Crime and Punishment.

Experimental Evidence on the Inspection Game.

Rational Choice Sociology: Theory and Empirical Applications.
Venice International University, 6th December 2006

Research Question

Theoretical analysis

Experimental Design

Empirical Results

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Research Question

"Sentence severity and crime: Accepting the null hypothesis."
(Doob & Webster, 2003)

"Penalty has no impact on crime"
(Tsebelis, 1990)

1. **How is this puzzle solvable?**
   In other words: What is the theoretical argument?

2. **How is it possible to test the argument**
   (a) with high construct validity
   (b) with high internal validity?

Research Question

Economic model of crime (Becker, 1968)
Decision theoretic formulation

- Criminals as rational actors
- **Higher punishment → less crime**

Game theoretic model of crime: Inspection Game
(Tsebelis, 1989, 1990, 1993, 1995)

Criminal	Controller	
	control	not control
crime	$-\pi_1$, π_2	π_4 , 0
no crime	0 , $-\pi_3$	0 , 0

- Only mixed equilibria
- *Criminals*' decision based on *controller's* utility → **punishment no impact on *crime***
- *Controller's* decision based on *criminal's* utility → **punishment impact on *control***
- **Conclusion:** Interaction between criminals and controllers neglected so far

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Theoretical analysis

Review: Inspection Game (Tsebelis, 1989)

Criminal	Controller	
	control	not control
crime	$-\pi_1$, π_2	π_4 , 0
no crime	0 , $-\pi_3$	0 , 0

Extension: Welfare loss due to crime has to be incorporated in model because

(a) Theoretical model reflects better what we mean by crime

(b) Higher construct validity in experiment

However: Conclusions might be different

Theoretical analysis

Extended inspection game:

2 "players" who can commit crime. Crime defined as welfare transfer, which

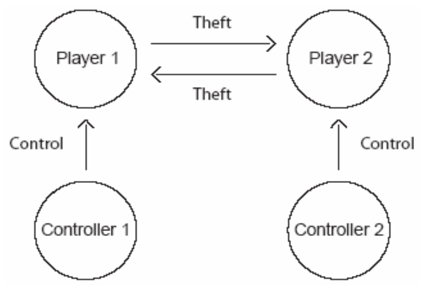
(a) increases player's payoff on cost of other player's payoff

(b) decreases collective welfare

1 controller for each "player" with:

(a) negative control costs

(b) positive net rewards for successful controls



Player:

s:= Welfare transfer

γ:= Welfare inefficiency; $0 < \gamma < 1$

p:= Punishment; γ s < p

Controller:

k:= control cost

r:= reward; r > k

Theoretical analysis

Payoffs

$$u\begin{pmatrix} P1 \\ P2 \\ C1 \\ C2 \end{pmatrix}(s_1, s_2, c_1, c_2) = \begin{pmatrix} s_1(\gamma s - c_1 p) - s_2 s \\ s_2(\gamma s - c_2 p) - s_1 s \\ c_1(s_1 r - k) \\ c_2(s_2 r - k) \end{pmatrix}$$

Best answers

$$s_1^R = \begin{cases} 1 & ,\gamma s > c_1 p \\ [0,1] & ,\gamma s = c_1 p \\ 0 & ,\gamma s < c_1 p \end{cases} , \quad s_2 = \begin{cases} 1 & ,\gamma s > c_2 p \\ [0,1] & ,\gamma s = c_2 p \\ 0 & ,\gamma s < c_2 p \end{cases}$$

$$c_1 = \begin{cases} 1 & ,s_1 r > k \\ [0,1] & ,s_1 r = k \\ 0 & ,s_1 r < k \end{cases} , \quad c_2 = \begin{cases} 1 & ,s_2 r > k \\ [0,1] & ,s_2 r = k \\ 0 & ,s_2 r < k \end{cases}$$

Pure Nash equilibria

$$c_1 = 1 \Rightarrow s_1 = 0 \Rightarrow c_1 = 0 \Rightarrow s_1 = 1 \Rightarrow c_1 = 1 \Rightarrow s_1 = 0$$

Result: No pure equilibria

Mixed Nash equlibrium:

$$s_1^* = s_2^* = \frac{k}{r}$$
$$c_1^* = c_2^* = \frac{\gamma s}{p}$$

In Words:

Probability of crime: Control costs / Reward

Probability of control: Loot / punishment

Research Question

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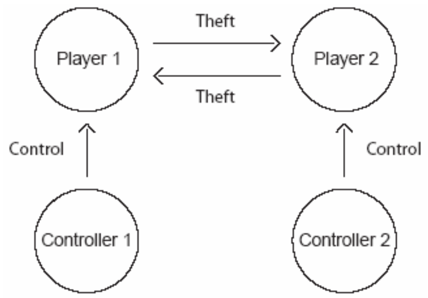
Empirical Results

Experimental Design



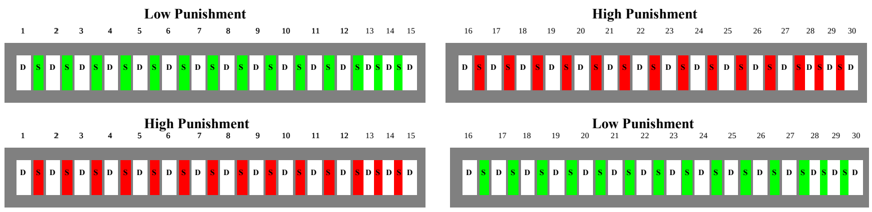
- ↳ Subjects earn money in knowledge quiz
- ↳ Subjects randomly split half into »players« and »controllers«
- ↳ Each player randomly matched with one different player and controller each period
- ↳ Players can take simultaneously money from personal account of the other
- ↳ Controllers could invest control costs to reveal decision of matched player.
- ↳ Conducted with Z-tree (Fischbacher) in computer lab

Experimental Design

2 Experiments:

1) Low punishment → High punishment *(5 sessions à 20 subjects, 48 players, 48 controllers)*

2) High punishment → Low punishment *(5 sessions à 20 subjects, 50 players, 50 controllers)*



Experimental Design

Parameters and information conditions

Players		Low Punishment	High Punishment
s_j	Loss victim	10	10
γ	crime inefficiency parameter	0.5	0.5
$\gamma\ s_j$	Gain thief	5	5
p_c	Strength of punishment	6	25
	Exchange Rate (Pt.- €)	0.1	0.1
Controllers			
k_c	Control costs	5	5
r_c	Reward succesful control	10	10
	Exchange rate (Pt.- €)	0.02	0.02

Experimental Design

Predictions

$$s_1^* = s_2^* = \frac{k}{r}$$

$$c_1^* = c_2^* = \frac{\gamma s}{p}$$

$$\frac{k}{r} = \frac{5}{10} = 0.5$$

$$\frac{\gamma s}{p} = \frac{5}{6} = 0.8 \qquad \frac{\gamma s}{p} = \frac{5}{25} = 0.2$$

Prediction 1: **Theft rate** $\rightarrow$ **0.5 all 30 periods**

Prediction 2: **Control rate** $\rightarrow$ **0.8 low punishment condition**
$\rightarrow$ **0.2 high punishment condition**

- Research Question
- Theoretical analysis
- Experimental Design
- Empirical Results

Empirical Results

Subjects

↳ 5 Euro show up fee + 5 Euro stakes in average

↳ 196 subjects

↳ Randomly chosen from address pool of 692 students from various fields from the University of Leipzig

↳ Randomly allocated to one experimental session

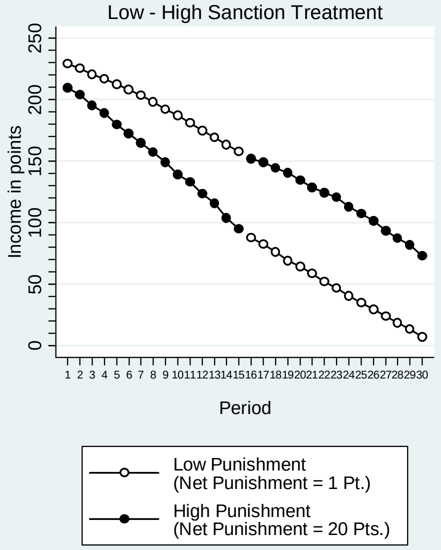
Empirical Results

(1) Description of welfare dynamic over time

Empirical Results

Income change for players

Low - High Sanction Treatment



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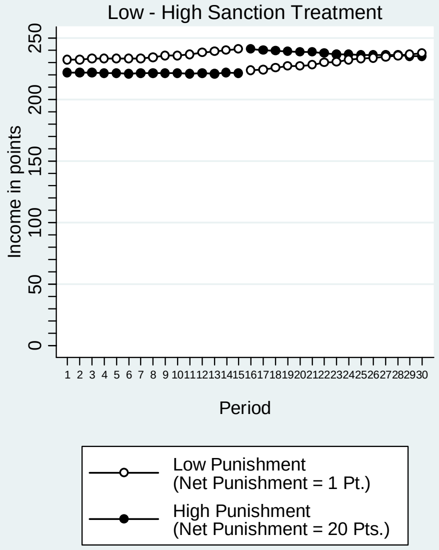
Income change for controllers

Low - High Sanction Treatment



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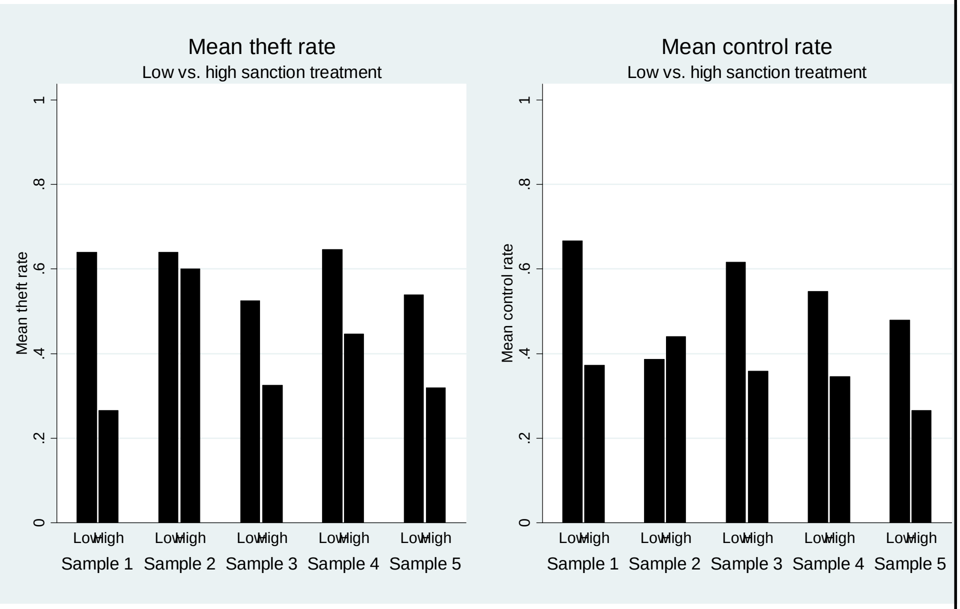
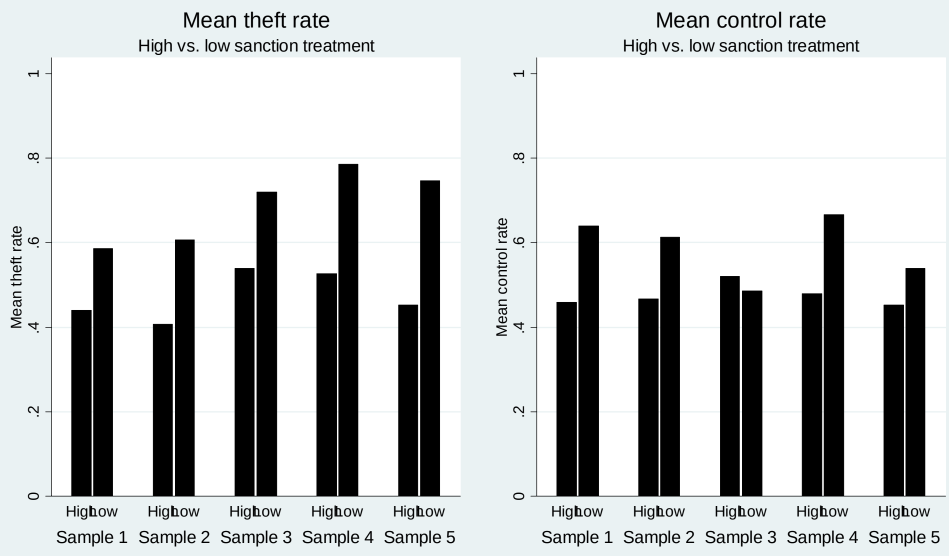
Empirical Results

(2) Static analysis of mixing

Empirical Results



Empirical Results



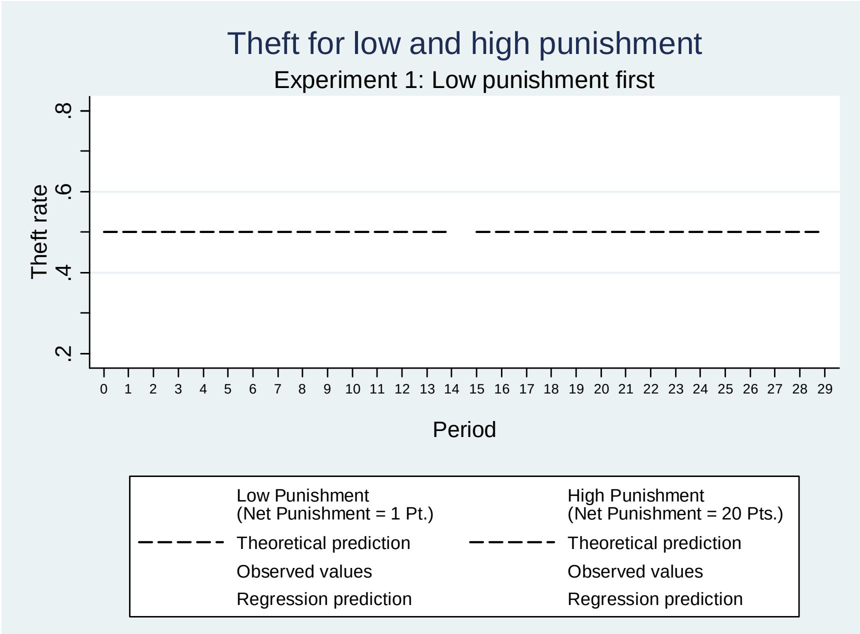
Empirical Results

(3) Dynamic analysis of mixing:

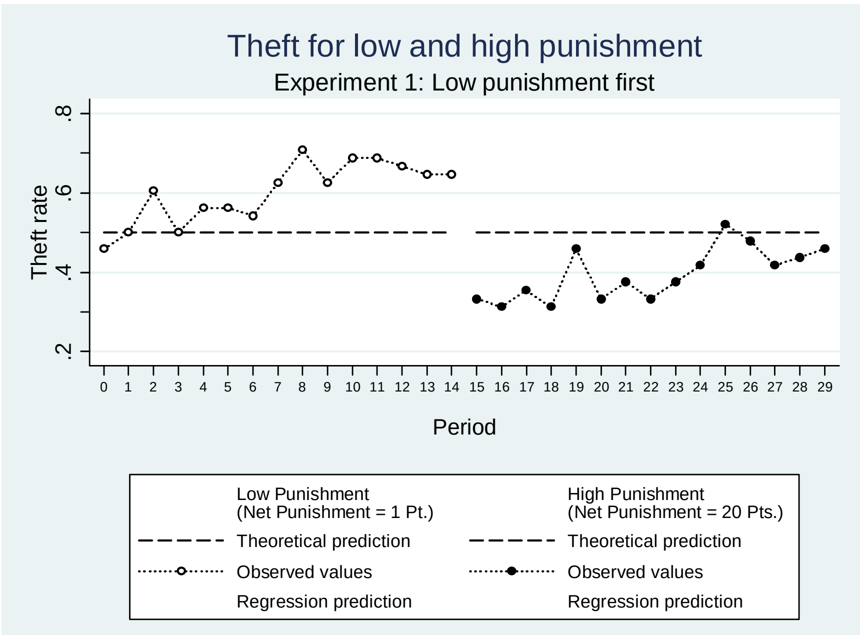
Learning dynamic results in convergence towards Nash equilibria

(Macy, 1991; Roth & Erev, 1995; Fudenberg & Levine, 1998; Macy & Flache, 2002)

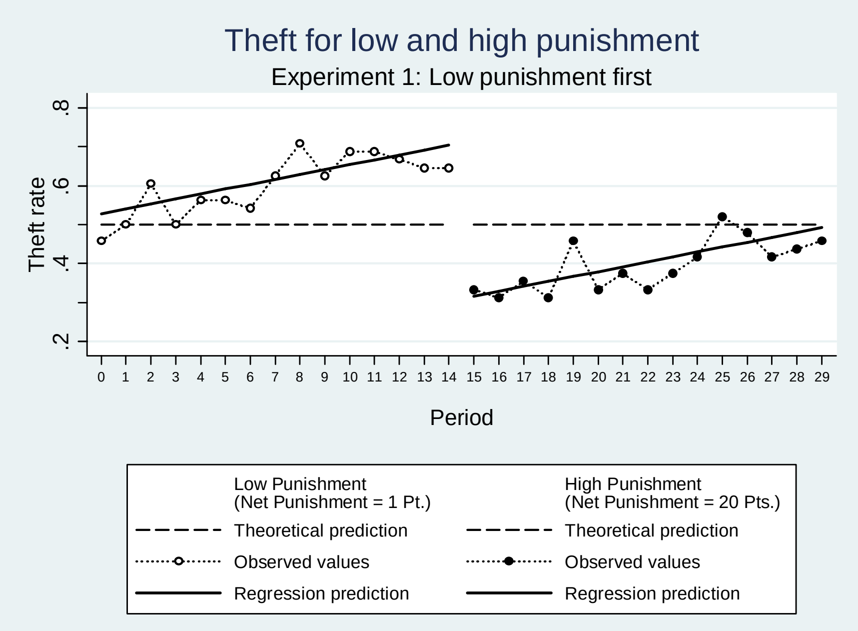
Empirical Results



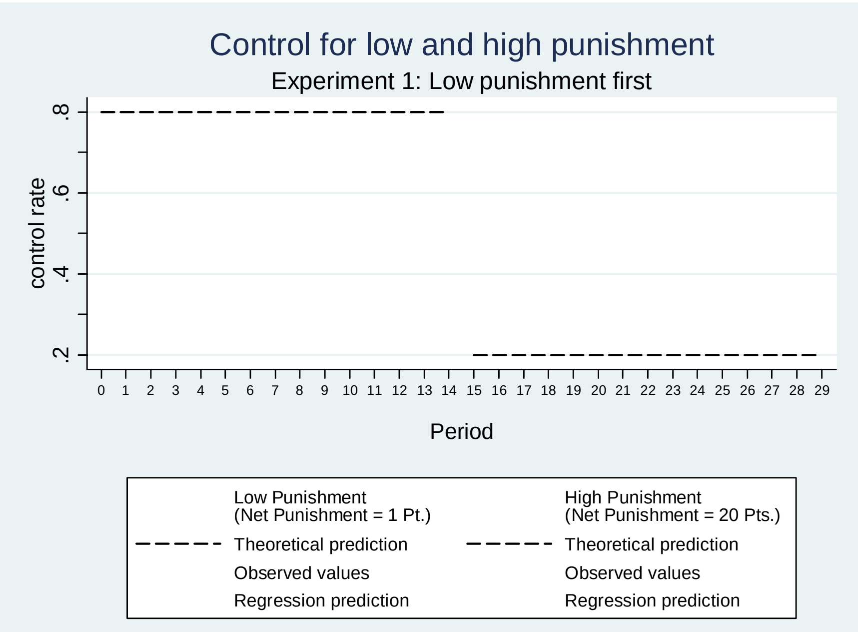
Empirical Results



Empirical Results



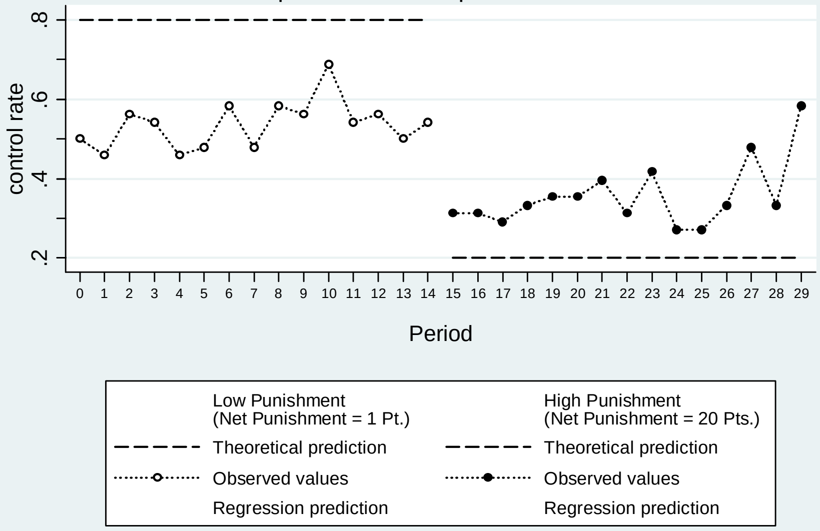
Empirical Results



Empirical Results

Control for low and high punishment

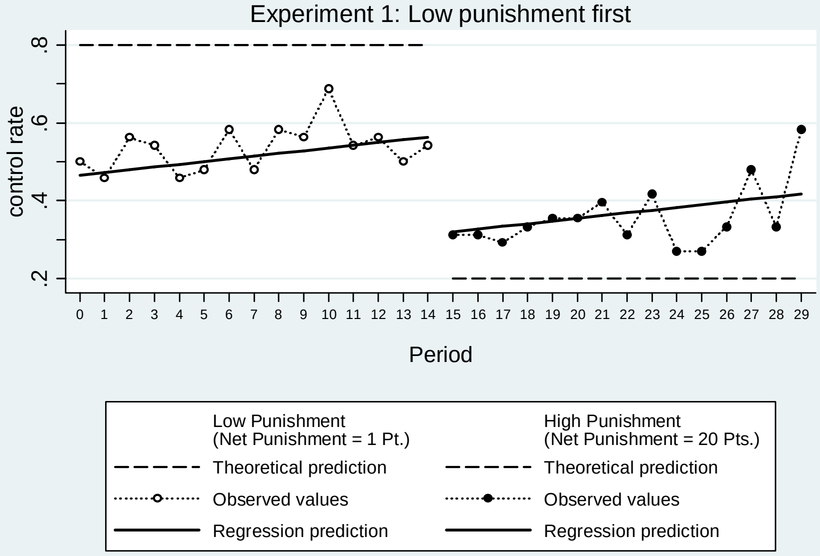
Experiment 1: Low punishment first



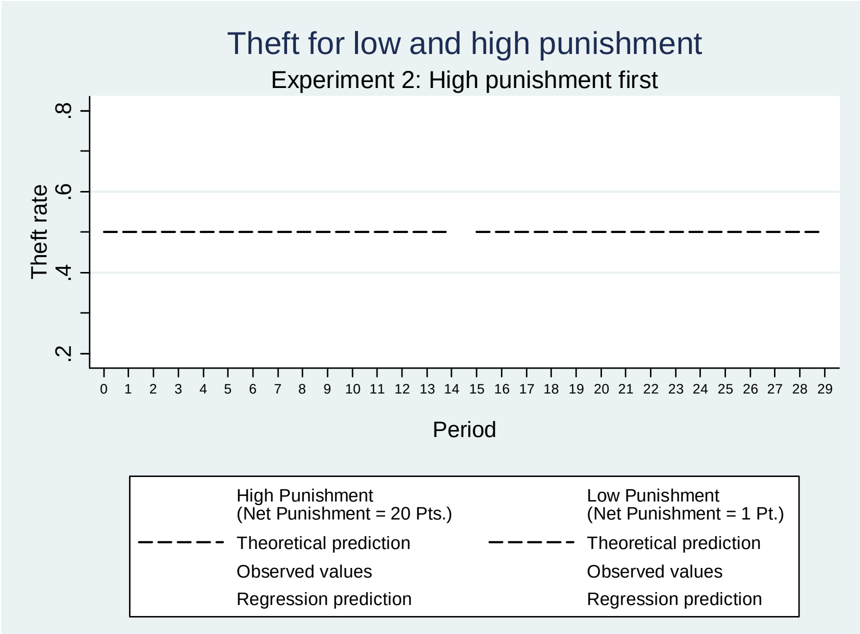
Empirical Results

Control for low and high punishment

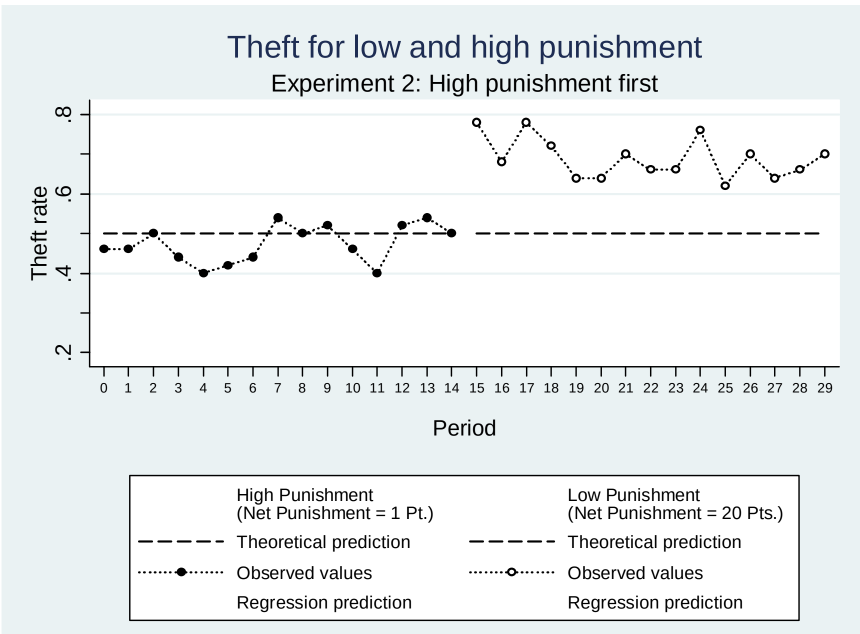
Experiment 1: Low punishment first



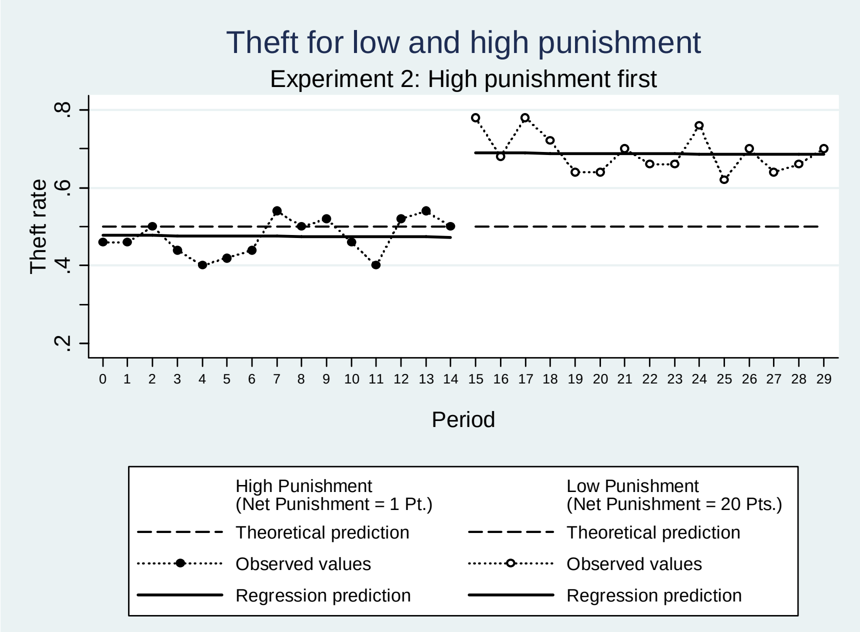
Empirical Results



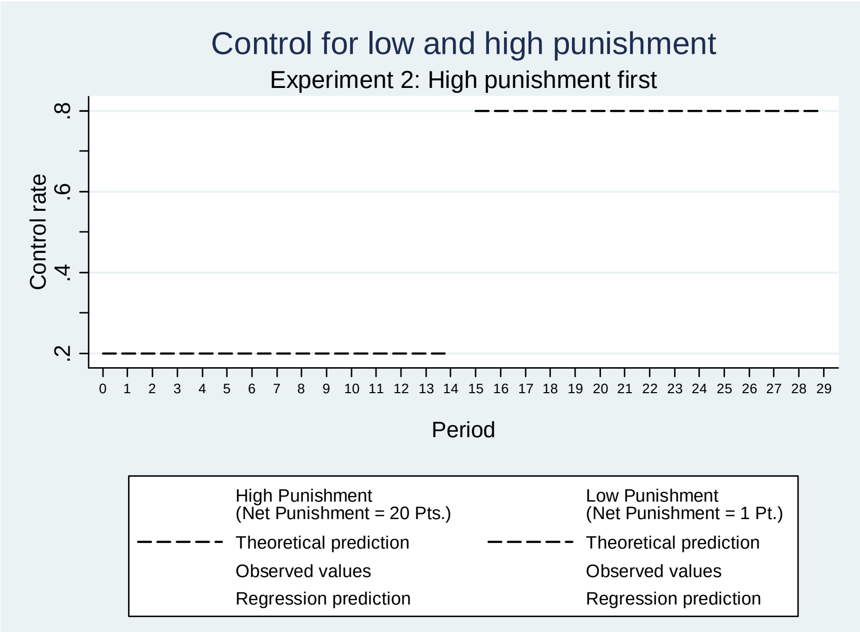
Empirical Results



Empirical Results



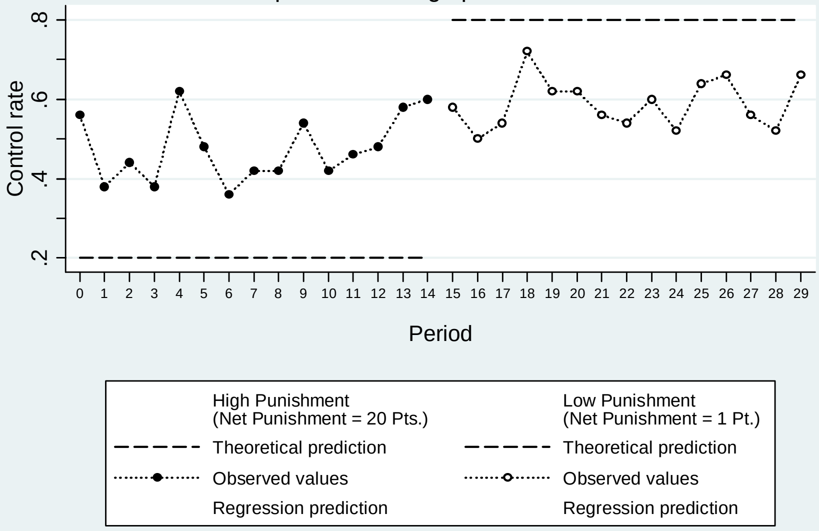
Empirical Results



Empirical Results

Control for low and high punishment

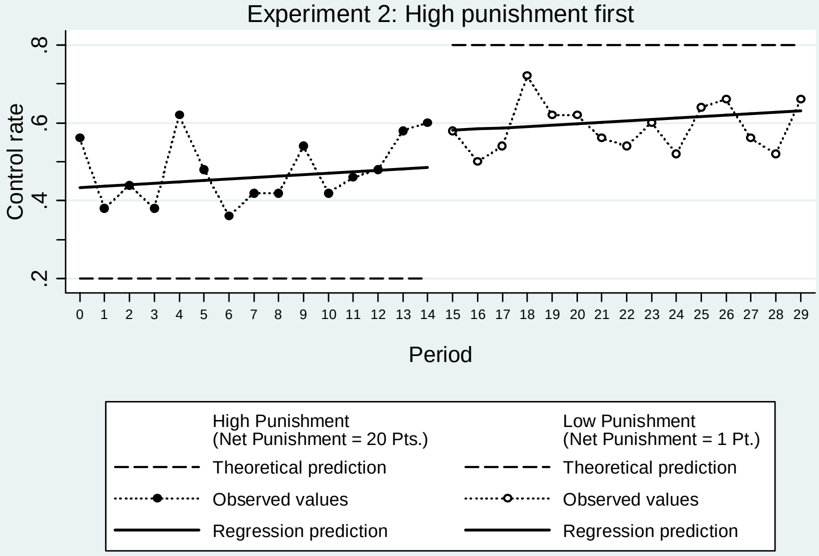
Experiment 2: High punishment first



Empirical Results

Control for low and high punishment

Experiment 2: High punishment first



Empirical Results

Regression Models for Theft and Control

Linear Random intercept & random Period models

Error Covariance Structure: Compound Symmetry

Model	(1) Theft	(2) Control
Intercept	**0.69 ***	**0.58 ***
	(22.18)	*(19.14)*
High Punishment	**- 0.21 ***	**- 0.15 ***
	(- 12.53)	*(- 8.36)*
First low punishment	**- 0.16 ***	**- 0.11 ***
	(- 4.99)	*(- 3.44)*
Period / 15 (First low punishment)	**0.19 ***	**0.10 ***
	(4.50)	*(2.40)*
Period / 15 (First high punishment)	**- 0.00**	**0.05**
	(- 0.12)	*(1.27)*
Random intercept	0.0183	0.0142
Random period	0.0005	0.0004

* significant at 5%, t-values in parentheses

Empirical Results

Conclusions

1. **Higher punishment → less control**
2. **Higher punishment → less crime**
3. **Controllers insensitive:**
   Control too little for low punishment and too much for high punishment
4. **Criminals sensitive:**
   Adapt to inefficiency of controllers
5. **Efficient policy: High control incentives**

Empirical Results

Next steps:

1. **Do higher control incentives result in less crime?**

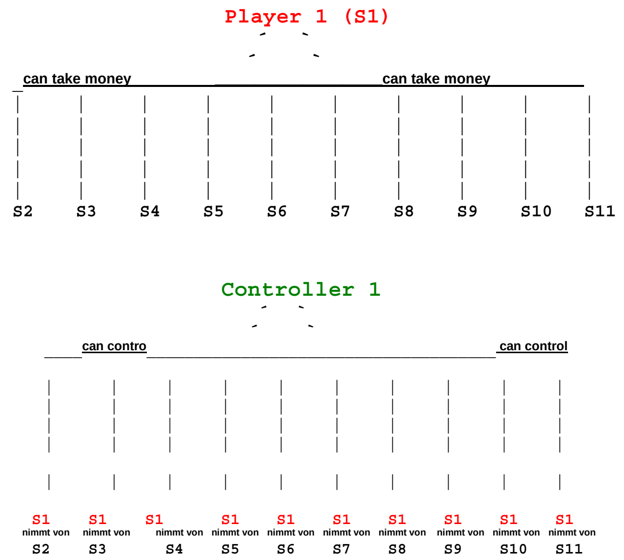
   → 2nd Experiment on variation of reward levels

2. **Improvement of measurement**
   - **(a) Metric measurement of crime & control: “Frequentistic” design**
   - **(b) More periods**

   → 3rd Experiment

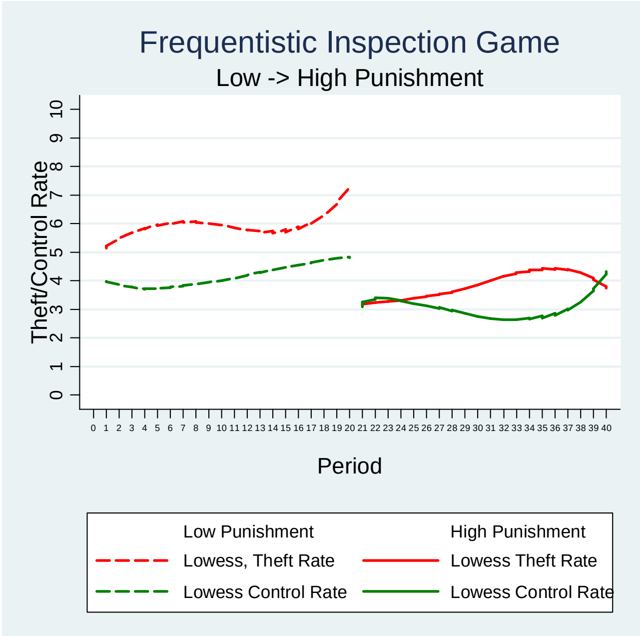
Empirical Results

Pilotstudy: Frequentistic Inspection Game



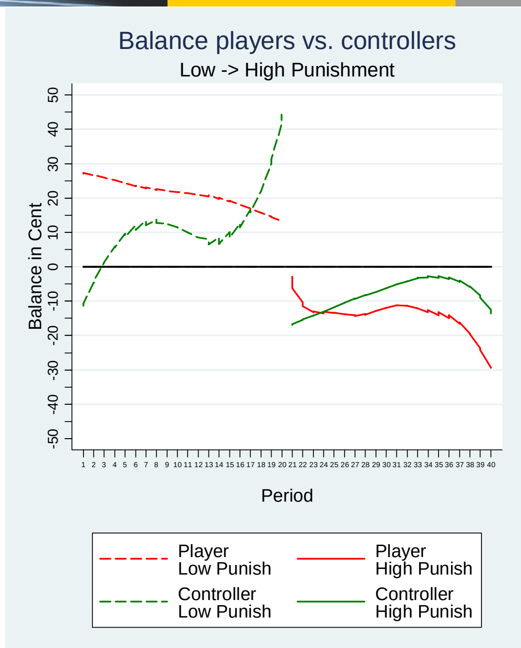
Empirical Results

Pilotstudy (n=44)



Empirical Results

Pilotstudy (n=44)



Preliminary Conclusion for frequentistic design

1. *Frequentistic design allows for more precise testing of mixing hypotheses*

2. *Low punishment results in positive "balance" while high punishment results in negative "balance" for both parties*