

Sabotage and Deterrence Incentive in Tournament: An Experimental Investigation and Policy Implications

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ABSTRACT

This research analyzes the impact of deterrence incentive on sabotage behavior in rank-order tournament using experimental method. Laboratory findings confirm Becker's deterrence hypothesis in a tournament setting. Implementing punishment suppresses sabotage behavior. In addition, increasing probability of inspection is more effective than increasing the magnitude of penalty despite equivalence of expected punishment. Furthermore, analysis of the data reveals existence of cognitive biases influencing sabotage behavior. Findings also suggest that perceived legitimacy of the enforced rule and regulations is important. This study supports existing theoretical frameworks pertaining to tournament and economics of crime, and also provides policy implications for contest designers.

Keywords: Sabotage, Rank-order tournament, Deterrence incentive, Experiment

JEL Classification: C72, C91, D23, M52

1. Introduction

Lazear and Rosen (1981), a seminal paper on tournament, describes a rank-order tournament model in which employees compete for a share of the principal's purse, called 'prizes'. The rankings of their observable output levels determine prize allocation. The use of tournament as an incentive scheme is a common practice in firms and organizations. A notable example is promotional tournament in which the principal seeks to promote only one agent to a higher position. In this case, high prize in tournament implies salary the agent receives at higher post while low prize implies no raise in the salary.

Nonetheless, competition does not always result in an efficient outcome. People are heterogeneous in nature and some may resort to unfair play. When the environment is loosely monitored, it is possible for contestants to engage in unfair means to decrease others' probability of winning and thereby improve their own relative standing in the tournament. Unfair play in tournament studied here is known as sabotage.

In the context of Personnel Economics, Lazear (1989) defines sabotage as "*any (costly) actions that one worker takes that adversely affect the output of another*". In this case, one can imagine the saboteur surreptitiously damaging the rival's output. Such kind of sabotage is rather blatant and outright. From the Industrial Organization literatures, Salop and Scheffman (1983) define sabotage as '*raising rival's cost*'. In this case, the victim of sabotage finds it difficult to effectively exert productive efforts. For instance, employees in the organization can withhold vital information, pass manipulated information and damage others' equipment used in the production process. All these acts are done to make it more difficult for the rivals to win. Though both concepts are

different, sabotage either directly reduces rivals' output or increases their cost, which eventually reduces their chance of winning the tournament. Applications of sabotage in tournament exist in a great deal- warfare, business, worker contest, politics and even sports. Irrespective of its form, sabotage is undesirable and it is in the interest of both the contest designer (principal) and the participants (agents) to reduce this unfair practice in order to make competition fair and healthy.

Despite widespread occurrence in the real world, the issue of sabotage in tournament has not been extensively analyzed by researchers owing to data unavailability. Thus, most of the studies in this extension aimed to investigate policies to restrict unfair measure under different contest designs (varying number of prize, prize spread, number of players, etc.). Among these works, Harbring and Irlenbusch (2005, 2008, 2011) and Harbring et al. (2007) are among the most prominent works in this extension. Previous studies suggest that sabotage can be mitigated by minimizing prize spread (Lazear, 1989; Harbring & Irlenbusch, 2005), separating contestants by distance (Lazear, 1989), inclusion of external candidate (Chen, 2003), concealing intermediate information about output (Gürtler et al., 2013) and framing an instruction in an employment context (Harbring & Irlenbusch, 2011).¹ Another method to mitigate sabotage in tournament is by punishment. In the real world, those who commit crime are punished if caught. Depending on the magnitude of punishment and the probability of getting caught, punishment will decrease the marginal benefit (or

¹ For a complete survey on sabotage in tournament, see Chowdhury & Gürtler (2015). For a complete survey on experimental literatures related to rank-order tournament, see Dechenaux, Kovenock & Sheremeta (2015).

increase the marginal cost) of exerting destructive efforts. Intuitively, appropriate level of punishment should be able to deter sabotage in tournament.

The objective of this study is to analyze the impact of external deterrence incentive on sabotage behavior in tournament. Becker (1968) argued in his seminal work that crime can be deterred with appropriate punishment. Closest to this study, there are two notable theoretical papers by Curry and Mongrain (2009) and Gilpatric (2011) who combine deterrence incentive with rank-order tournament game with cheating. However, gap still exists in the experimental paradigm for which this paper aims to fulfill. In all, this paper aims to incorporate the theoretical framework of economics of crime in a tournament setting so to test its prediction power. The experimental findings would then be inferred to provide contest designers and practitioners with guidelines to deter sabotage behavior by using appropriate extrinsic deterrence incentive.

The rest of the paper proceeds as follows- Section 2 lays down the theoretical framework, Section 3 outlines the experimental design, Section 4 discusses the findings, and Section 5 provides conclusion with policy implications.

2. Tournament Model with Sabotage and Deterrence Incentive

2.1. The Model

This tournament model is an extended version from Lazear and Rosen (1981) where players choose productive and destructive efforts. Productive effort or investment increases own output. On the other hand, destructive effort or sabotage decreases opponent's output and thereby his likelihood of winning the tournament.

The production function of agent i follows this equation:

$$y_i = e_i - s_{-i} + \varepsilon_i \quad (1)$$

where

y_i is observable output

e_i is unobservable effort level; $e_i \in [0, \dots, \bar{e}]$

s_{-i} is destructive effort by agent i 's rival; $s_{-i} \in [0, \dots, \bar{s}]$

ε_i is performance luck; $\varepsilon_i \in [-\varepsilon, \dots, +\varepsilon]$.

Work environment is in such a way that principal cannot observe efforts (e_i) owing to the random shock or performance luck (ε_i). This random term is i.i.d. for all players and is drawn from a uniform distribution with interval $[-\varepsilon, +\varepsilon]$. Thus, since principal can only observe output (y_i), he awards workers based on their relative performance. Player with higher output will receive winner prize (W_1) and the one with lower output receives loser prize (W_2) where $W_1 > W_2 > 0$.

From this point, the discussion has been adapted from Gilpatric (2011) who examined cheating in rank-order tournament with deterrence incentive. While cheating raises own output, sabotage decreases rival's output but ultimately, they result in "increasing own chancing of winning" in the case of 2-player tournament.

Now we focus on the sabotage decision by player i . If he decides to sabotage ($s_i > 0$), the output level of the opponent reduces by that amount and the consequent effect is the increase in the probability of ranking first. From the parameter defined above, $s \in [0, \dots, \bar{s}]$ which represents a decrease in the output level caused by sabotage. It is assumed here that all contestants are inspected by the principal with probability α and this is a common knowledge in the game.

The inspection system used here is known as “correlated audit”- if inspection occurs, both players are inspected; else none is inspected. In the event that inspection occurs, a contestant is caught sabotaging with probability $\beta(s)$, which is a twice continuously differentiable function which satisfies these conditions- $\beta(0) = 0, \beta'(0) = 0, \beta' \geq 0$ and $\beta'' > 0$

Penalty in this game comes in 2 forms; (i) the contestant is disqualified from the winner prize and receives loser prize and (ii) the contestant incurs “outside” penalty in addition to the cost incurred in the contest. The first type of punishment is a common norm to bring about fairness in the competition. The second type of punishment² can be thought of as an additional cost after the saboteur is caught (i.e. humiliation, spoiling employment record). In this study, we assume that the probability of getting caught depends on the magnitude of sabotage but the penalty when caught is fixed at F .

We now consider a 2-player tournament game between player i and j . Both players compete for the winner prize by making a simultaneous choice of effort and sabotage. We make two important assumptions. First, the cost of sabotage is incurred upon detection. Therefore, sabotage in this study is “costless” to the undertaker as long as it is not detected. Second, it is assumed that cost function for effort is a standard convex function $C_e(e_i)$ with $C' > 0$ and $C'' > 0$. This experiment uses both real effort task³ (for effort) and induced value effort task (for sabotage) and therefore quantitative prediction cannot be made regarding effort at equilibrium as true cost function is unknown. Henceforth, cost of effort is represented with disutility from work while

² Gilpatric (2011) refers to the second type of punishment as “reputation cost” that reduces future earnings.

³ Real effort task used here is The Slider Task which was first developed and used by Gill and Prowse (2011).

the cost of sabotage comes with probability of detection. Let $P_i(e_i, s_i, e_j, s_j)$ be the probability that player i ranks first.

The expected payoff of player i can be written as:

$$\begin{aligned} E\pi_i(e_i, e_{-i}, s_i, s_{-i}) = & \alpha\Delta(1 - \beta(s_i)) \left(1 - \right. \\ & \left. \beta(s_j)\right) P_i(e_i, s_i, e_j, s_j) + \alpha\Delta\beta(s_j)(1 - \beta(s_i)) + \\ & (1 - \alpha)\Delta P_i(e_i, s_i, e_j, s_j) + W_2 - C_e(e_i) - F\alpha\beta(s_i) \end{aligned} \quad (2)$$

The first term signifies the payoff when player i wins when inspection occurs but no one is caught. The second term is the payoff when player i wins when inspection occurs but player j is caught and disqualified. The third term is the payoff when player i wins when there is no inspection. The expected payoff function for player j is symmetric to Equation (2).

Assuming that player i is a rational, self-interested decision maker, he maximizes his expected payoff choosing e_i and s_i . Equation (3) and (4) are player i 's best response functions:

$$e_i: \Delta \frac{\partial P_i(e_i, s_i, e_j, s_j)}{\partial e_i} [\alpha(1 - \beta(s_i))(1 - \beta(s_j)) + (1 - \alpha)] - C'_e(e_i) \quad (3)$$

And

$$\begin{aligned} s_i: & -\alpha\Delta\beta'(s_i) \left[(1 - \beta(s_j)) P_i(e_i, s_i, e_j, s_j) + \beta(s_j) \right] + \\ & \Delta \frac{\partial P_i(e_i, s_i, e_j, s_j)}{\partial s_i} \left[(1 - \alpha) + \alpha(1 - \beta(s_j))(1 - \beta(s_i)) \right] - \\ & F\alpha\beta'(s_i) = 0 \end{aligned} \quad (4)$$

Furthermore, we make a Nash Cournot assumption. In other words, players arrive at a symmetric equilibrium where

they choose $e_i = e_{-i} = e^*$ and $s_i = s_{-i} = s^*$. We can write the unique symmetric equilibrium as:

$$C'_e(e) = \Delta \frac{\partial P_i(e_i, s_i, e_j, s_j)}{\partial e_i} \{1 - 2\alpha\beta(s) + \alpha(\beta(s))^2\} \quad (5)$$

And

$$\beta'(s) = \frac{\Delta \frac{\partial P_i(e_i, s_i, e_j, s_j)}{\partial s_i} [1 - 2\alpha\beta(s) + \alpha(\beta(s))^2]}{\frac{\Delta\alpha(1+\beta(s))}{2} + \alpha F} \quad (6)$$

It should be noted that with the Nash Cournot assumption, the marginal probability that the player wins depends on the distribution of the random noise. It was shown in Harbring and Irlenbusch (2008) that in a symmetric equilibrium e^* and s^* , the marginal probability of winning equals $\frac{1}{2\bar{\varepsilon}}$ where $\bar{\varepsilon}$ is the spread of random component.

Equation (6) defines the degree of sabotage in symmetric equilibrium if an interior solution exists. The probability of inspection α should be sufficiently large such that an interior solution exists.

The level of sabotage in equilibrium depends on the probability of inspection α , the shape of $\beta(s)$ which determines how quickly the probability of detecting sabotage increases with sabotage level, the distribution of ε and the ratio of outside penalty to the spread $\frac{F}{\Delta}$. However, when there is no inspection ($\alpha = 0$), both agents will exert maximum level of sabotage because it is costless. But when there is inspection ($\alpha > 0$), sabotage should decrease monotonically. It can be concluded that sabotage in symmetric equilibrium decreases with the probability of inspection, ratio of outside penalty to spread and higher random noise. As the primary

focus of this research involves sabotage behavior, discussion about how effort reacts with probability of inspection is skipped⁴.

Based on the above model, parameters are specified as in Table 1.

Table 1
Parameter specification

Parameters	Specification
Productive efforts	$e \in [0,48]$
Destructive efforts	$s \in [0,10]$
Prize spread ($W_1 = 150, W_2 = 50$)	$\Delta = 100$
Interval size of random component	$\bar{\varepsilon} = 20$
Cost functions for productive efforts	$C(e) = \frac{e^2}{c_e}$ with $c_e > 0$
Probability of detection	$\beta(s) = \frac{s^2}{100}$
Outside penalty if caught	$F = 20,40$

Source: Author's specifications

With the above specification, the FOCs in (5) and (6) can be rewritten as:

$$e^* = \frac{5c_e}{4} \left\{ 1 - \alpha \frac{s^2}{50} + \frac{\alpha s^4}{100^2} \right\} \quad (7)$$

$$\alpha s^4 - 40\alpha s^3 - 200\alpha s^2 - 5600\alpha s + 10000 = 0 \text{ for } F = 20 \quad (8)$$

$$\alpha s^4 - 40\alpha s^3 - 200\alpha s^2 - 7200\alpha s + 10000 = 0 \text{ for } F = 40 \quad (9)$$

⁴ Interested readers can consult Gilpatric (2011). The sole difference is with 'cheating' and 'sabotage'.

Equation (7) implies that effort level at equilibrium is dependent on the level of sabotage at equilibrium. The value of e^* is unknown and depends on the value of c_e . On the other hand, the level of sabotage at equilibrium is independent of effort level. From Equation (8) and (9), s^* can be calculated for any positive level of α . When $\alpha = 0$, it is rationale for subjects to choose $s^* = \bar{s} = 10$. Thus, we can conclude that when there is no inspection, we have corner solution where subjects choose maximum level of sabotage, which implies $s^* = 10$. When inspection is enforced, sabotage reduces with an increase in the probability of inspection α and level of penalty F .

2.2. Experimental Design

As the main objective of this research is to test the impact of deterrence hypothesis on sabotage behavior in tournament, only probability of inspection and magnitude of penalty are varied across treatments. NoDeter treatment is a baseline case in which there is no inspection. There are 3 treatments conditions; (i) Deter treatment, (ii) DeterPenalty treatment and (iii) DeterInspect treatment. Table 2 shows the probability of inspection, the magnitude of punishment, and theoretical prediction for sabotage level at equilibrium for each treatment.

Table 2
Treatment specification and sabotage level at equilibrium

	No inspection ($\alpha = 0$)	Low inspection ($\alpha = 0.4$)	High Inspection ($\alpha = 0.8$)
Outside penalty = 0	NoDeter (Treatment 1) $s^* = 10$	-	-

Table 2 (Continued)

Outside penalty=20	-	Deter (Treatment 2) $s^* = 3.67$	DeterInspect (Treatment 4) $s^* = 2.03$
Outside penalty =40	-	DeterPenalty (Treatment 3) $s^* = 3.06$	-

Source: Author’s experimental design

Table 3
Experimental Protocol

Session type	Game 1	Game 2	Game 3	Questionnaire
Type 1	NoDeter	Deter	DeterPenalty	Holt and Laury & questionnaire
Type 2	NoDeter	Deter	DeterInspect	

Source: Author’s experimental design

There will be 2 types of experimental sessions (see Table 3), which are different only in Part 3. Each session is divided into 4 parts. In parts 1-3, subjects play tournament game with sabotage according to the specified treatments. Each part contains 10 rounds of the game. Every session ends with a post-game Questionnaire which includes Holt and Laury form to measure risk aversion.

This design uses both “within-subject” as well as “between-subject” design. Within the session, subjects play tournament game under 3 institutional setting; no punishment, low punishment and high punishment. The difference between sessions is in Game 3 where DeterPenalty (Treatment 3) has high outside penalty and DeterInspect (Treatment 4) has high probability of inspection. This allows us to examine their relative power of kinds of deterrence

incentives. Our theoretical model suggests inspection to be a better stick. The limitation of this design pertains to the “carry-over effect” within the session. Nonetheless, as the asymmetric change of punishment is not of our concern, this design is appropriate in addressing the research questions.

2.3. Experimental Procedure

There were 4 experimental sessions (see Table 4); 2 sessions were conducted at Faculty of Economics, Chulalongkorn University on 28th and 29th April 2016 and the other 2 sessions were conducted at Faculty of Economics, Thammasat University on 11th May 2016. The experiments were conducted with Z-Tree (Fischbacher, 2007). All participants are Economics students (86% undergraduate and 14% graduate). 46% are male. Age range of subjects is 19-26 years (mean age is 22.4).

Table 4
Sessions conducted

Session no.	No. of participants	Venue	Session type
1	22	Chulalongkorn University	Type 1
2	10	Chulalongkorn University	Type 2
3	16	Thammasat University	Type 1
4	8	Thammasat University	Type 2

Source: Author’s compilation

Three things need to be noted; (i) participants at Chulalongkorn University were students enrolled in Experimental Economics course while participants at

Thammasat University were Economics students in general, (ii) participants received Starbucks Gift cards as reward for their performance in the game and (iii) prizes for Chulalongkorn students were set at 500, 300, 100 Thai Baht and nothing, while for Thammasat students, prizes were set at 600, 400, 200 and 100 Thai Baht. The proportion of prizes was 1:1:1:2.

Before commencing, participants are informed that they will be playing 3 Games; 10 rounds of each. There is 1 practice round for Game 1 so that participants can get familiarized with the Slider Task. The experimenter informs the participants that only 3 out of 30 rounds will be randomly selected. The sum of payoffs will then be ranked which is used to determine the rewards each subject would receive. They are also informed that they will be randomly matched with a new opponent after each round (i.e. Stranger Matching Protocol).

Instructions used are framed⁵ as an employment-context one. Before commencing and during the practice round, subjects are allowed to ask the experimenter about the game. In each round, participants are presented with 48 Sliders with initial value at 0. For each slider positioned at 50, the subject receives 1 Point, which is used as a proxy for effort. After 120 seconds, the screen reports the number of sliders correctly positioned. Then, subjects decide their sabotage level (from 0 to 10). After all subjects make decision, the screen reports the outcome of the tournament. After Game 1 (NoDeter treatment), the experimenter continues with

⁵ Although Harbring and Irlenbusch (2011) found framing effect to suppress sabotage, framed instruction is used in this study to merely enhance subjects' understandability of the game. When deterrence incentive is implemented, neutral instruction may rather be equivocal. Translated instruction is available from the author upon request.

instruction of Game 2 (Deter treatment). To ensure that subjects acknowledge the deterrence incentive, a new screen with information about inspection is added prior to the sabotaging stage. In addition, information about probability of detection with each level of sabotage is provided on the screen of sabotaging stage. The experiment is resumed after all subjects understand the game. After Game 2, the experimenter informs the change in Game 3. The change to the game is either higher penalty (DeterPenalty treatment) or higher probability of inspection (DeterInspect treatment). Then, the game is resumed. Subjects are asked to fill out post-game questionnaire form, which includes a lottery form⁶ adapted from Holt and Laury (2002) to measure risk aversion. All participants are informed about the selected rounds. They are rewarded based on their rankings of the tournament. All sessions lasted approximately 2 hours.

2.4. Research Hypotheses

Hypothesis 1: Deterrence incentive causes lower average sabotage

Hypothesis 1 corresponds to the classical argument made by Becker (1968). As discussed earlier, theory predicts that sabotage decreases with expected punishment.

Hypothesis 2: The average level of sabotage is lower in treatments with relatively heavier punishment compared to those with relatively lighter punishment.

The experimental design discussed in the previous section allows us to derive both main effect and interaction effects of the factors that are varied. According to the theory, sabotage should follow this relationship; $s_{G3.2} < s_{G3.1} <$

⁶ This task is uncompensated.

$s_{G2} < s_{G1}$. This follows directly from the fact that penalty is the heaviest in Game 3.2.

Hypothesis 3: The average level of sabotage in DeterInspect (Game 3.2) is lower than that of DeterPenalty (Game 3.1).

Despite the equivalence of expected punishment in DeterPenalty and DeterInspect, theory predicts that sabotage level is lower in DeterInspect, where probability of inspection is high. This suggests that inspection is a more effective deterrence incentive.

3. Findings and Analysis

3.1. Hypothesis Testing

Before proceeding to the testing of the hypotheses, it is vital to ensure that all sessions are comparable. For this purpose, Kruskal Wallis test is used to ensure equality of populations with regards to the average effort level in the Slider Game.

Table 5
Kruskal-Wallis equality-of-populations rank test (for efforts)

Game	Rank Sum (by Session)				Chi-squared with ties (d.f.=3)	p- value
	1	2	3	4		
1	534	214	568.50	279.50	7.596	0.0551
2	640.50	275.50	411.50	268.50	1.322	0.7239
3	599	228	510	259	2.596	0.4581

Source: Author's calculation

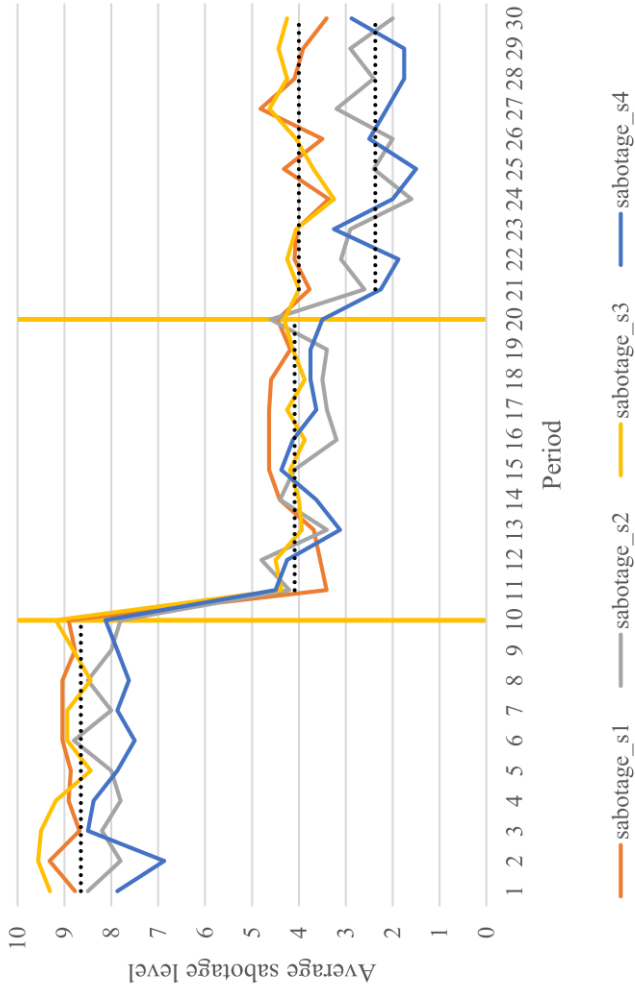
Kruskal Wallis test does not reject the null hypothesis of equality of population ($p > 0.05$ for all games). This implies that despite unequal number of participants across sessions, subjects of all sessions exert similar level of efforts on average. Given similar effort levels, we compare sabotage behaviors in various games to test the hypotheses.

Hypothesis 1: Deterrence incentive causes lower average sabotage

Figure 1 exhibits the average sabotage level in all sessions. Based on the graphical presentation, several observations can be made; (i) sabotage level in Game 1 is at a high level (average of 4 sessions at 8.65), (ii) sabotage level reduces when deterrence incentive is implemented (iii) in sessions where subjects played DeterPenalty in Game 3 (sessions 1 and 3), sabotage level is somewhat the same as in Game 2, (iv) in sessions where subjects played DeterInspect in Game 3 (sessions 2 and 4), sabotage level is lower relative to that of Game 2. At this simple level, deterrence hypothesis seems to hold well, except for DeterPenalty.

To confirm the hypothesis, sabotage levels of Game 1, 2 and 3 are compared. As subjects play the 3 games consecutively, within-subject analysis is employed. Using average sabotage levels for Wilcoxon signed-rank test (yielding one observation per individual), it is found that sabotage is higher in NoDeter in comparison to Deter, DeterPenalty and DeterInspect.

Figure 1
Average sabotage level in respective period and session



Source: Author's illustration

Note: sabotage_s1 refers to average sabotage level in session 1, so on. Black dotted lines are weighted average sabotage levels for all sessions in respective games.

Table 6
Wilcoxon signed-rank test (Game 1 and 2; Game 2 and 3; Game 1 and 3)

Session no	Observations	$H_0: \text{sabotage. } G_1 = \text{sabotage. } G_2$		$H_0: \text{sabotage. } G_2 = \text{sabotage. } G_3$		$H_0: \text{sabotage. } G_1 = \text{sabotage. } G_3$	
		Critical value	Prob > z	Critical value	Prob > z	Critical value	Prob > z
1	22	z = 3.815	0.0001***	z = 0.488	0.6256	z = 3.686	0.0002***
2	10	z = 2.553	0.0107**	z = 2.293	0.0218**	z = 2.499	0.0125**
3	16	z = 3.413	0.0006***	z = 0.440	0.6599	z = 3.466	0.0005***
4	8	z = 2.457	0.0140**	z = 2.457	0.0140**	z = 2.460	0.0139**

Source: Author's calculation

Note: *** indicates 1% level of significance, ** indicates 5% level of significance

The null hypotheses that average sabotage level in Game 1 equals that of Game 2 and 3 are rejected (at 1% and 5% level of significance). This implies that sabotage levels in Game 1 differ significantly from those in Game 2 and 3 where deterrence incentive is implemented. However, when average sabotage levels in Game 2 and 3 are compared, Wilcoxon sign-rank test rejected the null hypotheses (at 5% level) for sessions in which subjects played DeterInspect as Game 3. On the other hand, the test finds no significant difference in average sabotage between Game 2 and 3 for sessions in which subjects played DeterPenalty as Game 3.

It can then be concluded that this result supports Becker's deterrence hypothesis (at least qualitatively) as sabotage level decreases with punishment. However, sabotage behavior in DeterPenalty treatment deviates from expected pattern. Thus, result 1 can be summarized as follow:

Result 1: Sabotage can be suppressed by implementing deterrence incentive. In general, our finding supports Becker's (1968) deterrence hypothesis (except for DeterPenalty in which sabotage only weakly decreases).

Hypothesis 2: The average level of sabotage is lower in treatments with relatively heavier punishment compared to those with relatively lighter punishment.

Table 7 compares predictions by theory and average sabotage levels in all games. Due to unequal number of observations in each session, weighted average for each game is reported.

Table 7
Comparisons of theoretical predictions and average sabotage levels in all games

Session no.	Game 1 (NoDeter)		Game 2 (Deter)		Game 3.1 (DeterPenalty)		Game 3.2 (DeterInspect)	
	Theory	Experiment	Theory	Experiment	Theory	Experiment	Theory	Experiment
1	10	8.90	3.67	4.22	3.06	3.93	-	-
2	10	8.14	3.67	3.90	-	-	2.03	2.51
3	10	9.03	3.67	4.14	3.06	4.09	-	-
4	10	7.85	3.67	3.86	-	-	2.03	2.19
Weighted Average	10	8.65	3.67	4.09	3.06	4.00	2.03	2.37

Source: Author's calculation

It can be summarized from Table 7 that sabotage level in games with relatively lighter expected punishment is lower. However, the difference in sabotage levels in Game 2 and 3.1 is very small. Two sample t-test confirms insignificant difference in the average sabotage levels in Game 2 and 3.1 ($p = 0.6364$). Thus, it can be concluded that sabotage level in games with relatively heavier punishment is lower (except for Game 3.1 to Game 2 where sabotage levels are similar). Therefore, result 2 can be formulated as follow:

Result 2: Sabotage levels in treatment with heavier punishment are lower than those with relatively lighter punishment. This only holds true for the case of DeterInspect, where probability of inspection is high. However, sabotage levels in DeterPenalty are similar to those in Deter, despite the increment in the level of penalty.

Hypothesis 3: The average level of sabotage in DeterInspect (Game 3.2) is lower than that of DeterPenalty (Game 3.1).

To test Hypothesis 3, we find if there is a treatment effect in Game 3. In Game 3, participants either played DeterPenalty (Game 3.1) or DeterInspect (Game 3.2). Since samples are independent, we employ Mann-Whitney U test for Game 3, comparing them by treatment⁷. The test rejects the null hypothesis at 5% level of significance ($p = 0.0256$), implying that subjects in DeterPenalty and DeterInspect reacted towards types of disincentives differently. Despite the same level of expected punishment, probability of inspection

⁷ As Game 1 and 2 are same for all sessions, there should be no treatment effect. Kruskal Wallis confirms no significant difference in sabotage behavior across sessions in Game 1 and 2 ($p = 0.5404$ and $p = 0.9701$ respectively).

is a better tool to curb sabotage in tournament. With this finding, we can formulate Result 3 as follow:

Results 3: In line with the theoretical prediction, sabotage level in DeterInspect is lower, compared to that of DeterPenalty despite the equivalence of expected level of punishment. This finding suggests that probability of inspection is a better ‘stick’ in suppressing sabotage behavior in tournament.

3.2.Noise in the Experimental Data

To reinforce Table 7 that biases exist, Table 8 reports one-sample t-test which indicates significant differences between experimental data and theoretical predictions. For NoDeter treatment, the test rejects null hypothesis at 1% level of significance, confirming a negative bias. For Deter and DeterPenalty treatments, the test also rejects the null hypothesis at 1% level of significance. This implies that sabotage behavior in the 2 settings exceed the predictions. For DeterInspect treatment, the test only rejects the null hypothesis at 5% level of significance, indicating a more subdued positive bias in this case.

Table 8
One-sample t-test, comparing experimental data and theoretical predictions

Game	Hypothesis	Critical value	$\Pr(T < t)$	$\Pr(T > t)$	$\Pr(T > t)$
Game 1 (NoDeter)	$H_0: \text{mean} = 10$ $H_a: \text{mean} < 10$	$t = -11.0726$	0.0000***	0.0000***	1.0000
Game 2 (Deter)	$H_0: \text{mean} = 3.67$ $H_a: \text{mean} > 3.67$	$t = 3.4926$	0.9997	0.0005***	0.0003***
Game 3.1 (DeterPenalty)	$H_0: \text{mean} = 3.06$ $H_a: \text{mean} > 3.06$	$t = 6.0035$	1.0000	0.0000***	0.0000***
Game 3.2 (DeterInspect)	$H_0: \text{mean} = 2.03$ $H_a: \text{mean} > 2.03$	$t = 1.8289$	0.9655	0.0691*	0.0345**

Source: Author's calculation

*indicates 10% level of significance, ** indicates 5% level of significance, *** indicates 1% level of significance.

The theoretical prediction that a rational utility maximizer would choose maximum sabotage in NoDeter treatment ($\bar{s} = 10$) is invalidated. There exists heterogeneity in the sabotage behavior; while some subjects chose maximum sabotage level, a group chose a suboptimal level of sabotage. Two subjects chose zero level of sabotage for all periods even when there is no deterrence incentive. Choosing sabotage below $\bar{s} = 10$ in NoDeter treatment is to play a ‘dominated strategy’. This might have occurred because humans may not be ‘purely selfish’ as claimed by an economic theory. Other studies (i.e. see stealing game by Schildberg-Hörisch & Strassmair, 2012) have also found a similar ‘prosocial’ behavior which contradicts theoretical predictions. Presumably, even though this competition is a non-cooperative game, not all subjects want to win by unfair means. Hence, the ‘supposedly irrelevant factor’ in the economic model results in a negative bias in the behavior in NoDeter treatment.

On the other hand, sabotage behavior in treatments with deterrence incentive exhibits positive bias. The data shows that when there is threat of punishment, subjects either reduce their sabotage or sabotage more highly. While reducing level of sabotage is intuitive, those who sabotage more highly do so owing to the need to compensate for the risk of detection itself. In other words, when disincentive is in place, there is a tendency that less people will sabotage, but those who decide to sabotage intensify their activity to compensate the risk born.

Another plausible explanation for the prevalence of positive bias in sabotage behavior may exist on account of cognitive biases known as “self-serving bias” and “optimism bias”. Self-serving bias refers to a tendency for people to attribute an occurrence of positive events to be intrinsic, while attributing negative events to extrinsic factors. This

cognitive dissonance is quite common (i.e. we often account our success on how hard we work but blame misfortune when we fail). Optimism bias refers to a tendency for people to have unrealistic optimism. Studies in psychology and neuroscience have found that people are more likely to be overoptimistic and anticipate outcomes in their own favor. For instance, we are more likely to overestimate the chances of good events (i.e. success, marriage, promotion, winning lottery) but underestimate the chances of bad events (i.e. failure, divorce, getting fired, losing a bet).

In the light of these biases, participants may suffer from the illusion that they may not be caught. Put differently, they may underestimate probability of bad outcome (getting inspected and detected), and thus think that they will not be caught. This finding is in line with that of Nagin and Pogarsky (2003) who found that subjects who suffer from self-serving biases are more likely to cheat in their experiment. This is why in Deter and DeterPenalty treatments, where probability of inspection is low, positive bias is more pronounced, compared to DeterInspect treatment where probability of inspection is higher.

In addition to the self-serving and optimism biases, motivational crowding may play a role in the biased decision-making. Intrinsic motivation may influence decision making when there is no deterrence incentive. However, implementing deterrence incentive interferes with subjects' intrinsic motivation, shifting their attention to extrinsic ones. In effect, subjects become less inclined to play fair when they are being monitored. This finding is in line with literatures pertaining to motivation crowding theory⁸. Since the net effect of deterrence incentive is ambiguous, this may have caused biases in the experimental data.

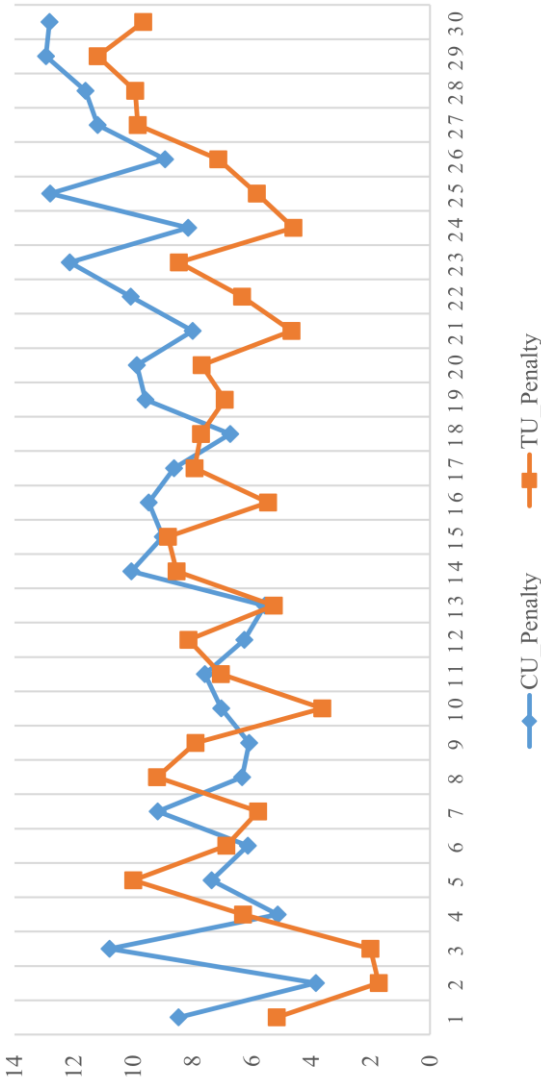
⁸ See Tversky and Kahneman (1986)

3.2.1. *Variances and Adjustment Towards Social Norm*

The experimental findings also shed light on behavioral adjustment towards a social norm. Figure 2, 3 and 4 exhibit variances in the sabotage levels chosen in each period. Upon observation, variances of sabotage in NoDeter and Deter are somewhat similar; variances fluctuate but stabilize at a high level. However, the patterns of variance start to diverge at around period 23. In sessions with DeterPenalty as Game 3 (see Figure 2), the pattern of variance is upward. On the other hand, in sessions with DeterInspect as Game 3 (see Figure 3), the pattern is downward. F-test confirms that variances of DeterPenalty are significantly higher than those of DeterInspect at 1% level of significance ($F(379,179) = 1.5188, p = 0.0008$).

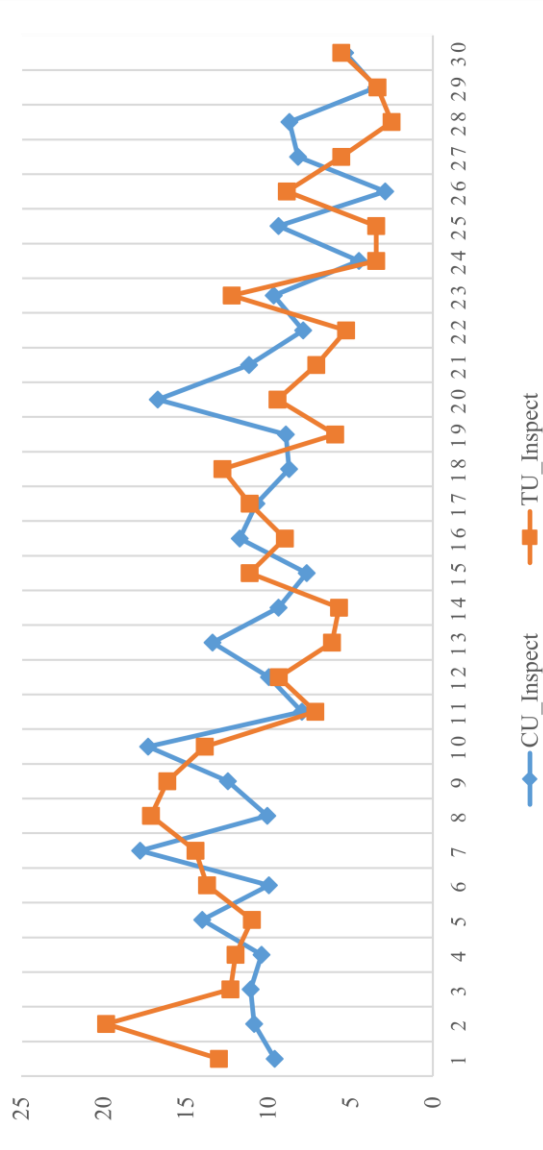
Fluctuation and divergence suggest that people adapt their strategies given the institutional setting. Different games represent different monitoring and sanctioning institutions. In NoDeter treatment, subjects tend to converge to a sabotaging strategy. As time passes and the majority of participants choose to sabotage, the action establishes a “culture” for the society. If the subject does not sabotage, he loses the competitive advantage and falls behind his peers. Hence, subjects conform to the society. Even in Deter treatments, the pattern of sabotage is similar to that of NoDeter. Participants react to deterrence incentive by reducing sabotage level, but as expected punishment is low, sabotaging is still a norm in the society. Sabotage behavior differs in DeterPenalty and DeterInspect treatments. It can be seen from Figure 2 that variance of sabotage in DeterPenalty escalates towards the end of the game. High variance can be interpreted in such a way that subjects are segregated into two groups; those who continue to sabotage intensively and those who adapt by cutting back on their sabotage.

Figure 2
Variances of sabotage in sessions 1 and 3 (with DeterPenalty as Game 3)



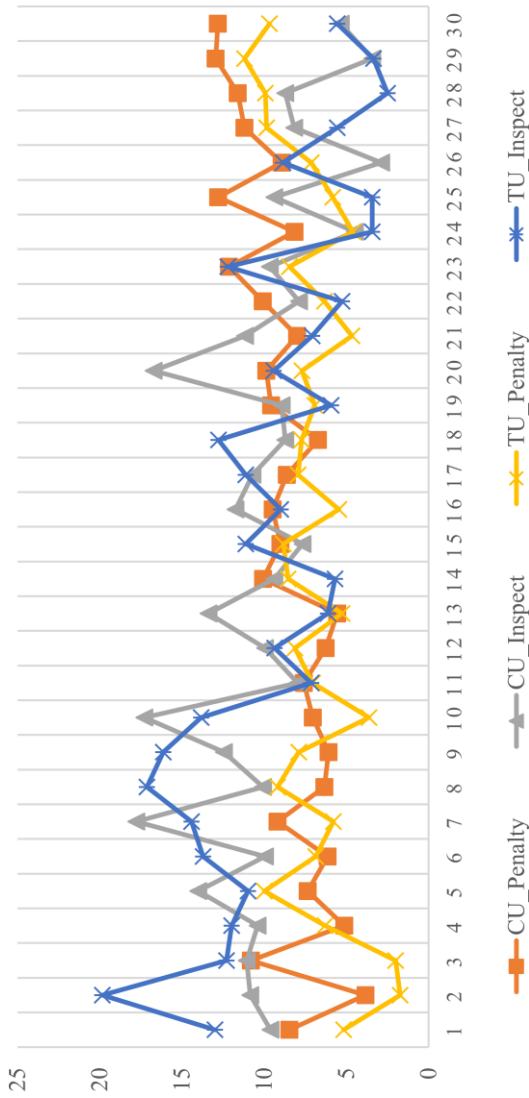
Source: Author's illustration

Figure 3
Variances of sabotage in sessions 2 and 4 (with DeterInspect as Game 3)



Source: Author's illustration

Figure 4
Variances of sabotage in all sessions



Source: Author's illustration

In contrary, variance of sabotage in DeterInspect gradually descend to a low level towards the end of the game. As probability of inspection is high in this game, majority of the subjects adapt their strategy more quickly and therefore approach a new social norm- “exerting low sabotage”. This may be because deterrence incentive in Deter and DeterPenalty is not powerful enough, rendering the law enforced illegitimate in the eyes of the saboteurs. On the other hand, high inspection imparts legitimacy to the law enforcement and thereby brings about low level of sabotage in the society.

3.3.Panel Regression Analysis

To further support the findings, Table 9 reports random effect regressions for all periods. Time-lag of sabotage is included to examine whether subjects’ decision making display any focalism (i.e. anchoring). A time-lag dummy variable indicating if a subject has been caught in period $t - 1$ sheds light on the effect of getting caught on sabotage decision. Other independent variables include demographic variables including gender, age, and dummy variables to control for treatment effects (Deter, DeterPenalty and DeterInspect respectively). In addition, an interaction term of gender and time-lag dummy variable of getting caught is included to find out the effectiveness of punishment based on gender differences. Degree of risk aversion has been dropped from the model as 16 participants made irrational decisions, rendering their degrees of risk aversion unmeasured. Irrational decisions can be detected in Holt and Laury form for those who switch back and forth between safe to risky options.

Table 9
Linear Random-Effects Regressions: Testing treatment effects on sabotage behavior

Independent variables	Dependent variable: $s_{i,t}$ (sabotage level)
$s_{i,t-1}$ (continuous, time lag)	0.6334*** (0.0188)
$caught_{i,t-1}$ (dummy, time lag)	-1.2116*** (0.3063)
$gender$ (dummy)	0.0347 (0.1151)
$caught_{i,t-1} \times gender$ (Interaction of dummy variables)	1.1087*** (0.4092)
age (continuous)	0.0583* (0.0334)
$Game\ 2$ (dummy)	-1.8835*** (0.1580)
$Game\ 3$ (dummy)	-1.6414*** (0.1775)
$Inspect$ (dummy)	-0.7045*** (0.2001)
Constant	1.8162** (0.7655)
R^2	0.5990
Individuals	56
No. of observation	1624

Source: Author's calculation

Note: The observation is a subject's sabotage level in a period. Treatment NoDeter (Game 1) is the baseline case. Standard errors are given in the parentheses, *indicates 10% level of significance, ** indicates 5% level of significance, *** indicates 1% level of significance.

Our finding suggests that subjects are persistent with their choice of sabotage. The time-lag of sabotage is highly significant. Time-lag dummies for getting caught suggest that the effect of punishment is effective. When subjects are caught, they reduce sabotage level in the following period due to fear. As for the demographic variables, age is significant at 10% level, which suggests that older samples tend to sabotage more highly. Dummies for Game 2 and Game 3 are highly significant, confirming existence of treatment effects; sabotage level in Deter, DeterPenalty and DeterInspect treatments are lower relative to NoDeter treatment. The dummy *Inspect* additionally breaks down the treatment effect for DeterInspect. The result reports significant treatment effect which suggests that an increment in probability of inspection can further curb sabotage behavior.

One interesting finding is related to gender and the effectiveness of punishment. Even though the dummy variable *gender*, which takes the value 1 for male participants, is insignificant, its interaction term with time-lag of getting caught is significant at 1% level. In effect, a male participant who has been caught in period $t - 1$ reduces sabotage in period t by -0.1029, while the female counterpart who has been caught reduces sabotage by -1.2116. This finding implies that the effectiveness of punishment on gender differences is asymmetric. In other words, the same punishment is more effective on female participants.

3.4. Interpretation of Findings

The findings of this study are in line with others in the field of behavioral economics and laws, in particular to those focusing on deterrence incentive and crimes. Overall, the findings support Becker's deterrence hypothesis. Extrinsic

deterrence incentive reduces sabotage behavior in a competitive setting. However, analysis of the experimental data confirms the relative strength of inspection but finds no significant effect of increasing magnitude of penalty.

There are, however, noises in the experimental data. In NoDeter treatment, sabotage level is significantly lower than the prediction. This negative bias may stem from subjects' intrinsic motivation. Nonetheless, when deterrence incentive is implemented, subjects abandon intrinsic motivation and focus on the extrinsic motivation (i.e. 'how to win under such circumstances'). This has, therefore, caused a positive bias in treatments with deterrence incentive, especially in Deter and DeterPenalty treatments, where probability of inspection is low. Subjects effectively 'self-select' their own strategy. While some subjects reduce sabotage in fear of getting caught, those who decide to sabotage do so more aggressively to compensate for the risk of getting caught. In addition, positive bias may also stem from self-serving bias and optimism bias. Participants may underestimate the likelihood of getting caught and think that situation is in their favor. Also, penalty is conditional on inspection and detection. When probability of inspection is low, detection and magnitude of penalty may become irrelevant for some subjects. They may perceive punishment to 'not occur after all' because getting punished requires 'inspection' as well as 'detection' to occur. On the other hand, there is relatively lesser positive bias in sabotage behavior in DeterInspect treatment, where probability of inspection is high. As punishment also includes revoking the right to win high prize, it is better for subjects to play safe by reducing sabotage level. Thus, by cutting back on sabotage level, subjects maintain the right to win.

Furthermore, panel regression sheds light on the behavioral responses of participants in the game. Based on

the findings, sabotage decision is anchored. In their mind, subjects evaluate their own strategy using the information given. Saboteurs immediately cut down their sabotage level in the period following the detection. In addition, female participants cut down more level of sabotage after they have been caught. This finding is in line with literatures related to gender differences. Many studies found that females tend to display lesser degree of risk-taking behavior when compared to males. Mather and Lighthall (2012) confirmed that under a stressful condition, males are more likely to take more risky decisions compared to females due to the fact that there are gender differences in brain activity that engages in evaluation of risk (Sundheim, 2014). Charness and Gneezy (2012) analyzed data from 15 investment games and found that women are more financially risk averse compared to men.

Finally, our findings are in line with studies pertaining to institutional economics and law enforcement in the society. Cooperative environment cannot be sustained in a sanction-free society because there is no law enforcement. Subjects feel compelled to sabotage as it is a social norm and not doing so deprives them of the competitive advantage in the contest. However, low inspection does not reduce sabotage either as the enforced rule is not perceived as legitimate. Social dilemma, which is to have contestants sabotaging heavily, is resolved by implementing appropriate scheme of deterrence incentive. In our case, high inspection is a key towards a fairer tournament. Though deterrence incentive cannot fully discourage sabotage behavior in tournament, it redirects individuals' flow of decisions and strategies towards a new social norm (Henrich, 2006).

4. Conclusion, Policy Implications, and Limitations

4.1. Conclusions

This research aims to test the impact of extrinsic deterrence incentive on sabotage in Lazear and Rosen's (1981) rank-order tournament by conducting a laboratory experiment. In the tournament with sabotage, players can increase their chance of success either by exerting productive or destructive efforts. By allowing players to sabotage their opponents, tournament theory mimics one 'additional' dimension of human nature- some people play unfair in order to win the contest.

Theoretically, this study tests a 2-player tournament with sabotage extension and follows a deterrence incentive in Gilpatric (2011). Players are inspected by a perfectly correlated auditing system. In case of inspection, the chance that contestants are detected depends on the sabotage level chosen. If detected, a caught saboteur loses by default (i.e. receive low prize and suffer outside penalty). This, by effect, implies that the opponent wins high prize irrespective of relative output levels. In the case that both players are detected, they both are penalized.

The experimental results support Becker's (1968) deterrence hypothesis that punishment reduces crime. However, sabotage in DeterPenalty treatment is similar to that of Deter treatment, whose punishment is relatively lighter. On the other hand, sabotage behavior is lower in DeterInspect, compared to DeterPenalty treatment despite equivalence of expected punishment. Therefore, this study finds that inspection is relatively better in curbing sabotage behavior. This is because by increasing the probability of inspection and keeping magnitude of penalty low, there is higher chance of triggering detection system, which

eventually leads to higher chance of getting detected if subjects do not alter strategy.

Nonetheless, there exists heterogeneity in choice of sabotage. Even in NoDeter treatment when there is no punishment, some subjects play a dominated strategy by choosing low levels of sabotage. This accounts for the negative bias in NoDeter treatment. Similar to other studies, participants display others-regarding preferences and may choose not to hurt others. Additionally, since NoDeter is a control treatment, the intrinsic motivation contributes to subjects' decision making in a meaningful way.

On the other hand, sabotage behavior in treatments with deterrence incentive possesses a considerable degree of positive bias. This can be accounted from the fact that announcing about punishment interferes with subjects' intrinsic motivation and causes them to pay more attention to an extrinsic one. Furthermore, when deterrence incentive is introduced, subjects are segregated into 2 groups; those who exert low sabotage, and those who sabotage more intensively to compensate for the risk of detection. Positive bias exists in a greater deal in Deter and DeterPenalty treatments. Since rate of inspection is low, subjects may experience an illusion caused by self-serving bias and optimism bias. These biases are known to cause people to overestimate chances of good outcomes and underestimate risks. Thus, positive bias in DeterInspect treatment exists in a smaller degree as inspection is high.

As a final note, the findings reveal an insight about law enforcement and social order. Without punishment, sabotage is a social norm. Though some subjects choose low sabotage, they are overwhelmed by those who sabotage highly. However, a new social norm (i.e. low sabotage) can be achieved with an efficient punishment system. As high inspection brings about low level of sabotage, it can then be

concluded that sabotage level will be low if and only if subjects perceive the enforced rule as legitimate. If subjects do not perceive the legitimacy of punishment, implementing punishment fails to alter maladaptive behavior.

4.2. Policy Implications

Certain policy implications can be drawn from this study. As tournament is a non-cooperative game, participants may resort to all kinds of actions to increase their chance of success. Contest designers and practitioners in personnel management should take into account the possibility of sabotage behavior in tournament. This loophole in tournament should be filled to make it ‘fair’ for players who do not display rent-seeking and destructive behaviors.

Sabotage can be reduced significantly by implementing an efficient punishment system to achieve a desirable outcome. Contest designers should also consider legitimacy of the punishment scheme. Weakly enforcing a rule for ‘the sake of having it’ cannot curb sabotage behavior among contestants. Our findings suggest that high inspection drives down sabotage as it imparts credibility and legitimacy of the enforced rule. When imposed rule and regulations are perceived as legitimate, people are more likely to conform to them. Thus, contestants should perceive that they would be inspected regularly so that they keep sabotage to the minimum.

In addition, the rule that ‘anyone who is found to have used unfair measures to augment the chance of winning will lose by default’ is extremely effective in the sense that contest designer automatically makes the cost of sabotage high. After all, the aim of participating in a tournament is to win high prize. Hence, putting high prize at stake creates a

dynamic that reverses contestants' strategy, nudging them to lessen the degree of unfair play.

Nonetheless, inspection in the real environment requires the principal to expend resources. Thus, principal should find an optimum to balance between cost and benefit of inspection. Despite the effectiveness of inspection, announcement of the level of punishment is relatively less costly compared to implementation of an inspection system.

4.3.Limitations and Recommendations for Further Studies

This study possesses several limitations, which can be improved in the future. Unlike most experimental studies, incentive used in this study is non-monetary incentive. Starbucks Gift card is not universally acceptable like cash. Starbucks Gift card is also indivisible and less liquid compared to cash. Nonetheless, 50% of the participants mention their desire to win the prize while 34% mention their desire to win the game (not prize).

However, the issue does not entirely associate with using Starbucks Gift card as an incentive, but with the distribution of incentive. The values of Starbucks Gift cards are unequal. Such prize distribution creates unbalanced incentive for the participants. While some subjects strategically behave to win the prize, others may not put in effort to play the games because incentive is unevenly distributed. Cash payment would solve this limitation as it is divisible. Monetary incentive can be structured in such a way that all subjects are incentivized.

Other limitations arise from experimental protocol. For instance, the number of participants across sessions is unequal. While Kruskal Wallis test confirms that all sessions are comparable since samples exert similar level of efforts in the Slider task, it is more ideal to have equal number of

subjects across sessions. This result can also be enhanced by recruiting larger samples.

There are potential areas regarding different designs and rules to discourage sabotage in tournament. For instance, in promotional tournament, caught saboteurs may be removed from the contestant pool for certain time periods as a result of bad reputation. Contest organizers usually share information regarding unfair players, which imposes high cost on the saboteur. Further analysis about the relationship of cognitive biases and sabotage behavior would clarify the causes of noise in the experimental data. Another issue of interest concerns principal's decision in choosing kinds of punishment since inspection is costly in the real world. Design of the game can be innovated to replicate real world situations, which can potentially further the area of experimental paradigm to represent the world.

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