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Discretionary Sanctions and Rewards in the Repeated Inspection Game

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We experimentally investigate a repeated "inspection game" where, in the stage game, an employee can either work or shirk and an employer simultaneously chooses to inspect or not inspect. The unique equilibrium of the stage game is in mixed strategies with positive probabilities of shirking/inspecting while combined payoffs are maximized when the employee works and the employer does not inspect. We examine the effects of allowing the employer discretion to sanction or reward the employee after observing stage game payoffs. When employers have limited discretion, and can only apply sanctions and/or rewards following an inspection, we find that both instruments are equally effective in reducing shirking and increasing joint earnings. When employers have discretion to reward and/or sanction independently of whether they inspect, we find that rewards are more effective than sanctions. In treatments where employers can combine sanctions and rewards, employers rely mainly on rewards, and outcomes closely resemble those of treatments where only rewards are possible.

Data, as supplemental material, are available at http://dx.doi.org/10.1287/mnsc.2014.2124.

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1. Introduction

In this paper we compare the effectiveness of positive and negative incentives in an inspection game. This game is often used to represent strategic settings characterized by an imperfect alignment of interests between players (e.g., interactions between employers and employees, tax authorities and taxpayers, regulators and firms, law enforcement agencies and citizens, etc.).[1] Note that these settings typically have a hierarchical structure: an authority wishes to induce compliance from subordinates. A standard approach to encourage compliance is to use explicit contracts that specify automatic and fixed penalties in response to observed noncompliance. For example, labor contracts may specify penalties for employees who are found to underperform or violate the company's conduct policy. In addition to automatic incentives, authorities may also use *discretionary incentives* to align subordinates' interests with their own. For example, in the labor context, the nature and severity of the sanctions relating to underperformance may vary from verbal and written warnings to dismissal, and employers often have discretion over which disciplinary actions (if any) to take against employees. Moreover, in many settings authorities complement the use of sanctions for poor performance with the use of automatic and/or discretionary rewards. For example, again in the labor context, employers may decide to introduce bonus schemes to reward good performance. Such schemes can vary from those where bonuses are part of the employee's contractual entitlement to those where bonuses are awarded on a discretionary basis to motivate employees. Rewards

[1] See Avenhaus et al. (2002) for a review of the theory and discussion of applications of inspection games.

can also be given in the form of perks, such as public recognitions of contribution (e.g., employee of the month awards), and other nonmonetary benefits.

We conduct an experiment to study the roles of sanctions and rewards. Our experiment builds on the standard inspection game discussed in Fudenberg and Tirole (1991). They discuss a one-shot interaction between an employee who chooses whether to work or shirk and an employer who simultaneously chooses whether or not to inspect the employee. Working is costly to the employee and generates revenue for the employer. Inspections are costly to the employer. The employee receives a wage from the employer unless she is inspected and found shirking: in this case the employer automatically withholds her wage. This can be interpreted as a contract where the employee is paid a flat wage conditional on working. To enforce the contract, the employer needs to provide verifiable evidence of shirking to the court, and costly inspections are necessary for providing verifiable evidence. Joint payoffs are maximized when the employee works and the employer does not inspect, but in the unique mixed-strategy Nash equilibrium of the one-shot game inspections and shirking occur with positive probability. Thus, *automatic* incentives alone are not sufficient to eliminate shirking in equilibrium.

Our focus is on a repeated version of this game, and how the use of *discretionary* rewards and/or sanctions, on top of the automatic sanctions embedded in the inspection game, can discourage shirking. In practice, the scope for using discretionary incentives varies considerably across institutional settings, and so we vary the scope across various treatments.

In a Baseline treatment, where discretionary incentives are not available, we find substantial rates of inspection and shirking: the proportion of inspections is 70% and employees shirk about 46% of the time. In our other treatments, we allow employers to sanction or reward employees after observing stage game payoffs. Both sanctions and rewards are costly for the employer, whereas sanctions reduce, and rewards increase, the employees' payoff.

In one set of treatments, we only allow the use of sanctions or rewards after the employer has inspected. Thus, although payoffs reveal the employee's actions, the employer has discretion to reward workers or punish shirkers only if an inspection has been carried out to provide complementary evidence about the employee's action. For instance, a manager who wants to punish a slacking employee may be compelled to create a track record to justify the intended punishment to a labor union. Similar forms of limited discretion are commonplace in performance evaluation schemes in many organizations where performance appraisers are themselves agents in a principal-agent relationship with a principal. Even though the appraiser knows the appraisee has performed well, some costly monitoring process has to be used before the appraiser can award a discretionary bonus. For example, this may be the case in firms where managers who exercise reward or punishment power over subordinates are themselves accountable to superiors for their decisions.

In these limited discretion treatments, we find that the availability of either sanctions or rewards reduces the proportion of shirking relative to the baseline treatment (to 29% in both cases). In the treatment with sanctions this is achieved with a lower inspection rate than in the treatment with rewards. An implication of this is that sanctions or rewards increase combined earnings by roughly the same amount, but the efficiency gains accrue solely to the employer when sanctions are available, whereas the efficiency gains are shared in the case of discretionary rewards. We think this is a direct consequence of the nature of the incentive tools; rewards allow the employer to redistribute part of the efficiency gains, whereas this is not possible with sanctions.

One feature of the limited discretion treatments is that if the employer wants to reward the worker for working, she needs to inspect and incur the associated inspection costs. This makes a strategy of encouraging work by rewarding workers less efficient, and so our limited discretion treatment may underestimate the efficacy of rewards. In another set of treatments, we allow the employer to administer discretionary rewards or punishments independently of whether the employer inspected. This set of treatments is relevant for situations where employers do not have to justify their behavior to a principal, as may be the case in owner-managed firms where managers do not have to explain their use of discretionary rewards or punishments to a superior.[2]

We find that extending the employer's discretion in this manner does not alter the effectiveness of punishment, but increases the effectiveness of discretionary rewards. When employers are free to use discretionary rewards without the need for inspections, the rate of shirking drops to 15%. As a result, rewards are more effective than punishment in the high discretion treatments. As in the limited discretion treatments, the efficiency gains of punishments only benefit the employer, whereas with rewards, the greater increase in combined earnings is shared much more equally.

To compare the effectiveness of discretionary rewards and sanctions, our experiment varies the availability of the instruments across treatments, and

[2] We thank an associate editor for suggesting these additional treatments.

employers have available, at most, one of the instruments. In natural workplaces both instruments are often available to employers. Thus, we conducted additional treatments where employers can combine discretionary sanctions and rewards. In these treatments we find that employers rely mainly on rewards, and the results from these treatments are very similar to the treatments where only rewards are available.

In summary, our findings suggest that both positive and negative discretionary incentives can be effective in disciplining the behavior of subordinates and increasing efficiency. However, the two instruments work quite differently and their relative merits depend on how freely they can be administered. From an efficiency perspective, sanctions involve an obvious disadvantage relative to rewards, in that punishment is costly to both the punisher and punishee. If the threat of sanctions eliminates shirking, then punishment is not necessary and these deadweight costs can be avoided, but if the threat works imperfectly, the loss of efficiency is compounded by the costs of having to use the instrument. In contrast, if rewards successfully motivate subordinates, then they must be actively used. In our setting, rewards increase combined earnings, although if employers need to engage in costly inspections in order to administer rewards, then these costs undermine the efficacy of rewards.

The remainder of this paper is organized as follows. In the next section we introduce the inspection games used in our experiment and in §3 describe our design and experimental procedures. We present our experimental results in §§4 and 5. In §6 we discuss how our findings relate to the literature in more detail, and we conclude.

2. The Inspection Game

The inspection game involves two players and simultaneous moves. The employer chooses between "inspect" and "not inspect," and the employee chooses between "work" and "shirk." In the standard version of the game, the employer incurs a cost of h from inspecting. If the employee works, the employee incurs a cost of c and the employer receives revenue of v. If the employer does not inspect, the employee always receives a wage of w. If the employer inspects, the employee receives the wage only if she works. The resulting payoffs are shown in Figure 1(a). We assume that all variables are positive and $v > c$, $w > h$, $w > c$. Note that joint payoffs are maximized when the employee works and the employer does not inspect. In the unique Nash equilibrium, the employer inspects with probability $p = c/w$ and the employee shirks with probability $q = h/w$. The employer receives an expected payoff of $\pi^{\text{employer}} = v - w - hv/w$, the employee receives an expected payoff of $\pi^{\text{employee}} = w - c$, and joint payoffs are $\pi^{\text{employer}} + \pi^{\text{employee}} = v - c - hv/w$.

Figure 1 **Inspection Game**

(a) Standard inspection game

	Work	Shirk
Inspect	$v-w-h$ / $w-c$	$-h$ / 0
Not inspect	$v-w$ / $w-c$	$-w$ / w

(b) Experimental inspection game

	Work	Shirk
Inspect	30 / 20	10 / 15
Not inspect	45 / 20	5 / 35

Notes. Employer is ROW player, employee is COLUMN player. Within each cell, the employer's payoff is shown at the top and the employee's payoff at the bottom.

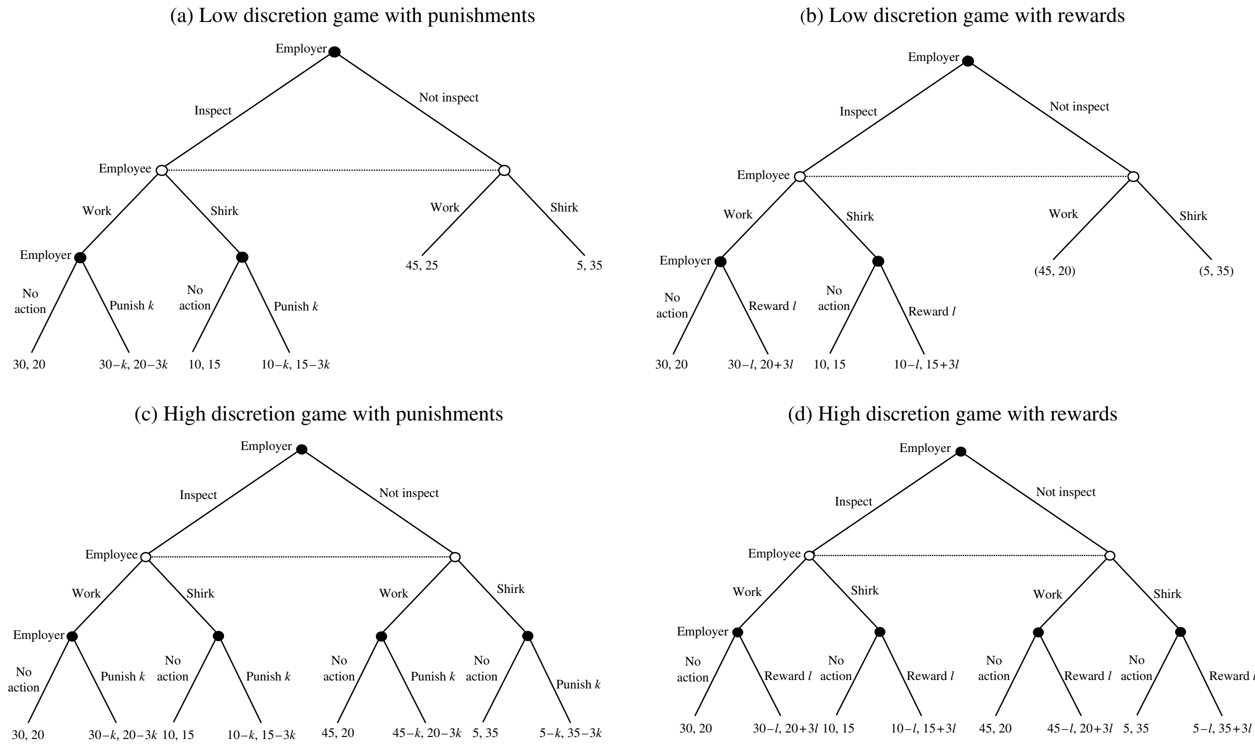
For the experiment, we set $v = 40$, $w = 20$, $c = 15$, and $h = 15$ and added a constant of 15 to the employee's payoff and 25 to the employer's payoff to ensure that all earnings are positive. Figure 1(b) presents the resulting payoffs that we used in the experiment. With these parameters, the employer's equilibrium inspection probability is $p = 3/4$ and the employee's equilibrium shirking probability is $q = 3/4$, giving expected payoffs of 15 for the employer and 20 for the employee. This inspection game is the stage game in our baseline treatment.

In our treatments with low discretionary power, if the employer has chosen "not inspect," the stage game ends. However, if the employer chose "inspect," the stage game continues. In the games where we allow for punishments, the employer observes the employee's choice and then chooses between "no action" and punish." If he chooses "no action," then the payoffs are simply determined by the payoffs of the inspection game. If he chooses "punish" he must assign a punishment level k from the set {0, 1, 2, 3, 4, 5} and the employer's payoff from the inspection game is then decreased by k and the employee's payoff is decreased by $3k$. Thus, these discretionary punishments are costly for both parties and have a negative direct impact on combined earnings.[3] Figure 2(a) presents this augmented game graphically.

Similarly, in the games where we allow for rewards, the employer can choose between "no action" and "reward" after an inspection. If he chooses "reward," he then chooses the reward level l from the set {0, 1, 2, 3, 4, 5} and the employer's payoff from the inspection game is then decreased by l while the

[3] Except, of course, in the case where the employer assigns zero punishment. We decided to include this in the set of available punishments because it may be useful for signaling purposes in settings where the game is played repeatedly, e.g., an employer might assign zero punishment tokens as a warning.

Figure 2 Augmented Inspection Games



Notes. The first payoff accrues to the employer and the second payoff to employee. When choosing k (or l), the employer is informed of whether the worker worked or shirked, and therefore can choose a different k (or l) after work than after shirk.

employee's payoff is increased by $3l$.[4] Note that the use of rewards can increase combined earnings; a maximal reward costs the employer 5 points and benefits the employee 15 points, giving a net benefit of 10 points. Note, however, that rewards can only be given following an inspection, and the inspection cost (15 points) exceeds the net benefit from maximal rewards. Thus, combined earnings are still maximized when the employee works and the employer does not inspect. The augmented game with reward possibilities is shown in Figure 2(b).

In our high discretion treatments, the employer can assign punishments or rewards independently of whether he inspects. The extensive forms of the stage game are shown in Figures 2(c) and 2(d).

Subgame perfect equilibria of the augmented games can be identified by backward induction. A selfish and rational employer will never assign positive rewards or punishments since it lowers her own payoff. This behavior is anticipated by the players, and, as a result, play in the phase preceding the punishment/reward phase remains unaffected. Thus, in the subgame perfect equilibrium, players mix between their actions in precisely the same way as in the baseline treatment, i.e., $p = 3/4$ and $q = 3/4$, and discretionary rewards or punishments are never used.

In naturally occurring workplace settings, and in our experiment, employers and employees are usually engaged in a repeated interaction. Here, we consider the case where in each stage the game described above is played and where a player's earnings are simply the sum of his earnings over all stage games. After each stage game, there will be a new stage game with independent probability δ and this process continues until it is terminated by chance. As is well known, repetition of the stage game equilibrium constitutes a subgame perfect equilibrium of the indefinitely repeated game, but other outcomes can be sustained as equilibria as well.

First, consider the Baseline game where punishment and rewards are not possible. Repetition of the joint payoff maximizing outcome cannot be sustained in equilibrium. To see this, note that for any pair of strategies yielding the outcome "not inspect, work" in every stage, and hence a payoff of 20 for the employee in every stage, the employee can deviate to a strategy

[4] We also conducted low discretion sessions where the impact/fee ratio (i.e., the cost/benefit of the instrument to the employee relative to the cost of instrument to employer) was one to one. These treatments did not result in significant differences from Baseline in terms of either shirk rate, inspection rate, employer payoff, or employee payoff. See Nosenzo et al. (2012) for details. Several public good experiments also find that costly punishment/reward is more effective with a higher impact/fee ratio (e.g., Ambrus and Greiner 2012, Egas and Riedl 2008, Nikiforakis and Normann 2008).

that specifies shirking in the first stage and working in all subsequent stages. This deviation is profitable since it yields 35 in the first stage and 20 in all subsequent stages.

However, even if the joint-payoff maximizing outcome cannot be fully achieved it can be approximated rather closely by subgame perfect equilibrium strategies. Consider the following strategies: On the equilibrium path, the employer does not inspect and the worker shirks every nth stage. If the worker shirks in any other stage, or if the employer ever inspects, both players revert to the one-shot Nash equilibrium in all stages thereafter. These strategies generate a cycle of outcomes where "not inspect, work" occurs except for every nth stage when "not inspect, shirk" occurs. The expected sum of payoffs from the beginning of the cycle is $V_{\text{cycle}}^{\text{employer}} = 45/(1-\delta) - \delta^{n-1}40/(1-\delta^n)$ for the employer and $V_{\text{cycle}}^{\text{employee}} = 20/(1-\delta) + \delta^{n-1}15/(1-\delta^n)$ for the employee. Letting $V_{\text{Nash}}^{\text{employer}} = 15/(1-\delta)$ and $V_{\text{Nash}}^{\text{employee}} = 20/(1-\delta)$ be the expected sums of payoffs from one-shot Nash equilibrium play, the cycle strategies form a subgame perfect Nash equilibrium if

$$V_{\text{cycle}}^{\text{employee}} \geq 35 + \delta V_{\text{Nash}}^{\text{employee}} \quad \text{and}$$
$$5 + \delta V_{\text{cycle}}^{\text{employer}} \geq 10 + \delta V_{\text{Nash}}^{\text{employer}}.$$

The first inequality ensures that the employee has no incentive to deviate at the beginning of the cycle (as he approaches the end of the cycle any incentive to deviate only diminishes). The second ensures that the employer has no incentive to deviate at the end of the cycle. As δ increases, these constraints can be met with larger n, and the relative frequency of attaining the efficient stage game outcome approaches one.

Similarly, when employers can only reward following an inspection, the indefinitely repeated game does not have a fully efficient subgame perfect equilibrium, but there are analogous subgame perfect equilibrium strategies that cycle between "not inspect, work" and "inspect, work" and improve on the one-shot equilibrium for both players. As δ increases the relative frequency of attaining the efficient stage game outcome approaches one.

For our other treatments, the efficient outcome can be supported by subgame perfect equilibrium strategies. When employers can reward independently of whether they inspect, the efficient outcome is "not inspect, work" followed by maximal rewards, giving the employer a stage payoff of 40 and the employee a stage payoff of 35. This outcome can be supported by simple Nash reversion strategies. The employee never has an incentive to deviate from working, the employer never has an incentive to inspect, and as long as $40/(1-\delta) \geq 45 + \delta 15/(1-\delta)$, or, equivalently, $\delta \geq 1/6$, the employer has no incentive to withhold the reward. When employers can punish (either following an inspection, or independently of whether they inspect) it is possible to attain repetition of the efficient outcome "not inspect, work" in a subgame perfect equilibrium, because punishment allows the employer to reduce the employee's stage payoff below 20, and this can then serve as a threat that induces the employee to work. If the employee shirks in a stage, a disciplinary phase will start in which the employer persistently chooses to inspect and to assign punishment points. In this phase, the employee's stage game payoff is reduced below 20 and if the discount factor is sufficiently high, the employee will prefer to work if she faces this threat.[5] On the equilibrium path the outcome "not inspect, work" is observed in every stage, punishment is not actually used, and all of the efficiency gains relative to the one-shot equilibrium accrue to the employer.

3. Experimental Design and Procedures

The computerized experiments were carried out at the University of Nottingham with 178 subjects recruited from a campus-wide distribution list.[6] No subject participated in more than one session. Three sessions were conducted for each of five treatments, with either five or six pairs of participants in a session. Sessions consisted of a number of rounds, and at the end of a session subjects were paid in cash according to their accumulated point earnings from all rounds. Sessions took about 40 minutes on average and earnings ranged between £5.65 and £23.20, averaging £13.21.

At the beginning of a session subjects were randomly assigned to computer terminals and given paper copies of instructions, which an experimenter then read out loud. The instructions concluded with a series of questions testing subjects' understanding of the instructions. Answers were checked by the experimenters, who dealt privately with any remaining questions. During a session, no communication between subjects was allowed.

After the instructional phase, subjects were assigned to pairs and roles. Within each pair, one subject received the role of employer and the other the role of employee.[7] Subjects knew that they would stay in the same role and in the same pair during the

[5] For details, see Nosenzo et al. (2012).

[6] Subjects were recruited through the online recruitment system ORSEE (Greiner 2004). The instructions to subjects that were used in the experiment are reproduced in Online Appendix A (available as supplemental material at http://dx.doi.org/10.1287/mnsc.2014.2124).

[7] The actual labels used in the experiment were "employer" and "worker."

whole experiment. They were informed that the session consisted of at least 70 rounds. From round 70 onward, each round could be the last one with probability 1/5.[8]

In each treatment, at the beginning of a round, the employee chose between "high effort" (work) and "low effort" (shirk) and, at the same time, the employer chose between "inspect" and "not inspect." Choices led to point earnings as presented in the right panel of Figure 1. In the Baseline treatment these were the only choices made in the round, and subjects were immediately informed about the choices and point earnings within their pair.

The other treatments varied from the Baseline treatment in the instruments available to employers for incentivizing employees (punishments or rewards), and the level of discretion available to employers in using the incentives (low or high). In these treatments, after being informed of whether the employee chose work or shirk, the employer had to make an additional choice. In the low discretion treatments, this additional choice was available to the employer only if he had first committed to an inspection. In the high discretion treatments, the additional choice was available to the employer regardless of his choice whether or not to inspect. In the $P_{\text{Low\_Discretion}}$ and $P_{\text{High\_Discretion}}$ treatments, the employer chose between "no action" and "punish," and if "punish" was chosen, the employer then chose the number of punishment tokens, between zero and five, to assign to the employee. Each token cost the employer one point and reduced the employee's earnings by three points. In the $R_{\text{Low\_Discretion}}$ and $R_{\text{High\_Discretion}}$ treatments, the employer chose between "no action" and "reward," and if "reward" was chosen, he then had to choose the number of reward tokens, between zero and five, to assign to the employee. Each token cost the employer one point and increased the employee's earnings by three points. Finally, both players were informed of all choices and earnings in the pair (so the employee was also informed in case the employer assigned zero reward/punishment tokens). Table 1 summarizes the experimental design.

4. Results

4.1. The Impact of Incentives on Inspecting and Shirking

Figure 3 displays the proportion of inspecting (top panels) and shirking (bottom panels) across rounds disaggregated by treatment. Table 2 reports average rates of inspecting and shirking across the first 70 rounds of the experiment as well as significance levels of treatment comparisons based on two-tailed Wilcoxon rank-sum tests.[9]

Table 1 Experimental Design

Treatment	Punishments	Rewards	Level of discretion	Number of pairs
Baseline	No	No	—	17
$P_{\text{Low\_Discretion}}$	Yes	No	Low	18
$P_{\text{High\_Discretion}}$	Yes	No	High	18
$R_{\text{Low\_Discretion}}$	No	Yes	Low	18
$R_{\text{High\_Discretion}}$	No	Yes	High	18

First, consider the low discretion treatments. The rate of inspection is similar in Baseline and $R_{\text{Low\_Discretion}}$. As shown in Figure 3 (top left panel) in both treatments, inspections increase across rounds and stabilize at the Nash stage game equilibrium level (75%) in the last third of the experiment. The rate of inspection is somewhat lower in the $P_{\text{Low\_Discretion}}$ treatment, although only the difference between $P_{\text{Low\_Discretion}}$ and $R_{\text{Low\_Discretion}}$ is statistically significant at the 5% level (see Table 2).

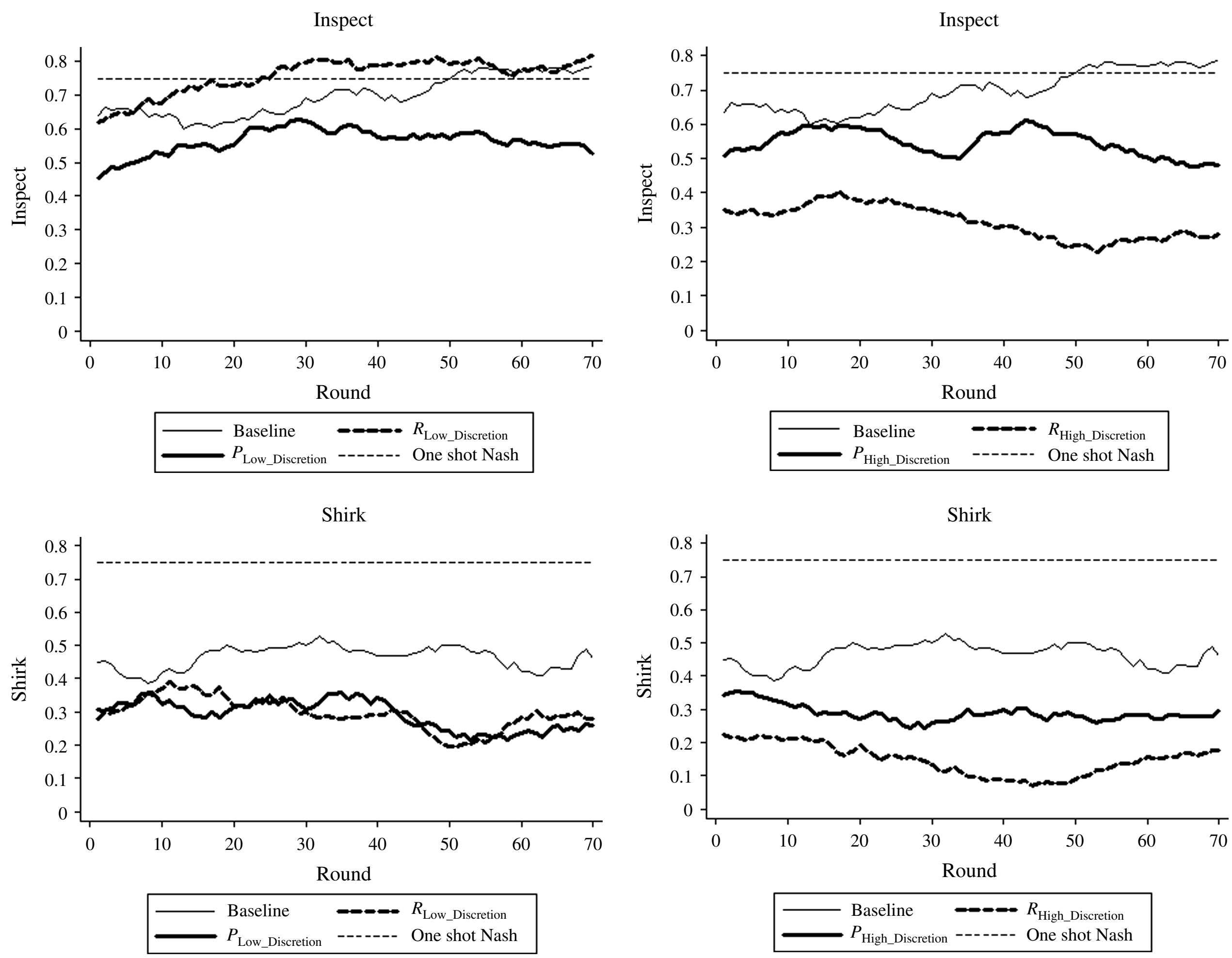
The rate of shirking in the low discretion treatments is shown in the bottom-left panel of Figure 3. In all treatments this is quite stable across rounds and much lower than the Nash stage game equilibrium level (75%). There is noticeably less shirking in $P_{\text{Low\_Discretion}}$ and $R_{\text{Low\_Discretion}}$ than in Baseline, and these differences are statistically significant. It is worth noting that the rate of shirking is not significantly different in $P_{\text{Low\_Discretion}}$ and $R_{\text{Low\_Discretion}}$, and so the lower inspection frequency in the punishment treatment relative to the reward treatment is not associated with higher shirking. Thus, under low discretion, both incentive tools are equally effective in reducing shirking, but inspection rates are lower when punishment is available.

The right panels of Figure 3 contain data from the Baseline and high discretion treatments. Similar to the low discretion case, the rate of inspection in $P_{\text{High\_Discretion}}$ is somewhat lower than in Baseline, but the difference is not statistically significant. The inspection rate in the $R_{\text{High\_Discretion}}$ treatment is significantly lower than in Baseline and $P_{\text{High\_Discretion}}$. Thus,

[8] In fact, the last round was randomly determined according to these rules prior to the Baseline sessions, and this resulted in three sessions with 71, 73, and 83 rounds, respectively. We then used these durations for the other treatments as well.

[9] In all tests we consider data from each pair as one independent observation and so the tests are applied to 18 independent observations per treatment (17 in Baseline). Tests are applied to averages based on the first 70 rounds of the experiment, where we have data from all 89 pairs who took part in the experiment. Analysis using all data is complicated by the fact that some pairs interacted for more rounds than others and we have very small sample sizes in the later rounds. However, all our main results also hold in the full sample. To check whether there is any evidence of learning in our data, we repeated the analysis using only observations from the second half of the experiment. All our main results are unchanged; details are available from the authors on request.

Figure 3 **Proportion of Inspections (Top Panels) and Shirking (Bottom Panels) Across Rounds**



Note. The figure is based on data from 18 games per treatment (17 in Baseline).

and in contrast to the low discretion case, inspections are used much less frequently when rewards can be administered independently of the commitment to an inspection. In fact, the difference in inspection rates between the *R* treatments with low and high discretion is statistically significant at the 1% level. On the contrary, in the case of punishment, the higher discretion in the use of the instrument does not significantly affect the frequency with which employers commit to inspections.

The lower inspection rate in the $R_{\text{High\_Discretion}}$ treatment is not associated with a higher rate of shirking. In fact, the level of shirking in $R_{\text{High\_Discretion}}$ is noticeably lower than in Baseline and $P_{\text{High\_Discretion}}$, and these differences are highly significant. The rate of shirking is also significantly lower in $P_{\text{High\_Discretion}}$ than Baseline. Thus, the higher discretion available to employers in the use of rewards increases the effectiveness of the instrument: the rate of shirking in the $R_{\text{High\_Discretion}}$ treatment is significantly lower than in $R_{\text{Low\_Discretion}}$. In contrast, the effectiveness of punishment in deterring shirking is not affected by level of discretion available to the employer.

In summary, although theoretically the efficient outcome can be approximated even in the standard inspection game, our experiments reveal considerable efficiency losses in the absence of discretionary incentives. The availability of discretionary punishment and rewards considerably improves efficiency, although the relative effectiveness of the instruments depends on the level of discretion available to employers. When employers can only administer incentives after an inspection (low discretion case), punishments and rewards are equally effective in discouraging shirking relative to the standard inspection game. However, the punishment tool has the advantage that the reduction in shirking is achieved with less costly inspections than when rewards are available. Thus, the effectiveness of punishment seems to mainly operate through the *threat* rather than the *use* of sanctions. In contrast, the effectiveness of rewards relies on the *active use* of the instruments, which,

Table 2 Average Inspection and Shirking Rates

	Baseline ($n=17$)	$P_{\text{Low\_Discretion}}$ ($n=18$)	$R_{\text{Low\_Discretion}}$ ($n=18$)	$P_{\text{High\_Discretion}}$ ($n=18$)	$R_{\text{High\_Discretion}}$ ($n=18$)
Inspect (%)	70	56	76	55	32
Shirk (%)	46	29	29	29	15
	Baseline	$P_{\text{Low\_Discretion}}$	$R_{\text{Low\_Discretion}}$	$P_{\text{High\_Discretion}}$	$R_{\text{High\_Discretion}}$
Baseline	—	—	—	—	—
$P_{\text{Low\_Discretion}}$	n.s./**	—	—	—	—
$R_{\text{Low\_Discretion}}$	n.s./**	**/n.s.	—	—	—
$P_{\text{High\_Discretion}}$	n.s./**	n.s./n.s.	—	—	—
$R_{\text{High\_Discretion}}$	***/***	—	***/**	**/***	—

Notes. The first two rows of the table contain the average rates of inspecting and shirking across the first 70 rounds of the experiment. The remaining rows of the table contain significance levels of pair-wise two-tailed Wilcoxon rank-sum tests. In each cell the first entry refers to tests applied to inspection rates, and the second entry refers to tests applied to shirking rates.
**$p < 0.05$; ***$p < 0.01$ (n.s., not significant).

in the low discretion treatments, involves inefficient inspections on the part of the employer. In the high discretion treatments, however, employers can use the instruments independently of whether they inspect. Although this does not change the effectiveness of punishment relative to the low discretion case, it has a dramatic impact in the reward treatment. Here we observe substantially less shirking and inspecting than in the low discretion case. Thus, rewards can be more effective than sanctions, if employers do not have to engage in costly inspections to use the incentives.

4.2. The Use and Effectiveness of Punishments and Rewards

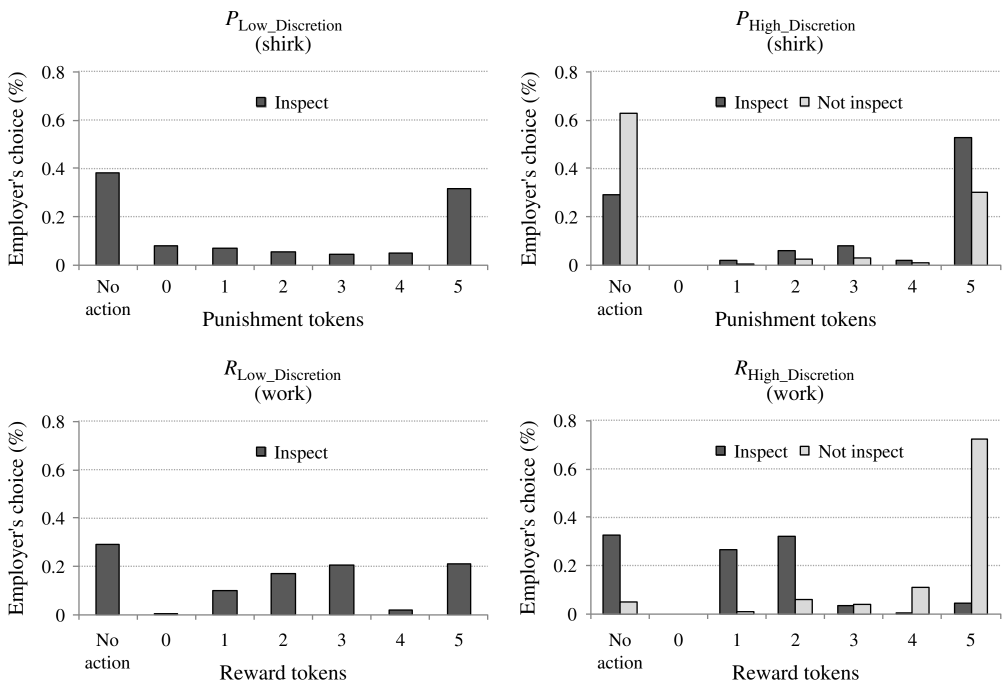
We next focus on the treatments with discretionary punishments or rewards, and examine how employers used the incentives and how employees reacted to this. In the experiment, after learning the choice of the employee, employers decided whether to take no action or to assign punishment or reward tokens, depending on the treatment (in the low discretion treatments, these choices were available only after an inspection). Figure 4 shows the proportion of "no action" decisions and punishment/rewards tokens assignments disaggregated by treatment. In the experiment, punishments are mainly targeted at shirkers and rewards are mainly given to employees observed to have worked in that round. Thus, we observe very little use of punishment against employees who worked—this occurs in 36 out of 1,382 games—and very little use of rewards for shirkers, in 48 out of 480 games. Therefore, in Figure 4 we report punishment decisions for the cases where the employee was observed to shirk for the $P_{\text{Low\_Discretion}}$ and $P_{\text{High\_Discretion}}$ treatments, whereas we report reward decisions for the cases where the employee was observed to work for the $R_{\text{Low\_Discretion}}$ and $R_{\text{High\_Discretion}}$ treatments. In the high discretion treatments (right panels), we disaggregate the data depending on whether or not the punishment/rewards tokens were assigned after an inspection. In the low discretion treatments (left panels), token assignments were only possible after an inspection.

In the $P_{\text{Low\_Discretion}}$ (top-left) and $P_{\text{High\_Discretion}}$ (top-right) treatments, punishment happens more often than not when an employee is caught shirking after an inspection (62% of the games in $P_{\text{Low\_Discretion}}$ and 71% in $P_{\text{High\_Discretion}}$). However, when the employer does not inspect in $P_{\text{High\_Discretion}}$, shirkers are only punished 37% of the times. When employers decide to punish, in both treatments by far the most common use of the incentive tool is to assign maximal punishment to the employee (five tokens). Overall, the expected number of punishment tokens assigned to an employee who shirks is equal to 2.10 in $P_{\text{Low\_Discretion}}$, 3.10 in $P_{\text{High\_Discretion}}$ when the employer inspects, and 1.70 in $P_{\text{High\_Discretion}}$ when the employer does not inspect.

In the $R_{\text{Low\_Discretion}}$ treatment (bottom-left) employers reward employees found working in 71% of the games, and in the $R_{\text{High\_Discretion}}$ treatment (bottom-right) in 67% of the games where the employer inspects and 95% of the games where the employer does not inspect. Rewards are used differently under low and high discretion. In $R_{\text{Low\_Discretion}}$, following an inspection, employers tend to use either maximal rewards (21% of the time), or to assign two or three reward tokens (respectively, 17% and 20% of the time). In $R_{\text{High\_Discretion}}$, maximal rewards are used only 4% of the times after an inspection, and the most frequent assignments are one or two reward tokens (respectively, 27% and 32% of the time). Moreover, the pattern of rewards is different when employers do not inspect: here rewards are mostly used to reward employees maximally (this occurs in 72% of the games). As a consequence, the expected number of reward tokens assigned to an employee who works varies from 2.18 in $R_{\text{Low\_Discretion}}$, to 1.26 in $R_{\text{High\_Discretion}}$ when the employer inspects, to 4.33 $R_{\text{High\_Discretion}}$ when the employer does not inspect. This change in the way rewards are used may reflect employers' concerns with relative earnings. For example, differences in earnings between the players are minimized by assigning two or three reward tokens following "inspect, work" and by assigning five reward tokens following "not inspect, work."

Table 3 reports ordinary least squares (OLS) regressions of the use of the punishment/reward instruments across the four treatments. In all regression models, the dependent variable is the number of punishment or

Figure 4 Use of Punishments for Shirk and Rewards for Work



Note. Based on 223 games in $P_{\text{Low\_Discretion}}$, 365 games in $P_{\text{High\_Discretion}}$, 660 games in $R_{\text{Low\_Discretion}}$, and 1,074 games in $R_{\text{High\_Discretion}}$.

rewards tokens assigned to an employee.[10] We regress this on a constant and on a dummy variable assuming value 1 if the employee is observed to shirk in that round. For the high discretion treatments, we also include a dummy variable assuming value 1 if the employer inspects in that round. We also control for period and learning effects by including a "round" variable in all models. To account for the panel structure of the data, we add individual-level fixed effects to all regression models.

The regressions confirm that punishments are mainly used to sanction shirkers, and rewards are mainly given to employees who are observed to work. Both under low and high discretion, employers assign significantly more punishment tokens and significantly fewer reward tokens to employees who have shirked in that round. The regressions also show some differences in the use of punishment and rewards across rounds. Employees are punished less in later rounds of the experiment, although the effect is only significant in the low discretion treatment. The use of rewards is instead more stable over time. Finally, the regressions confirm that in the high discretion treatments the use of the instruments varies depending on whether or not employers commit to an inspection. Employees are punished somewhat more strongly after an inspection, although the difference is not statistically significant, whereas they receive significantly less rewards when the employer inspects.

We next examine the effectiveness of the punishment and reward instruments by studying employees' probability of shirking in the round following the assignment of a punishment or reward. Table 4 shows, across treatments, the proportion of employees who shirk in round t following a "no action," "punish," or "reward" decision by the employer in round $t-1$. As before, for the $P_{\text{Low\_Discretion}}$ and

[10] In the regressions, the dependent variable assumes value 0 also when the employer chooses "no action."

Table 3 Use of Punishments and Rewards

	$P_{\text{Low\_Discretion}}$	$P_{\text{High\_Discretion}}$	$R_{\text{Low\_Discretion}}$	$R_{\text{High\_Discretion}}$
1 if shirk	1.294***	2.423***	−0.906***	−1.629***
	(0.343)	(0.438)	(0.220)	(0.423)
1 if inspect	—	0.088	—	−0.841***
		(0.239)		(0.223)
Round	−0.004**	−0.005	0.001	0.002
	(0.002)	(0.003)	(0.003)	(0.004)
Constant	0.193	0.101	1.453***	3.409***
	(0.124)	(0.221)	(0.121)	(0.130)
No. of observations	1,260	1,260	1,260	1,260
No. of groups	18	18	18	18
R^2	0.169	0.403	0.141	0.573

Notes. Fixed-effects OLS regressions with robust standard errors. Dependent variable is number of punishment/reward tokens assigned. When the employer chooses "no action," the dependent variable takes value 0. Robust standard errors reported in parentheses.
$^{**}p < 0.05$; $^{***}p < 0.01$.

Table 4 Probability of Shirking in Round t After Punishments/Rewards in Round $t-1$

Treatment	Employer/employee actions in round $t-1$	Punishment/reward in round $t-1$			
		No action or zero tokens	One or two tokens	Three or four tokens	Five tokens
$P_{Low\_Discretion}$	Inspect, shirk	50% ($n=102$)	50% ($n=28$)	62% ($n=21$)	48% ($n=69$)
$P_{High\_Discretion}$	Inspect, shirk	49% ($n=47$)	25% ($n=12$)	44% ($n=16$)	52% ($n=84$)
	Not inspect, shirk	38% ($n=123$)	33% ($n=6$)	25% ($n=8$)	29% ($n=62$)
$R_{Low\_Discretion}$	Inspect, work	27% ($n=192$)	18% ($n=179$)	7% ($n=146$)	15% ($n=136$)
$R_{High\_Discretion}$	Inspect, work	35% ($n=93$)	14% ($n=170$)	0% ($n=12$)	0% ($n=13$)
	Not inspect, work	32% ($n=40$)	17% ($n=53$)	15% ($n=120$)	2% ($n=559$)

Notes. Proportion of employees who shirk in round t in response to a given punishment/reward assignment in round $t-1$. Number of games reported in parentheses.

$P_{High\_Discretion}$ treatments we restrict attention to cases where the employee was observed to shirk in round $t-1$, and for the $R_{Low\_Discretion}$ and $R_{High\_Discretion}$ treatments to cases where the employee was observed to work. For the high discretion treatments, we further disaggregate the data depending on whether the employer made an inspection in round $t-1$.

Table 4 suggests that the use of punishments has limited effectiveness in discouraging shirking. If the employer takes no action or assigns zero punishment tokens to an employee who is observed to shirk in round $t-1$, the probability that the employee will shirk again in round t is between 38% and 50% depending on treatment. This probability of shirking is hardly reduced by the use of punishments: if the employer assigns maximal punishment (five tokens) to a shirker, the probability that the employee will shirk again in round t varies between 29% and 52% across treatments. In fact, in some cases, the use of punishment seems to *increase* the probability of shirking (e.g., in $P_{Low\_Discretion}$ and in $P_{High\_Discretion}$ after an inspection). The use of rewards has instead a stronger dissuasive effect on shirking. Withholding a reward from an employee who is observed to work in round $t-1$, increases the probability that the employee will shirk in round t to between 27% and 35% depending on treatment. However, the probability of shirking falls between 0% and 15% when the employer rewards maximally an employee who is observed to work. The dissuasive effect of rewards appears particularly strong in $R_{High\_Discretion}$, where the probability of shirking is virtually reduced to zero with the use of maximal rewards.

In Table 5, we examine these patterns more formally by conducting a regression analysis of employees' responses in round t to punishments/rewards assigned by the employer in round $t-1$. We run a separate regression model for each of our four treatments. In all models, the dependent variable assumes value 1 if the employee shirks in round t, and 0 otherwise. We regress this on a set of dummy variables for the possible game outcomes in round $t-1$ ("inspect, shirk"; "inspect, work"; "not inspect, shirk"—note that the efficient outcome "not inspect, work" is used as baseline category). We measure the impact of punishment and reward on shirking across the four possible outcomes of the game by interacting the outcome variables with the number of punishment/reward tokens assigned to the employee in round $t-1$.[11] All models also include a constant and a "round" variable to control for period and learning effects. We estimate linear probability models with individual-level fixed effects to account for the panel structure of the data.

The regressions for the punishment treatments confirm the limited effectiveness of sanctions in discouraging shirking. In neither punishment treatment does punishing a shirker reduce the employee's propensity to shirk in the next round, and, in fact, in $P_{Low\_Discretion}$ there is a marginally significant *positive* effect. Moreover, in both punishment treatments, punishing an employee who works significantly increases the probability that the employee shirks in the next round. This seems a reasonable response to a perverse use of the punishment instrument, although these cases are quite rare in the data.[12] Rewards are instead

[11] When the employer chooses "no action," we assign value 0 to these variables. In the low discretion models only, interactions with game outcomes where the employer inspects are included in the regressions.

[12] This perverse effect of punishment echoes the findings on the reduced effectiveness of sanctions when these are perceived as unkind or hostile by the recipient of the punishment (e.g., Fehr and Gächter 2002, Fehr and Rockenbach 2003, Fehr and List 2004, Dickinson and Villeval 2008, Houser et al. 2008, Fuster and Meier 2010, Nikiforakis et al. 2012).

Table 5 Effectiveness of Punishments and Rewards

	$P_{\text{Low\_Discretion}}$	$P_{\text{High\_Discretion}}$	$R_{\text{Low\_Discretion}}$	$R_{\text{High\_Discretion}}$
"Inspect, shirk" in $t-1$	−0.078	0.126	0.084	0.060
	(0.056)	(0.131)	(0.071)	(0.106)
"Inspect, work" in $t-1$	−0.219***	−0.097	−0.210***	−0.029
	(0.051)	(0.061)	(0.055)	(0.083)
"Not inspect, shirk" in $t-1$	−0.152**	−0.082	−0.026	−0.067
	(0.067)	(0.093)	(0.066)	(0.125)
Tokens × "Inspect, shirk" in $t-1$	0.038*	0.008	−0.007	−0.211***
	(0.020)	(0.019)	(0.043)	(0.050)
Tokens × 'Insp, work" in $t-1$	0.032**	0.053**	0.021	−0.064**
	(0.012)	(0.022)	(0.014)	(0.029)
Tokens × "Not inspect, shirk" in $t-1$	—	0.002	—	−0.041
		(0.016)		(0.033)
Tokens × "Not inspect, work" in $t-1$	—	0.106***	—	−0.031**
		(0.013)		(0.015)
Round	−0.001	−0.000	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.438***	0.339***	0.408***	0.292***
	(0.053)	(0.076)	(0.044)	(0.072)
No. of observations	1,242	1,242	1,242	1,242
No. of groups	18	18	18	18
R^2	0.024	0.049	0.079	0.157

Notes. Fixed-effects OLS regressions with robust standard errors. Dependent variable assumes value 1 if the employee shirks in round t, and 0 otherwise. When the employer chooses "no action," the "tokens" variables take value 0. Robust standard errors reported in parentheses.
$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

more effective in discouraging shirking. This is particularly evident in the $R_{\text{High\_Discretion}}$ treatment, where all four interaction terms between game outcomes and number of assigned tokens enter the regression with a negative sign, and in three cases the coefficients are significantly different from zero at the 1% or 5% level. The effect is less clear in the $R_{\text{Low\_Discretion}}$ treatment, where the two interaction terms between reward tokens and game outcomes enter with a positive and negative coefficient, respectively. In both cases, however, the coefficients are not significantly different from zero.[13]

In summary, our analysis shows that employers mainly target punishments at shirkers and target rewards at employees who are observed to work. The instruments, however, appear to have a different impact on employees' behavior. The use of punishment seems to have a limited effect on shirking: the probability that employees shirk in a given round of the experiment is hardly affected by whether or not the employer has meted out punishments toward them in the previous round. On the other hand, the use of rewards seems to reduce shirking. Employees who work and receive a reward are very likely to continue working in subsequent periods, whereas they are more likely to shirk if the employer withholds the reward from them. These patterns are consistent with our earlier observation that the effectiveness of sanctions mainly relies on the threat of punishment rather than the active use of the instrument, whereas the effectiveness of rewards stems from their active use.

4.3. Efficiency and Earnings

We conclude our analysis by examining the impact of punishments and rewards on players' earnings and efficiency. We focus on total earnings, i.e., the earnings that players received at the end of each round, including any cost or benefit following the use of rewards and punishments. Since the maximum possible earnings in $R_{\text{High\_Discretion}}$ are higher than in the other treatments, as a measure of efficiency, we take the percentage of maximum possible earnings extracted by the players. Table 6 reports players' individual earnings, combined earnings, and efficiencies per game across treatments.

In Baseline, combined earnings can range from 25 points (when the employer inspects and the employee shirks) to 65 points (when the employer does not inspect and the employee works). In the Nash stage game equilibrium, predicted combined earnings are 35 points (i.e., an efficiency of 54%). In

[13] We also conducted analogous regressions to examine the determinants of employers' propensity to inspect. The regressions show no clear relation between use of punishments and the propensity to inspect, but do show that the use of rewards in a given round reduces the probability that the employer inspects in the next round (for both low and high discretion treatments). Details are available from the authors on request.

Table 6 Individual Earnings and Efficiency

	Baseline ($n = 17$)	$P_{Low\_Discretion}$ ($n = 18$)	$R_{Low\_Discretion}$ ($n = 18$)	$P_{High\_Discretion}$ ($n = 18$)	$R_{High\_Discretion}$ ($n = 18$)
Employer's earnings	22.82	27.97	25.30	27.08	33.03
	[53%]	[59%]	[52%]	[58%]	[53%]
	(*7.66*)	(*6.93*)	(*4.22*)	(*4.25*)	(*7.00*)
Employee's earnings	20.09	19.54	23.37	19.74	29.48
	[47%]	[41%]	[48%]	[42%]	[47%]
	(*2.42*)	(*2.06*)	(*3.49*)	(*3.15*)	(*5.69*)
Combined earnings	42.91	47.51	48.67	46.82	62.51
	(*8.64*)	(*7.69*)	(*7.20*)	(*5.53*)	(*12.33*)
Efficiency	66%	73%	75%	72%	83%
	Baseline	$P_{Low\_Discretion}$	$R_{Low\_Discretion}$	$P_{High\_Discretion}$	$R_{High\_Discretion}$
Baseline	—	—	—	—	—
$P_{Low\_Discretion}$	*/**/n.s.	—	—	—	—
$R_{Low\_Discretion}$	**/*/***	n.s./n.s./***	—	—	—
$P_{High\_Discretion}$	*/**/n.s.	n.s./n.s./n.s.	—	—	—
$R_{High\_Discretion}$	***/***/***	—	***/ ***/***	***/**/***	—

Notes. "Combined earnings" are the sum of employer and employee earnings. "Efficiency" is combined earnings as a percentage of maximum possible earnings. (In all treatments maximum possible earnings are 65, except $R_{High\_Discretion}$ where maximum possible earnings are 75.) Percentage of combined earnings accrued to the employer and the employee in square brackets. Standard deviations based on group averages in parentheses. The lower part of the table reports significance levels of pair-wise two-tailed Wilcoxon rank-sum tests. In each cell the first entry refers to tests applied to combined earnings, the second entry to tests applied to employers' earnings, and the third entry to tests applied to employees' earnings.
$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$ (n.s., not significant).

the experiment, efficiency is 12% higher than this, and combined earnings average 42.91 points across rounds. Averaged over all pairs, the main recipient of this efficiency gain is the employer, who earns much more than predicted (22.82 versus 15 points), whereas employees' earnings are close to the predicted level (20.09 versus 20 points).

In the low discretion treatments, the availability of punishment and rewards has a positive and significant impact on efficiency and earnings. Relative to Baseline, combined earnings are significantly higher in both $P_{Low\_Discretion}$ and $R_{Low\_Discretion}$ and efficiency increases to 73% in $P_{Low\_Discretion}$ and 75% in $R_{Low\_Discretion}$. Although efficiency is slightly higher in $R_{Low\_Discretion}$ than $P_{Low\_Discretion}$, the difference in combined earnings is not statistically significant.[14] Relative to Baseline, employers' earnings are significantly higher in $P_{Low\_Discretion}$, whereas employees' earnings are lower, although this difference is not statistically significant. Thus, the ability to punish is mostly beneficial to employers, who on average reap about 59% of combined earnings. In contrast, the efficiency gains from rewards are shared by employers and employees (52% of combined earnings accrue to employers and 48% to employees). Relative to Baseline, both employers' and employees' earnings increase significantly in $R_{Low\_Discretion}$.

Analogous patterns emerge in the high discretion treatments. Relative to Baseline, combined earnings are significantly higher both in $P_{High\_Discretion}$ and especially in $R_{High\_Discretion}$. This corresponds to efficiencies of 72% and 83%, respectively. The difference in efficiency between high discretion punishments and rewards is statistically significant.[15] Employers' earnings are significantly higher in $P_{High\_Discretion}$ than in Baseline. Employees are slightly worse off in $P_{High\_Discretion}$, but the effect is again not significant. Thus, the availability of punishments is mostly beneficial to employers, who reap about 58% of combined earnings. In contrast, the availability of rewards allows a more equitable distribution of earnings across players (with employers obtaining 53% and employees 47% of combined earnings). Both employers' and employees' earnings increase significantly in $R_{High\_Discretion}$ relative to Baseline.

In summary, both rewards and punishments significantly enhance efficiency. The effects of both instruments are similar in magnitude for the low discretion case, whereas rewards are more efficient than punishments under high discretion. Under both low and high discretion, the main recipient of efficiency

[14] Of course, each time a reward token is assigned in $R_{Low\_Discretion}$ combined earnings increase by two points so it is perhaps not surprising that combined earnings and efficiency are higher in $R_{Low\_Discretion}$ (however, note that given our parameterization of the game in all treatments, combined earnings are maximized when the employee works and the employer does not inspect). We also calculated combined earnings net of the costs and benefits of reward/punishment tokens. In this case combined earnings are still significantly higher in the incentive treatments than Baseline, and the difference between combined earnings in $R_{Low\_Discretion}$ and $P_{Low\_Discretion}$ is still insignificant.

[15] We obtain the same results if we focus on combined earnings net of the costs and benefits of reward/punishment tokens.

gains is the employer when punishments are available, whereas efficiency gains are shared more equitably when rewards are available.

5. A Further Treatment: Combining Rewards and Punishments

The previous results raise an obvious question as to what would follow from the availability of both rewards *and* punishment, since both instruments are available to employers in many naturally occurring settings. In this section we report two additional treatments that examine this question. In these treatments employers could follow up an inspection with "no action," "punish," or "reward," and, if "punish" or "reward" were chosen the employer could assign punishment or reward tokens. We ran a treatment with low discretion ($R\&P_{\text{Low\_Discretion}}$) and a treatment with high discretion ($R\&P_{\text{High\_Discretion}}$). Apart from the expanded set of options available to employers, the sessions were conducted in the same way as those of the initial study. In all, we recruited 72 subjects and ran three sessions of each treatment with 12 subjects per session. These sessions took about 40 minutes on average and earnings ranged between £7.10 and £23.30, averaging £14.89.

As in the previous treatments, the availability of low discretion incentives reduces shirking: the rate of shirking in $R\&P_{\text{Low\_Discretion}}$ (31%) is similar to those in $R_{\text{Low\_Discretion}}$ and $P_{\text{Low\_Discretion}}$ (29%), and is significantly lower than in Baseline (31% versus 46%, $p = 0.049$). An important result from our previous low discretion treatments is that the reduction of shirking is achieved with a lower inspection rate when the punishment tool is available than when rewards are available. When both punishments and rewards are simultaneously available, the frequency of inspections is 66%, higher than when only punishments are available ($P_{\text{Low\_Discretion}}$, 56%), but lower than when only rewards are available ($R_{\text{Low\_Discretion}}$, 76%). These differences in inspection rates between $R\&P_{\text{Low\_Discretion}}$ and the other treatments are not statistically significant ($p \geq 0.199$).

The effectiveness of the instruments increases under high discretion. Shirking in the $R\&P_{\text{High\_Discretion}}$ treatment is reduced to 11%, similar to the rate in $R_{\text{High\_Discretion}}$ (15%, $p = 0.506$), and much lower than those in Baseline (46%, $p = 0.000$), $P_{\text{High\_Discretion}}$ (29%, $p = 0.000$), and $R\&P_{\text{Low\_Discretion}}$ (31%, $p = 0.002$). The inspection rate in $R\&P_{\text{High\_Discretion}}$ is 20%, also similar to that in $R_{\text{High\_Discretion}}$ (32%, $p = 0.335$) and much lower than in any of the other treatments (56% or higher, $p < 0.001$ in all comparisons).

We emphasize three main findings from the $R\&P$ treatments. First, employers use the reward instrument more often than the punishment instrument in the $R\&P$ treatments. In $R\&P_{\text{Low\_Discretion}}$, employers use rewards following an inspection in 49% of games, whereas they punish in 20% of games. In $R\&P_{\text{High\_Discretion}}$, rewards are used in 71% of games, and punishments are only used in 5% of games.[16] Thus, it is perhaps not surprising that, as we have seen earlier, the outcomes in the $R\&P$ are more similar to those in the R than the P treatments.[17]

Second, employees are not disciplined more effectively when employers can combine punishments and rewards, compared to the case where only rewards are available. In fact, although the simultaneous availability of punishments and rewards leads to higher combined earnings both in $R\&P_{\text{Low\_Discretion}}$ (47.15 points) and in $R\&P_{\text{High\_Discretion}}$ (64.68 points) compared to Baseline (42.91 points, $p = 0.069$ and $p = 0.000$, respectively), combined earnings in these two treatments are not significantly different from $R_{\text{Low\_Discretion}}$ (48.67, $p = 0.429$) or $R_{\text{Higher\_Discretion}}$ (62.51, $p = 0.589$).[18]

Finally, the efficiency gains from combining punishment and reward instruments are shared by the employer and employee. Compared to Baseline, where employees earn on average 20.09 points per game, employees' earnings increase by about 10% in $R\&P_{\text{Low\_Discretion}}$ (to 22.12 points, $p = 0.021$) and by about 45% in $R\&P_{\text{High\_Discretion}}$ (to 29.20 points, $p = 0.000$). Similarly, employers' earnings increase from 22.82 in Baseline by about 10% in $R\&P_{\text{Low\_Discretion}}$ (albeit insignificantly so; 25.03 points, $p = 0.121$), and by about 55% in $R\&P_{\text{High\_Discretion}}$ (to 35.47 points, $p = 0.000$). This is different from the P treatments where efficiency gains accrue only to the employer, and more closely resembles the pattern in the R treatments.

[16] The use and effectiveness of punishment and rewards in the $R\&P$ treatments is similar to that in the other incentive treatments. Rewards are mainly assigned to employees who are found working and punishments to employees caught shirking. The active use of punishment is not a very effective way to discourage shirking, whereas the reward instrument is more effective. Details are reported in Online Appendix B.

[17] An interesting question is whether there are differences in the use of the two instruments by each employer, and whether these differences are stable across rounds. In the experiment, we see that most employers predominantly use rewards. With low discretion, 12 employers reward more often than they punish, whereas only five employers punish more often than they reward. One employer uses each instrument equally often. The results are even stronger when discretion is high. Here, 15 employers use rewards more often, while one employer uses punishments more frequently and two employers use both instruments at the same rate. In both treatments, employers' preferences for an instrument are remarkably stable. Only one employer in the low discretion treatment switched from mainly using rewards in the first half of the experiment to mainly using punishment in the second half of the experiment.

[18] Combined earnings in $R\&P_{\text{Low\_Discretion}}$ are not significantly different from $P_{\text{Low\_Discretion}}$ ($p = 0.912$), whereas combined earnings in $R\&P_{\text{High\_Discretion}}$ are significantly higher than in $P_{\text{High\_Discretion}}$ ($p = 0.000$).

6. Discussion and Conclusion

It is interesting to relate our main findings to the extant literatures in experimental economics and management science. Several related literatures have studied the effectiveness of sanctions and rewards as incentive schemes (e.g., Andreoni et al. 2003, Brandts and Charness 2003, Charness et al. 2008, Nikiforakis and Mitchell 2014), though in different settings and under different conditions than those studied here. One related literature focuses on social dilemma settings (e.g., Gürerk et al. 2006, Sefton et al. 2007, Rand et al. 2009, Sutter et al. 2010, Drouvelis and Jamison 2015). There are several differences between the typical setup studied in this literature and our inspection game. A key difference between the settings is that in the inspection game, players are asymmetric in terms of their ability to assign or receive punishments or rewards, whereas in the typical social dilemma situation players can mutually punish/reward each other.[19] Thus, our setup seems better suited to study the effectiveness of positive and negative incentives in hierarchical interactions.

In this sense, our study is also related to the literature on the use of bonuses and fines in principal-agent games (e.g., Fehr et al. 2007, Fehr and Schmidt 2007) or on the effect of punishment in gift-exchange or trust games (Fehr and Rockenbach 2003). However, the focus of this literature is on the comparison between automatic (enforceable) incentives and discretionary incentives that cannot be enforced by a third party. In contrast, in this paper we focus on two different forms of discretionary incentives (rewards and sanctions) and compare their effectiveness in disciplining shirking.[20]

Most closely related is the study by Nosenzo et al. (2014), who also examine the effectiveness of sanctions and rewards in inspection games.[21] They focus on automatic punishments and rewards that are pure monetary transfers in one-shot inspection games. As in the present study, they find that punishments discourage shirking, reduce inspection rates, and lead to higher efficiencies, but differently from the present study, they find that rewards are ineffective in reducing shirking or raising efficiency.

Thus the disciplining power of punishment is robust across the two contexts, whereas the effectiveness of rewards seems to be more sensitive to details of the environment. A theoretical analysis of how rewards and punishment affect behavior can be used to reconcile these findings. In Nosenzo et al. (2014), the fact that punishment is more effective than reward for discouraging shirking is consistent with the equilibrium predictions of their one-shot game. In our setup, the subgame perfect equilibrium of the stage game is unaffected by the possibility of using discretionary rewards or punishments because they are costly and so should not be used by a profit-maximizing employer. Nevertheless, either punishments or rewards can discourage shirking in a repeated game. Thus, as also noted by Rand et al. (2009) in a public goods context, rewards may be more effective in repeated game environments. An interesting avenue for further research would be to more systematically examine the factors required to facilitate the effectiveness of positive incentives.

A further difference of our study from Nosenzo et al. (2014) is that we also study additional treatments where we allow employers to use both sanctions and rewards. Somewhat differently from some of the previous studies that also examined the joint availability of sanctions and rewards (e.g., Sefton et al. 2007, Andreoni et al. 2003), we do not find that combining the instruments enhances efficiency relative to settings where only rewards are available. This finding is in line with findings from the principal-agent literature (Fehr and Schmidt 2007), where contracts combining bonuses and penalties do not induce significantly more effort than contracts that only specify bonuses.

Taken together, the findings from our paper and the related experimental literatures suggest that both discretionary sanctions and rewards can be effective in encouraging compliance and influencing behavior in the direction of more socially efficient outcomes. The power of sanctions relies on the threat of punishment rather than on its use, whereas the effectiveness of rewards requires the incentive tool to be actively used. An implication of this is that the use of rewards results in a redistribution of wealth between authorities and subordinates, whereas sanctions can be used by authorities to reap most of the benefits generated by the incentive tool.

Our paper also confirms some findings in the management science literature and adds some novel insights. In management science, for some decades there has been a focus on how "transformational" leadership can improve the performance in firms (Podsakoff et al. 2010). This literature stresses the

[19] Exceptions are Gürerk et al. (2009), Heijden van der et al. (2009), O'Gorman et al. (2009), Carpenter et al. (2012) and Nosenzo and Sefton (2014) who study settings where the ability to punish/reward group members is restricted to one player.

[20] There are also related studies that compare economically equivalent contracts that are framed either as bonuses or fines (e.g., Hannan et al. 2005, Hossain and List 2012, Bigoni et al. 2014, Armantier and Boly 2015). In contrast to these studies, in our setting, the difference between reward and sanctions is not simply a matter of framing, and the two instruments provide different incentives to the players.

[21] As far as we are aware, there have only been two other experimental studies of inspection games. Glimcher et al. (2005) discuss inspection games with different parameterizations of the inspection cost, and Rauhut (2009) studies the impact of the severity of automatic sanctions. Neither study compares sanctions with rewards.

importance of charismatic and visionary leaders. Recent research recognizes the importance of "transactional" leadership, according to which managers can use contingent rewards and punishments to substantially improve employee attitudes, perceptions, and job performance (Ball et al. 1994, Podsakoff et al. 2006, Walumbwa et al. 2008).

In agreement with our findings, the management science literature suggests a positive role for contingent rewards on subsequent job performance, whereas the role of contingent punishment is more ambiguous. Several studies report that supervisors using rewards are more successful in encouraging subordinates to work hard than supervisors who use sanctions (e.g., Sims 1980, Podsakoff et al. 1982, George 1995). In a review, Podsakoff et al. (2006) report a positive relation between contingent punishment and employee attitudes and perceptions, but not between this form of leadership behavior and employee performance. Ball et al. (1994) suggest that the effectiveness of contingent punishment depends on the perceived fairness of the punishment and the type of employee to whom the punishment is meted out. Employees with a "belief in a just world" respond in the intended way and improve their behavior if the punishment is considered appropriate. Some employees are predisposed to interpreting punishment in negative terms, though, and for them punishment may prove counterproductive. Our results agree with this conclusion; we find that the actual use of punishments hardly reduces shirking and the actual use of rewards has a dissuasive effect on shirking. We think it is encouraging that conclusions based on correlational data of the relevant actors in the field are by and large supported by experimental data that allow for causal inferences.

Our paper also adds new insight to the management science literature. We find that the effectiveness of sanctions appears to be less sensitive to the details of the social and economic environment, whereas rewards can be more effective in some environments than others. In particular, rewards become a very attractive tool if the manager has a lot of discretionary power and can choose to reward without inspecting a worker. This implies that the relative effectiveness of rewards and punishments depends on the extent to which the managers have to justify their behavior.

The management science literature suggests some promising avenues for further experimental research. In particular, in our paper, it is relatively straightforward to judge whether a reward or punishment is fair because an employee only chooses between working and shirking. In practice, it will often be much harder to judge employee behavior, and therefore there will be more room for self-serving distortions of what constitutes a fair reward or punishment. It will be interesting to study the extent to which the current findings will generalize when more uncertainty about worker performance is introduced. In addition, on the basis of a questionnaire in the laboratory and a survey in the field, O'Reillys and Puffer (1989) point to the social role that contingent punishments may play in organizations. Their results suggest that contingent punishments positively affect the motivation and satisfaction of team members who observe the punishment being administered to the misbehaving worker. It would be interesting to study if such equity feelings translate to an improvement in the behavior of the observing team members. They may perform better if they feel that misbehaving workers are punished.

Supplemental Material

Supplemental material to this paper is available at http://dx.doi.org/10.1287/mnsc.2014.2124.

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