Queing for Credit

Sequential Group Lending: Theory and Experiment in Microfinance

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Queuing for Credit: Increasing the Reach of Microfinance Through Sequential Group Lending

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Labortaory Experiment on Sequential Group Lending

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MICROFINANCE

Reccurent theme: individuals with negligible wealth that are too poor to borrow become *credit-worthy* if they *borrow collectively* under *joint-liability contract*

Group Lending: *borrow in groups*

Joint-liability: *inter-linked contracts*

- Collateral aligns borrower's incentive with lender's
- Poor with no collateralisable wealth left out of credit market
- *Joint-liability* aligns borrowers' incentive with lender's

First Wave

Compares joint liability with individual lending in terms of lending efficiency

Strands of the literature

Adverse Selection

- Varian (1990), Ghatak (1999, 2000), Van Tassel (1999), Aghion & Gollier (2000)

Moral Hazard

- Ghatak (1999), Stiglitz (1990), Conning (2000)

Auditing and Enforcement

- Besley & Coate (1995), Ghatak (1999)

Criticism of the First Wave

- Pitt & Khandkar (1998), Aghion & Morduch (2000), Karlan and Morduch (2009)
  - Results from *impact evaluation* exercise gloomy
  - Group lending does not do always do better than individual lending
  - Theory literature under estimates the *practical problems* associated with group lending
  - *Various mechanisms*, other than group lending, used in microfinance

Second Wave

Look beyond joint liability at the internal mechanism of group lending

Sjostrom and Rai (2005): *cross-reporting*

Jain and Mansuri (2003): *periodicity of loans*

Aniket (2007): *Role of Savings, negative assortative matching in wealth*

Moral Hazard Strand

Recurrent Theme: it is more efficient to *incentivize effort collectively* for the group rather than individually

Ghatak (1999): incentivizing effort less expensive

Varian (1990): collective project choices more prudent

Conning (2000): incentivizing complementary tasks leads to multiple equilibria

ENVIRONMENT

- opportunity cost of capital ρ
- Impoverished Agent k
  - Risk neutral
  - Cash wealth 0
  - Reservation income 0

Lender

Risk neutral

No access to monitoring technology

Faces a competitive loan market $\Rightarrow$ zero profit condition)

Project that succeeds with probability π^i

$$\rho = \pi^i r$$

Borrower's Project & Effort Level

- Borrower's project

$$\text{1 unit of capital} \longrightarrow \begin{cases} x_s = \overline{x} & \text{with probability } \pi^i \\ x_f = 0 & \text{with probability } (1-\pi^i) \end{cases}$$

- Borrower chooses effort level $i = \{H, L\}$

$$\pi^i = \begin{cases} \pi^h & \text{(High effort level)} \\ \pi^l & \text{(Low effort level)} \end{cases}$$

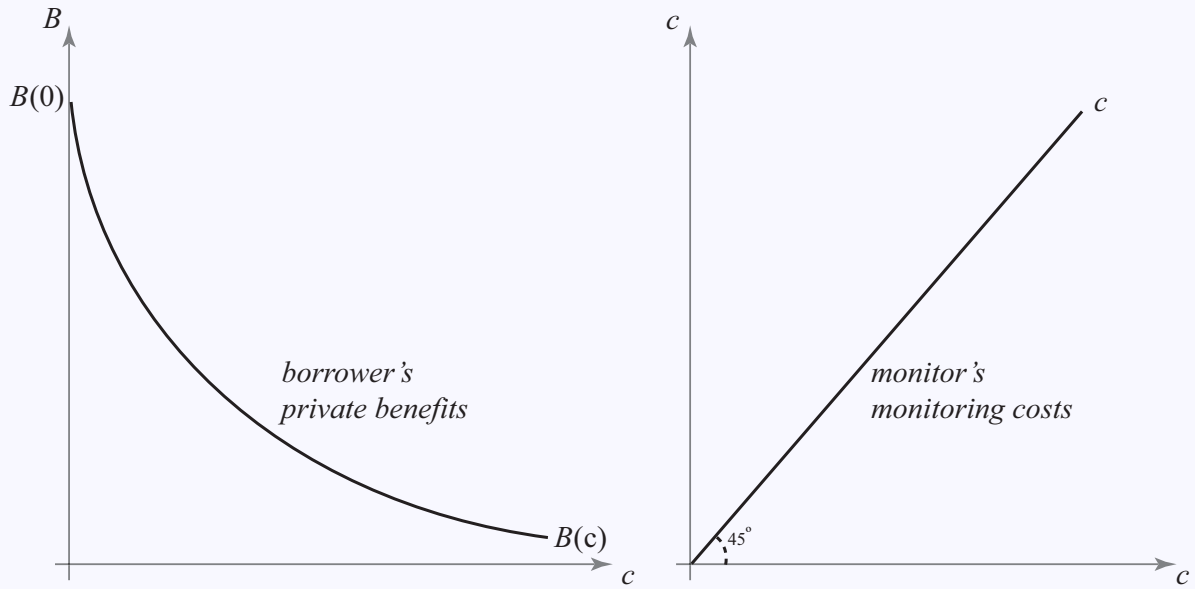
- Borrower's effort unobservable
- Agent's reservation income is 0

Effort level & Private Benefits

Effort	Cost of action	Private Benefits
High	0	0
Low	0	$B(c)$

- Monitoring with intensity c curtails private benefits B
  - cost of monitoring with intensity c is c
  - monitoring is unobservable
- Private benefits are non transferable amongst agents

Monitoring



Assumption (Monitoring function)

i. $B(0) > 0$

ii. $B(c) \geqslant B(c+\varepsilon) \geqslant 0$ *for all* $c, \varepsilon \geqslant 0$

Environment

- opportunity cost of capital ρ
- Impoverished Agent k
  - Risk neutral
  - Cash wealth 0
  - Reservation income 0
- Lender
  - Risk neutral
  - No access to monitoring technology
  - Cost of capital ρ
  - Zero profit condition

Individual Lending: Constraints

Contract with outcome contingent payoffs (b_s, b_f)

$$E[b_i \mid H] \geqslant 0 \qquad \text{(PC)}$$

$$E[b_i \mid H] \geqslant E[b_i \mid L] + B(0) \qquad \text{(ICC}_e\text{)}$$

$$b_i \geqslant 0;\ i = \{s, f\} \qquad \text{(LL)}$$

Optimal Contract:

$$b_s = \frac{B(0)}{\Delta\pi},\ b_f = 0$$

Using Lender's zero profit condition

$$E[x_i \mid H] \geqslant \rho + E[b_i \mid H \qquad \text{(L-ZPC)}$$

$$\bar{x} \geqslant \left[\frac{\rho}{\pi^h} + \frac{B(0)}{\Delta\pi}\right] = \bar{x}_{ind}$$

threshold project financed under simultaneous group lending

Simultaneous Lending: Timings

$t = 0$	$(b_{ss}, b_{sf}, b_{fs}, b_{ff})$	Group loan contract offered
		Project initiated
$t = 1$	(c_1, c_2)	Borrowers choose monitoring intensity
$t = 2$	(e_1, e_2)	Borrowers choose effort level
$t = 3$		*Project outcome realised*
		Borrowers obtain payoffs

Simultaneous Lending: Constraints

- Each borrower's individual ICC$_e$ for subgame $\xi(c,c)$

$$\pi^{h^2} b_{ss} \geqslant \pi^{l^2} b_{ss} + B(c)$$

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

Cost of inducing high effort is decreasing in monitoring intensity

- Group's Collective ICC$_{e,c}$:

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

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

"good" versus "bad" equilibrium

Cost of satisfying both task simultaneously increasing in monitoring intensity

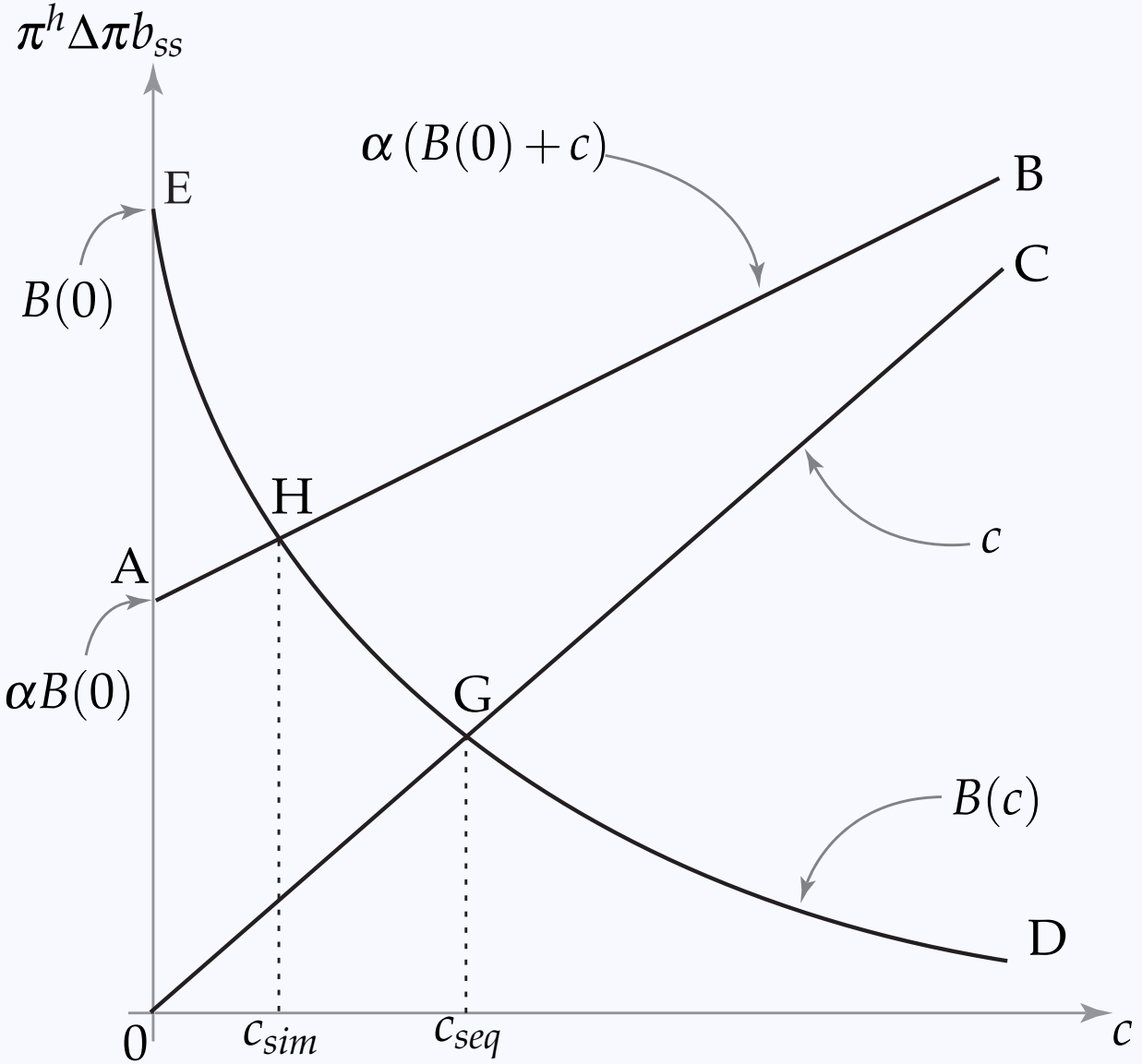


Figure: Monitoring Intensities in Group lending

c_{sim} & $\bar{x}_{sim}$

Condition 1 & 2

$$b_{ss} = \frac{B(c_{sim})}{\pi^h \Delta\pi} = \frac{B(0) + c_{sim}}{\pi^{h2} - \pi^{l2}}$$

$B(c_{sim}) = \alpha(B(0) + c_{sim})$; $\alpha = \frac{\pi^h}{\pi^h + \pi^l}$

c_{sim} is the monitoring intensity that minimises b_{ss}

Using the lender's zero profit condition

$$E[x_i \mid HH] \geqslant \rho + E[b_{ij} \mid HH] \qquad \text{(L-ZPC)}$$

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

threshold project financed under simultaneous group lending

Sequential Lending: Timings

$t=0$		Group loan contract (b_{ss}, b_{sf}, b_{ff}) offered
		Project initiated by Borrower 1
$t=1$	c_2	Borrower 2 choose monitoring intensity
$t=2$	e_1	Borrower 1 choose effort level
$t=3$		*Project outcome realised*
		If project fails, game terminates, borrowers get b_f
		If project succeeds, the game continues
		Project initiated by Borrower 2
$t=4$	c_1	Borrower 1 choose monitoring intensity
$t=5$	e_2	Borrower 2 choose effort level
$t=6$		*Project outcome realised*
		Borrowers obtain payoffs

Sequential Lending: Constraints

Each borrower's individual $ICC_{e,c}$

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

each task incentivized individually

group's collective incentive compatibility condition slack

c_{seq} & $\bar{x}_{seq}$

Condition 3

$$b_{ss} = \frac{B(c_{seq})}{\pi^h \Delta\pi} = \frac{c_{seq}}{\pi^h \Delta\pi}$$

c_{seq} is the monitoring intensity that minimises b_{ss}

Using the lender's zero profit condition

$$E[x_i \mid HH] \geqslant \rho + E[b_{ij} \mid HH] \qquad \text{(L-ZPC)}$$

$$\pi^h(1+\pi^h)\bar{x} \geqslant (1+\pi^h)\rho + \pi^{h^2} \cdot 2b_{ss}$$

$$\bar{x} \geqslant \left[\frac{\rho}{\pi^h} + \frac{2}{1+\pi^h} \cdot \frac{B(c_{seq})}{\Delta\pi}\right] = \bar{x}_{seq}$$

threshold project financed under sequential group lending

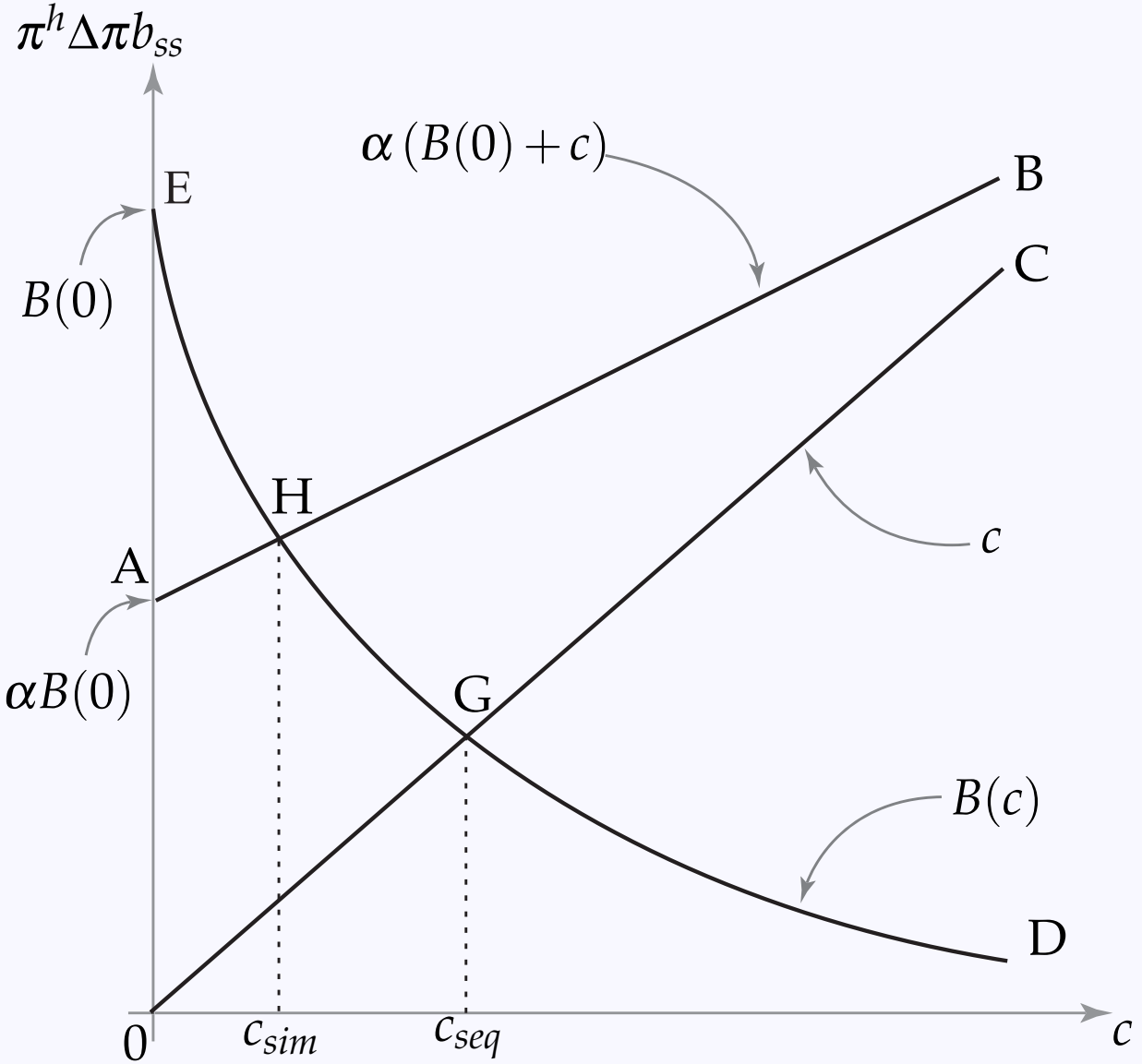


Figure: Monitoring Intensities in Group lending

COLLUSION

- Sequential Lending temporally separates the decisions on task

  Interpret Condition 2 in terms of collusion

  - Condition 2 *binds* in simultaneous lending

    collusion rents without side-contracting abilities

  - Condition 2 is *slack* in sequential Lending

    collusion rents require explicit side-contracting abilities

    inability to side-contract exploited to lower borrower's rents

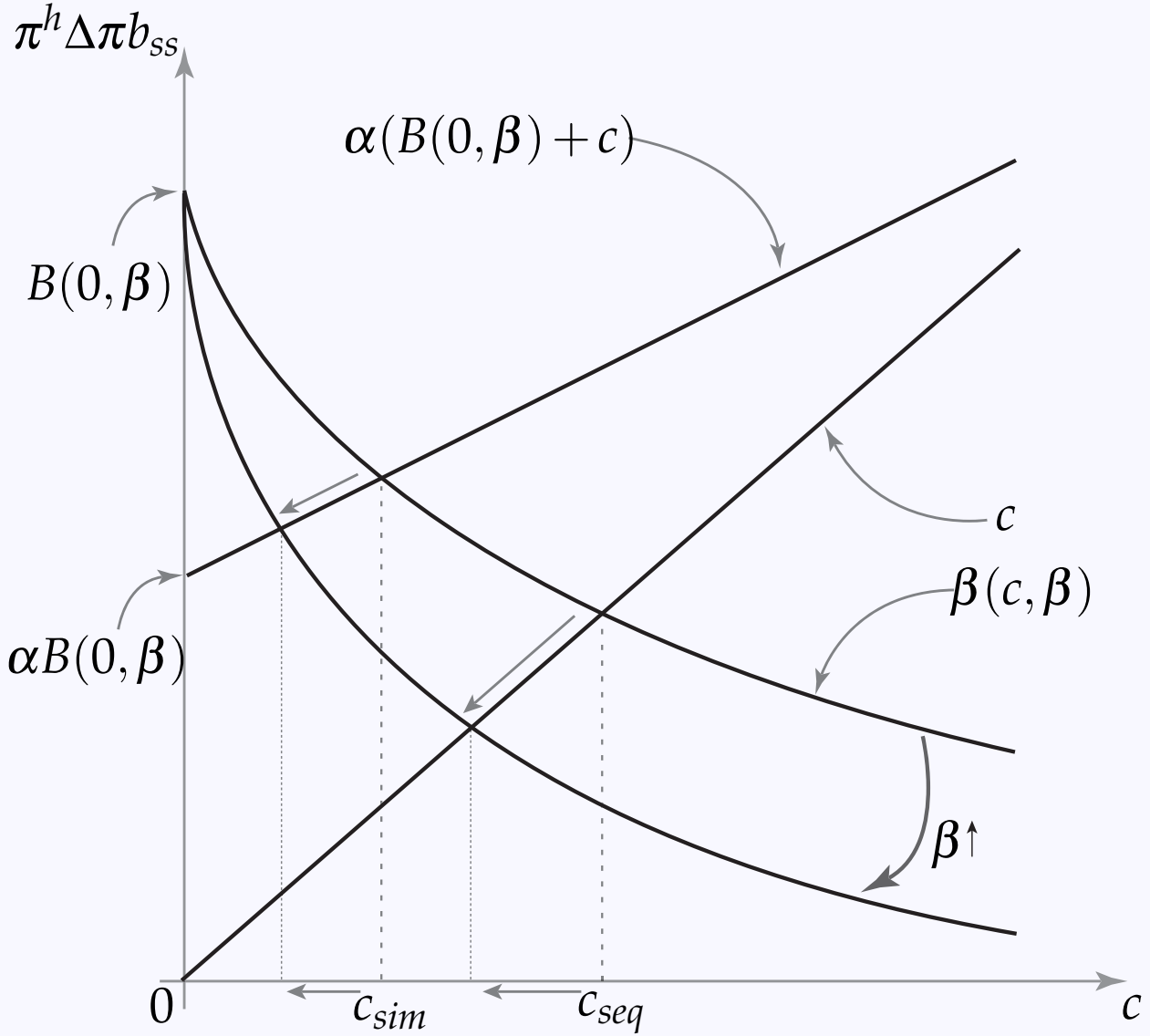


Figure: c_{sim} and c_{seq} as Monitoring Efficiency Increases

Varying Monitoring Technology

- As *monitoring becomes more efficient*, both $\bar{x}_{sim}$ and $\bar{x}_{seq}$ decrease
- *Threshold project* lower under sequential lending if monitoring is *sufficiently efficient*
- With *extremely efficient monitoring technology*,

  simultaneous lending: some socially viable project not feasible

  sequential lending: all socially viable projects feasible

Lab Experiment

Question: Does lending sequentially reduce the collateral (wealth) requirement?

Can a given repayment rate be sustained with lower a collateral requirement under sequentially lending?

Does sequential lending induce greater peer-monitoring than sequential lending?

Design

Project: Invest 50 token and obtain 140 tokens if successful.

Endowment: Players endowed with w tokens and borrow $(50-w)$ from lender, where $w = \{10, 20, 30, 40\}$

Monitoring Choice: Choose c, the *proportion of ex post payoff committed to monitoring cost*

Effort Choice: (H, L) such that $p^h = 0.75,\ p^l = 0.25$

With low effort, borrower obtains private benefit

$$\begin{cases} 50 \text{ tokens} & \text{with probability } 1-c \\ 0 & \text{with probability } c \end{cases}$$

Design

Borrower's payoff: The final expect payoff of borrower 1 with peer borrower 2

$$E[\Pi_1 \mid e_1, e_2, c_1, c_2, w_1] = (1 - c_1)\left(p_1^{e_1} p_2^{e_2}\left[\overline{x} - (1 - w_1)\right] + (1 - c_2)B \cdot I\right)$$

$\overline{x} = 140$

$B = 50$

c_1, c_2 are the monitoring choices of borrower 1 and 2

e_1, e_2 are the effort choices of borrower 1 and 2

w_1 is borrower 1's wealth endowment

$I = 1$ if $e_1 = H$ and $i = 0$ if $e_1 = L$

Very Preliminary Results

We ran experiments for simultaneous lending ($w = 10$ and $w = 20$) and sequential lending ($w = 10$) where each player played 10 rounds.

- For endowment $w = 10$, sequential lending induces *higher* monitoring intensity than simultaneous lending
- In simultaneous lending, *higher* monitoring intensity is induced as endowment increases from $w = 10$ to $w = 20$