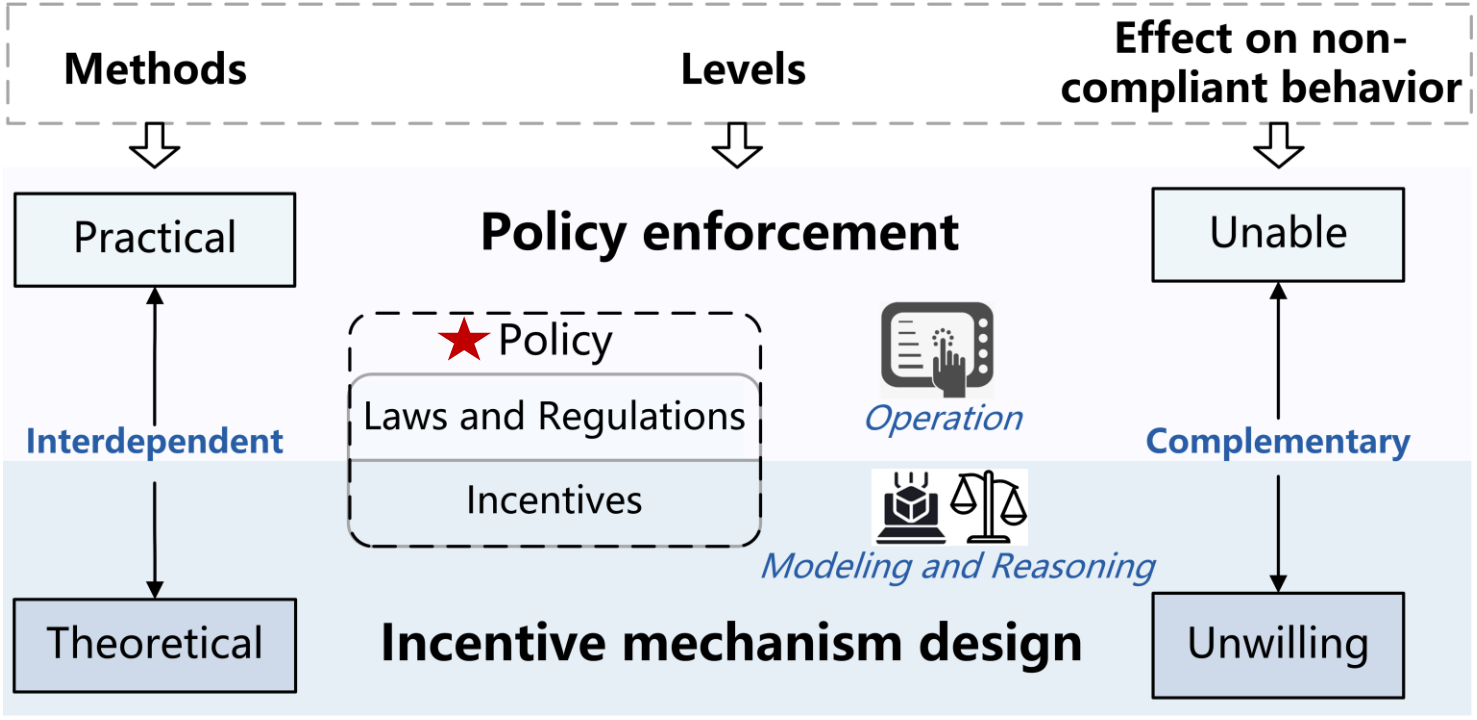
Policy Enforcement for Data Security

DL4LD Steering Committee Meeting
Speaker: Xin Zhou

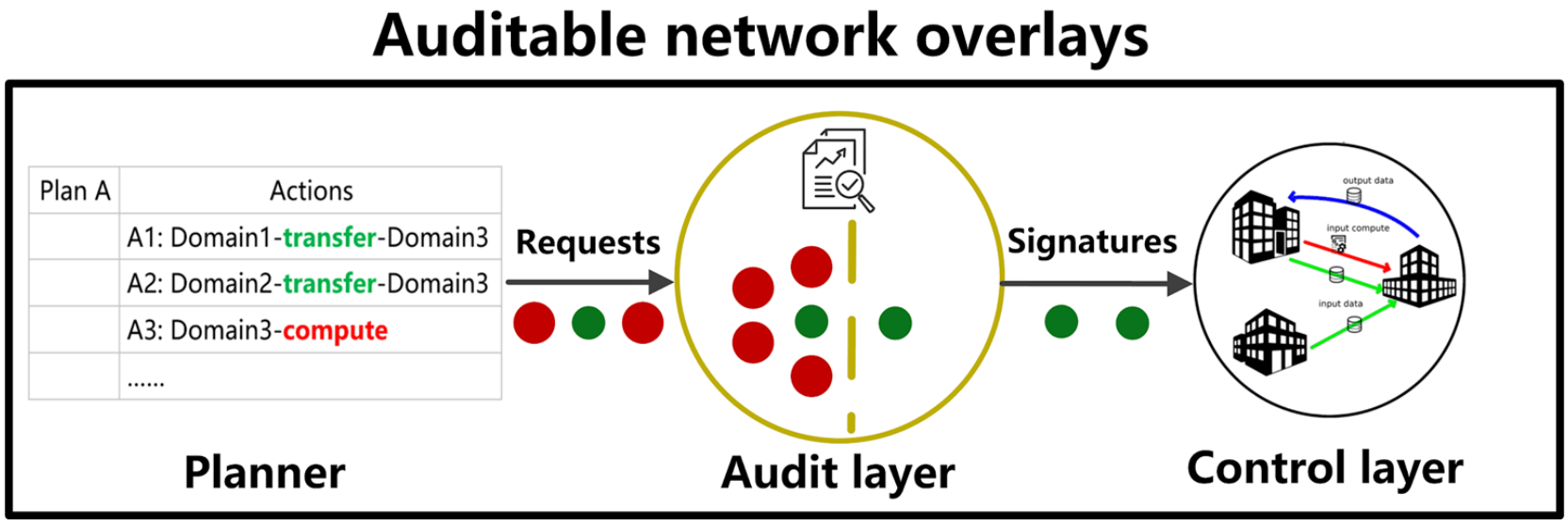
25th Nov 2021

Complex Cyber Infrastructure

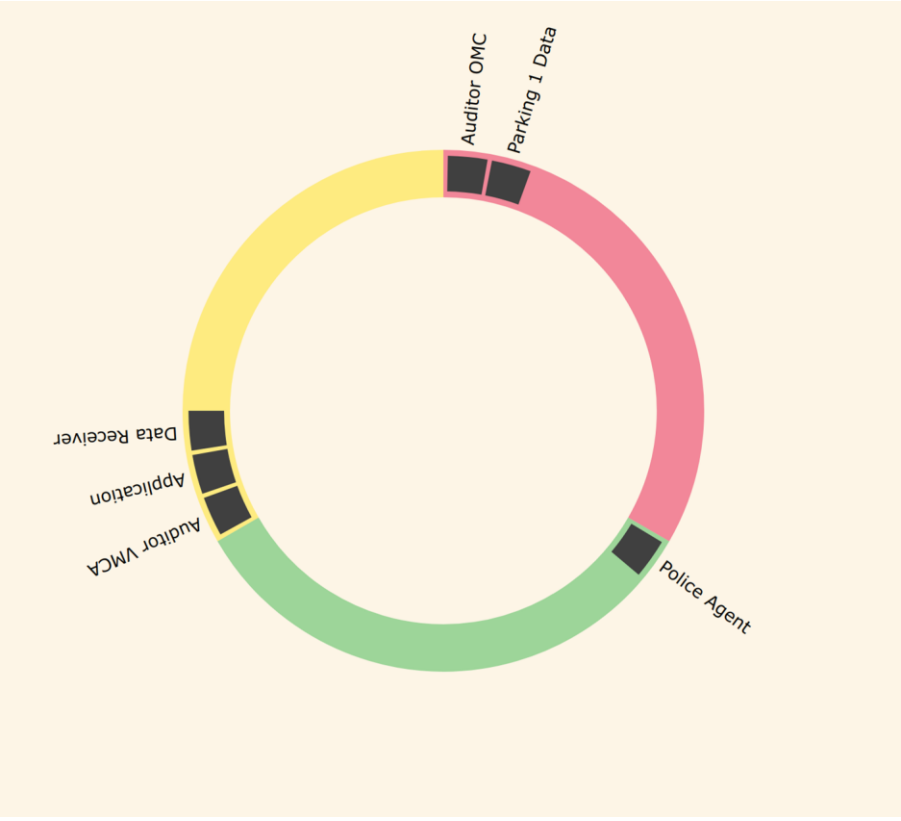
Policy enforcement for data security



Work 1 Policy Enforcement for Data Sharing



Work 1 Policy Enforcement for Data Sharing



- Multi-domain overlay network
  - Signaling over message queue
- 3 domains
  - OMC (Stadium)
  - VMCA (Traffic)
  - Police (Authority)
- 6 Actors
  - 2 Auditors
  - 1 Application (Planner)
  - 1 Sensor (Police Agent)
  - 1 Data sender
  - 1 Data receiver
- 2 Scenarios
  - **Normal condition**
  - **Emergency condition**

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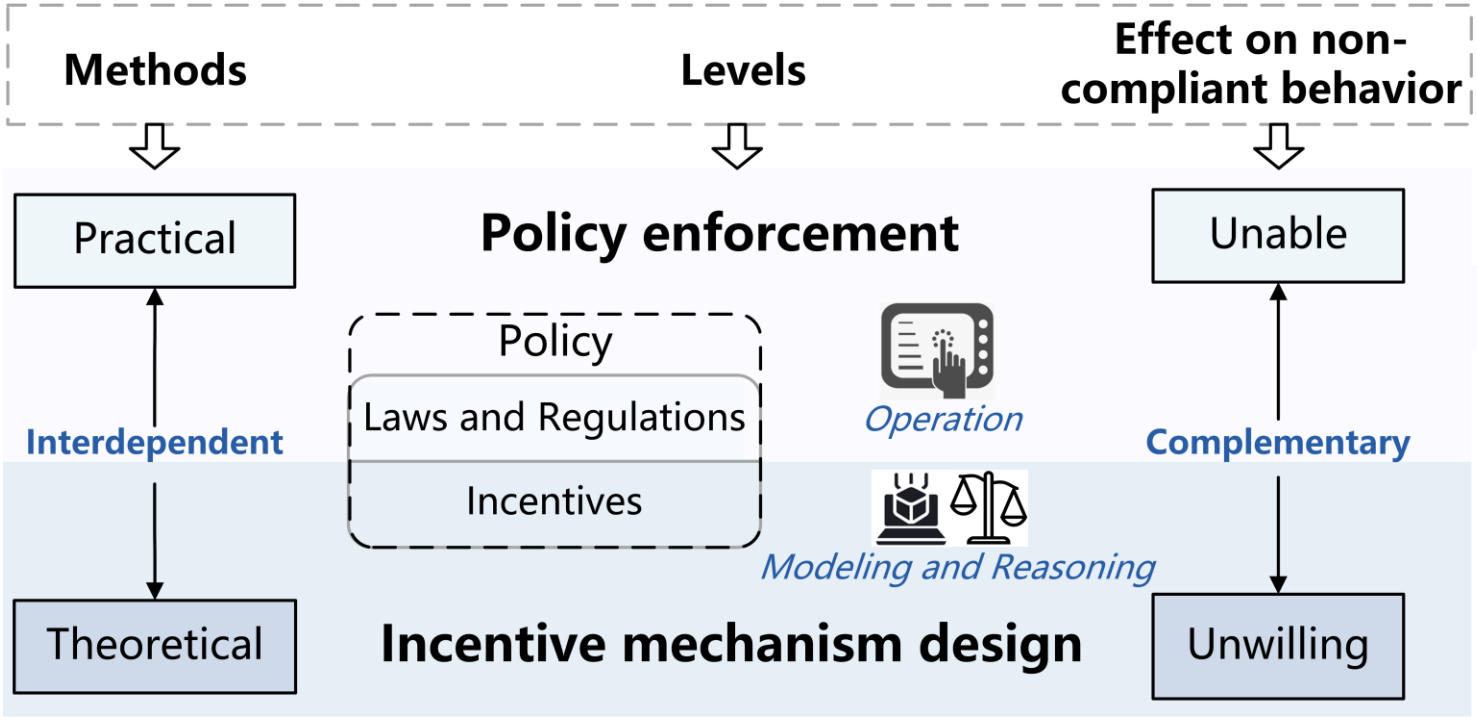

Work 1

Work 2 Costly incentives design

- Incentive mechanism

Table 1. Related parameters under different conditions

Condition	Reward		Probability of reward	Fine		Probability of fine
$[C, C]$	r_0	$*$	$P_0^r = R_{CC}$	–		–
$[C, D]$ *or* $[D, C]$	r_1	$*$	$P_1^r = R_{CD}$	$\|f_1\|$	$*$	$P_1^f = F_{CD}$
$[D, D]$	–		–	$\|f_0\|$	$*$	$P_0^f = F_{DD}$

- Change the expected payoff of participants

	C	D
C	R	S
D	T	P

	C	D
C	R+R_{CC}	S+R_{CD}
D	T-F_{CD}	P-F_{DD}

Work 2 Costly incentives design

- Incentive mechanism

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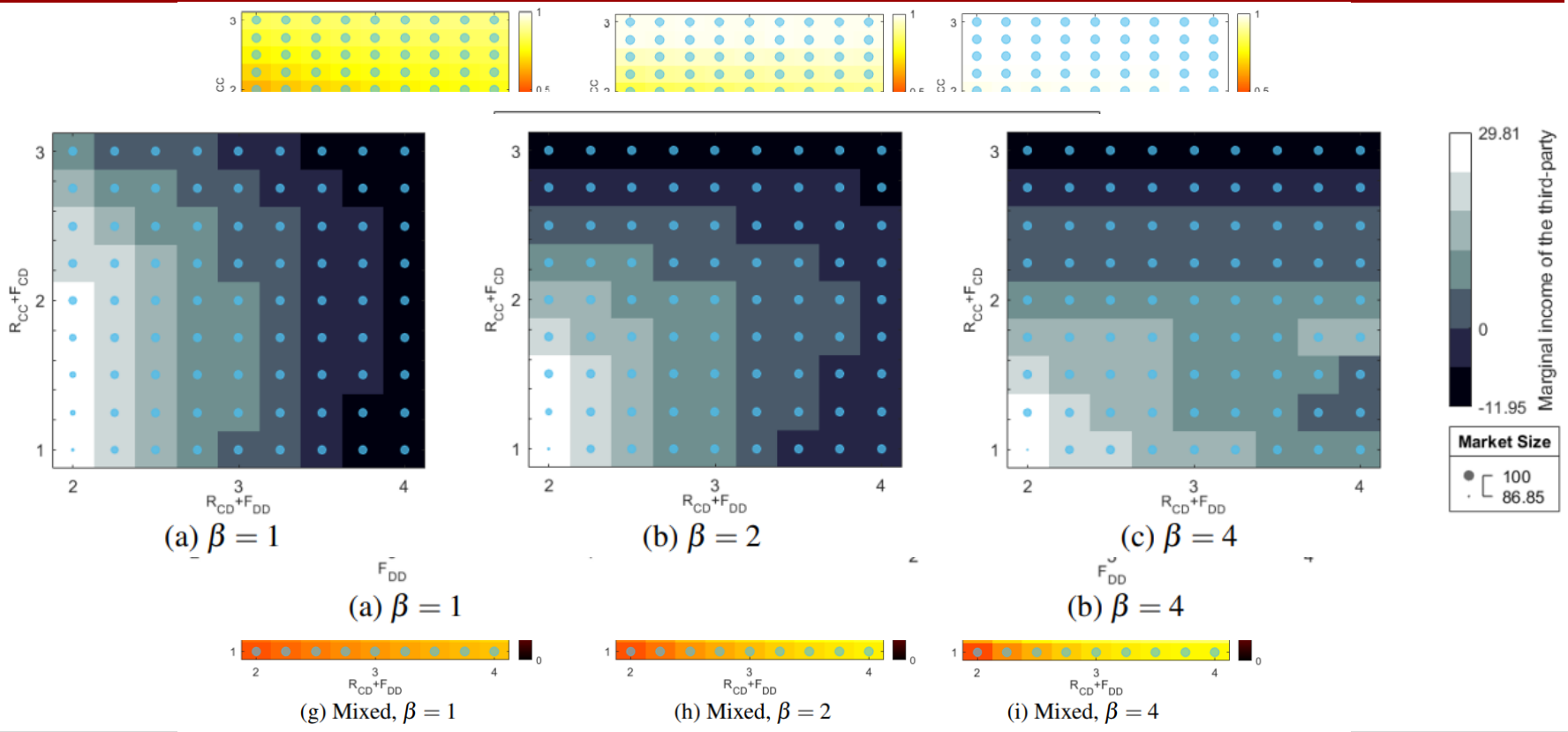
$[D, D]$	–		–	$\|f_0\|$	$*$	$P_0^f = F_{DD}$

- Population: cooperators (x), defectors (y)
- Cost[1-3]: $E = x^2 \cdot M \cdot R_{CC} + xy \cdot M \cdot R_{CD} + \alpha \cdot M(xy \cdot F_{CD} + y^2 \cdot F_{DD})$
- Income[4,5]: $I = c_0 \cdot M + xy \cdot M \cdot F_{CD} + (y)^2 \cdot M \cdot F_{DD}$

Work 2 Costly incentives design



(a) $\beta = 1$ (b) $\beta = 2$ (c) $\beta = 4$

F_{DD}

(a) $\beta = 1$ (b) $\beta = 4$

(g) Mixed, $\beta = 1$ (h) Mixed, $\beta = 2$ (i) Mixed, $\beta = 4$

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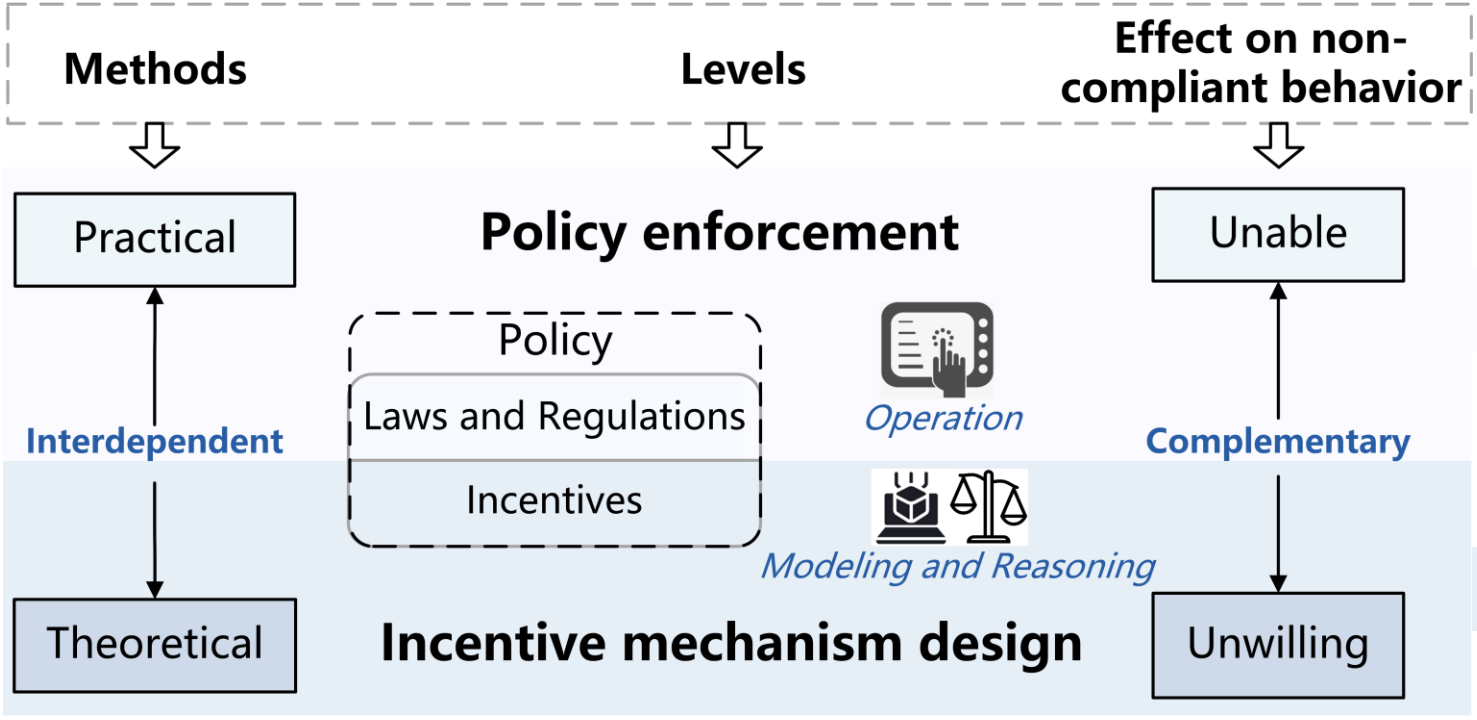
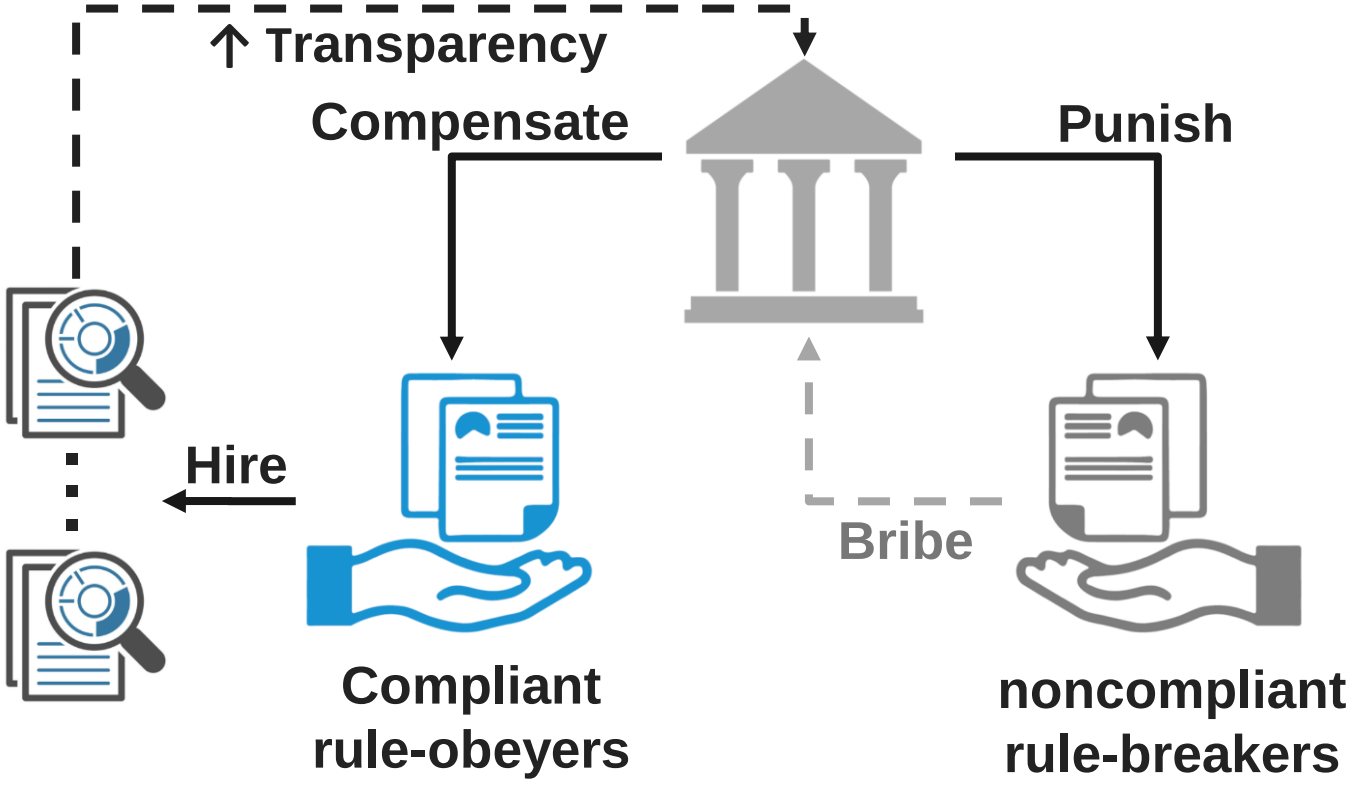


Work 3 Auditors, a way out facing corruption



Work 3 Auditors, a way out facing corruption

- **Rule-obeyer**
  - Hire an auditor => higher cost => higher *p* detect corruption / get compensation
  - Worthy when facing corrupt third-party
- **Rule-breakers**
  - Bribe => escape from the punishment
  - Worthy when facing corrupt third-party
- **Third party**
  - Corrupt => additional income
  - Worthy when auditors are less

Work 3 Auditors, a way out facing corruption

- To what extent can auditors contain corruption?
- How many cooperators will hire auditors?
- With what probability should the third-party accept the bribe?
- How will the population of rule-obeyers and rule-breakers evolve in a long term?
- What factors can influence such dynamic?

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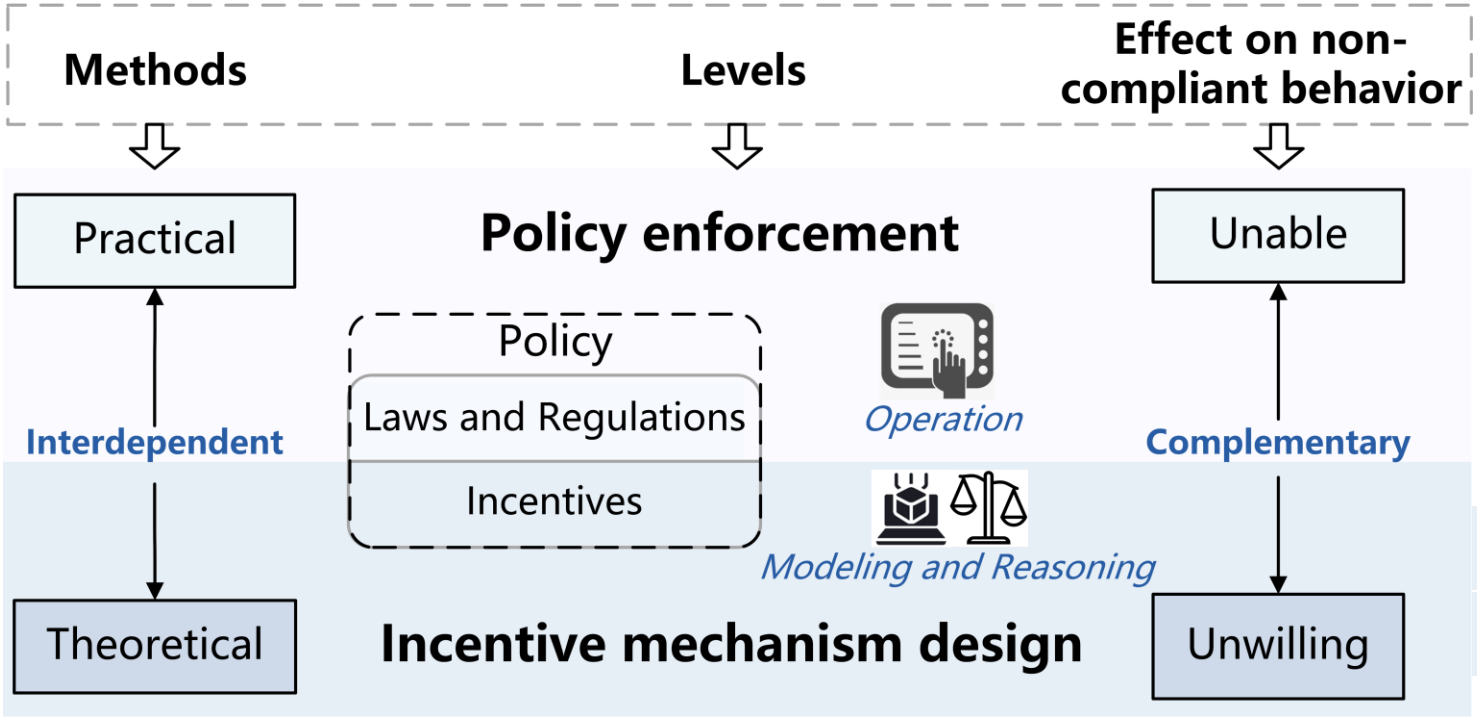

Work 1

Work 2

Work 3

What have finished

- Zhou X*****, Cushing R*****, Koning R, et al. Policy Enforcement for Secure and Trustworthy Data Sharing in Multi-domain Infrastructures[C]//**2020 IEEE 14th International Conference on Big Data Science and Engineering** (BigDataSE). IEEE, 2020: 104-113.
- Zhou X*, Belloum A, H.Lees M, et al. Costly incentives design on an institutional level: cooperation, sustainability and affluence. Scientific Reports, under review.
- **Supercomputing Conference 2020**
- **ICT Open 2021**

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