The Micro in Microfinance

Lecture Notes on Credit and Microfinance [1]

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Abstract. A series of lecture on the theory of microfinance. Using contract theoretic models, the lecture summaries the current research in the microfinance. The lecture cover consumption credit, adverse seletion, moral hazard and contract enforcement.

These are lectures notes that accompany the lectures delivered by Kumar Aniket at the University of Cambridge from 16 January to 6 February 2009. The lecture slides and other material for the course can be found at http://www.aniket.co.uk/teaching/microfinance/.

Lectures

List of Figures v

Chapter 1. Consumption and Credit 1

1. Introduction 1
2. Types of Default 1
3. Credit Ceiling and its implications 3

Chapter 2. Adverse Selection 9

1. Introduction 9
2. Model 9
3. Individual Lending 11
4. Group Lending with Joint Liability 16

Summary 20

Exercise 20

Chapter 3. Moral Hazard 23

1. Introduction 23
2. Project Choice Model 24
3. Effort Choice Model 29
4. Sequential Group Lending 34

Exercise 35

Chapter 4. Enforcement and Savings 37

1. Enforcement 37
2. Strategic Default 39
3. Savings 46

Exercise 49

Bibliography 51

List of Figures

1 Credit Ceiling and Risk Premium 6

1 Perfect Information Benchmark 12
2 Under-investment in Stiglitz and Weiss (1981) 14
3 The Over-investment Problem in De Mezza and Webb (1987) 15
4 Under and Over investment Ranges 16
5 Risky and Safe Types' Indifference Curves 18
6 Separating Joint Liability Contract 19

1 Safe and Risky Projects 25
2 Switch Line and Optimal Contract under Individual Lending 26
3 Switch Line and Optimal Contract under Group Lending 28
4 Monitoring Intensities in Group Lending 33
5 Monitoring Intensities as Monitoring Efficiency Increases 35

1 Penalty and Threshold Functions 40
2 Default and Repayment Regions 41
3 Advantages and Disadvantage of Group Lending 42
4 threshold Output with Social Sanctions 43
5 Advantages and Disadvantage of Group Lending 44

CHAPTER 1

Consumption and Credit

ABSTRACT. This lecture looks at the role credit constraint play in shaping an individual's outlook towards risk. We find that the cost an agent is ready to pay to insulate herself from income risk increases with as her credit ceiling decreases. This may lead severely credit constrained individuals to choose low mean income low risk occupations over high mean income high risk occupations leading them to get entrapped in poverty.

1. Introduction

In this section we introduce information problems associated with credit contracts and discuss their classification.

The source of all problems in the credit markets is the risk of default by the borrower. Once the borrower has obtained the loan amount, she could refuse to repay the loan when the repayment is due.

2. Types of Default

Borrower's refusal to repay could potentially be involuntary or voluntary in nature. *Involuntary default* occurs when the borrower is no longer in position to meet her repayment obligations. Conversely, *Voluntary default* occurs when the borrower has sufficient resources to make the repayment, but chooses not to repay because it is not in her interest to do so. As the decision to not repay the loan is strategic in nature, voluntary default is also called strategic default in the literature.

The lenders find ways and means to reduce the risk of voluntary and involuntary default. If the lenders are able to reduces the risk of default below a critical threshold, they would choose to lend. Conversely, if the risk of default is sufficiently large or pervasive, the credit markets may freeze up with the lenders either not lending or lending extremely selectively to relatively few.

Broadly speaking, individuals do not have a problem in borrowing from a lender if the following two conditions are met.

(1) *Individuals are wealthy and possess sufficiently large collateral.* A wealthy individual with sufficiently large collateral would always be able to borrow. The collateral goes a long way in compensating the lender for the risk of default. The problem is acute for individuals who do not have a sufficiently large collateral.
(2) *An effective system for enforcing contracts exists.* This could be a well functioning legal or court system or some alternative informal mechanism for enforcing contracts. For instance, the mafias do not seem to have any problem extracting the payments from individuals.

The two factors above complement each other. A improved legal or court system would decrease the wealth threshold for borrowing and vice versa. Even in the absence of a legal system, the wealthiest never have a problem getting credit.[1] Or with an extremely effective legal system, a poor person has access to credit.[2]

The problems in the credit markets come down to lack of wealth and collateral and ineffective legal system (or alternative systems for enforcing contracts). The problem of borrowing from the formal credit markets get extremely acute for the poorest of the poor living in the countries with an ineffective legal system.

We will take an information oriented approach to the problems of credit markets. This entails looking at the the credit markets problems as information problems and classifying them accordingly.

Classification of Information Problems. In case of an **involuntary default**, the borrower defaults because she is no longer in a position to meet her repayment obligation. For example, the borrower could end up with insufficient resources to meet her repayment obligations due to the following reasons.

(1) The borrower invests in a risky project that fails.
(2) The investment loan is diverted for consumption purposes.

We can further divide the reasons for involuntary default. It could either be due to some information that could be ascertained *before* the credit contract is signed or *after* the credit contract is signed. Before the credit contract is signed, the lender would like to ascertain the riskiness of the borrower or her project. The lack of this information gives rise to the problem of *adverse selection*. After the contract is signed the lender lacks the information regarding the use of the borrowed funds and the actions taken by the borrower on the projects. This lack of information gives rise to the problem of *moral hazard*.

The problem of adverse selection can potentially be solved by *screening* the borrower for their risk types. Screening entails the lender distinguishing between borrowers of different risk types. The information component of the problem should be obvious. It is obviously not easy to ascertain the how risky a person would be as a borrower. The risk type of a person here refers to everything that would influence her ability to repay. As we would see further in the course, given the lack of direct knowledge about the potential borrower's ability to repay, the lender resorts indirect ways to ascertain information about the borrowers.

The problem of moral hazard could potentially be solved by getting the borrower *monitored*. Through this monitoring process, the lender obtains information about the borrowers use of the fund and the diligence with which she follows up the project. Through the monitoring process the lender acquires information about the borrowers actions.

The problem of involuntary default thus translates into the problem of finding finding appropriate means and mechanisms to screen and monitor the borrower.

[1] A relatively rich person living in a developing country.
[2] A relatively poor person living in a OECD country.

In case of **voluntary** or **strategic default**, the borrower has sufficient resources to repay the loan but chooses not do so because she has no incentive to repay.[3]

From the information point of view, the first step is for the lender to establish the reason for the default. It may not be obvious prima facie[4] whether the reason for default is voluntary or involuntary. *Auditing* the borrower establishes the reason for the borrower's default. Auditing in many instances may be an extremely costly process.

If auditing does establish that the default is an voluntary one, the lender needs to enforce the credit contract. *Enforcement* is the problem of ensuring that the borrower meets her contractual obligations, which would entail extracting the repayment from the borrower.

Weak legal system limits the lender's ability to enforce contract. It is interesting to note the symmetry between the international debt and credit contracts in the developing countries.

International debt: There is no effective international court of law with enforces international debt contracts. In case of a threat of default, the lenders often take recourse to extra-ordinary punitive measures to enforce the credit contracts. These measures could include threatening to stop further lending or threatening to impose restrictions on trade with that country.

Credit Contracts in Developing Countries: Contracts in developing countries, especially in rural areas and the informal sector, often have enforcement problems that are similar to the problems associated with international debt. The courts, if they exist, are slow, cumbersome and expensive. In some cases, they may be susceptible to corruption or be less than fair.

3. Credit Ceiling and its implications

3.1. Eswaran and Kotwal (1990). Eswaran and Kotwal (1990) suggests that *ability to smooth consumption* affects an agent's *capacity to bear risk*. The borrowing constraints or the credit ceilings restrict the agent's ability to pool risk over time and stabilise his over time consumption, which in turn, increases the cost of risk borne by the agent. Eswaran and Kotwal (1990) shows that the *risk premium* or the price that the agent is ready to pay to insulate himself from risk is increases as his credit ceiling decreases.

The credit constraint has an impact on the occupational choice made by the agents. If volatility increases with expected mean income, a credit constrained agent may choose to stick with low mean income occupations.

An agent can *smooth consumption* if the agent is sufficiently wealthy on her own accord or has access to credit for consumption. An agent who is either sufficiently wealthy or has access to credit can disengage the consumption from the income realised in each period. She can dissave or borrow when her income is low and save or repay the loan when her income is high.

[3]Since the borrower takes a decision regarding whether to repay the lender, involuntary default sometimes is referred to as ex post moral hazard. The ex post part refers to borrower's action taken after the project outcome has been realised. The action of choosing the project and making a decision on the effort is taken before the project outcome is realised an is this called ex ante moral hazard.

[4]self-evident before any investigation

Consequently, this analysis has less bite for societies where financial markets work relatively well[5] leading to low wealth threshold for accessing the financial markets and where everyone in the society is comfortably above this wealth threshold. Consequently, this relationship between ability to smooth consumption and risk bearing capacity becomes significant when

(1) Credit markets do not work relative well due to information and enforcement problems and
(2) the wealth distribution is extremely skewed.

We are using this example to understand why the poor may get caught in the vicious circle of poverty. Thus, the credit market in this model is an informal credit market. The informal lenders have their own way to acquiring information cheaply and enforcing contracts. The imperfections in the credit markets reflects itself only in terms of credit ceilings, i.e., the maximum amount a borrower can borrow. The lender use the credit ceilings to manage the risk of default.

Evidence from papers like Aleem (1990), Udry (1990), Ghatak (1976) and Timberg and Aiyar (1984) to name few suggests that informal credit markets in developing countries are extremely segmented. There is considerable variation in the terms of the loan offered to borrowers, even when they are quite similar to each other and live in close geographically proximity to each other. For sake of simplicity, we are ignoring the variation in interest rates on loans and focussing exclusively on the credit ceiling. For the purposes of the model, this means that credit ceiling vary for seemingly homogenous agents in the model.

3.1.1. *Model.* Two period model in which an agent's income in each period is uncertain yet identically and independently distributed. Good and bad states of nature occur with equal probability. The agent's income is $z + \sigma$ in good state and $z - \sigma$ in the bad state. The table below shows the agent's total lifetime income in all possible states of nature over the two periods.

		Period 2	
	States	Good	Bad
Period 1	Good	$2(z+\sigma)$	$2z$
	Bad	$2z$	$2(z-\sigma)$

TABLE 1. Agent's total lifetime income in all possible states of nature

The agents are risk-averse and with identical von-Neumann-Morgenstern utility functions $U(c^1, c^2) = u(c^1) + u(c^2)$ where c^1 and c^2 denote the first and second period consumption respectively and $u'(c) > 0$ and $u''(c) < 0$. The agents are homogenous in all respects expect one. Agents have differing credit ceilings, which are exogenously given. To keep matters simple, we have assumed that the agent's rate of time preference and interest rate are both zero.

The borrower decides his first period consumption c^1 after his first period income has been realised. This may entail borrowing an amount a certain amount from the financial markets. Once the second period income has been realised, the borrower repays back the amount borrowed and consumes the rest of income as c^2.

The only decision that the agent makes is on c^1, that is how much to consume in period 1 after the period 1 income has been realised. The decision on c^1 is contingent on how much she

[5] The lenders are able to solve the information and enforcement problems for a large part of the individuals in the society. Robert Shiller in his new book calls this process financial democratisation where all individuals can access borrow and save in the financial markets. (Shiller, 2008)

can borrow in period 1. In period 2, once the income has been realised, the borrower repays back the loan and consumes the residual amount.

We have assumed that the borrower has full liability and cannot default on her repayment obligations. This is not an unusual assumption in informal markets, where default is not usually an option. As we would see in the the rest of the lectures, when agents borrow from the formal financial institutions or microfinance institutions, defaulting becomes and option.

3.1.2. *Unconstrained Utility Maximisation.* Lets assume the b is the amount the agent would have liked to borrow if there were no ceiling on the amount she can can borrow. If the **bad state** is realised in period 1, the agent would like consume c_{bad} in period one by borrowing $b = c^1_{bad} - (z - \sigma) > 0$. Once income in period 2 is realised, the agent repays her loan b and consumes the residual amount. Thus, c^2_{bad} depends on the income realisation in period 2 and c^1_{bad}. If good state occurs in period 2, $c^2_{bad} = (z + \sigma) - b$. If bad state occurs in period 2, the $c^2_{bad} = (z - \sigma) - b$. By substituting for b we obtain the following.

$$c^2_{bad} = \begin{cases} 2z - c^1_{bad} & \text{if period 2 state is } \textit{good} \\ 2(z - \sigma) - c^1_{bad} & \text{if period 2 state is } \textit{bad} \end{cases}$$

Let $\tilde{c}^1_{bad}$ be the amount the agent would consume if she did not have any credit ceiling. $\tilde{c}^1_{bad}$ thus solves the agent's unconstrained utility maximisation problem below.

$$\max_{c^1_{bad}} u(c^1_{bad}) + E(u(c^2_{bad}))$$

At $\tilde{c}^1_{bad}$, the marginal utility out of consumption in period one is equated to the expected marginal utility from consumption in the period 2.

If **good state** is realised in period 1, the agent would like to borrow[6] $b = c^1_{good} - (z + \sigma) < 0$. As above we can find c^2_{good} by substituting for b.

$$c^2_{good} = \begin{cases} 2(z + \sigma) - c^1_{good} & \text{if period 2 state is } \textit{good} \\ 2z - c^1_{good} & \text{if period 2 state is } \textit{bad} \end{cases}$$

Let $\tilde{c}^1_{good}$ be the amount the agent would consume if she did not have any credit ceiling. $\tilde{c}^1_{good}$ solves the agent's unconstrained utility maximisation problem below.

$$\max_{c^1_{good}} u(c^1_{good}) + E(u(c^2_{good}))$$

At $\tilde{c}^1_{good}$, the marginal utility out of consumption in period one is equated to the expected marginal utility from consumption in the period 2. Given the income uncertainty in period 2, agent would never consume the full period 1 income of $(z+\sigma)$ and the credit ceiling would never bind.

		Consumption	
		Period 1	Period 2
States in Period 1	bad	$\tilde{c}^1_{bad}$	Total income - $\tilde{c}^1_{bad}$
	good	$\tilde{c}^1_{good}$	Total income - $\tilde{c}^1_{good}$

TABLE 2. Agent's consumption in all states without credit ceiling

[6] This would turn out of negative borrowing or saving.

3.1.3. *Constrained Utility Maximisation.* Lets solve the problem for a agent with a credit ceiling B. The agents problem can be written as

$$\max_{c^1} u(c^1_{bad}) + E(u(c^2_{bad}))$$
$$\text{subject to} \quad b \leqslant B. \tag{1}$$

Equation (1) could potentially only bind when bad state occurs in the period 1. Lets call the smallest value of the credit ceiling that will not end up binding B_c. Then B_c can be defined by $B_c = \max[\tilde{c}^1_{bad} - (z - \sigma), 0]$. We can use B_c to determine the agent's optimal consumption function when there is a (1) credit ceiling. This consumption function is given by

$$c^*_{bad}(B) = \begin{cases} (z - \sigma) + B & \text{for} \quad B < B_c \\ \tilde{c}^1_{bad} & \text{for} \quad B \geqslant B_c \end{cases} \tag{2}$$

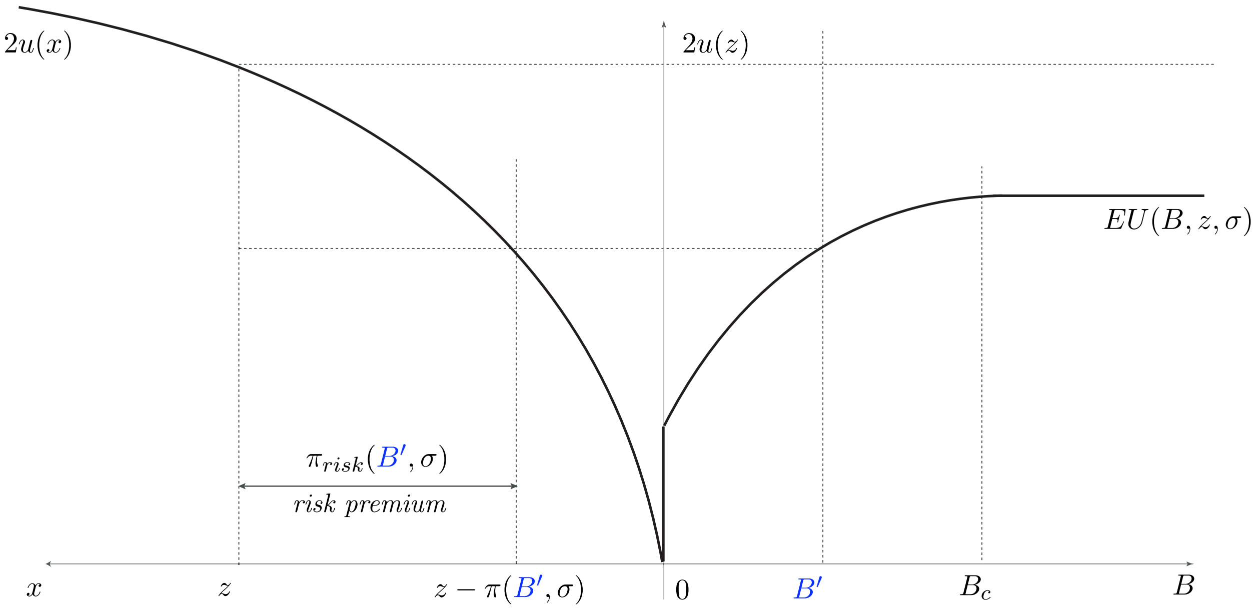

FIGURE 1. Credit Ceiling and Risk Premium

		Consumption	
		Period 1	Period 2
States in Period 1	bad	$c^*_{bad}(B)$	Total income - $c^*_{bad}(B)$
	good	$\tilde{c}^1_{good}$	Total income - $\tilde{c}^1_{good}$

TABLE 3. Agent's consumption in all states *with* a binding credit ceiling B

What we finally have is that the agent's expected utility depends on $\tilde{c}^1_{bad}$ and $\tilde{c}^1_{good}$ if the credit ceiling does not bind. In this case the expected utility is independent of B and is given by

$$EU(z, \sigma) = u(\tilde{c}^1_{bad}) + E\Big(u(c^2_{bad}(\tilde{c}^1_{bad}))\Big) + u(\tilde{c}^1_{good}) + E\Big(u(c^2_{good}(\tilde{c}^1_{good}))\Big)$$

If the credit ceiling B binds, it would depend on $c^*_{bad}(B)$ and $\tilde{c}^1_{good}$.

$$EU(B,z,\sigma) = u(c^*_{bad}(B)) + E\Big(u\big(c^2_{bad}(c^*_{bad}(B))\big)\Big) + u(\tilde{c}^1_{good}) + E\Big(u\big(c^2_{good}(\tilde{c}^1_{good})\big)\Big)$$

c^*_{bad} is agent's optimal consumption in period 1 if a bad state is realised in the period 1. If bad state is realised in period one, the agent would like to borrow. Consequently, the agent's period 1 consumption and expected utility is increasing in credit ceiling B till B_c is reached. After that, the expected utility becomes flat in B.

$\tilde{c}^1_{good}$ is agent's optimal consumption in period 1 if a good state is realised in the period 1. With the realisation of the good state, the borrower would like to save for the next period and thus the credit ceiling does not have an impact on expected utility. Of course, the expected utility is a function of Z and σ as the Z and σ has an impact on consumption in both period in all states of nature.

Using $EU(B,z,\sigma)$, we can find the agent's certainty equivalent income. The certainty equivalent is the risk-less income that would give the borrower the same utility as the expected utility from the risky income process described above. Let the certainty equivalent income be x per period and it can be obtained by the expression below.

$$2U(x) = EU(B,z,\sigma).$$

The left hand side of the expression is the lifetime utility out of a risk less income stream x per period. The left hand side is the expected utility out of a risk income stream which is $z-\sigma$ and $z+\sigma$ with equal probability in each period.

The agent's risk premium π_{risk} is implicitly defined by the expression above. The risk premium is the cut in her income the agent is willing to take in order to completely eliminate the risk from her income process. The risk premium π_{risk} is given by the expression $x = z - \pi_{risk}$ and

$$2U\big(z - \pi_{risk}\big) = EU(B,z,\sigma).$$

The risk premium obtained from the expression above would be a function of B and σ. This risk premium is increasing in the credit ceiling B till B reaches B_c. This implies that smaller the credit ceiling, the larger the cut the agent is willing to take to eliminate the risk from the income process. Beyond B_c, the risk premium is independent of B.

Lets take this further and visualise a situation where a agent has a choice of occupation between a low z with a low σ and a high z with a high σ. Since the risk premium is increasing in B (for $B \leqslant B_c$), it is certainly possible that people with low credit ceiling would be forced to take the occupation with low z and low σ and people with sufficiently high credit ceiling would be able to take on the high z and high σ job.

Thus, we have demonstrated how agents in a economy with segmented credit markets could be caught in the vicious cycle of poverty for ever. An external intervention that loosens the credit constraints have the potential of transforming this economy and freeing the poor from the vicious clutches of the poverty trap.

In dealing risk, we can distinguish between risk management and risk coping strategies. The risk management strategies attempt to reduce the riskiness of the income process ex ante. This could entail the process of undertaking a low risk low expected income activity. Conversely, risk coping stragties include self insurance (saving) and risk pooling. The risk coping strategies deal with effect of income risk ex post in order to smooth consumption. As we have seen above, factors like endowment, technology and the formal and informal institutions affect which strategies are used to deal with risk. For a more in depth discussion on this topic see Dercon (2004).

3.1.4. *Stray Reference in Lecture.* Karlan and Zinman (2008) shows that randomly give credit constrained individuals access to credit improves their welfare. This shows that credit constraint may be one of the causes of poverty. Dercon and Shapiro (2005) revisited the ICRISAT data set after three decades and found that there can a clear threshold below which individuals get entrapped by poverty. Individuals who had income below a threshold in 1980s still had similar incomes where as the individuals with income above a the threshold had seen marked improvement in their economic situations.

CHAPTER 2

Adverse Selection

Abstract. We explore adverse selection models in the microfinance literature. The traditional market failure of under and over investment in individual lending loan contracts are explained. In group lending, a joint liability contract induces positive assortative matching within the group. Further, joint liability contracts can achieve the first best by solving the problems of under and over investment.

1. Introduction

In this lecture, we look at the problem of private information. The potential borrowers are socially connected and live in a informationally permissive environment, where they know themselves and each other very well. The lender is not part of this information network and thus does not have access to the borrowers' information network.

The lender can use contract to extract this information. The lecture explores one specific type of contract which would bind people together in groups allow the lender to extract the information from the social network and in the process be an improvement over the traditional individual lending contracts.

2. Model

The potential borrowers differ in their respective inherent characteristics or ability to execute projects. We interpret these characteristics as the ones that determine the borrower's chances of successfully completing the project. We assume that borrowers are fully aware of their own characteristics as well as the characteristics other borrowers around them. The lender's problem is that the borrowers posses some private or hidden information, which is relevant to the the project. The lender would like to extract this information. The only way he can do that is through the loan contracts he offers the borrowers. We set out the main ideas in the context of the wider adverse selection literature and then examine how the lender can improve his ability to extract information by offering inter-linked contracts to multiple borrowers simultaneously.

The lender could offer the contract to group in stead of individuals. This would allow him to inter-link a borrowers payoff by making it contingent on her own as wells as her peer's payoff. The part of the payoff that is contingent on her peer's outcome is the joint liability component of the payoff. We show that this joint liability component is critical in dissuading the wrong kind of borrower and encouraging the right kind of borrower.

2.1. The Principal-Agent Framework. We use the principal agent framework to analyse the problem of lending to the poor. Usually, a principal is the uninformed party and the agent the informed party, the party possessing the private or hidden information. This information needs to have a bearing on the task the principal wants to delegate to the agent. The information gap between the principal and the agent has some fundamental implication for the bilateral or multi-lateral contract they may choose to sign. Further, even though the agent(s) may renege on their contract, the assumption always is that the principal never does so.

In the context of the credit markets, the term principal is used interchangeably with lender and the term agent is used interchangeably with borrower. Unless stated otherwise, we assume throughout the lectures that the lender and the borrower(s) are both risk-neutral.

2.2. Project. A project requires an investment of 1 unit of capital and at the start of period 1 and produces stochastic output x at end of period 1. All borrowers have zero wealth and can thus only initiate the project if the lender agrees to lend to her.

Explanation: This is a way of introducing the limited liability clause, which ensures that the borrower's liability from a loan contract is limited to the output of the project. The lender does not acquire wealth from the borrower ex post if the project fails. To make the distinction clear, collateral is the wealth acquired by the lender before the lending starts. Some lenders, especially the informal ones, may have the ability to force the borrower to give up wealth after the borrower has defaulted on the loan. As we discussed in the last lecture, the limited liability clause maybe realistic when describing the borrower's interaction with an formal lender, who is from outside the social network, but may not be realistic when describing the borrower's interaction with the local informal lenders.

As is typical in a adverse selection model, the value, as well as the stochastic property of the output depends on the type of borrower undertaking the project. To keep matters simple, we assume that the project produces a output with strictly positive value when it succeeds and zero when it fails.

A project undertaken by a borrower of type i produces an output valued at x_i when it succeeds and 0 when it fails. Further, the probability of the project succeeding is contingent on the borrower types. The project succeeds and fails with probability p_i and $1 - p_i$.

The Agents. We have a world with two types of agents or borrowers, the *safe* and the *risky* type. The projects that risky and safe types' undertake succeed with probability p_r and p_s respectively with $p_r < p_s$. That is, the risky type succeeds less often then the safe type. The proportion of risky type and safe type is θ and $1-\theta$ respectively in the population. The expected payoff of an agent of type i is given by

$$U_i(r) = p_i(x - r).$$

Given that interest is paid only when the agents succeed, the safe agent's utility is more interest sensitive as compared to the risky agent's utility since she succeeds more often.[1] Both types are impoverished with no wealth and have a reservation wage of $\bar{u}$.

The Principal. The principal's or the lender's opportunity cost of capital is ρ, i.e., he either is able to borrow funds at interest rate ρ to lend on to his clients or has an opportunity to invest his own funds in a risk-less asset which yields a return of ρ.

We assume that the lender is operating in a competitive loan market and can thus can make no more than zero profit. This implies that the lender lends to the borrowers at a *risk adjusted interest rate*. The lender's zero profit condition $\rho = p_i r$ ensures that on a loan that has a repayment rate of p_i, the interest rate charged is always

$$r_i = \frac{\rho}{p_i} \tag{3}$$

[1] As we see in the section on group lending, this leads to the safe types utility having a steeper slope than the risky types in the figures ahead.

It is important to note that competition amongst the lenders ensures that a particular lender can only choose whether or not to enter the market. He is not able to explicitly choose the interest rate he lends at. He always has to lend at the risk adjusted interest rate, at which he makes zero profits. Given that p_r, p_s, θ and ρ are exogenous variables, we can take the respective risk adjusted interest rate to be exogenously given as well.

In the lecture on moral hazard we discuss the conditions under which making the assumption of zero profit condition would be justified. We find that this assumption is not critical at all. What matters is the surplus that a project creates. The assumptions on loan market just determine the way in which this surplus is shared between the lender and the borrower.

2.3. Concepts.

2.3.1. *Repayment Rate.* The repayment rate on a particular loan is the proportion of borrowers that repay back.[2] If the lender is able to *ensure* that he lends only to the risky type, his repayment rate is p_r. Similarly, it is p_s if he only lends to the safe type. If he lends to both type, his average repayment rate is $\bar{p} = \theta p_r + (1-\theta)p_s$.

2.3.2. *Pooling and Separating Equilibrium.* If the lender is not able to instinctively distinguish the agent's types, then the only way in which he can discriminate between the two types is by inducing them to self select and reveal their hidden information.

In a pooling equilibrium, both types of agents accept the same loan contract. Consequently, both types of agents are pooled together under the same loan contract. Conversely, in a separating equilibrium, a particular loan contract is accepted by only one type. The lender is able to induce the agents to reveal their private information by self selecting into different types of loan contracts.

2.3.3. *Socially Viable Projects.* Socially viable projects are the ones where the output exceeds the opportunity cost of labour and capital involved in the project.

$$p_i x \geqslant \rho + u \qquad i = r, s; \tag{4}$$

That is the expected output of the project exceeds the reservation wage of the agent and the opportunity cost of capital invested in the projects. In an ideal (read first best) world, all the socially viable projects would be undertaken and that lays the perfect information bench mark for us. What is of interest to us is how the problems associated with imperfect information restrict the range of projects that remain feasible.

3. Individual Lending

In this section we look at individual lending and explore the implication of hidden information on the optimal debt contracts offered by the lender to the borrower.

3.1. First-Best. In the first best world, the lender can identify the type he is lending to and can tailor the contract accordingly. Consequently, he would lend to the safe type at the interest rate $r_s = \frac{\rho}{p_s}$ and to the risky type at the interest rate $r_r = \frac{\rho}{p_r}$. Given that $p_r < p_s$, i.e., the risky type succeeds and repays back less often, the risky type gets the loan at a higher interest rate as compared to the safe type. (Figure 1)

[2]Put another way, given the past experience, it is also the lender's bayesian undated probability that the borrowers of future loans would repay.

3.2. Second-Best. In absence of the ability to discriminate between the risky type and the safe type agents, the lender has no option but to offer a single contract. This contract may either attract both types or just attract one of the two types.

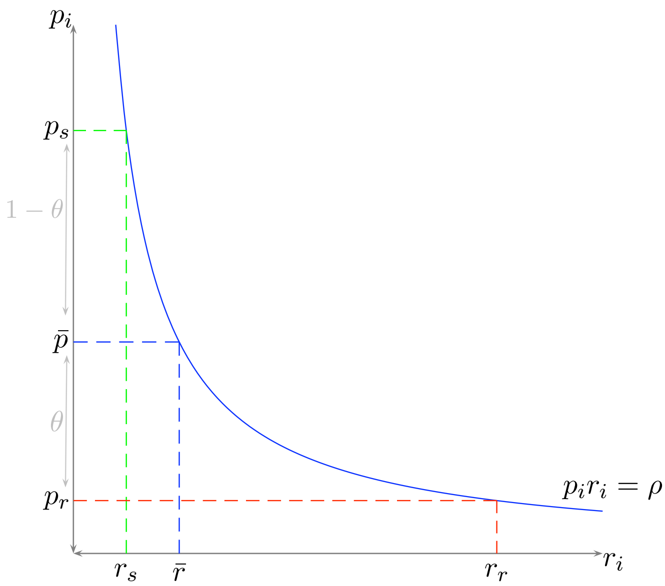

FIGURE 1. Perfect Information Benchmark

3.2.1. *Contract Space.* The lender can either offer a contract that is targeted towards a specific type or could offer a contract that induces both type in the borrowing pool. For risky and safe type, the interest rate is the risk adjusted interest rate $r_r = \frac{\rho}{p_r}$ and $r_s = \frac{\rho}{p_s}$ respectively. If the borrowing pool has both types, the lender's average or pooling repayment rate across his cohort of risky and safe borrowers is given by

$$\bar{p} = \theta p_r + (1-\theta)p_s \tag{5}$$

In this case, the interest rate would be $\bar{r} = \frac{\rho}{\bar{p}}$. The lender's contract space is $[r_s, r_r]$ given that $r_s \leqslant \bar{r} \leqslant r_r$.

3.2.2. *The Constraints.* The lender has to makes sure that any contract that he offers satisfies the following conditions.

(1) *Participation Constraint:* This condition is satisfied if the lender provides the borrower sufficient incentive to accept the loan contract.

$$U_i(r_r, \ldots) \geqslant \bar{u}$$

(2) *Incentive Compatibility Constraint:* In a separating equilibrium, the incentive compatibility condition is satisfied if each borrower type has the incentive to take the contract meant for her and does not have any incentive to pretend to be the other type. These conditions are as follows.

$$U_r(r_r, \ldots) > U_r(r_s, \ldots)$$
$$U_s(r_s, \ldots) > U_s(r_r, \ldots)$$

The ... are just additional variables that the lender could specify in the contract, which would help in getting these constraints satisfied.

Explanation: Lets explore thus further and say that the lender's contract has two components, the interest rate r and some other component ϑ. The lender can now offer two contracts. He can offer a contract (r_r, ϑ_r) meant for the risky type and a contract (r_s, ϑ_s) for the safe type. We would get a separtating equilibrium if the following conditions hold.

$$U_r(r_r, \vartheta_r) > U_r(r_s, \vartheta_s)$$
$$U_s(r_s, \vartheta_s) > U_s(r_r, \vartheta_r)$$

The first equation just says that the risky type strictly prefers taking the contract meant for her, that is she prefers taking that contract (r_r, ϑ_r) over a alternative contract (r_s, ϑ_s). Similarly, the second equation is satisfied when the safe type strictly prefers taking the contract (r_s, ϑ_s) over one the alternative one (r_r, ϑ_s).

Of course this would only work if ϑ_i entered the borrower's utility function. If it did not, the lender would be left with a contract that effectively only specifies the interest rate r and thus the lender would be offering only one interest rate to both types.[3] At this interest rate, either both types would accept the contract leading to a pooling equilibrium or only one type would accept the contract leading to a separating equilibrium.

(3) *Break even condition:* Break-even condition is the lower bound on the profitability, that is, the lender's profit should not be less than zero. Turns out the competition in the loan market puts an upper bound on profits and ensures that profits cannot be more than zero. This is called the *zero profit condition.* Thus, in this case the lender's break even condition and zero profit condition give us a condition that binds with equality.

Turns out, the precise course of action the lender would take depends on the stochastic properties of project. Specifically, it depends on the first and second moments.

3.3. The Under-investment Problem. Stiglitz and Weiss (1981) analyse the problem under the assumption that both types' project have the same expected output and the risky type produces an output of a higher value than the safe type since he succeeds less often.

$$p_r x_r = p_s x_s = \hat{x} \tag{6}$$
$$p_r < p_s \;\Rightarrow\; x_r > x_s$$

It also follows from the assumption that the lender can lend to the safe type in only the pooling equilibrium. Any interest rate that satisfies the safe type's participation constraint also satisfies the risky types participation constraint. This is because the safe type's payoff is always lower than the risky type's payoff at any given positive interest rate.

$$U_s(r) < U_r(r) \qquad \forall\, r > 0;$$

Consequently, the safe type can only borrow in a pooling equilibrium. With the assumption in (6), she will never ever *participate* in the separating equilibrium. This implies that there are some of safe type's projects that are not financed, even though they are socially viable, due to the problems associated with hidden information.[4] The safe type would only participate in the

[3] If the lender offered two interest rates, all rational borrowers would choose the lower one.

[4] This is the range of safe type's projects that would have been financed in the first best but do not get financed in the second best.

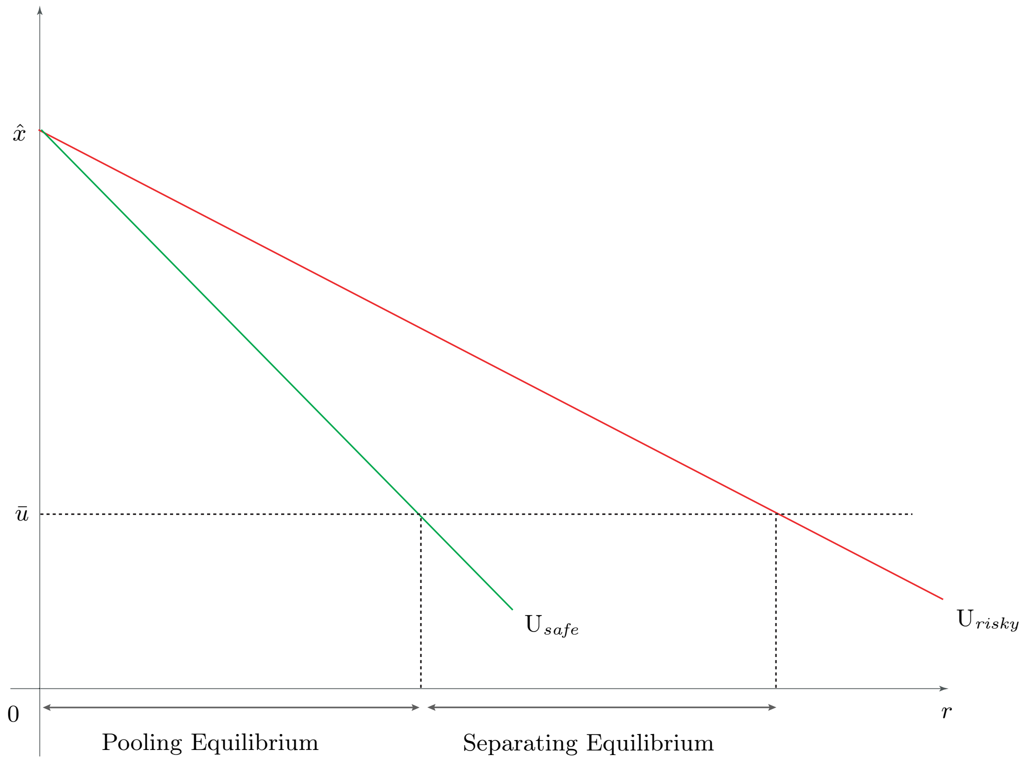

FIGURE 2. Under-investment in Stiglitz and Weiss (1981)

pooling equilibrium if her participation constraint is satisfied at the pooling interest rate $\bar{r}$.

$$U_s(\bar{r}) = p_s x_s - p_s \bar{r} \geqslant u$$

We substituting for the value of $\bar{r}$ using (3) and (5) in the condition above. Using $\hat{x} = p_s x_s$, we can write this condition as

$$\hat{x} \geqslant \frac{p_s}{\bar{p}}\rho + u. \tag{7}$$

Consequently, (7) gives us a lower bound on the expected output of the projects that get financed. Since $p_s > \bar{p}$,[5] we find that there are projects that would not be financed even though they are socially viable.[6]

$$\hat{x} \in \left[\rho + u,\ \left(\frac{p_s}{\bar{p}}\right)\rho + u\right]$$

If (7) is not satisfied, the lender would lend only lend to the risky type in a separating equilibrium. Please check that all risky type's socially viable projects get financed either in the pooling or the separating equilibrium.

Consequently, the *under-investment problem* in Stiglitz and Weiss (1981) is that there are some safe type's project that do not get financed even though they are socially viable. In terms of their productivity, these projects on the lower end of the socially viable projects. They are below the threshold level defined by (7) but above the threshold given by (4). Conversely, all risky type's socially viable projects get financed.

[5]The pooling repayment rate is a weighted sum of risky and safe type's respective repayment rates and thus would always be lower than the higher of the two repayment rates, the safe type's repayment rate.

[6]Note that the projects that are not financed are on the lower end of the productivity scale. If the projects are productive enough, all socially viable projects get financed.

3.4. The Over-investment Problem. De Mezza and Webb (1987) analyse the case when the two types produce identical outputs when they succeed. Consequently, the safe type's project has a higher productivity than the risky type's project.

$$p_r\bar{x}_{<}p_s\bar{x} \tag{8}$$

It follows that for an interest rate in the relevant range, the safe type's payoff is always higher than the risky type's payoff.

$$U_s(r) > U_r(r) \quad \forall\, r \in [0, \bar{x}];$$

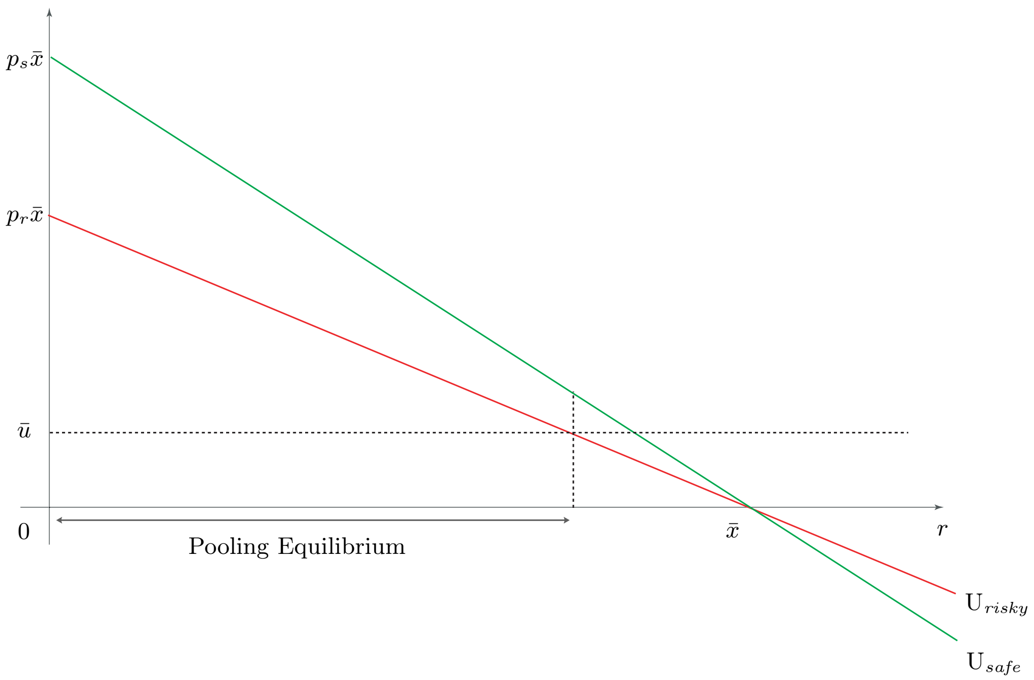

FIGURE 3. The Over-investment Problem in De Mezza and Webb (1987)

The risky type would stay in the market till her participation constraint below is satisfied.

$$U_r(\bar{r}) = p_r(\bar{x} - \bar{r}) \geqslant u$$

Substituting for the value of $\bar{r}$ using (3) and (5), this condition becomes

$$p_r\bar{x} \geqslant \frac{p_r}{\bar{p}}\rho + u. \tag{9}$$

Given that $p_r < \bar{p}$, the threshold given by (9) is below the social viability threshold given by (4). This implies that the risky type are able to undertake projects that are not socially viable. Risky type's projects with expected output in the range

$$p_r\bar{x} \in \left[\left(\frac{p_r}{\bar{p}}\right)\rho + u,\ \rho + u\right]$$

are financed even though they are not socially viable. The risky types in this case are abe to borrow because they are being cross-subsidised by the safe type.

The over-investment problem in De Mezza and Webb (1987) is that there are risky type's projects that are financed even though they are not socially viable and have a negative impact on the social surplus. This happen because the lender is not able to discriminate between a borrower of a safe and risky type due to the hidden information they posses. The over-investment projects are the ones that do not satisfy the socially viability condition defined by (4) and are yet above the threshold defined by (9) which allows them to satisfy the risky type's participation constraint. The under and over-investment problem is summarised in Figure 4.

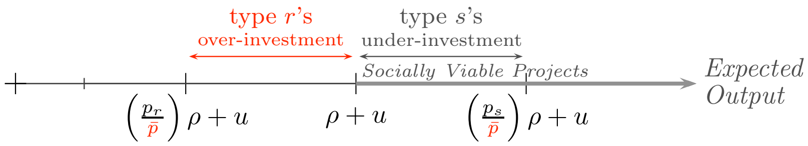

FIGURE 4. Under and Over investment Ranges

4. Group Lending with Joint Liability

This section is a simplified version of Ghatak (1999) and Ghatak (2000). The lender lends to borrowers in groups of two. The contract that the lender offers the group is such that the final payoffs are contingent on each other's outcome. Consequently, the members within the group are jointly liable for each other's outcome. If a borrower succeeds, she pays the specified interest rate r. Further, if her peer fails, she is required to pay an pay an additional joint liability component c. The lender offers a joint liability contract (r, c) where he specifies

- r: The interest rate on the loan due if the borrower succeeds.
- c: The additional joint liability payment which is incurred if the borrower succeeds but her peer fails.
  Of course, if a borrower's project fails, the limited liability constraint applies and the borrower does not have a pay anything

A borrower's payoff in the group lending is given by.

$$\begin{aligned} U_{ij}(r, c) &= p_i p_j (x_i - r) + p_i(1 - p_j)(x_i - r - c) \\ &= p_i(x_i - r) - p_i(1 - p_j)c \end{aligned}$$

With probability p_i, the borrower succeeds. If she succeeds, she repays r and keeps $(x_i - r)$ for herself. With proability $p_i(1 - p_i)$, she succeeds but her peer fails. In this case she has to make the joint liability payment c. Given the group contract (r, c) on offer, lender requires that the borrowers self-select into groups of two before they approach him for a loan.

DEFINITION 1 (Positive Assortative Matching). *Borrowers match with their own type and thus the groups are homogenous in their composition.*

DEFINITION 2 (Negative Assortative Matching). *Borrowers match with other type and thus the groups is heterogenous in its composition.*

With positive assortative matching, the groups would either have both safe types or both risky types. With negative assortative matching each group would have one safe type and one risky type.

Proposition 1 (Positive Assortative Matching). *Joint Liability contracts of the type given above lead to positive assortative matching.*

To see this, lets examine the process of matching more closely. It is evident that due to the joint liability payment c, everyone want the safest partner they can get. The safer the partner, the lower the probability of incurring the joint liability payment c due to her failure. We need to examine the benefits accruing to the risky type by taking on a safe peer and the loss incurred by the safe type by taking on a risky peer.

$$U_{rs}(r,c) - U_{rr}(r,c) = p_r(p_s - p_r)c \tag{10}$$

$$U_{ss}(r,c) - U_{sr}(r,c) = p_s(p_s - p_r)c \tag{11}$$

$$p_s(p_s - p_r)c > p_r(p_s - p_r)c \tag{12}$$

(10) gives us the gain accruing to the risky type from pairing up with a safe type in stead of a risky type. (11) gives us the loss incurred by a safe type from pairing up with a risky type in stead of another safe type. (12) compares the two equation above and finds that (10) is smaller than (11). It follows that

$$U_{ss}(r,c) - U_{sr}(r,c) > U_{rs}(r,c) - U_{rr}(r,c). \tag{13}$$

Turns out, the safe type's loss exceeds the risky type's gain. The risky type would not be able to bribe the safe type to pair up with her. Joint liability contract leads to positive assortative matching whereby a safe type pairs up with another safe type and the risky type pairs up with another risky type.

Proposition 2 (Socially Optimal Matching). *Positive assortative matching maximises the aggregate expected payoffs of borrowers over all possible matches*

$$U_{ss}(r,c) + U_{rr}(r,c) > U_{rs}(r,c) + U_{sr}(r,c) \tag{14}$$

(14) is obtained by rearranging (13). This implies that positive assortative matching maximises the aggregate expected payoff of all borrowers over different matches.

4.0.1. *Advanced References.* The matching process is determined by the *supermodularity* property of the function that determines the matching process. Becker (1973) discusses how the matching takes place in the marriage market. Topkis (1998) has a comprehensive mathematical treatment of supermodularity. Milgrom and Roberts (1990) and Vives (1990) for explore useful applications in game theory and economics.

4.0.2. *Indifference Curves.* The indifference curve of borrower type i is given by

$$U_{ij}(r{,}c) = p_i(x_i - r) - p_i(1 - p_j)c = \bar{k}$$

$$\left[\frac{dc}{dr}\right]_{U_{ii}=\text{constant}} = -\frac{1}{1-p_i}$$

This implies that the safe type's indifference curve is steeper than the risky type's indifference curve.

$$\left|-\frac{1}{1-p_s}\right| > \left|-\frac{1}{1-p_r}\right|$$

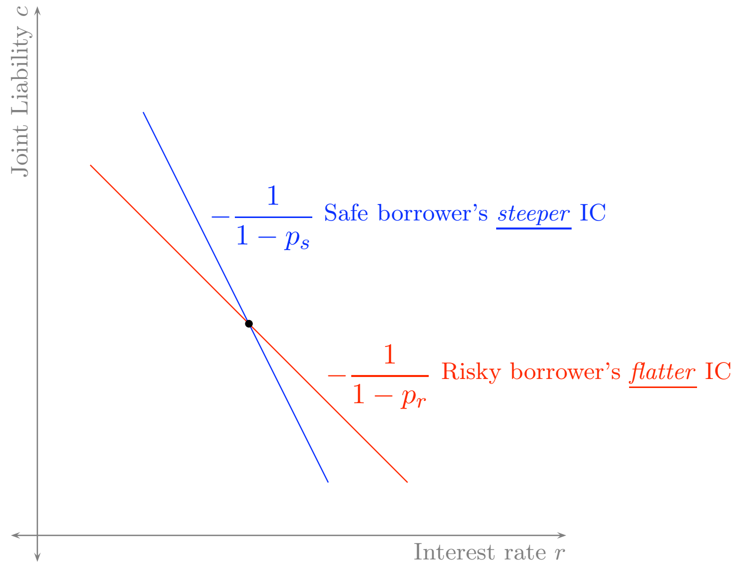

FIGURE 5. Risky and Safe Types' Indifference Curves

This is because the safe type is less concerned about the the joint liability payment c because she is paired up with a safe type. She would like to get a low interest rate r and would happily trade of a higher joint liability payment in exchange. Conversely, the risky type dislikes the joint liability payment comparatively more. The risky type is stuck with a risky type borrower and incurs the joint liability payment more often than the safe type. She would prefer to have a lower joint liability payment down and does not mind the resulting increase in interest rate. The lender can use the fact that the safe groups and the risky groups trade off the joint liability payment and interest rate payment at different rates to distinguish between the two types of group.

4.0.3. *The Lender's Problem.* Now that there are two instruments in the contract, namely r and c, the lender can use the fact the two types trade off r with c at a different rate to induce them to self select into contracts meant for them. The lender offers contracts (r_r, c_r) and (r_s, c_s) and designs the contracts in such a way that the risky type borrowers take up the former and safe type take up the latter contract. The lender offers group contracts (r_r, c_r) and (r_s, c_s) that maximises the borrowers payoff subject to the following constraint:

$$r_r p_r + c_r(1-p_r)p_r \geqslant \rho \quad \Rightarrow \quad \frac{dc}{dr} = -\frac{1}{1-p_r} \tag{L-ZPC$_r$}$$

$$r_s p_s + c_s(1-p_s)p_s \geqslant \rho \quad \Rightarrow \quad \frac{dc}{dr} = -\frac{1}{1-p_s} \tag{L-ZPC$_s$}$$

$$U_{ii}(r_i, c_i) \geqslant \bar{u}, \qquad i = r, s \tag{PC$_i$}$$

$$x_i \geqslant r_i + c_i \quad i = r, s \tag{LLC$_i$}$$

$$U_{rr}(r_r, c_r) \geqslant U_{rr}(r_s, c_s) \tag{ICC$_{rr}$}$$

$$U_{ss}(r_s, c_s) \geqslant U_{ss}(r_r, c_r) \tag{ICC$_{ss}$}$$

L-ZPC$_i$ is the lender's zero profit condition for borrower type i, PC$_i$ the Participation Constraint for type i, LLC$_i$ the limited liability constraint for type i and ICC$_{ii}$ the incentive compatibility constraint for group (i, i).

To discuss the optimal contract that allows the lender to separate the types, we need to define the $(\hat{r}, \hat{c})$. This is at the point where (L-ZPC$_s$) and (L-ZPC$_r$) cross.

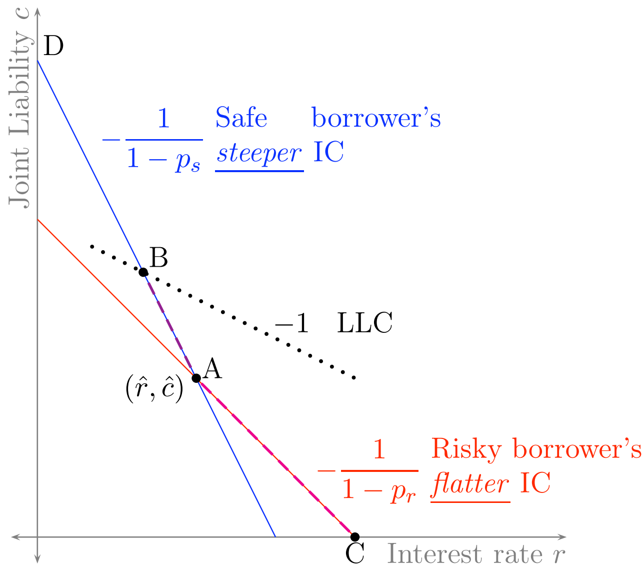

FIGURE 6. Separating Joint Liability Contract

4.0.4. *Separating Equilibrium in Group Lending.*

PROPOSITION 3 (Separating Equilibrium). *For any joint liability contract* (r, c)

i. *if* $r_s < \hat{r}$, $c_s > \hat{c}$, *then* $U_{ss}(r_s, c_s) > U_{rr}(r_s, c_s)$
ii. *if* $r_r > \hat{r}$, $c_r < \hat{c}$, *then* $U_{rr}(r_r, c_r) > U_{ss}(r_r, c_r)$

The *safe groups* prefer joint liability payment *higher* than $\hat{c}$ and interest rates *lower* than $\hat{r}$. Conversely, the *risky groups* prefer joint liability payments lower than $\hat{c}$ and interest rate higher than $\hat{r}$. With joint liability payment, the lender is able to charge each type a different interest rate. The lender can tailor his contract for the borrower depending on her type. This allows the lender to get back to the first best world where each type was charged a different interest rate.

4.1. Optimal Contracts. There are potentially two types of optimal contract. The separating contracts were the safe group's contract is northeast of $(\hat{c}, \hat{r})$ and the risky group's contract which is southeast of the this point. The second kind of contract is the pooling contract at $(\hat{c}, \hat{r})$.

4.2. Solving the Under-investment Problem. Under-investment takes place in the individual lending when

$$\rho + u < \hat{x} < \frac{p_r}{\bar{p}}\rho + u.$$

The safe type are not lent to even though their projects are socially productive. With joint liability separating contracts (above), the safe type are lent to if the following condition is met:

$$\hat{x} > \left(\frac{p_s + p_r}{p_r}\right)\rho$$

This condition just ensures that the LLC is to the right of $(\hat{c}, \hat{r})$. That is $\bar{R} \geqslant \hat{c} + \hat{r}$. With the pooling contracts explained above, the safe type are lent to if the following condition is met:

$$\hat{x} > \left(\frac{p_s}{\bar{p}}\right)\rho + \beta u$$
$$\text{where } \beta \equiv \theta p_r^2 + (1-\theta)p_s^2.$$

This condition ensures that the limited liability constraint is satisfied for the joint liability contract.

4.3. Solving the Over-investment Problem. Over-investment takes place in the individual lending when

$$\rho + u > p_r \bar{x} > \left(\frac{p_r}{\bar{p}}\right)\rho + u.$$

The risky type are lent to even though their projects are socially unproductive. In group lending, the risky types participation constraint when she is paired up with another risky type would be given by:

$$p_r \bar{x} - [p_r r + p_r(1-p_r)c] \geqslant u \tag{PC$_r$}$$

The lender's zero profit constraint for the risky groups is given by

$$p_r r + p_r(1-p_r)c = \rho$$

This implies that the risky type's participation constraint would be satisfied if

$$p_r \bar{x} \geqslant \rho + u$$

This eliminates the over-investment problem. The risky borrowers with the socially unproductive projects will drop out on their own. The condition below ensures that $(\hat{c}, \hat{r})$ satisfies the limited liability constraint.

$$\bar{x} > \left(\frac{1}{p_s} + \frac{1}{p_r}\right)\rho$$

Summary

We have been able to show that the joint liability contract lead to positive assortative matching within groups. Once this matching process takes place, the lender is able to distinguish between the groups of two types using the contract variables r and c. We have also been able to show that this solves the under-investment and over-investment problems prevalent in the individual loan contracts and achieve the first best.

Exercise

(1) Each wealth-less agent has a project which requires an initial investment of £200. The project produces output valued at £500 if it succeeds and £0 when it fails.

There are two types of agents. For type a agent, the project succeeds with probability 0.2 and fails with probability 0.8. For type b agent, the project succeeds with probability 0.8 and fails with probability 0.2.

The lender lends to groups of two with a group lending contract as follows: Each agent in the group repays £300 when both her own and her peer's project succeed,

£400 when her own project succeeds but her peer's project fails and £0 when her own project fails.

(a) Show that the type b agent prefers to group with another type b agent as compared to type a agent.

(b) Explain why type a agent is not able to group with type b agent even though she would like to.

(2) When lending to agents who have no collateral, explain how group-lending with joint-liability is able to solve the problem of under-investment (Stiglitz and Weiss, 1981) and over-investment (De Mezza and Webb, 1987).

CHAPTER 3

Moral Hazard

ABSTRACT. Ex ante moral hazard emanates from broadly two types of borrower's actions, project choice and effort choice. In loan contracts, groups with interlinked contracts make better project choices and effort choices than individuals. Further, the choice for the lender remains between encouraging the borrowers to behave cooperatively or strategically through the terms of the contract. The borrowers could be induced to interact strategically by asking them to queue for loans. The lending efficiency gains made from strategic interaction between the borrowers increases as the information environment becomes more permissive.

1. Introduction

In this lecture we examine the two approaches to the moral hazard problem taken in the literature. Any lack of information that the lender has about borrower's action between the time the loan has been disbursed and the borrower's project outcome has been realised is classified as ex ante moral hazard.[1]

The literature has explored two types of borrower's actions in the moral hazard context. The first type of models are the *project choice* models. Stiglitz (1990) is an excellent example of this type. The borrower chooses between a risky project that requires a lumpsum initial investment and safe project which is perfectly divisible. The second kind of models are the *effort choice* models. In these models the borrower chooses the diligence with which she would pursue the project, that is, whether she would exert high or low effort on the project. The risk of project failure decreases in the borrower's effort level.

There are two distinct ways in which the lender could the influence the borrower's behaviour and in the process alleviate the moral hazard problem. The first way is to influence the borrower's behaviour directly through payoffs. The second way is for the lender to monitor the borrower either directly or delegate the task of doing so to someone who can influence the borrower. Often, this entails lending to borrowers in a group and inducing an borrower to influence her peer (and vice-versa) through the joint liability clause.[2]

Depending on the cost of monitoring, the lender can use either direct payoff or monitoring or a combination of the two to influence the borrower's behaviour. Whether the lender chooses to monitor himself or delegates the task depends on how costly acquiring information is between the borrowers relative to cost of doing so for the lender himself. The standing assumption in the microfinance literature remains that the information is far more permissive amongst the borrowers than it is between the lender and the borrowers.

The problem is complicated due to the borrower's lack of wealth. If the borrower's had wealth, the lender would be able to influence the borrower's behaviour by requiring them to acquire a sufficient stake in their own project or put up a collateral. The borrower's would thus lose their

[1] Ex post moral hazard refers to the lack of information lender has about the outcome of the borrower's project once it has been realised.

[2] With the joint liability clause, a borrower's payoff are contingent on her peer's outcome.

stake in the project or their collateral if the project fails, which in turn, gives them incentive to choose the right project and exert effort on the project. The key concept here is that the collateral or acquiring stake in the project is a means of punishing the borrower for her failure, which in turn reduces that economic rents left to the borrower to induce diligence. Group lending, through its interlinked contracts, finds a way of punishing the borrowers, not for their own failure, but for the failure of their peers. This punishment reduces the rents that the lender has to leave the borrowers to induce diligence in them.

The borrower's ability to influence each other ultimately determines how effective this joint liability punishment mechanism would be. If the borrower can influence each other perfectly, then effectively, the lender is lending to one composite individual who undertakes two distinct projects. As the information partition between the borrowers becomes increasingly more opaque, joint liability as a punishment mechanism becomes less and less effective in reducing economic rents left to the borrowers.

Stiglitz (1990) assumes that the borrowers are perfectly informed about each other and their ability to influence each other knows no bound. Consequently, the lender can induce the borrowers to share information and influence each other costlessly in group lending. Aniket (2006b) varies the information permissiveness between the borrowers and pins down the cost of inducing the borrowers to influence each other in group lending. Further, it suggests a new innovative mechanism that the lender can use to reduce the cost making the borrowers influence each other's actions.

2. Project Choice Model

In this section we explore the moral hazard problem associated with choosing the right kind of project. Stiglitz (1990) made seminal early contribution to the literature with a project choice model. We will explore this idea through a simple model that I set up in this section.

The models shows that if the borrower choice is between a risky project that requires lumpsum investment and a safe project that is perfect divisible, the lender can control the borrower's project choice through the size of the loan. Further, the borrowers are able to loans that larger in groups as compared to the ones they obtain individually.

The borrowers are wealthless and aspire to borrow funds from the lender to invest into the projects. The projects produce positive output when it succeeds and 0 output when it fails. The borrower has the option of undertaking either a risky project or a safe project. The respective projects succeed with the probability p_r and p_s with $p_r < p_s$.

Even though the risky project requires a fixed initial sunk-cost investment of α, it compensates by giving a higher marginal return to scale β_r than the safe project β_s. Conversely, the safe project has no initial fixed cost investment and has a lower marginal return to scale.

2.1. Individual Lending.

The lender cannot observe the project undertaken and thus has to influence the project choice through the contract he offers the borrower. The lender specifies the terms of the contract, that is the loan size L and rate of interest r due on the loan. The lender's own opportunity cost of capital is ρ and the loan market is competitive, which ensures that the lender makes zero profits. Lender's zero profit condition is given below.

$$r = \frac{\rho}{p_i}, \qquad \forall\ i = s, f. \tag{L-ZPC}$$

The lender charges the borrower's the risk adjusted interest rates on the loan.

The types of projects are summarised in table 2.1. We assume that that the risky project has a higher expected marginal return to scale than safe project.

Assumption 1. $p_r\beta_r - p_s\beta_s = k$

That is the expected marginal return on scale is higher by amount k for the risky project as compared to the safe project. The borrower compares the higher expected marginal return

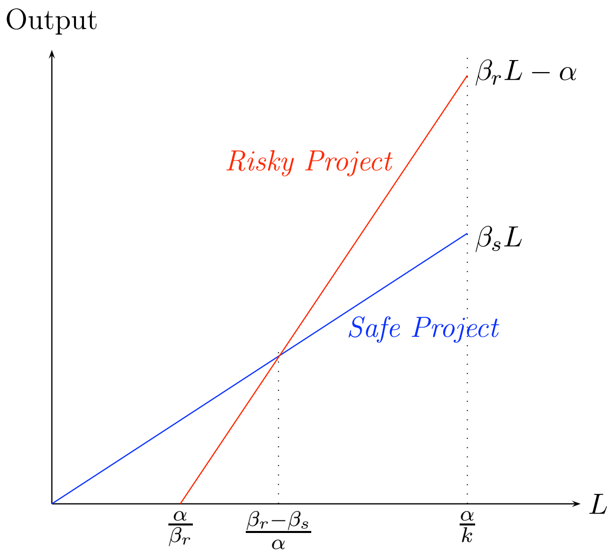

Figure 1. Safe and Risky Projects

(net of the interest rate payments) with the sunk cost when she decide between the risky and the safe project. Let V_i be the borrower's payoff from project type i.

$$
\begin{aligned}
V_r &> V_s \\
p_r(\beta_r L - rL) - \alpha &> p_s(\beta_s L - rL) \\
L &> \frac{\alpha}{\Delta pr + k}
\end{aligned} \tag{15}
$$

At a given interest rate, if the borrower gets a loan beyond the scale threshold defined by (1), the borrower prefers undertaking a risky project over a safe one. This scale threshold is reached when the higher expected marginal return[3] of the risky project overwhelms the initial fixed cost investment associated with it.[4] With a higher interest rate, the difference between the two

[3] net of interest rate

[4] By choosing the risky project, the borrower's gains are an increase in expected marginal return of kL and lower expected interest rate payment ΔprL. She also loses the sunk cost investment of α. The threshold scale is the one which balances the two and makes the borrower indifferent between the two types of projects.

Project	Successful		Failure		Investment		Interest
	Prob.	Output	Prob.	Output	Sunk-Cost	Scale	Payment
Risky	p_r	$\beta_r L$	$1 - p_r$	0	α	L	rL
Safe	p_s	$\beta_s L$	$1 - p_s$	0	0	L	rL

projects types' expected marginal return to scale decreases and leading to decreases in the value of the threshold.

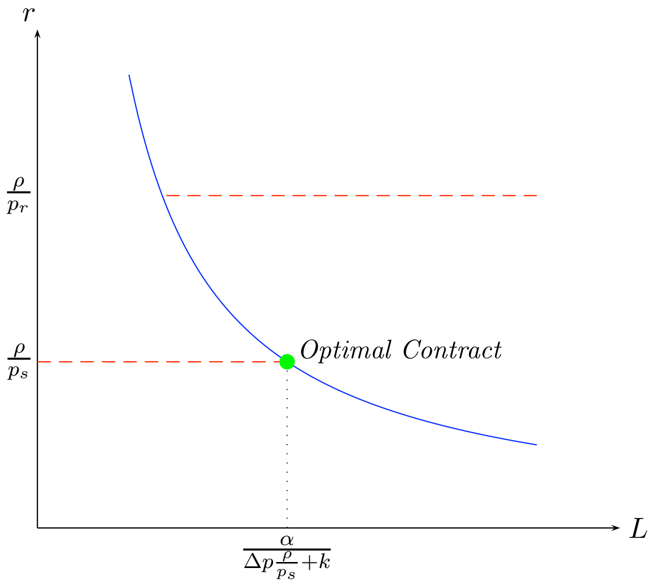

FIGURE 2. Switch Line and Optimal Contract under Individual Lending

In the $L-r$ space, we can draw the locus of r and L, where the borrower is indifferent between undertaking a risky or a safe project. This downward sloping line is the threshold level of scale beyond which the borrower prefers undertaking a risky project. The line has a negative slope to reflect the fact that higher interest rate lower the threshold scale.[5]

$$L = \frac{\alpha}{\Delta pr + k} \tag{16}$$

The lender's zero profit condition (L-ZPC) implies that the lender would offer contracts in which he is sets the interest rate at the respective risk adjusted interest rates. The borrower that undertakes a risky and safe project gets loans at $r_r = \frac{\rho}{p_r}$ and $r_s = \frac{\rho}{p_s}$ respectively. Using lender's zero profit condition (L-ZPC) for safe projects and (16), we can find the range of contracts which are able to induce the borrower to choose a safe project over a risky one.

For the safe projects, the lender should be charging $\frac{\rho}{p_s}$, the risk-adjusted interest rate using (L-ZPC). At interest rate $\frac{\rho}{p_s}$, the maximum loan size is given by L^*given by[6]

$$L^* = \frac{\alpha}{\Delta p \frac{\rho}{p_s} + k}.$$

If he lender lends more than that, the borrower would automatically switch to a risky project.

2.1.1. *Group Lending.* In group lending the lender lends to groups of two. The additional repayment requirement in group lending is the joint liability payment c. This is incurred if the borrower succeeds but her peer fails. Thus, for a group undertaking identical projects of the type i the probability with which a particular lender incurs the joint liability payment is given

[5]The switch line can also be written as $r = \frac{1}{\Delta p}\left(\frac{\alpha}{L} - k\right)$, which could be interpreted as the highest interest rate the lender can charge on a loan of size L before the borrower switches to the risky projects.

[6]We find this using the (L-ZPC) and (16)

by $p_i(1-p_i)$.[7] Borrower's payoffs under group lending with joint liability payment is given by.

$$V_{ss} = p_s(\beta_s L - rL) - p_s(1-p_s)cL$$
$$V_{rr} = p_r(\beta_r L - rL) - \alpha - p_r(1-p_r)cL$$

where V_{ss} and V_{rr} are the borrower's payoffs respectively when the groups symmetrically undertake either risky or safe projects.

Even though this looks like a matching process similar to Ghatak (2000), it is actually not a matching process. Matching can only describe the situation when individual borrowers have inherent characteristics. In this context, the individuals are homogenous with both borrowers having access to the technology that would allow them to undertake the risky and the safe project. Hence, the borrowers take the decision cooperatively, once they have seen the terms of the loan contract. Of course, the question is whether cooperative decision making is feasible. Turns out, there is no information partition between the borrowers and there information or enforcement cost between the borrowers. The borrowers can fully observe each other's project while it is going on and fully enforce and side contract or any arrangement they make amongst themselves. The group can thus act like a composite individual which takes on two stochastic projects of type i and pays r_i if both of these stochastic projects succeeds and pays $r_i + c$ when only one of the project succeeds. As we would see ahead, due to the lender's zero profit condition, the expected repayment to the lender remains the same in the group lending, though the variance of the repayment goes up in group lending. As an exercise, show that the variance of the repayment increases in c.

Even though at first glance it may seem that the borrower's payoffs are lowered due to the joint liability payment, it turns out the group lending allows the borrowers to get larger loans which in turn increases their payoffs.

The new switch like gives us the locus of the contracts where the group is indifferent between undertaking the risky or the safe projects. The group would undertake a risky project if the following condition is met.

$$V_{rr} > V_{ss}$$
$$p_r(\beta_r L - rL) - \alpha - p_r(1-p_r)cL > p_s(\beta_s L - rL) - p_s(1-p_s)cL$$

This gives us the threshold loan size beyond which the borrower would undertake a risky projet.

$$L > \frac{\alpha}{\Delta pr + k - \Delta p(p_s + p_r - 1)c} \tag{17}$$

consequently, at a given interest rate r and joint liability payment c, the borrower prefers undertaking a risky project beyond the threshold loan size defined by (17).

We now need to incorporate the joint liability payment c in the lender's zero profit condition. For a group undertaking project of the type i, the lender receives c with the probability $p_i(1-p_i)$, when a member of the group succeeds and her peer fails. As the lender shifts the repayment burden to the peer by increasing c, the interest rate fall concomitantly. We have to be careful here because the repayment has two components, the interest rate and the joint liability payment. Falling interest rate is does not mean that the total expected repayment by the borrower falls

[7] We assume that the borrowers in a group make their decision cooperatively and after full communication. They also have perfect information about each other. This allows us to restrict our analysis to the symmetric choices where either both the borrowers undertake risky projects or both undertake safe projects. If the borrowers had imperfect information about each other, they interact strategically with each other and the analysis can no longer be restricted to symmetric decisions.

as well. The lender has to meet his zero profit condition and this condition would ensure that the expected total repayment of the borrowers are always equal to ρ. Even though the expected repayment in individual and group lending remain identical, the variance of the repayment in the group lending increases due to the joint liability component of the repayment.

If the lender is lending to group that undertakes a safe projects, his zero profit condition would be as follows.

$$p_s r + p_s(1 - p_s)c = \rho$$
$$r = \left(\frac{\rho}{p_s}\right) - \left(\frac{1 - p_s}{p_s}\right) c \tag{L-ZPC(G)}$$

Thus, due to joint liability payment c, the interest rate component of the repayment by the groups is lowered by amount $\left(\frac{1-p_s}{p_s}\right) c$ when compared to the interest rate individual in lending. This would help use in finding the optimal contract on the switch line. Using the interest rate and the threshold level defined by (17), we can find the maximum loan size the lender would be willing to give to the borrowers in group lending. Given the opportunity cost of capital ρ, the maximum loan size is given by the following expression.

$$L_G^* = \frac{\alpha}{\Delta p \left(\frac{\rho}{p_s}\right) + k - \varphi c} \tag{18}$$

where $\varphi = \Delta p \left(\frac{1-p_s}{p_s} + (p_s + p_r - 1)\right)$.[8] It should be clear from (18) that for $c > 0$, the borrower obtains a larger loan in group lending than in individual lending. Further, as c increases, the loan size increases. Undertaking some burden of repayment in case of the peer's failure through joint liability component thus allows the borrowers to get larger loans in group lending. This of course comes at the cost variance of repayment going up.

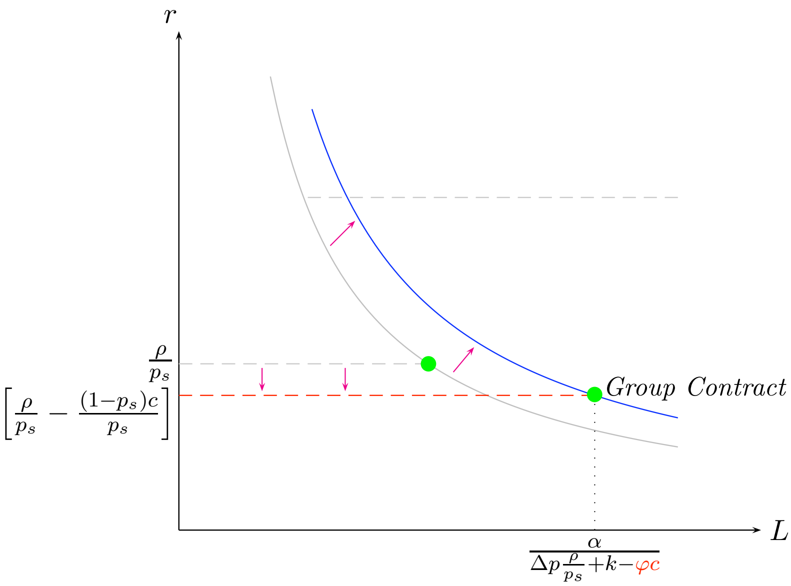

FIGURE 3. Switch Line and Optimal Contract under Group Lending

[8] $\varphi > 0$ if $p_s + p_r > 1$.

3. Effort Choice Model

This section is based simple versions of the models in Aniket (2006b) and Conning (2000). A project requires an investment of 1 unit of capital and produces output x with probability π^i and and 0 with probability $1-\pi^i$, where i is the effort level exerted by the borrower.[9] If the borrower is diligent and exerts *h*igh effort level ($i = h$) the project succeeds with probability π^h. Conversely, if the borrower exerts *l*ow effort ($i = l$) the project succeeds with probability π^l and the borrower enjoys private benefits B.[10] These private benefits are are only visible to her and not to other borrowers or lenders.[11] We assume that the borrower's reservation utility is 0.

3.1. Perfect Information Benchmark. In the perfect information world the lender can observe the borrower's effort level and ensure that she exerts an high effort level. He can thus offer her a contract contingent on her effort level. The constraints the optimal contract needs to satisfy are the borrower's participation and limited liability constraint and the lender's break even condition. We will discuss each constraint below.

We assume that the borrower are wealth-less and thus the limited liability constraint applies. The limited liability constraint just says that the borrower cannot pay more than the output of the project. This just implies that borrower's interest rate should be greater than x and she should be allowed to default in case the project fails.

The borrower's participation constraint is satisfied if the borrower has sufficient incentive to accept the contract. If the project succeeds, the borrower's pays an interest rate of r on the loan. If it fails, the borrower declares default and pays nothing. Given borrower's effort level $i \in \{h, l\}$, her expected payoff is given by $\pi^i(x-r)$. The borrower's participation constraint that the lender would like to satishy would be given by

$$\pi^h(x-r) \geqslant 0. \tag{PC-I}$$

The participation constraint would be satisfied if $x \geqslant r$. Turns out that the limited liability constraint and the participation constraint are identical in this case. In the perfect information world, the lender is able to ensure that the borrower exerts high effort. The lender's break even constraint requires that his profits are non-negative are would be as follows.

$$\pi^h r \geqslant \rho \tag{L-ZPC-I}$$

Lender's break even constraint is satisfied if $r \geqslant \frac{\rho}{\pi^h}$, or the interest rate is greater than risk adjusted interest rate. We are moving away from the lender's zero profit condition, which ensured that the lender made zero profit and not more. The lender's break even condition puts a lower bound on his profit but does not put an upper bound. Consequently, we are allowing the lender to make positive profits and explore its implication.

The participation constraint puts an upper bound on the interest rate and the break even constraint puts a lower bound on the interest rate. An in an optimal contract that satisfies

[9] Note that we have choosen to use p to represent probability associated with the inherent characteristics of either the project or a borrower and π with effort which the borrower may choose explicitly.

[10] An alternative way of looking at this would have been to assume that exerting high effort is more costly for the borrower as compared to the low effort.

[11] We assume in latter sections that a borrowers' private benefits may be curtailed if her peer monitors her. Monitoring may not be costless and the peer may have to bear the cost of monitoring. The assumption would be that the lender is not able to curtail these private benefits.

the borrower's participation and limited liability and lender's break even constraint, the interest rate has to be in the range given below.

$$\frac{\rho}{\pi^h} \leqslant r \leqslant x \tag{19}$$

The first thing to notice about (19) is that an optimal contract and thus a feasible interest rate would exist only if the $x \leqslant \frac{\rho}{\pi_h}$. That is, if the project is not more productive than the opportunity cost of capital, it would not be finanaced even in the first best world. Put another way, the project should be socially viable.

Now lets assume that the project is strictly socially viable, i.e., $x > \frac{\rho}{\pi^h}$. Then r can take any value in the range $(\frac{\rho}{\pi^h}, x)$. If $r = \frac{\rho}{\pi^h}$, then the borrower's expected payoff is $\pi^h(x - \frac{\rho}{\pi^h})$ and the lender makes zero profit.[12] Conversely, if $r = x$, then the borrower's expected payoff is 0 and the lender makes expected profits of $\pi^h x - \rho$.[13]

What this shows us is that financing a socially viable project creates a positive social surplus of $\pi^h x - \rho$. This social surplus can either be allocated entirely to the borrower or entirely to the lender or shared between the two.

3.1.1. *Lender's Break Even versus Zero Profit Condition.* Who gets what proportion of the profit depends entirely on the relative bargaining position of the borrower and the lender. If the lender has all the bargaining position, he would keep the entire surplus. This is the case if the lender was a monopolist.[14] Conversely, if there is a competitive loan market, the lender would be undercut by his competitors till he makes zero profit. In this case the lender has no relative bargaining strength and all the bargaining power lies in the hand of the borrower. We have been referring to this case as the *zero profit condition*.

Now lets deviate for a moment and think of how a higher borrower's reservation utility[15] would change the analysis. If the borrower reservation utility u increases, the surplus created is decreased. Who gets the surplus still gets determined by the relative bargaining strength.

Solving any optimal contract problem entails finding the *contract space* or the region which satisfies all the constraints and then using the objective function to find the optimal contract(s). With perfect information, the contract space is $r \in (\frac{\rho}{\pi^h},\ x)$ and the objective function tells us whether we are maximising or minimising r. We maximise r if the lender is a monopolist and minimise it if the loan market is competitive.

3.2. Second Best World: Individual Lending. Lets analyse how the imperfect information changes the contract space. In the imperfect information world, the lender does not observe the borrower's effort level and has to induce the borrower to exert his proffered effort level (high in this case) through the contract he offers her. The incentive compatibility constraint below ensures that the borrower has sufficient incentive to exert high effort.

$$\pi^h(x - r) \geqslant \pi^l(x - r) + B \tag{ICC-I}$$
$$r \leqslant x - \frac{B}{\Delta\pi}$$

[12] The lender's break even condition *binds* and the borrower's participation constraint is *slack*.

[13] which is positive because we assumed that $\frac{\rho}{\pi^h} < x$ as the beginning of this analysis.

[14] In this case, we maximise the lender's profit subject to his *break even condition*.

[15] We have assumed that his 0 till now.

The participation constraint puts a upper bound on r. If the interest rate is too high, it interferes with the borrower's incentive to exert high effort. The *contract space* in the second best world is the range of r which satisfies the borrower's participation and incentive compatibility constraint and the lender's break even condition. The borrower's participation constraint and the lender's break even constraint is identical to the ones given by (PC-I) and (L-ZPC-I). The lender's break-even constraint puts an lower bound on the interest rate and the borrower's participation constraint puts an upper bound on the interest rate.[16] All three constraints above can be satisfied if the following conditions are met.

$$\frac{\rho}{\pi^h} \leqslant r \leqslant \left(x - \frac{B}{\Delta\pi}\right) \tag{20}$$

Comparing the (20) to the (19), we find that the range is curtailed in the second best world due to the incentive compatibility constraint. If the interest rate is set in the range $\left(\frac{\rho}{\pi^h},\ x - \frac{B}{\Delta\pi}\right)$, then the borrower would definitely exert high effort.

In the first best world, allocating the borrower 0 expected payoff satisfied her participation constraint. In the second best world, 0 expected payoff does not satisfy the incentive compatibility constraint and thus the lender has to offer her expected payoff of at least $\pi^h\left(\frac{B}{\Delta\pi}\right)$ to ensure that she exerts high effort.[17]

In the first best world, the surplus created by financing the project is $\pi^h x - \rho$. In the first best world, this was shared amongst the borrower and the lender according to the relative bargaining strength. Imperfect information reduces the surplus by $\pi^h \frac{B}{\Delta\pi}$, the rent allocated to the borrower in order to incentivise her to exert high effort. In the second best world, the surplus created by financing the project is $\pi^h\left(x - \frac{B}{\Delta\pi}\right) - \rho$,[18] which is shared between the borrower and the lender according to the relative bargaining strength.

Lending Efficiency: This is connected to the concept of lending efficiency. The first best world surplus of a project is reduced by the rent allocated to agents by the principal to incentivise them to take a particular action. For every institutional mechanism, we can find the associated surplus. The lower the rents allocated to the borrowers, the higher the surplus created by the project. Thus, the lower the rents required to implement a project (in this case, to get it financed) the more efficient the project is considered. Lending efficiency is thus the metric by which all the institutional mechanism are evaluated.

Borrower's Private Benefits: It should be obvious that anything that decreases the borrower's private benefit B should be able to increases the surplus from the project and thus increase the lending efficiency. There are a category of models that look at how efficiently monitoring can reduce the private benefits and increase the lending efficiency.

[16] It should be clear that the incentive capability constraint puts puts a smaller upper bound on the r than the participation constraint and thus we can ignore it. If the borrower's incentive compatibility constraint binds, then her participation constraint would automatically be satisfied.

[17] If (ICC-I) holds with equality, it gives us $x - r = \frac{B}{\Delta\pi}$ which implies that the borrower's expected payoff should be $\pi^h \frac{B}{\Delta\pi}$ at the least.

[18] This distance of the green arrow in Figure 3.2 multiplied by the probability of success.

3.3. Delegated Monitoring. The lender has no ability to reduce the borrower's private benefits but he could hire someone who lives in the same area or is socially connected to the borrower to do exactly that. Let assume that this person is able to reduce the private benefits of the borrower by monitoring her. Specifically, the borrower's private benefit B is a function how intensively she is being monitored. To the monitor, the cost of monitoring is m. As m increases, the monitor monitors more intensely and B, the private benefits fall. Assumption below characterise the monitoring function.

ASSUMPTION 2 (Monitoring Function $B(m)$). *$B(m) > 0$; $B'(m) < 0$.*

Of course, the lender has to incentivize the monitor by making her payoffs contingent on the outcome of the project.[19] Incentivizing the monitor would require satisfying her limited liability, participation and incentive compatibility constraint. We assume that like the borrower, the monitor's reservation utility is 0. The limited liability constraint ensures that the monitor's wage w is not less than 0 irrespective of the project outcome.[20]

$$\pi^h w \geqslant 0 \tag{PC-M}$$

$$\pi^h w - m \geqslant \pi^l w \tag{ICC-M}$$

The participation constraint is satisfied for any non-negative w. The incentive compatibility condition is satisfied if $w \geqslant \frac{m}{\Delta\pi}$. So, the cost of getting m amount of monitoring for the lender is offering the monitor a wage of at least $\frac{m}{\Delta\pi}$ if the project succeeds. In expected terms, this cost is at least $\pi^h \frac{m}{\Delta\pi}$. The benefit of hiring a monitor is that it reduces the borrower's rent. The borrower's incentive compatibility condition is now given by

$$\pi^h(x - r) \geqslant \pi^l(x - r) + B(m). \tag{ICC-I'}$$

This can be written as $x - r \geqslant \frac{B(m)}{\Delta\pi}$. The borrower's expected payoff has to be at least $\pi^h \frac{B(m)}{\Delta\pi}$ which is less than payoff the borrower got when there was no monitoring. With monitoring the expected surplus of the project is $\pi^h \left(x - \frac{B(m)}{\Delta\pi} - \frac{m}{\Delta\pi} \right) - \rho$.

The optimal amount of monitoring is the m that maximises the surplus. That is $B'(m) = -1$. Thus, there would be postive amounts of monitoring if $B'(0) < -1$. Further, if this condition holds, it should be clear that the lending efficiency increases in m till the reduction in private benefits at the margin is exactly matched by cost of monitoring ($B'(m) = -1$).

3.4. Simultaneous Group Lending. This section examines the lending efficiency of group lending under costly monitoring as described by Assumption 2. In simultaneous group lending, borrower form into groups of two before they approach the lender for a loan. The lender offers the group a contract contingent on the state of the world, i.e., the outcome of the project. Without loss of generality, we can confine ourselves to the contract where each borrowers are obliged to pay interest rate r on their loans if both the projects succeed and 0 if both project fails. If only one of the two projects succeeds, joint liability kicks in and the lender confiscates the *full* output x of the project.[21] To summarise, the borrowers get a positive payoff only if both projects succeed. In all other cases, they get a 0 payoff.

[19] Since that is the only signal the lender gets, he has no option but to make the monitoring payoff contingent on that signal.
[20] This just means that the lender cannot penalise the monitoring for the failure of the project.
[21] implying $r + c = x$

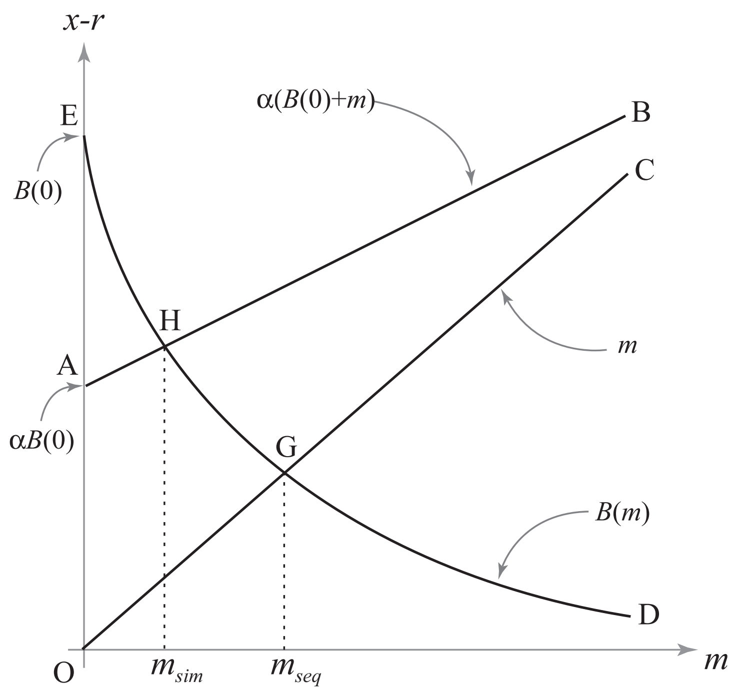

FIGURE 4. Monitoring Intensities in Group Lending

If they accept the contract offered by the lender, the borrowers first decide the intensity with which they would monitor each other and subsequently choose the effort level. Once the project's outcome is realised, the borrower get their payoff depending on the outcome of the project. The contract space is determined by the following two constraints.[22] For the proof, see the appenxix in Aniket (2006b).

(1) The individual borrower's incentive compatibility condition in group lending (ICC-Sim) which ensures that a borrower exerts high effort when her peer exerts high effort ($j = h$) and both choose to monitor with intensity m.

$$(\pi^h)^2(x-r) - m \geqslant \pi^l\pi^l(x-r) + B(m) - m \tag{ICC-Sim}$$

$$r \leqslant x - \left(\frac{B(m)}{\pi^h\Delta\pi}\right)$$

(2) The group's collective compatibility condition (GCC) ensures that the borrowers in the group collectively (and symmetrically) choose to exert high effort and monitor each other.

$$(\pi^h)^2(x-r) - m \geqslant (\pi^l)^2(x-r) \tag{GCC}$$

$$r \leqslant x - \left(\frac{B(0)+m}{(\pi^h+\pi^l)\Delta\pi}\right)$$

(ICC-Sim) and (GCC) can be summarised in the following condition:

$$r \leqslant x - \frac{1}{\pi^h\Delta\pi}\max\Big(B(m), \alpha(B(0)+m)\Big)$$

[22]See Aniket (2006b, Pages 30-33)

where $\alpha = \frac{\pi^h}{\pi^h + \pi^l}$. Again, the question is to find the optimal level of monitoring. The optimal level of monitoring would be the one which creates the greatest surplus, which would be achieved when $\alpha(B(0) + m) = B(m)$. (H in Figure 4) Assumption 2 ensures that there would be positive level of monitoring in group lending.

4. Sequential Group Lending

In sequential group lending, one borrower gets the loan while the second borrower is waiting for her loan. The second borrower only gets the loan if the first borrower succeeds. Again, borrowers only get a positive payoff if both borrowers borrow and the both projects succeed. Aniket (2006b) shows that the both borrowers would choose to monitor with intensity m and exert high effort if the following condition is met:[23]

$$r \leqslant x - \frac{1}{\pi^h \Delta\pi} \max\Big(B(m), m\Big) \tag{ICC-Seq}$$

The surplus would be maximised and the optimal level of monitoring would be achieved when $B(m) = m$. (G in Figure 4) Looking at Figure 4, it should be clear that sequential lending creates a greater surplus than simultaneous lending. This is because in simultaneous lending, the group's collective incentive compatibility conditions (GCC) has to be satisfied. This is akin to the group behaving cooperatively just like it was able to do in Stiglitz (1990). Even though a group behaving cooperatively does better than individual lending, it is not much of an improvement in a multi-tasking environment, i.e., the two-task environment in Aniket (2006b) where the lender has to incentivise monitoring and effort level. In a two-task environment, the sequential lending does much better because the lender has to incentivise the tasks individually (ICC-Seq) and not collectively (GCC).

[23]See Aniket (2006b, Pages 33-36)

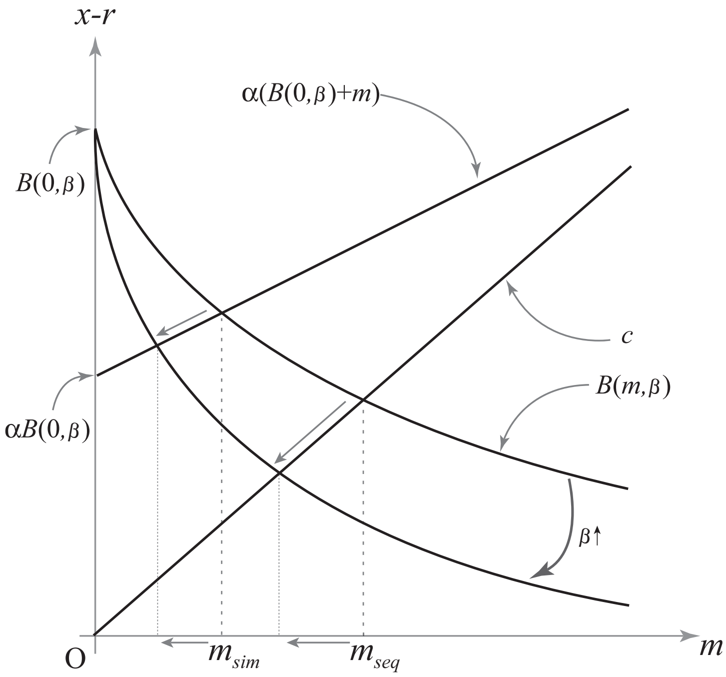

FIGURE 5. Monitoring Intensities as Monitoring Efficiency Increases

Lets now examine what happens if we vary the monitoring function. Lets think of a parameter β that controls the efficiency of the monitoring function. With a higher β increases, a given m is associated with a lower B. Figure 5 shows how the monitoring function moves towards the origin as β increases. What is interesting is that as $\beta \to \infty$, the monitoring becomes more and more efficient and we get closer to the first best world or to *almost* perfect information world. With $\beta \to \infty$, the borrowers are still allocated a positive payoff in the simultaneous lending where as in sequential lending they are allocated 0 payoffs. That is even with *almost* perfect information, sequential group lending can achieve *almost* first best where as simultaneous group lending cannot.[24]

Exercise

(1) Each borrower has a project which requires an investment of 1 unit of capital. With probability π^i the project succeeds and produces output x and with probability $1 - \pi^i$, it fails and produces 0.

When the agent exerts high (and low) effort, the project succeeds with probability π^h (and π^l) respectively where $\pi^l < \pi^h$. Further, the borrower obtains a private benefit B when she exerts low effort. The borrowers have no wealth and no alternative source of income and the lender's opportunity cost of capital is ρ.

(a) Find the least productive project that would be financed under individual lending in the first and the second best world.[25]

[24]With almost perfect information, the contract space for simultaneous group lending is $\frac{\rho}{\pi^h} \leqslant r \leqslant x - \alpha B(0)$ and sequential group lending is $\frac{\rho}{\pi^h} \leqslant r \leqslant x$.

[25]*Hint:* Higher the value of x, the more productive project. So find the value of smallest value of x for individual and group lending.

(b) Find the least productive project that would be financed under simultaneous and sequential group lending.[26]
(c) Define lending efficiency. What can we say about the lending efficiency of the three mechanism above, i.e., individual, simultaneous and sequential group lending.

(2) How does group lending help alleviate the moral hazard problem.
(3) If you were the lender, lending to a group and you could hypothetically choose whether the borrowers in a group interacted cooperatively or non cooperatively, which one would you prefer and why?

[26]Remember that this is a single task environment.

CHAPTER 4

Enforcement and Savings

Abstract. The lender has a limited ability to enforce contracts. Group lending without social sanctions may or may not improve repayment rates over individual lending. Stronger social sanctioning ability amongst the group members tilts the repayment rate in favour of group lending. The poor often do not have sufficient opportunities to save. Microfinance could contribute in poverty alleviation by offering savings opportunities along with borrowing opportunities it has traditionally offered. Offering saving opportunities in group lending leads to negative assortative matching along the wealth lines within the groups.

1. Enforcement

The objective of this course is to analyse the interaction between the *lender(s)* and *wealth-less* or *poor borrower(s)* in the context of financial markets. We have hitherto looked at how credit constraint impact the way the poor put a price on risk. We have also examined how group lending contracts solve the information problems of adverse selection and moral hazard associated with lending to the poor. In this lecture, we explore the problems associated with lender's limited ability to enforce contracts. The limited ability to enforce contracts creates opportunity for strategic or involuntary default by the borrower, which in turn, reduces the lending to the poor. Consequently, any mechanism that improves the ability to enforce contracts can help the poor in the obtain credit from the financial markets.

1.1. The Setup. In a typical credit market scenario, a lender offers the borrower a contract which specifies the following:

(1) The amount he is ready to loan.[1]
(2) The duration of the loan[2]
(3) The repayment obligation or the interest rate charged on the loaned amount.

Once the loan duration is over, the borrower could either meet the repayment obligation or default on the loan. If she chooses to default, it could be due to the following two reasons.

Involuntary Default. The project fails and produces insufficient output to meet the repayment obligations.

Voluntary or Strategic Default. The project produces sufficient output to meet the repayment obligations but the borrower *chooses* not to repay due to strategic considerations.

In the previous lectures we have looked at involuntary default due to adverse selection and ex ante moral hazard. This lectures examines the impact of the strategic defaults.

[1]To keeps matter simple, we assume that the borrower requires just 1 unit to capital to undertake a specific project.
[2]In the limited time available in the course, we have not looked at how the lender can use the time period of the loan to enhance the lending efficiency, though we did look at how he can use the sequence of the loans to enhance the lending efficiency.

Even though credit markets are notorious for problems created due to lack of information, in case of involuntary or strategic default, there is actually no information problem. The borrower declares that she wants to default and the lender comprehends that fully. There is imperfect information associated with the the reason for default. Without auditing the lender cannot verify the state of the project and does not know whether the default has been due to the involuntary or strategic reasons. Consequently, there is a information problem of state verification for a lender who wants to be fair. For a lender who does not care about fairness there is no information problem.

There is of course a distinct problem of enforcing the terms of the loan contract. The lender could either have offered a contract that takes into account the state of the project or could have a offered a contract that obliges the borrower to repay irrespective of the state of the contract. The student loans contract is a good example of contract that explicitly specifies the state or outcome in its terms. The student loans specify that the borrower (student) would is obliged to start repaying the loan only after she or he starts earning beyond a certain threshold. Conversely, if the borrower borrows a certain amount from the bank for an unspecified purpose, the borrower has to repay back irrespective of the outcome. The only recourse in this context for the borrower is to declare bankruptcy.

In what follows, we look at the problem or enforcing the contract. A good paper that deals with the problem of efficiency of auditing or costly state verification is Rai and Sjöström (2004).

1.1.1. *Agents.* The lender and the borrower(s) are both risk-neutral. The borrower has zero wealth and can thus only initiate a project with a sunk cost only if the lender agrees to lend to her.

1.1.2. *Project.* A borrower's project requires an investment of 1 unit of capital at the start of period 1 and produces stochastic output x at the end of period 1.

1.1.3. *Distribution of x.* The output is a random variable here with a with a distribution function $F(x)$ defined over the support $[\underline{x}, \bar{x}]$. For any x, $F(x)$ is the probability that the value of the outcome is between $\underline{x}$ and x. As usual $F(\underline{x}) = 0$, $F'(x) > 0$ and $F(\bar{x}) = 1$. That is the probability of getting output less than $\underline{x}$ is 0, less than $\bar{x}$ is 1 and the $F(\cdot)$ is increase in x in the intervening region.

This reflects the fact that the borrower does not know what how valuable the outcome of the project would be when she invests in it. For instance, if the borrower borrows to grow a particular crop, the value of the crop would increase and decrease with the price of the crop, which cannot be forseen ex ante. It has also often been the case with borrowers borrowing to buy a house in UK. There is no way to estimate what the value of the property would be in the future.

From the perspective of information, a action by a borrower that can enhance the value of the outcome of the project would get captured as a ex ante moral hazard problem. The source of randomness in outcome in this model is exogenous and not related in any way to the borrowers action. This exogenous randomness leads to the value of the outcome x varying continuously between a minimum of $\underline{x}$ and maximum of $\bar{x}$ described the distribution function $F(x)$.

From the enforcement perspective, the idea is that the more valuable the outcome of the project, the more keen the borrower is to hold on the outcome. If the lender can affect this value ex post, then it gives the lender a handle to enforce the contract.

1.1.4. *The Loan Contract.* : The lender offers the borrower(s) a contract whereby each borrower receives 1 unit of capital investment for investing in a specific project. The contract specifies the borrower's total repayment obligation is $r(> 1)$ once the project output is realised.

To make the model extremely stark, we assume that the borrower can always meet the repayment obligations. Doing this allows us to concentrate on the enforcement problems and allows us to abstract from the problem of involuntary default that may arise due to insufficient output of the project.

We assume that repayment is an all or nothing decision, i.e., the borrower either repays r or declares default, in which case she pays nothing. Thus, once the project has been completed and the project output has been realised, the borrowers arrive upon their decision regarding the repayment of the loan by comparing the consequence of repayment with the consequence of default.

1.1.5. *Lender's Enforcement Ability.* In an ideal world, the lender would have an unlimited ability to enforce contacts (read punish the borrower for defaulting) and would obtain repayment with certainty. Of course, we have assumed away involuntary default by assuming that the borrower always has sufficient resources to repay back the loan. With limited enforcement capability, the lender would only be able to obtain repayment in the cases where the punishment meted out by the lender exceeds the borrower's benefit from defaulting. We also assume that the borrowers have an ability to sanction each other.

Aside Within the principal agent models, there is a part of the literature that looks the agents ability to side contract with each other. Side contracts are contracts that the agents can sign amongst themselves to coordinate their actions. Of course, these side contracts also have an enforcement problem. The agents need an ability to enforce the side contracts. Within the microfinance literature, this ability to side contract comes from the borrowers ability to sanction each other. The monitoring section of Aniket (2006b) discusses this in further detail. The ability to side contract can enhance (Besley and Coate (1995), Stiglitz (1990)) as well as diminish (Aniket, 2006b) the efficiency of group lending over individual lending.

We first set out the individual lending case below. Once we have analysed the individual lending case, we then explore ways in which the lender can harness the borrower's ability to social sanction each other by lending to groups of borrowers. The lender's objective remains to maximise the repayment rate by using local social sanctions amongst the borrowers to leverage his own limited ability to punish them.

2. Strategic Default

2.1. Individual Lending. This section presents a simplified version of the Besley and Coate (1995) model. 1 unit of capital investment yields x. x is distributed on $[\underline{x}, \bar{x}]$ according to the distribution function $F[x]$.[3]

Definition 3. Penalty Function $p(x)$ *is the output contingent penalty that the lender can impose on the borrower(s) once the project has been completed and the output x has been realised.*

We assume that $p'(x) > 0$, $p''(x) \leqslant 0$ *and* $p(x) < x \ \forall x$.

[3] $F(\underline{x}) = 0$ and is continuous on $[\underline{x}, \bar{x}]$, .

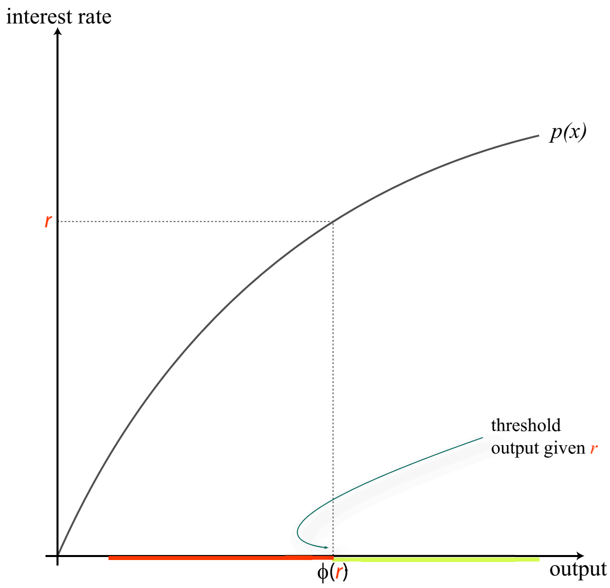

FIGURE 1. Penalty and Threshold Functions

The critical assumption is that the lender's ability to impose the penalty is increasing in x, the value of the outcome of the project. The outcome of the project varies continuously between $\underline{x}$ and $\bar{x}$ described by the distribution function $F(x)$.

The borrower's decision to repay or default depends on the value of the project outcome and described as follows. The borrow repays if the penalty exceeds the interest rate due and default if the penalty is smaller than the interest rate. The decision is summarised in the table below.

$r \leqslant p(x)$	Repay	*borrower prefers to repay as r is lower than penalty*
$r > p(x)$	Default	*borrower prefers to default as penalty is lower than r*

Since the penalty is increase in x, for a exogenously given interest rate r, there is critical x beyond which the penalty exceeds the interest rate r. Thus, as can be observed in Figure 1, for every interest rate r, the borrower would choose to repay beyond a particular x.

Lets define the *threshold function* $\phi(\cdot) \equiv p^{-1}(\cdot)$ as the inverse of the penalty function. Thus, $\phi(r)$ is the *critical* project outcome at which the borrower is indifferent between repayment and default. If output is greater than $\phi(r)$, the penalty is greater than r and repayment is the more attractive of the two option. If the output is less (or equal) than $\phi(r)$, default is the more attractive of the two option.

DEFINITION 4. Threshold Function $\phi(r)$: *Given r, the threshold function gives the threshold output beyond which the borrower would choose to repay. Conversely, if the project output is below this threshold output, the borrower would choose to default strategically.*

It follows that $\phi'(r) > 0$, $\phi''(x) \geqslant 0$ and $\phi(r) > r \; \forall r$.

Given that $\phi(\cdot) \equiv p^{-1}(\cdot)$, for every r, there is a output level that makes the borrower indifferent between repaying and defaulting. If the output is above this amount, the borrower would repay. If the output is below this amount, the borrower would default. Since the output is stochastic, for a large enough draw of the output, the borrower repays back and a small enough draw defaults.

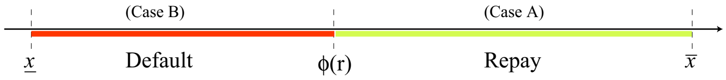

FIGURE 2. Default and Repayment Regions

$\phi(r) \leqslant x$	Repay	*the output is greater than the threshold given r*
$\phi(r) > x$	Default	*output is lower than the threshold output given r*

We can see from Figure 2 that under individual lending, the loan repayment has the following pattern:

Case	**Project output range**	**Loan status**
A	Greater than $\phi(r)$	Repay
B	Otherwise	Default

Given r, the borrower defaults in the range $(\underline{x},\, \phi(r))$ and repays in the range $(\phi(r),\, \bar{x})$. As r increases, the default range increases and the repay range decreases. Π_I, the individual Lending repayment rate is given by

$$\Pi_I(r) = 1 - F[\phi(r)]$$

and it turns out that $\Pi_I'(r) < 0$, implying that as r increases, Π_I decreases. This follows from $\phi'(r) > 0$ and $F'(x) > 0$.

2.2. Group Lending without Social Sanctions. Groups are composed of two ex ante identical, borrowers 1 and 2. (B1 and B2 henceforth)

2.2.1. *Group Lending Contract.* : The group gets 2 units of capital for investment for the borrower's respective projects. A collective repayment obligation of $2r$ is due once the projects are completed. Both borrowers are symmetrically penalised if this repayment obligation is not met.

The group members are jointly-liable for the repayment, i.e., they are collectively responsible for repaying $2r$. The borrowers thus get penalised not just on the basis of their own output realisation but also on the basis of the realised output of their peer.

Timeline:

Borrower 1 and 2's respective project outputs x_1 and x_2 are realised.[4]
Stage 1: Borrowers decide simultaneously whether to repay r or not.
Stage 2: If the decision is unanimous, payoffs are as follows:

Both choose to repay: $x_1 - r, \quad x_2 - r$
Both choose not to repay: $x_1 - p(x_1), \quad x_2 - p(x_2)$

When the decision is not unanimous, the borrower who decided to repay in the first stage can revise her decision by either paying $2r$ or 0.

E.g., if B1 chooses repay and B2 chooses not repay in stage 1, then B1's final payoffs are:

Stick to the decision and repay: $x_1 - 2r, \quad x_2$
Revise decision and default: $x_1 - p(x_1), \quad x_2 - p(x_2)$

[4]The value of the output is common knowledge amongst the peers but unknown to the lender

Under group lending, the loan repayment has the following pattern:[5]

Case	Project output range	Group Loan status
C	At least one greater than $\phi(2r)$	Repaid
D	Both between $\phi(r)$ and $\phi(2r)$	Repaid
E	Otherwise	Not Repaid

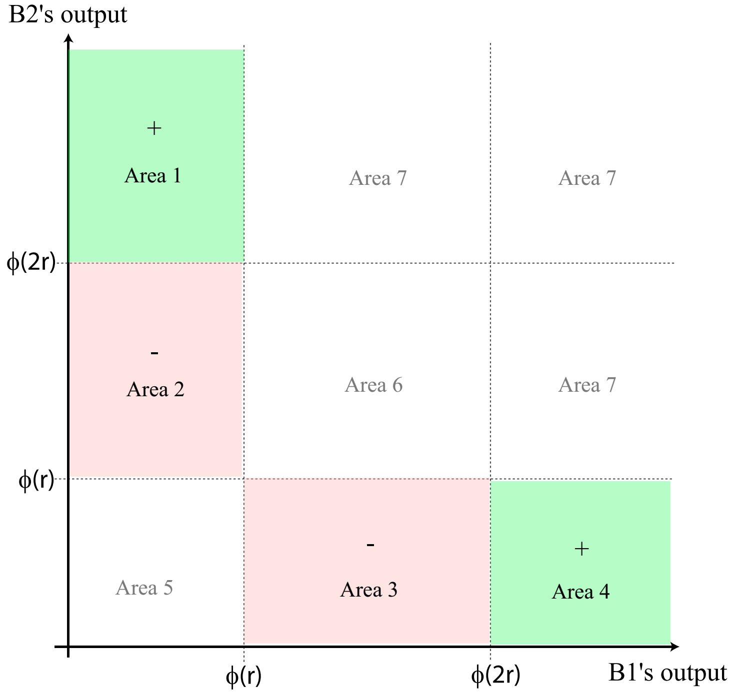

FIGURE 3. Advantages and Disadvantage of Group Lending

The group loan is repaid in Case C and D. In Case C at least one borrower's output is more than $\phi(2r)$. The borrower with output greater than $\phi(r)$ would prefer to repay $2r$ for herself and her peer rather than facing the penalty meted out by the lender. In Case D, both borrower's output is between $\phi(2r)$ and $\phi(r)$. In this case both borrower's prefer to repay back r for their own loan. In this output range, the borrower would not have repaid for her peer. The group lending repayment rate is thus given by

$$\Pi_G(r) = \underbrace{1 - \Big\{F[\phi(2r)]\Big\}^2}_{\text{Case C}} + \underbrace{\Big\{F[\phi(2r)] - F[\phi(r)]\Big\}^2}_{\text{Case D}}$$

where $F(\phi(2r))$ and $F(\phi(r))$ is the probability that the realised output is below the thresholds $\phi(2r)$ and $\phi(r)$.

Figure 3 allows us to compare group lending with individual lending. [6]

[5] Under Case D, non-repayment is a possibility if both borrowers believe that the other will not repay. This coordination failure can easily be assumed away by allowing the borrowers to renegotiate after stage 1.

[6] Area 5: Official penalty is not strong enough to give either borrower incentive to repay. Area 6: Both borrowers prefer repaying r to incurring official penalties. Area 7: The group always repays back since repaying $2r$ is better than incurring official penalties.

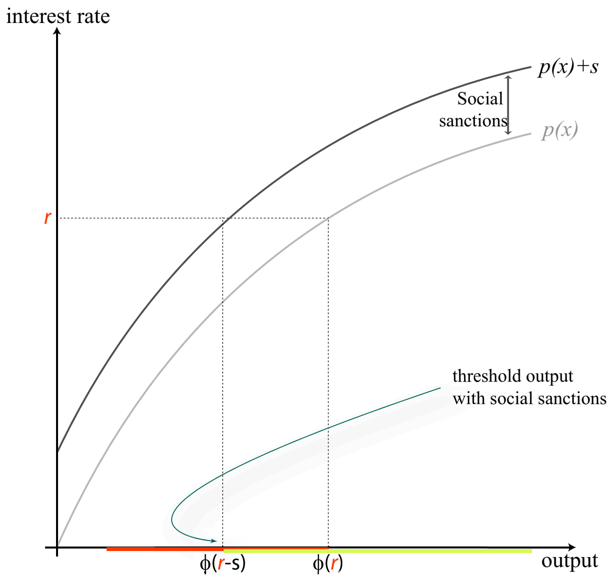

Figure 4. threshold Output with Social Sanctions

+ Under Area 1 and Area 4, B1 and B2 respectively would have defaulted under individual lending. Turns out that the loans are repaid under group lending.
− Under Area 2 and Area 3, B2 and B1 respectively would have repaid under individual lending but does not repay under group lending due to joint liability.

To compare the repayment rate under individual and group lending we would have to compare $\left(\Pi_I(r)\right)^2$ to $\Pi_G(r)$. Consequently, whether repayment rate under group lending is higher or lower as compared to individual lending would be determined by the shape of the distribution function $F(x)$.

2.3. Group Lending with Social Sanction. In the previous sections, the only cost to a borrower from defaulting was the lender's penalty. In this section we look at the use social sanctions within group lending. The group member's ability to social sanction each other can be used to leverage the impact of the lender's limited ability to penalise the borrowers. In group lending without social sanction, the default amongst the group was in Case E. We look at Case E further when the group member's have an ability to socially sanction each other.

Case	Project output range	Group Loan status
E1	$x_m < \phi(r);\ \ \phi(r) \leqslant x_n < \phi(2r)$	Maybe Repaid
E2	Both less than $\phi(r)$	Not Repaid

where x_m and x_n are the actual realised values of the random variables x_1 and x_2, the borrower's respective outputs. In the Case E1, the group members impose a negative externality on each other, i.e., one group member would like to pay off her own loan but defaults because her peer is going to default.

Definition 5. *If a group member imposes a negative externality on her peer, she faces a social sanction s in response.*[7]

[7] To keep matter simple, we assume that s is a constant.

B1 imposes a negative externality B2 when B2 gets penalised from the lender for $B1$'s actions. That is B2 gets pernalised not because of her own output realisation but due to B1's output realisation. Given the threat of sanction s from her peer, a borrower would be ready to repay back under the following conditions.

$$\boxed{\begin{array}{ll} r \leqslant p(x)+s & \text{Repay} \\ r > p(x)+s & \text{Default} \end{array}} \Rightarrow \boxed{\begin{array}{ll} \phi(r-s) \leqslant x & \text{Repay} \\ \phi(r-s) > x & \text{Default} \end{array}}$$

In group lending with social sanctions, the group's repayment decision in Case E is as follows:

Case	**Project output range**	**Group Loan status**
E1a	$\phi(r-s) \leqslant x_m < \phi(r);\ \ \phi(r) \leqslant x_n < \phi(2r)$	Repaid
E1b	$x_m < \phi(r-s);\ \ \phi(r) \leqslant x_n < \phi(2r)$	Not Repaid
E2	Both less than $\phi(r)$	Not Repaid

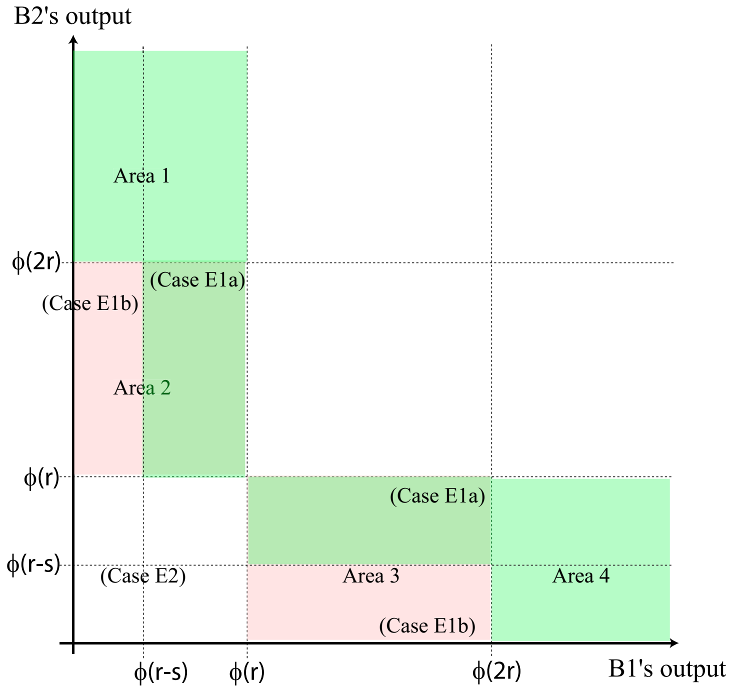

FIGURE 5. Advantages and Disadvantage of Group Lending

The repayment rate under group lending with social sanctions is given by:

$$\begin{aligned} \Pi_{G_S}(r) &= 1 - \{F[\phi(r)]\}^2 - 2\int_{\phi(r)}^{\phi(2r)} F[\phi(r-\bar{s})]dF(x) \\ &= 1 - \underbrace{\{F[\phi(r)]\}^2}_{2^{\text{nd}}\text{ term}} - \underbrace{2F[\phi(r-\bar{s})]\Big\{F[\phi(2r)] - F[\phi(r)]\Big\}}_{3^{\text{rd}}\text{ term}} \end{aligned}$$

The second term represents the likelyhood that both borrowers realise a return which is below $\phi(r)$ and hence neither has an interest in repaying the loan. The third term represents the case where one borrower would like to repay but the other cannot be induced to repay, although she is being socially sanctioned by her peer.

Under harsh social sanctions, i.e., $s \to r$, the repayment rate reduces to

$$\lim_{s \to r} \Pi_{G_S} = 1 - \{F[\phi(r)]\}^2$$

It should be easy to check that Π_{G_S} is greater than Π_G and Π_I. Thus, joint liability raises repayment rate if the social sanctions are sufficiently strong.

2.4. Related Ideas. One of the problems faced by borrowers is that the microfinance lenders may over-punish the borrowers, i.e., punish the borrower even when she is unlucky and defaults involuntarily. Think of what would happen if you borrowed from the mafia. their enforcement mechanism is close to perfect. From a social perspective, this is a deadweight loss. In an interesting paper, which is beyond the scope of this course, Rai and Sjöström (2004) analyse the implication of allowing the borrowers to cross-report on each other. That is the borrowers submit reports about each other project outcomes. They assume that even though lender has unlimited enforcement ability (i.e.,extremely high punishment), the lender is unable to distinguish between involuntary and strategic default. Thus, if the lender is not able to verify the state, the lender would over punish under both involuntary and strategic default. Punishment for involuntary default is a deadweight loss.[8]

Many microfinance programmes allow borrowers to cross report on each other once the output has been realised. Cross-reporting allows the lender to gather information on a problem borrower's output[9] by soliciting reports from her peers and showing leniency when all reports agree with each other. Rai and Sjöström (2004) show that this reduces the deadweight loss.

In a similar vein, Jain and Mansuri (2003) suggest that the microfinance lenders like to use the information and enforcement capability of the local moneylender. They do so by requiring that the borrowers repay in tightly structured installments, which begins very soon after the disbursement of the loans. This induces the borrowers to borrow from the local moneylender in order to repay the microfinance lender. Thus, the lender leverages his own capabilities by employing the local moneylender's capabilities in his favour.

2.5. Conclusion. To summarise, the lender can use the social sanctions amongst the borrowers to enhance his own enforcement capabilities. In individual lending, once the output has been realised, given the penalty that the lender can impose, the borrowers deduce the *output threshold level* below which they choose to default on the repayment of the loan and attract the lender's penalty. This gives rise to strategic defaults, i.e., individual borrowers default even when their output is on one hand sufficiently high to meet the loan repayment obligations but on the other hand below the above mentioned threshold.

In group lending, joint liability enables the lender to use the local intra-group social sanctions to extract repayment when the group's output is greater than its repayment obligations but one of the group members has the incentive to strategically default. Besley and Coate (1995) show that the advantage of group lending is that a group member with really high project returns can pay off the loan of a partner whose project does very badly. This is a kind of insurance for the borrowers.

The disadvantage of group lending is that a moderately successful borrower may default on her own repayment because of the burden of having to repay her partner's loan. However, if social

[8] Recall that by assuming that the borrower always have sufficient resources to repay the lender, we abstracted from the idea of involuntary default in discussion above.

[9] one that defaults

ties are sufficiently strong, the net effect is positive because by defaulting wilfully, a borrower incurs sanctions from both the bank and the group members. With sufficiently close social ties amongst the group members, the repayment under group lending is higher than under individual lending.

The insight of the Besley and Coate (1995) model is that in absence of strong social sanctions, there is a tradeoff between group and individual lending repayment rate. As social sanctions increase, the balance starts titling in favour of group lending.

3. Savings

3.1. Introduction. Do poor people save? The presumption often has been that the poor are asset and income poor. There is vibrant literature in economic development that is trying to study the lives of the poor in great detail. The empirical evidence from these papers is shining the light on the lives of the poor. Banerjee and Duflo (2007) is an excellent survey of the literature in this area.

Along with having very low average income, the poor actually tend to have extremely volatile income stream. They often tend to have multiple sources of income which tend to extremely seasonal in nature. A poor person may have a continuous employment for two for three months that allows them to earn a significant amount. But then, they may have to go through a six month fallow period where they have no income source at all. This vulnerability is an important characteristics of poverty.[10] It follows that a person with stochastic income stream would like to smooth their consumption by moving resources from one period to another by both saving and borrowing.

As we have seen earlier, the poor are often credit constrained. The credit constraint not only make it more difficult to smooth consumption but also play a part in entrapping people in a poverty trap. It is striking that the poor also have extremely limited opportunities to save. In this section, we cast a cursory look at the opportunities the poor have in terms of saving instruments. We also discuss the extent to which microfinance can solve the problem by offering explicit saving opportunities.

It is widely reported that the poor often have no opportunities to save. Even if there are opportunity to save, the poor often get negative interest rates for their savings. That is, they pay a fee to person who keeps their saving deposits safe. Besley (1995) describes the *susu* men in Africa who come around to collect deposits from households. When the households want their deposits back, they have to pay a fee to the *susu* men, effectively rendering the interest rate on savings negative. Besley (1995) reports that the conjecture is that people willing to obtain a negative interest rate on their savings in return for the safekeeping service that the *susu* men provide. If the households retained the savings at home, they would feel compelled to help out their neighbours and other people in their social network who will inevitably suffer a income shock. Thus, handing over their savings to the susu men is a commitment device for which they are read to pay a service fee. Of course there are many indigenous institutions like ROSCAs (Besley et al. (1993b), Besley et al. (1993a)) which offer saving opportunities. The membership of a ROSCA can vary between 15 to 25. The ROSCA meets periodically and every member contributes a certain amount into the saving pot of the ROSCA. Then one member gets to take

[10] Dercon (2004) suggests that of all the income shock that poor household are hit, two third are idiosyncratic in nature and one third are covariate. Covariate shock are shock that are more widespread in nature where as idiosyncratic shocks are one that hit a specific person.

the whole saving pot. Who take the saving pot is either decided randomly or by a process of bidding. After each member has got the saving pot once, the ROSCA gets disbanded. We find that the institutions like these are severely limited in the saving opportunities it provides the poor, both due to their lack of geographical spread and the design of these institutions.

3.2. Saving Opportunities in Group Lending. In this section we explore the full implication of offering saving opportuinities in a group lending microfinance institution. We would try to pin down the optimal design of a group lending microfinance institution that offers individuals saving as well as borrowing opportunities. This section is based on Aniket (2007), which analyses the design of an microfinance institution that offers saving opportunities in a static setting.

Most of the papers in the microfinance literature assume that wealth-less borrowers can borrow from the lender. Even though the rhetoric in microfinance has been that the poor can borrow without any wealth, it is not true in reality. In practice, the microfinance institutions have devised sophisticated mechanism of using wealth to ensure that the borrowers are screened in response to adverse selection or sufficiently incentivised in response to moral hazard. One popular way of doing so is to use the duration of the loan contract to ensure that the borrowers slowly acquire a stake in their project over the period of the loan. (See Aniket (2006a)) For instance, if the returns from a particular project is due over a three year period, the lenders would lend only for a period of 18 months. The repayment installments are thus due before the returns from project is realised. This would require that the borrower is forced to use her accumulated savings to repay back the loan. If the enforcement mechanism is sufficiently strong, only borrowers with sufficient wealth would choose to borrow. Once they have borrowed, they are forced to acquire stake in their projects as the repayment period progresses. This would give them the requisite incentive to ensure that the project succeeds.

The standard assumption in the literature is that microfinance institutions lend to the wealthless without any requirement of posting any collateral. Studies like Aniket (2006a) have challenged this standard assumption.

In a departure from the existing literature, Aniket (2007) analyses the wealth threshold for accessing the service of the microfinance institutions. It derives the wealth threshold for accessing the financial services offered by the microfinance institutions rather than assuming that it is zero. The paper shows that interlinked group contracts that incorporate opportunities to save[11] can reduce the required wealth required to access the financial services offered by the microfinance institution.

In this variation of the group lending mechanism, the agents can take on the mutually exclusive roles of being a borrower or a saver. The role of borrower and saver and the implication of offering saving opportunities in group lending is described below.

(1) *The lender can only offer savings opportunities by restricting credit within the group.* Within a group, individuals cannot be borrowers and savers at the same time. The individuals can either be net borrowers or net savers. Thus, it follows that the microfinance institution would need to restrict credit within the group in order to create net savers. For instance, in a two person group, only one person may be allowed to borrow.
(2) *Restricting credit within the group creates intra-group competition for loans.* Since there are limited number of loans available within the group, the group members compete

[11] see below the exact mechanism required to be able to offer saving opportunities in the group lending

within the group for loans. This ex post competition for loans would influence the ex ante assortative matching during the group formation stage.

(3) *Borrowers choose whether they want to join the group as borrower or savers.* The two person group is now composed of one borrowers and one saver. The borrower acquires a *stake* in her own project. The savers also acquires a *stake* in the borrowers project. These stake are clearly specified by the borrower. The rest of the capital for investment into the project comes from the lender.

If the project succeeds, both borrowers and savers get a positive payoff. If it fails, both borrower and saver get zero. This types of a contract gives the saver an explicit incentive to monitor the borrower and ensure that borrower is diligent in pursuing her project. The lender solves the maximisation problem to obtain the optimal contract that specifies the stake that the borrower and saver should acquire in the project. Depending on the wealth required to acquire stake in the project as a borrower or a saver, the agent form group and approach the lender.

We illustrate results in Aniket (2007) below with a simple numerical example .[12]

3.2.1. *Numerical Example.* Lets say the borrower wants to buy a buffalo which would cost £100. For individual lending, the lender specifies that he is ready to lend £60, which implies that the borrower would have to acquire a stake of £40 in the buffalo to be able to buy it. By requiring the borrower to acquire a stake of £40, the lender is giving her the incentive to be diligent in looking after the buffalo.[13] Thus, with individual lending, everyone who has more than £40 would be able to acquire a buffalo and everyone who has less than £40 would be unable to do so.

The microfinance institution (henceforth the lender) could offer the following group contract. If a group, composed of a borrower and saver approaches the lender, he is ready to lend £70 subject on the condition that the borrower acquires a stake of £25 and the saver a stake of £5 in the buffalo. The borrower's stake goes down from £30 in individual lending to £25 in group lending because of the involvement of the saver. The saver, with a stake of £5 has an explicit incentive to monitor the borrower and ensures that she is diligent in looking after the buffalo, thus reducing the probability of the buffalo dying (read failure of the project).

Consequently, in this economy, anyone with £25 or more has the option of becoming either a borrower or a saver in the group. Any one with more than £5 but less that £25 can only join the group as a saver. With this contract, lets examine the assortative matching that would take place along wealth lines in groups.

We can leave the agents with more than £40 of wealth. They can borrow individually from the lender. Lets call an individual with a wealth between £40 and £25 *not-so-poor* and an individual with wealth between £25 and £5 *poor.* We can ignore the individuals whose wealth is below £5 since they are too poor to be able to access the lender financial services.

[12] For the derivation of the optimal contracts, see the appendix of Aniket (2007)

[13] If the borrower had no stake in the buffalo, he would have not incentive to look after it. In the previously analysed traditional group lending mechanism, in the absence of any wealth, the borrower is given this incentive through joint liability contracts. In these contracts, since the wealth-less borrowers cannot be punished for their own failure, they are punished for the failure of their peers, which in turn gives them an incentive to monitor and ensure diligence by their peers. By reintroducing wealth, we can derive the stake which would give the borrowers a sufficient incentive to be diligent. This stake also serves as a wealth threshold. Anyone above this wealth threshold would be able to borrow and anyone below this wealth threshold would not be able to do so.

3.2.2. *Assortative Matching.* Who would the poor person like to group with. If she groups with another poor person, the group would turn out to be non-functional group as both group members would not have the sufficient wealth to be a borrower and initiate group lending. Conversely, if she groups with a not-so-poor individual, the not-so-poor individual would be able to take on the role of a borrower. The poor individual has clear incentives to group with the not-so poor individual.

Who would the not-so-poor individual like to group with. If she groups with another not-so-poor individual, she would have to compete for loans in the group. By grouping with poor person, she can ensure that the there is no competition for loans within the group. Thus, a not-so-poor individual would like to group with a poor individual to ensure that there is no competition for loans within the group.

To summarise, offering saving opportunities leads to restricting credit within the group. The optimal contracts that follow in Aniket (2007) are such that the wealth threshold for borrowers is higher than the wealth threshold for savers. This, is turn, leads to negative assortative matching along wealth lines within the group. The negative assortative matching ensures that there is no competition for loans within the group.[14]

If consumption smoothing is the objective, then both credit and saving opportunities can play their part. If borrowing for the investment projects is the objective, then one way to achieve this would be to allow the wealth-less to borrow. As we have seen, there are significant information problems associated with lending to the wealth-less. An alternative mechanism could be that microfinance institutions only lend to individuals who have wealth which is sufficient to solve the adverse selection and moral hazard problems. For the people unable to borrow, it offers opportunity to save, which would help them accumulate sufficient wealth and become borrowers in the future.

The question remains. Is it more efficient to give people opportunities to borrow their way out of poverty or to save their way out of poverty.[15] The research in this area is still in its infancy and hopefully we would find the answer to this question in the years to come.

Exercise

(1) The question based on Ghatak and Guinnane (1999). In the enforcement model in Section 2.4 (Pages 209-211), the individual liability borrowing repayment condition is

$$u(x) - u(x - r) \leqslant B$$

where x is the output realisation of the project, r is the interest rate due and B is the net present discounted value of having continued access to credit in the future. The joint-liability group lending repayment condition is

$$u(x) - u(y - 2r) \leqslant B.$$

[14]Even though this may sounds a bit different, this kinds of mechanism is not very different from the one we live in. Developed financial markets allow the small investors (poor) to acquire stakes in the investment projects of the better off financial institutions.

[15]The stylised facts suggest that poor have relatively more borrowing opportunities (even if it is at expensive interest rates) than saving opportunities.

Assume that $B > 0$ and the utility function is logarithmic (to the base e), i.e., $u(x) = \log_e(x)$.

(a) Show that under both types of lending arrangements, borrowers repay only if the output exceeds a certain threshold level. Which type of lending arrangement has a higher threshold?

(b) Find the output range over which group lending does better in terms of repayment than individual lending and vice versa.

(c) Explain why the repayment rate improves if the group members are able to impose social sanctions on each other.

(d) If the group maximises joint welfare in this model (as would be the case if the repayment decisions are taken co-operatively), argue that repayment rates under joint liability will be identical to repayment rates under individual liability.

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