How to Organize Crime

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Motivation

- Protecting information is an important concern of criminal organizations.
- Institutions facing these organizations need to understand their structures.
- Wide heterogeneity: Mafia centralized organizations vs. terrorist “cells”
- What determines the internal structure of criminal organizations? How do they react to investigation policies? How can one break their internal cohesion?

Key trade-off

- Criminal organizations benefit if the people who constitute them exchange information.
- Information sharing makes organization more vulnerable to external threat

Goal of this paper: building a model to study this trade-off and to rationalize different organization structures.

Sketch of the model

- Each player has a piece of private and verifiable information about himself
- Trade-off:
  - If A has information about B, then organization gets a fixed benefit W (examples)
  - If A has information about B, then if A is detected (probability α), so is B. If an agent is detected organization pays b>0. More on detection…

Two detection models

- Agent-based detection
  - Detection probabilities of each agent (α_i) are set by external authority, they do not depend on agent's activity level
  - Examples: intelligence, list of potential members, etc.
- Cooperation-based detection
  - Probability of being detected is a function of cooperation level. Scrutiny of authority is ineffective if not criminal activity
  - Examples: monitoring territory, searching for illegal activities, constitutional limits, etc.

Information structure

B ⟶ A Agent A has information on agent B

A ⟷ B Agents have information about each other

A,B,C ⟶ D A,B and C all revealed information to D

Example: Agent-based detection

- A, B, C and D exchange information to create links
- Having an agent linked
  - benefit 1 to the organization, no additional benefits if linked to more than one
- Having an agent detected
  - cost 2 to the organization
- Probability of getting detected directly
  - A and B: probability ¼
  - C and D: probability $\beta \geq$ ¼

Example (cont'd)

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- Add first 3 links to minimize their cost: hierarchy (or binary cells)
- 4th link costly in hierarchy: binary cells dominates hierarchy
- Cost of each link in binary cells $2\times(1-\frac{1}{4})\frac{1}{4}=3/8<1$ $\longrightarrow$ optimal structure

Example (cont'd)

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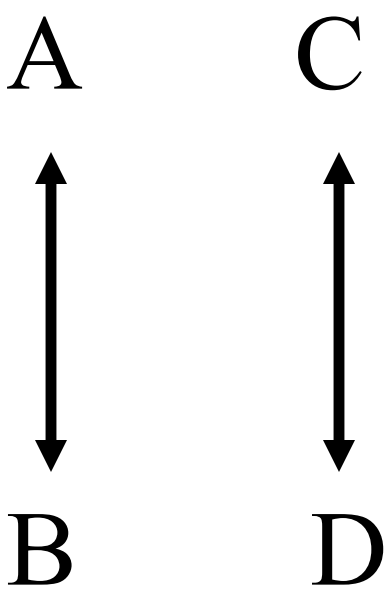
- Suppose instead $\beta = 3/4$
- For first 3 links hierarchy is optimal (top either agent A or agent B)
- Total cost with 4th link (A linked to B)
  - E.g., focus on C and see if it is better to link him to D only or to {A,B} together

$\longrightarrow$ Hierarchy optimal since $\frac{1}{4} + \frac{1}{4} - 1/16 < 3/4$

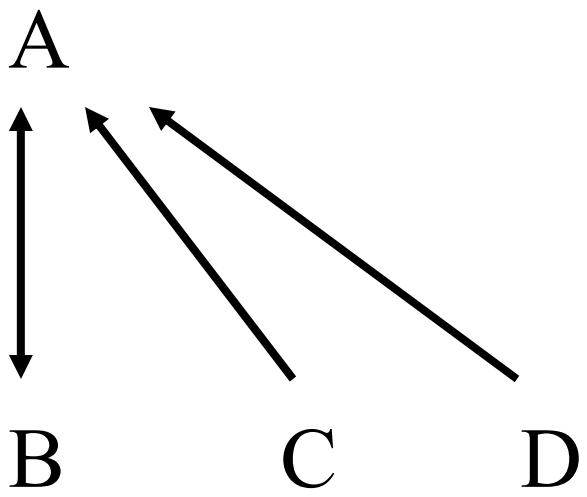
Example: if $\beta \leq$ 7/16

- Binary cells is optimal structure



Example : if $\beta \geq 7/16$

- Centralized Hierarchy is optimal
- A/B as information hub

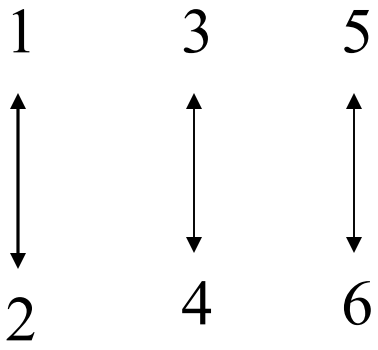


Preview of the results

- Agent-based detection
  - Full characterization of optimal organization structure for given probabilities of detection
    - "Binary cells"
    - Mixed centralized structures - properties
  - Full characterization of strategy for external agent
- Cooperation-based detection
  - Full characterization of optimal organization structure
    - More centralization, sometimes cells
  - Full characterization of strategy for external agent
- Comparison and discussion
- Extensions

Efficient structure in symmetric case: $\alpha_i=\alpha\ \forall i$

- If $W \geq b\alpha(1-\alpha)$, the most efficient information structure is a binary cell structure, otherwise it is an anarchy.

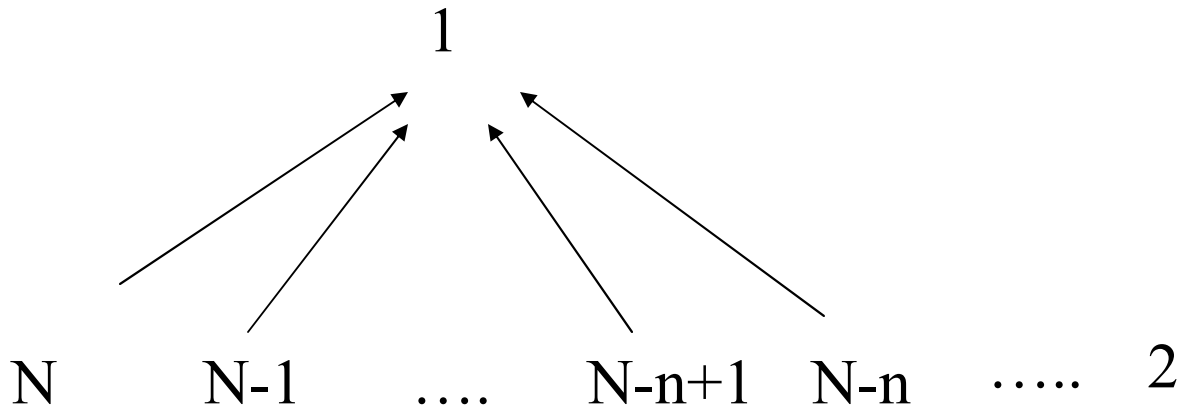


The general case

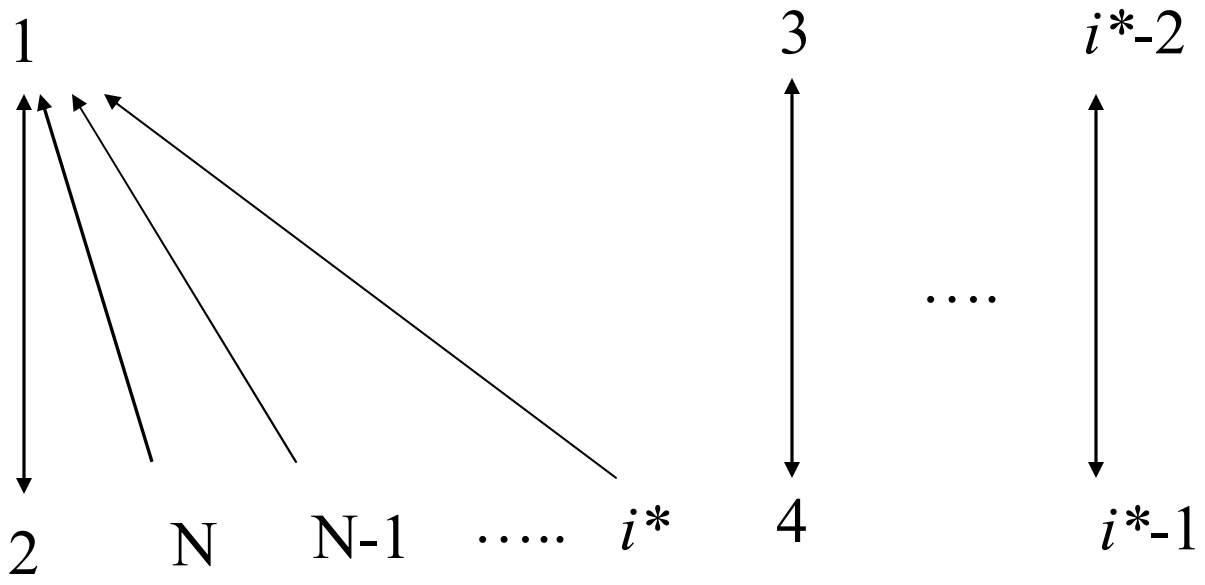
- Probabilities of detection $\{\alpha_1,..,\alpha_N\}$
  w.l.o.g. *increasing* $\alpha_1 \leq \alpha_2 \leq ... \leq \alpha_N$
- Plan:
  - Fix the number of linked agents $n \in \{1,..,N\}$
  - Optimal structure given n (cost minimizing)
  - Benefit of adding links
  - Characterization of optimal structure

Optimal structure for given n

- If $n \leq$ N-1 the optimal organization structure is a hierarchy in which the n highest-probability players reveal their information to 1 (cheapest links)



Full cooperation: Optimal structure with N links



where i^* is lowest odd s.t. $\dfrac{2(1-\alpha_i)(1-\alpha_{i+1})}{(2-\alpha_i-\alpha_{i+1})} < (1-\alpha_1)(1-\alpha_2)$

External agent

- Fixed budget B to allocate to detect agents
- The induced cost of link of the symmetric allocation is *b(B/N)(1-B/N)*
- By previous result, given a symmetric allocation, the organization
  - Will stay in anarchy (no cooperation) if $W < b(B/N)(1-B/N)$
  - Will generate a binary cell structure (full cooperation) if $W > b(B/N)(1-B/N)$
- If $W < b(B/N)(1-B/N)$, the optimal allocation is symmetric (α_i=B/N for all i), since it achieves no cooperation.

External agent: Optimal strategy

- What if W > b(B/N)(1-B/N)? In this case, a symmetric allocation reaches full efficiency. Is there something better?

- **Result:** If $W > b(B/N)(1-B/N)$ the optimal strategy is $\alpha_1=0$ and $\alpha_i=B/(N-1)$ for all $i\neq 1$.

Cooperation-based Detection: Main Result

- First N-1 links's cost is higher if the detection of these agents is high. Hierarchy is still optimal structure for 1,..N-1 links

- Differently from agent-based cooperation, agents that are less scrutinized are linked first. Top of the organization (most wanted agent) rarely cooperates.

Model comparisons

- If treatment of agents is symmetric we have:
  - Either anarchy or binary cells under agent-based cooperation model.
  - Either hierarchy or binary cells under cooperation-based
- Binary cell structure can emerge as optimal structure in both models
- Tendency to centralization in cooperation-based detection model.
- When are hierarchies optimal? Asymmetric treatment (in agent-based) or cooperation-based

Further comments

- Alternative organizations are optimal reaction to investigation policies
- Detecting illegal activities on territory vs. monitoring agents directly lead to different organization structures.
- In turn, from authorities' point of view, in different investigation environments resources should be allocated differently!
- In agent-based detection model, results suggest that external agent can do better than binary cells by imposing asymmetric treatment and induce hierarchy instead
- In cooperation-based detection model we show that external agent better off by allocating some fixed budget (sufficient to discourage them to cooperate) on as many agents as possible.