The Diffusion of Microfinance

Banerjee, Chandrasekhar, Duflo, Jackson

Presented by Vince Chen

1. Stated Problems

- How does participation in a microfinance program diffuse through social network?
- Does a good social network contribute to diffusion of participation?
- Basic information transmission (contagion) vs. Diffusion by social network endorsement?
- Diffusion probability differences between participants and non-participants?

Background on Microfinance

- Bharatha Swamukti Samsthe (BSS) operates a conventional group-based microcredit program: borrowers from groups of 5 women who jointly liable for their loans, in rural southern Karnathka (in India).

- When BSS starts working in a village, it seeks out a number of people defined “leaders”, who based on cultural context are likely to be influential in the village.

2. Data Attributes

- Baseline survey in 75 villages before BSS' entry

  Village questionnaire: village leaderships, presence of NGOs and self-help groups, geographical features

  Household census: demographical info., GPS coordinates, amenities (social connections)

- Detailed survey (sub-sample, **46**%) after modulation including age, sub-caste, education, language, occupation
- These surveys gathered social network data on 13 dimensions, including friends or relative visit one's home, to pray, borrow and lend money or material goods, obtain / give advice

2. Data Attributes

- Participation state: m_{it}
- Informed stated: s_{it}
- Personal characteristics: x_t
- Peer ratio of participation over informed: f_{it}

  (calculated by individual's social network which can be identified by individual census)

- Descriptive Statistics:
- **18.5%** average take-up rate; **12%** "leaders"; average number of connection, **15**; **223** average households in a village; **2.2** network path length; **26%** clustering rate

2. Data Attributes

- **Eigenvector Centrality**
- A household's centrality is defined to be proportional to the sum of its neighbors' centrality. (the ith entry of the eigenvector corresponding to the maximal eigen-value of the adjacency matrix.)

- Eigenvector depicts the degree of social network
- Eigenvector centrality and the importance of injection points

3. Conceptual View

- Two Categories of Information Diffusion
- “**Mechanical effect**”, information transmission as in the spread of a disease or rumor
- “**Endorsement effect**”, interactive effects between individuals, as in the adoption of technology, or strategic complementarities
- Difficult to disentangle these two effects in reduced form model

3. Conceptual View

- **Action Timing**:

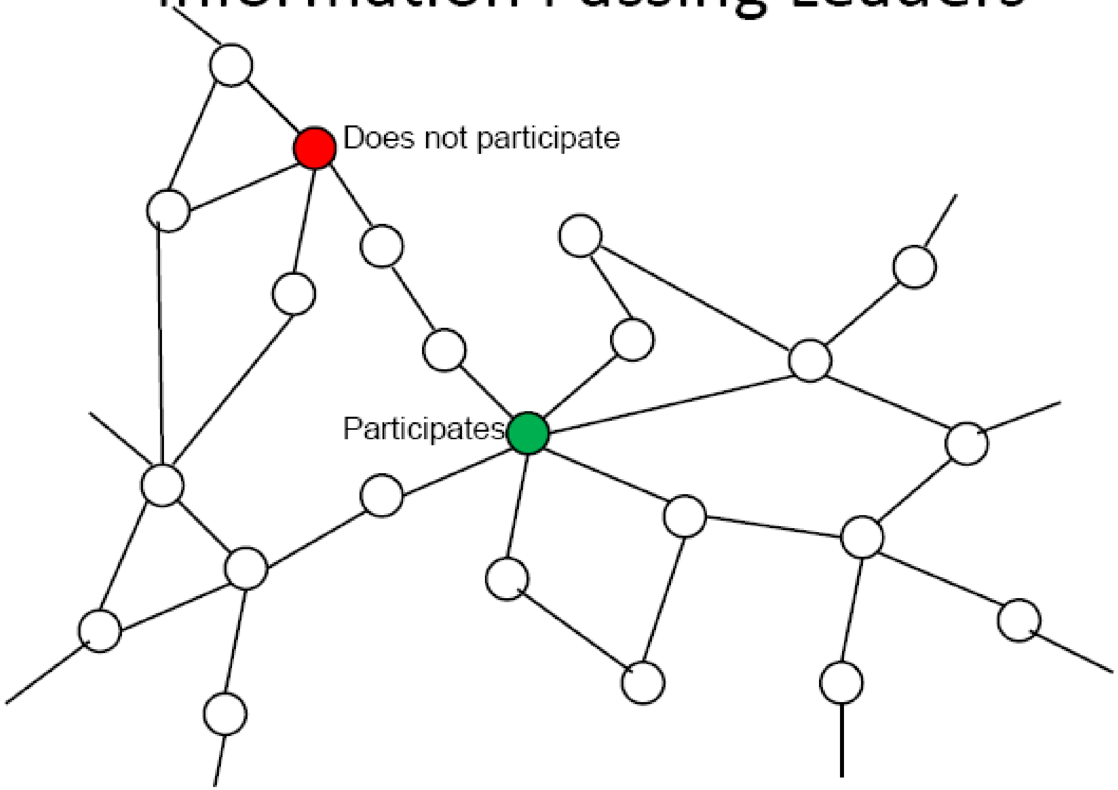
A. BSS informs the set of initial leaders

B. Leaders decide whether or not to participate

C. Households that are informed pass information to their neighbors, with same probability (may differ, participation)

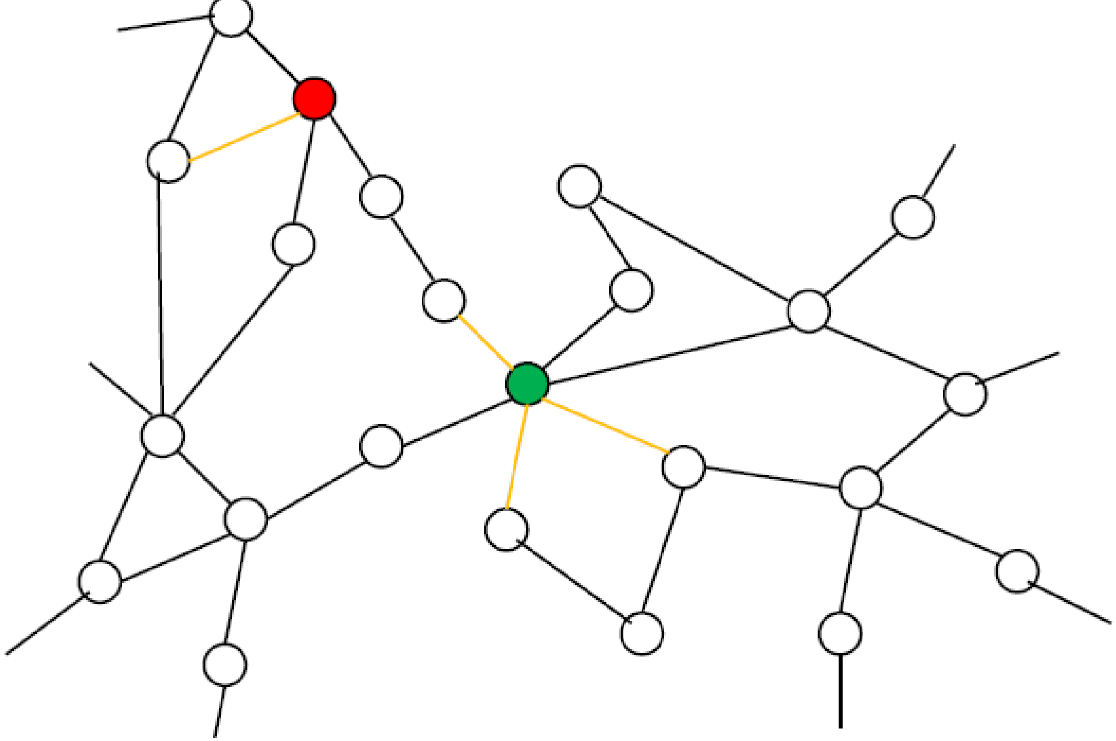
D. In each period, households who were informed in the previous period decide, once and for all, whether or not to participate, depending on their characteristics and potentially on their neighbor's choice as well (the endorsement effect)

Information Passing Leaders



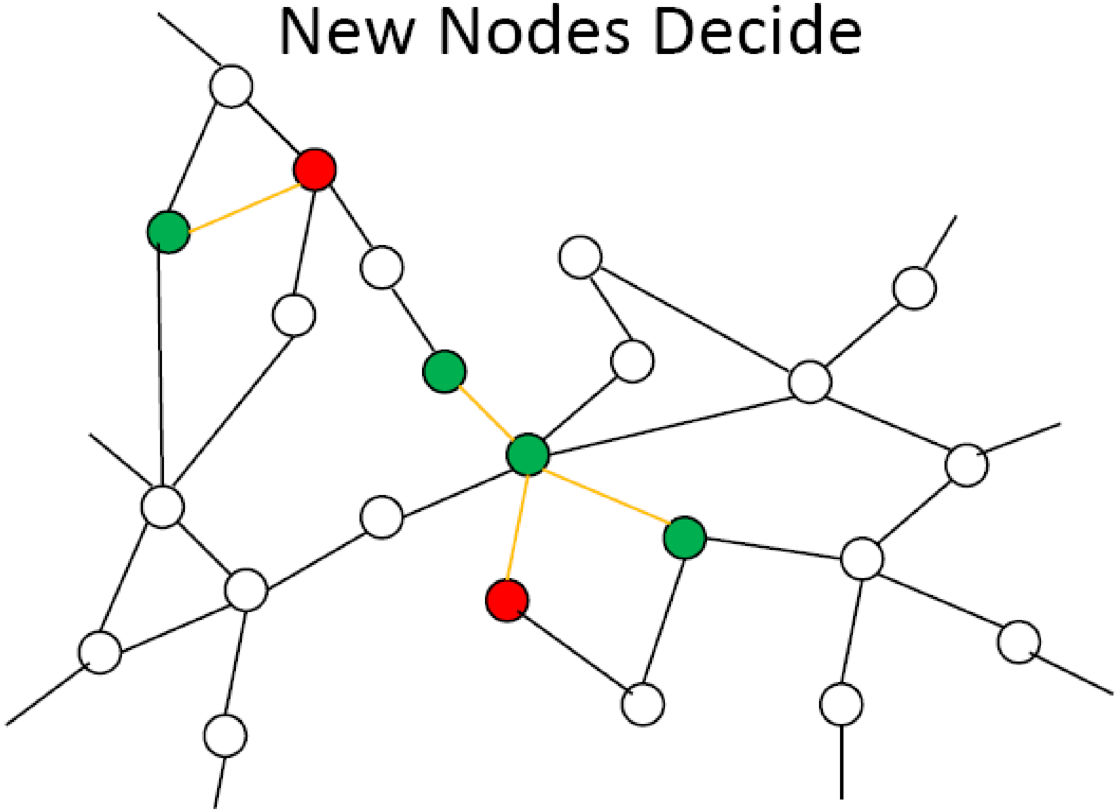
BSS informs the set of initial leaders. Then leaders decide whether or not to participate

Passing: Different Probabilities

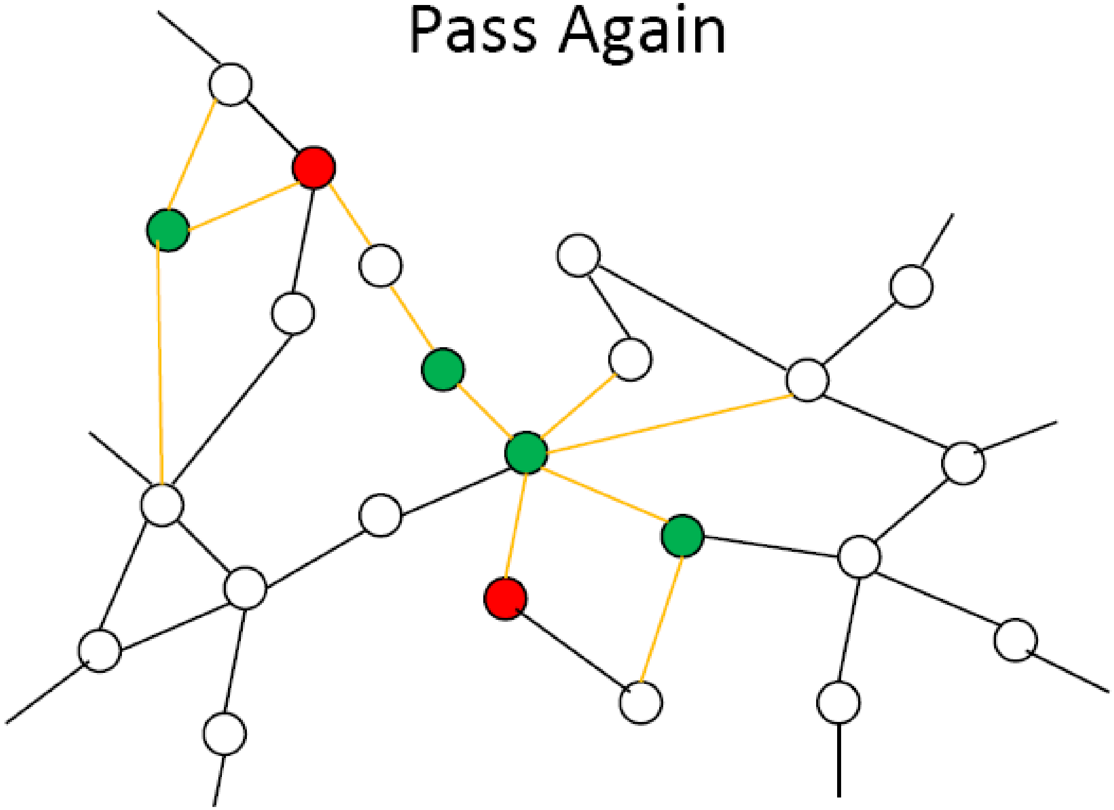


Households that are informed pass information to their neighbors, with same probability (may differ, participation)

New Nodes Decide



Pass Again



3. Conceptual View

- **Participation probability when informed**, p_i, which is a function of individual's *personal characteristics* X_i and his or her *peers' choices* F_i
- "Information" model:

$$p_i = \mathrm{P}(\text{participation}|X_i) = \Lambda(\alpha + X_i'\beta),$$

- "Information with endorsement" model:

$$p_i^E = \mathrm{P}(\text{participation}|X_i) = \Lambda(\alpha + X_i'\beta + \lambda F_i),$$

- where F_i = #(informed + participate) / #(informed), representing for peer effect

3. Conceptual View

- Probability that an informed agent informs a given neighbor in a round, conditional on the informed agent choosing NOT to participate, $\boldsymbol{q^N}$
- Probability that an informed agent informs a given neighbor in a round, conditional on the informed agent having chosen to participate, $\boldsymbol{q^P}$

- Complete Model: (q^N, q^P, p_i)
- Variables: m_{it} (participate or not), s_{it} (inform or not), x_{it} (individual characteristics), f_{it} (degree of peer choices), …

4. Empirical Strategy: Overview

- How can we test whether injection points and / or social network matter?
- Primarily, we test the statistical relation between average take-up rate and personal / village characteristics, which can capture injection and social network, by reduced form regression
- Then we construct structural form to estimate the model discussed in previous section,

$$(q^N, q^P, p_i(\boldsymbol{\alpha}, \beta, \gamma))$$

4. Empirical Strategy: Reduced Form

- Identify whether injection point matter
- Model 1. $y_r = \beta_0 + \beta_1 \cdot \xi_r^L + W_r'\delta + \epsilon_r$

  where y_r is average take-up rate, ξ_r^L is personal characteristics of leader, W_r is village feature

- Model 2.

$$y_r = \beta_0 + \beta_1 \cdot \xi_r^L + \beta_2 \cdot \xi_r^{LM} + W_r'\delta + \epsilon_r$$

- Model 3. Considering time-varying correlation pattern

$$y_{rt} = \beta_0 + \beta_1 \cdot \xi_r^L \times t + (X_r \times t)'\delta + \alpha_r + \alpha_t + \epsilon_{rt}$$

4. Empirical Strategy: Reduced Form

Table 3: Leaders/Injection points

	Take-up Rate	Take-up Rate	Take-up Rate	Take-up Rate	Take-up Rate	Take-up Rate
	(1)	(2)	(3)	(4)	(5)	(6)
Eigenvector Centrality of Leaders	1.634*		1.934**	1.843	1.254*	1.332*
	(0.904)		(0.967)	(1.101)	(0.735)	(0.782)
Number of Households	-0.000382	-0.000704***	-0.000270	-0.000273	-0.000305	-0.000299
	(0.000247)	(0.000188)	(0.000270)	(0.000280)	(0.000216)	(0.000226)
Degree of Leaders		-0.00111	-0.00324	-0.00287		
		(0.00231)	(0.00259)	(0.00276)		
Fraction of Taking Leaders					0.323***	0.317***
					(0.101)	(0.105)
Eigenvector Centrality of Taking Leaders					-0.175	-0.253
					(0.428)	(0.427)
Savings				-0.0568		-0.0523
				(0.0940)		(0.0854)
Fraction GM				-0.0151		-0.00792
				(0.0363)		(0.0302)
Constant	0.150	0.362***	0.162	0.292	0.0924	0.0924
	(0.112)	(0.0573)	(0.106)	(0.202)	(0.0915)	(0.186)
Observations	43	43	43	43	43	43
R-squared	0.293	0.235	0.311	0.319	0.502	0.502

Note: Dependent variable is the microfinance participation rate of non-leader households and report heteroskedastic robust standard errors.

4. Empirical Strategy: Reduced Form

- Examine correlation between village-level participation rate on a set of variables that capture network structure

Table 5: Network Characteristics and Participation

	Take-up Rate	Take-up Rate	Take-up Rate	Take-up Rate
	(1)	(2)	(3)	(7)
Number of Households	-0.000721***			-0.000278
	(0.000185)			(0.000737)
Degree		-0.00779*		-0.0231
		(0.00443)		(0.0264)
Clustering Coefficient			0.0693	0.348
			(0.304)	(0.684)
Path Length				-0.219
				(0.364)
First Eigenvalue of Adjacency Matrix				0.00718
				(0.0205)
Second Eigenvalue of Stochastized Matrix				-0.0179
				(0.304)
Constant	0.346***	0.300***	0.167**	0.906
	(0.0469)	(0.0712)	(0.0785)	(0.839)
Observations	43	43	43	43
R-squared	0.232	0.056	0.001	0.267

Note: Dependent variable is the microfinance participation rate of non-leader households.

4. Empirical Strategy: Structural Form

- Recall the model established before

$$p_i^E = \mathrm{P}(\text{participation}|X_i) = \Lambda(\alpha + X_i'\beta + \lambda F_i),$$

- How to estimate parameters?
- Method of simulated moments (MSM) to estimate parameters in the model
- Bayesian Bootstrap Algorithm (BBA) to estimate the distribution of estimators

4. Empirical Strategy: Structural Form

- Method of Simulated Moments (MSM), to **estimate parameters**, β, γ, q^N, q^P
- Moments to be chosen: ……
- Given initial parameters, we simulate the model and then obtain simulation data and simulated moments. Compared with empirical moments, we then adjust parameters, unless criterion value is sufficiently smaller.

$$\widehat{\theta} = \underset{\theta \in \Theta}{\operatorname{argmin}} \left(\frac{1}{R} \sum_{r=1}^{R} m_{sim,r}(\theta) - m_{emp,r} \right)' \left(\frac{1}{R} \sum_{r=1}^{R} m_{sim,r}(\theta) - m_{emp,r} \right).$$

4. Empirical Strategy: Structural Form

- MSM Procedure:

1) Current period with beginning state (m_t, s_t)
2) The newly informed makes participation decision, based on X and F (to be updated)
3) Information transmission, associated with m_{it} (also to be update), q^N, and q^P
4) Next period with new state (m_{t+1}, s_{t+1})

4. Empirical Strategy: Structural Form

- Bayesian Bootstrap Algorithm, to **estimate distribution** of parameter^

1) Compute deviation from simulated and empirical moment for each village and at each grid of parameter

$$d(r, \lambda) := \frac{1}{S} \sum_{s \in [S]} m_{sim,r}(s, \theta) - m_{emp,r}.$$

2) Bootstrap sample and estimate average weighted deviations from simulated and empirical moments

$$D(b) := \frac{1}{R} \sum_{r \in [R]} \omega_r^b \cdot d(r, \lambda)$$

3) Estimate bootstrap estimator of parameter

$$\lambda^{\star b} = \arg\min Q^{\star b}(\lambda); \quad Q^{\star b}(\lambda) := \|D(b)\|_{\ell_{2,R}}.$$

4) Obtain simulated distribution of parameter $\{\lambda^{\star b}\}_{b \in B}.$

4. Empirical Strategy: Structural Form

Table 6: Structural Estimates

	(1)	(2)	(3)	(4)
Panel A: Standard Moments				
Panel A.1	q^N	q^P		$q^N - q^P$
Information Model	0.10	0.50		-0.40
	[0.0481]	[0.1693]		[0.1718]
Panel A.2	q^N	q^P	λ	$q^N - q^P$
Information Model w/ Endorsement	0.10	0.45	0.15	-0.40
(Eigenvector weighted)	[0.0382]	[0.1544]	[0.1227	[0.1635]
Panel A.3	ρ			
Distance from Taking Leader Model	-0.25			
	[0.0404]			
Panel B: Alternative Moments	q^N	q^P		$q^N - q^P$
	0.05	0.60		-0.55
	[0.0318]	[0.1444]		[0.1449]
Panel C: Tiled Roofing	q^N	q^P		$q^N - q^P$
	0.90	0.80		0.10
	[0.0336]	[0.0763]		[0.0766]
Panel D: Nested Model	q^N	q^P	ρ	$q^N - q^P$
	0.15	0.90	-0.05	-0.75
	[0.2558]	[0.1247]	[0.0620]	[0.2784]

4. Empirical Strategy: Structural Form

- Discussion on Identification
- Identification between information effect and endorsement effect

- Traditional pitfalls of identifying peer effect also applies here!

- Robust Checks

5. Discussions

- Exogenous social network, endogenous information diffusion process, endogenous participation decision making
- 1) About “exogenous social network”
- Network establishment: unilateral (pay fee to join a club), bilateral (matching, marriage), multilateral (multiple matching, e.g. teamwork)

5. Discussions

- 2) Identification problem: those who are informed but not participate have less incentive to inform other in his around, why?
- Information Effect or Endorsement Effect?
- Endorsement: less incentive to inform, less agents to participate in the future
- Fi, #(those who informed) vs. #(those who in his around) ?

5. Discussions

- 3) About “endogenous participation decision”
- Considering a cross-sectional case, agents knowing about whether others in his around have information or not, make participation decision not only dependent on how many people have participated, but also on how many people decide to participate, or even will decide to participate (forward-looking).

5. Discussions

- 4) Consequence: Sampling algorithm in MSM leads to inconsistent estimators
- Leading example:
- X ~ N (a + bY, 1), Y ~ N (a + bX, 1)
- Correct process {X, Y} ~ joint distribution
- In this paper, given data {x’, y’}, they sample {xs} from N (a + by’), and {ys} from N (a + bx’), then obtain {xs, ys}
- Actually, these two distributions are not the same!

The End

Thank you!