problem is

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

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

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

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

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

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

Using the lender's zero profit condition (L-ZPC) the borrower's participation constraint can be written as

$$\pi^h\left(\bar{x}-\frac{\rho}{\pi^h}\right) \geqslant \left(\boldsymbol{R}-\frac{\rho}{\pi^h}\right)\boldsymbol{w_s} \tag{B-PC}$$

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

$$\left(\pi^h\boldsymbol{R}-\rho\right)\boldsymbol{w_s} \geqslant c \tag{S-PC}$$

$$\Delta\pi\boldsymbol{R}\boldsymbol{w_s} \geqslant c \tag{S-ICC}$$

As discussed in the previous section, We can summarise the three constraints above, namely the saver's participation and incentive compatibility constraint and the borrower's participation constraint, with

$$\boldsymbol{w_s} \geqslant \max\left[\frac{c}{(\pi^h\boldsymbol{R}-\rho)}, \frac{c}{\Delta\pi\boldsymbol{R}}\right] \vee c \leqslant \pi^h(\bar{x}-\frac{\rho}{\pi^h}) \tag{21}$$

There are two relevant ranges for R. In the *first range*, $R \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right)$, the (S-PC) binds and (S-ICC) is slack. In the *second range*, $R \geqslant \frac{\rho}{\pi^l}$, the (S-ICC) binds and (S-PC) is slack. The (B-PC) is satisfied if $c \leqslant \pi^h(\bar{x}-\frac{\rho}{\pi^h})$.

Using the lender's zero profit condition (L-ZPC), the borrower's incentive compatibility constraint can be written as

$$\boldsymbol{w_b} \geqslant 1 - \frac{1}{\left(\frac{\rho}{\pi^h}\right)}\left[\bar{x}-\frac{B(c)}{\Delta\pi}\right] + \frac{1}{\left(\frac{\rho}{\pi^h}\right)}\left(\boldsymbol{R}-\frac{\rho}{\pi^h}\right)\boldsymbol{w_s} \tag{22}$$

Substituting (21) and (22) in the lender's objective function can be written as a function of $\boldsymbol{R}$ and c.

$$\begin{aligned}\phi &= \pi^h r\Big[1-\Big(\boldsymbol{w_b}\left(\boldsymbol{R},\boldsymbol{w_s},c\right)+\boldsymbol{w_s}\left(\boldsymbol{R},c\right)\Big)\Big] \\ &= \begin{cases}\pi^h\bar{x}-\pi^h\left(\dfrac{B(\boldsymbol{c})}{\Delta\pi}+\dfrac{\boldsymbol{c}}{\pi^h-\frac{\rho}{\boldsymbol{R}}}\right) & \text{for } \frac{\rho}{\pi^h} < R \leqslant \frac{\rho}{\pi^l} \\ \pi^h\bar{x}-\pi^h\left(\dfrac{B(c)+c}{\Delta\pi}\right) & \text{for } \quad R \geqslant \frac{\rho}{\pi^l}\end{cases}\end{aligned} \tag{23}$$

For the *first range*, $\boldsymbol{R} \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right)$, we find that

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

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

$$\frac{\partial \phi^2}{\partial c^2} = -\pi^h \left(\frac{B''(c)}{\Delta\pi} \right) < 0$$

$$\frac{\partial \phi^2}{\partial c\, \partial R} = -\pi^h \left(\frac{\rho}{\pi^h \boldsymbol{R} - \rho} \right) < 0$$

For the *second range*, $\boldsymbol{R} \geqslant \frac{\rho}{\pi^l}$, 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 $\boldsymbol{R}$ is given by the following function

$$B'(c) = \max \left[- \left(\frac{\pi^h - \pi^l}{\pi^h - \dfrac{\rho}{\boldsymbol{R}}} \right) \, , \, -1 \right] \tag{24}$$

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

$$\begin{aligned} \boldsymbol{R} &\geqslant \frac{\rho}{\pi^l} && \forall\, \bar{x} \in \left[\tfrac{\rho + c^*}{\pi^h} \, , \, \infty \right) \quad \text{where } B'(c^*) = -1 \\ \boldsymbol{R} &= \frac{\rho}{\pi^h + \dfrac{\Delta\pi}{B'(\tilde{c})}} && \forall\, \bar{x} \in \left(\tfrac{\rho}{\pi^h} \, , \, \tfrac{c^* + \rho}{\pi^h} \right) \quad \text{where } \tilde{c} = \pi^h \bar{x} - \rho \end{aligned} \tag{25}$$

B.1 Contracts

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

$$\begin{aligned} \boldsymbol{R}^* &= \frac{\rho}{\pi^l} \\ \boldsymbol{w_s}^* &= \frac{1}{\boldsymbol{R}^*} \frac{c^*}{\Delta\pi} \\ r &= \frac{\rho}{\pi^h} \\ \boldsymbol{w_b}^* &= 1 - \frac{1}{\left(\frac{\rho}{\pi^h}\right)} \left[\bar{x} - \frac{B(c^*)}{\Delta\pi} - \frac{c^*}{\pi^h}\right] \end{aligned} \tag{26}$$

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 $\boldsymbol{R} = \tilde{\boldsymbol{R}} < \boldsymbol{R}^*$. Thus, the saver would be offered a contract $(\tilde{\boldsymbol{R}}, \tilde{\boldsymbol{w_s}})$ and the borrower would be offered a contract $(r, \tilde{\boldsymbol{w_b}})$ where

$$\begin{aligned} \tilde{\boldsymbol{R}} &= \frac{\rho}{\pi^h + \frac{\Delta\pi}{B'(\tilde{c})}} \\ \tilde{\boldsymbol{w_s}} &= \frac{1}{\tilde{\boldsymbol{R}}} \frac{\tilde{c}}{\Delta\pi} \\ r &= \frac{\rho}{\pi^h} \\ \tilde{\boldsymbol{w_b}} &= 1 - \frac{1}{\left(\frac{\rho}{\pi^h}\right)} \left[\bar{x} - \frac{B(\tilde{c})}{\Delta\pi} - \frac{\tilde{c}}{\pi^h}\left(\frac{-1}{B'(\tilde{c})}\right)\right] \end{aligned} \tag{27}$$

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 $(\boldsymbol{R}^*, \boldsymbol{w_s}^*)$, which is required to induce the saver to monitor with intensity c^* would not satisfy the borrower's participation contract.

B.1.1 Low Productivity Project and Borrower Participation Constraint

Lets 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 $(\, \boldsymbol{R}^* \, , \boldsymbol{w_s}^* \,)$. The contract would satisfy the borrower's participation constraint if

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

Thus contradicting the initial assumption about the project.

B.2 Economic Rents

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

$$
\begin{aligned}
E[b_i \mid H] - \rho w_b = &\; \pi^h \left[\bar{x} - r(1 - w_s - w_b) - R w_s\right] - \rho w_b \\
= &\; \pi^h \left[\bar{x} - r - (R - r) w_s\right]
\end{aligned}
\tag{28}
$$

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

$$
\begin{aligned}
E[s_i \mid H] - \rho w_s - c = &\; \pi^h R w_s - c - \rho w_s \\
= &\; (\pi^h R - \rho) w_s - c \begin{cases} = 0 & \forall\, R \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right] \\ \geqslant 0 & \forall\, R \geqslant \frac{\rho}{\pi^l} \end{cases}
\end{aligned}
\tag{29}
$$

In the first range, $R \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right]$, the saver gets zero rent as her participation constraint binds. In the second range, $R \geqslant \frac{\rho}{\pi^l}$, the saver gets non-negative rents as her participation constraint is slack.

Using (28) and (29), we it is clear that in the first range, $R \in \left(\frac{\rho}{\pi^h}, \frac{\rho}{\pi^l}\right]$, the total rents obtained by the saver and the borrower are decreasing in R.

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

Conversely, in the first range, $R \geqslant \frac{\rho}{\pi^l}$, the total rents obtained by the saver and the borrower are constant for a given c.

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

Thus, R just serves the purpose of transferring rents from the borrower to the saver. For the optimal contract $(r, \boldsymbol{w_b^*})$ and $(\boldsymbol{R}, \boldsymbol{w_s^*})$ given by (26) in the previous section, the rents are given by

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

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

For the optimal contract $(r, \tilde{\boldsymbol{w}}_{\boldsymbol{b}})$ and $(\boldsymbol{R}, \tilde{\boldsymbol{w}}_{\boldsymbol{s}})$ given by (27) in the previous section, the rents are given by

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

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

The borrower gets all the rent and the saver gets zero rent.

Notes

[1]Most group members borrowed to buy buffaloes. For a typical loan of Rs. 10,000 at 24% per annum, the borrower was required to repay Rs. 1200 in the first month. Even if the buffalo starting producing milk from the very first day, the borrower would still have a shortfall of Rs. 450 in the first month. This is assuming that the buffalo produces 5 kgs of milk a day which sells at Rs. 5 a kg. The shortfall in the tenth month would be of Rs. 270.

[2]Increasing r reduces the borrowers 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.

[3]For low productivity project, namely $\bar{x} \in \left(\frac{\rho}{\pi^h}, \frac{c^* + \rho}{\pi^h}\right)$, the borrower's participation and incentive compatibility constraints would simultaneously bind.

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