Complex networks of corruption

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Patterns of corruption

Case study 1

Case study 2

Case study 3

Case study 4

...

Patterns of corruption

Case study 1

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...

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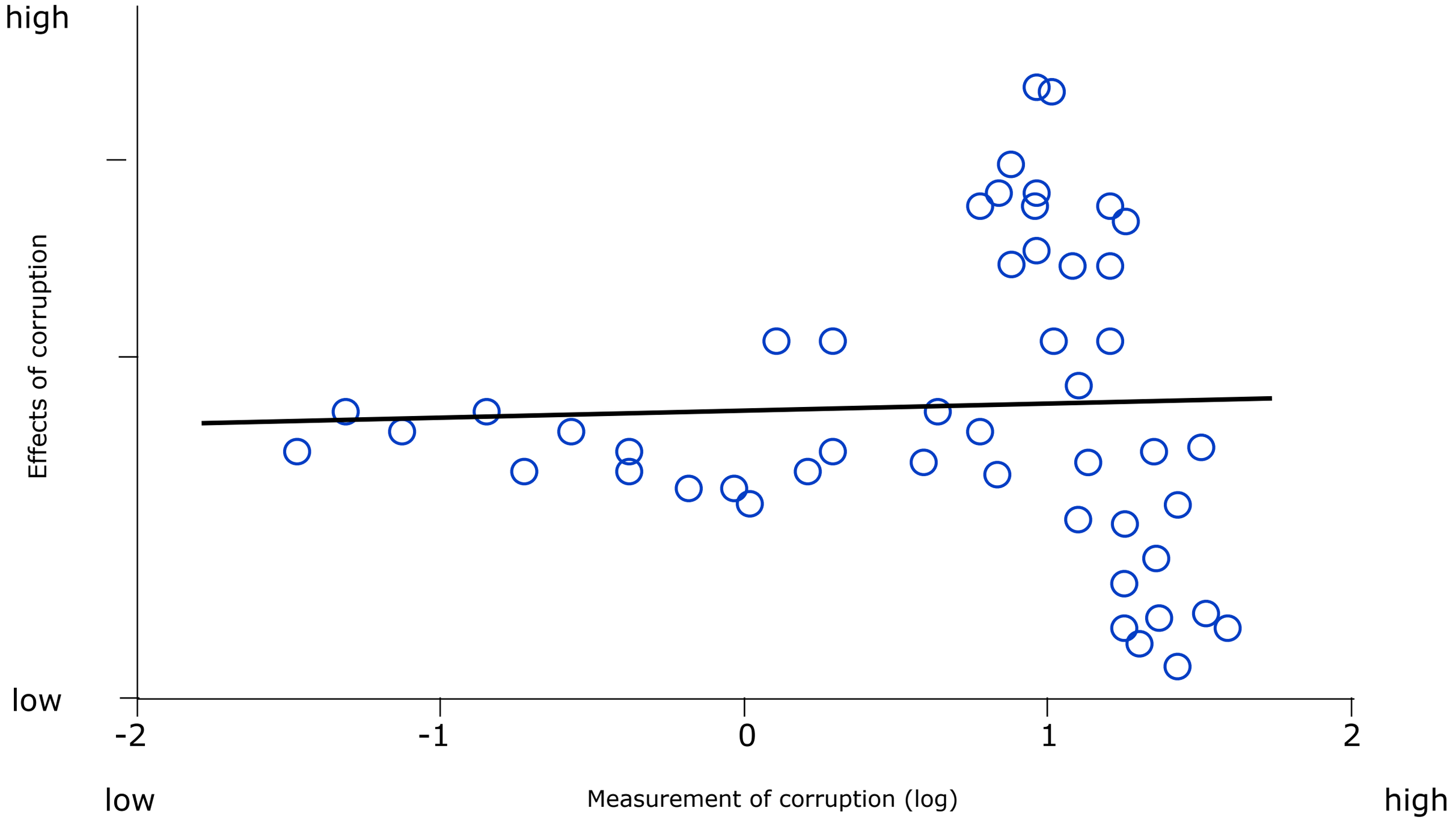
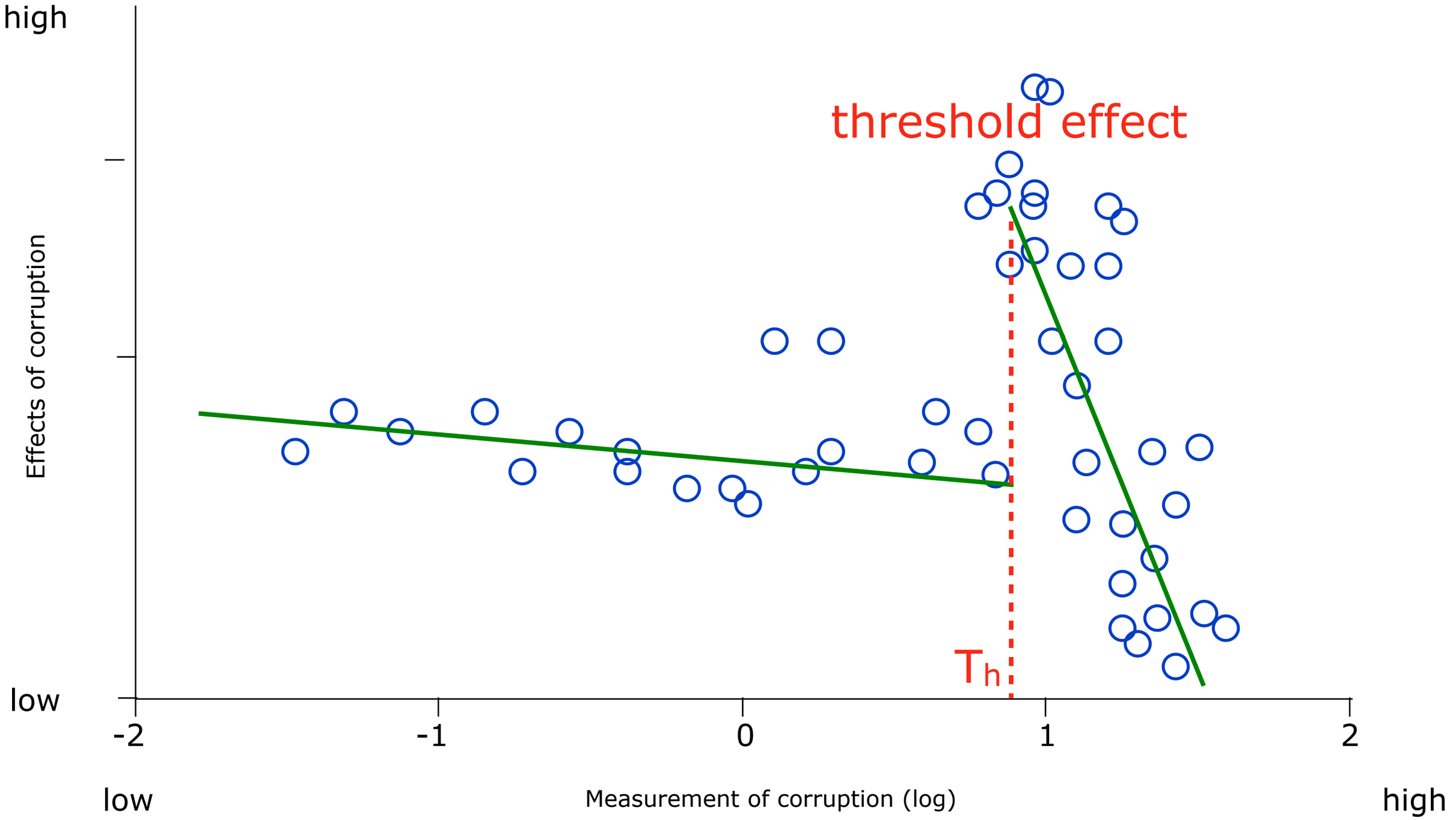
does a pattern emerge?

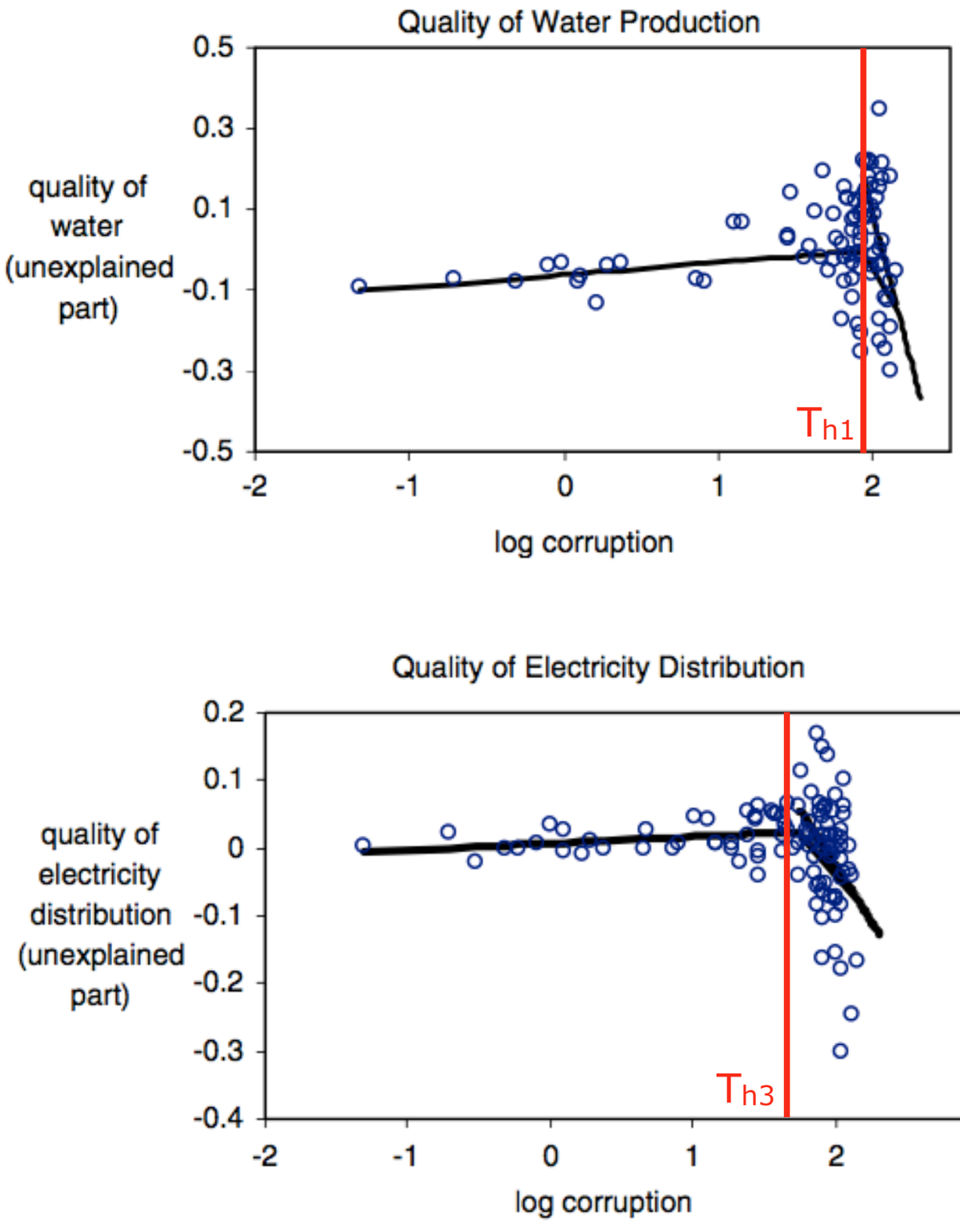
Patterns of corruption

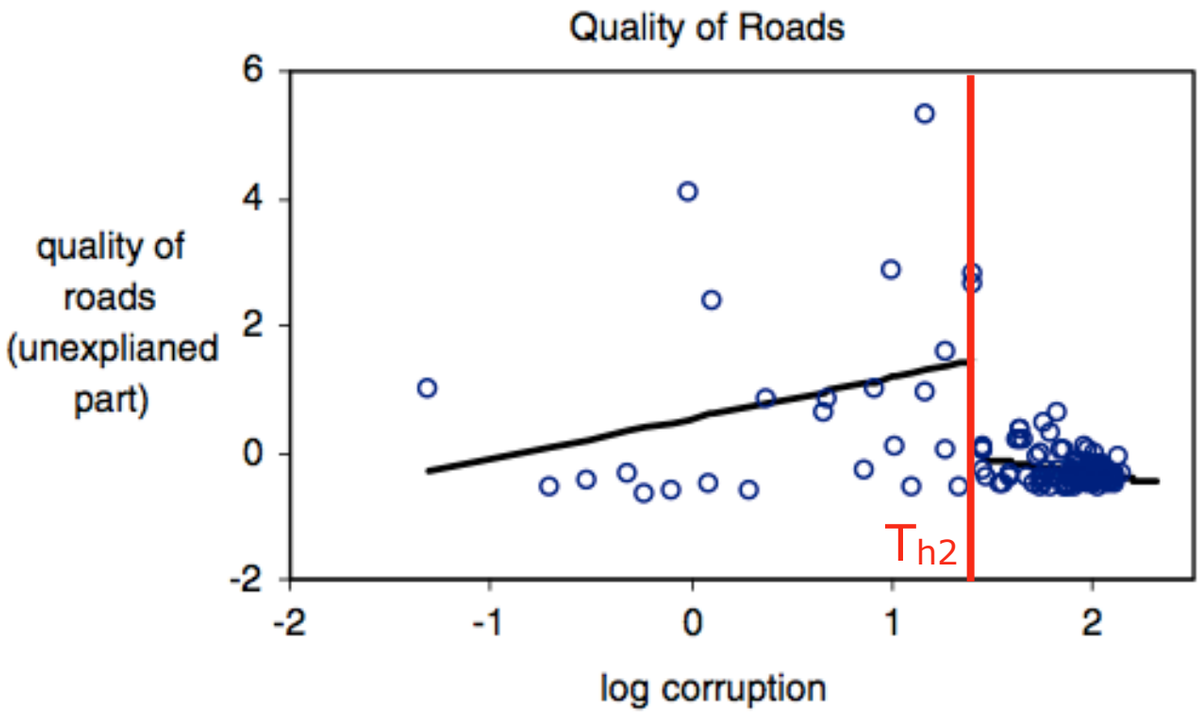


Patterns of corruption



Threshold Effects of Corruption





N. Bose et al., Threshold Effects of Corruption: Theory and Evidence. World Development, 36 (7), 2008.

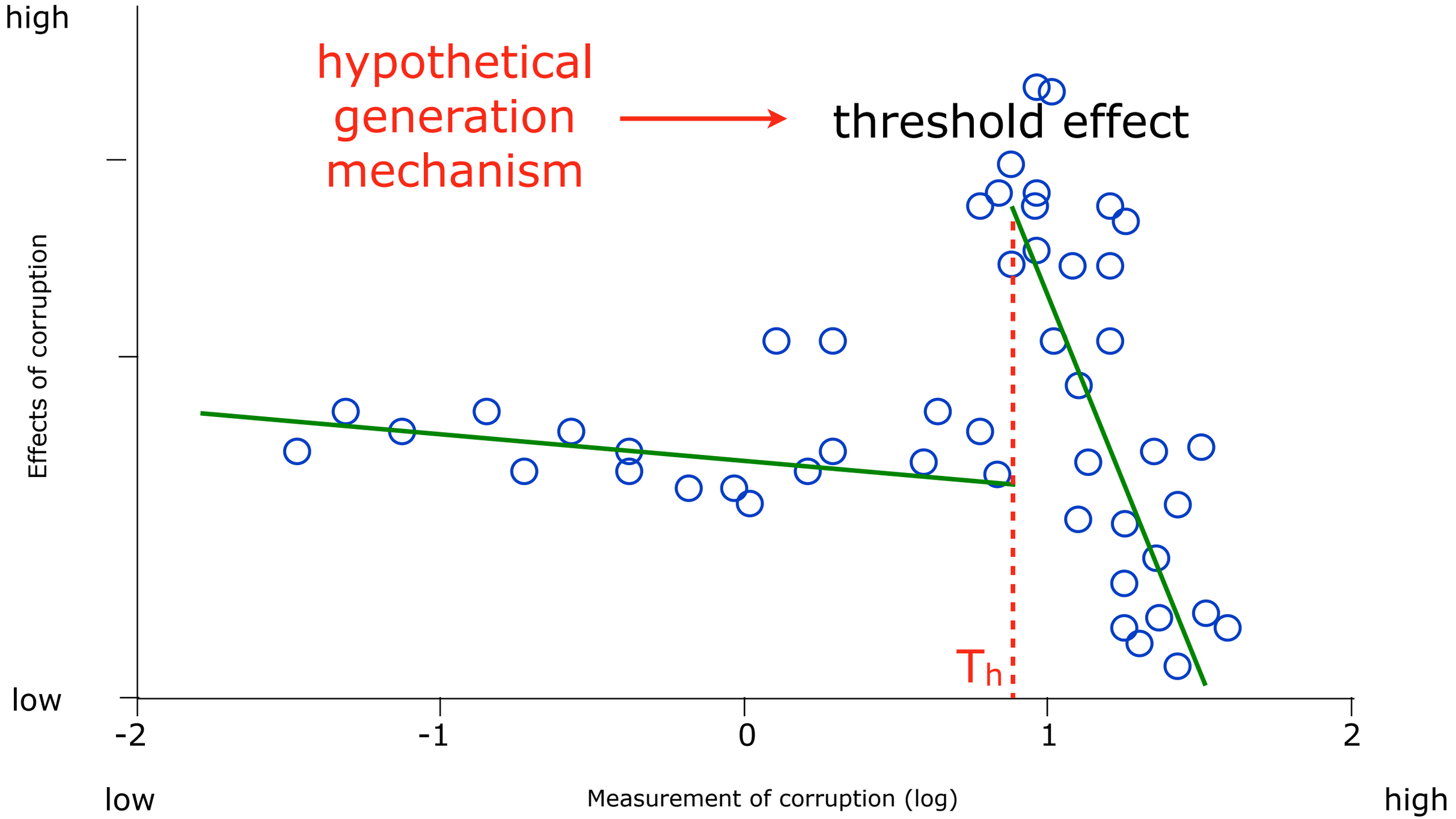
Key questions

- Can capturing patterns help us:
  - understand corrupt norms? T_h value?
  - design specific anti-corruption policies?
- Limitations of analytic approaches?
  - human incentives
    (bounded + unbounded rational players)
  - social networks
    (contact + financial networks)
- Agent-based modeling as public policy simulators?

Focus

- Micro motives (local mechanisms) that leads to macro phenomenon (e.g., threshold effect)
- Model the structure and dynamic processes on networks

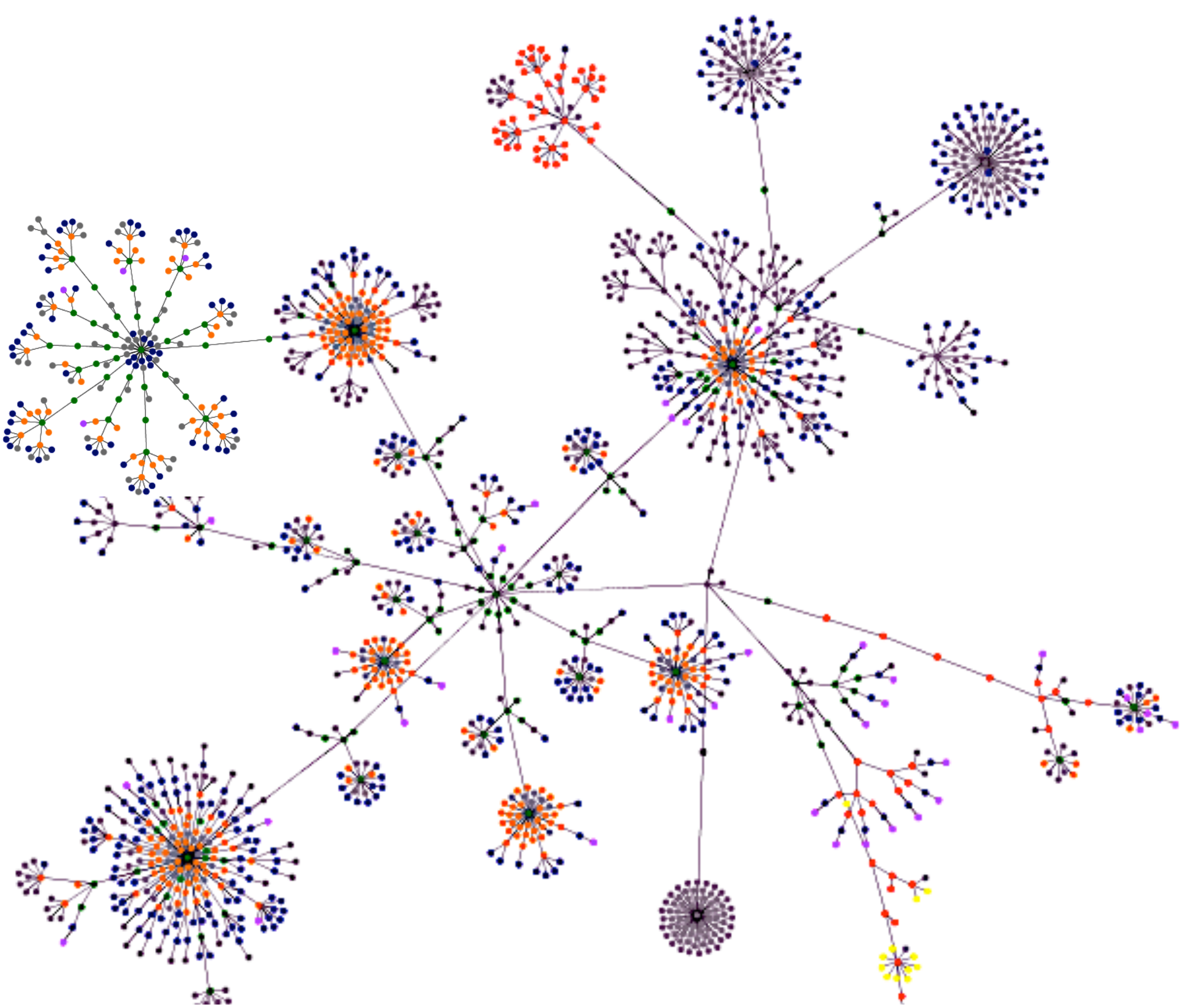
Patterns of corruption



Outline

- Social networks
  - generation of patterns of corruption
  - hypothetical generation mechanism
- Advantages + disadvantages
- Your opinion / suggestion?

Complex social networks



Which vertex would proof most crucial?

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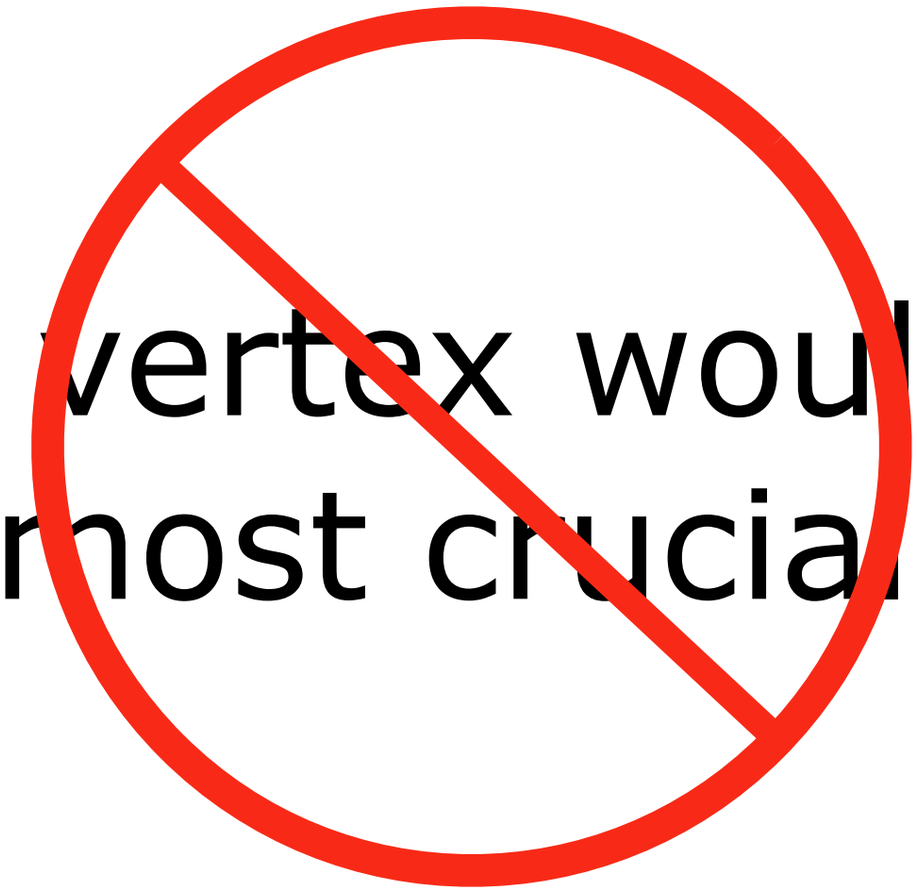

statistical properties!!

Structure

Social networks are not random!

1. Possible mechanisms guiding network formation

2. Ways to exploit structure to achieve certain aims

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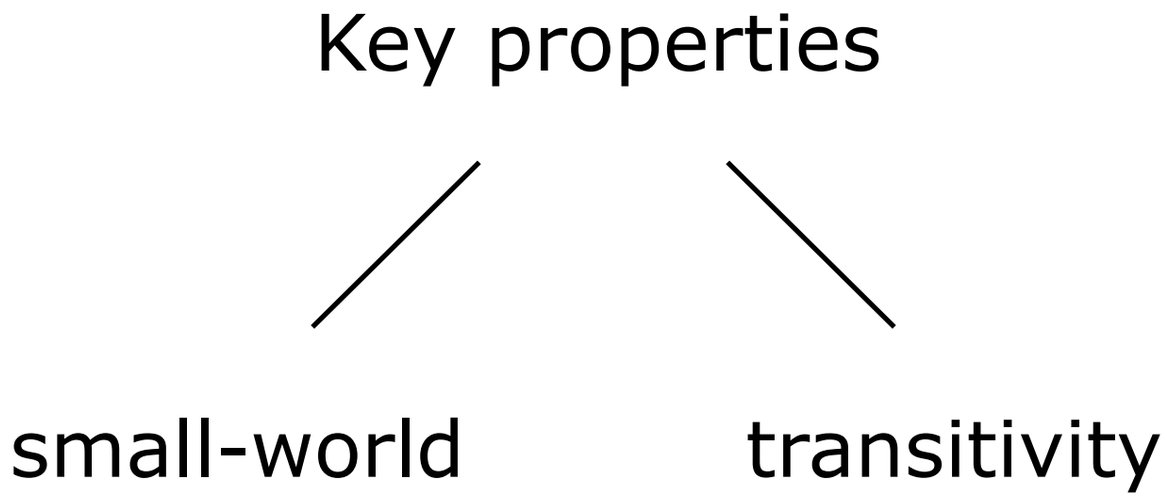
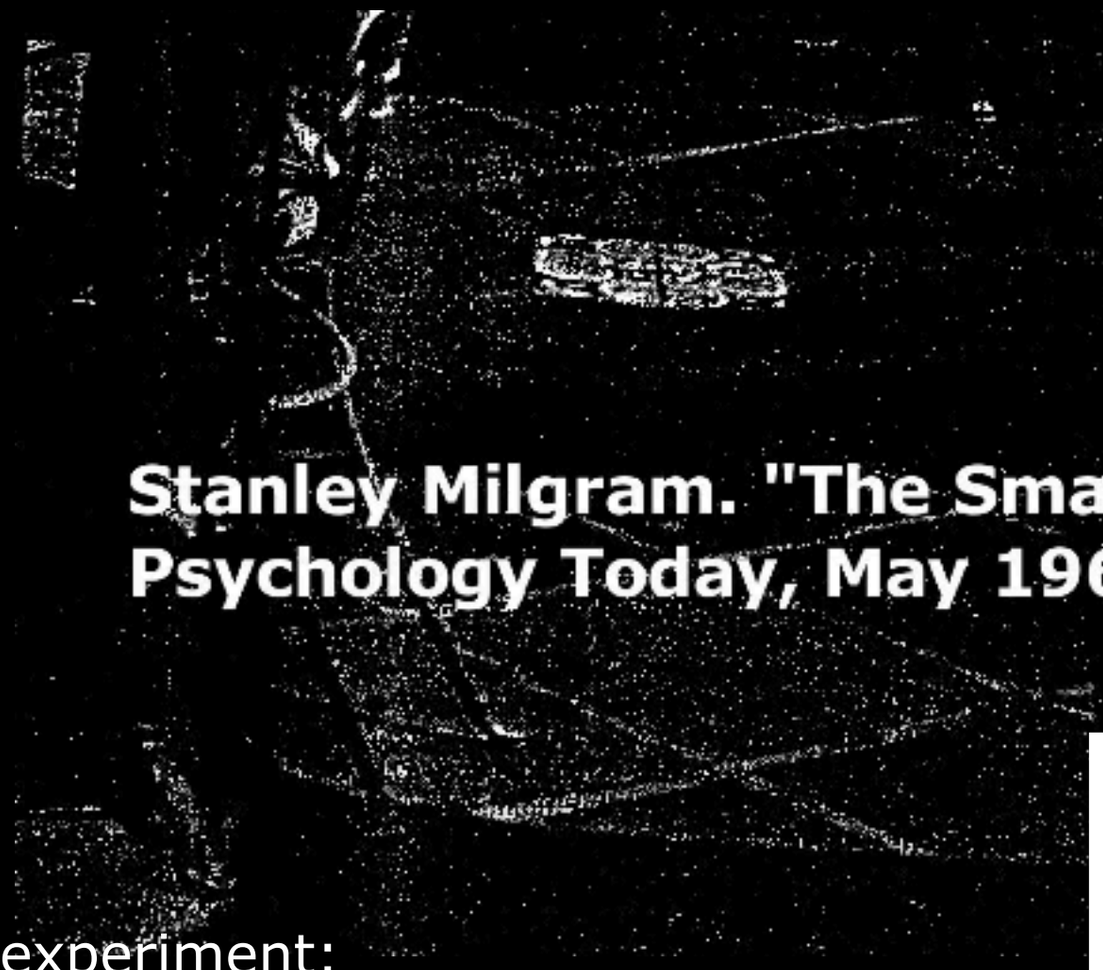
1. Possible mechanisms guiding network formation

2. Ways to exploit structure to achieve certain aims



Small-word



Stanley Milgram. "The Small World Problem". Psychology Today, May 1967.

<u>The basic experiment:</u>

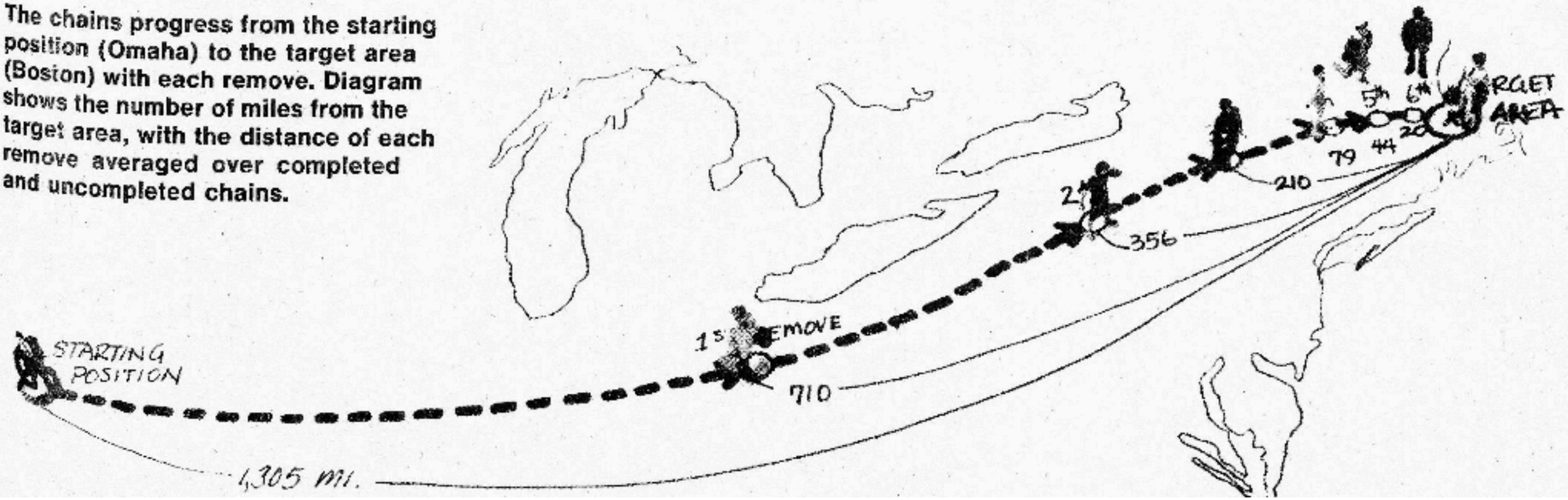
- The name of the target person + certain information (orient the participants towards specific individuals)
- If you do not know the target person on a first-hand bases, do not try to contact him directly
- A roster on which each person in the chain writes his name (prevent endless looping)

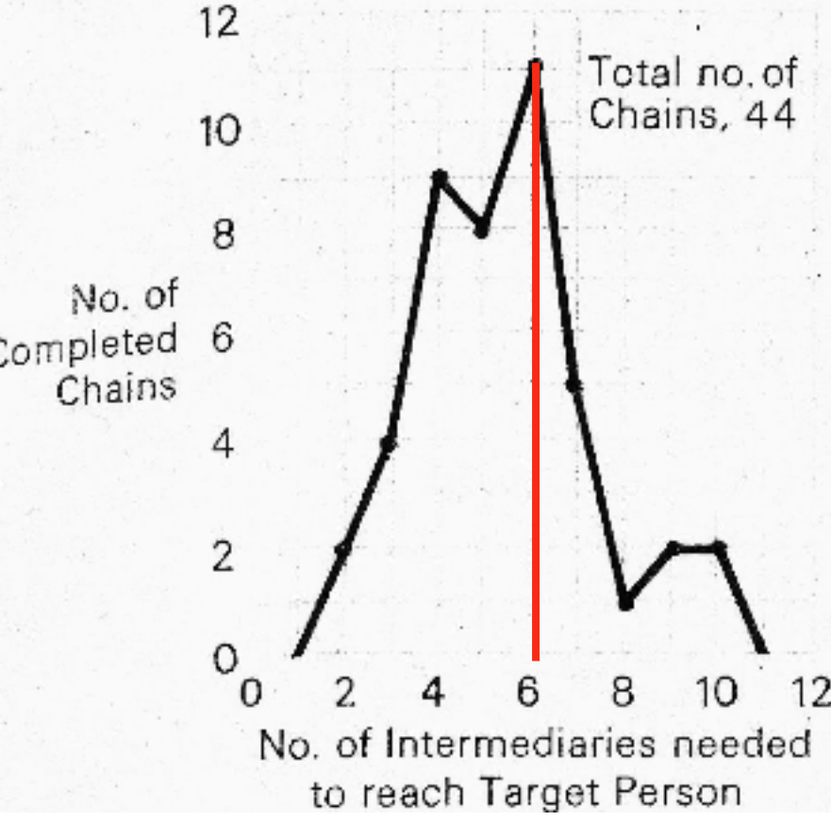
The Small-World

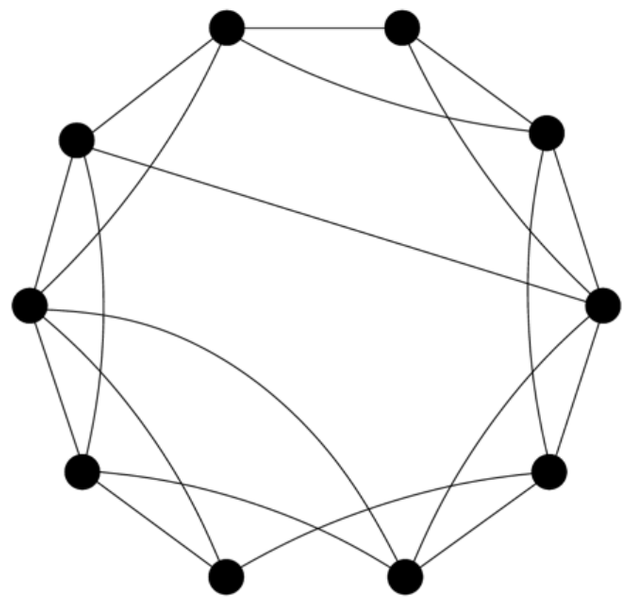
By Stanley Milgram

Almost all of us have had the experience of encountering someone far from home, who, to our surprise, turns out to share a mutual acquaintance with us. This kind of experience occurs with sufficient frequency so that our language even provides a cliché to be uttered at the appropriate moment of recognizing mutual acquaintances.
We say, "My it's a small world."

The chains progress from the starting position (Omaha) to the target area (Boston) with each remove. Diagram shows the number of miles from the target area, with the distance of each remove averaged over completed and uncompleted chains.





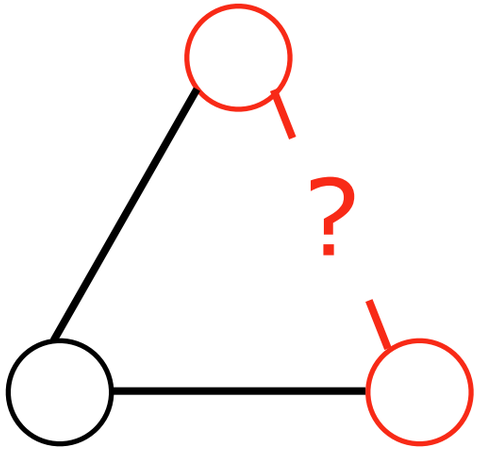


$$\ell = \frac{1}{\frac{1}{2}n(n+1)} \sum_{i \geq j} d_{ij}$$

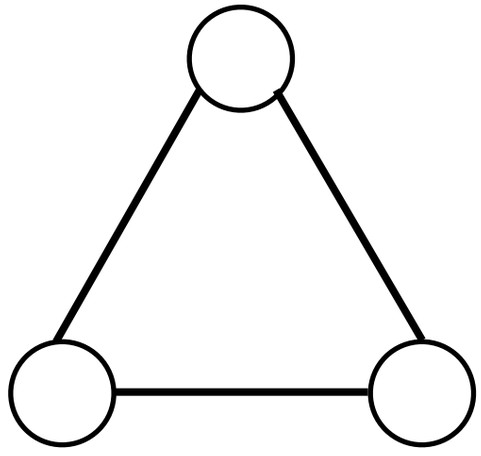
Stanley Milgram, The small world problem. Phycology today, 1967

Transitivity or clustering

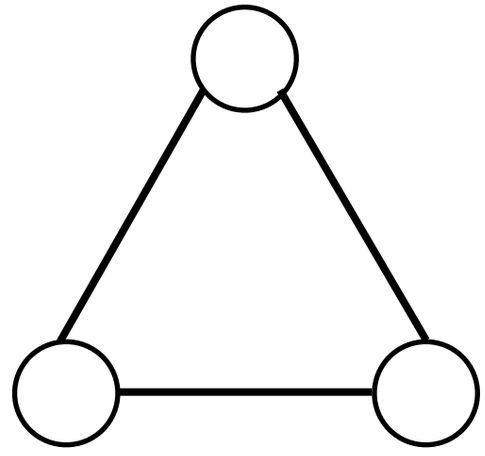
“A friend of a friend
is also my friend”



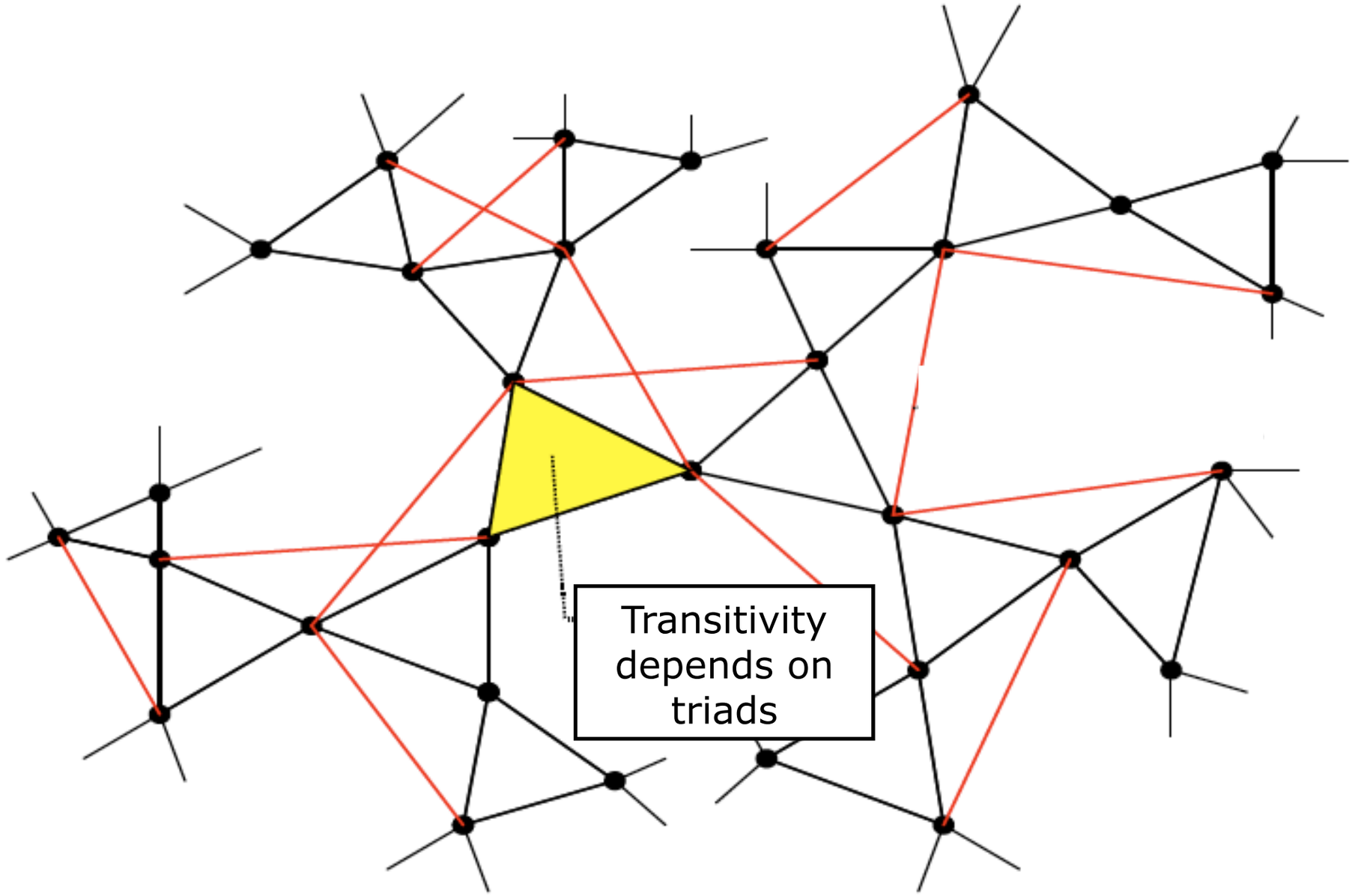
potentially
transitive



intransitive



transitive

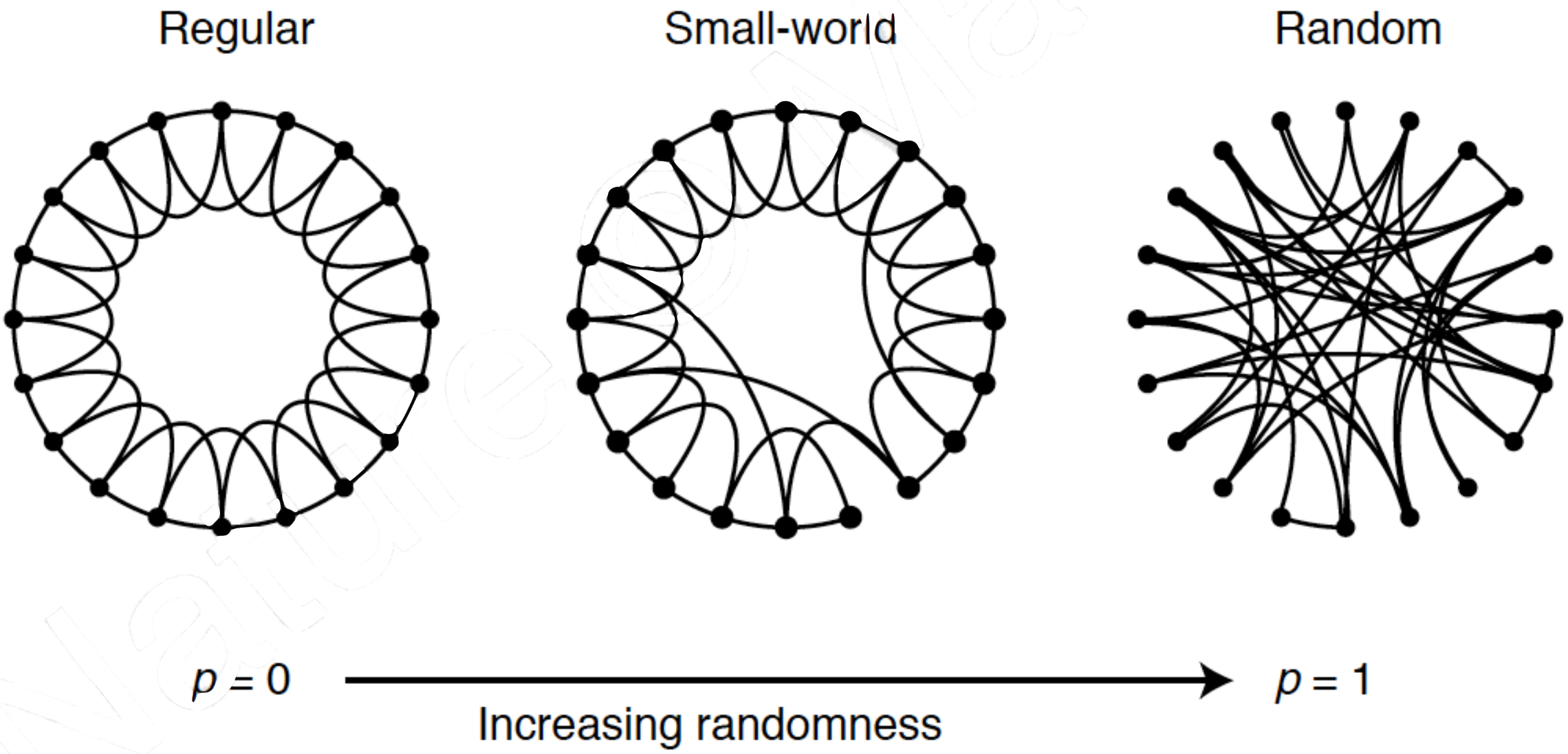


P. Blanchard et al., Epidemics of Corruption,
DOI: physics/0505031, arXiv, 2005

network	type	n	m	z	ℓ	α	$C^{(1)}$	$C^{(2)}$
film actors	undirected	449 913	25 516 482	113.43	3.48	2.3	0.20	0.78
company directors	undirected	7 673	55 392	14.44	4.60	–	0.59	0.88
math coauthorship	undirected	253 339	496 489	3.92	7.57	–	0.15	0.34
physics coauthorship	undirected	52 909	245 300	9.27	6.19	–	0.45	0.56
biology coauthorship	undirected	1 520 251	11 803 064	15.53	4.92	–	0.088	0.60
telephone call graph	undirected	47 000 000	80 000 000	3.16		2.1		
email messages	directed	59 912	86 300	1.44	4.95	1.5/2.0		0.16
email address books	directed	16 881	57 029	3.38	5.22	–	0.17	0.13
student relationships	undirected	573	477	1.66	16.01	–	0.005	0.001
sexual contacts	undirected	2 810				3.2		

M. E. J. Newman, The structure and function of complex networks, SIAM Review, 45, 167-256 (2003)

Strogatz-Watts

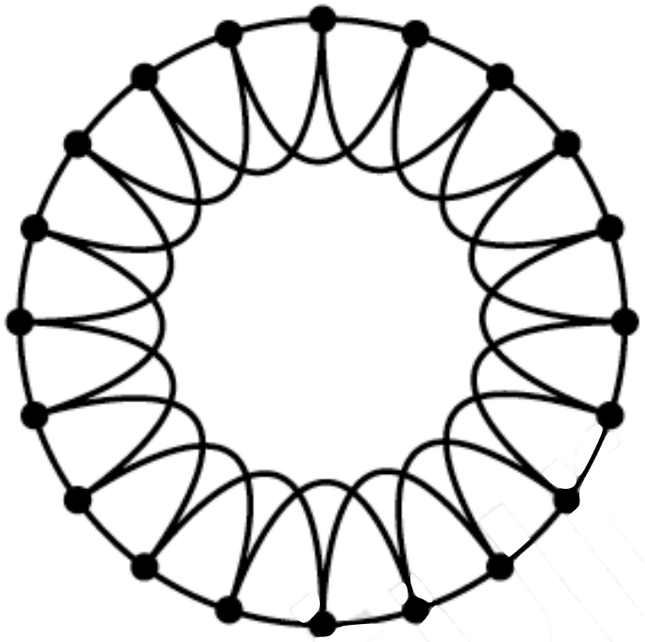


high cluster
large path length

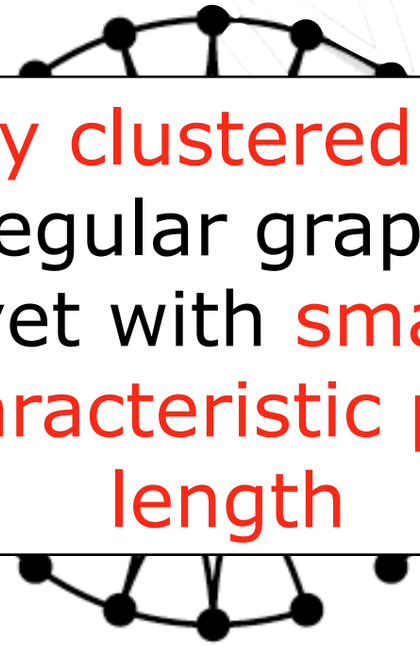
low cluster
small path length

Strogatz-Watts

Regular

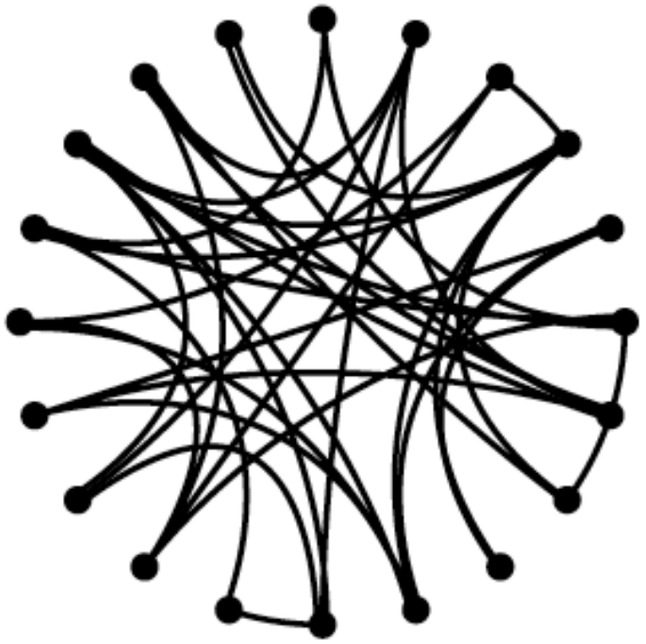


Small-world



highly clustered like a regular graph, yet with small characteristic path length

Random

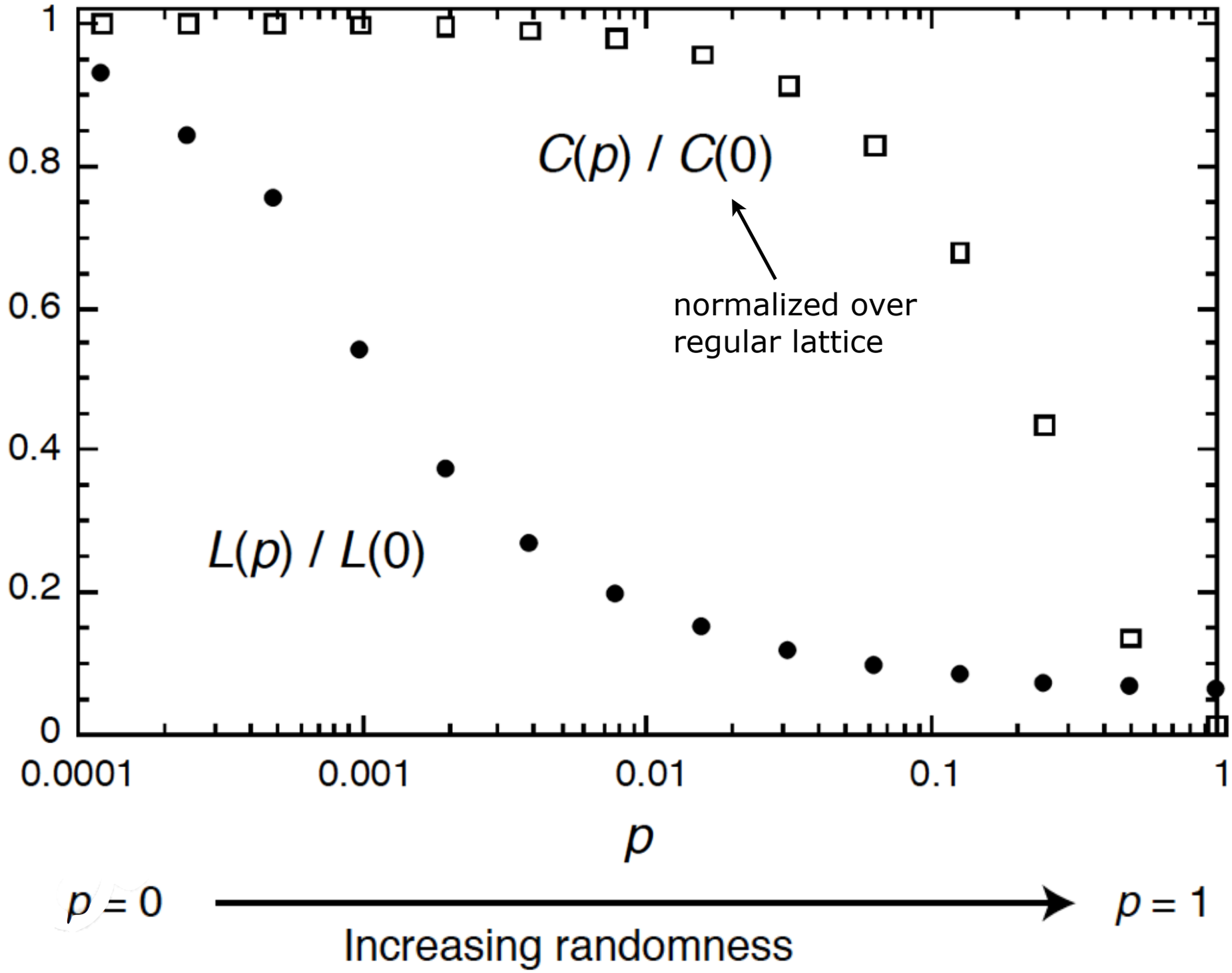


$p = 0$ ⟶ $p = 1$

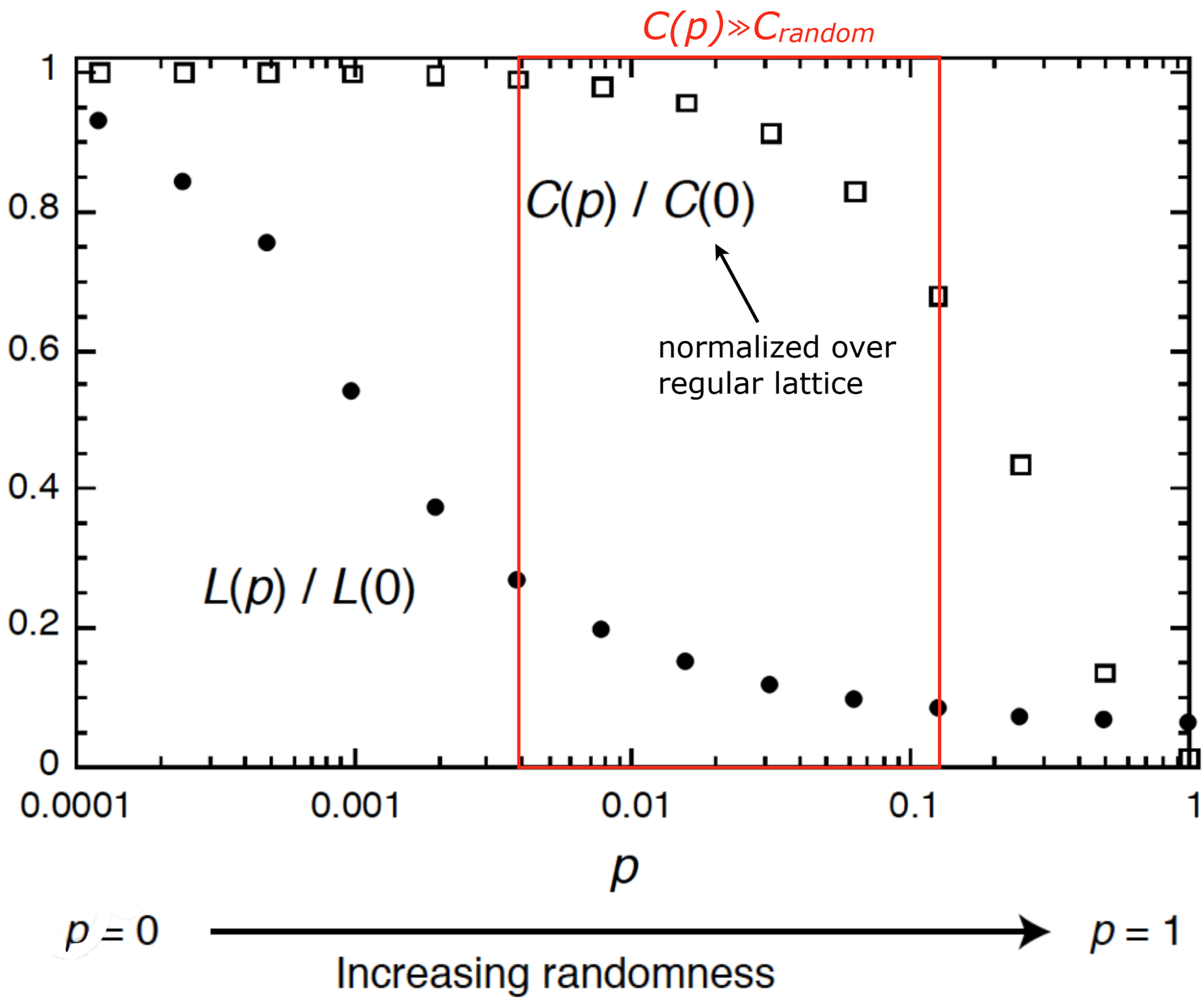
Increasing randomness

high cluster
large path length

low cluster
small path length



Collective dynamics of ‘small-world’ networks
by Ducan J. Watts and Steven H Strogatz



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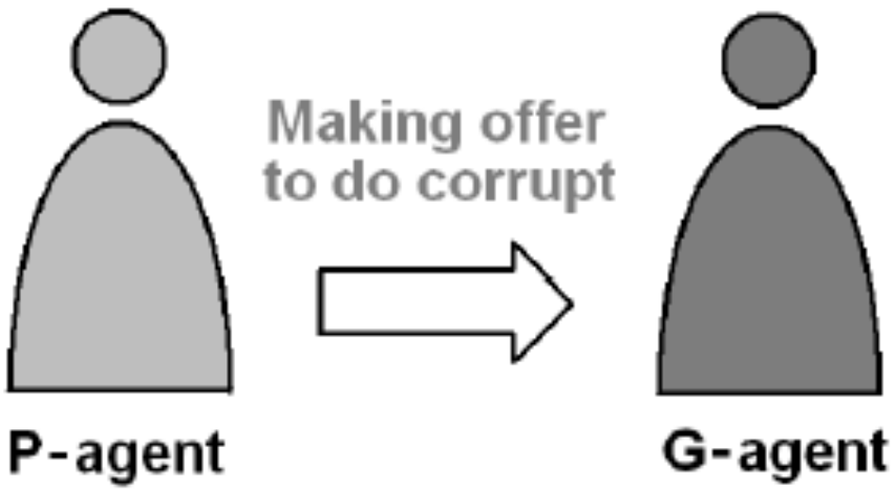
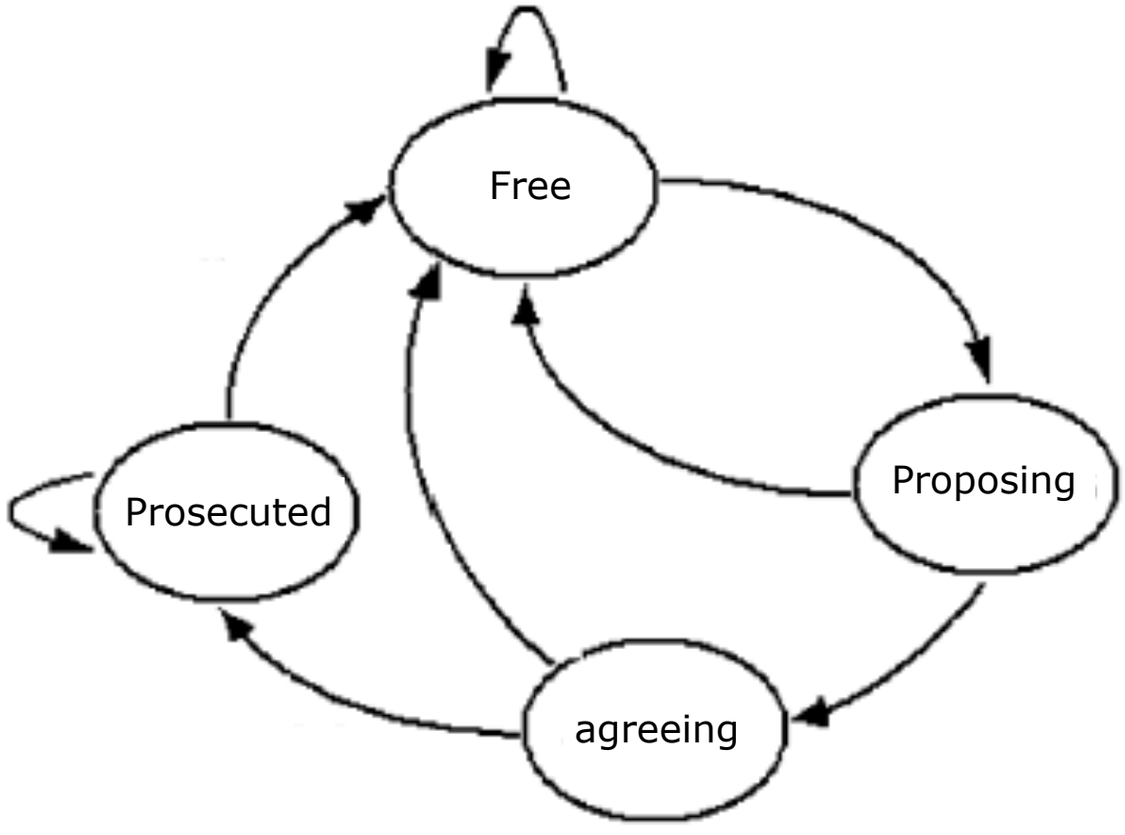
Dynamics

Agent-based model





Payoffs

$$E = (1 - C)[F\alpha^* + (1 - F)\beta] + C(\beta - k\beta) \quad (1)$$

$$E > \beta \quad (2)$$

where:

E is the utility to evaluate

C: a subjective factor that represents the fear of being discovered

F: a subjective factor that indicates the confidence that the corrupt act succeed

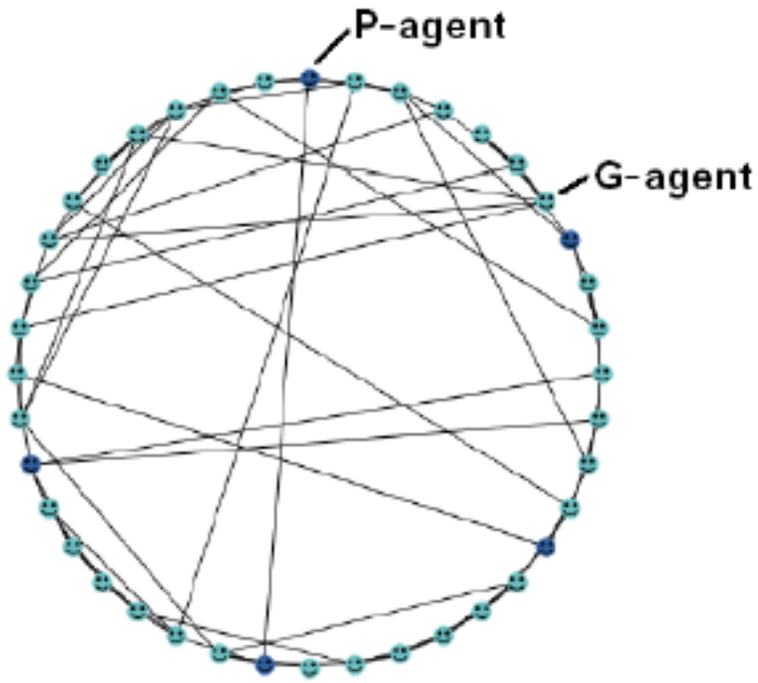
α is the profit (payoff) of corrupt behavior

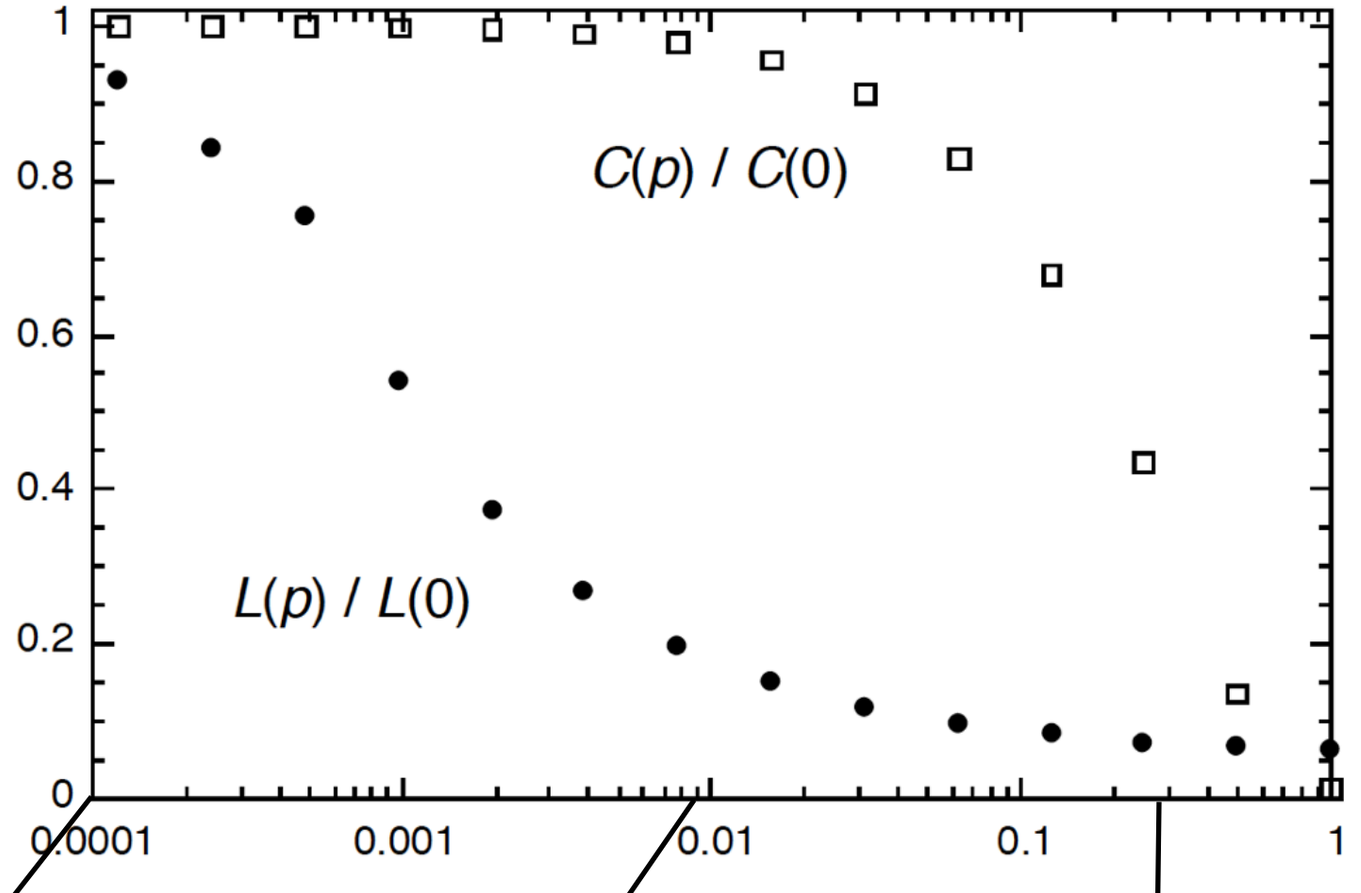
α^* is the expectation of corruption and is calculated as $\alpha^* = (1 - i)\alpha$

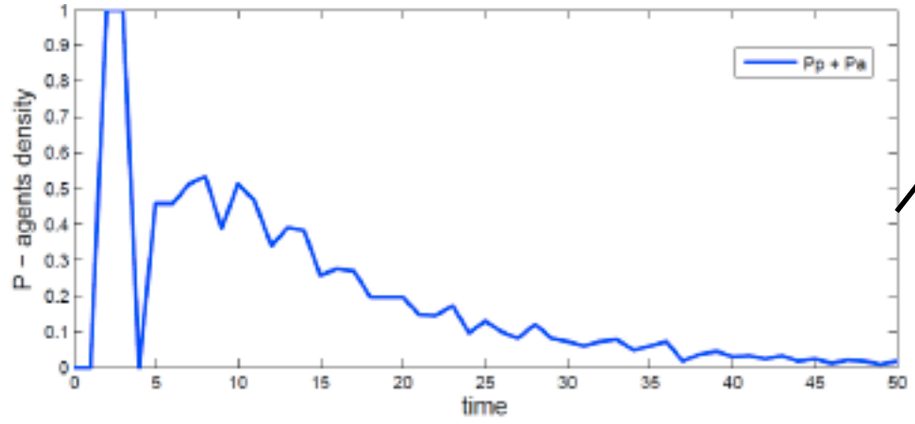
i: honesty index, and is obtained from a Gaussian random distribution

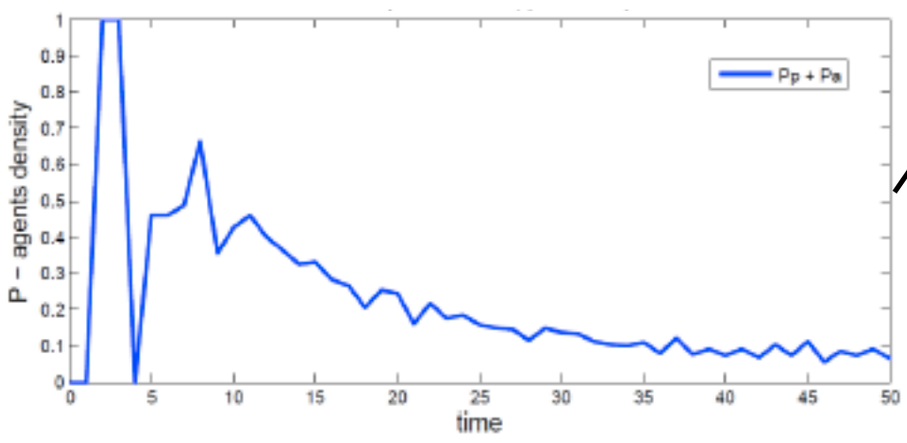
k: sentence period applied to the corrupt agents who are captured. It is expressed in number of iterations

β is the profit (payoff) of honest behavior


P-agent
G-agent


C(p) / C(0)
L(p) / L(0)
p
0
0.2
0.4
0.6
0.8
1
0.0001
0.001
0.01
0.1
1


Pp + Pa
P – agents density
time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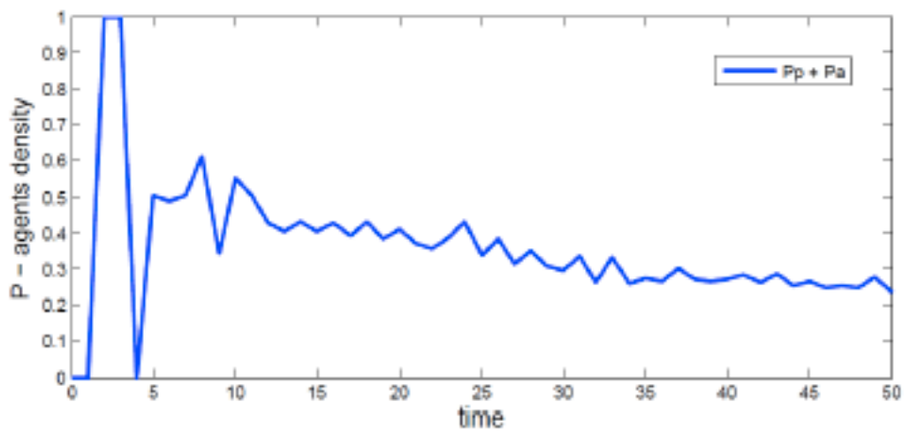

Pp + Pa
P – agents density
time

Implications?

Lawmakers have not yet considered the consequences of [network structure]. Still understanding the way we are connected is an essential step in creating a more just society and in implementing public policies affecting everything from public health to the economy

N. Christakis and J. Fowler
Connected (2009), p. 31

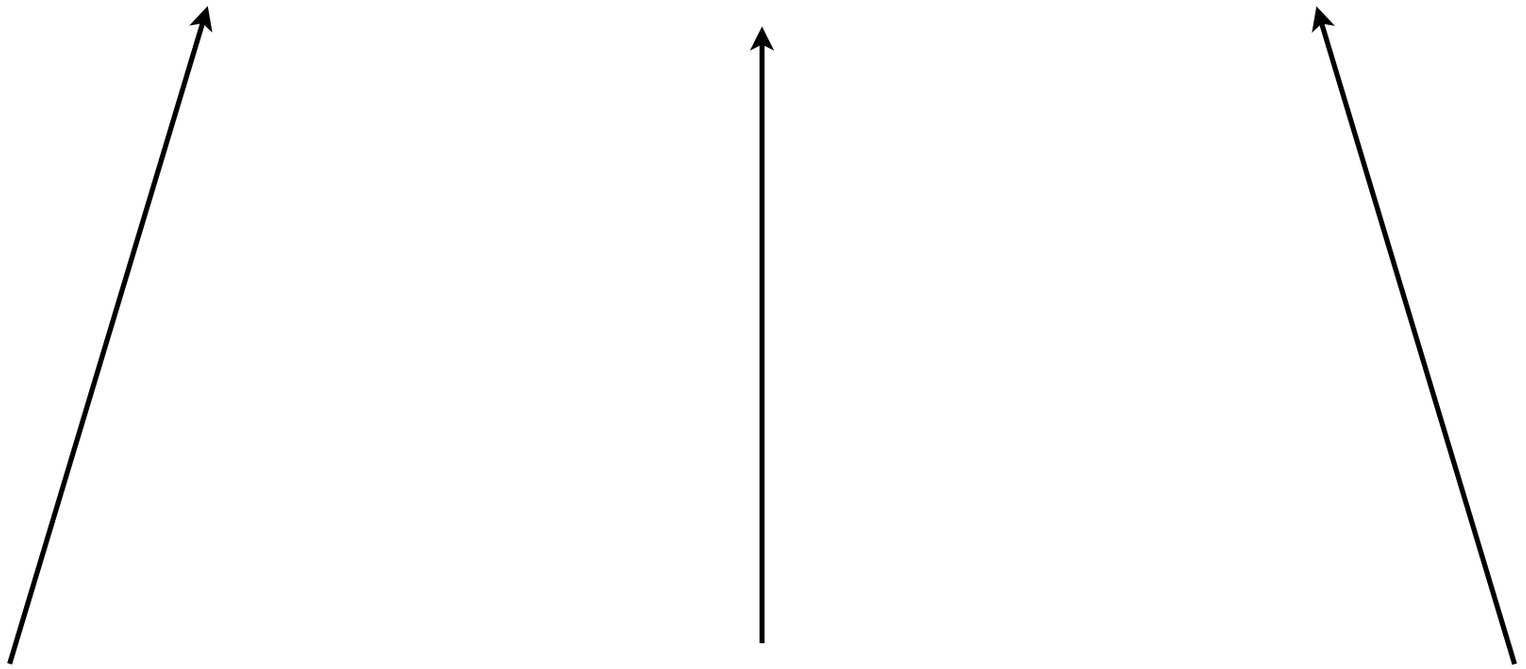
No single model can account for all corrupt behavior

All models are wrong but some are useful

George E. P. Box

Evaluate alternatives

pattern of corruption

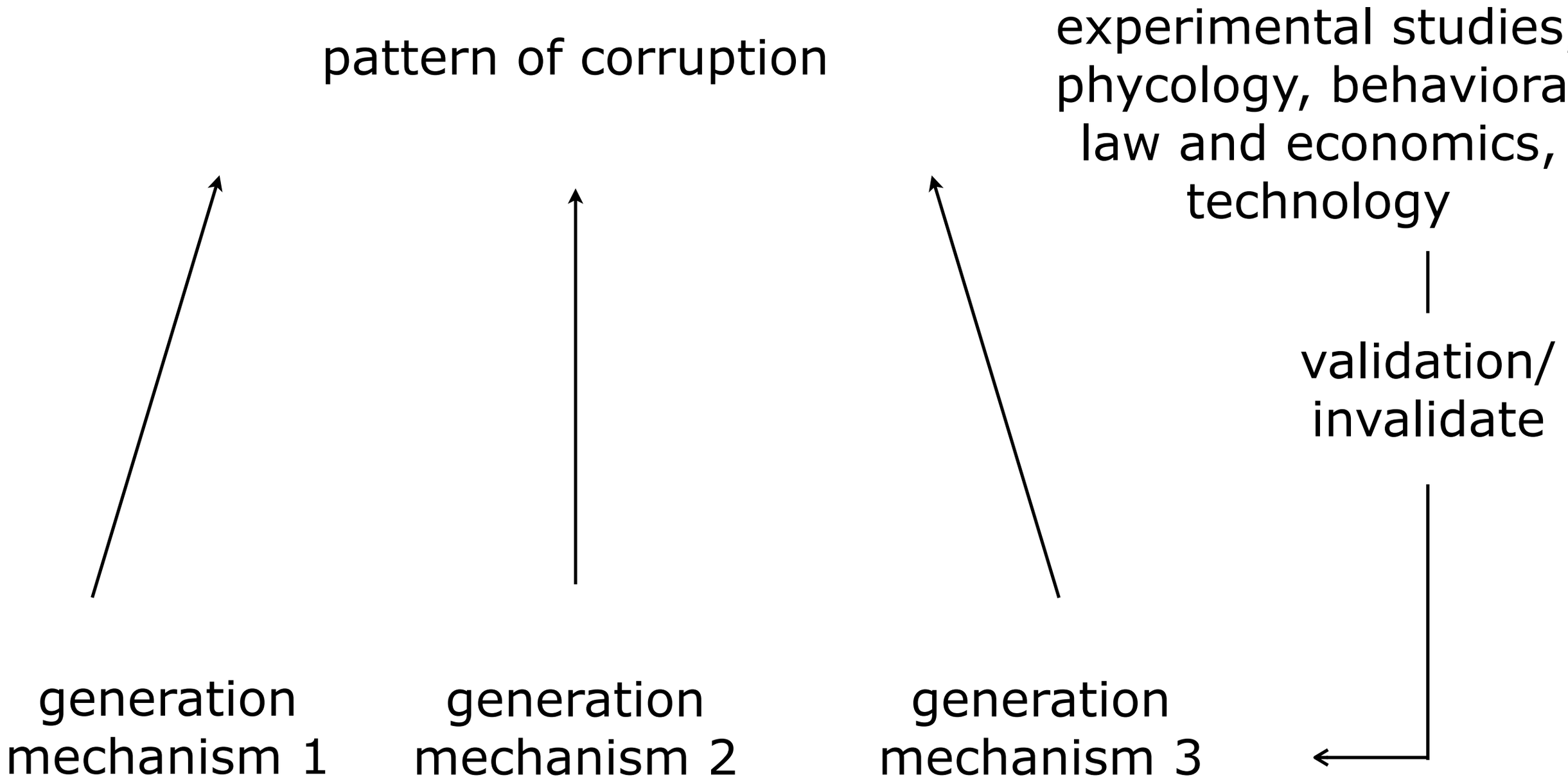


generation mechanism 1

generation mechanism 2

generation mechanism 3

Evaluate alternatives



Advantages

- Framework for studying causal relationships
- If A leads to B, at least one mechanism must exist
- Different mechanisms can be classified into systematic categories for influencing the level of corruption
- Consensus?

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Disadvantages

- Generation mechanisms are hypothetical. Real?
- Need for validation (e.g., using statistics)

Final remarks

1. Our lives are deeply intertwined with complex networks (explain patterns)

2. Potential of data + networks

3. Good network models can shape...

    - collection of data
    - questions being asked
    - design of official responses
    - close the gap between systemic thinkers and policy-makers

Some additional reading...

- Networks: An Introduction
  (M. Newman, 2010)

- Linked
  (A.-L. Barabasi, 2003)

- Connected
  (N. Christakis and J. Fowler, 2009)

- Generative Social Science: Studies in Agent-Based Computational Modeling
  (J. Epstein, 2007)

- Super Crunchers
  (I. Ayres, 2008)

- Behavioral Law and Economics
  (C. Sunstein, 2000)

http://razzmatazz.mgis.in/education-and-environment/rights-to-information-act/corruption-its-true/