Lectures in Growth and Development

(M. Ghatak, LSE, 2018)

Ec428

Topic 5: Credit Markets in Developing Countries

These notes are not guaranteed to be error free. If you spot one, please let me know.

Also material marked with ** means optional material.

Introduction

- Credit market - all forms of financial intermediation.
- Links savers to investors
- What is so special about credit markets?
  - Matches talents, skills, and resources
  - Helps investment in skills
- Otherwise, your economic outcome dependent on how much wealth you start out with, not innate talent.

- So credit markets important for individuals and economies to rich their full potential

- Why are they particularly likely to be imperfect?
  - The act of buying & paying up separated in time (same in insurance market)
  - When the time comes people may be
    * Unable to repay
    * Unwilling to repay
  - Taking people to court is costly.
  - Also, limited liability - legal limits to how much you can punish (not true in pre-capitalist economies)

- Anticipating this, lenders are more careful than other sellers. They
  - Screen (corresponds to adverse selection)
  - Monitor (corresponds to moral hazard)
  - Threaten to cut out future loans (corresponds to enforcement or commitment problems)
  - Obtain collateral (like a "hostage")
  - Implications: Credit markets don't function as the textbook model implies.

Stylized facts

- High interest rates in LDCs (see Banerjee 2004): rural areas 52%, urban areas 28-68%
  - Compare to US rates: 6-14% during 1980-2000.
  - Can't be explained by default (explains at most 7-23% - percentage, not percentage points - of level of the interest rates)
  - Big gap between deposit and lending rates - Pakistan (Aleem, 1990) - lending rate 78%, cost 32%
  - In India average lending rate 20% in 1976, buy deposit rates low - bond rate 3%

- Presence if informal sector
  - Timberg and Aiyar, 1984: informal lenders supply 20-30% of capital needs of small scale firms in urban/semi-urban areas in India
  - In rural areas, a study (Dasgupta, 1989) professional moneylenders provide 45% of credit

- A wide range of interest rates prevailing in the same area with no apparent arbitrage
  - Siamwalla et al (World Bank Economic Review, 1990): study of rural credit markets in Thailand, found informal sector annual interest rate to be 60% whereas formal sector rate ranged from 12-14%.
  - Aleem (1990): standard deviation of 38%, 2% and 150% both within two standard deviations

- Borrowers are able to borrow only up to a limit for a given interest rate, and are not given a larger loan even if they are willing to offer a higher interest rate. The very poor are unable to borrow at any interest rate (Credit rationing)

- Evans and Jovanovic (Journal of Political Economy, 1989), found that even in the US entrepreneurs on average are limited to a capital stock no more than one and one-half times their wealth when starting a new venture, & the very poor are unable to borrow at any interest rate

- In India, strong positive correlation between wealth and debt, plus rich pay lower interest rate

- Appears to be a fair bit of ex ante competition

- Production and trade main reasons for credit

- Not consistent with standard supply-demand model of credit market with interest rates adjusting to clear market

- One explanation: monopoly.
  - Can explain different interest rates (price discrimination)
  - However, why charge high interest rates since that kills loan demand?
  - What is the informal sector doing?
  - Also, public sector banks are present so monopoly power is restricted

- Another explanation - interest rate regulations

- But does not apply to informal sector

- More convincing answer - transactions costs creates natural entry barriers
  - See Aleem, 1990, WBER for evidence from Pakistan
  - Also, in their study of Vietnamese firms McMillan and Woodruff (1999) report:

"... trade credit tends to be offered when (a) it is difficult for the customer to find an alternative supplier; (b) the supplier has information about the customer's reliability through either prior investigation or experience in dealing with it; and (c) the supplier belongs to a network of similar firms, this business network providing both information about customers' reliability and a means of sanctioning customers who renege on deals. Social networks, based on family ties, also support relational contracting, although the evidence for their efficacy is weaker than for business networks.

- Study formal models of the borrower-lender relationship subject to the following problems

- Two broad classes of distortions - behaviour and selection

- Behaviour

1. Enforcement, or strategic default
    - Borrower can default even when he is able to repay due to imperfect legal system even without any informational asymmetries

2. Moral Hazard - ex ante or ex post
    - The action of borrower that affects repayment prospects cannot be costlessly observed
    - May not put adequate effort to make project succeed or take too much risk (ex ante moral hazard)

- May under-report revenue in order to minimize repayment (ex post moral hazard or costly state verification)

- Selection
  - Adverse Selection: Borrower knows more about his type than the lender does
  - Those who are most willing to take loans may not be the best risks from the lender's point of view

- We will cover one model each capturing the behaviour and selection issues in the lecture

Enforcement

- Suppose the producer uses a production technology $F(L) = \sqrt{L}$ converting loans into output.

- The production function has the standard features of positive but diminishing marginal returns.

- Let ρ be the interest rate.

- Suppose the producer is choosing how much to borrow. Then he solves:

$$\max F(L) - (1 + \rho)L$$

- First-order condition

$$F'(L) = \frac{1}{2\sqrt{L}} = 1 + \rho$$

or

$$L^* = \frac{1}{4\left(1+\rho\right)^2}.$$

- Notice that if the producer had enough money, he would not have to borrow - he would self-finance

- In that case, he will use the same amount of capital as above - with complete and perfectly competitive markets, it does not matter what your endowment is, you make the efficient production decision, as we saw in Topic 3.

- Lets return to the producer who needs to borrow but now introduce a market friction.

- Suppose people can simply refuse to repay even when they are able to.

- Can use collateral:

$$F(L^*) - (1+\rho)L^* \geq F(L^*) - c$$

- So c has to be as high as $(1+\rho)L^*$

- Otherwise, can borrow up to your assets a

- By definition rationed, as $a < (1 + \rho)L^*$

- Notice the result that $L(1 + \rho) = a$ is true only in a static model, and only when there are no other punishments for default (e.g., non-pecuniary costs, such as harassment by lender)

- Marginal products will vary, and will exceed interest rates

- If there are future periods where the borrower could again need a loan, the threat of credit denial in the future might make him behave properly.

- We show even in this case credit rationing will typically arise.

- Let a be the amount of assets that can put up as collateral.

- Let v be the per period outside option or reservation payoff of a borrower, which indicates what he will receive if he does not receive loans.

- This could be expected payoff from borrowing from another lender, or returns from an activity that does not require borrowing

- Let $R = (1+r)L$ denote the amount he needs to pay back, principal plus interest.

- Let δ be the discount factor.

- He will want to repay if

$$\frac{F(L) - R}{1-\delta} \geq F(L) + \frac{\delta}{1-\delta}v - a$$

- This is the incentive-compatibility constraint (ICC)

- The right hand side is the payoff from defaulting and the left hand side is the payoff from repaying.

- This can be simplified as

$$\delta\left[F(L)-v\right]+(1-\delta)\,a\geq R$$

- The lender will break even so long as

$$z=R-(1+\rho)L=0.$$

- These two equations can be solved for the two unknowns, r and L (recall that $R=(1+\rho)\,L$).

- In particular, $r=\rho$ and so the ICC gives a single equation in a single unknown, L. Let the solution be $\tilde{L}$.

- It is easy to see in Figure 1 that typically, credit rationing will arise.

- Also, now $\tilde{L}(1+\rho)$ will be typically higher than a since only when $\delta = 0$ we get back the same expression as in the static model

- The zero profit constraint and the incentive compatibility constraint will be satisfied at some level of loan $\tilde{L}$ which will typically be less than the efficient level of loan, L^*.

- There could be multiple solutions, but $\tilde{L}$ Pareto dominates the others.

- It is easy to see that the higher is the outside option of the borrower, the lower his wealth, and the lower is δ, his discount factor, the greater will be the extent of rationing.

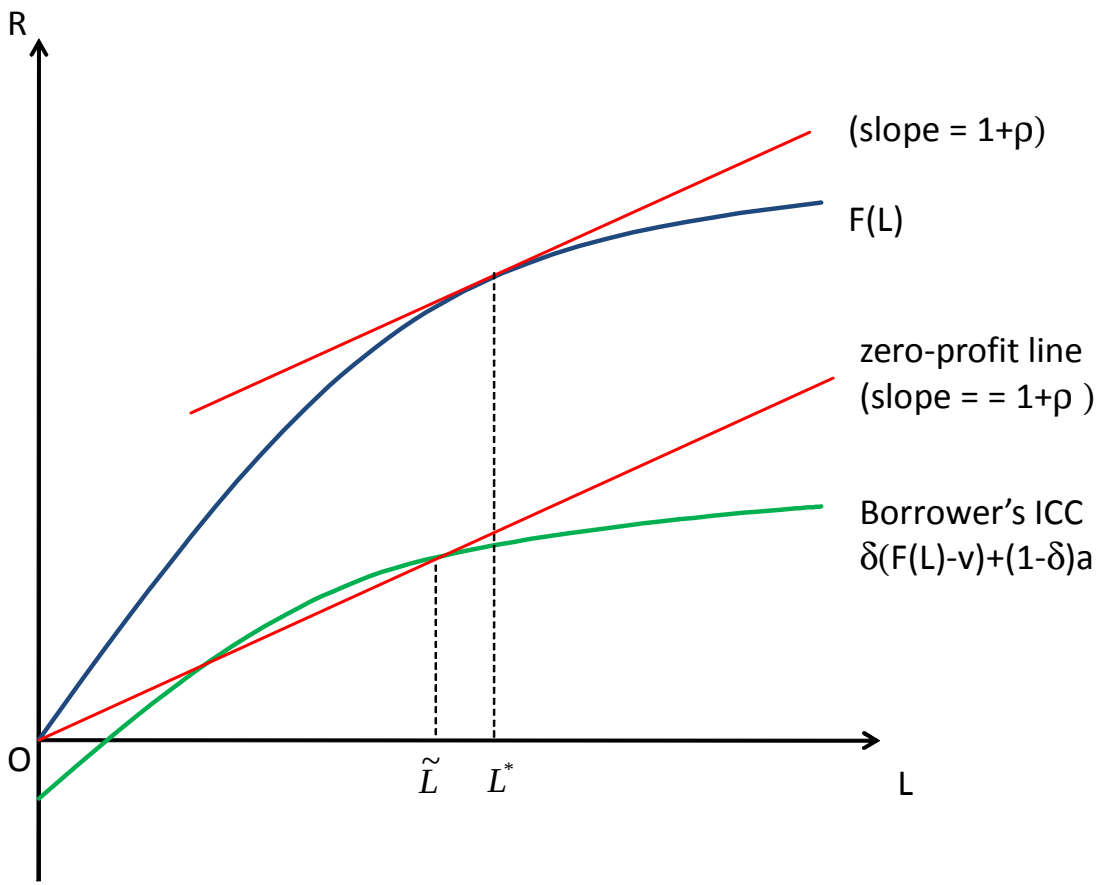

R
(slope = 1+ρ)
F(L)
zero-profit line
(slope = = 1+ρ)
Borrower's ICC
δ(F(L)-v)+(1-δ)a
O
$\tilde{L}$
L^*
L

Figure 1

- On the other hand for low levels of v, high values of a, and high values of δ, it is possible $\tilde{L} > L^*$ in which case L^* will be chosen

- It would have been chosen in the first-best, and so it becomes feasible in the second-best people should still choose it).

- It is not efficient to have the loansize exceed L^* since the borrower demands at most L^*

- Several implications:
  - How much you can borrow depends on your wealth
  - Very poor borrowers may not be able to borrow at all
- See diagram below that gives $\tilde{L}$ as a function of a

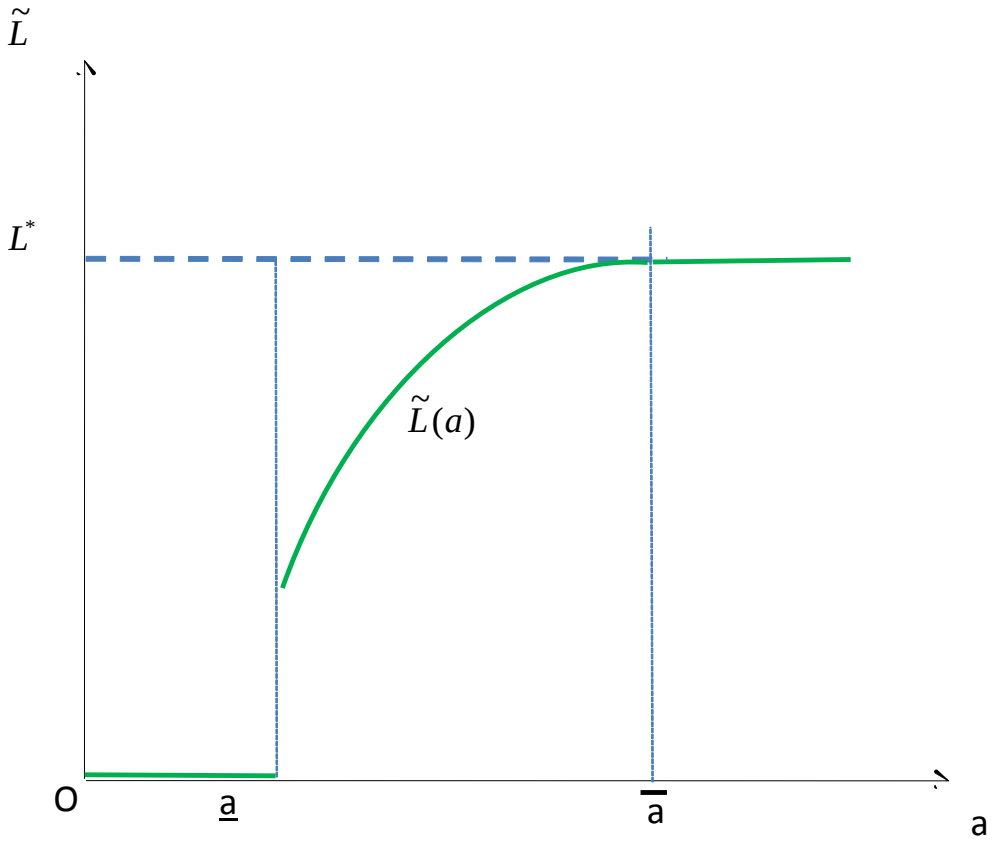


Figure 2

How Could Better Credit Market Institutions Affect Output?

- Recall that the IC is

$$\frac{F(L) - R}{1 - \delta} \geq F(L) + \frac{\delta}{1 - \delta} v - a$$

- Let there be some credit-rating system that leads to some loss (e.g., reputation, ability to borrow from other sources) if you default

- This can be captured as a fall in v

- Also, let there be some friction in the ability of lender's to grab collateral: say, if you have wealth worth a, due to problems in the legal system, only $(1-\tau)\,a$ is the collateral value of wealth

- Then the IC can be written as:

$$\delta\left[F(L)-v\right]+(1-\delta)\,(1-\tau)\,a\geq R$$

- Now we can see that a fall in v or τ will increase $\widetilde{L}$

- In the model we have, there is no default and so all borrowers will be charged the same interest rate if there is competition

- Adding a shock to the model will fix this

- Say, p is the probability of success, in which case output is $F(L)$ and otherwise it is 0 in which case they default voluntarily.

- Let V be the expected lifetime payoff from being in the relationship, and $U \equiv \frac{v}{1-\delta}$ (exogenously given) from being outside it.

- We have:

$$\begin{aligned} V &= p\{F(L)-R\}+\delta pV+(1-p)(\delta U-a) \\ &= \frac{p\{F(L)-R\}}{1-\delta p}+\delta\frac{(1-p)}{1-\delta p}U-\frac{(1-p)}{1-\delta p}a \end{aligned}$$

- Notice for $p=1$ it collapses to the same expression as the earlier part:

$$V=\frac{F(L)-R}{1-\delta}$$

- The incentive constraint is

$$F(L)-R+\delta V \geq F(L)-a+\delta U$$

- This simplifies to:

$$\delta\left[pF(L)-v\right]+(1-\delta)\,a\geq R$$

- Once again, if you set $p=1$ it becomes the same as in the previous case.

- The zero profit condition is

$$\begin{aligned} pR+(1-p)\,a &= (1+\rho)L \\ \text{Or, } R &= \frac{(1+\rho)L}{p}-\frac{(1-p)\,a}{p}. \end{aligned}$$

- Now the interest rate $\hat{r}$ (which is given by $1+\hat{r}=\frac{R}{L}$) is no longer equal to ρ unless $p=1$

$$1+\hat{r}=\frac{(1+\rho)}{p}-\frac{(1-p)\,a}{pL}.$$

- The higher is a the lower is $\hat{r}$

- Therefore, interest rates will differ - richer borrowers will be charged a lower rate

- Also, so long as $(1+\rho)L > a$ (loans are not fully collateralized, which is possible due to dynamic incentives) $\hat{r} > \rho$.

- Now borrowers will be charged an interest rate that will be higher than opportunity cost of capital, even with competition

- The zero profit condition and the incentive constraint can be solved together for $\hat{r}$ and L.

Ex Ante Moral Hazard

- Project return can take on two values, Y ('high' or 'success') and 0 ('low' or 'failure') with probability p and $1-p$ respectively.

- The borrower chooses p, ('effort'), which costs him $c(p) = \frac{1}{2}\gamma p^2$.

- Opportunity cost of funds ρ (principal plus interest rate)

- Opportunity cost of labor, u.

First-Best (Effort Observable)

- The entrepreneur will solve the following profit maximization problem:

$$\max_{\{p)} \pi = pY - \frac{1}{2}\gamma p^2 - \rho - u$$

  - Yields

$$p^* = \frac{Y}{\gamma} < 1.$$

- Now consider the case where he has no cash but some illiquid asset worth a.

- Let r be the gross interest rate, i.e., when the net interest rate is $\hat{r}$, $r = 1 + \hat{r}$

- Earlier we had variable loan size and used the notation R for gross amount to be repaid, now loan size is normalized to 1 and so r is equivalent to R

- The lender faces a limited liability constraint: pay r when the project return is high and $-a$ when the project return is low.

- This means that the borrower's payoff is

$$\pi^b = p\,(Y - r) - (1 - p)a - \frac{1}{2}\gamma p^2 - u$$

- The lender's expected payoff is

$$\pi^l = pr + (1 - p)a - \rho.$$

- If the lender could observe his effort level then what they should do is find a contract that maximizes their joint expected payoff:

$$\pi^b + \pi^l = pY - \frac{1}{2}\gamma p^2 - \rho - u$$

- This is exactly the expected payoff of a self-financed entrepreneur.

- Naturally, the effort they will mutually agree to choose will be

$$p^* = \frac{Y}{\gamma}.$$

Second-Best (Effort Unobservable)

- Now the borrower will choose p so as to maximize his private payoff.

- The incentive-compatibility constraint (IC):

$$p = \arg \max_{p \in [0,1]} \left\{ p(Y - r) - (1 - p)a - \frac{1}{2}\gamma p^2 - u \right\}$$

- This yields

$$p = \frac{Y - r + a}{\gamma} \in (0, 1).$$

- Effort will therefore be less than first-best (as $r < a$)

- The underlying environment is that of competition: lenders compete for borrowers which drives their profits to zero

$$pr + (1 - p)a - \rho \geq 0.$$

- So long as $r > a$ (loan not fully collateralized) interest rate would be higher than ρ, reflecting default

- Solving out the zero-profit condition

$$r = \frac{\rho - (1 - p)a}{p}$$

- Interest rate will be decreasing in wealth

- If wealth is zero $r = \frac{\rho}{p}$ which is the highest possible, and so p is the lowest possible, from the IC

- It is possible (see the appendix for details) that unless u is very low, the contract cannot satisfy all the constraints (incentive, zero-profit, and borrower's participation) and so no borrowing will take place.

- In the appendix we work out the contracting problem in detail

Adverse Selection

- Two types of borrowers characterised by the probability of success of their projects, p_r and p_s, where

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

- Henceforth they will be referred to as 'risky' and 'safe' borrowers, exist in proportions θ and $1 - \theta$ in the population.

- The outcomes of the projects are assumed to be independently distributed.

- The rest similar to above section.

- Full information case: from the bank's zero-profit constraint

$$r_i^* = \frac{\rho}{p_i}, \quad i = r, s$$

- Adverse Selection: Charging separate interest rates to the two types borrowers would not work. A risky borrower would have an incentive to pretend to be a safe borrower.

- The expected payoff to borrower of type i when the interest rate is r is

$$U_i(r) \equiv p_i Y_i - \ rp_i, i = r, s.$$

- Stiglitz and Weiss (1981) : risky and safe projects have the same mean return, but risky projects have a greater spread around the mean.

- Using a simple version of their model as in Ghatak (2000), suppose:

$$p_s Y_s = p_r Y_r \equiv Y$$

- Assume that these projects are socially productive in terms of expected returns given the opportunity costs of labour and capital :

$$Y > \rho + u. \qquad (A1)$$

- Under asymmetric information, if the bank charges the same nominal interest rate r then safe borrowers will have a higher expected interest rate:

$$p_s(Y^s - r) < p_r(Y^r - r).$$

- Pooling contract: $r = \frac{\rho}{\theta p_r + (1-\theta) p_s}$.

- A pooling contract does not exist that attracts both types of borrowers if:

$$Y < \frac{p_s}{\overline{p}} \rho + u. \qquad (A2)$$

- Under-investment problem in credit markets with adverse selection (Stiglitz and Weiss, 1981).

Solutions

- Collateral: if feasible, then could screen borrowers by offering two contracts: one with low interest and high collateral and one with high interest and low collateral
  - Risky borrowers will self-select the latter and safe borrowers the former
  - Why? Because a risky borrowers is more likely to fail and so does not like high collateral
  - Probability of granting loans as a screening device. Advantage over pooling debt contracts is that some safe borrowers will obtain credit at the full-information interest rate. Hence both welfare and repayment rates will be higher.

  - However, not feasible if borrowers are poor.

- Credit history

- Start with small loans to check type, then give bigger loans

Evidence

- The theory points out certain mechanisms through which credit markets affect development outcomes

- In particular, if credit market institutions work better (e.g., improved legal system) then output should go up

- In all three models, if the borrower faces a greater cost of default (effective value of a goes up, greater reputational loss etc), credit constraints would be relaxed

- We will first give a broad overview of the some of different approaches in which people have tried to test for the presence of capital market frictions, and its impact on constraining development potential at the macro (country or region) or micro (individual or firm) level

- Only two papers will be covered in depth - the De Mel, Mckenzie and Woodruff (QJE 2008) paper and the Karlan and Zinman (Econometrica, 2009) - and are required readings

Macro Level Evidence

1. Financial development & growth performance across countries

- The size of the domestic credit market is strongly positively correlated with per capita income across countries (as suggested by Figure 3 taken from Rajan-Zingales 1998)

- However, the causality could be the other way round: richer countries have larger markets for everything, including credit.

- Also, both per capita income and size of the credit market could be driven by other factors, such as good government policies, so that this correlation does not necessarily suggest a causal relationship

- Cross country evidence for the period 1960-1989 by King & Levine (1993) suggests that controlling for many country & policy characteristics, higher levels of financial development are associated with faster rates of contemporaneous & future (next 10-30 years) economic growth.

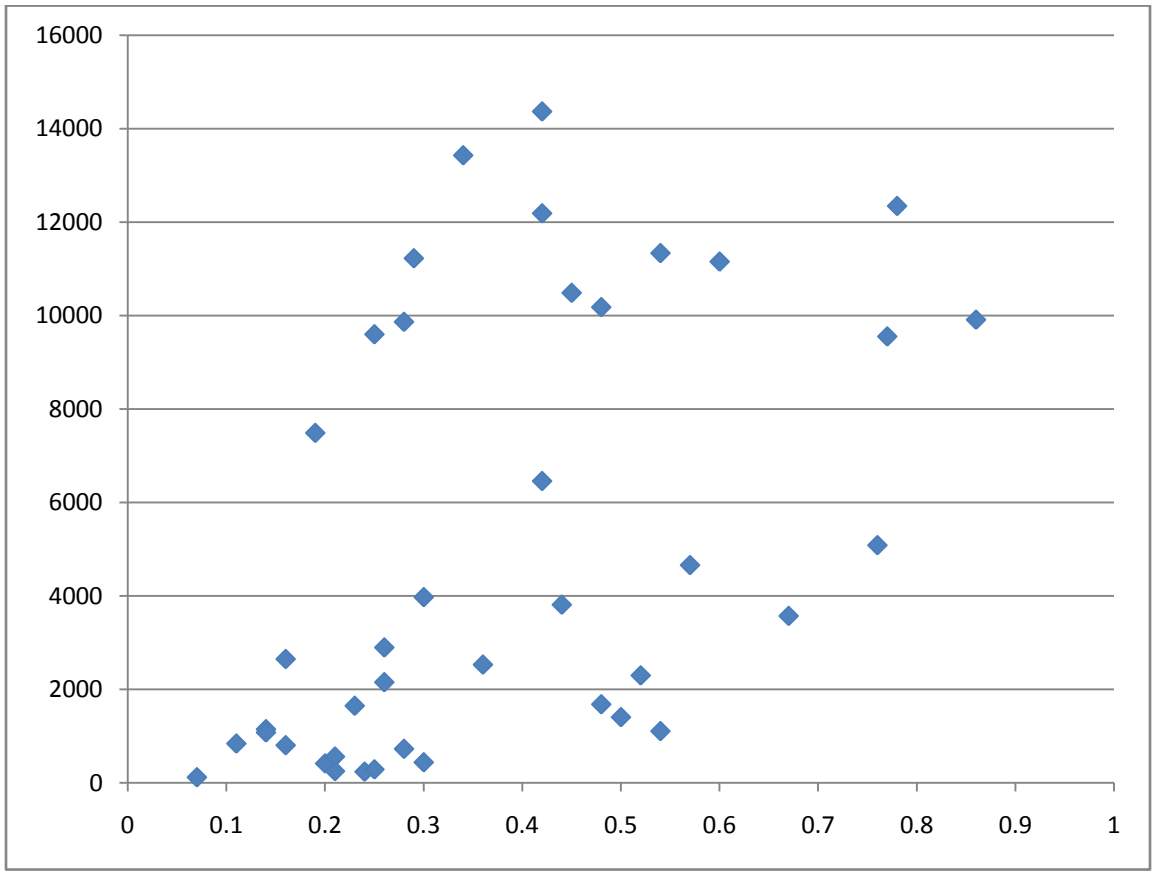
- Rajan & Zingales (1998) point out that this study could have two potential limitations.

  - Both financial development & growth could be driven by a common omitted variable such as the propensity to save.

  - Financial development may simply be a leading indicator of future development & not a causal factor - anticipating future growth financial institutions lend more.

- They propose an alternative test - do industries that are technologically more reliant on external finance (e.g., Drugs & Pharmaceuticals as opposed to Tobacco) grow faster in countries that are more financially developed?

Figure 3



Source: Rajan and Zingales (1998)

Size of the Credit Market and Per Capita Income Across Countries

Per Capita Income(US 1980 $) on vertical axis
Domestic credit to Private Sector over GDP on horizontal axis

- Roughly speaking, they are comparing the growth performance of industry A and industry B in US vs. India where A and B vary in terms of how credit-dependent they are

- Any common country level factor is taken out using the inter-industry comparison

- They find a strong positive evidence on financial development on growth of industries that are more credit-dependent. Moreover, decomposing industry growth into that due to expansion of existing firms, & entry of new firms, they find financial development has a much larger (almost double) effect on the latter.

- Still problems of interpretation remain

- The common trend assumption may not have held
- Country level factors could affect different industries differentially, in which case the "cross-country" criticism resurfaces
- For example, the regression results could be interpreted as showing contract enforcement matters, not credit constraints per se: those industries that are credit-dependent also are R&D intensive and are more likely to be affected by institutional quality
- Also, US might have a comparative advantage in credit-dependent industries, which means they have more innovations (notice that this argument does not apply for levels, only growth rates)

2. Cross country evidence (Djankov, McLiesh, and Shleifer, 2006)

- Why do some countries have much bigger capital market than others?

- Study 129 countries over a 25 year period finds that legal rights of lenders (ability to force repayment, grab collateral) is positively correlated with the ratio of private credit to GDP.

- Changes in this measure are associated with an increase in the ratio of private credit to GDP.

Micro level Evidence

1. Individual level: Does wealth affect transition from worker to entrepreneur?

   - If credit markets were perfect, the only thing that should affect your ability to become an entrepreneur is your ability

   - Regression runs probability of becoming an entrepreneur on measures of ability (x) & wealth (a):

$$y_i = \alpha + \sum_{j=1}^{n} \beta_j x_{ij} + \gamma a_i + \varepsilon_i$$

- Wealth seems to matter. Panel data studies from the US (Evans & Leighton, AER 1989) and the UK (Blanchflower & Oswald, JLE 1998) that studied the same cohort of young men over several years

- Obviously, hard to control for all measures of ability & wealth could capture some of this omitted ability variables (families that save more work harder, families that save more earn more & so are more able etc.)

- Blanchflower & Oswald considered effects of wealth shocks which could be assumed to reasonably independent of ability - gifts & bequests.

- Wealth still seems to matter.

- But it is possible that likelihood of a positive wealth shock could be correlated with personal traits that affect positively the likelihood of becoming an entrepreneur (being likeable).

2. Firm level

- Interest rates are very high in developing countries - but could reflect scarcity.

- There are big differences in interest rates that are not being equalized by arbitrage, but that could be because the underlying risk-profiles of the borrowers and the costs of financial intermediation are different.

- You might say that rates of return to capital in firms estimated using data on firm earnings and capital stock are high, and exceed significantly the formal or informal interest rates available.

- If returns from capital significantly exceed its cost, firms should be expanding their capital stock, and if they aren't that means they are credit constrained.

- Not necessarily, critics will say.

- The ability of entrepreneurs affect both the choice of the capital stock, and the rate of return (for example, smart guys need less capital and can generate more returns), and without controlling for it, these are biased estimates.

- In particular, we don't know whether we are measuring the returns to ability or to capital and whether the capital stock is optimally chosen given the entrepreneur's ability, or the firm is credit-constrained.

- OK, since ability is notoriously hard to measure, you would think that this is the point at which economists would give up.

- Several approaches to overcome this.

Approach 1: Using a Policy Shock

- In "Are Firms Credit Constrained? Testing Credit Constraints Using a Directed Lending Program" (Banerjee-Duflo, RES 2014) consider a policy shock in the banking sector in India.

- A firm is credit constrained if marginal product of capital is higher than the market interest rate.

- If credit markets were perfect then changes in access to close substitutes of credit, such as current cash flow of a firm, should not have an effect on the decision to invest. Problem with this test: shocks to the cash flow of a firm are not always exogenous (e.g., hire a good manager)

- Policy change
  - All banks are required to lend 40% of their credit to the priority sector which includes small scale industry at a subsidized interest rate.
  - In 1998 the government increased the size limit for a firm to be considered a small scale unit (from $130,000 to $600,000).
- If a firm is not credit constrained (call it unconstrained) then having some extra subsidized loans is a great thing, but it would not result in a significant amount of extra investment.
- It would mainly re-organize its loan portfolio and pay off some of the more expensive loans. In contrast a firm that is constrained, will increase investment.

- While the investment levels of both constrained and unconstrained firms could go up, the rate of growth of investment should be higher for constrained firms.

- If you just look at the rate of growth of firms that were not initially covered by this policy, and was brought under it due to the policy shift, and find that they grew significantly (in terms of investment, revenue, profits etc.) that per se would not establish they were credit constrained.

- There could have been an increase in growth opportunities in the economy

- You want to take the effect of these other shocks out.

- The obvious way is to compare these firms with firms that were already borrowing under this policy and continued to do so.

- That is, BD take a difference-in-difference approach: they compare the outcome variable of interest before and after the policy change ("difference") and compare this for the group that was subject to the policy change to a control group that was not subject to the policy change ("difference-in-difference").

- Find that profits and sales grew much faster with relaxation of credit constraints

- Is it possible that profits and sales increased because cheaper loans became available, and not necessarily because firms were credit constrained?

- BD show that the interest rate did not decline for big firms relative to small firms when they were included in the priority sector

- Yet they borrow more, suggesting binding credit constraints.

Approach 2: Using a Randomized Control Trial (de Mel, Woodruff, Mckenzie, QJE 2008)

- The authors have come up with a direct approach - random capital grants
- Why not take a random sample of firms and then randomly give some of them some extra capital and measure the difference with those who did not get it?
- The authors randomly distributed small capital grants worth $100 and $200 to a sample of small enterprises (with less than $1000 in capital) in Sri Lanka.

- Since by design the grants were given randomly, both talented and not-so-talented entrepreneurs would get them.

- If we measure the effect of these grants, it will capture the average effect across all talent levels.

- In particular, we will not have to worry that the extra capital generated by the grant to a firm is correlated with the ability of its entrepreneur and so we will be measuring the effect of extra capital only.

- Table 1 suggests that the treatment and control groups are roughly similar in all respects, starting with initial level of profits, initial capital stock, various characteristics of the entrepreneur (age, education) and the firm.

Table 1: Comparison of Control and Treatment Groups in de Mel et al Study

	Treatment	Control	Average
Profits (March 2005)	3919	3757	3851
Capital Invested Excluding Land and Building	25633	27761	26530
Age of Entrepreneur	41.8	41.9	41.8
Years of Schooling	8.9	9.2	9
Age of Firm	10.8	9.7	10.3

Note: All monetary data in Sri Lankan Rupees.

Table 2: Impace of Grants on Profits on Treatment Firms in de Mel et al Study

Treatment	Effect on Capital Stock	Effect on Real Profits
10,000 LKR	10781	1421
20,000 LKR	23431	775

Note: All monetary data in Sri Lankan Rupees deflated to reflect March 2005 prices.
Profits are measured monthly.

Source: de Mel et al (2009)

- This confirms the validity of their randomization strategy.

- The authors then estimate the effect of these two types of treatments on capital stock and profits.

- The difference between the capital stock and the profit levels of the treatment firms relative to the control firms are displayed in Table 2.

- They estimate the returns to capital to be around 4% per month, or 60% per year.

- This is substantially higher than market interest rates.

- This suggests the firms are indeed credit-constrained.

- In the appendix, this is discussed in greater detail.

- One puzzle: why does the 20K grant have a lower effect on profits than a 10k one?

- The authors' response: ultimately their Sri Lanka study doesn't have sufficient power to really look at these differences between the 10K and 20K grants

- The 95% confidence interval for the 10K cash grant is 452 to 2390, and for the 20K cash grant is -488 to 2039.

- They can't reject equality of treatment effects (p=0.41), nor can they reject that the 20K has 1.7 times the effect as the 10K (p=0.11).

- Similarly, for the log specification, the confidence intervals are really wide (e.g. 0 to 0.42 for the 20K cash treatment).

- The CDF the authors shared (pooling together rounds 6 to 9 of the data), Figure 4, show a little better what is going on.

- Both treatments do better than the control, but the 20K treatment dominates the 10K in lower parts of the distribution of real profits, while the 10K dominates the 20K in the upper parts.

- Taking logs puts more weight on the lower part, which is why you see a higher treatment effect for the 20K than the 10K in logs.

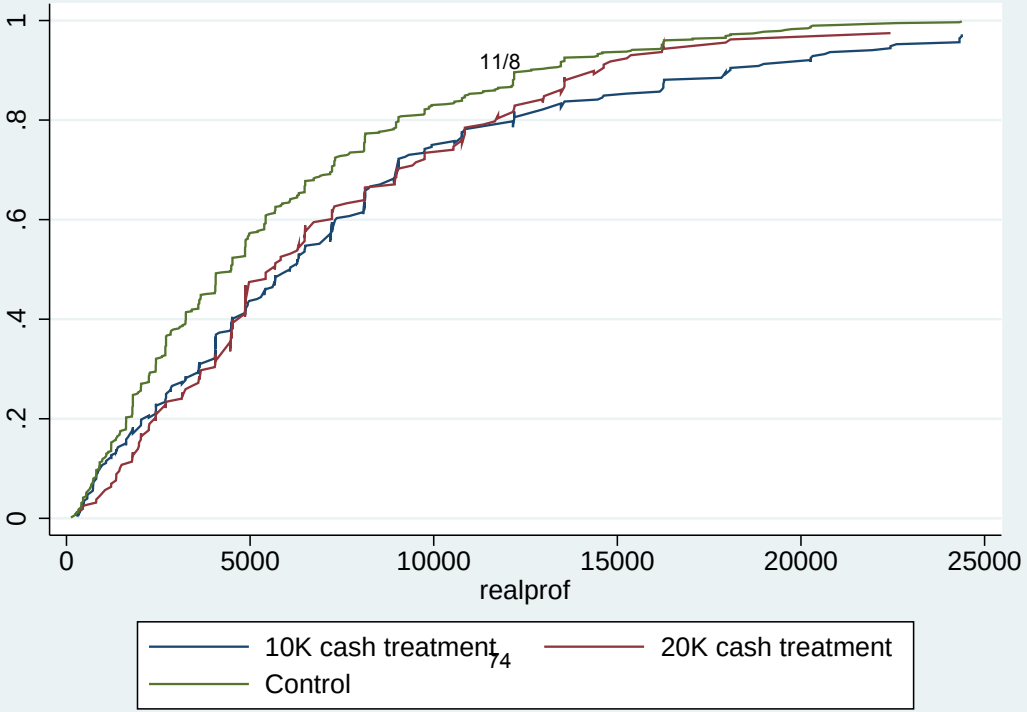

11/8
0
.2
.4
.6
.8
1
0
5000
10000
15000
20000
25000
realprof
10K cash treatment
20K cash treatment
Control

Figure 4

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.

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.

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.)

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**	0.379***	5.16**	5.29**	4.59**
	(2.34)	(0.121)	(2.26)	(2.28)	(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: 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: 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.

Exploring the Mechanism Behind Credit Market Frictions

- So far we examined what happens if capital constraints are relaxed on investment and productivity/output
- From the policy point of view, important to understand what causes credit market frictions
- A recent study has come up with a very interesting way to test between moral hazard and adverse selection (Karlan-Zinman, Econometrica, 2009)
- Experimental study in South Africa

- Lender competes in a "cash loan" industry segment that offers small, high-interest, short-term credit with fixed repayment schedules to a "working poor" population.

- Cash loan borrowers generally lack credit history and/or collateralizable wealth - can't borrow from standard sources

- First the Lender randomized interest rates attached to "pre-qualified," limited-time offers mailed to 58,000 former clients with good repayment histories.

- Private information may be less prevalent among past clients than new clients if hidden information is revealed through the lending relationship

- Randomized direct mail offers issued by a major South African lender along three dimensions:
  - high vs. low initial "offer interest rate" appearing on direct mail solicitations (both less than lender's usual rate)
  - of those who accepted high offer rate half randomly received a low "contract" rate and the other half received the offer rate "contract interest rate"
  - a dynamic repayment incentive: some randomly chosen borrowers are offered the contract rate for future loans so long they remain in good standing.

- Randomization assumption - borrowers did not know beforehand that the contract rate may be lower than the offer rate.

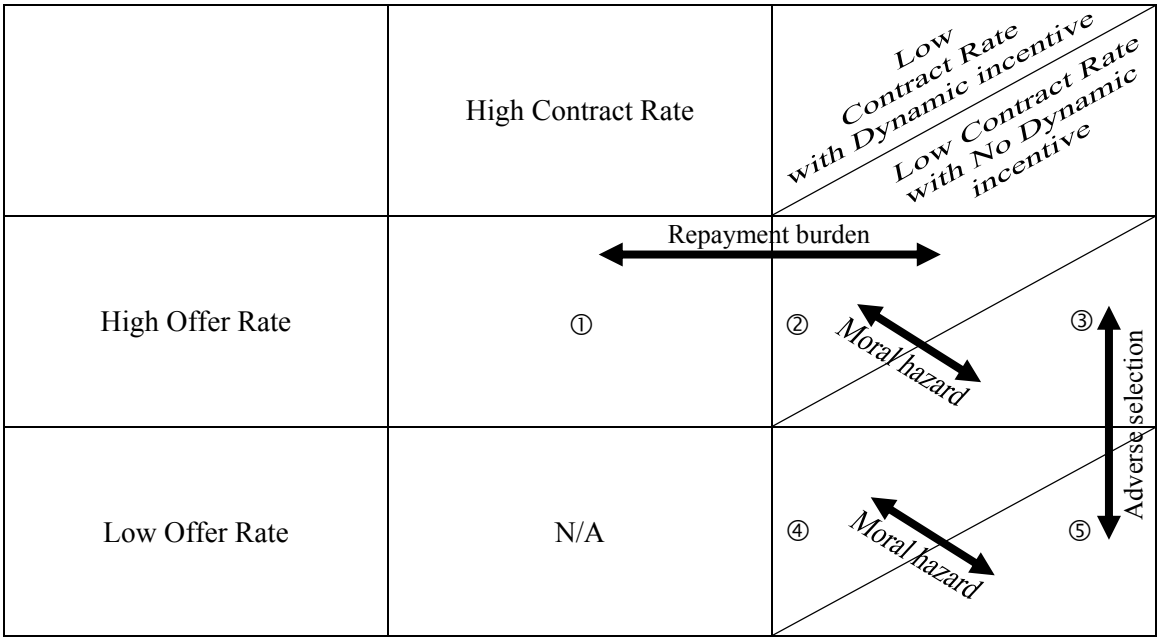
- Otherwise programme placement is not random

- See Figure 5.

- Adverse selection: comparison of those who accepted offer at high offer rates but received low contract rates and those who accepted at low offer rate

- Repayment burden: of those who were offered high rate, comparison of those who received high offer rate vs those who received low rate

Figure 5. Basic Intuition Behind the Experimental Design



Section V formally derives our identification strategy and related assumptions. This figure provides some basic intuition behind our strategy of using three dimensions of random variation in interest rates to identify the presence or absence of specific asymmetric information problems. The actual experiment generated continuous variation in two of the three rates (offer and contract), conditional on observable risk. Here for expositional purposes we label each assigned rate either "high" or "low" based on the median experimental rate for the borrower's observable risk category. This highlights that our methodology:

- Identifies adverse selection by focusing on those who borrow at the low contract rates, and comparing the repayment behavior of those who select in at high offer rates (cells 2 and 3 in the diagram) with those who select in a low offer rates (cells 4 and 5). If there is adverse selection then default will be lower in cells 4 and 5.
- Identifies moral hazard by focusing on those who borrow at low contract rates, and comparing the repayment behavior of those who received the dynamic repayment incentive (cells 2 and 4 in the diagram) with those who did not (cells 3 and 5). If the dynamic repayment incentive alleviates moral hazard then default will be lower in cells 2 and 4.
- Identifies repayment burden by focusing on those who select in at high offer rates, and comparing the repayment behavior of those who borrow at high contract rates (cell 1 in the diagram) with those who borrow at low contract rates (cells 2 and 3 in the diagram). If there is a repayment burden effect then default will be lower in cells 2 and 3.

- Pure moral hazard: for those who received contract rate, comparison of those who received dynamic incentives vs those who did not

- Design of experiment captured in Figure 6.
- In Table 3, for mean comparisons, moral hazard effect is very strong
- Similar results if one controls for lender's measure of observable risk and month dummy
- Findings suggest that about 10% of default is due to moral hazard, the rest due to observable risk differences.
- The fact it is a pre-selected sample, must largely explain why there is no evidence of adverse selection

Figure 6

Operational Steps of Experiment

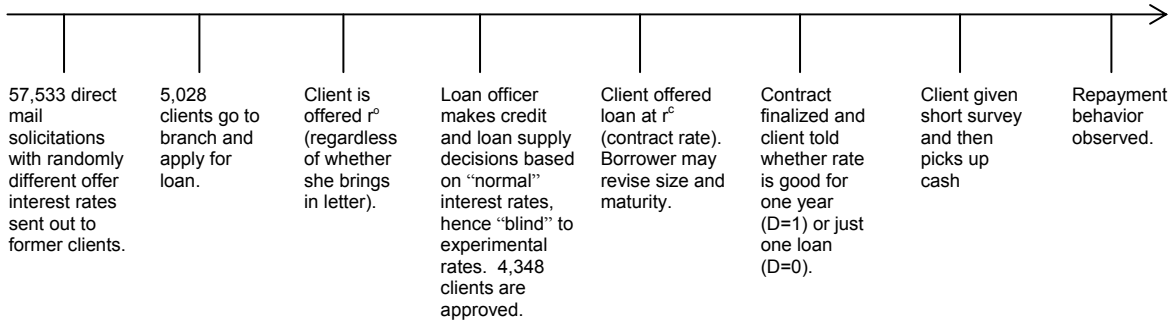


Table 3

Identifying Adverse Selection, Repayment Burden, and Moral Hazard: OLS on the Full Sample OLS

Dependent Variable:	*Monthly Average Proportion Past Due*		*Proportion of Months in Arrears*		*Account in Collection Status*	
	(1)	(2)	(3)	(4)	(5)	(6)
Offer Rate (Selection)	0.004	0.004	0.002	0.002	0.007	0.007
	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)
Contract Rate (Repayment Burden)	-0.000	-0.002	0.007*	0.003	0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)
Dynamic Repayment Incentive Dummy (Moral Hazard)	-0.011*	0.003	-0.016**	0.013	-0.019**	0.000
	(0.005)	(0.011)	(0.008)	(0.018)	(0.009)	(0.019)
Dynamic Repayment Incentive Size (Moral Hazard)		-0.004		-0.008**		-0.005
		(0.003)		(0.004)		(0.004)
Constant	0.079***	0.094***	0.139***	0.171***	0.069***	0.090***
	(0.014)	(0.019)	(0.025)	(0.027)	(0.024)	(0.028)
Observations	4348	4348	4348	4,348	4348	4348
Adjusted R-squared	0.04	0.04	0.11	0.11	0.03	0.03
Mean of dependent variable	0.09	0.09	0.22	0.22	0.12	0.12
Prob(both Dynamic Incentive variables = 0)		0.08*		0.01***		0.05**

* significant at 10%; ** significant at 5%; *** significant at 1%. Each column presents results from a single model estimated using the base OLS specification (equation 14). Tobits and probits (not reported) produce qualitatively identical 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. All models include controls for lender-defined risk category and month of offer letter. Adding loan size and maturity as additional controls does not change the results. A positive coefficient on the Offer Rate variable indicates adverse selection, a positive coefficient on the Contract Rate variable indicates a reduced-form repayment burden effect, and a negative coefficient on the Dynamic Repayment Incentive variable indicates moral hazard that is alleviated by the dynamic pricing incentive.

Jack, Kremer, de Laat, and Suri (2018)

- Farmers were randomly assigned to one of four experimental loan groups, two of which were randomly divided into subgroups after take up of the loans, to fund buying a water tank of about $320, which is 20% of average consumption.

- There is a direct instrument of borrowers having to make deposits (lets call it x_1), then there is joint liability in the form of guarantors pledging part of the loan in the form of depositing some fraction of the loan (x_2), and the possibility of collateralizing some fraction of the value of the tank (x_3).

- The four cases vary in these dimensions.

- One group was offered loans with the standard 100% secured joint-liability conditions typically offered by the the saving and credit co-operative SACCO that the researchers collaborated with. The borrower was required to make a deposit of one-third of the loan and to have up to three guarantors deposit the other two-thirds of the loan with the SACCO as financial collateral. This group is called **Group C** $(x_1 = 0.33, x_2 = 0.66, x_3 = 0)$

- A second group was offered the opportunity to put down a 25% deposit, and to collateralize the remaining 75% of the loan with the tank. This group is denoted **Group D** $(x_1 = 0.25, x_2 = 0, x_3 = 0.75)$

- In a third group, the borrower had to put down 4% of the loan value in a deposit and could find a guarantor to pledge the remaining 21%, so the total cash pledged against default was 25% of the loan. Like the deposit group, 75% of the loan was collateralized with the tank. This group is denoted **Group G** $(x_1 = 0.04, x_2 = 0.21, x_3 = 0.75)$

– In a final group, 96% of the value of the loan was collateralized with the tank and only a 4% deposit was required. This is denoted **Group A** ($x_1 =, x_2 = 0, x_3 = 0.96$)

- This is a Table that summarises the design

	x_1	x_2	x_3
Group C	0.33	0.66	0
Group D	0.25	0	0.75
Group G	0.04	0.21	0.75
Group A	0.04	0	0.96

Table 1

- Comparing **Group G** with **Group D** group with the 25% deposit group isolates the impact of replacing individual with joint liability

- In order to distinguish treatment and selection effects of deposit requirements, the set of farmers in **Group D** who took up the loan was randomly divided into two sub-groups.
  - In one, all loan terms were maintained, while in the other, deposits were waived one month after the deposit was made, leaving borrowers with a deposit of 4% as in **Group A**.
  - The deposit (maintained) and deposit (waived) subgroups are denoted **Group DM** and **Group DW**, respectively.
- Similarly, within **Group G** in one subgroup loan terms were maintained and in the other, guarantors had their pledged cash returned and were released from default liability.
  - These guarantor-maintained and guarantor-waived subgroups are denoted **Group GM** and **Group GW**

	x_1	x_2	x_3
Group DM	0.25	0	0.75
Group DW	0.04	0	0.75
Group GM	0.04	0.21	0.75
Group GW	0.04	0	0.75

Table 2

	x_1	x_2	x_3
Group C	0.33	0.66	0
Group D	0.25	0	0.75
Group G	0.04	0.21	0.75
Group A	0.04	0	0.96

Table 1

- The selection effect of the deposit is the difference between borrowers in groups **A** and **DW as in** Karlan-Zinman.

- The deposit treatment effect is the difference between the **DM** and **DW** subgroups.

- Selection and treatment effects of the guarantor are defined analogously

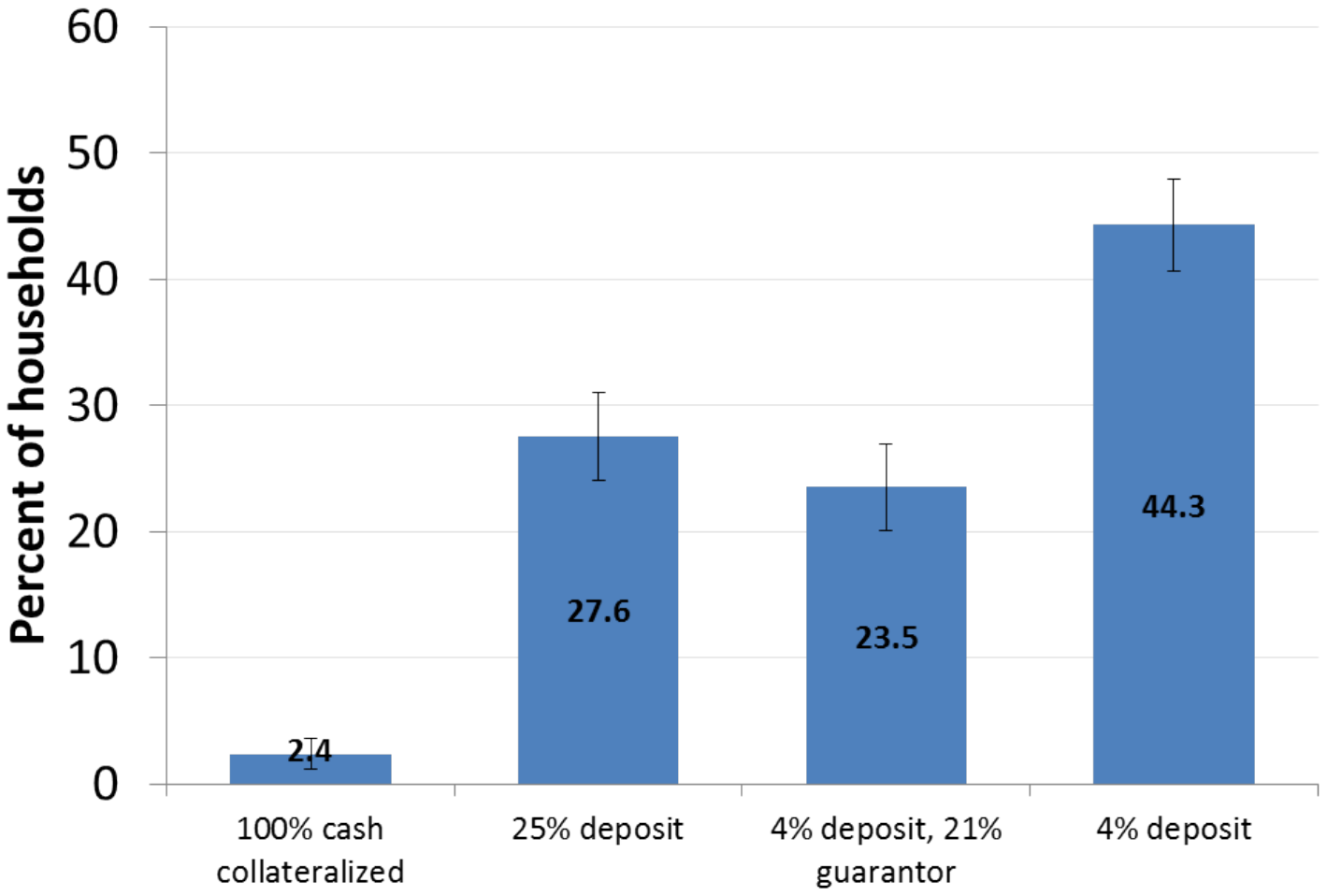
The Technology: Water Tanks

- New tanks lightweight, durable plastic, filled from roof (mostly corrugated iron in this area), or with piped water; 5000 liter capacity
- Introduced about 10 years ago, now dominate the market
- Offered and prominently displayed at agro-dealers
- Cost: 24,000 KSh = \$320, about 20% of annual household consumption
- Farmers install gutter system, platform
- Well-suited as collateral
  - Hard to hide or transport without truck
  - Durable

Savings and Credit Associations

- Farmers sell milk through dairy cooperative, with associated savings and credit association (SACCO)
  - Can facilitate debt collection by deducting debt from milk payments
- 1% monthly interest rate (regulatory cap)
- Repossession costs: KSh 8,500 on average, out of which farmers could be charged no more than KSh 4,000

Take Up, Initial Experiment



Note: Error bars represent 90% confidence intervals.

Take Up

- High elasticity of loan take up
  - 40% of population would like to borrow at the interest rate, but cannot because of borrowing requirements
  - Almost 95% of farmers willing to borrow with 4% deposit will not borrow with 100% deposit
- Joint liability does not increase credit access relative to individual liability
- Under the model, this implies borrower, guarantor requirements costly

- Allowing borrowers to collateralize loans for water tanks using assets purchased with the loans dramatically increased borrowing.
  - Only 2.4% of farmers borrowed under the savings cooperative's standard borrowing conditions.
  - The loan take up rate increased to 23.9% under 25% deposit or guarantor requirements and 75% tank-collateralization.
  - The take-up rate further increased to 41.9% when all but 4% of the loan could be collateralized with the tank.
  - This implies that more than 90% of those who wished to borrow at the available interest rate were credit-constrained.

- However, no evidence that joint liability expands credit access. There was no statistically significant difference in loan take up between farmers offered loans with a 25 percent deposit requirement and those offered the opportunity to substitute guarantors for all but 4 percent of the loan value.

- Defaults did not increase with moderate deposit requirements and asset collateralization.

- In particular, there were no tank repossessions when 75% of the loan could be collateralized with the tank itself and 25% was collateralized with deposits from the borrower and/or guarantors.

Tank Repossession and Loan Non-Recovery (Combined Sample)

Group	Tank repossession		Loan non-recovery	
	Count	Rate (percent)	Count	Rate (percent)
4% deposit (A)	3/431	0.7 (0.14, 2.02)	0/431	0 (0, 0.85)
25% deposit (D)	0/357	0 (0, 0.83)	0/357	0 (0, 0.83)
21% guarantor, 4% deposit (G)	0/361	0 (0, 0.83)	0/361	0 (0, 0.83)
100% cash collateralized (C)	0/10	0 (0, 25.89)	0/10	0 (0, 25.89)
25% deposit or guarantor	0/718	0 (0, 0.42)	0/718	0 (0, 0.42)

Tank Repossession and Loan Non-Recovery (Combined Sample)

- Principal and interest fully recovered in all of the loans
- No tank repossesssions with 25% deposit or with 21% guarantor and 4% deposit
- Since no tank repossessions when borrowing requirements waived, no estimated treatment effect of borrowing requirement
- Three tank repossessions (0.7%) in 4% deposit group, combined
- Can reject null hypothesis that repossession rate is the same in 4%, 25% cash collateralization groups at 5.3% level, using Fisher's exact test
    - Adverse selection implies that profit-maximizing deposit requirement exceeds welfare-maximizing deposit requirement

- Reducing the deposit requirement to 4% with 96% asset-collateralization induced a 0.7% repossession rate overall, corresponding to a 1.63% repossession rate among the marginal farmers induced to borrow by the lower borrowing requirements.

- The hypothesis of equal rates of tank repossession under a 4% deposit requirement and under a 25% deposit or guarantor requirement is rejected.

- It is clearly impossible to use asymptotics based on the normal distribution when we observe zero or close to zero repossessions

- We can create exact confidence intervals based on the underlying binomial distribution.

- For example, in the combined 4% deposit group, all 431 loans were fully recovered (Table 5)

- We can therefore reject the hypothesis that the underlying loan non-recovery rate was more than 0.69%. To see this, if the true rate was 0.69%, the probability of observing at least one case of loan non-recovery in 431 would be $(1 - 0.0069)^{431} = 0.05$.

- Using a similar approach with three repossessions, we can reject the hypothesis that the underlying repossession rate was more than 2.02% or less than 0.14%.

- Table 5 displays Clopper-Pearson exact confidence intervals for the rates of repossessions and loan non-recovery under the point estimates for each loan type, calculated on the combined sample

- Karlan-Zinman tests based on ex post waivers or borrowing requirements suggest that this difference is entirely due to adverse selection, rather than the treatment effects associated with moral hazard.

Table 6: Loan Repayment

	During Loan Cycle			Late at End of Loan		
	(1) Late ever	(2) Rec'd pending default letter	(3) Security deposit reclaimed	(4) Repaid late	(5) Late balance (KSh)	(6) Months late
4% deposit loan	0.57***	0.29***	0.09***	0.12***	221.79***	0.13***
	[0.11]	[0.03]	[0.02]	[0.02]	[50.02]	[0.03]
25% deposit loan, maintained	0.59***	0.33***	0.16***	0.02	45.67	0.02
	[0.12]	[0.06]	[0.05]	[0.02]	[33.04]	[0.02]
25% deposit loan, waived	0.46***	0.28***	0.08**	0.12***	161.90**	0.13***
	[0.12]	[0.06]	[0.04]	[0.04]	[66.76]	[0.05]
21% guarantor loan, 4% deposit, maintained	0.51***	0.18***	0.10**	0.06*	101.91	0.08*
	[0.13]	[0.05]	[0.04]	[0.03]	[63.43]	[0.05]
21% guarantor loan, 4% deposit, waived	0.43***	0.32***	0.14***	0.14***	297.52***	0.22**
	[0.13]	[0.07]	[0.05]	[0.05]	[111.67]	[0.09]
Constant (100% secured joint-liability loan)	0.11	0.00	-0.00	0.00	0.00	0.00
	[0.11]	[0.00]	[0.00]	[.]	[0.00]	[0.00]
Deposit Selection Effect P-value 25% dep loan waived = 4% dep loan	0.10	0.97	0.80	0.99	0.47	0.99
Guarantor Selection Effect P-value 25% guar loan waived = 4% dep loan	0.07	0.64	0.38	0.66	0.54	0.34
Deposit Treatment Effect P-value 25% dep loan maintained = 25% dep loan waived	0.13	0.55	0.20	0.02	0.12	0.03
Guarantor Treatment Effect P-value 25% guar loan maintained = 25% guar loan waived	0.42	0.10	0.54	0.18	0.13	0.16
Mean of dependent variable	0.64	0.28	0.11	0.10	180.36	0.12
Observations	456	456	456	456	456	456

Note: * p<0.1, ** p<0.05, *** p<0.01. Heteroskedasticity-robust standard errors in brackets.

Real Impacts

- Evidence of increased tank usage
  - 4% group farmers experienced a 27% increase in tank ownership compared to 100% group (p¡0.01)
- Wide standard errors on milk production
  - Point estimate: 0.047 point increase in log production
  - Not significant
- Some evidence of increased sales to dairy (admin data)
  - 4% group farmers were more likely to sell milk to the dairy ($p < 0.10$)
  - Stronger evidence outside of top 5% of observations
- Time savings
  - Treatment girls spent 3.17 fewer minutes per day fetching water ($p < 0.01$)
  - Treatment boys spent 9.66 fewer minutes per day tending livestock ($p < 0.10$)
- Increased schooling for girls
  - 4 percentage points (4.3%) higher enrollment in Difference-in-Difference specification

Key Results

- Reducing deposit, guarantor requirements increases take up of credit from 2% to 44%
- Substituting joint liability for deposit requirements does not expand access
- All principal and interest repaid; no evidence that 25% borrowing requirement increases tank repossession
- No evidence that waiving requirements increases tank repossession
- Moving from 25% to 4% deposit requirement selects borrowers with 1 in 62 tank repossession rate
- Savings and credit cooperative loosened borrowing requirements, following study

Appendix

A1. The optimal contracting problem in the moral hazard model

- The lender's optimization problem is

$$\max_{p,r} p(Y - r) - (1 - p)a - \frac{1}{2}\gamma p^2$$

subject to

$$pr + (1 - p)a - \rho \geq 0$$

$$r - a = Y - \gamma p.$$

- The expected payoff of a borrower:

$$p\{Y - (r - a)\} - a - \frac{1}{2}\gamma p^2 = \frac{1}{2}\gamma p^2 - a.$$

- Combine the IC and the ZPC to obtain:

$$p\,(r-a)+a-\rho = p\,(Y-\gamma p)+a-\rho = 0.$$

- This yields a quadratic equation in p :

$$\gamma p^2 - pY + (\rho - a) = 0$$

- Solution is the bigger root, i.e.,

$$p^*(a) = \frac{Y + \sqrt{Y^2 - 4\gamma(\rho - a)}}{2\gamma}.$$

- Why?
  - Because, for both roots the bank earns zero profits and is indifferent.
  - But borrowers are better off, the higher is p
  - The reason is, the borrower's payoff function is $\frac{1}{2}\gamma p^2 - a$, which is increasing in p.

- Corresponding to p^*, the equilibrium interest rate is

$$r^*(a) = a + \frac{Y - \sqrt{Y^2 - 4\gamma(\rho - a)}}{2}$$

- Once again, notice that if $a = \rho$, then p is at the first-best level.

- Otherwise, the effort level is increasing in a.

- As the borrower's equilibrium payoff is increasing in p, this means that social surplus is increasing in a.

- Also, the interest rate is decreasing in a for $a \leq \rho$

- Corresponding to p^*, the equilibrium interest rate is

$$r^*(a) = a + \frac{Y - \sqrt{Y^2 - 4\gamma(\rho - a)}}{2}$$

- Notice that

$$\frac{dr^*(a)}{da} = 1 - \frac{\gamma}{\sqrt{Y^2 - 4\gamma(\rho - a)}}$$

- This is negative as

$$1 > \frac{\sqrt{Y^2 - 4\gamma(\rho - a)}}{\gamma}$$

  - This follows from the fact that $p^*(a) = \frac{Y + \sqrt{Y^2 - 4\gamma(\rho - a)}}{2\gamma} < 1$.
  - But $\frac{\sqrt{Y^2 - 4\gamma(\rho - a)}}{\gamma} < \frac{Y + \sqrt{Y^2 - 4\gamma(\rho - a)}}{2\gamma}$ as $Y > \sqrt{Y^2 - 4\gamma(\rho - a)}$ (which follows from $a \leq \rho$).
  - Therefore, $\frac{\sqrt{Y^2 - 4\gamma(\rho - a)}}{\gamma} < 1$

- This result has several implications:
  - In equilibrium different interest rates will be charged, and still no arbitrage will be possible even thought the credit market is competitive with free entry. In particular, richer borrowers will face more favorable interest rates and will undertake projects that will succeed more on average.
  - The effort level will be less than the first-best level. That means default rates higher than first-best
  - Any policy that increases the collateralizable wealth of the borrower (which could result from redistribution, or by improving the legal system that makes titling assets cheaper) will increase the equilibrium effort level.

- For wealth level sufficiently low it may be impossible to satisfy the zero profit condition of the lender and the participation constraint of the borrower in which case very poor borrowers will not receive loans. This is another form of inefficiency due to moral hazard. A necessary & sufficient condition for this to occur is if $\frac{1}{2}\gamma \{p^*(0)\}^2 < u$.

- Effort, and hence expected surplus is decreasing in the opportunity cost of capital. This means capital-scarce economies are more likely to be subject to inefficiencies in the credit market which suggests a vicious circle - because of these inefficiencies, income and hence savings are going to be low, and so capital will remain scarce. A subsidy to the interest rate would help in this model.

A2. How to interpret "difference-in-difference" coefficients

- Suppose

$$y = \alpha + \beta x + \gamma z + \mu xz$$

- Then

$$\frac{\partial y}{\partial x} = \beta + \mu z$$

- This captures change in y due to change in x.

- Also, change in y due to change in z is captured by

$$\frac{\partial y}{\partial z} = \gamma + \mu x$$

- How does change in y due to change in x change when z changes?

$$\frac{\partial^2 y}{\partial x \partial z} = \mu.$$

- Suppose x is policy and z is time.

	$z = 0$	$z = 1$	diff
$x = 0$	y_{00}	y_{01}	$(y_{01} - y_{00})$
$x = 1$	y_{10}	y_{11}	$(y_{11} - y_{10})$
diff	$(y_{10} - y_{00})$	$(y_{01} - y_{11})$	diff in diff

- That is x takes value 1 for those subject to policy and 0 for those not subject to policy. The variable z takes value 1 for time period after policy implemented and 0 for previous time period.

- Then the effect of change in policy is:

$$\frac{\partial y}{\partial x}$$

- Trouble: other things were changing along with policy.

- That is why, we need

$$\frac{\partial^2 y}{\partial x \partial z}$$