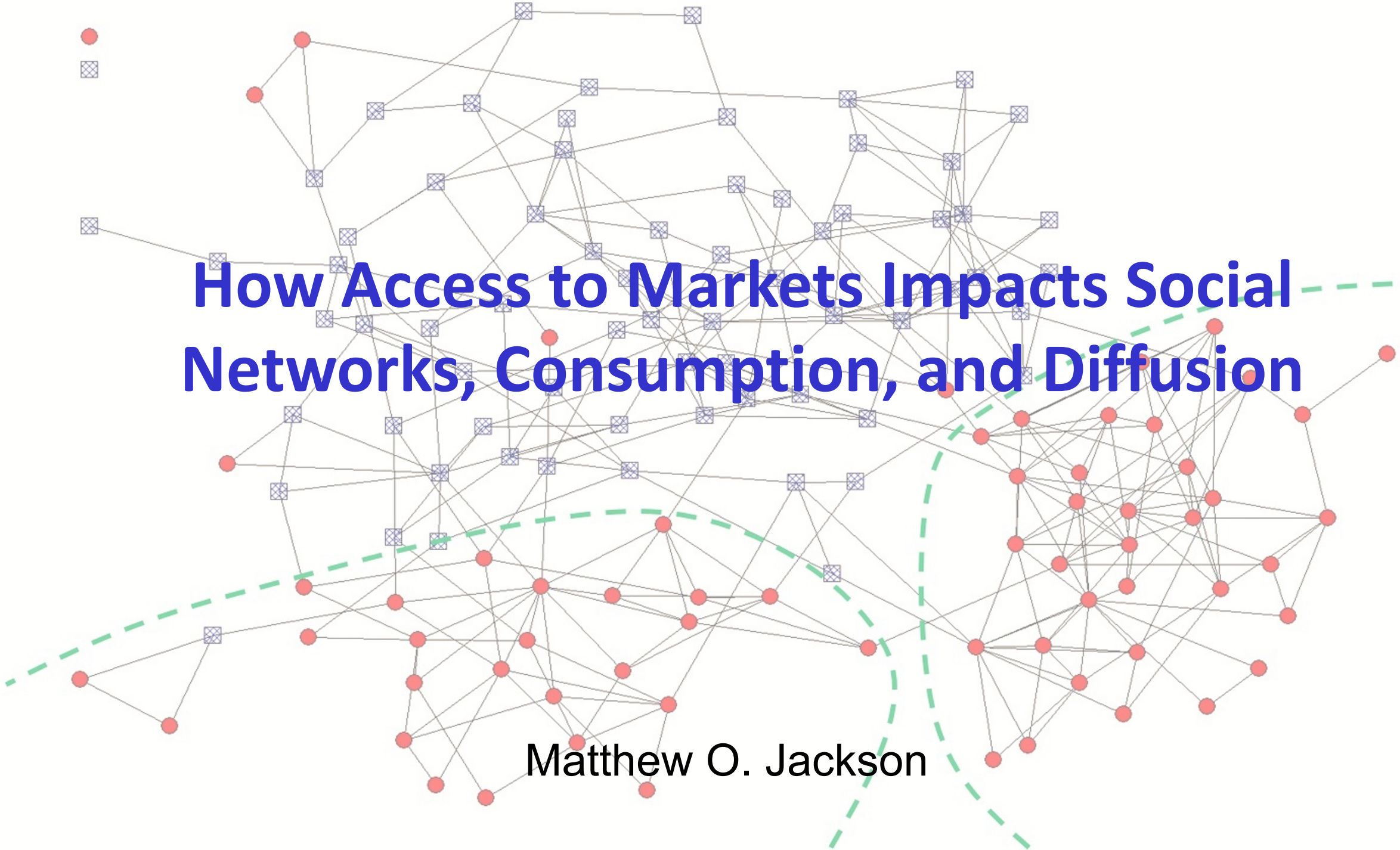
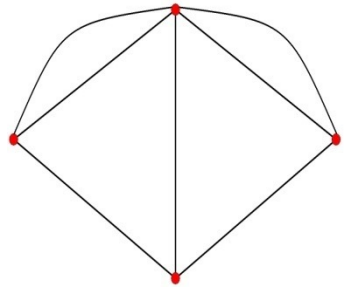


How Access to Markets Impacts Social Networks, Consumption, and Diffusion

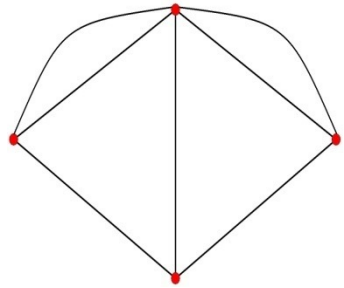
Matthew O. Jackson

Growing Application Areas:



- Labor/Education: job contact networks, peer influence
- Development: social learning, diffusion, norms
- Public: corruption, crime
- Organizations: learning, teams, culture
- Political Economy: alliances, conflict, polarization
- Trade and Macro: shock propagation,
- Finance: contagion, intermediation, efficiency

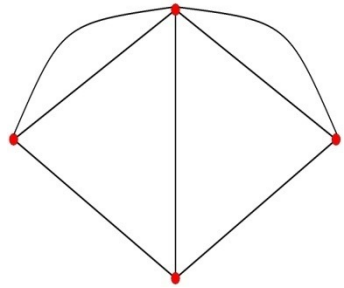
Networks



Symbiotic relationship between informal networks and formal markets:

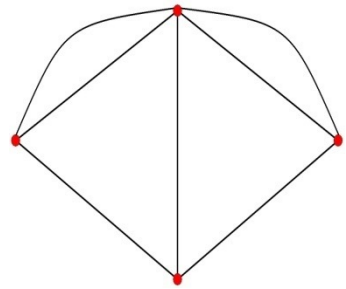
- Network structure determines market participation
- Market participation changes network structure

Externalities!



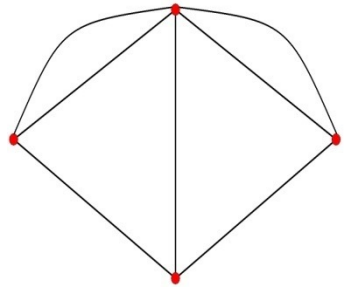
- Network connections determine who knows loans available
- Access to loans changes informal networks borrowing/lending
- Changes in borrowers' networks affect non-borrowers' networks
- Changing borrowing networks also affects advice networks…
- Advice networks impact diffusion, but so do other networks…

Outline



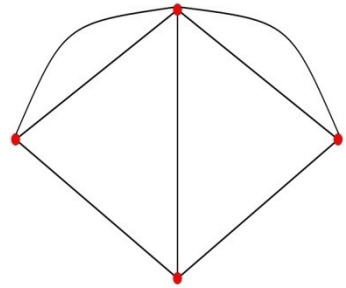
- Diffusion on networks impacts market participation
- Networks are changed by the market, multiple layers
- Multiple layers of networks impact diffusion

Outline



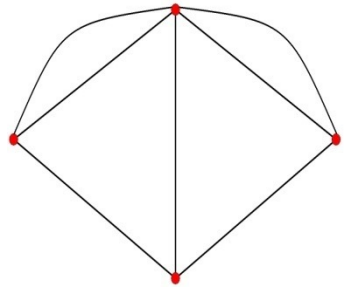
- **Diffusion on networks impacts market participation**
- **Networks are changed by the market, multiple layers**
- **Multiple layers of networks impact diffusion**

Background - Microfinance



- Karnataka India 75 villages:
  - 43 offered microfinance loans
  - 32 controls

Background - Microfinance



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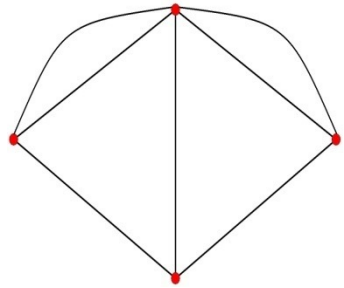
  - 32 controls

Banerjee, Chandrasekhar, Duflo, Jackson (Science 2013, Restud 2019)

Banerjee, Breza, Chandrasekhar, Duflo, Jackson, Kinnan (Restud, 2023)

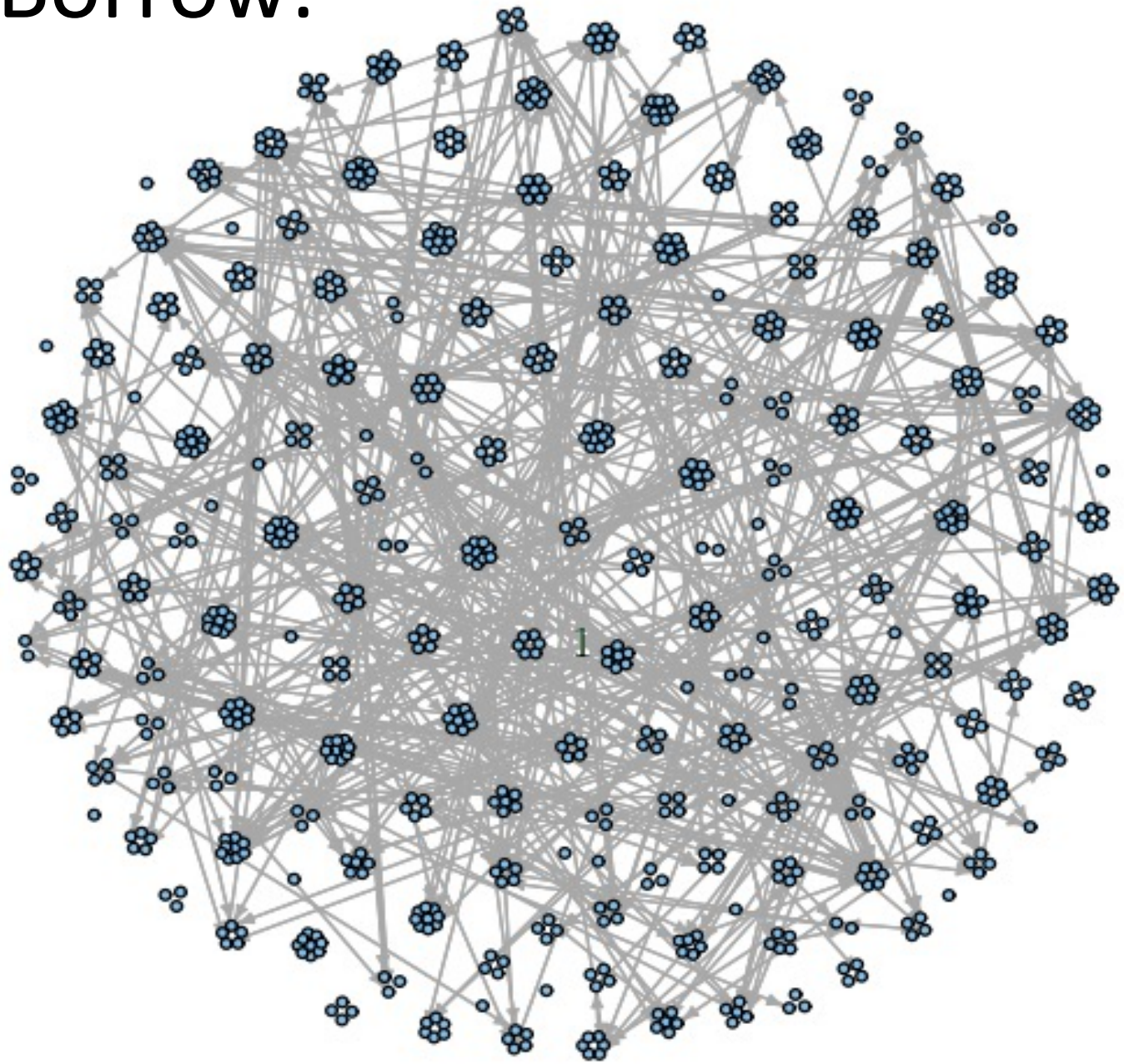
Networks influencing Market Participation

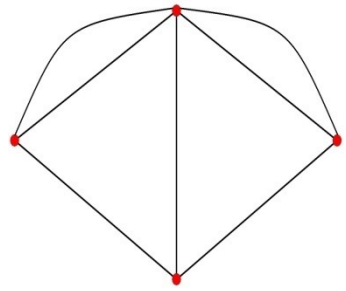


- Some villages had much more loan participation than others
- Do initial contact/injection points of microfinance information matter?
- How should we measure influence/centrality?

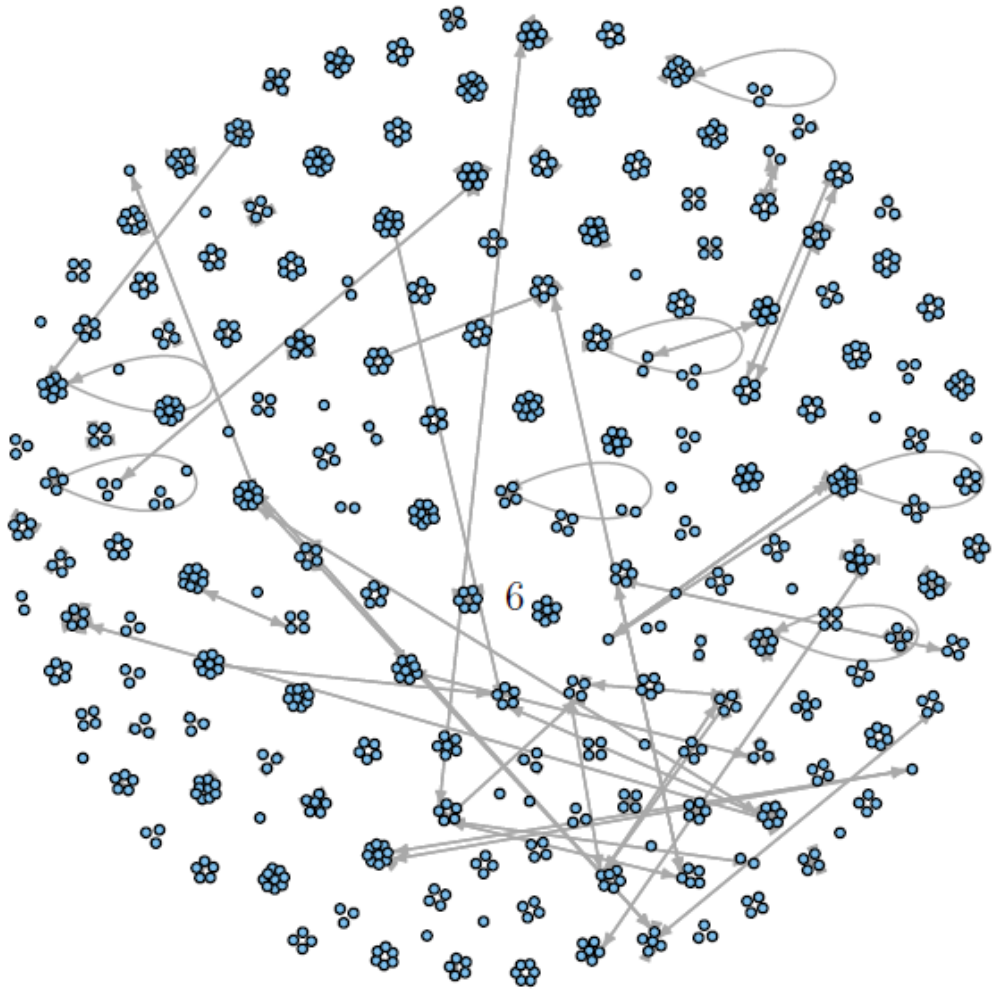
Karnataka

Borrow:

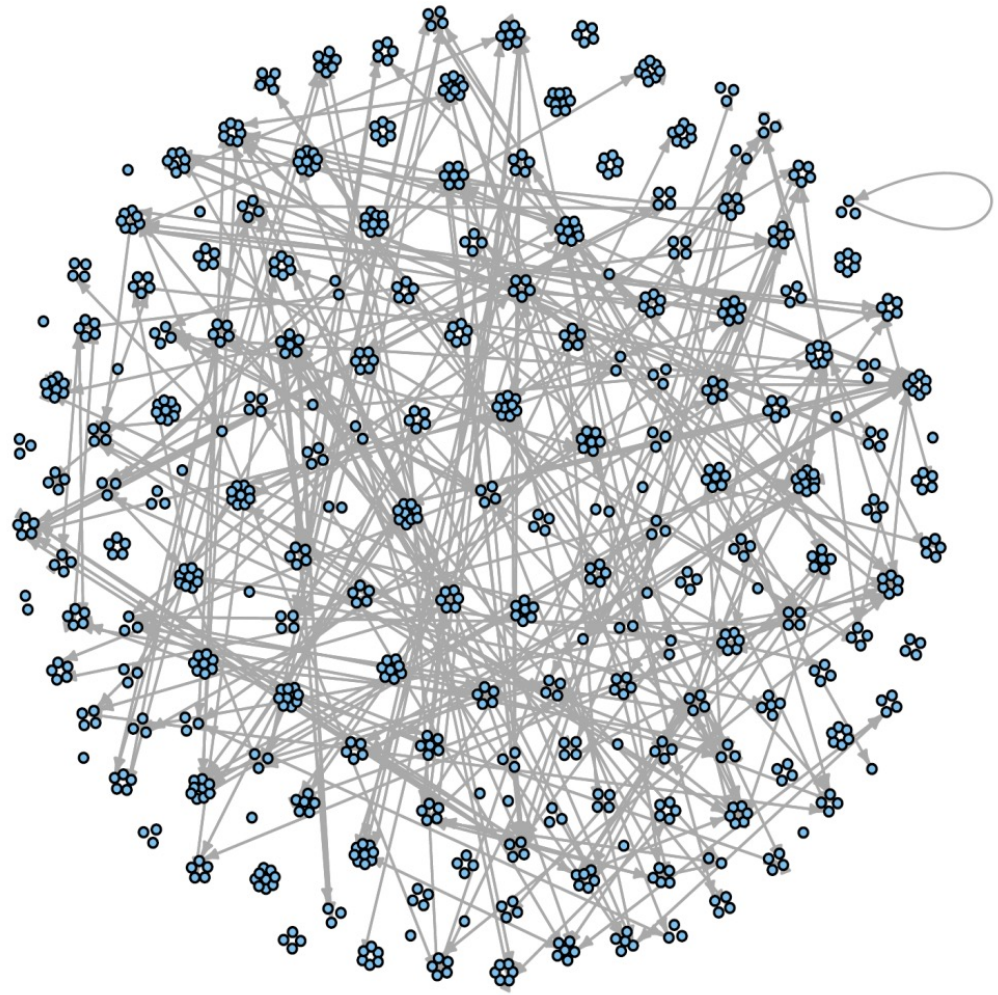




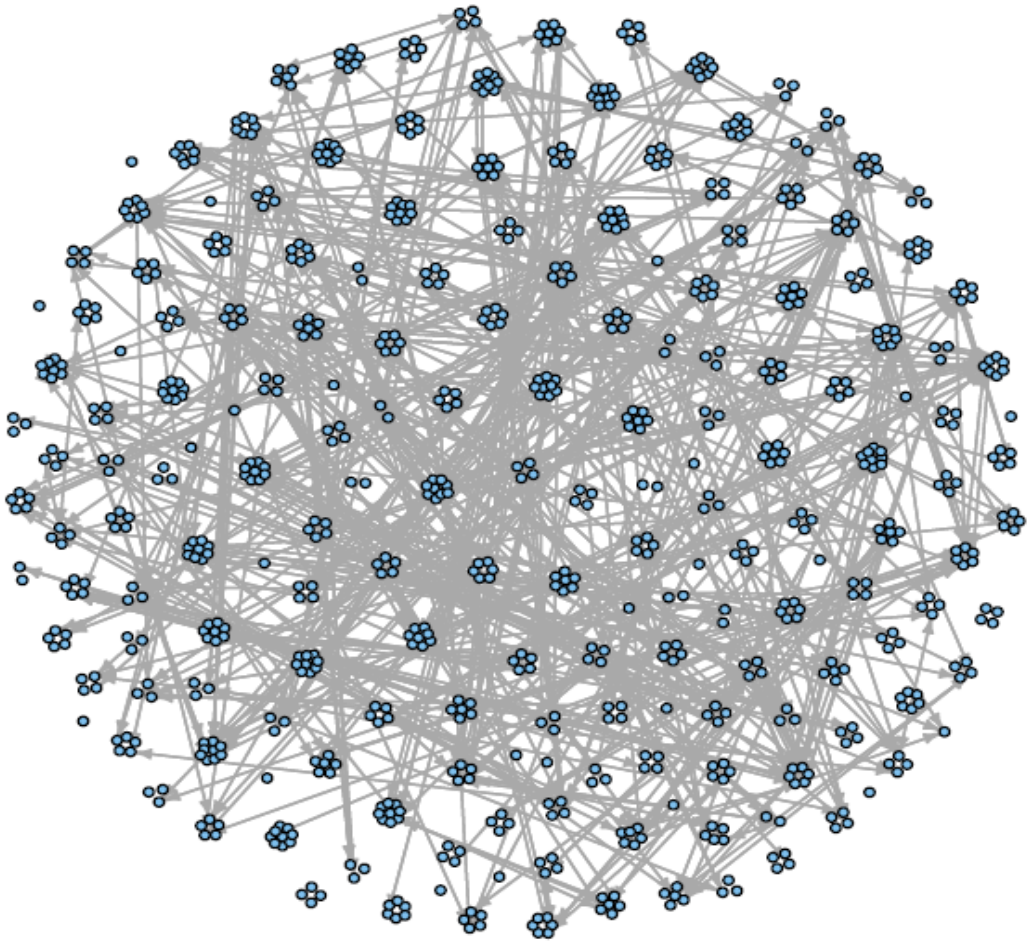
Temple



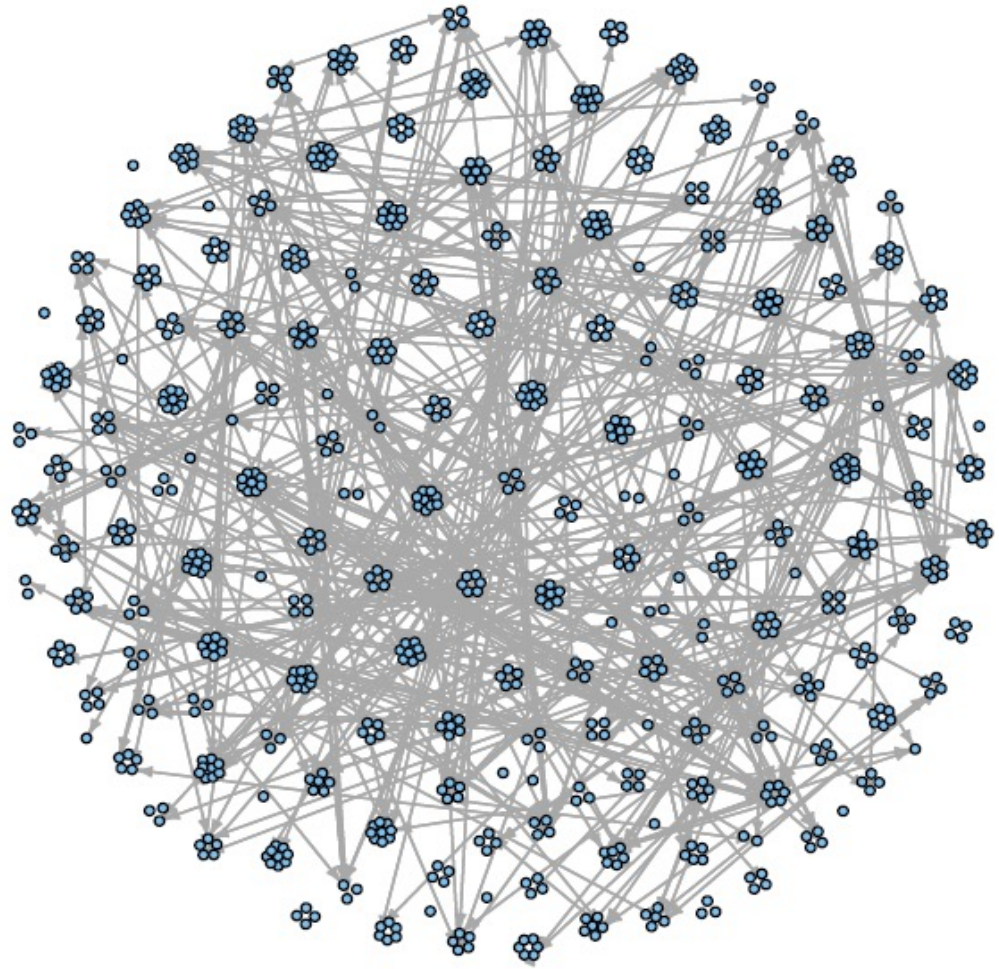
Advice



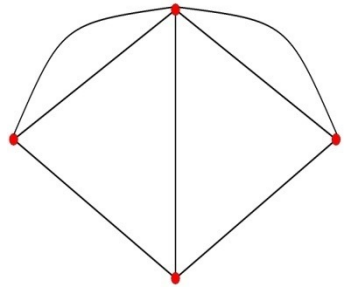
Kero-Come



Medic



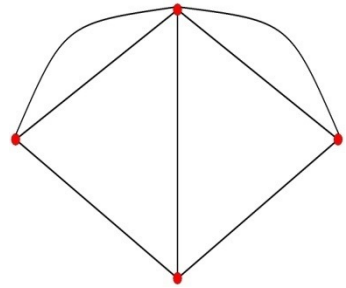
Centrality and Information Diffusion



- In each village bank told a few `leaders' about the availability of loans and asked them to spread information

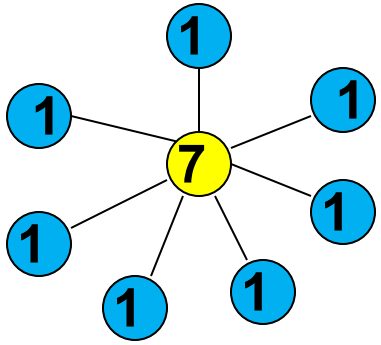
- In some villages these people were very central and good spreaders of information, in other villages they were not central

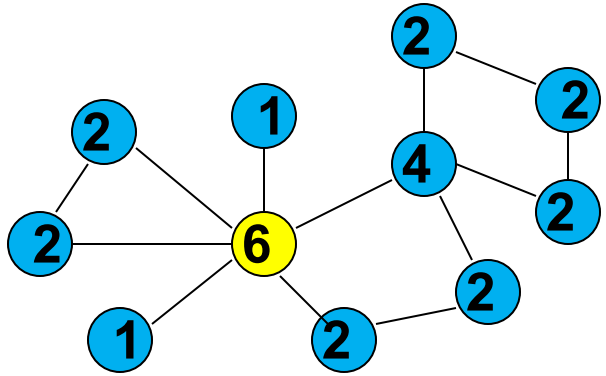
- How should we measure influence/centrality?



Centrality Measures:

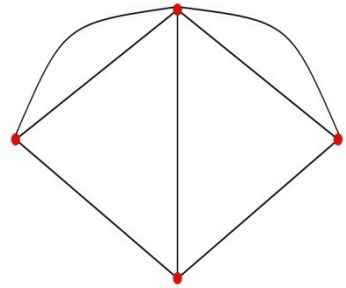
- Most basic measure -- simply count how many links a node has:



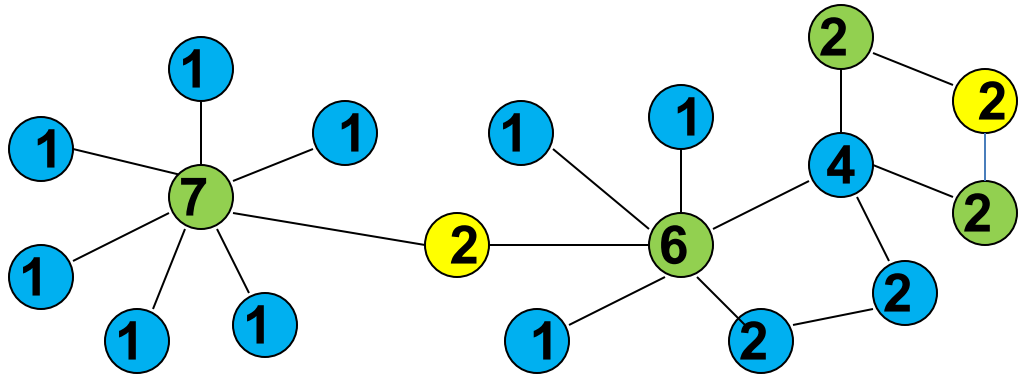


- Degree Centrality

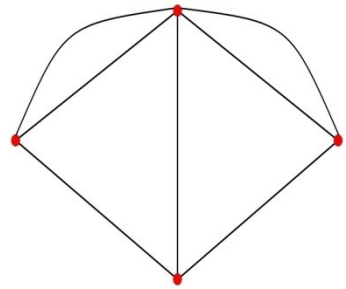
Degree Centrality?



- More reach if connected to a 6 and 7 than a 2 and 2?



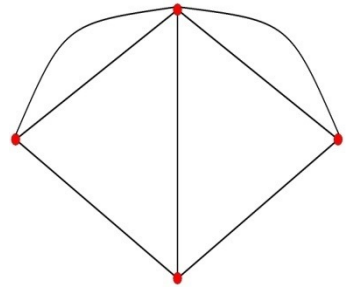
Eigenvector Centrality



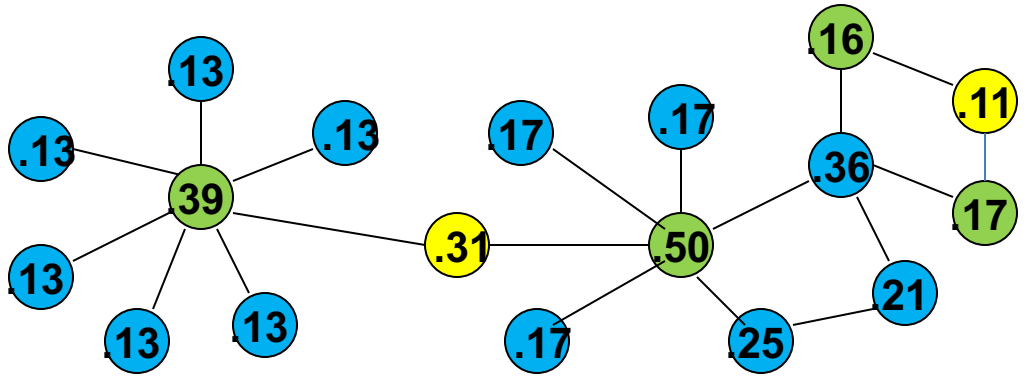
- Centrality is proportional to the sum of neighbors' centralities

$$C_i \text{ proportional to } \sum_{j:\ \text{friend of } i} C_j$$

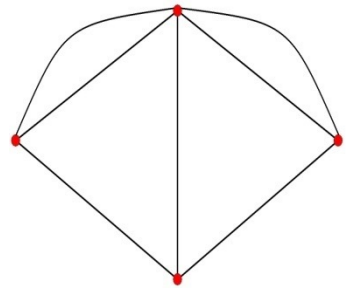
Eigenvector Centrality



Now distinguishes more ``influential'' nodes

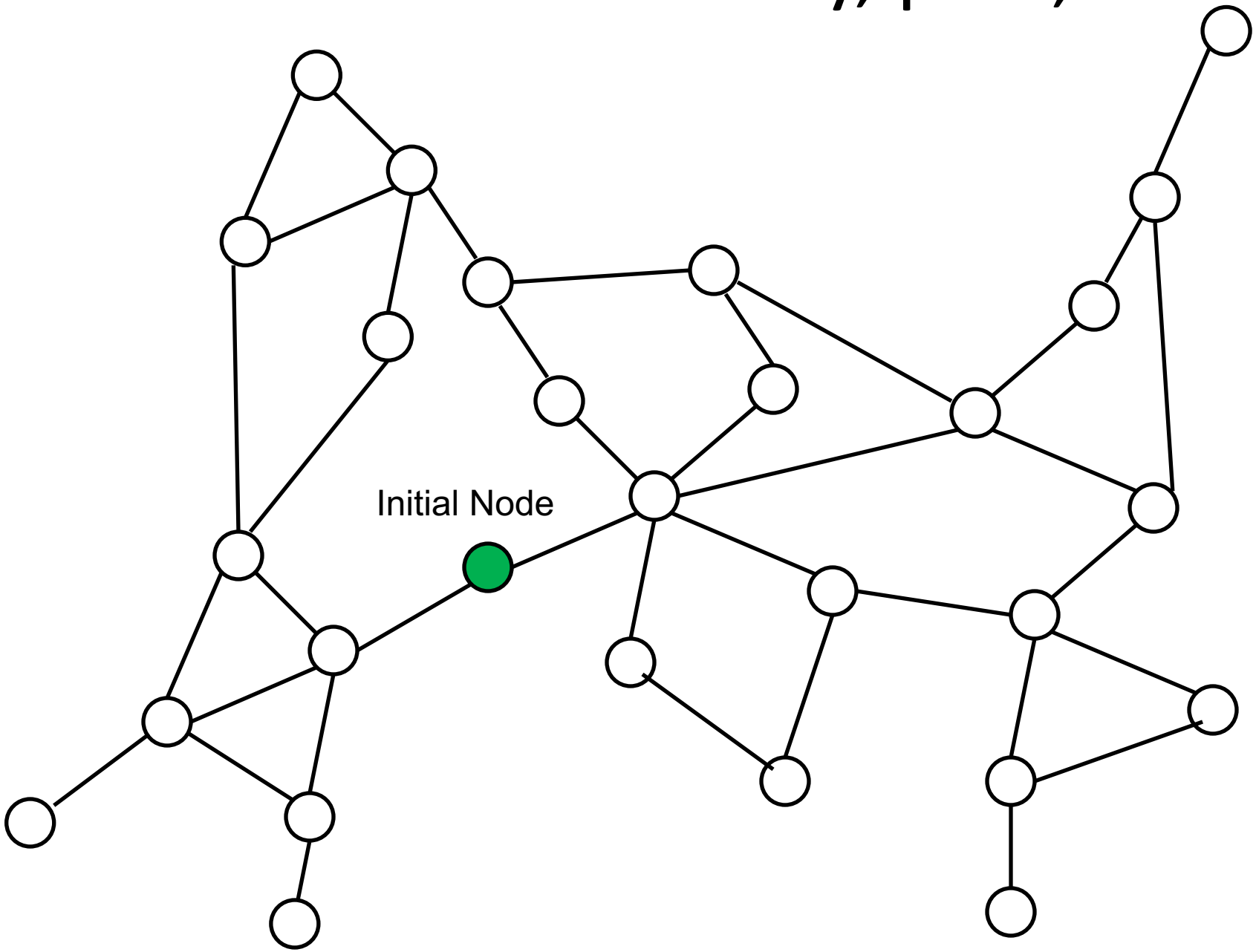


Diffusion Centrality: DC_i (p,T)

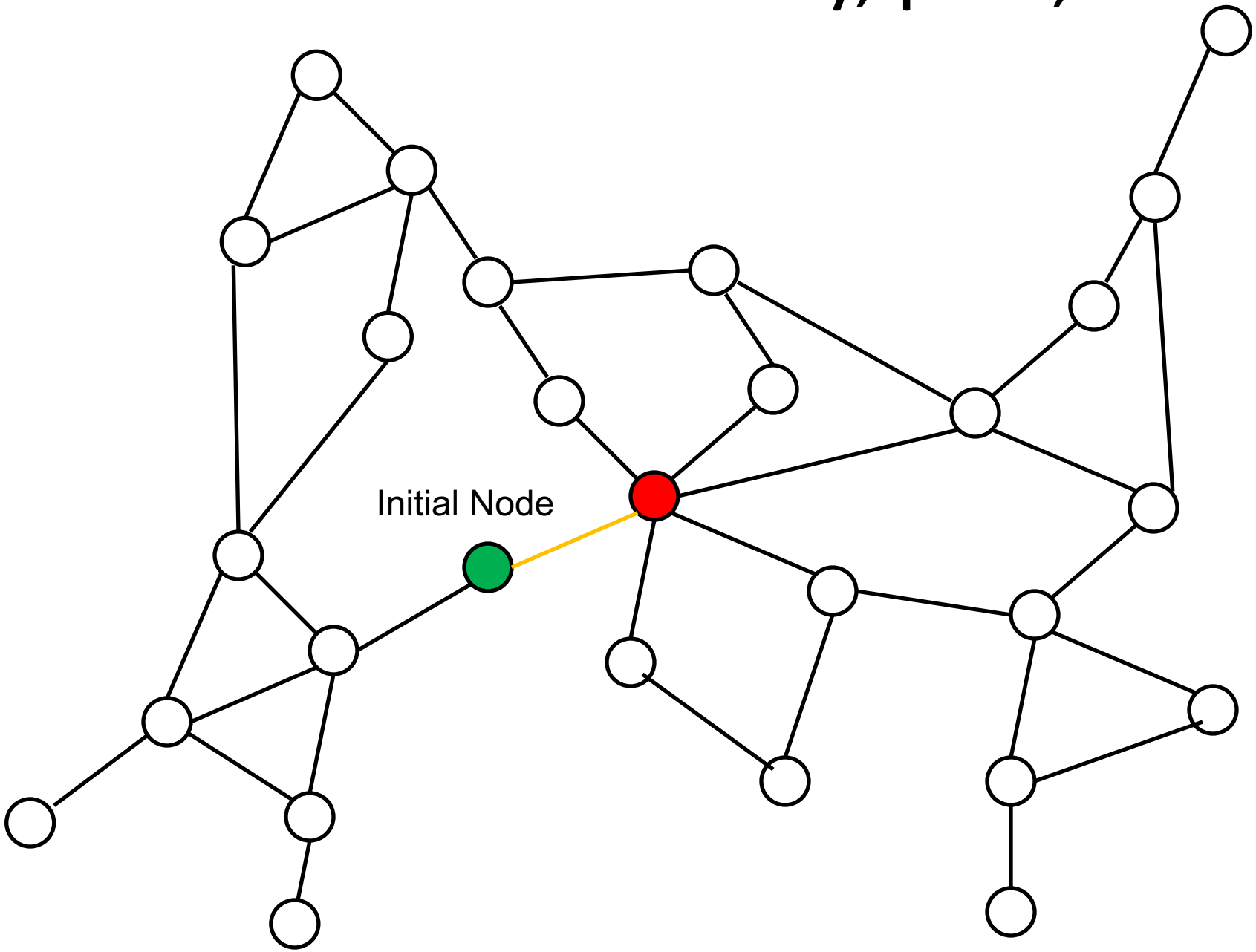


- How many people end up informed if:
  - person *i* is initially informed,
  - each informed person tells each of its neighbors with probability p in each period,
  - run for T periods?

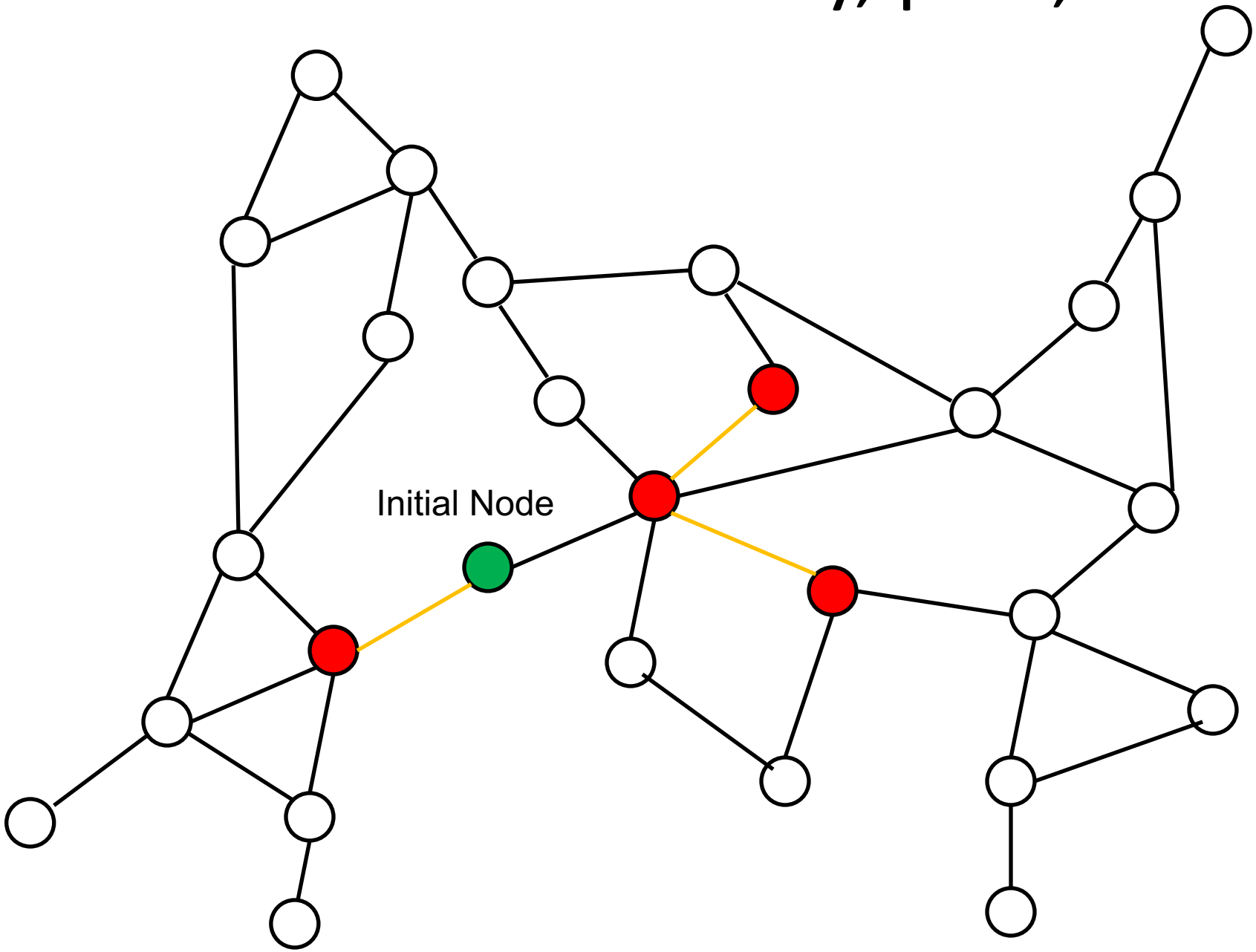
Diffusion Centrality, p=.5, T=4



Diffusion Centrality, p=.5, T=4



Diffusion Centrality, p=.5, T=4



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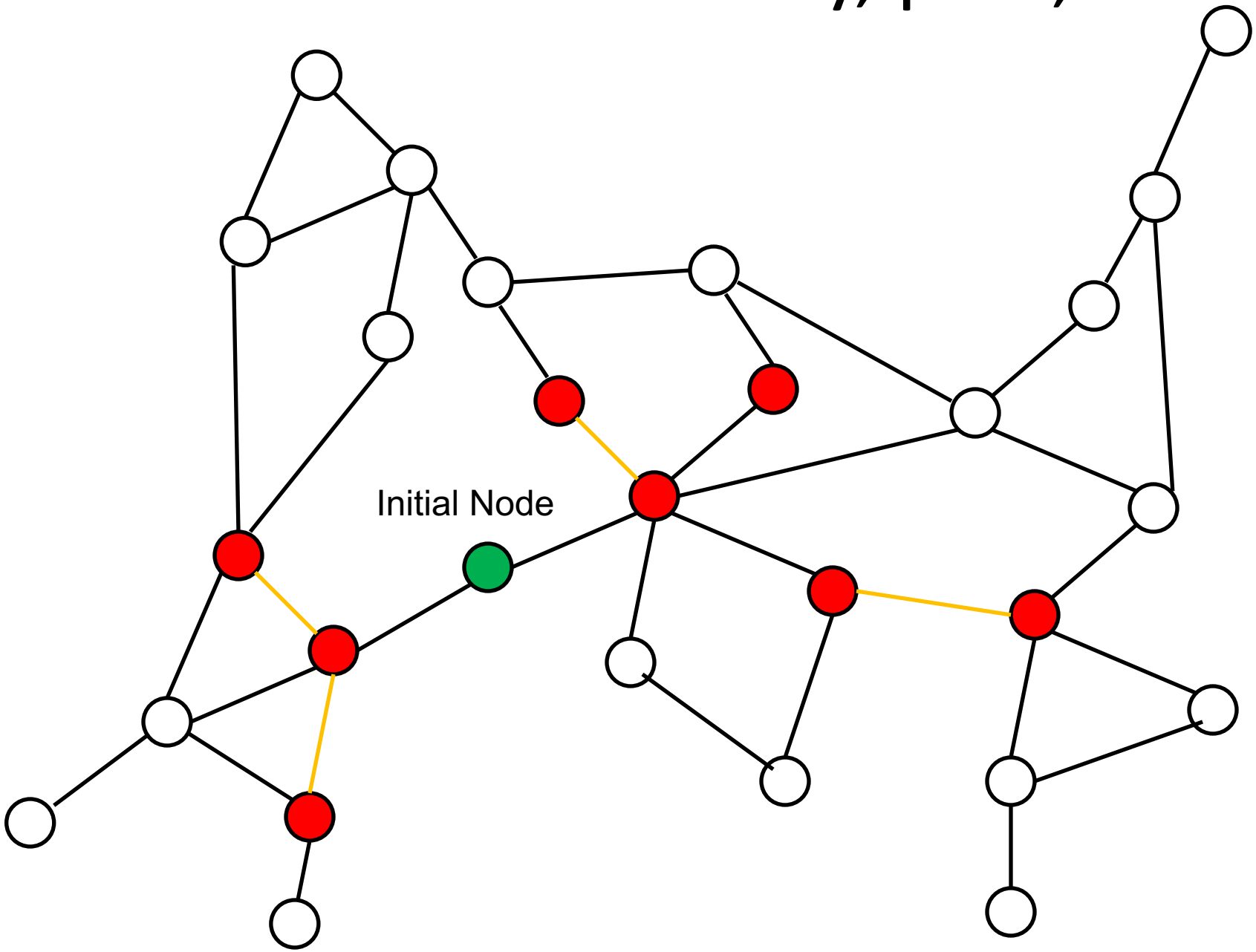

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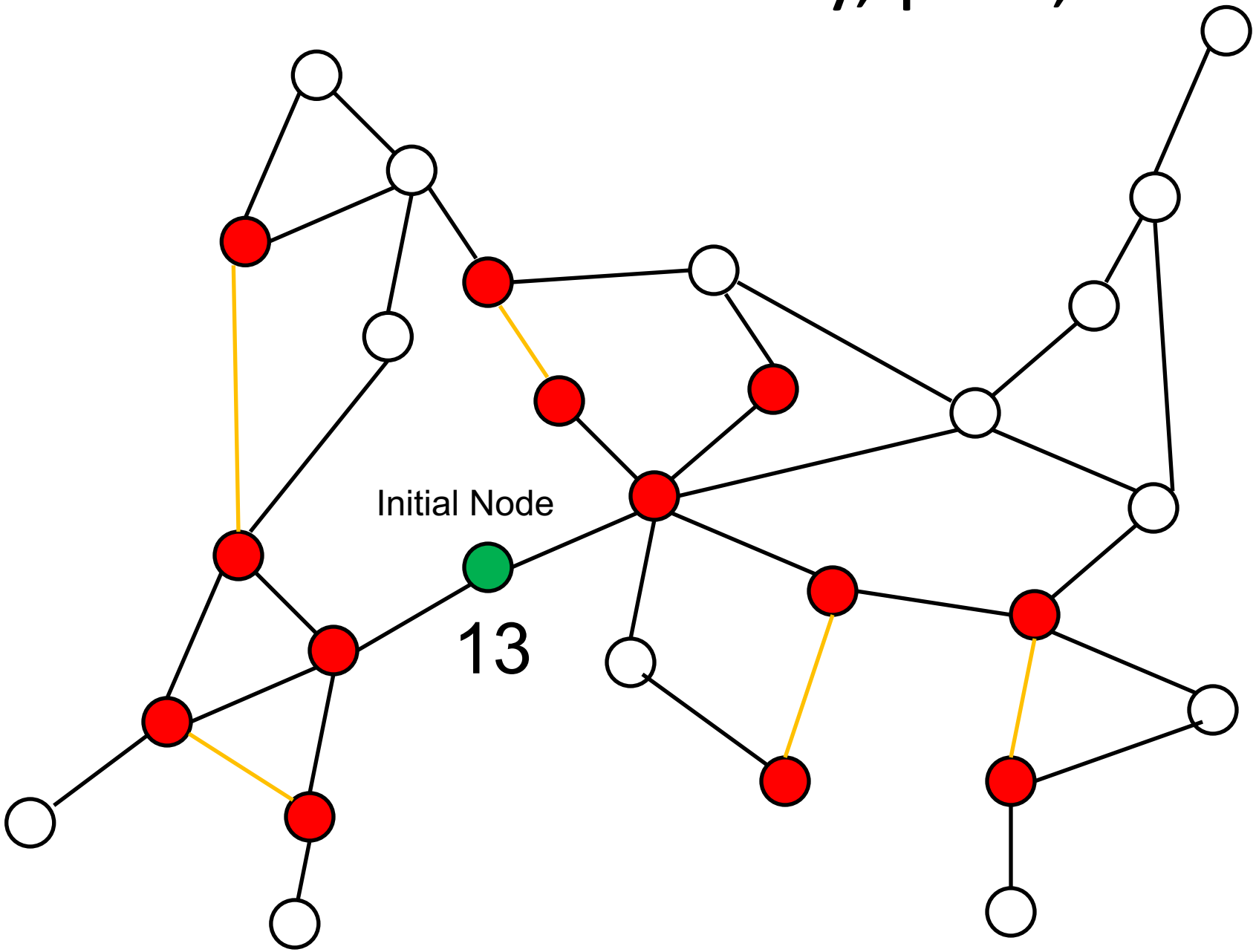

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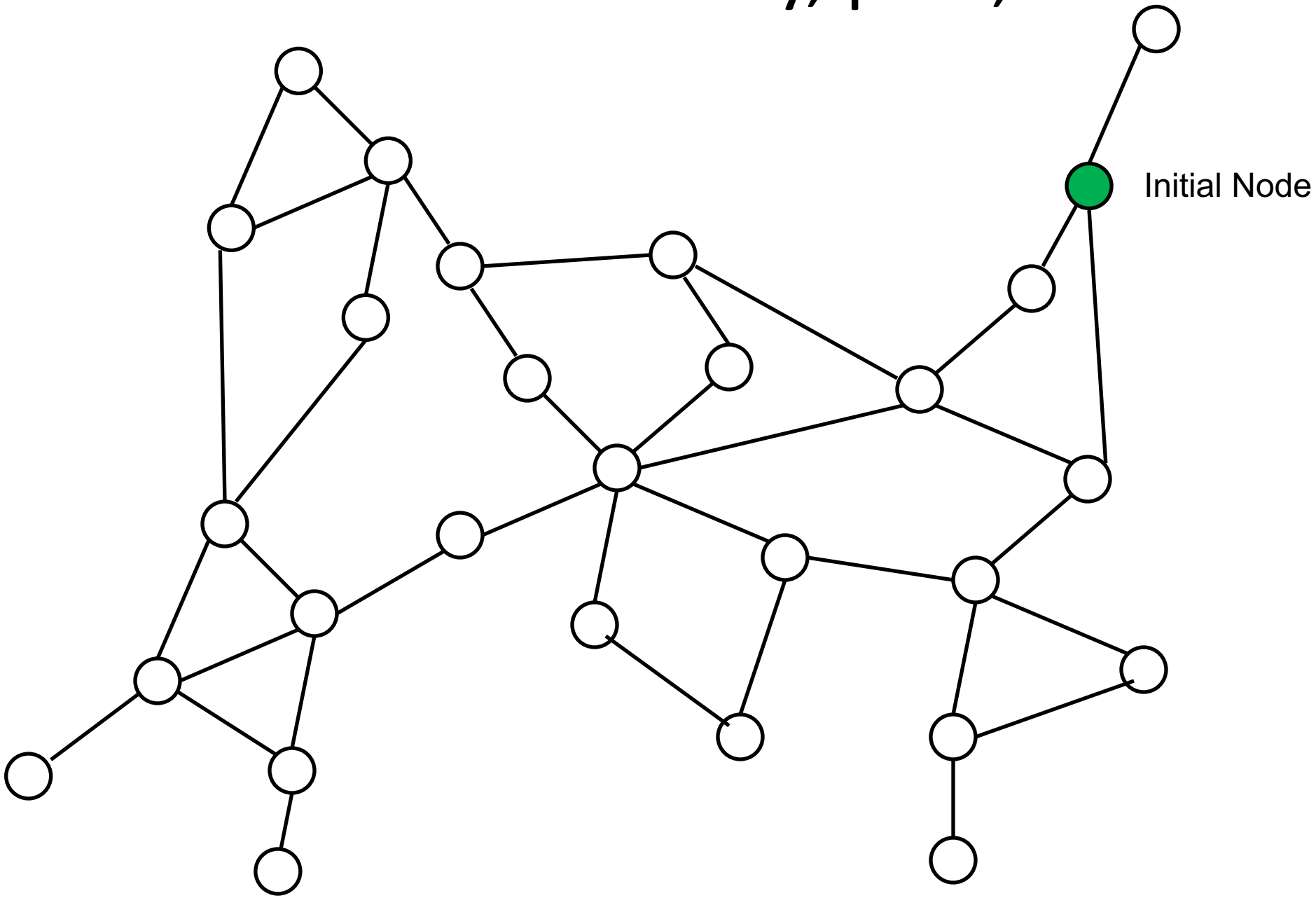

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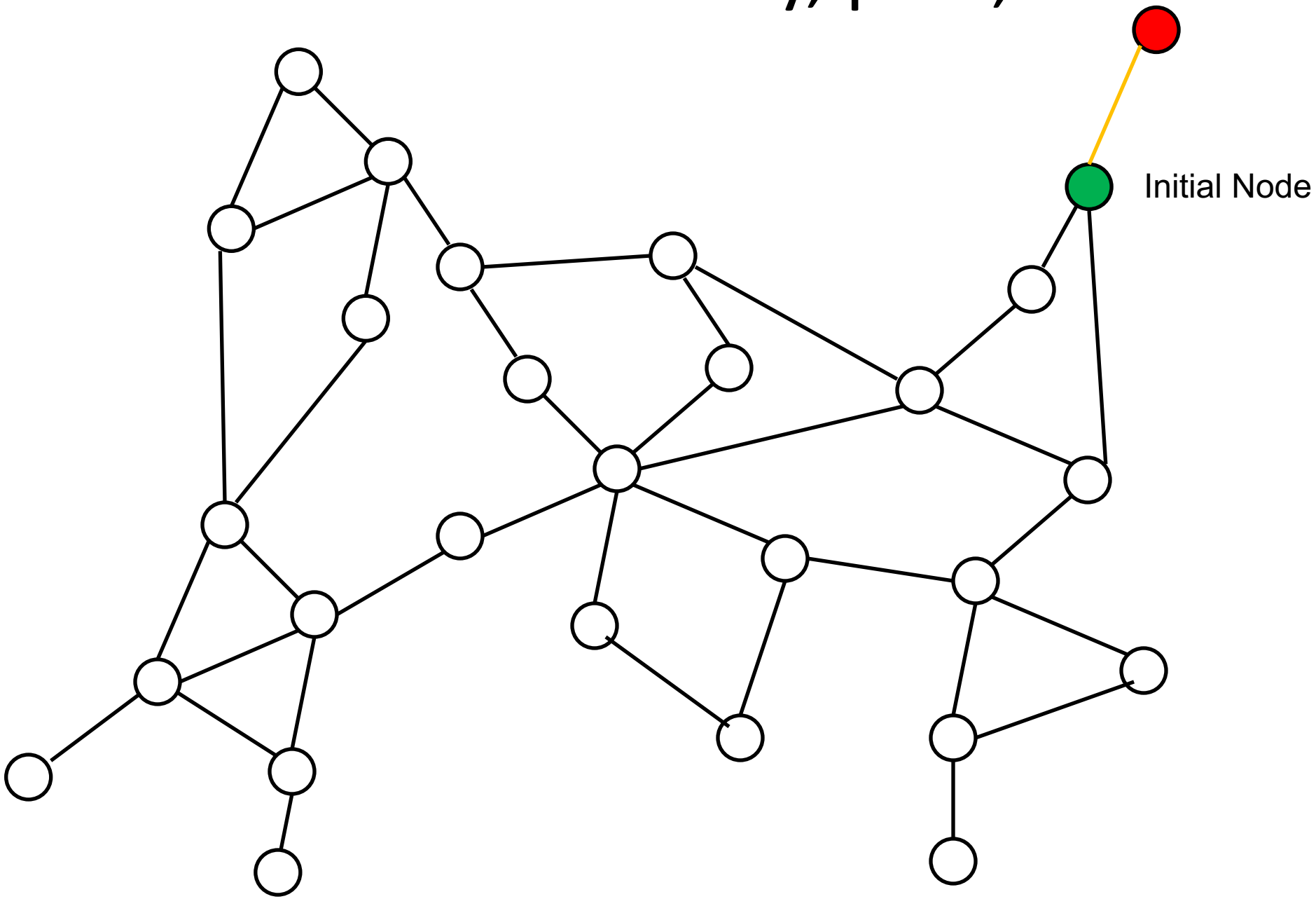

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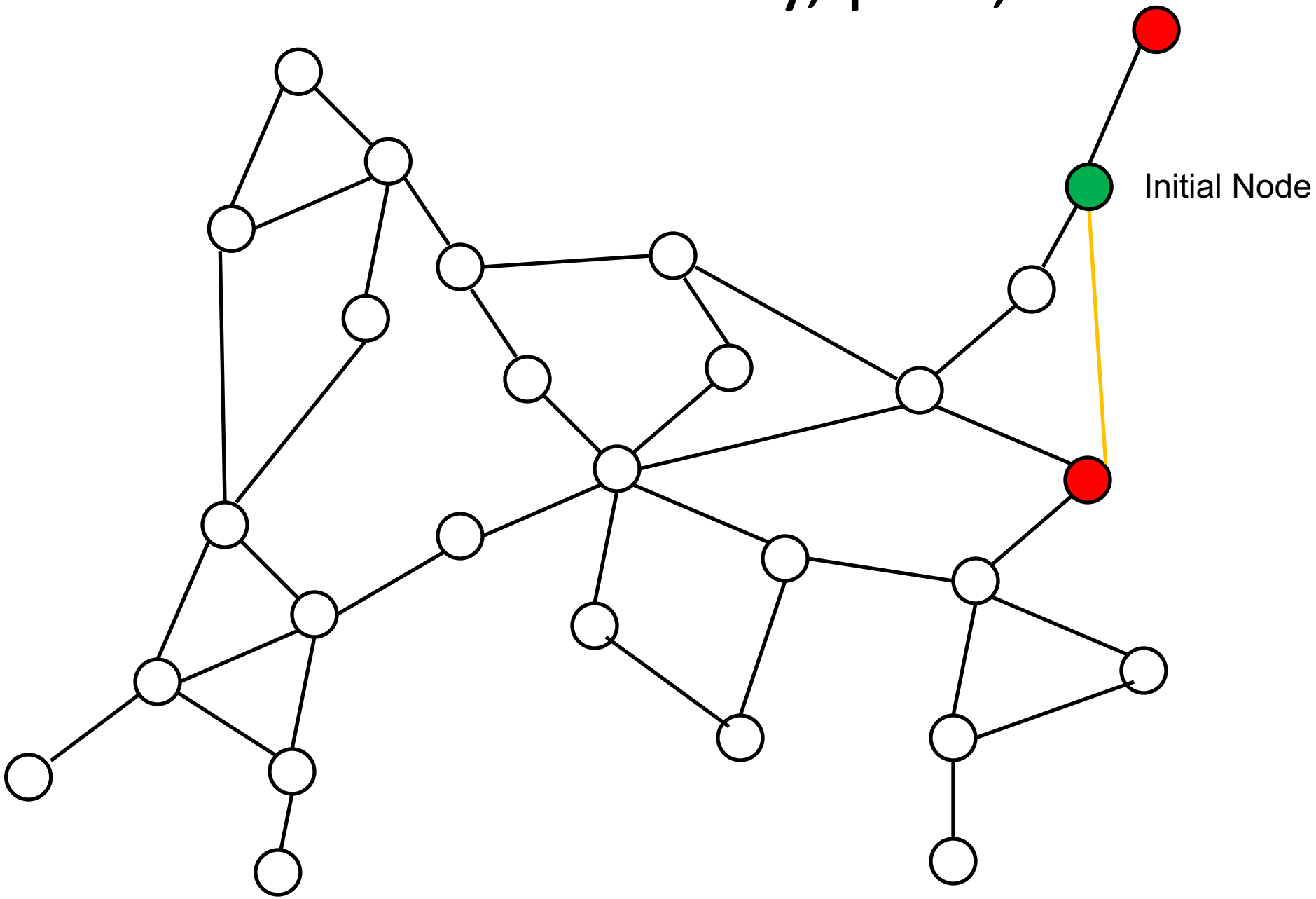

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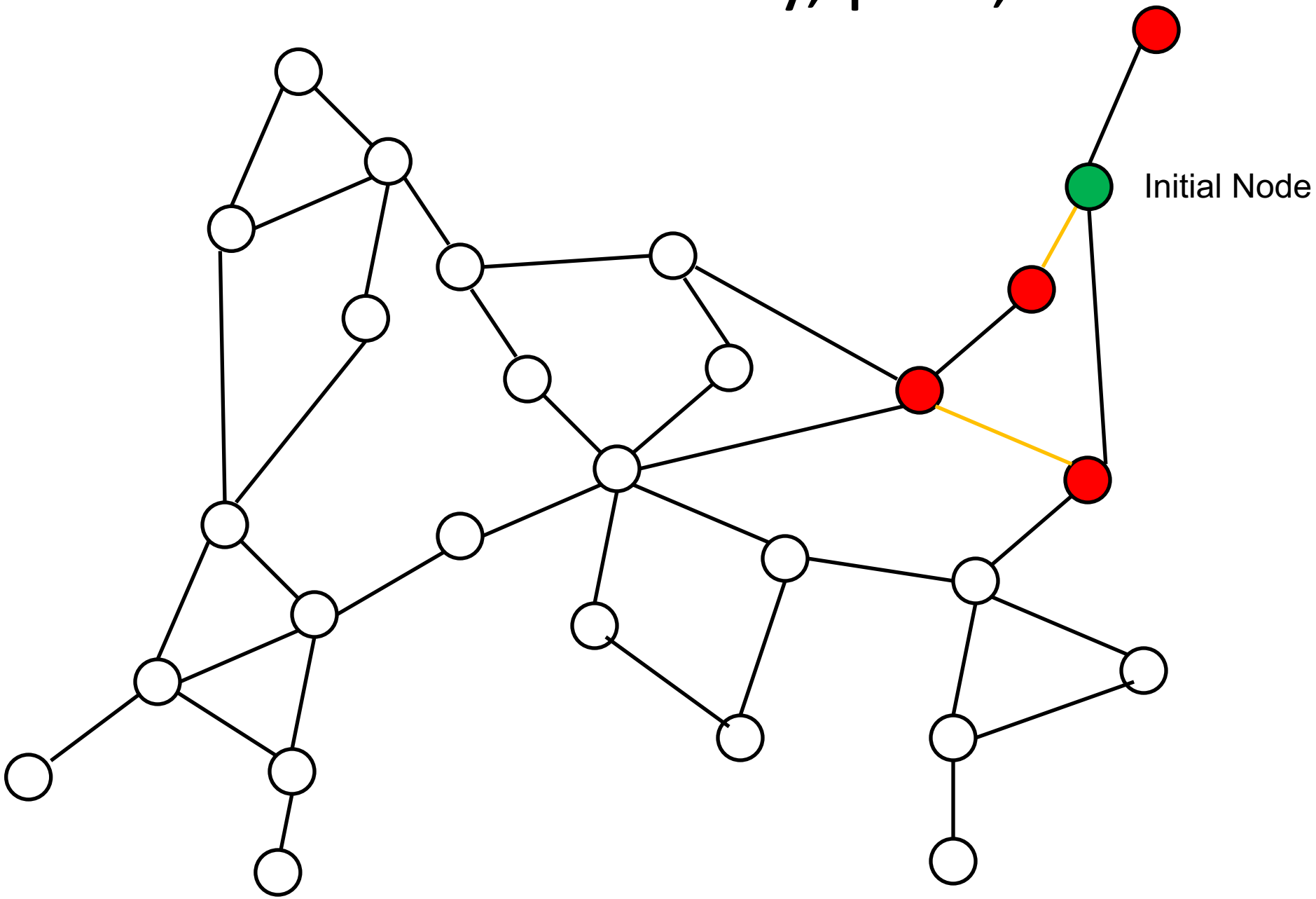

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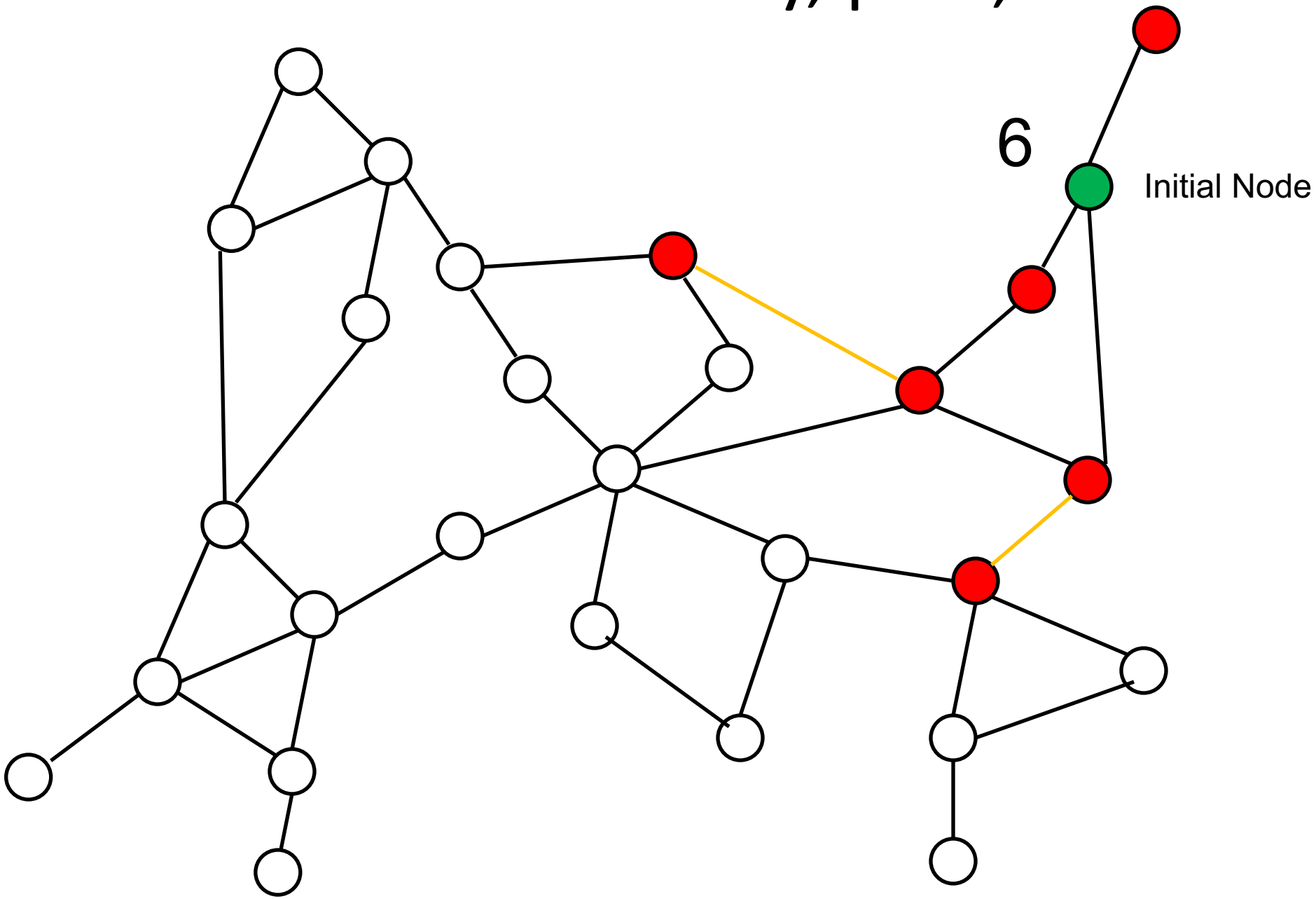
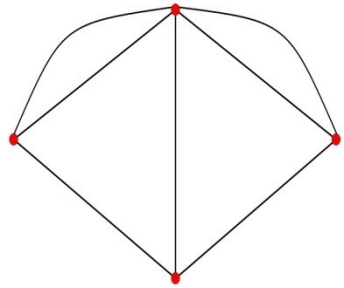


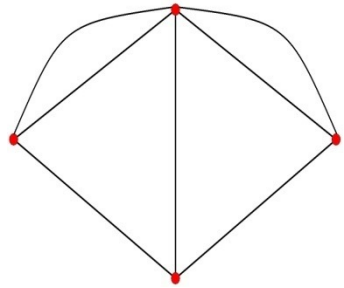
Theorem relating diffusion centrality to others:



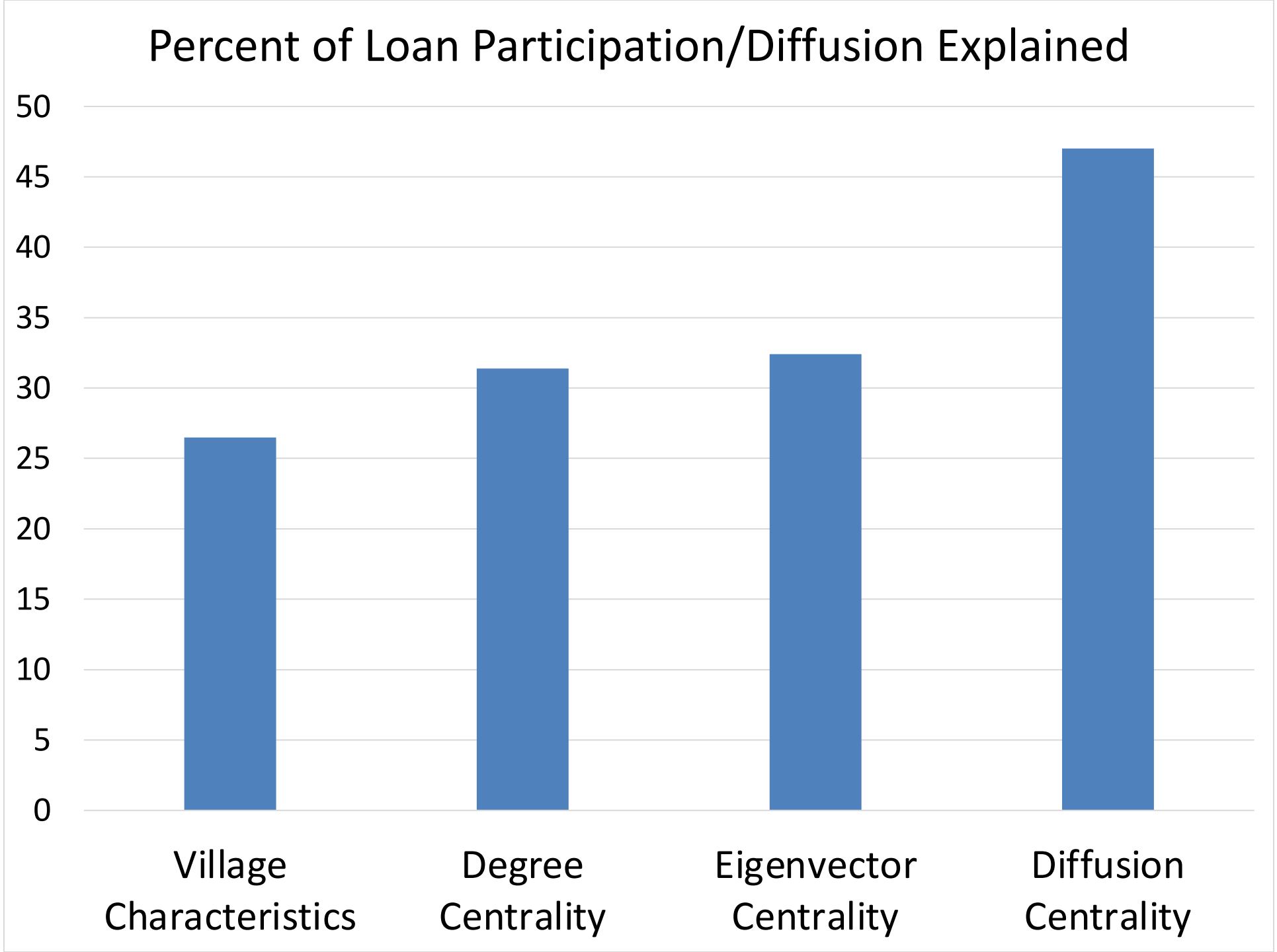
If communication occurs just once (T=1) then diffusion centrality is proportional to degree centrality.

If communication occurs many times (T is large) and p is large enough then diffusion centrality converges to eigenvector centrality.

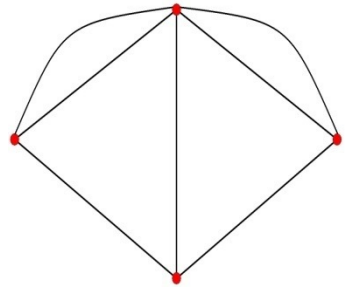
Importance of Injection Points:



- Hypothesis 1: higher *degree* centrality of first-informed people in a village leads to higher diffusion
- Hypothesis 2: higher *eigenvector* centrality of first-informed people in a village leads to higher diffusion
- Hypothesis 3: higher *diffusion* centrality of first-informed people in a village leads to higher diffusion


Percent of Loan Participation/Diffusion Explained
50
45
40
35
30
25
20
15
10
5
0
Village Characteristics
Degree Centrality
Eigenvector Centrality
Diffusion Centrality

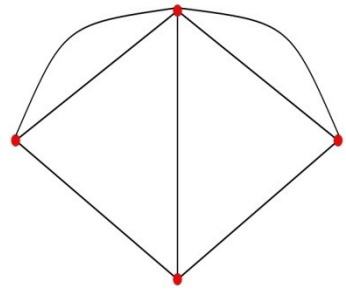
Network Diffusion



- Networks impact market participation

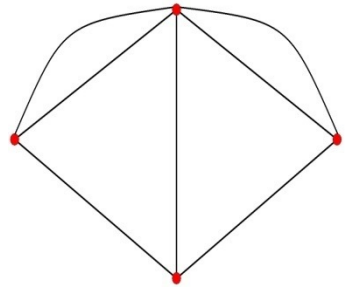
- Need to measure centrality appropriately!

Outline



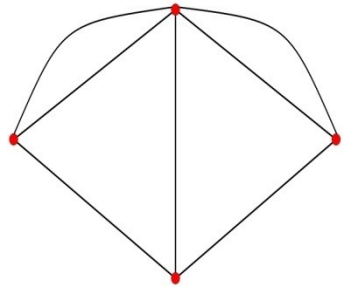
- Diffusion on networks impacts market participation
- Networks are changed by the market, multiple layers
- Multiple layers of networks impact diffusion

Timeline



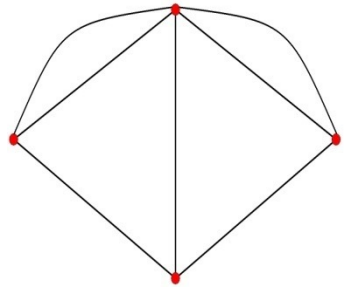
- 2006 We surveyed 75 villages that the bank intended to enter
- 2007-2010 Bank entered 43 villages offered loans, not other 32
- 2011-2012 We resurveyed all villages

Kenneth Arrow 1999



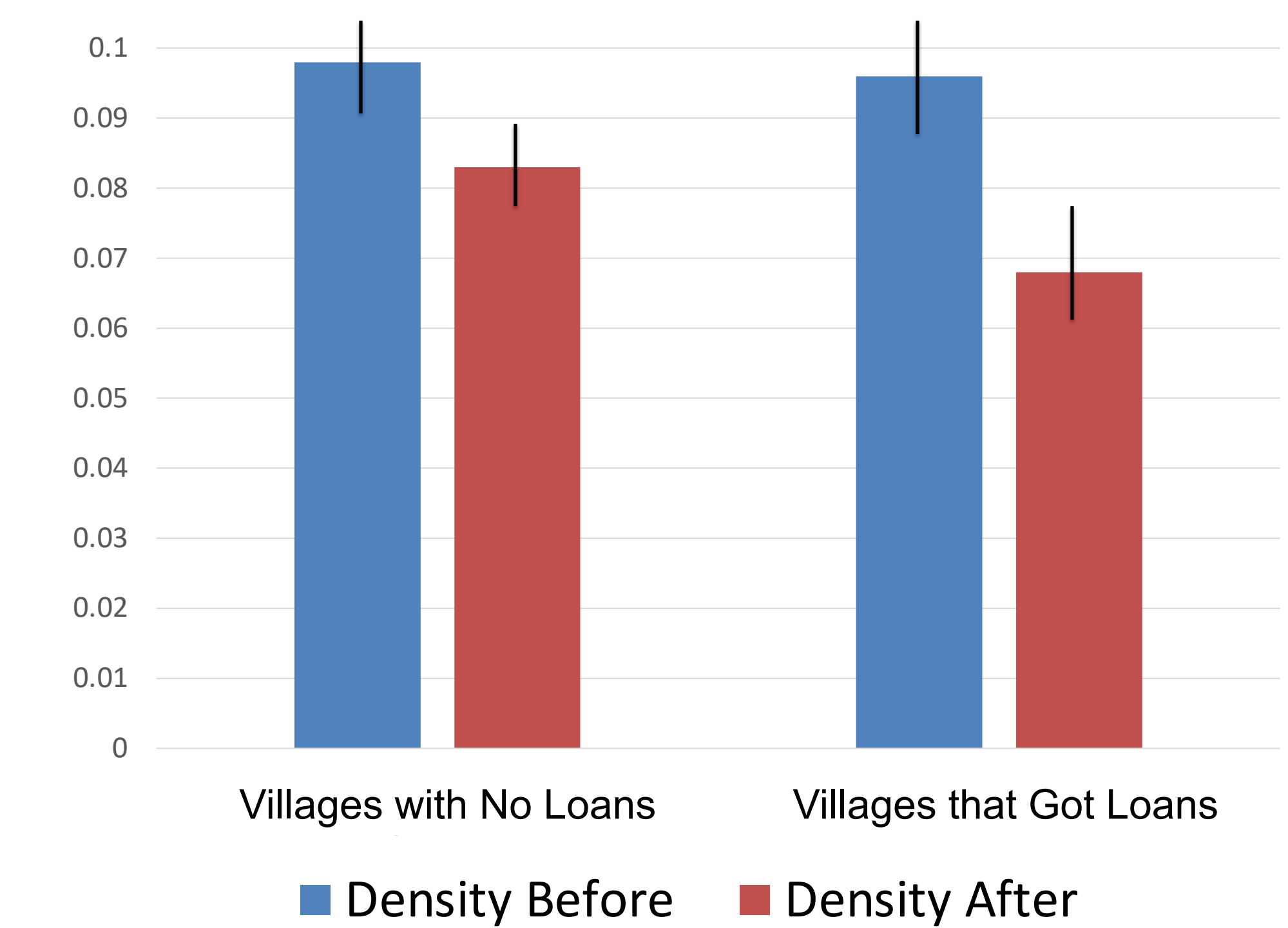
``This leads to an important and long-standing question: does the market (or, for that matter, the large, efficient, bureaucratic state) destroy social links that have positive implications for efficiency?''

Kenneth Arrow 1999

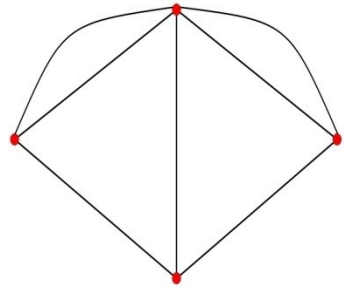


``This leads to an important and long-standing question: does the market (or, for that matter, the large, efficient, bureaucratic state) destroy social links that have positive implications for efficiency?''

Here: Does availability of formal loans change informal networks?

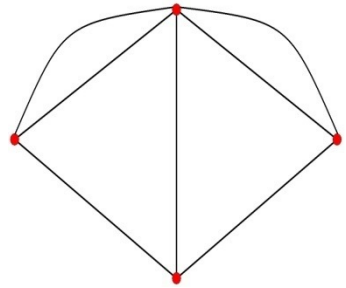

0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Villages with No Loans
Villages that Got Loans
Density Before
Density After

Do Networks Change?



- Does the introduction of formal loans change the informal networks? Yes

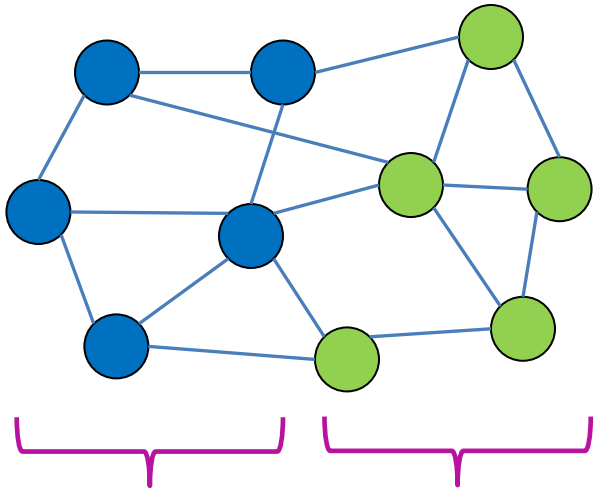
Do Networks Change?



- Does the introduction of formal loans change the informal networks? Yes

Whose networks change? Just loan takers?

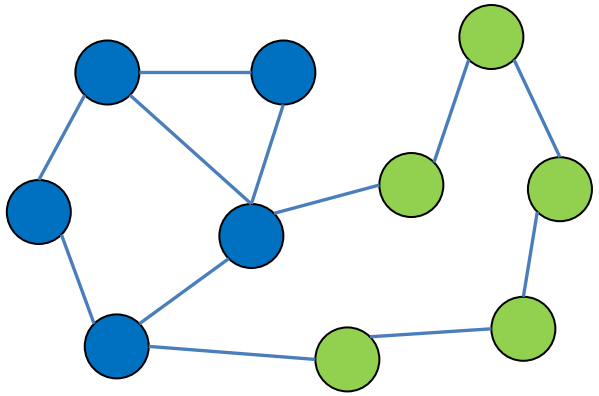
Impact of MF on Networks



MF participants

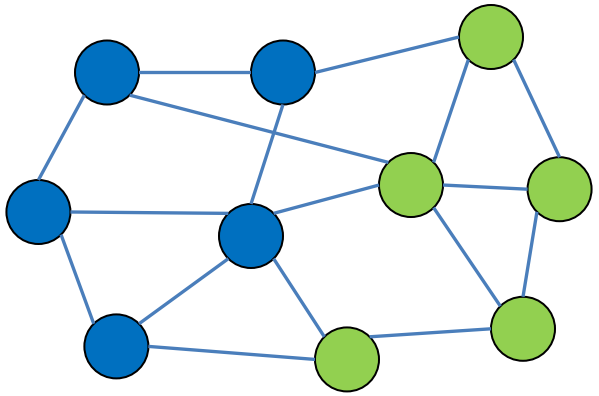
non participants

BEFORE

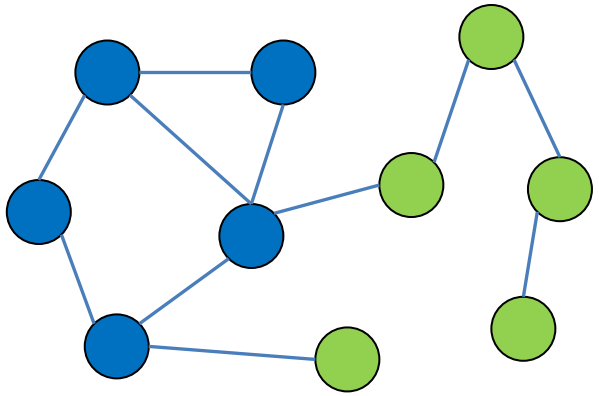


AFTER

Impact of MF on Networks

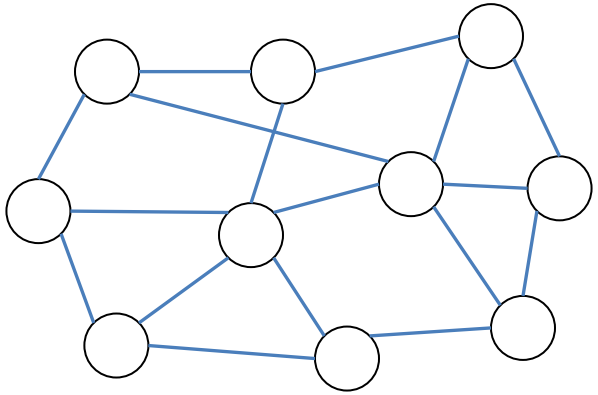


MF
village

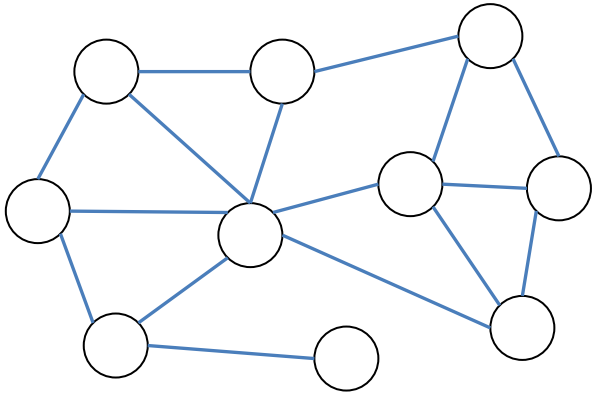


BEFORE

AFTER

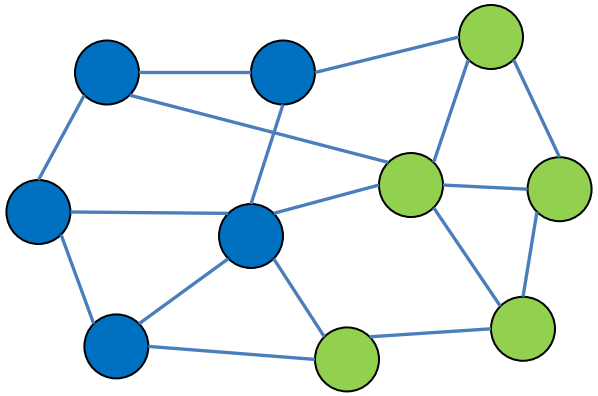


Non-MF
village

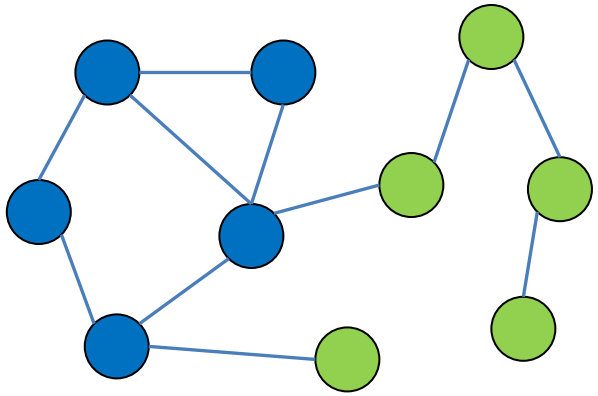


But which are blues/green?

Impact of MF on Networks

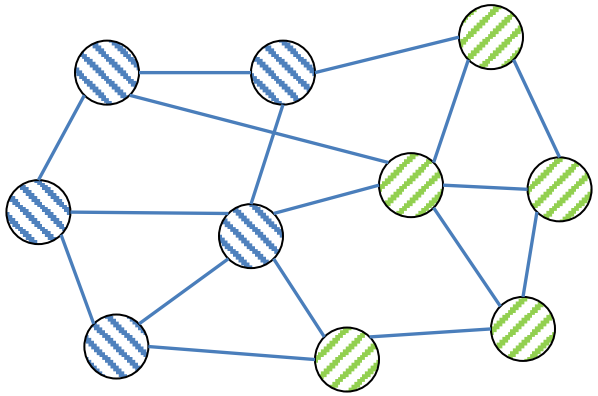


MF
village

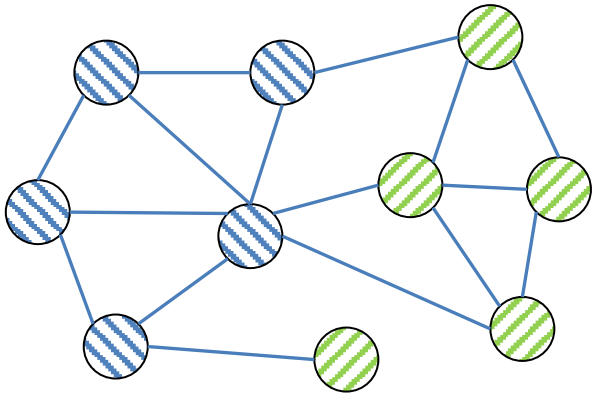


BEFORE

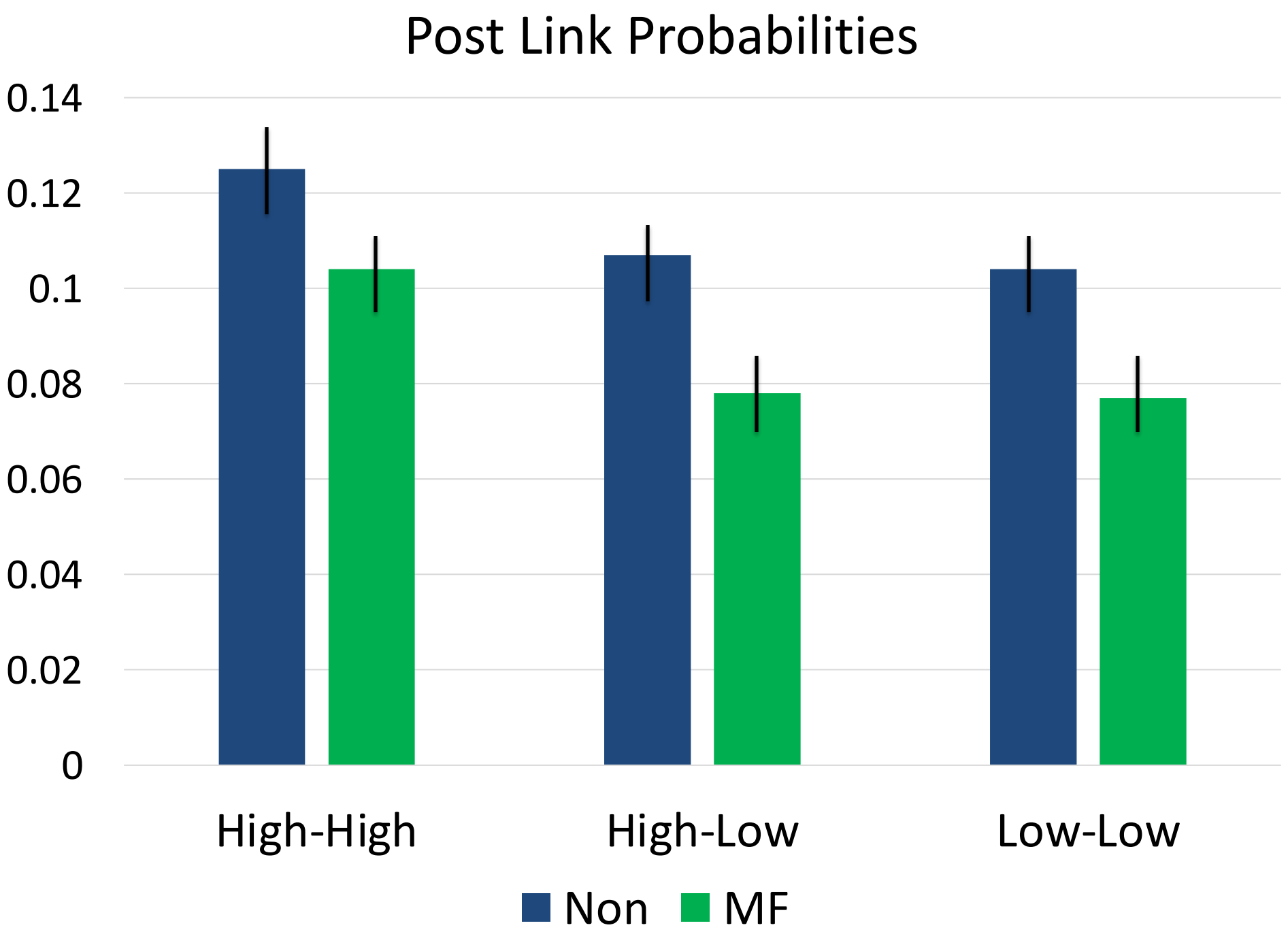
AFTER



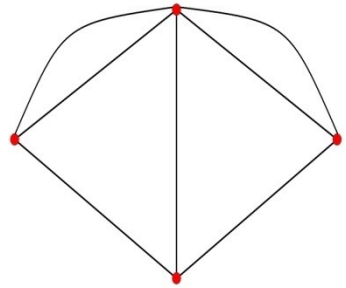
Non-MF
village



But which are blues/green?


Post Link Probabilities
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
High-High
High-Low
Low-Low
Non
MF

Hyderabad India

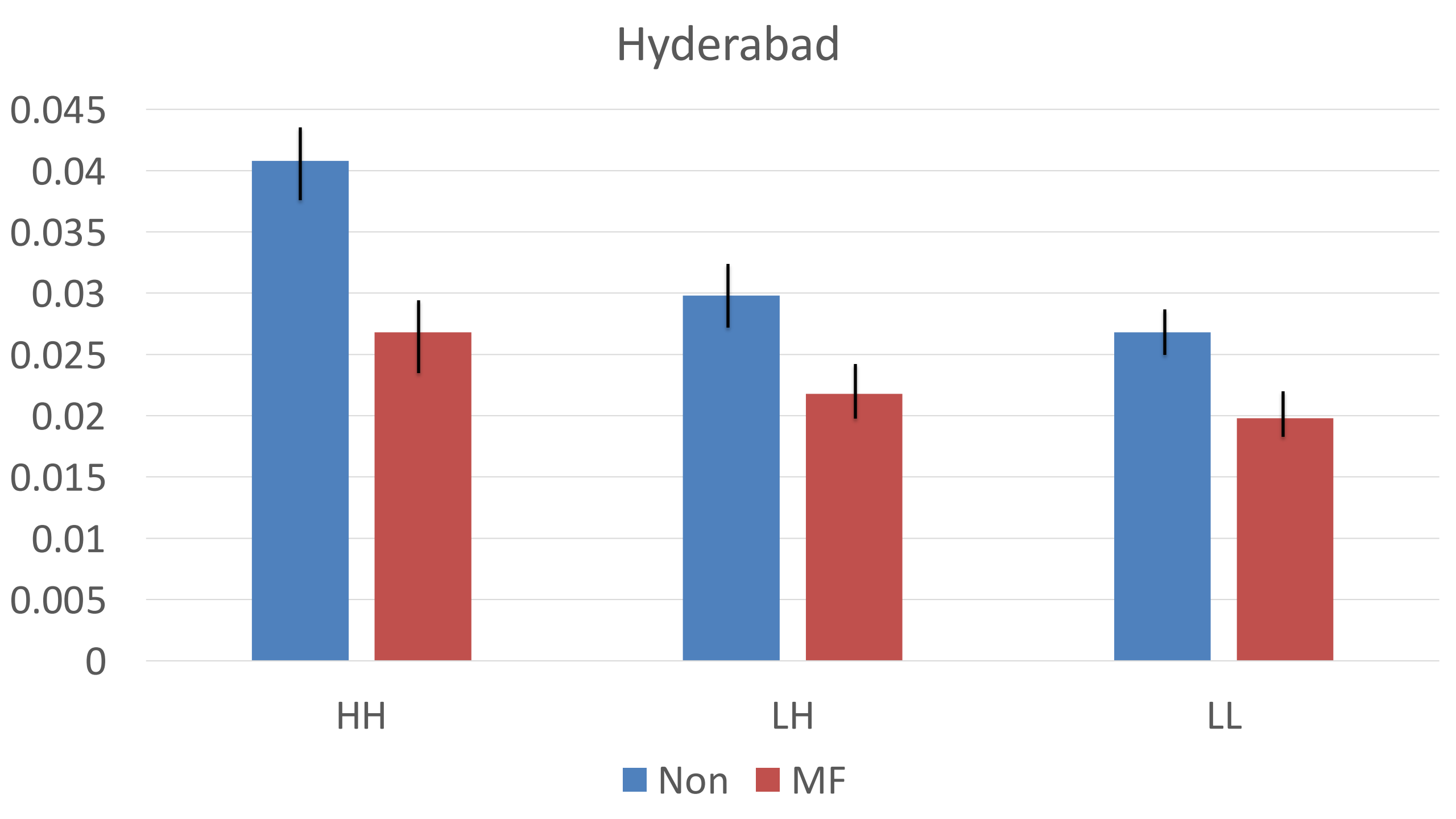


Randomized Controlled Experiment

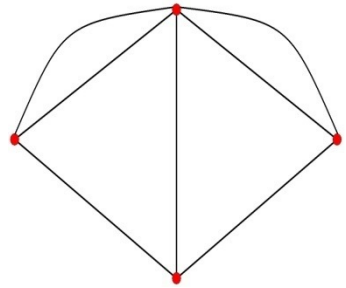
104 villages, half get microfinance 2006

network data from after microfinance 2012

Similar effects in sign, magnitude…

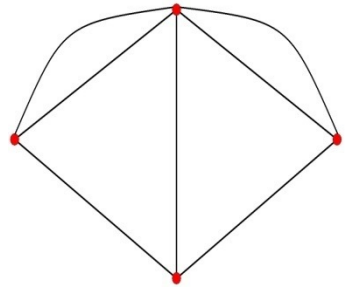

Hyderabad
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
HH
LH
LL
Non
MF

Networks Change



- Introduction of formal loans changes the informal networks
- Loss of networks for *everyone*
- Only some people get loans, what is the impact for those who do not?

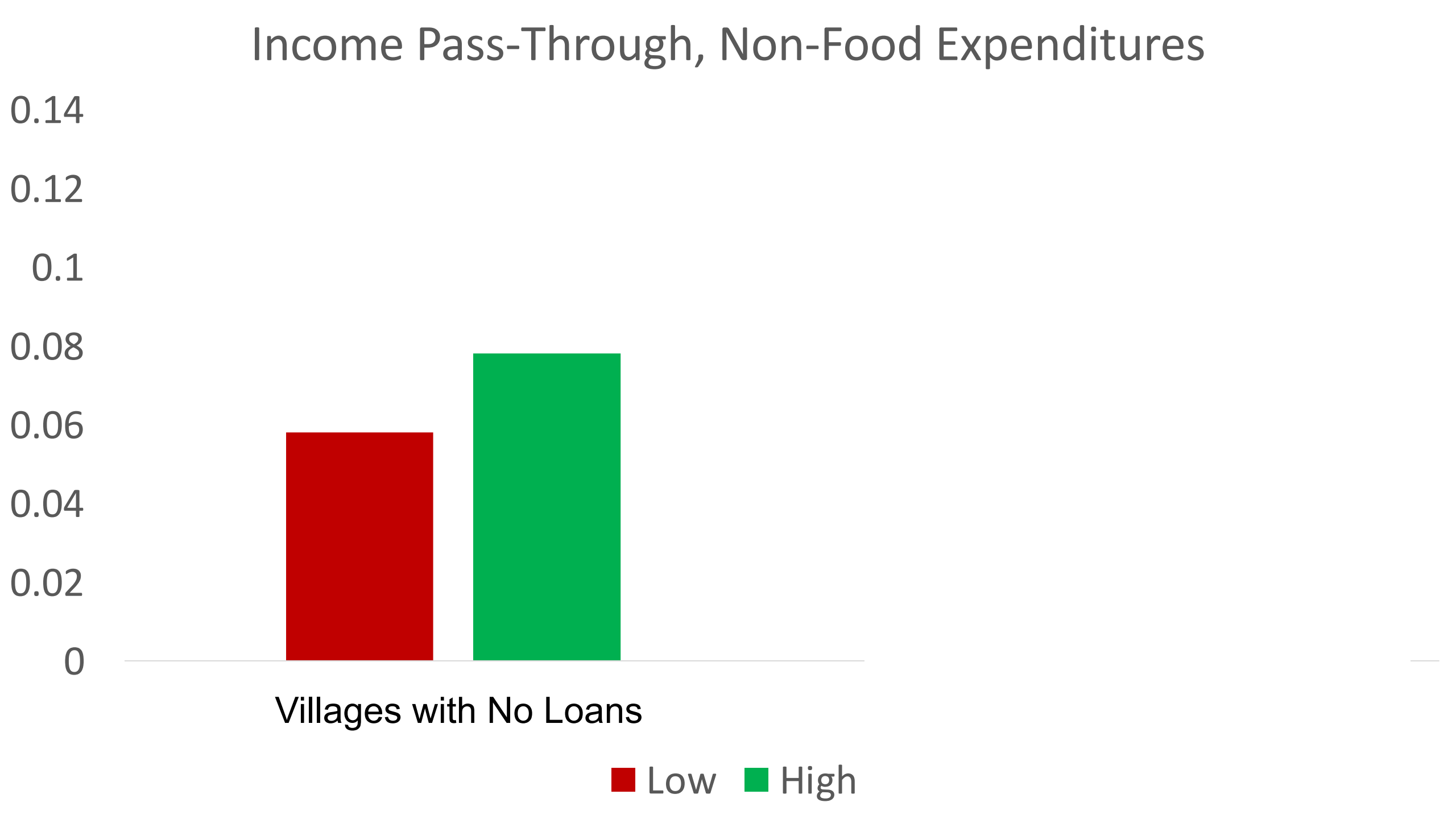
Hyderabad

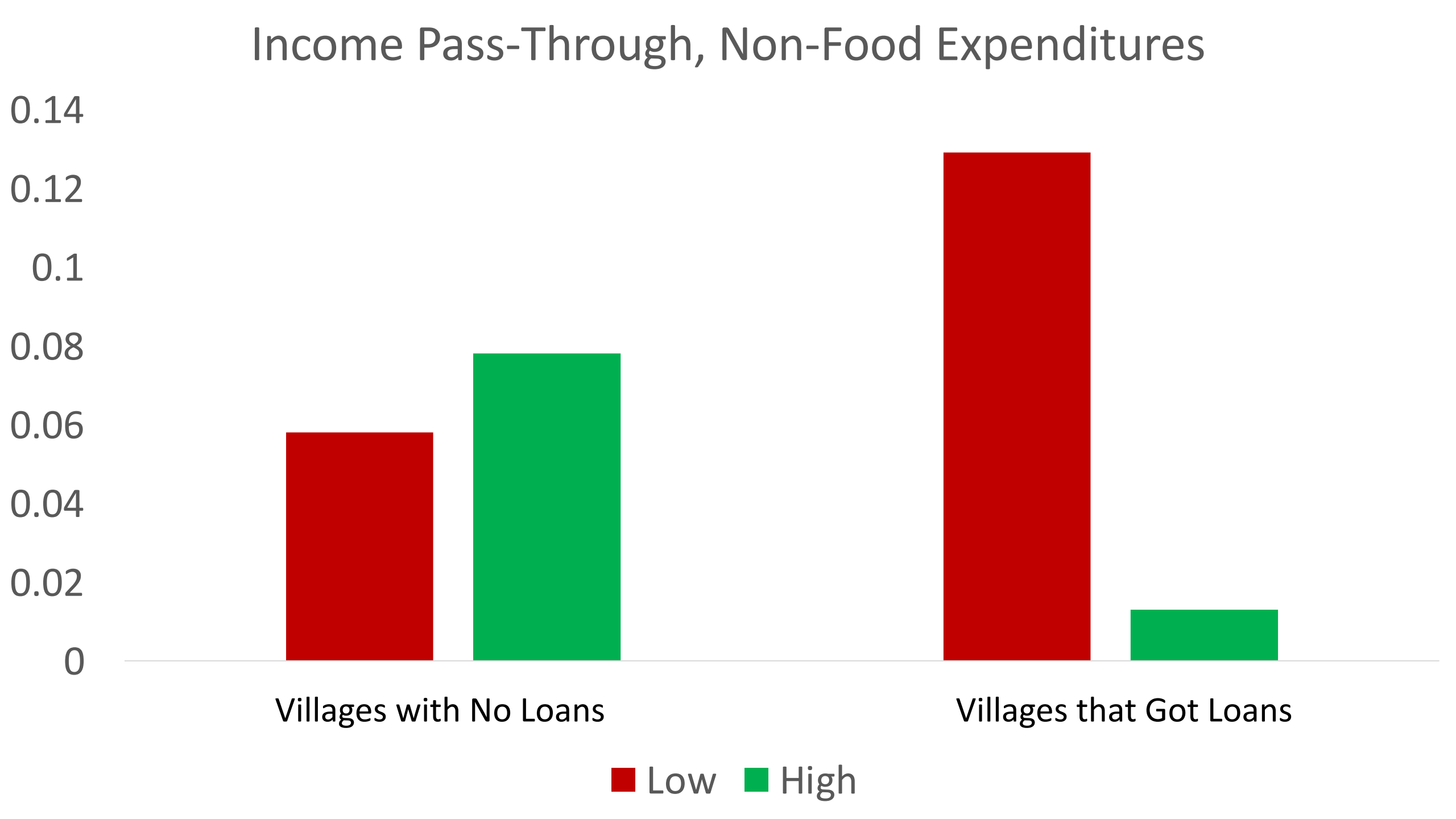


also measure consumption, income

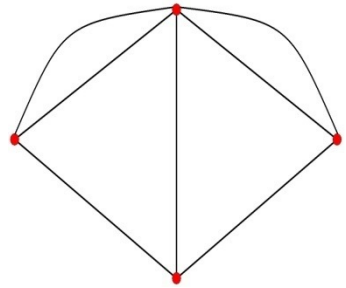
How much of variation in monthly income becomes variation in expenditures?

If there was perfect risk sharing then this should be 0


Income Pass-Through, Non-Food Expenditures
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Villages with No Loans
Low
High

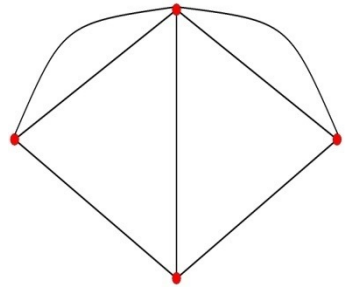

Income Pass-Through, Non-Food Expenditures
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Villages with No Loans
Villages that Got Loans
Low
High

Networks Change and it Matters



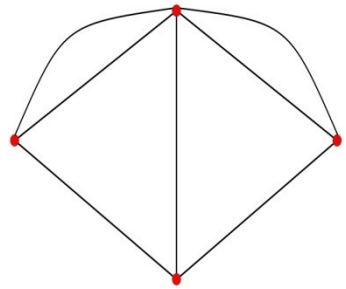
- Introduction of formal loans change the informal networks.
- Changes networks of those not getting loans too
- Worse risk-sharing for those not getting loans

Network Changes



- Explanation for loss of networks by everyone even though only some people got loans:

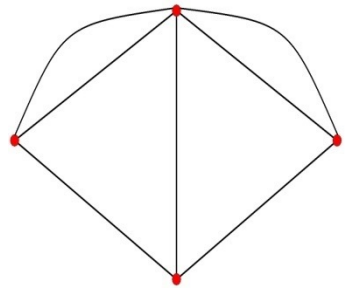
Network Changes



- Explanation for loss of networks by everyone even though only some people got loans:

- Externalities
  - takes effort to socialize
  - people who got loans decrease socializing
  - then so do people who did not get loans…

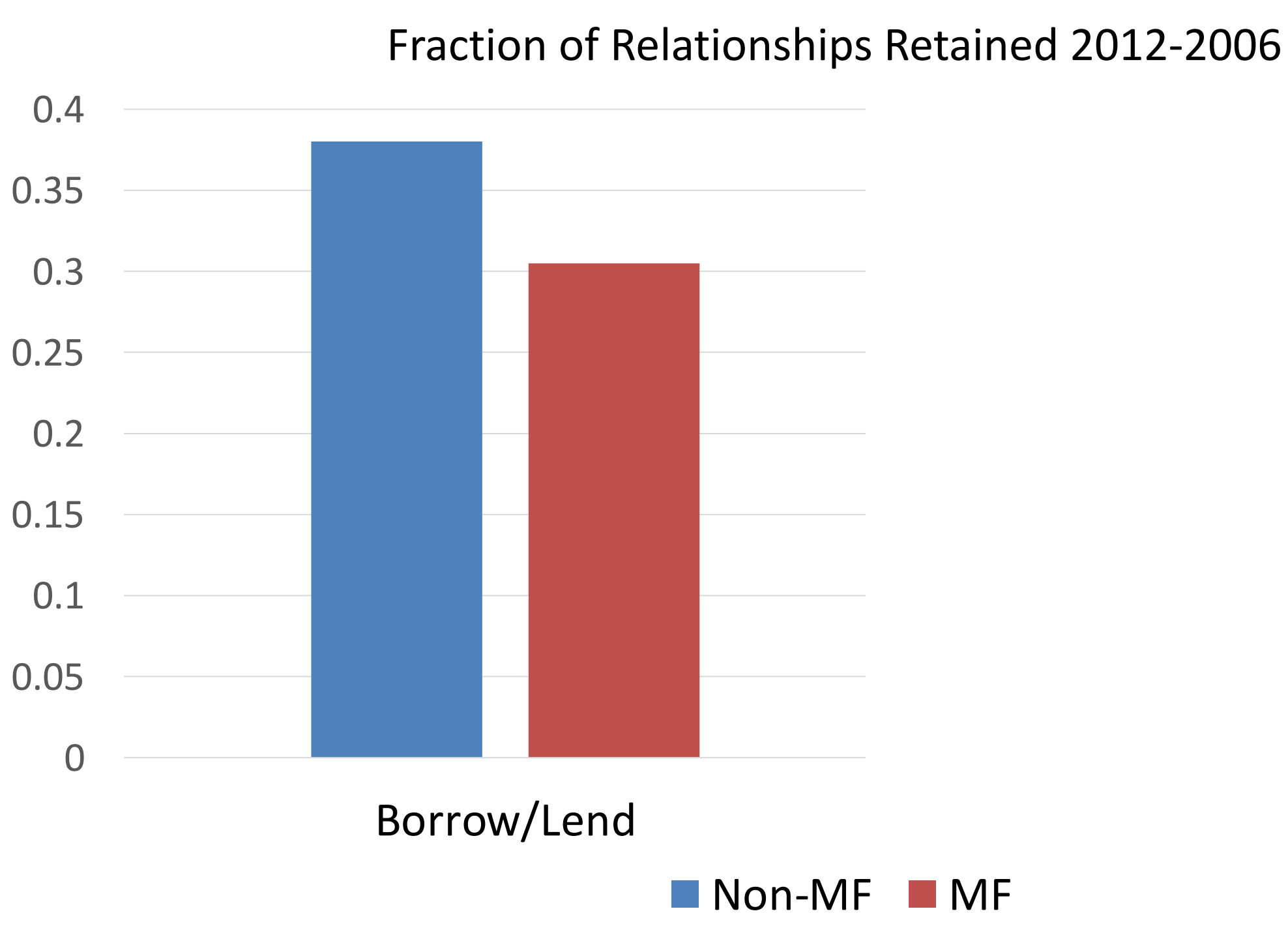
Network Changes

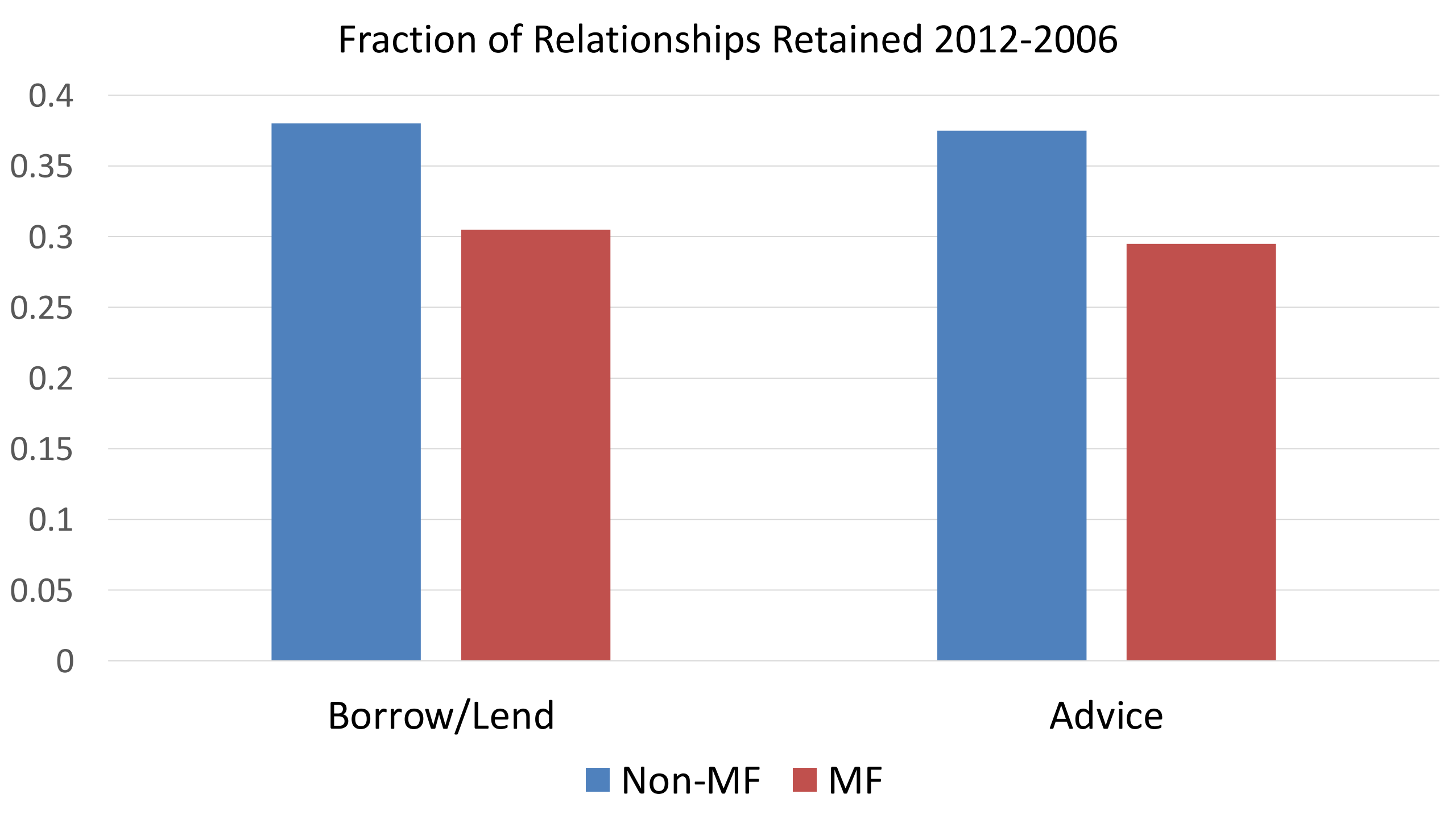


- Explanation for loss of networks by everyone even though only some people got loans:

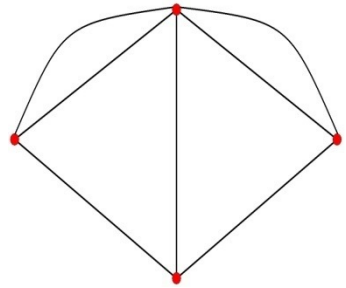
- Externalities
  - takes effort to socialize
  - people who got loans decrease socializing
  - then so do people who did not get loans…

Then this might impact all networks, not just borrow/lend?


Fraction of Relationships Retained 2012-2006
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Borrow/Lend
Non-MF
MF

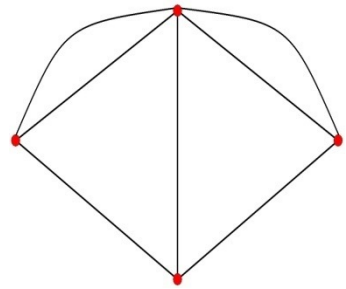

Fraction of Relationships Retained 2012-2006
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Borrow/Lend
Advice
Non-MF
MF

So Far:



- Networks determine diffusion of microfinance
- Market changes networks: loss of relationships by all villagers and including non-borrowing networks
- Networks are intertwined: how does that impact diffusion?
  - Let us better understand network layers and their impact…

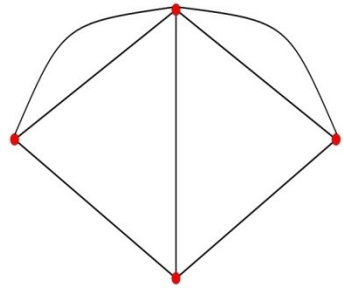
Outline



- Diffusion on networks impacts market participation
- Networks are changed by the market, multiple layers
- Multiple layers of networks impact diffusion

Chandrasekhar, Chaudhary, Golub, Jackson (2023)

Experiment on Diffusion:

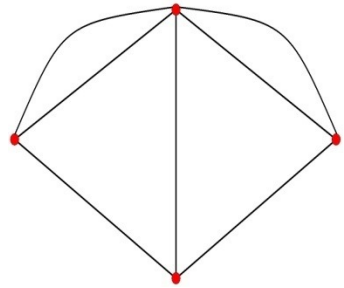


- Spread information about a chance to win a cell phone
  - Roll dice, win 50 to 275 rupees, if roll a 12 get cell phone (3000 rupees)

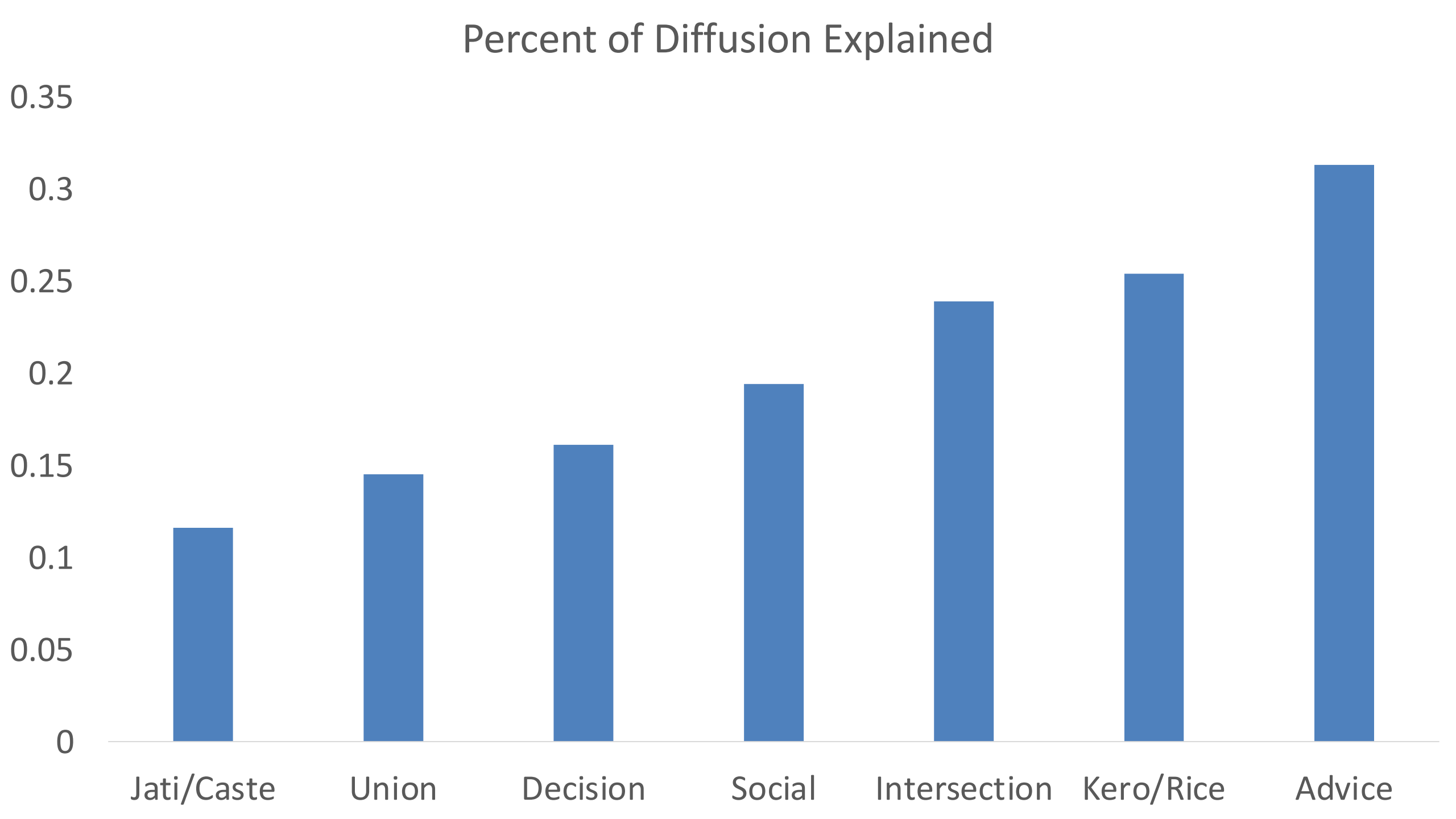
- Randomly choose 3 to 5 people to ask to spread information – the ``seeds''

- 68 villages

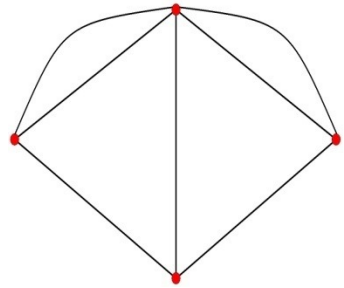
Diffusion



- Which network layers predict diffusion in the experiment?
- Look at `diffusion centrality' of seeds according to network layer
- See which network layers predict diffusion


Percent of Diffusion Explained
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Jati/Caste
Union
Decision
Social
Intersection
Kero/Rice
Advice

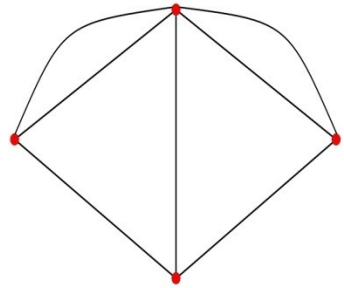
Implications for Diffusion



- Different layers are differently predictive, but multiple layers matter

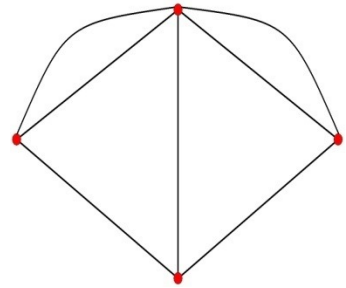
- Rethink diffusion in light of multiplexing
  - How multiplexing impact diffusion?
  - Theory, field experiment, simulations

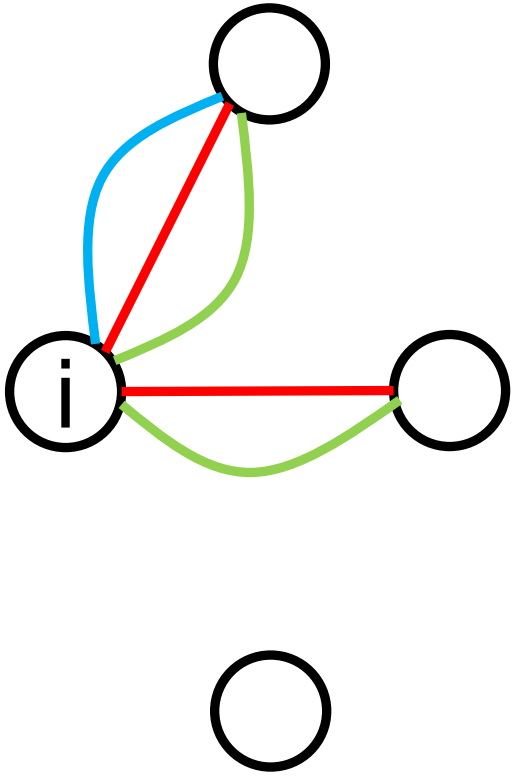
Multiplexing and Diffusion



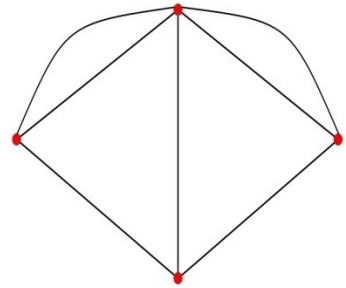
- Does diffusion depend on amount of multiplexing?

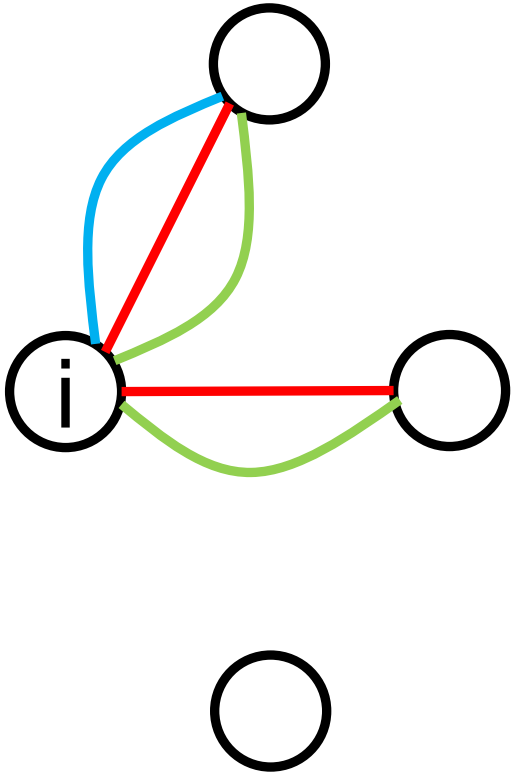
Less Multiplexed

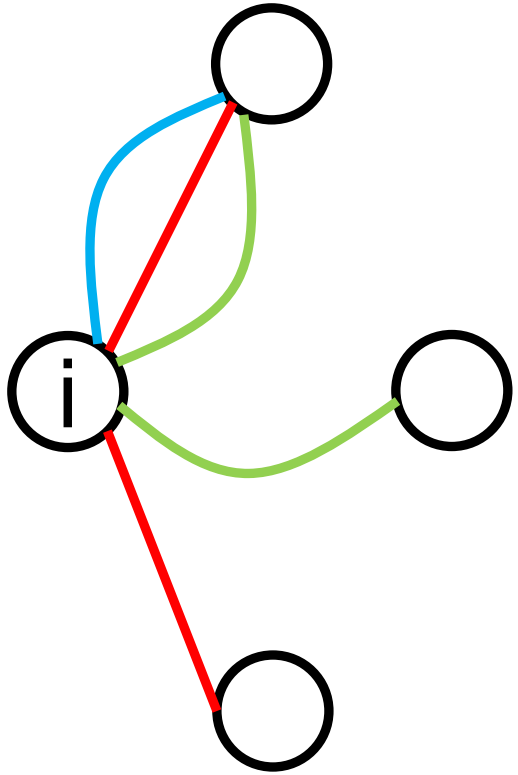




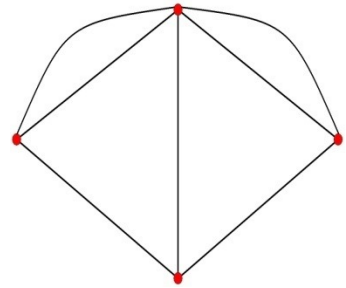
Less Multiplexed

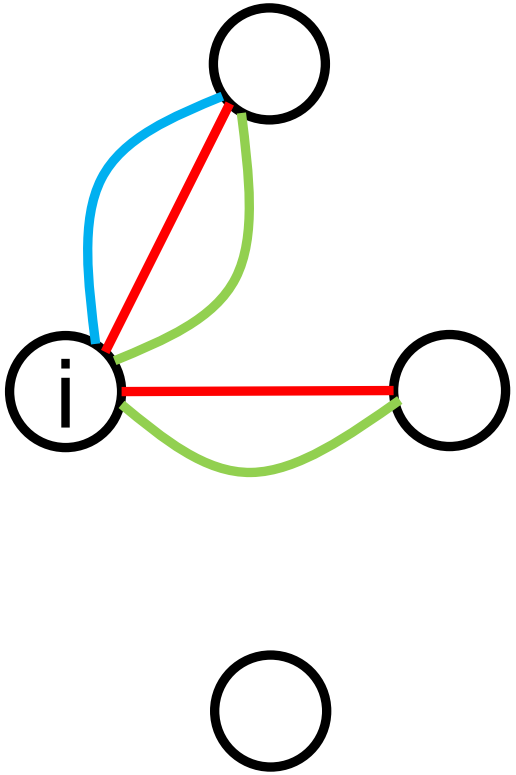


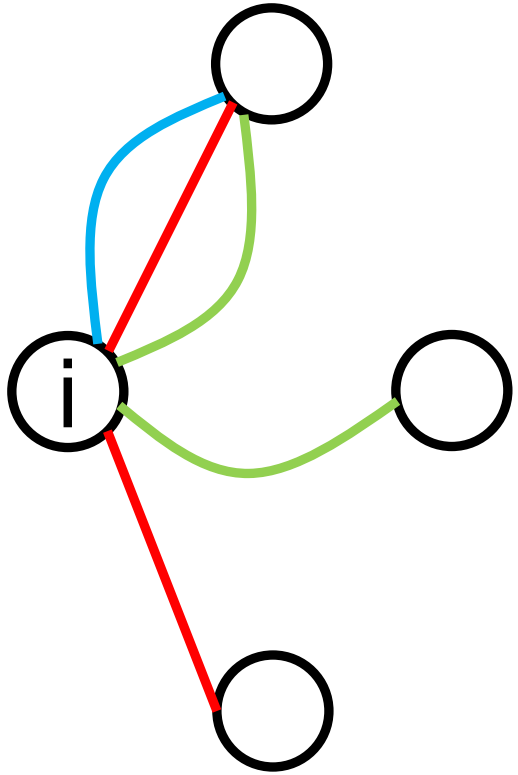


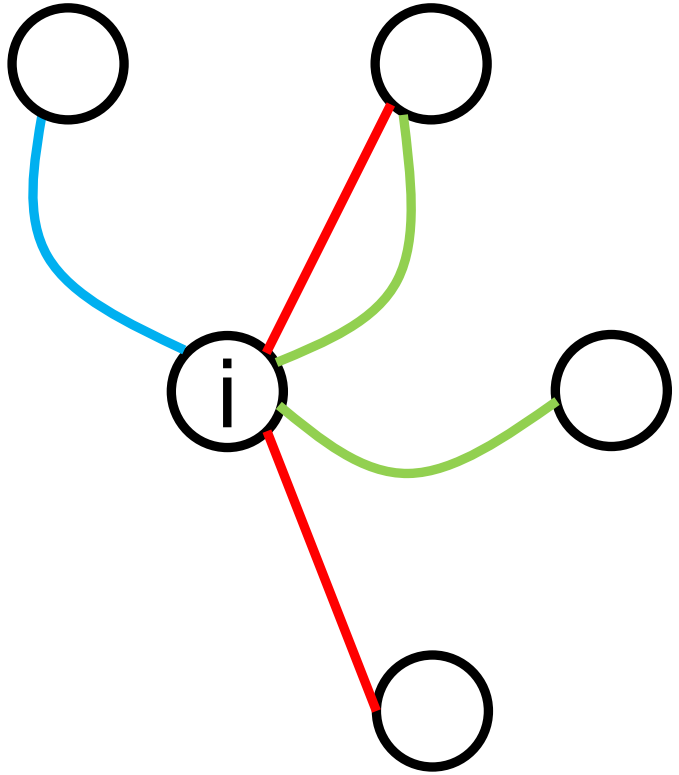


Less Multiplexed

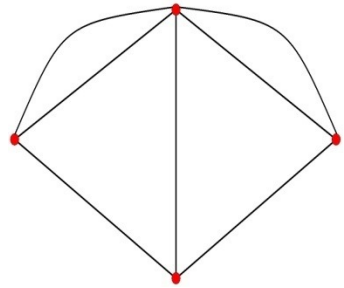








Proposition: Multiplexing Hurts Diffusion under Simple Contagion



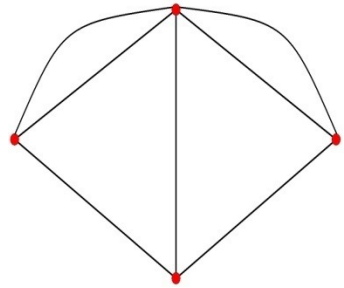
With simple contagion or diffusion:

people who are more multiplexed are less likely to be informed pr infected

overall infection is **decreasing** in multiplexing.

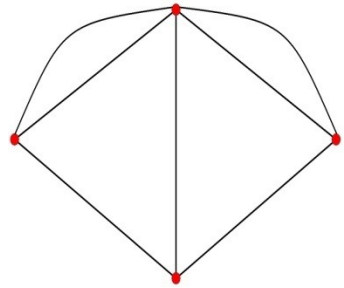
	Participation
High Multiplexing x Seed Set Centrality	-.039**
	(.017)
Seed Set Centrality	.052***
	(.016)
High Multiplexing	-.023
	(.016)
Observations	68

Impact of Multiplexing

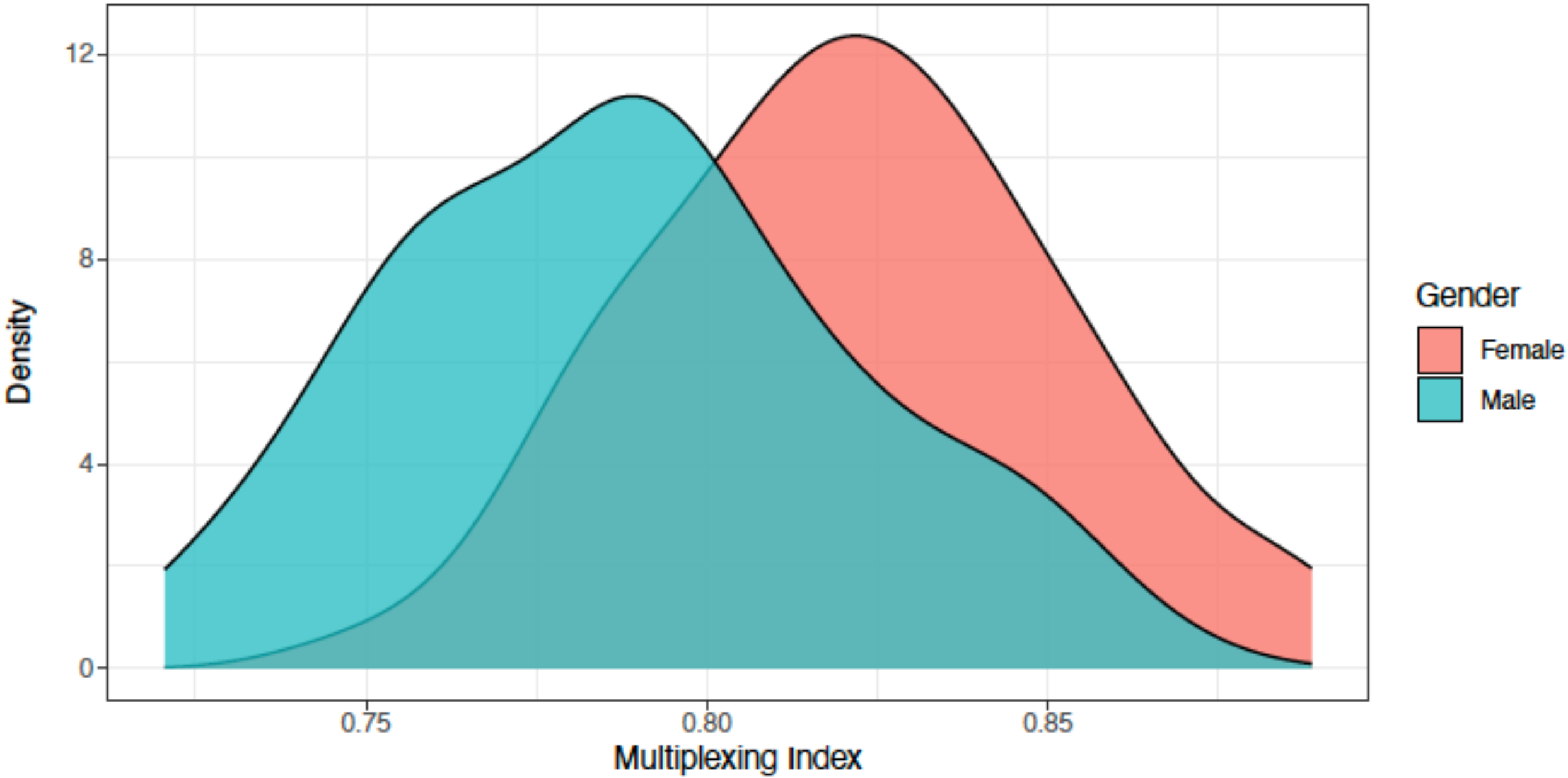


- People who are more multiplexed are less informed
- They have less diverse information access
- Villages with more multplexing are worse at spreading information

Who Multiplexes?

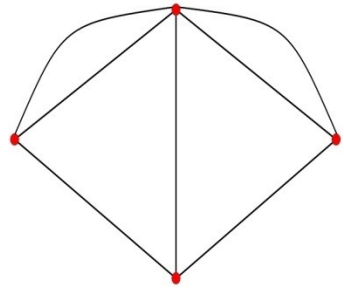


- Does multiplexing vary across individuals?
- Does multiplexing vary across villages?
- Which ones are more multiplexed?


12
8
4
0
Density
0.75
0.80
0.85
Multiplexing Index
Gender
Female
Male

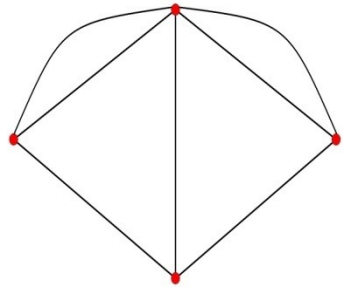
	High Multiplexing
Poverty Index	.017**
	(.007)
Observations	12732

Summary



- Networks impact market participation
- Market participation changes networks, for everyone,
- Increased variance in consumption for non-loan takers,
- Changes non-borrowing networks
- Multiple layers of networks affect diffusion

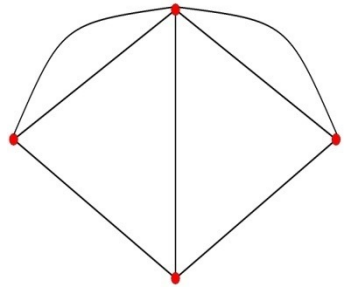
Policy Thoughts



- Substantial unintended consequences of loan introduction
  - Non-loan takers suffer increased consumption variance

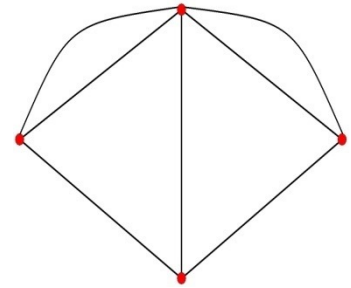
- Need multi-faceted policies to address externalities between:
  - informal networks and markets
  - markets and informal networks
  - different people
  - different layers of networks…

Thoughts for Researchers



- Cannot study `markets' without analyzing informal networks

- Form networks for one purpose, but use them in many – need to understand multiplexing…

- Reanalyzing diffusion with many network layers
  - Multiplexing hurts simple diffusion
  - Multiplexing can help in other contexts?

Discussion