– The Theory of Microfinance –
Credit Constraints, Rationing & Agency Theory

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The Lectures

Objective

- Ideally I'd like to provide an introduction to the economic literature on micro-finance, from the early works to the latest working papers. Effectively it will be an introduction to a sub-theme (but an important one) of this literature.
- Equally importantly, it would be great if you learned something methodologically. To this end I will
  - give an introduction to some key models, discuss the modeling techniques, think about the models' limitations.
  - discuss a wide range of empirical approaches.
  - give special emphasis to discussing how to combine the two!

The Lectures

Spirit

- One appeal: The notes almost certainly contain errors. Please let me know!
- Acknowledgement: Credit goes to Konrad Burchardi at IIES. These notes are substantially based on his.
- Disclaimer: Obviously most ideas in these lectures are not mine, and mostly without proper citation.
- One thing: I hope I'll talk at most half the time. Interrupt me at your convenience!

Microcredit: Short Introduction

Typical Contract

What is micro-finance?

Many things, but a typical 'first generation' contract has the following components:

- Female borrowers.
- Borrowers form lending groups.
- Borrowers jointly liable for the repayment of group loan.
- Non-agricultural enterprise borrowing.
- Regular group meetings with the loan officer.
- Regular repayment schedules.

We focus on the effect of **joint liability** and **self-selection**!

Microcredit: Short Introduction

Credit markets

Why might we need micro-credit loans?

In a **perfect** (efficient) credit market, borrowers would borrow up the where the marginal expected return equals the interest rate, and the interest rate equals the cost of funds of the lender.

Both things do not seem to be true in reality:

- The informal market interest rates are 40%-200%, or more. Banerjee reports: Chennai fruit vendors pay up to 5% *a day*!
- Aleem found in Pakistan that the average interest rate was 78.5% annually, and the average cost of capital was 32.5%.
- Most of the poor do not have access to any form of formal credit (excluding microcredit). The rich have larger loans, and pay lower rates.

Microcredit: Short Introduction

Expansion of Micro-Finance

The hope was (and is) that micro-lending might help to provide the poor with credit at lower rates, and do so profitably.

Indeed micro-finance institutions (MFI) have been lending to the poor, and often done so profitably. Their repayment rates have been very high.

Micro-lenders have expanded rapidly ($\rightarrow$ next slide) since the first scheme in the late 1970's (Grameen Bank).

In recent years the micro-finance industry has been changing: About 1/2 of micro-finance institutions are individual liability lenders, and about 1/4 are for-profits or cooperatives.

Microcredit: Short Introduction

Expansion of Micro-Finance

Table 1.1
Growth of microfinance coverage as reported to the Microcredit Summit Campaign, 1997–2007

End of year	Total number of institutions	Total number of clients reached (millions)	Number of "poorest" clients reported (millions)
1997	655	16.5	9.0
1998	705	18.7	10.7
1999	964	21.8	13.0
2000	1,477	38.2	21.6
2001	2,033	57.3	29.5
2002	2,334	67.8	41.6
2003	2,577	81.3	55.0
2004	2,814	99.7	72.7
2005	3,056	135.2	96.2
2006	3,244	138.7	96.2
2007	3,352	154.8	106.6

Source: Daley-Harris 2009.

Microcredit: Short Introduction

Questions

However, our understanding of why credit markets fail in the first place and why micro-credit contracts help to lend where other contract forms do not is still limited/incomplete.

This course tries to sketch out these debates, and what we know, if we know something.

Outline

1. Credit Constraints
   - Impact of Credit Constraints
2. Credit Rationing
   - Adverse Selection Problem
   - (Ex-Ante) Moral Hazard Problem
   - Testing Models of Credit Market Failure
3. Agency Theory: Why Joint Liability might help
   - Adverse Selection and Peer Selection
   - Moral Hazard and Peer Monitoring
   - Testing Models of Microcredit

Borrowers' Credit-Constraint: Empirical Evidence

There are several models of why credit markets might not provide (sufficient) credit to socially beneficial projects, e.g.:

- Stiglitz and Weiss (1981): Some socially desirable projects do not obtain credit.
- Stiglitz (1990): Borrowers obtain a smaller loan than optimal.

Is this a real issue, i.e. **are borrowers credit-constraint?**

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008

One way to answer this question is to **estimate the marginal return to capital**, and compare it to the cost of funds.

Problem: The question is difficult to answer! Differences and changes in capital stock are likely correlated with ability, demand shocks, and other factors associated with the differences in the profitability of investments across firms.

Very convincing evidence on the marginal return to capital is from De Mel, McKenzie, and Woodruff, 2008. They **provide grants experimentally** and measure the effect on profits.

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008: Setting

- Three southern and southwestern districts of Sri Lanka.
- Sample of firms/microenterprises with invested capital of 100,000 LKR (about US$1,000) or less, excluding investments in land and buildings.

→ Treatments (below) large shock to business capital.

- Surveyed quarterly between 2005 and 2007.
- Full survey of 659 enterprises. After baseline survey data, 41 enterprises eliminated because they exceeded the 100,000 LKR maximum size or because a follow-up visit could not verify the existence of an enterprise. The remaining 618 firms constitute the baseline sample.
- In analysis excluding firms directly affected by Tsunami. Baseline sample of 408 enterprises. Of those 203 firms in retail sales and 205 in manufacturing/services.

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008: Experiment

Random Treatment: The prize consisted of one of 4 grants:

- 10,000 LKR ($\approx$ US$100) of equipment/inventories, or
- 20,000 LKR in equipment/inventories, or
- 10,000 LKR in cash, or
- 20,000 LKR in cash.

The 10,000 LKR treatment is equivalent to about three months of median profits reported by the firms in the baseline survey.

The median initial level of invested capital, excluding land and buildings, was about 18,000 LKR, implying that the small and large treatments correspond to approximately 55% and 110% of the median initial invested capital.

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008: Reduced Form Treatment Effects

TABLE II

EFFECT OF TREATMENTS ON OUTCOMES

Impact of treatment amount on:	Capital stock (1)	Log capital stock (2)	Real profits (3)	Log real profits (4)	Owner hours worked (5)
10,000 LKR in-kind	4,793*	0.40***	186	0.10	6.06**
	(2,714)	(0.077)	(387)	(0.089)	(2.86)
20,000 LKR in-kind	13,167***	0.71***	1,022*	0.21*	−0.57
	(3,773)	(0.169)	(592)	(0.115)	(3.41)
10,000 LKR cash	10,781**	0.23**	1,421***	0.15*	4.52*
	(5,139)	(0.103)	(493)	(0.080)	(2.54)
20,000 LKR cash	23,431***	0.53***	775*	0.21*	2.37
	(6,686)	(0.111)	(643)	(0.109)	(3.26)
Number of enterprises	385	385	385	385	385
Number of observations	3,155	3,155	3,248	3,248	3,378

Notes: Data from quarterly surveys conducted by the authors reflecting nine survey waves of data from March 2005 through March 2007. Capital stock and profits are measured in Sri Lankan rupees, deflated by the Sri Lankan CPI to reflect March 2005 price levels. Columns (2) and (4) use the log of capital stock and profits, respectively. Profits are measured monthly and hours worked are measured weekly. All regressions include enterprise and period (wave) fixed effects. Standard errors, clustered at the enterprise level, are shown in parentheses. Sample is trimmed for top 0.5% of changes in profits.

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008: Reduced Form Treatment Effects

Table II:

- The grants did increase the capital stock (first stage).
- The grants did increase profits (reduced form).

→ What we are interested in is: What is the marginal effect of an additional unit of business capital on profits?

→ The grants are an instrument for capital stock.

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008: IV Estimates

TABLE IV
INSTRUMENTAL VARIABLE REGRESSIONS MEASURING RETURN TO CAPITAL FROM EXPERIMENT

	Real profits IV-FE (1)	Log real profits IV-FE (2)	Real profits 4 instruments (3)	Real profits adjusted (1) IV-FE (4)	Real profits adjusted (2) IV-FE (5)
Capital stock/log capital stock (excluding land & buildings)	5.85** (2.34)	0.379*** (0.121)	5.16** (2.26)	5.29** (2.28)	4.59** (2.29)
First-stage					
Coefficient on treatment amount	0.91***	0.33***		0.91***	0.91***
F statistic	27.81	49.26	6.79	27.81	27.81
Observations	3,101	3,101	3,101	3,101	3,101
Number of enterprises	384	384	384	384	384

Notes: Data from quarterly surveys conducted by the authors reflecting nine waves of data from March 2005 through March 2007. Capital stock and profits are measured in Sri Lankan rupees, deflated by the Sri Lankan CPI to reflect March 2005 price levels. Profits are measured monthly. The estimated value of the owner's labor is subtracted from profits in columns (4) and (5), as described in the text. In column (4), the owner's time is valued by regression coefficients from a production function using baseline data; in column (5), we use the median hourly earnings in the baseline sample for each of six gender/education groups. A single variable measuring the rupee amount of the treatment is used as the instrument in columns (1) and (2) and (4) and (5). In column (3), we use four separate variables indicating receipt of each treatment type. Except in column (2), the coefficients show the effect of a 100-rupee increase in the capital stock. All regressions include enterprise and period (wave) fixed effects. Standard errors, clustered at the enterprise level, are shown in parentheses. The *F* statistic is the partial *F* statistic in the first-stage regression on the excluded instruments.
*** $p < .01$, ** $p < .05$, * $p < .1$.

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008: IV Estimates

Result:

- Table IV, Column (1): The instrumental variable estimate of the *monthly* gross return to capital is 5.85%. (More than 60% per year.)

Digression: Is this really an estimate of the marginal return to capital?

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008: Interpretation

Take a simple model of a firm: Profits are a multiplicative function of effort e and capital x, $\pi = p(e)q(x)$. Suppose effort has cost ηe. The entrepreneur will choose effort to maximize π:

$$p'(e)q(x) = \eta. \tag{1}$$

Hence equilibrium effort e is a function of x. Is this a problem?

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008: Interpretation

Assume the functional form $p(e) = e^{\alpha}$ and $q(x) = Bx^{\beta}$. This suggests, to estimate the marginal return to capital (!), we *should* run the regression (instrumented):

$$log(\pi_i) = log(B) + \alpha\ log(e_i) + \beta\ log(x_i) + \epsilon_i.$$

However, we did see results from the regression (instrumented):

$$log(\pi_i) = log(B) + \beta\ log(x_i) + \nu_i, \quad \nu_i = \epsilon_i + \alpha\ log(e_i).$$

The problem: Equation 1 shows that whatever shocks x (the capital grants here) will also impact effort/labour supply. In other words: The exclusionary restriction is violated.

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008: IV Estimates

Therefore the authors correct for the effect of additional labour supply in columns (4) and (5):

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***$p < .01$, **$p < .05$, *$p < .1$.

It does not change much. Certainly not the basic take-away!

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008: IV Estimates

Back to our question: Are we actually interested in the marginal return to capital (in the production function)? No.

We want to know by how much the profits increase to an injection of capital - taking into account the endogenous effort response! Then the estimate from column (1) is just right.

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008: Take-Away

Result:

- The instrumental variable estimate of the monthly gross return to capital is 5.85%. (More than 60% per year.)
- The average of two yearly deposit rates published by the central bank for April 2005 - an estimate of the cost of funds (excluding banks' administrative costs) - 8% per year.

→ Strong evidence that micro-entrepreneurs in Sri Lanka are credit constraint.

Marginal Return to Capital

De Mel, McKenzie, Woodruff, 2008: Further Results

They "find that there is considerable heterogeneity of the returns along measurable dimensions. [...] Returns to capital are generally higher for entrepreneurs who are more severely capital constrained – those with higher ability and with fewer other wage workers in the household who can provide liquidity."

"One important exception to this is that while the conventional wisdom holds that women are more severely credit constrained, [they] find that the returns are much higher in enterprises owned by males than in enterprises owned by females."

Marginal Return to Capital

Other Studies

Other Studies:

- McKenzie and Woodruff (2006) estimate returns to capital among the smallest urban microenterprises in Mexico of around 180% per year. Returns in the Mexican data fall to around 40%-60% per year above US$500 of capital stock.
- McKenzie and Woodruff (2008) undertake a similar experiment among enterprises in Mexico with less than US$900 of capital stock. They find returns in the range of 250%-360% per year.
- Udry and Anagol (2006) estimate returns of small-scale agricultural producers in Ghana to be 50% per year (amongst those producing traditional crops) and 250% per year (non-traditional crops).

Marginal Return to Capital

Other Studies

Other Studies (cont'd):

- Banerjee and Duflo (2004) take advantage of changes in the criteria identifying firms eligible for earmarked credit from Indian banks. They derive estimates of returns for this set of firms of 74%-100% per year.
- Burgess and Pande (2005) show that branch expansion into rural unbanked locations in India significantly reduced rural poverty. Evaluated at the sample mean, they find that rural branch expansion can explain a 14 to 17 percentage point decline in rural headcount, about half the overall fall in the period.

Models of Credit Market Failure

It seems that marginal returns to credit are a lot higher than the cost of funds. Why? Can models of credit market failures help to explain these facts?

Literature

Credit Constraints

De Mel, Suresh, David McKenzie, and Christopher Woodruff. 2008. "Returns to Capital in Microenterprises: Evidence from a Field Experiment." *The Quarterly Journal of Economics* 123(4):1329-1372.

Outline

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   - Impact of Credit Constraints
2. Credit Rationing
   - Adverse Selection Problem
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Adverse Selection in Credit Markets

Seminal Contributions

Ok, so why might credit markets not function in the first place?

There are two seminal papers, which describe how *asymmetric information* about the borrower's *types'* can lead to credit market inefficiencies:

- Stiglitz and Weiss (1981) show that projects which would generate a social surplus might not obtain a credit.
- De Meza and Webb (1987) show that projects which do not generate a social surplus might obtain funding.

First, let us understand these arguments in a simple model.

Adverse Selection Problem

Model Set-Up

The borrower:

- Agents are endowed with 1 unit of labour, and an **uncertain** investment project.
- Agents can either sell their labour, and earn an outside option $\bar{u}$, or start the investment project, for which they require 1 unit of capital. They are risk-neutral.
- Projects have outcome x, which is 'success' or 'failure'.
- The return of the projects is uncertain, characterized by random variable y_i , which takes value R_i, when the outcome is 'success', which happens with probability p_i, and 0 otherwise.
- Agents have no wealth! (No collateral.)

The lender:

- The lender has cost of funds ρ and is risk-neutral.

Adverse Selection Problem

First-Best contracts

First-Best: It would be socially optimal that any borrower i undertakes his project if and only if

$$p_i Y_i \geq \bar{u} + \rho.$$

1. Why?
2. This would be achieved by offering a debt contract[1] in which the borrower pays interest $r_i = \rho/p_i$ in case of success. He would then take the loan if and only if it is socially optimal to do so and the bank would make zero-profit. (Show it.)

$\rightarrow$ Problem: p_i might not be observable by the borrower!

[1] We will focus on debt contracts throughout, so contracts which are conditional on outcomes, but not on returns. This can be rationalized with a costly state-verification argument a la Townsend (1979).

Adverse Selection Problem

Types of borrowers

Assume that p_i is **not observable** to the lender. This implies that the lender must make the same offer (which might be a menu of contracts) to all clients.

For simplicity assume two types of borrowers, $i \in \{r, s\}$: 'risky' ones (with share $1 - \theta$) and 'safe' ones (with share θ), where

$$0 < p_r < p_s < 1.$$

There are (at least) two ways to think about 'riskiness', which both lead to inefficiencies, but very different ones.

Adverse Selection Problem

Notion of 'riskiness'

A. Stiglitz and Weiss, 1981

Assume $p_s Y_s = p_r Y_r = \bar{Y}$: all projects yield the same expected return.

Assume that $\bar{Y} > \rho + \bar{u}$: all projects are socially desirable.

(Safe projects are second-order-stochastically-dominanting risky projects.)

B. De Meza and Webb, 1987

Assume $Y_s = Y_r = Y$: all projects yield the same when successful, risky projects are just less likely to succeed.

Assume $p_s Y > \rho + \bar{u} > p_r Y$: only safe projects are socially desirable.

(Safe projects are first-order-stochastically-dominanting risky projects.)

Adverse Selection Problem 1

Stiglitz and Weiss, 1981

A. Stiglitz and Weiss, 1981

Given that the lender needs to offer the same interest rate to all borrowers, is it still necessarily true that all borrowers do obtain a loan (as should be in the Stiglitz and Weiss set-up)?

Suppose it was true that both types borrow at some common interest rate r. Then r needs to satisfy

$$[\theta p_s + (1-\theta)p_r]r \geq \rho \tag{2}$$

for the lender to make non-negative profits.

Adverse Selection Problem 1

Stiglitz and Weiss, 1981

The borrower borrows at any interest rate iff

$$p_i(Y_i - r) > \bar{u}.$$

Suppose that r was the lowest possible, satisfying (2) with equality. Even then it is possible that

$$\begin{aligned} p_s[Y_s - \rho/(\theta p_s + (1-\theta)p_r)] &< \bar{u} \\ p_r[Y_r - \rho/(\theta p_s + (1-\theta)p_r)] &> \bar{u}, \end{aligned}$$

so the **safe borrowers do not realize their project!**

Do you see the math? (Remember: $\bar{Y} - \rho > \bar{u}$ holds for both.)

Adverse Selection Problem 1

Stiglitz and Weiss, 1981

Intuition: The presence of risky borrowers drives the break-even interest rate of the bank up. It might be so high, that safe borrowers do not make a profit even when successful. Only the risky ones, who in this case have a very high return, would make a profit in case of success at this interest rate.

Consequence

The only equilibrium is in this case that only the risky types borrow, at interest rate $r = \rho/p_r$. **Some socially desirable projects might not take place!** We observe high interest, low repayment rates.

[Obviously: The parameter value might as well be such that both types borrow at $r = \rho/(\theta p_s + (1-\theta)p_r)$.]

Adverse Selection Problem

Key Assumptions

Key assumptions for both results:

- Limited Liability: Individuals cannot be held responsible for losses. In particular, we assumed that they had no (limited) wealth, or that their wealth can not be pledged as collateral. Otherwise... agents, and in particular risky types, could be made pay the cost of failure. Then the interest rate could be ρ both in case of success and failure, and the agents participation constraint would be the same as the social optimum condition.

Adverse Selection Problem

Key Assumptions

Key assumptions for both results:

- Limited Liability: [...]
- Asymmetric Information: Contracts can not be conditioned on the type, so in particular risky types can not be forced to pay more in case of success (or failure, but that is ruled out by limited liability anyway). Otherwise... effectively different interest rates could be charged, making borrowing attractive for safe types in (A) and unattractive for risky types in (B).

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

Ghatak (2000) shows, that with **joint liability contracts** and **endogenous group formation** the latter can be achieved:

Risky types can be made to pay more in case of success, reducing the expected effective interest rate for save types.

["Lenders can use degree of joint liability to screen borrowers with different (unobservable) probability of repayment."]

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Moral Hazard Problem

Sitglitz (1990)

Again, let us first recap how moral hazard can cause credit market failure, and then understand how joint liability might help.

We consider the model of Stiglitz (1990), which highlights the effect of **moral hazard in project choice** (as opposed to effort choice).

Moral Hazard Problem

Set-Up

Set-Up:

- Individuals can, after obtaining the credit, choose one of two projects: a **safe project**, and a **risky project**. They are successful with probability $p_S > p_R$, respectively.
- A credit contract is characterized by the loan size L and the interest rate r.
- In case of success the projects yield $Y_i(L)$.

$\rightarrow$ Note that we introduced the loan amount, so potentially we can derive implications on the size of loans (which in the previous model we did not).

Moral Hazard Problem

Set-Up

Set-Up (cont.):

- Assume that $p_S Y_S(L) > p_R Y_R(L)$ and $Y_S(L) < Y_R(L)\ \forall L$.
  - $\rightarrow$ So the safe project is always socially preferable, but not necessarily privately. Do you see the latter?
- Individuals have a concave instantaneous utility function U, and greater scale projects require greater effort. The utility cost of effort $v(e)$ is convex. Expected utility from project i is:

$$V_i(L, r) \quad = \quad U(Y_i(L) - rL)p_i - v(e(L)), i \in \{S, R\}.$$

Moral Hazard Problem

Project Choice

If the borrowers were always choosing the save project, i.e. the socially preferable one, the bank could provide the efficient amount of capital. The "if" is not true.

Hence: **When does the borrower choose which project?**

Borrowers are indifferent when $V_S(L, r) = V_R(L, r)$. This defines a *switch line* in the (L, r) space.

Moral Hazard Problem

Project Choice

Under some assumptions we can characterize the slope of the *switch line* in the (L, r) space:

- Take the total differential: $\frac{dr}{dL} = -\frac{\frac{\partial V_R}{\partial L} - \frac{\partial V_S}{\partial L}}{-L(p_R U'_R - p_S U'_S)}$.
- We know $p_R < p_S$ and that $U'_R < U'_S$, since U is concave and $Y_R(L) > Y_S(L)$. Hence $-L(p_R U'_r - p_S U'_S) > 0$.
- Assume $\frac{\partial V_R}{\partial L} = p_R U'_R \times (Y'_R - r) > p_S U'_S \times (Y'_S - r) = \frac{\partial V_S}{\partial L}$. This is really an assumption that $Y'_R >> Y'_S$.

$\rightarrow$ Then $\frac{dr}{dL} < 0$.

Moral Hazard Problem

Project Choice

Intuitively:
An increase in r makes the risky project more attractive: You pay it less often, and the utility loss is smaller (concave U).

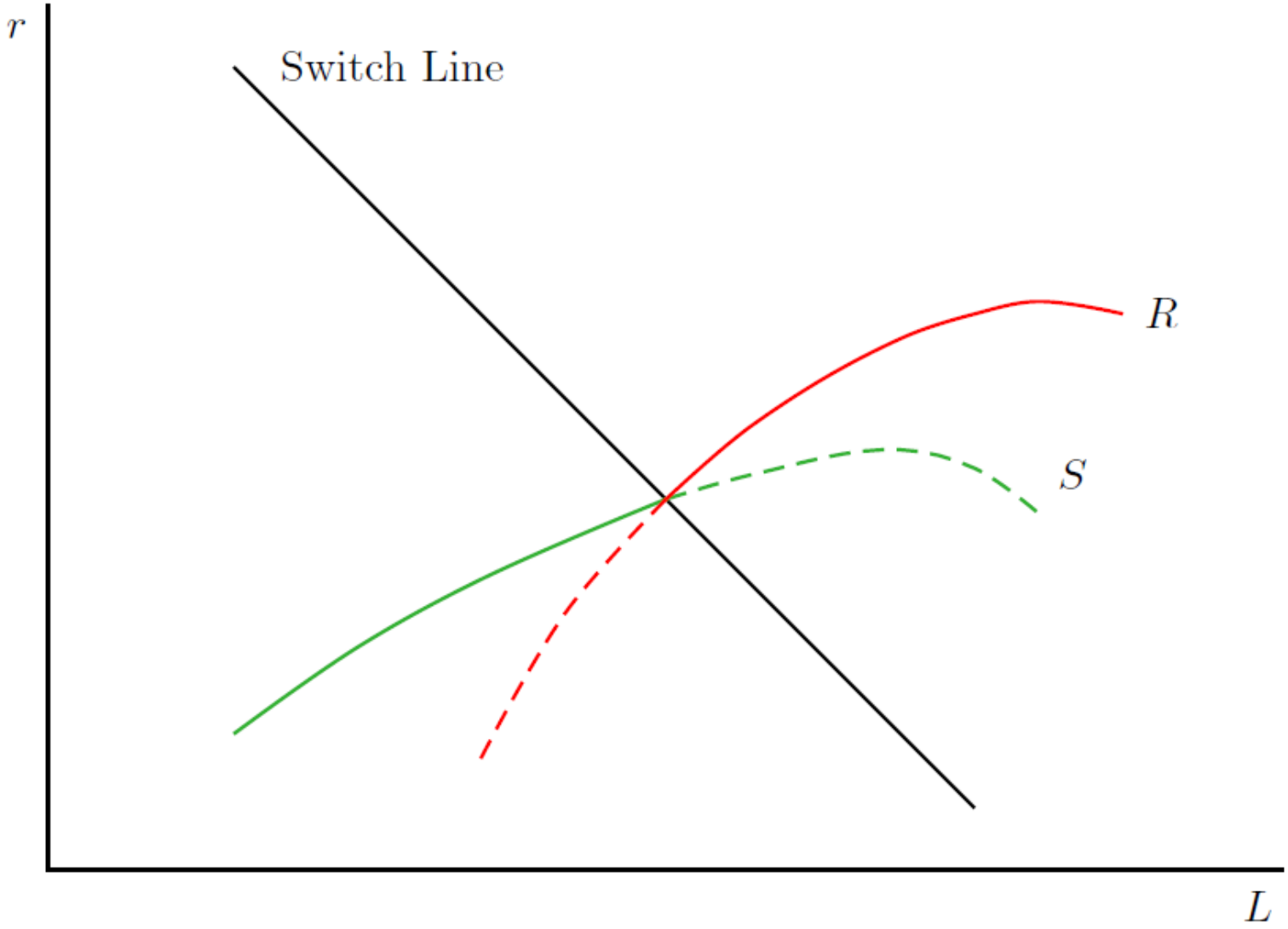
We assumed an increase in L makes the risky project relatively more attractive.

Hence for the borrower to be indifferent between both, an increase in r needs to be accompanied by a decrease in L!

Graphically: ...

Moral Hazard Problem

Project Choice



Moral Hazard Problem

Project Choice

Ok, so we (and the lender) know what the borrower will do given any contract (L, r) he is offered.

What will the lender do?

[An aside: Like in *any* moral hazard model we are just solving for the subgame-perfect equilibrium of a sequential game.]

Moral Hazard Problem

Lender Behaviour

Set-up (cont.):

- Banks maximise profits.
- Credit markets are perfectly competitive.
- But: Borrowers can borrow from at most one bank!

→ Then the banks will – in equilibrium – make zero profits and offer the contract which gives the highest utility to the borrower. Why?

Moral Hazard Problem

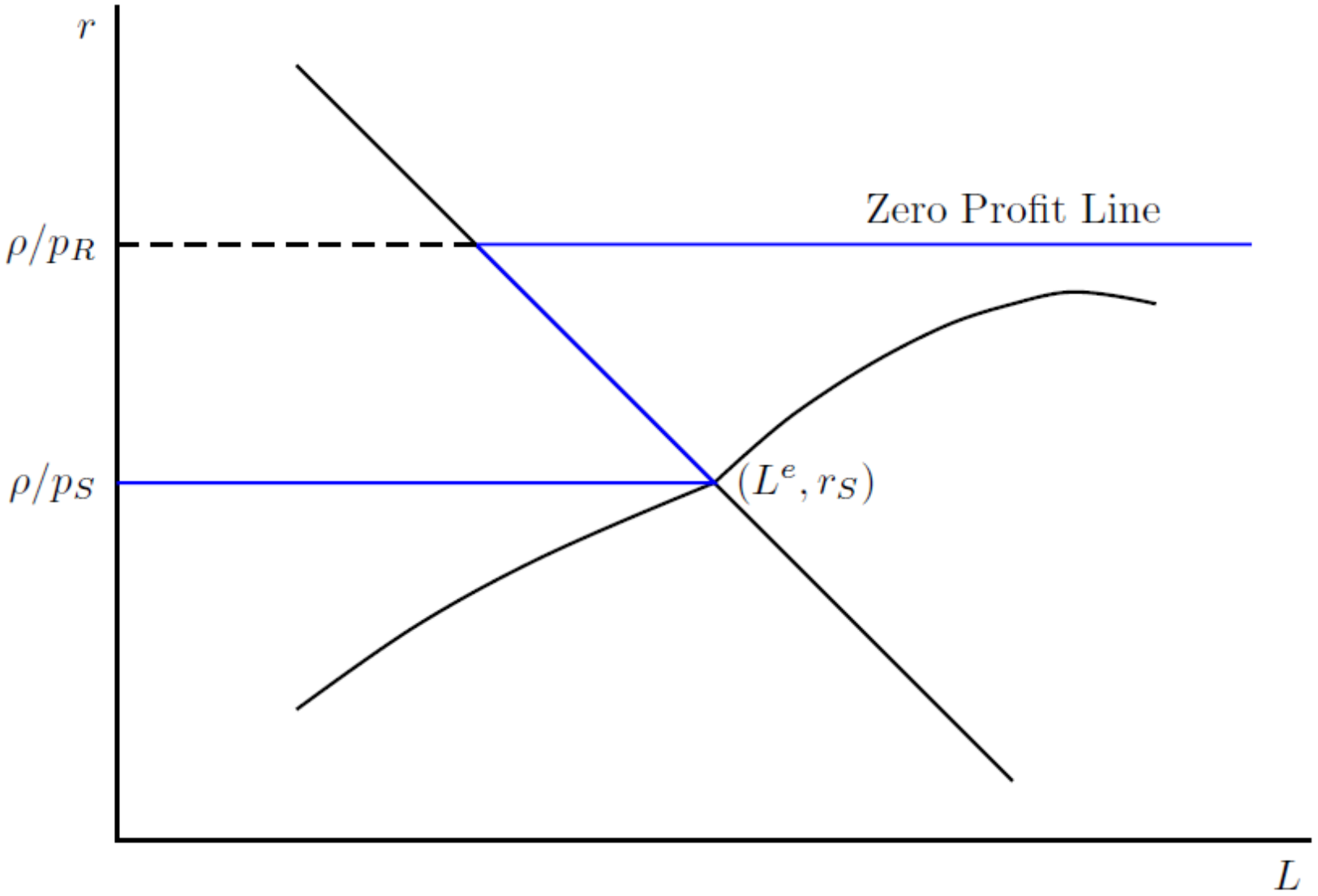
Equilibrium

Which are the zero profit contracts? Contracts with $r_S = \rho/p_S$ where the safe project is chosen, and all contracts with $r_R = \rho/p_R$ when the risky project is chosen.

Graphically: ...

Moral Hazard Problem

Equilibrium



Moral Hazard Problem

Equilibrium

Hence a contract (L^e, r_S) will be offered[2] even though at r_S the borrower would prefer a loan size bigger than L^e. He is not offered this loan, since the bank knows he would choose the risky project, in which case charging the low interest rate is not an equilibrium.

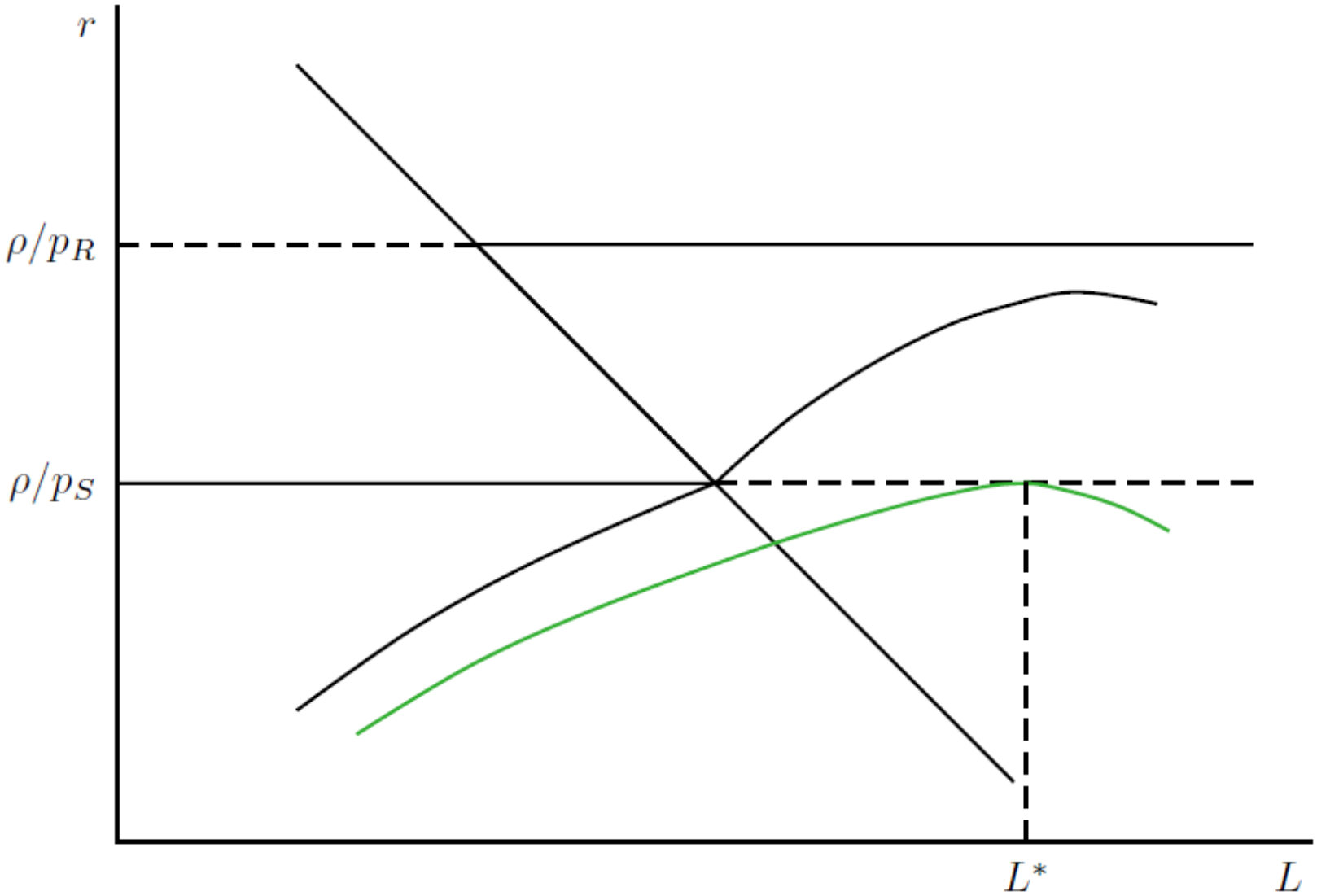
Result

Borrowers get a loan which is **smaller than socially optimal**.

[2] That is, if the indifference curves are not such that the high-risk contract is preferred, in which case there is no probem.

Moral Hazard Problem

Equilibrium



Moral Hazard Problem

Equilibrium

"[I]f the bank could directly control the actions of the borrower, it would specify that the borrower undertake the safe project. It cannot, and this is the basic problem with incentives in credit markets. By controlling the terms of the loan contract, the bank can induce the borrower to undertake the safe project."

(Stiglitz, 1990, p.356)

Peer Monitoring and Credit Markets

Stiglitz, 1990

Stiglitz (1990) shows, that with joint liability contracts the equilibrium loan size might be bigger than L^e.

The key idea is that joint liability **changes the probability distribution of pay-offs**.[3]

[3] The 'monitoring' aspect is well hidden in the paper (footnote 12). But read it yourself.

Outline

1. Credit Constraints
   - Impact of Credit Constraints
2. Credit Rationing
   - Adverse Selection Problem
   - (Ex-Ante) Moral Hazard Problem
   - Testing Models of Credit Market Failure
3. Agency Theory: Why Joint Liability might help
   - Adverse Selection and Peer Selection
   - Moral Hazard and Peer Monitoring
   - Testing Models of Microcredit

Testing Models of Credit Market Failure

Karlan and Zinman, 2009: Idea

Brain Storming: How would you design an experiment to test whether adverse selection or moral hazard are important for repayment rates?

Testing Models of Credit Market Failure

Karlan and Zinman, 2009: Idea

Let us start to think about **adverse selection**. The story was... that a different pool of individuals is applying for credit when the interest rate is different, *and that alone* has implications for the repayment rates.

→ So what we need is an experiment in which the **interest rate that people see when they apply is different**, but everything else is the same.

→ What is everything else? Everything, including especially the interest rate they need to pay, and their knowledge about it from the moment after selection happened.

Then any difference between the two groups is attributable to adverse selection, i.e. a different pool of borrowers applies.

Testing Models of Credit Market Failure

Karlan and Zinman, 2009: Idea

And how can one design an experiment to test whether **moral hazard** is important for repayment rates?

Testing Models of Credit Market Failure

Karlan and Zinman, 2009: Idea

There are different forms moral-hazard can take: ex-ante moral hazard in project choice, ex-ante moral hazard in effort choice, and ex-post moral hazard (enforcement problem).

Always the story is that a **higher r induces behavior** during and after the loan period **which makes repayment less likely**.

So what we need is two groups which are exposed to different interest rates, but are similar on observable and unobservable characteristics before they receive the loan.

Then any difference between the two groups is attributable to moral hazard.

Testing Models of Credit Market Failure

Karlan and Zinman, 2009: Experiment

Both of these ideas are very clean. On top, Karlan and Zinman (2009) combine them in one experiment elegantly:[4]

- Group 1 is offered the low interest rate, and once signed up, given the low interest rate.
- Group 2 is offered the high interest rate, and once signed up, given the low interest rate.
- Group 3 is offered the high interest rate, and once signed up, given the high interest rate.

Comparing group 1 and group 2 allows to test for adv. selection.
Comparing group 2 and group 3 allows to test for moral hazard.

[4] In fact, they have third intervention: In group 1 and 2, some borrower where offered a continued lower interest rate on future loans, if they remained in good standing. This should also induce moral hazard.

Testing Models of Credit Market Failure

Karlan and Zinman, 2009: Setting

Setting:

- Large South African micro-lender.
- Offers small, high interest, short-term, uncollateralized credit with fixed monthly repayment schedules.
- Cash loan sizes tend to be small relative to the fixed costs of underwriting and monitoring them, but substantial relative to a typical borrowers income.
- The lenders normal 4-month rates, absent the experiment: 7.75% - 11.75% per month depending on observable risk. 75% of clients in the high-risk category.
- Repeat borrowers had default rates of about 15%; first-time borrowers defaulted twice as often.
- Sample: 57,533 former clients with good repayment histories. Everyone had borrowed from the lender within the past 24 months, and did not have a loan outstanding in the 30 days prior to the offer.

Testing Models of Credit Market Failure

Karlan and Zinman, 2009: Results

TABLE I

EMPIRICAL TESTS OF HIDDEN INFORMATION AND HIDDEN ACTION: FULL SAMPLE

	OLS							
Dependent Variable:	*Monthly Average Proportion Past Due*		*Proportion of Months in Arrears*		*Account in Collection Status*		*Standardized Index of Three Default Measures*	
Mean of Dependent Variable:	0.09	0.09	0.22	0.22	0.12	0.12	0	0
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Contract rate (Hidden Action Effect 1)	0.005	0.002	0.006*	0.002	0.001	−0.001	0.014	0.004
	(0.003)	(0.004)	(0.003)	(0.004)	(0.005)	(0.005)	(0.011)	(0.013)
Dynamic repayment incentive dummy (Hidden Action Effect 2)	−0.019*	−0.000	−0.028**	0.004	−0.025**	−0.004	−0.080**	−0.000
	(0.010)	(0.017)	(0.011)	(0.021)	(0.012)	(0.020)	(0.032)	(0.057)
Dynamic repayment incentive size		−0.005		−0.009**		−0.006		−0.023*
		(0.004)		(0.004)		(0.005)		(0.013)
Offer rate (Hidden Information Effect)	0.005	0.004	0.002	0.002	0.007	0.007	0.015	0.015
	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)	(0.011)	(0.012)
Observations	4348	4348	4348	4348	4348	4348	4348	4348
Adjusted R-squared	0.08	0.08	0.14	0.15	0.06	0.06	0.10	0.11
Probability(both dynamic incentive variables = 0)		0.06		0.00		0.06		0.01
Probability(all 3 or 4 interest rate variables = 0)	0.0004	0.0005	0.0003	0.0012	0.0006	0.0016	0.0000	0.0001

*significant at 10%; **significant at 5%; ***significant at 1%. Each column presents results from a single OLS model with the RHS variables shown and controls for the randomization condtions: observable risk, month of offer letter, and branch. Adding loan size and maturity as additional controls does not change the results. Robust standard errors in parentheses are corrected for clustering at the branch level. "Offer rate" and "Contract rate" are in monthly percentage point units (7.00% interest per month is coded as 7.00). "Dynamic repayment incentive" is an indicator variable equal to one if the contract interest rate is valid for one year (rather than just one loan) before reverting back to the normal (higher) interest rates. "Dynamic repayment incentive size" interacts the above indicator variable with the difference between the lender's normal rate for that individual's risk category and the experimentally assigned contract interest rate. A positive coefficient on the Offer Rate variable indicates hidden information, a positive coefficient on the Contract Rate or Dynamic Repayment Incentive variables indicates hidden action (moral hazard).

The dependent variable in columns (7) and (8) is a summary index of the three dependent variables used in columns (1)–(6). The summary index is the mean of the standardized value for each of the three measures of default.

Testing Models of Credit Market Failure

Karlan and Zinman, 2009: Results

Results:

- The data certainly cannot reject the null that adverse selection is not important. At this interest rate margin, in this pool of borrowers. And this is a very selected pool: former clients with good repayment!
- There is some evidence that **moral hazard is important**, especially from the dynamic incentives experiment.

[An aside: Check their little theory for the modeling technique.]

Literature

Credit Rationing

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Stiglitz, Joseph E., and Andrew Weiss. 1981. "Credit rationing in markets with imperfect information." *The American Economic Review* 71(3):393-410.

Outline

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Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

Ghatak (2000) shows, that with **joint liability contracts** and **endogenous group formation** the latter can be achieved:

Risky types can be made to pay more in case of success, reducing the expected effective interest rate for save types.

["Lenders can use degree of joint liability to screen borrowers with different (unobservable) probability of repayment."]

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

Assume:

(a) that borrowers can observe each others' types,

(b) form groups of two,

(c) in case of own success and other member's failure need to pay additionally c, and

(d) the timing is: first (a menu of) contracts are announced, then groups are formed which choose a contract, then projects, returns and payments are realized.

Focus on the *underinvestment problem*.

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

Plan: We show that there is a menu of contracts (r_s, c_s) and (r_r, c_r) such that risky types match with risky types, and safe with safe (**Positive Assortative Matching**) and these contracts satisfy:

1. Risky (safe) groups prefer the contracts designated to them. (Incentive Compatibility)
2. Borrowers want to take a loan. (PC of Borrower)
3. The amount $r + c$ can be paid by borrowers when successful. (Limited Liability)
4. Lenders make zero-profit. (PC of Lender)

$\rightarrow$ Hence there is a menu of contracts which is feasible, and leads to all borrowers taking a loan, which is socially optimal.

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

The argument proceeds in 5 steps.

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

Step 1 (Proposition 1): *Joint Liability contracts lead to positive assortative matching in the formation of groups.*

The expected payoff of i with partner j is

$$U_{ij}(r,c) := p_i Y_i - [p_i r + p_i(1-p_j)c].$$

The net gain for risky borrower of being with safe partner is $U_{rs}(r,c) - U_{rr}(r,c)$, the net expected loss of a safe borrower from being with a risky partner is $U_{ss}(r,c) - U_{sr}(r,c)$. If $c > 0$, the latter is larger than the former. Therefore...? Role of side-payments? (Becker, 1993)

Intuition? Both gain the same from having a safe partner when succeeding, but...

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

The previous result shows that if there is *one* contract for all, there will be assortative matching. Now let us show

Step 2 (Lemma 1): *If* (r_r, c_r) *and* (r_s, c_s) *satisfy the incentive compatibility constraints then they will induce assortative matching in the group formation stage.*

The incentive compatibility constraints are:

$$U_{rr}(r_r, c_r) \geq U_{rr}(r_s, c_s)$$
$$U_{ss}(r_s, c_s) \geq U_{ss}(r_r, c_r).$$

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

Proof: Suppose not. Then a risky type must prefer having a safe partner and borrowing under (r_s, c_s) rather than having risky partner and borrowing under (r_r, c_r) even after compensating the safe borrower for having a risky partner, i.e.

$$U_{rs}(r_s, c_s) + U_{sr}(r_s, c_s) > U_{rr}(r_r, c_r) + U_{ss}(r_s, c_s).$$

We know from Proposition 1, if the lender had offered (r_s, c_s) only, there would have been assortative matching since

$$U_{rr}(r_s, c_s) + U_{ss}(r_s, c_s) > U_{rs}(r_s, c_s) + U_{sr}(r_s, c_s).$$

These inequalities can only be satisfied if $U_{rr}(r_s, c_s) > U_{rr}(r_r, c_r)$, which violates incentive compatibility.

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

Step 3: Since in the end the two contracts attract different borrowers, both must individually satisfy the zero-profit condition (otherwise the lender would not want to offer one of them). We construct a contract $(\hat{r}, \hat{c})$ such that both of these are satisfied simultaneously.

Step 4 (Lemma 2): Then we show, deviating from $(\hat{r}, \hat{c})$, which contracts satisfy incentive compatibility (and by Lemma 1 assortative matching applies).

Step 5 (Proposition 2): Lastly we show that there are such contracts and that all other constraints can be satisfied, too.

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

Step 3: For the two contracts (r_s, c_s) and (r_r, c_r) the non-negative-profit constraints are:

$$\begin{aligned} r_r p_r + c_r(1-p_r)p_r &\geq \rho \\ r_s p_s + c_s(1-p_s)p_s &\geq \rho. \end{aligned}$$

We consider the case where they hold with equality. (This makes getting save borrowers credit not unnecessarily hard.)

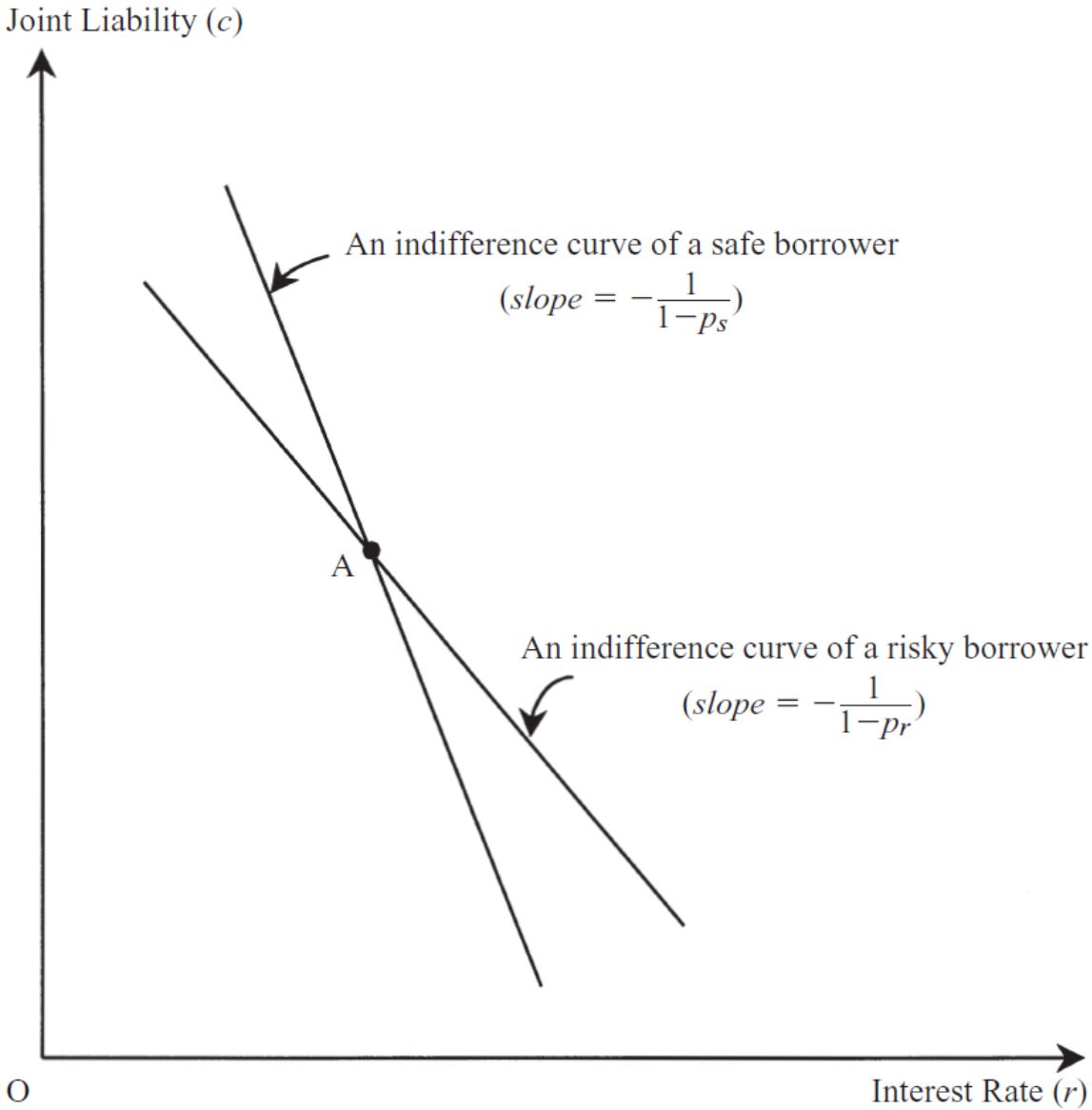
The contract which solves both with equality is:

$$\begin{aligned} \hat{r} &= \rho(p_r + p_s - 1)/(p_r p_s) \\ \hat{c} &= \rho/(p_r p_s). \end{aligned}$$

Graphically: ...

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)



Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

Step 4 (Lemma 2): *For any joint liability contract* (r, c) *if* $r < \hat{r}$ *and* $c > \hat{c}$ *then* $U_{ss}(r, c) > U_{rr}(r, c)$*, and if* $r > \hat{r}$ *and* $c < \hat{c}$ *then* $U_{ss}(r, c) < U_{rr}(r, c)$.

Intuition?

Proof: $U_{ss}(r, c) - U_{rr}(r, c) = (p_s - p_r)[r - c(p_r + p_s - 1)]$. This is positive if $r/c > (p_r + p_s - 1)$ and negative if $r/c < (p_r + p_s - 1)$. Note that $\hat{r}/\hat{c} = (p_r + p_s - 1)$.

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

Step 5 ($\approx$ Proposition 2): "Consider a pair of joint liability contracts (r_r, c_r) and (r_s, c_s) which lie on the zero-profit equations of the bank for the risky and safe borrowers, respectively. Suppose in addition, $r_s < \hat{r}$, $c_s > \hat{c}$ and $r_r > \hat{r}$, $c_r < \hat{c}$."

$\rightarrow$ By assumption these contracts satisfy the zero-profit conditions (Tick).

$\rightarrow$ By step 4 the contracts are incentive compatible (Tick), and hence by step 2 they induce assortative matching at the group formation stage (Tick).

$\rightarrow$ Since both contracts satisfy the respective zero-profit equation, the expected payoff to each type of borrower is $(\bar{Y} - \rho)$, and $\bar{Y} - \rho > \bar{u}$ by the Stiglitz-Weiss assumption. So both types of borrowers participate (Tick).

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

$\rightarrow$ What we are left to show is that the contracts satisfy the limited liability constraint. In fact this is not necessarily true for all thinkable contracts. We need to ensure that $r_s + c_s \leq Y_s$ $r_r + c_r \leq Y_r$. Note that (r_s, c_s) and (r_r, c_r) can each be chosen very close to $(\hat{r}, \hat{c})$. Further $\hat{r} + \hat{c} \leq Y_s$ (and hence $< Y_r$) is satisfied iff $\rho(p_r + p_s)/(p_r p_s) \leq Y_s$ which is satisfied if

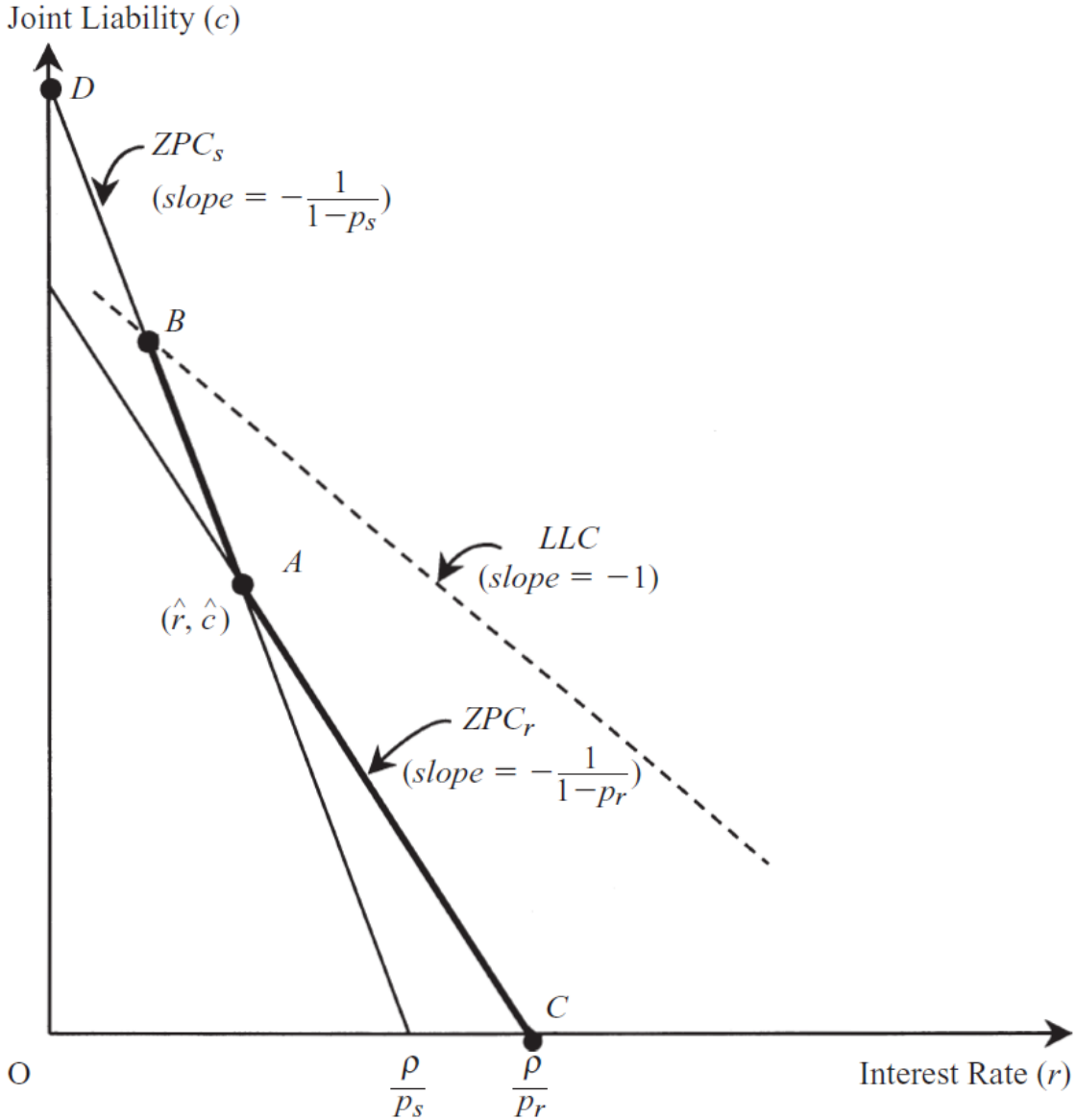
$$\rho(1 + \frac{p_s}{p_r}) < \bar{Y}.$$

This is guaranteed by assumption 4 in the paper (Tick).

Graphically: ...

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)



Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

Result

With joint liability contracts it is possible to device screening contracts, such that positive assortative matching of types happens, and both groups obtain a loan.

Note:

- The above result only holds under assumption 4. Otherwise joint liability does not help.
- The above result crucially depends on groups self-selecting!
- When the zero-profit constraints hold with equality, the risky type pays (in expectation) ρ/p_r when successful, and the safe type pays ρ/p_s. That is just what they would pay in the first-best! So JL contracts effectively achieve that riskier types pay a higher interest rate.

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)

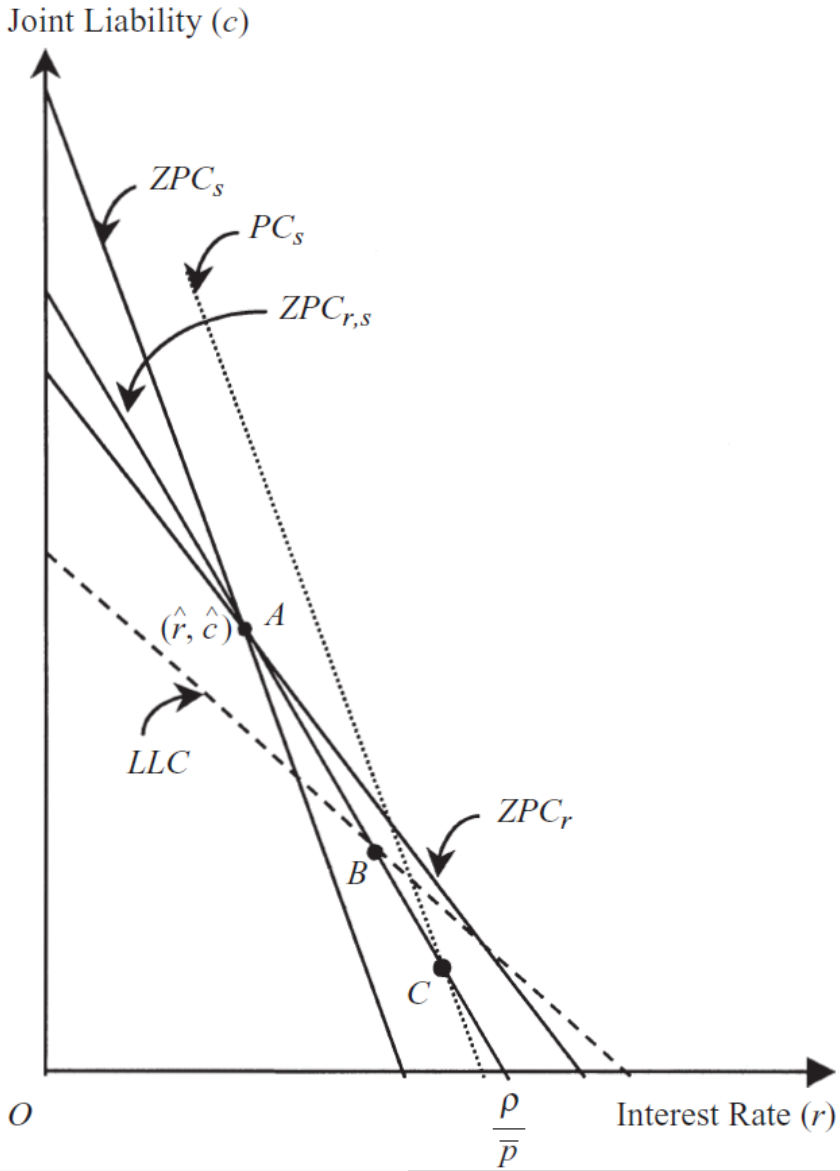
Further results of Ghatak (2000):

- With JL a pooling contract exists (so all types borrow, too) under even more general conditions (a relaxed version of assumption 4). But the main effect is the same, namely that risky types effectively pay more in case of success, despite the nominal terms being the same.

Graphically: ...

Joint Liability Lending and the Peer Selection Effect

Ghatak (2000)



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Peer Monitoring and Credit Markets

Stiglitz, 1990

Stiglitz (1990) shows, that with joint liability contracts the equilibrium loan size might be bigger than L^e.

The key idea is that joint liability **changes the probability distribution of pay-offs**.[5]

[5] The 'monitoring' aspect is well hidden in the paper (footnote 12). But read it yourself.

Peer Monitoring and Credit Markets

Stiglitz, 1990

Set-Up (cont.):

- Borrowers are in groups of two, returns are independent.
- When borrower B fails to be successful, while A is successful, A needs to pay an additional amount qL.

$\rightarrow$ The own expected payoff depends on partner's project.

- Assume that individuals in a group take their decision which project to choose jointly, and take the same.[6]

$\rightarrow$ The project is now 'more risky': the interest rate is lower, but with some probability amount qL needs to be paid.

[6] This can be justified with a game where 'monitoring' amongst group members is important.

Peer Monitoring and Credit Markets

Stiglitz, 1990

The **strategy of the proof**: Starting from $q = 0$, if q is increased by a little (and the bank held at zero profit):

1. By how much needs L to be increased, in order to compensate the borrower for the additional risk?
2. By how much can L be increased, without having the borrower choose the risky project?

- If there is a range where the latter is bigger than the former, we can increase L by more than necessary to compensate for risk without the borrower switching projects, hence making the borrower better off.

Peer Monitoring and Credit Markets

Stiglitz, 1990

Ad 1:

i) The bank's zero profit condition, given everybody chooses the safe project, is $p_S r + p_S(1-p_S)q = \rho$. The change in r induced by changing q is $dr/dq = -(1-p_S)$.

ii) The borrower's utility is

$$V_i \quad = \quad p_i^2 \cdot U[Y_i(L) - rL] + p_i(1-p_i) \cdot U[Y_i(L) - rL - qL].$$

We are interested in $\frac{dL}{dq}|_{V \text{and } q=0}$. First notice, $\frac{dL}{dq}|_V = -(\frac{\partial V_S}{\partial q} + \frac{\partial V_S}{\partial r}\frac{dr}{dq})/(\frac{\partial V_S}{\partial L})$. We know $\frac{\partial V_S}{\partial L} > 0$. We can show[7]:

$$\left(\frac{\partial V_S}{\partial q} + \frac{\partial V_S}{\partial r}\frac{dr}{dq}\right)|_{q=0} = \cdots = 0.$$

[7] Remember, we want to consider that r changes when q changes.

Peer Monitoring and Credit Markets

Stiglitz, 1990

Ad 2: We can use a very similar argument to show $\frac{dL}{dq}|_{\text{switch line and q=0}} > 0$.[8]

[8] Use the condition defining the switch line, take the total differential, and evaluate at $q = 0$.

Peer Monitoring and Credit Markets

Stiglitz, 1990

Result

With joint liability contracts bigger loans are given in market equilibrium, making the borrower better off. (And the borrower still chooses the safe project.)

Note:

- We had to assume that borrowers can only borrow from one lender.

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Testing Models of Microcredit

We saw that, in theory, micro-finance has some effects. **Does any of the models we saw explain these?**

To my mind, there are two levels to this question:

(a) Does micro-finance help by alleviating credit constraints?

→ Micro-finance has many aspects, and potentially many effects. We will come back to some of this later.

(b) If it helps by alleviating credit constraints, does any of the models analyzed so far explain why it helps?

We will now focus on (b) and assume that at least one effect of micro-finance is to alleviate credit constraints.

Testing Models of Microcredit

Two very different approaches to address this question:

- Ahlin and Townsend, 2007: Derive, creatively, several auxiliary predictions of each of the joint liability models. (Step 1) Differential predictions allow to test the models against each other. (Step 2)
- Gine and Karlan, 2011: Run an experiment where after groups have been formed, joint liability is randomly transformed into individual liability.

Testing Models of Microcredit

Ahlin and Townsend, 2007: Step 1

Step 1: Ahlin and Townsend (2007) derive (with assumptions) for each of Stiglitz (1990), Besley and Coate (1995), Banerjee et al. (1994) and Ghatak (1999) the **comparative statics they imply** for the rate of repayment with respect to:

- the joint liability payment,
- correlation of returns,
- cooperative behavior,
- productivity,
- the interest rate, and
- the loan size (amongst others),
- treating the interest rate as exogenous.

Testing Models of Microcredit

Ahlin and Townsend, 2007: Step 1

Is keeping the interest rate fixed innocuous? No. Some of the predictions might change when it is endogenised.

Example: They find for Ghatak (1999) that "[a] higher joint liability payment makes borrowing relatively less attractive. Thus the higher a groups [c], the smaller and more risky the pool from which it is drawn." (Proposition 10)

This is the opposite of the main take-away of Ghatak (2000).

What is the "correct" way of doing this?

Testing Models of Microcredit

Ahlin and Townsend, 2007: Step 1

The correct way of doing this depends on the empirical setting:

- If you have data from a setting where – for some reason – the interest rate is fixed/exogenous, deriving the predictions of the model with r kept fixed is appropriate. They argue this is true for their setting (Thai villages).
- If you have data from a setting where you cannot think of r as fixed – most cases of competitive or monopolistic credit markets – then one would need to derive predictions of a model which endogenises r.

[**An aside**: The nature of the competitive environment is often not analysed in this literature, but object of recent debates.]

Testing Models of Microcredit: Step 1

Ahlin and Townsend, 2007: Derived Comparative Statics

Table 1

Repayment Implications

An entry marked with a "‡" corresponds to a variable not included in the original model.

	Effect on Repayment			
Variable	Stiglitz	BBG	BC	Ghatak
liability payment q	$\downarrow^{a}$	$\uparrow$		$\downarrow$
positive correlation	$\uparrow^{\ddagger b}$		$\downarrow^{\ddagger b}$	$\uparrow^{\ddagger b}$
cooperative behavior	$\uparrow^{\ddagger}$	$\downarrow^{\ddagger c}$	$\downarrow^{\ddagger d}$	
cost of monitoring		$\downarrow$		
official penalties			$\uparrow$	
unofficial penalties			$\uparrow$	
screening				$\uparrow$
productivity H	$\uparrow^{\ddagger}$	$\uparrow^{\ddagger}$	$\uparrow^{\ddagger}$	$\uparrow^{\ddagger}$
interest rate r	$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$
loan size L	$\downarrow$	$\downarrow^{\ddagger}$		$\nearrow\searrow^{\ddagger}$

Under assumption A2, section 2.1.1.
All correlation results rely on general, symmetric parametrizations of the correlation.
If the marginal cost of penalizing is less than one.
If unofficial penalties are larger than the loss to a borrower due to his partner's default.

Testing Models of Microcredit

Ahlin and Townsend, 2007: Step 2

Step 2: The idea of the empirical work is to see how, given cross sectional data on group repayment R and characteristics $X = (X_1, ..., X_M)$, the frequency of repayment R varies across groups with different characteristics X.

Potentially one could determine the shape of the entire probability of repayment surface $P(R = 1|X)$ in each of the theories. To estimate this too little data is available. Instead they focus on estimating the partial $\partial P(R = 1|X)/\partial X_m$.

Testing Models of Microcredit

Ahlin and Townsend, 2007: Step 2

Even this requires further assumptions. They make two:

- Assumption 1: $P(R = 1|X^g)$ can be written as $P(\beta X)$. This restricts covariates to enter repayment probabilities as a linear combination, leaving P unrestricted.
- Assumption 2: The probability function P is logistic.

$\rightarrow$ This gives a standard logit model, which can be estimated by maximum likelihood.

Potential problems? Endogeneity, 'selection into models'.

Testing Models of Microcredit

Ahlin and Townsend, 2007: Step 2

I spare you going in detail through the empirics. They depend on finding some measures for all the above variables, which can be interpreted in various ways.

Their conclusion: "We find that the Besley and Coate model of social sanctions that prevent strategic default performs remarkably well, especially in the low-infrastructure northeast region. The Ghatak model of peer screening by risk type to overcome adverse selection is supported in the central region, closer to Bangkok. [...] Social structures that enable penalties can be helpful for repayment, while those which discourage them can lower repayment."

Literature

Agency Theory

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Summary

Theory

In the last two days, we have seen models of Stiglitz and Weiss (1981) and Stiglitz (1990) that explain why credit markets might not work and corresponding theories why the joint liability (and self-selection) of groups – in theory – might help to alleviate these problems in Ghatak (2000) and Stiglitz (1990).

Note:

- We focussed mostly on implications for repayment. However, a higher repayment rate does not necessarily correspond to higher welfare. It may just reflect the use of penalties to enforce repayment when it is not optimal.
- We as well assumed perfect competition of for-profit lenders (through a zero-profit constraint). What would the models imply for a different competitive environment?

Summary

Empirics

On the empirics side, we have

- seen some evidence that borrowers *are* credit constraint (de Mel et al., 2008).
- seen evidence that moral hazard can explain some of this (Karlan and Zinman, 2009). (In a very selected pool of borrowers, adverse selection does not.)
- looked at empirical work which tries to test whether some of the models of micro-finance (and which) can explain these effects (Ahlin and Townsend, 2007).