Rewarding Whistle-Blowers: Implications on Deterrence and on Principal-Agent Contracts

María C. Avramovich

Universidad Carlos III de Madrid, Madrid, Spain.

Abstract

I develop a model that demonstrates how whistle-blower programs that offer a reward to employees for the public exposure of corporate crimes can improve deterrence, but at the expense of compromising productive efficiency. In the model, rewards create a decision problem to employees on how to allocate effort among productive activities and activities related to gathering crime evidence, so that deterrence and productive efficiency are conflictive objectives. In this context, while rewards can improve deterrence, they can also distort the optimal contract between the principal and the agent. I also demonstrate that firm owners may have incentives to introduce private reward programs, which can have a higher deterrence effect than public whistle-blower programs.

JEL classification: D23, D86, K14, K42

Keywords: Corporate crime; Law enforcement; Rewarding whistle-blowing; Contract design; Deterrence

*I want to thank Natalia Fabra for stimulating my interest in this topic and her invaluable guidance in this work. I would also like to acknowledge the comments and guidance of Christian Ruzzier and Federico Weinschelbaum, with whom I discussed this topic and my work in its earliest versions. I also thank Juan Pablo Rincón Zapatero and Guido Friebel for their invaluable comments. I am grateful to Takamasa Suzuki, Sevinc Cukurova, Jesper Rudiger Sorensen, Daniel García González, and seminar participants at Universidad Carlos III de Madrid, ENTER Jamboree (Barcelona) and Universidad Nacional de Córdoba. The views in this work are mine alone and none of the aforementioned people are responsible for any errors or statements. Please address correspondence to: María C. Avramovich, Universidad Carlos III de Madrid, Departamento de Economía, Calle Madrid 126, Getafe (Madrid) 28903, Spain. E-mail: mavramov@eco.uc3m.es.
1 Introduction

Rewards in whistle-blowing legislation imply a serious challenge to the economic theory of enforcement. While they can improve deterrence on corporate crime, they can also create a non desired “hunt bounty” environment inside firms that distorts employees’ attention from production towards activities related to gathering crime evidence. In this paper I develop a model that captures the implications of rewarding whistle-blowers on deterrence and on optimal contracts among non-offenders.

A whistle-blower is an individual who provides credible information related to some corporate misconduct to the pertinent authority. The act of whistle-blowing is not meant to cause harm to the organization. Rather, it is meant to facilitate the public exposure of acts that occur within firms in detriment of the interest of the firm itself or social welfare.

To encourage whistle-blowing on corporate crimes, the USA legislation offers rewards to whistle-blowing. The False Claim Act (1986 and subsequent reforms), the IRS Whistle-blower Reward Program (2006), and the recent Dodd-Frank Act (2010), are the three main pieces of legislation governing rewards to whistle-blowing. These pieces of legislation differ in the crime of concern and the extent of applicability, but they have a common objective: to incentivize employees endowed with information to report corporate crimes.

By considering rewards as a mechanism that creates a decision problem for employees on how to allocate effort among productive activities and activities related to gathering crime evidence, I develop a model that analyzes the implications of rewarding whistle-blowers on deterrence and on optimal contracts among a principal and an agent that are not crime offenders.

In the model, there is a principal who owns a firm with two employees. One

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1 The term whistle-blowing originated from the practice of English policemen who blew their whistle when they observed the happening of some crime. The blowing of whistle alerted other law enforcement officers and the general public that a crime was being committed.

2 The False Claims Act (FCA) fights fraud against the USA federal government. The FCA makes it a crime for any person or organization to submit a record or claim for payment for services, property or other items to the government, knowing that the information is not true. Rewards oscillate between 15 and 30 percent of funds reimbursed to the government as a result of the investigation.

The Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) rewards private reports on securities violations, including violations of the Foreign Corrupt Practices Act (FCPA), that result in monetary sanctions greater than 1 million. The reward oscillates between 10 and 30 percent of the total recovery (i.e., the additional tax, penalty and other collected amounts).

The IRS Whistle-blower Reward Program rewards private reports on international financial crimes, including tax-fraud, money laundering, and the flow of narcotics and terrorist funding.

Detailed information on these pieces of legislation is available at:
http://www.justice.gov/
http://www.irs.gov/compliance/article/0, id=180171,00.html
employee can get personal gains from committing corporate crime, but to do so, he has to devote costly effort. The other employee can gather crime evidence and report it to the authority in exchange of a reward, but to do so, he has to take effort from productive activities to locate it into activities related to gathering crime evidence, as his effort is constrained.3

Effort devoted to gathering crime evidence increases the probability of crime detection, but it also reduces the probability of crime existence (as the gains from crime are decreasing in the probability of detection) and, consequently, the probability of obtaining the reward too. Hence, the non-offender employee’s effort allocation depends on: (1) reward levels, (2) his effort disutility, (3) the opportunity cost of gathering crime evidence in terms of the salary loss from less effort devoted to production, and (4) how his effort devoted to gathering crime evidence affects the probability of crime existence and that of crime detection.

There are two other important elements in the model. First, the principal observes effort devoted to production, but not so effort devoted to commit crime or to gathering crime evidence. As a result, he cannot design a contract over effort devoted to commit crime or to gathering crime evidence. Second, crime creates an externality to the principal, positive or negative, which makes him interested in the existence of crime or in its deterrence.

I demonstrate that while rewards can improve deterrence, they can also distort the optimal contract between the principal and the agent. With rewards, the principal overpays effort devoted to production when he gets high positive externalities from crime, as he wants to bias the agent’s effort allocation away from crime detection. Similarly, the principal underpays effort devoted to production when he gets high negative externalities from crime. There are two extreme cases, one in which the principal hires the agent only for his activities related to gathering crime evidence, and other in which, to reduce the probability of crime detection, he does not hire the agent. The latter one implies that rewards create a total loss of welfare.

By extending the analysis to private reward programs (i.e., inside-firm programs that reward the private exposure of the corporate crime), I demonstrate how these can substitute whistle-blower programs with a beneficial effect for the principal and deterrence.

3One can think of a manager as an offender, who works as many hours as required/desired; and a secretary as the other employee (the potential whistle-blower), who has a fixed amount of hours per working day. Assuming that both are fully efficient in their work, working hours and effort match perfectly. Hence, while the effort is limited for the secretary, it is not so for the manager (the offender).
2 Related Literature

The literature on whistle-blowing can be classified into two main strands: one that conceives whistle-blowers as individuals with altruistic concerns, and another that conceives whistle-blowers as self-interested individuals, who decide on whether to whistle the blow depending on an expected reward.

In this paper, I follow the latter conception. Equally important, I assume that whistle-blowers and firm owners do not take part in the crime. Together, these assumptions define a working framework appropriate for the analysis of many corporate crimes (e.g., collusion at managerial level, the non-compliance with safety regulations, environmental crimes), but, to the best of my knowledge, still not explored in the literature. Nevertheless, some of my results are in line with those already found in the literature regarding rewards to whistle-blowing.

Within a setup in which offender principals bribe whistle-blowers and hold their under-performance to avoid possible crime reports, Friebel & Guriev (2011) demonstrate that rewards to whistle-blowing may have undesired welfare effects. When rewards are not high enough to prevent crime, they increase losses from under-performance and bribes, as the opportunity cost of silence is increasing in rewards. Only reward levels that make bribes unprofitable improve deterrence, since crime concealment depends directly on bribes. Aubert, Kovacic & Rey (2006) analyze the same problem in a collusive game. But, in this context, even low reward levels improve deterrence, since the decision on whether to form a cartel can be highly sensible to the lower profits from collusion associated to bribes and employees’ under-performance.

My results are close to these in the sense that with rewards the agent’s payment from work may be higher than that without rewards, as the principal may want to distort the agent’s attention away from crime detection. But in my setup, this is not associated to a contract outside the law or under-performance, as the higher payment attempts to focus the agent’s attention in productive activities and, in none of the cases, allows for work inefficiencies. I also find that high rewards can imply full deterrence, but mostly if the principal is interested in it, which is exactly the opposite setup of Friebel et al. (2011) and Aubert et al. (2006). On the contrary, as in my setup the principal can dispense with the whistle-blower, the combination of high rewards and a principal against crime deterrence implies no contract between the principal and the agent, and thus a total loss of welfare.

Within the literature of rewards to whistle-blowing stands out the literature of leniency programs, that analyzes the effects of offering amnesties to crime offenders.

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5This assumption implies that (i) whistle-blowers are not regretful offenders, neither accept a bribe for their silence, and (ii) firm owners are not crime offenders, neither encourage crime actively.
offenders in exchange of their collaboration in the detection of crime. This
literature can be classified in two main strands: one that focuses on individ-
ual wrongdoers that commit occasional crimes, and another that focuses on
corporate wrongdoers that systematically commit the same crime, particularly
collusion.

Regarding leniency and occasional crimes, Kaplow & Shavell (1994), Malik
(1993) and Innes (1999) stand out. Assuming high fines under crime detection,
Kaplow & Shavell (1994) discuss the beneficial effects of leniency programs for
deterrence in environmental crimes, to which Malik (1993) adds their beneficial
effects associated to lower auditing costs in regulation. Innes (1999) extends
these works by studying prospective ex-post benefits from remediation, as the
clean-up activity is a central component of environmental law enforcement. Innes
demonstrates how clean-up benefits and fine amnesties after self-reporting can
be equivalent policies to deter environmental crimes.

The literature on leniency in collusion is extensive. Motta and Polo (2003)
is the first paper explicitly addressing the effects of leniency programs on collu-
sion in a dynamic analytical framework. They demonstrate that these programs
make enforcement more effective, but may also induce collusion since amnesties
decrease the expected cost of the misbehavior. In the optimal policy, the for-
ermer effect dominates and leniency programs improve deterrence. Their main
contribution in this paper lies in that leniency improves deterrence even in the
case where the leniency application is made after an investigation has started.
Harrington (2008) extends Motta and Polo (2003) with the additional novel fea-
ture of reports along the equilibrium path: in cartels under investigation, firms
may rush non-cooperatively to report information under a sufficiently generous
leniency program (effect named Race to the Courthouse). Equilibrium reports
during prosecution take place when the realization of the probability of a suc-
cessful conviction is high. Spagnolo (2000) and Buccirossi and Spagnolo (2001,
2006) highlight the possibility that smart wrongdoers can use leniency as a
threat against deviation, which allows them to sustain cartels that would not
be sustainable in the absence of leniency programs. Hence, moderate forms of
leniency may have the counterproductive side effect of facilitating illegal trans-
actions.

Despite the fact that I consider positive rewards instead of amnesties, my
paper differs from these mainly in that I disaggregate in two the figures of the
crime offender and the whistle-blower, none of them the firm owner. This, to-
gether with a firm owner that may be interested or not in crime, allows me to
analyze private incentives to execute and deter crime beyond the firm’s costs
associated to detection (e.g., fines, clean-up activities, etc.), as well as how these
incentives are affected by the behavior of the other members of the firm. In this
context, rewards to whistle-blowing entail a wide range of effects on deterrence,

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6For an extensive analysis of the literature of leniency in collusion, please refer to Spagnolo
(2008).
where both deterrence effects mentioned above are possible: a deterrence improvement, mostly when the principal is interested in that; and a deterrence loss, otherwise. As final comment, I want to add that my paper is pioneer in getting into the firm’s ‘black-box’ to seek the efficiency effects that rewarding non-offender whistle-blowers has in optimal contracts.

The rest of the paper proceeds as follows, I introduce the model in Section 3. In Section 4, I solve it for the case in which there are no rewards (benchmark case), and in Section 5, I solve the case with rewards. In Section 6, I consider the implications of rewards on deterrence and on the principal’s utility. In Section 7, I extend the analysis for the case in which the principal can introduce a private reward program regardless of the existence of a whistle-blower program. I conclude in Section 8.

3 The Model

A firm operates in a competitive market. In the firm, there is a principal, the owner of the firm, and two employees. The principal designs the contracts that govern the relationship between the firm and each employee, and the employees execute productive activities following these contracts. In particular, contracts are defined on the basis of employees’ efforts devoted to production, which are fully observable.

One employee can devote effort to commit corporate crime, which yields him private gains $g$. The crime creates hard evidence that can be found through an inspection. The other employee, instead, can not commit corporate crime, neither get any direct payoff from it. But, given crime, he can find evidence of it if he devotes effort to look for it.

Along this paper, I refer the former employee as ‘the offender’ and the latter employee as ‘the agent’.

Effort is costly. Effort devoted to production is observable, but not effort devoted to commit crime or to the gathering of crime evidence.

To fight crime, the anti-crime authority has two instruments:

- Inspections: given crime, it is detected with probability $\rho \in [0, 1]$.
- Whistle-blower program: offers a reward $R$ to employees who present evidence of corporate crime, excluding offenders. It rewards only if the inspector fails in detecting crime.\(^7\)

\(^7\)These assumptions are in line with the USA legislation of rewards to whistle-blowing.
If crime evidence is found, the firm and the offender pay corporate and individual fines $F$ and $f$, respectively.

Finally, crime entails a direct payoff $G$ to the principal, which can be positive or negative, $G \in \mathbb{R}$.

In this framework, I assume that the principal can identify which employee can commit corporate crime, i.e. he can identify which job positions give an employee the attributes required to commit crime. But, he can not directly observe whether there is crime in the firm, neither gather evidence of it. I also assume that it is profitable for the principal to hire the offender employee, despite the possibility of a corporate crime.

Regarding the agent and the offender’s activities, I assume that the offender’s activities related to production and crime are not related. However, the agent’s activities related to production and the gathering of crime evidence are technological substitutes.

Hence, in this model, the principal decides whether to hire the agent, and if so designs a contract for him.\(^8\) The offender decides whether to commit crime, and if so how much effort devote to it. Finally, the agent decides whether to gather crime evidence, and if so how to allocate effort among production and the gathering of crime evidence.

I define $z, e_1, e_2 \in [0, 1]$, effort devoted to commit crime, to productive activities and to gathering crime evidence, respectively.

At this point it is important to define two probabilities: The probability of crime existence $P_c$, and the probability that the agent finds crime evidence given that there exists crime $P_e$. I assume $P_c = z$, so that the higher the offender’s effort devoted to commit crime, the higher the probability of crime existence. Regarding $P_e$, I assume $P_e = e_2$, so that, given crime, the higher the agent’s effort devoted to gathering crime evidence, the higher the probability that he finds it.

Finally, I assume that the agent can not falsify evidence of crime.

The timing of the game is as follows: At date 0 the principal decides whether to hire an agent from a competitive market for agents. If so, he decides on the contract to offer him.

For the contract, I consider a linear payment scheme for productive effort $e_1$: $w(\alpha, \beta) = \alpha + \beta e_1$, where $\alpha \in \mathbb{R}$ and $\beta \geq 0$.

\(^8\)The agent’s effort devoted to productive activities is the only item of interest for the purpose of a contract, since the principal (1) always hires the offender, and (ii) does not have an instrument to distort the offender’s willingness to commit crime (as the offender’s effort devoted to commit crime is independent of his effort devoted to productive activities).
In the absence of a contract, the agent has zero utility, the principal hires only the offender and the game ends. If instead there is a contract, at date 1 the agent and the offender simultaneously decide on effort levels. At date 2, production, crime activities and activities related to gathering crime evidence are executed. At this time, an inspector visits the firm. The inspection ends with a report supporting or rejecting crime. If the agent has found evidence, he also submits a report with crime evidence to the anti-crime authority. At date 3, the principal gets a payoff \( Y(e_1) = ye_1 \) (with \( y > 0 \)) from production and pays \( w(\alpha, \beta) \) to the agent. Besides, given crime, the principal and the offender get payoffs \( G \) and \( g \), respectively. If the inspector or the agent report crime evidence, the firm and the offender pay \( F \) and \( f \), respectively. The agent gets the reward if he is the only one to report crime evidence.

In this setup, the agent’s utility function is:

\[
U(e_1, e_2) = (\alpha + \beta e_1) - \frac{(e_1 + e_2)^2}{2} + z (1 - \rho) e_2 R
\]

The first term in the RHS is the agent’s utility from effort devoted to production; the second term, his disutility from effort; and the third term, his utility from effort devoted to gathering crime evidence. This last term is composed of the probability of crime existence \( z \), times the probability of the agent being the only one to report crime evidence, \( (1 - \rho) e_2 \), times the reward \( R \). I assume \( R \leq F \).

The offender’s utility function is:

\[
O(z) = z \{ g - [ \rho + (1 - \rho) e_2 ] f \} \quad - \quad \frac{z^2}{2}
\]

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\(^9^9\)The upper-bound \( R = F \) is consistent with a reward program funded by fines, in line with the USA whistle-blower legislation.
The first term in the RHS is the offender’s expected utility from crime. Outside brackets, his effort devoted to committing crime. In brackets, his net gains from crime, that depend on the agent’s effort devoted to gathering crime evidence. The second term is the offender’s disutility from effort.

Finally, the principal’s utility function is:

\[ V(\alpha, \beta) = ye_1 - (\alpha + \beta e_1) + z \left\{ G - [\rho + (1 - \rho) e_2] F \right\} \]

The first two terms in the RHS are the principal’s net utility from the agent’s productive activities, and the last term his externalities from crime.

4 The Case of No Rewards to Whistle-Blowing

As a benchmark case, assume no rewards to whistle-blowing. Without rewards, the agent has no incentives to devote costly effort to the gathering of crime evidence \((e_2 = 0)\). Hence, given crime, the probability of crime detection is \(\rho\).

Solving by backward induction, at date 1 the agent and the offender choose the levels of effort \(e_2\) and \(z\), respectively, that maximize their utilities:

\[
\max_{e_1} U(e_1) = \alpha + \beta e_1 - \frac{e_2^2}{2}
\]

\[
\max_z O(z) = z \left( g - \rho f \right) - \frac{z^2}{2}
\]

For expository reasons, throughout the paper I set \(g = f = 1\) \(^{10}\), so that the offender’s problem simplifies to:

\[
\max_z O(z) = z (1 - \rho) - \frac{z^2}{2}
\]

**Lemma 1** Without rewards to whistle-blowing, effort devoted to crime is \(z^B = 1 - \rho\), and effort devoted to production is \(e_1^B = \min \{\beta, 1\}\).

Effort levels \(z^B\) and \(e_1^B\) equate the agent and the offender’s marginal utility and marginal disutility, respectively. The supra-index \(B\) denotes the Benchmark case.

At date 0, the principal chooses a contract \(w(\alpha, \beta)\) that maximizes his utility and is incentive compatible and acceptable to the agent:

\[
\max_{\alpha, \beta} V(\alpha, \beta) = ye_1 - (\alpha + \beta e_1)
\]

\(^{10}\)This simplification does not restrict the results of the paper.
\[ s.t. \quad e_1 \in \arg \max_{e_1} \left\{ \alpha + \beta e_1' - \frac{e_1'^2}{2} \right\} \quad \text{(IC)} \]
\[ \alpha + \beta e_1 - \frac{e_1'^2}{2} \geq 0 \quad \text{(PC)} \]

The (IC) and the (PC) are the agent’s incentive compatibility and participation constraints, respectively.

**Proposition 1** Without rewards to whistle-blowing, the optimal contract is given by \((\alpha^B, \beta^B) = (-\frac{y^2}{2}, y)\) for \(y \leq 1\), and \((\alpha^B, \beta^B) = (-\frac{1}{2}, 1)\) for \(y > 1\). In both cases the principal gets all the agent’s surplus.

**Corollary 1** Without rewards to whistle-blowing, the agent exerts effort \(e_1^B = \min\{y, 1\}\) at the optimal contract.

Without rewards to whistle-blowing, the principal offers an efficient contract that pays effort depending on the marginal productivity from work and in which the agent makes the effort level that equates his marginal utility and marginal disutility from effort. This contract is independent of \(z\).

## 5 Rewarding Whistle-Blowing

Rewards to whistle-blowing induce the agent to devote costly effort to the gathering of crime evidence. Given crime, effort devoted to gathering crime evidence raises the probability of detection and, therefore, reduces the offender’s willingness to commit crime. The latter, in return, reduces the agent’s incentives to gather crime evidence, since the probability of crime existence is downward sloping in effort devoted to commit crime. It follows that, with rewards, efforts devoted to commit crime and to gathering crime evidence depend on each other.

For the principal, rewards to whistle-blowing imply a shift in utility from changes in his net externalities from crime and in the optimal contract. The former change arises from (now) endogenous probabilities of crime existence and condemnation. The latter change arises from the property of technical substitutability in the agent’s effort: with rewards, the agent may wish to substitute effort devoted to productive activities by effort devoted to activities related to gathering crime evidence.

In what follows I solve the optimal contract between the principal and the agent in two steps. First, I solve the agent’s and the offender’s simultaneous effort decisions. Second, I solve the principal-agent problem given those effort decisions (i.e., I solve the optimal contract for \(e_1\)).
5.1 The Agent’s and Offender’s Simultaneous Effort Choices

At date 1, the agent chooses the levels of $e_1$ and $e_2$ that maximize his utility taking $z$ as given:

$$\max_{e_1, e_2} U(e_1, e_2) = \alpha + \beta e_1 - \frac{(e_1 + e_2)^2}{2} + (1 - \rho) z e_2 R$$  \hspace{1cm} (1)

And the offender chooses the level of $z$ that maximizes his utility taking $e_2$ as given:

$$\max_z O(z) = z \{1 - [\rho + (1 - \rho) e_2]\} - \frac{z^2}{2}$$  \hspace{1cm} (2)

Lemma 2 With rewards to whistle-blowing, there exist $\beta_0 \in [0, 1)$, $\beta_1 = \min \{\beta_{1a}, \beta_{1b}\} \in [0, 2)$, with $\beta_0 < \beta_1$, and $\hat{R} = \frac{1}{(1 - \rho)^2}$, such that:

(i) For $\beta < \beta_0 : (e_1, e_2) = (0, \beta_0)$ and $z = (1 - \rho)(1 - \beta_0)$.

(ii) For $\beta \in [\beta_0, \beta_1]$: $e_1, e_2, z \in [0, 1]$, with $e_1$ and $z$ upward sloping in $\beta$ and $e_2$ downward sloping in $\beta$:

$$e_2 = \beta - e_1 = 1 - \frac{\beta}{(1 - \rho)^2 \hat{R}}$$  \hspace{1cm} (3)

$$z = (1 - \rho)(1 - e_2) = \frac{\beta}{(1 - \rho) \hat{R}}$$  \hspace{1cm} (4)

(iii) For $\beta > \beta_1$ and

- $R < \hat{R} : (e_1, e_2) = (\min \{\beta, 1\}, 0)$ and $z = (1 - \rho)$.
- $R > \hat{R} : (e_1, e_2) = (1, \beta_{1b} - 1)$ and $z = (1 - \rho)(2 - \beta_{1b})$.

Boundaries $\beta_0$ and $\beta_1$ are upward sloping in $R$.\textsuperscript{11}

For all values of the parameters $\beta$ and $R$, the offender’s effort devoted to commit crime is given by the probability of not being discovered; i.e., the probability of not being discovered neither by the inspector $(1 - \rho)$, nor by the agent

\textsuperscript{11}In particular:

$$\beta_0 = \frac{(1 - \rho)^2 R}{1 + (1 - \rho)^2 R} < 1 \hspace{1cm} \beta_{1b} = 2\beta_0 \hspace{1cm} \beta_{1a} = (1 - \rho)^2 R$$

Whether $\beta_{1a}$ higher (lower) than $\beta_{1b}$ depends on the policy instruments $R$ and $\rho$: $\beta_{1a} < \beta_{1b} \iff R < \hat{R} = \frac{1}{(1 - \rho)^2}$. 

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Thus, the higher the agent’s effort devoted to gathering crime evidence, the lower the offender’s effort devoted to crime.

What about the agent’s effort allocation? For $\beta < \beta_0$, the $e_2$’s marginal contribution to the agent’s utility is higher than the $e_1$’s marginal contribution, as the agent is paid (relatively) little for each unit of effort devoted to production. Hence, he only devotes effort to gathering crime evidence. How much effort? It depends on $R$: the higher the level of $R$, the higher the $e_2$.

For $\beta \in [\beta_0, \beta_1]$ the agent allocates effort among production and the gathering of crime evidence. Equation (3) states the agent’s effort allocation in terms of the $e_1$’s and the $e_2$’s marginal contributions to the agent’s utility. Each level of effort is positively related to its own marginal contribution and negatively related to that of the other one. In terms of $\beta$, this implies that the agent substitutes $e_2$ for $e_1$ as $\beta$ increases (i.e., the higher the value of $\beta$, the more biased is the agent’s effort allocation towards productive activities), and vice versa. Note that the agent’s total effort is positively related to $\beta$ ($e_1 + e_2 = \beta$), so that total effort increases with $\beta$.

Equation (4) states the offender’s effort devoted to commit crime in terms of $e_2$, first, and in terms of $\beta$ and $R$, second. The higher is the agent’s relative payment from gathering crime evidence (i.e., the lower the ratio $\beta/R$), the more biased is the agent’s effort allocation towards this activity, and so the lower is the offender’s effort devoted to crime.

Finally, for $\beta > \beta_1$, the agent maximizes effort devoted to production, as he is paid a high amount for it. What about effort devoted to gathering crime evidence? The agent devotes effort to it if and only if the reward is high enough, $R > \hat{R}$. Hence, for high reward values, the agent devotes one unit of effort to productive activities and effort to gathering crime evidence depending on $R$: the higher the reward, the higher the agent’s effort devoted to gathering crime evidence. Instead, for low reward values, the agent only devotes effort to productive activities (at most one unit).\footnote{For explanatory purposes, and w.l.o.g., I assume $y \leq 1$ in all explanations throughout this section, although the general results hold for all values of $y$.}

Note that for $\beta > \beta_1$ the offender’s effort devoted to commit crime is maximum, as the agent minimizes effort devoted to gathering crime evidence.

Figures 2 and 3 show the agent’s effort allocation for different values of $\beta$ for $y \leq 1$ and the case values $R < \hat{R}$ and $R > \hat{R}$, respectively.
Figure 2: The agent’s effort allocation in terms of $\beta$ for $y \leq 1$ and low values of the reward ($R < \hat{R}$).

Figure 3: The agent’s effort allocation in terms of $\beta$ for $y \leq 1$ and high values of the reward ($R > \hat{R}$).
5.2 The Principal-Agent Problem

At date 0, the principal chooses a contract \( w(\alpha, \beta) \) that maximizes his utility and is incentive compatible to the agent and acceptable to both:

\[
\max_{\alpha, \beta} V(\alpha, \beta) = ye_1 - (\alpha + \beta e_1) + z \left\{ G - [\rho + (1 - \rho) e_2] F \right\}
\]

subject to:

\[
(1 - \rho) (1 - e_2)
\]

\[
\alpha + \beta e_1 - \frac{(e_1 + e_2)^2}{2} + (1 - \rho) ze_2 R \geq 0
\]

\[
ye_1 - (\alpha + \beta e_1) + z \left\{ G - [\rho + (1 - \rho) e_2] F \right\} \geq (1 - \rho) \left( G - \rho F \right)
\]

The (ICA) and the (ICO) are the agent and the offender’s incentive compatibility constraints, respectively; and the (PCA) and the (PCp) are the agent and the principal’s participation constraints, respectively.

Regarding the (PCp), the principal may be better off by not hiring the agent. In his decision, he compares the payoffs he gets from only hiring the offender (RHS) and from hiring both the agent and the offender (LHS). The principal hires the agent if, in doing so, he gets the highest payoff.

In what follows I solve the principal-agent problem for the optimal effort choices obtained in Section 5.1. To do it, I solve first the optimal contract for a ‘semi-constrained’ problem without the (PCp). I denote this problem the Semi-Constrained Principal-Agent (SCPA) problem. Second, I check whether the (PCp) holds at the optimal contract of the SCPA problem.

5.2.1 Solving the SCPA Problem

Plugging equations (3), (4) and the (PCA) binding into the principal’s objective function and solving for \( \beta \), the interior solution for \( \beta \) is given by:

\[
\beta^* = \varphi \left\{ y + k \left( (1 - \rho) (G - F) + (1 - \rho)^2 R \right) \right\}
\]

The coefficient \( k \) measures the principal’s capability to distort the agent’s effort allocation through \( \beta \), \( k = -\frac{\partial q_2}{\partial \beta} / \frac{\partial q_1}{\partial \beta} = \frac{1}{1+(1-\rho)^2R} \). The coefficient \( \varphi \) is a multiplier with \( \frac{\partial \varphi}{\partial R} < 0 \) and \( \lim_{R \to \infty} \varphi = \frac{1}{1} \).

\[\text{Particularly: } \varphi = \frac{R[1+(1-\rho)^2R]}{(1-\rho)^2R^2+2(R-F)} \text{, positive for } R > R_h = \frac{\sqrt{1+2F(1-\rho)^2} - 1}{(1-\rho)^2} \text{.}\]
Equation (5) states the agent’s marginal payment for \( e_1 \) in terms of both effort’s \((e_1 \text{ and } e_2)\) marginal contributions to the principal’s utility. In braces, the first term is the \( e_1 \)’s marginal contribution to production \((y)\). The higher the \( e_1 \)’s marginal contribution to production the more interested is the principal in \( e_1 \), and so the higher the \( \beta \) he is willing to pay for it.

The second term in braces is the \( e_2 \)’s marginal contribution to the principal’s utility given \( G, F \) and \( R \). This term can be positive or negative. Inside braces: The higher is the payoff \( G \), the higher is the principal’s benefit from crime, and so the higher the \( \beta \) he is willing to pay to reduce \( e_2 \). The higher is the corporate fine \( F \), the lower is the principal’s benefit from crime, and so the lower the \( \beta \) he is willing to pay to increase \( e_2 \). Finally, the higher is the reward \( R \), the higher is the level of \( e_2 \) the agent is willing to make, and so also the higher are the probability of detection and the \( \beta \) the principal has to pay to reduce \( e_2 \).

Outside brackets, the coefficient \( k \) measures the principal’s capability to distort the agent’s effort allocation through \( \beta \): the higher is the reward, the lower is the principal’s capability to govern over the agent’s effort allocation \((\frac{\partial k}{\partial R} < 0)\).

Note that the effect of rewards is ambiguous: while a reward increase induces the principal to increase \( \beta \) to discourage \( e_2 \), it also induces him to reduce \( \beta \), as for high reward levels he can not govern over the agent’s effort allocation.

Proposition 2 characterizes \( \beta^* \) in terms of \( G \), and Corollary 2 states the comparative statics of \( \beta^* \) with respect to \( R \).

**Proposition 2** *(Interior solution)* There exists \( G \), such that effort devoted to production is underpaid with respect to the benchmark case \((\beta^* < y)\) if and only if \( G < \underline{G} \).

**Corollary 2** *(i)* There exists \( \overline{G} \), with \( \overline{G} > \underline{G} \), such that a reward increase rises \( \beta^* \) if and only if \( G < \underline{G} \).

*(ii)* \( \beta^* \) approaches \( y \) as \( R \) goes to infinity.

For the intuition behind these results, consider a reward increase: if \( G < \underline{G} \), crime is so ‘bad news’ to the principal that he underpays \( e_1 \) to bias the agent’s effort allocation towards activities related to gathering crime evidence. But, as \( R \) goes up, the agent gets incentives from outside the firm to do so and, to restore incentives, the principal increases \( \beta \).

If, instead, \( G > \overline{G} \), crime is so ‘good news’ to the principal that he overpays \( e_1 \) to bias the agent’s effort allocation away from crime detection. As \( R \) goes up, the agent gets incentives from outside the firm to gather crime evidence so, to restore incentives, the principal increases \( \beta \). However, successive increases in \( R \) make this strategy increasingly costly to the principal and so, for a high enough
value of $R$, he finds himself better off by resigning to it and focusing only on the incentives on $e_1$. In terms of Corollary 2, for $G > \mathcal{G}$ we only observe the negative relationship between $\beta$ and $R$. This is due to the fact that for $G > \mathcal{G}$, $\beta$ is too high and it is not profitable for the principal to increase it further.

The second point of Corollary 2 is straightforward now: the higher the value of $R$, the lower the principal’s capability (and possibly interest as well) to govern over the agent’s effort allocation through $\beta$. So, regardless of the value of $G$, $\beta^*$ approaches its value for the benchmark case ($y$) for high values of $R$.

In the light of these results, it will be useful to define $\beta$’s interior solution in terms of $R$:

**Corollary 3** There exist $R_0$, $R_1$, with $0 \leq R_0 \leq R_1$, such that: $R \in [R_0, R_1]$ $\iff \beta^* \in [\beta_0, \beta_1]$.

**CORNER SOLUTIONS:** For $R \notin [R_0, R_1]$, there is no optimal contract profitable to both principal and agent, with $\beta^*$ and $e_1, e_2 \in (0, 1)$. Nevertheless, both parties can still find it profitable to celebrate a contract:

- For $R > R_1$ (i.e., $\beta < \beta_0$), the principal hires the agent only to gather crime evidence. Therefore, he sets $\beta = 0$.

- For $R < R_0$ (i.e., $\beta > \beta_1$), the principal hires the agent for his productive activities, regardless of his possible activities related to gathering crime evidence. For low reward levels ($R < \hat{R}$), the agent does not devote effort to gathering crime evidence, thus the principal will try to achieve productive efficiency: $\beta = e_1 = \min \{y, 1\}$. However, this will be only possible if $y > \beta_1$. Thus, in this corner solution, the principal sets: $\beta = \min \{\beta_{1a}, y\}, 1$ (remember that for $R < \hat{R}$, $\beta_1 = \beta_{1a}$).

Instead, for high reward levels ($R > \hat{R}$), the agent devotes effort to gathering crime evidence and maximizes effort devoted to work ($e_1 = 1$). An increase of $\beta$ beyond $\beta_1$ has no impact on $e_1$, as $e_1$ has already taken its maximum value, thus the principal sets $\beta = \beta_1 = \beta_{1b}$ (remember that for $R > \hat{R}$, $\beta_1 = \beta_{1b}$).

Summing up, the contract that solves the SCPA problem is the ‘candidate contract’ for the optimal contract. For medium/low reward values, this contract allows activities related to gathering crime evidence to co-exist with productive activities ($e_1 > 0$, $e_2 \geq 0$). Instead, for high reward values, this contract allows

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14For $\beta < \beta_0$, the corner solution is $(e_1, e_2) = (0, \beta_0)$. As $e_2$ does not depend on the particular value that $\beta$ takes in the interval $[0, \beta_0]$, w.l.o.g. $\beta$ can be set equal to zero.

15For $R < R_0$ effort $e_2$ is minimized. Particularly, when $R < \hat{R}$, $e_2 = 0$. 

16
Figure 4: Candidate marginal payment to productive effort for \( y \leq 1 \) and \( G > G \) (highlighted). Boundaries \( \beta_0 \) and \( \beta_1 \) in solid lines, and the interior solution \( \beta^* \) in dashed line. Productive effort is efficiently paid for low reward values and overpaid for medium/high reward values. For sufficiently high reward values \( (R > R_1) \), \( \beta = 0 \).

only for activities related to gathering crime evidence \( (e_1 = 0 \text{ and } e_2 > 0) \). Full productive efficiency can be achieved for reward values close to zero, otherwise productive effort is overpaid or underpaid with respect to the benchmark case (Figures 4 and 5).

5.2.2 The Principal’s Participation Constraint and the Optimal Contract

Under what conditions is the candidate contract an optimal contract? Plugging the candidate contract \( w(\alpha, \beta) \) of the SCPA model and the optimal effort levels, obtained in Section 5.1, in the (PCp), we obtain the following:

**Proposition 3** With rewards to whistle-blowing, there exist \( \hat{R}, G_0, G_1, G_a < G_b \), and \( \hat{y} \), such that the principal hires the agent if and only if:

(i) \( R \in [R_0, R_1] \) and \( y > \hat{y} \), or if \( y < \hat{y} \) but \( G \notin (G_a, G_b) \);

(ii) \( R > R_1 \) and \( G < G_0 \); and

(iii) \( R < \min \left\{ R_0, \hat{R} \right\} \), or if \( R \in (\hat{R}, R_0) \) and \( G < G_1 \).

Proposition 3 says that there is a contract in three cases. First, when the agent is not interested in gathering crime evidence. This is the benchmark case, that arises for very low reward values \( \left( R < \min \left\{ R_0, \hat{R} \right\} \right) \).
Second, when the agent’s productive activities are profitable enough to compensate the principal’s losses from the activities related to gathering crime evidence. This case arises for intermediate reward values and a high enough $e_1$’s marginal productivity ($R \in [R_0, R_1]$ and $y > \hat{y}$, or if $y < \hat{y}$ and $G > G_b$).\footnote{For $R \in [R_0, R_1]$, the principal knows that if he hires the agent, this will allocate effort among production and the gathering of crime evidence. For high values of $y$, hiring the agent is profitable to the principal regardless of $e_2$. For low values of $y$, instead, this is so if and only if $G \notin (G_a, G_b)$. A low payoff from crime ($G < G_a$), makes deterrence desirable to the principal, hence he hires the agent regardless of the detrimental effect that $e_2$ has on production. A high payoff from crime ($G > G_b$), instead, makes deterrence not desirable to the principal, but such a high payoff allows him to set $\beta$ high enough to reduce $e_2$ in such a way that hiring the agent is still profitable.}

Third, when the agent’s activities related to gathering crime evidence are profitable to the principal. This case completes Proposition 3 and arises when crime creates negative externalities to the principal, or if positive, too little.\footnote{This case contemplates three sub-cases: for $R > R_1$, the principal hires the agent to make activities related to gathering crime evidence. Such a contract takes place if and only if the principal’s payoff from crime is low enough ($G < G_a$). For $R \in [R_0, R_1]$ and $y < \hat{y}$, the agent allocates effort among production and the gathering of crime evidence. Such a contract takes place if and only if the principal’s payoff from crime is low enough ($G < G_a$). For $R < R_0$, the agent maximizes effort devoted to production and devotes effort to gathering crime evidence depending on the value of $R$. If $R < \hat{R}$, his effort devoted to gathering crime evidence is zero, as the reward is too low (benchmark case). But, if $R > \hat{R}$, his effort devoted to gathering crime evidence is positive. In this case, there is a contract if and only if the principal’s payoff from crime is low enough ($G < G_1$).}

Proposition 4 defines the principal-agent contract in the presence of rewards.
Proposition 4 With rewards to whistle-blowing, the principal-agent contract \( w(\alpha, \beta) \) is given by a marginal payment on productive effort given as follows:

(i) For \( R \in [R_0, R_1] \): \( \beta \) is defined as in equation (5).

(ii) For \( R > R_1 \): \( \beta = 0 \).

(iii) For \( R < R_0 \) and

- \( R < \hat{R} \): \( \beta = \min \left\{ \max \left\{ \beta_{1a} = (1 - \rho)^2 R, y \right\}, 1 \right\} \), or if

- \( R > \hat{R} \): \( \beta = \beta_{1b} = \frac{2(1 - \rho)^2 R}{1 + (1 - \rho)^2 R} \)

and \( \alpha \) such that the principal gets all the agent’s surplus.

Introducing rewards to whistle-blowing affects the optimal contract between the principal and the agent in two ways: the decision on whether to celebrate the contract (Proposition 3), and if so, the values \( \alpha \) and \( \beta \) that define it (Proposition 4).

Without rewards, there is always a contract, defined over the agent’s marginal productivity from effort devoted to productive activities. With rewards, instead, the existence of contract depends on the level of the reward, on the principal’s externalities from crime and, only in third place, on the agent’s marginal productivity from effort devoted to productive activities. Together, high rewards and high externalities from crime, create an environment in which hiring the agent is too costly for the principal. A low marginal productivity from effort devoted to production aggravates the situation. Therefore, we should expect no contract between the principal and the agent in these cases.

In the cases in which there is still a contract, productive efficiency can be achieved for reward values close to zero. Otherwise, productive effort is overpaid or underpaid with respect to the benchmark case.

6 Implications of Rewarding Whistle-Blowers

6.1 Deterrence

Through rewards to whistle-blowing, the anti-crime authority distorts the probability of crime existence: without rewards, this probability is \( P_c(e_2 = 0) = (1 - \rho) \), with rewards, it is \( P_c(e_2) = (1 - \rho)(1 - e_2) \), and hence lower than before. Corollary 4 follows immediately:
Corollary 4 The introduction of rewards to whistle-blowing improves deterrence if and only if, after rewards, there is a contract and $e_2 > 0$.

What if, given $e_2 > 0$, there is a reward increase?

Lemma 3 (Assume $e_2 > 0$) A reward increase assures an improvement in deterrence for:

(i) low (high) reward values, and

(ii) intermediate reward values and high values of $G$.

For low and high values of $R$, the agent chooses effort devoted to gathering crime evidence based solely on the value of $R$. In particular, the higher the reward, the higher his effort devoted to this activity. Therefore, unless $e_2$ is already 1 (its maximum value), a reward increase improves deterrence.

Instead, for intermediate reward values, the agent considers both $R$ and $\beta$, to choose how much effort to devote to gathering crime evidence. In this case, a reward increase can have two counter-effects on $e_2$: whereas it directly encourages $e_2$, it may also discourage $e_2$ (indirectly) through its impact on $\beta$. To see this, consider the case in which crime is not desired by the principal (i.e., $G$ is low). In this case, a reward increase is ‘good news’ to him: as $e_2$ is encouraged by the public authority, he can restore productive efficiency with a higher $\beta$. But, in return, a higher $\beta$ induces the agent to reduce $e_2$. Hence, the reward increase improves deterrence if and only if the $e_2$’s increment due to the higher $R$ more than compensates its subsequent reduction due to the higher $\beta$. Thus, for $\frac{\partial \beta}{\partial R} > 0$ (which holds for low values of $G$), the deterrence effect of a reward increase is ambiguous.

However, for $\frac{\partial \beta}{\partial R} < 0$ (which holds for high values of $G$), it is assured a gain in deterrence after a reward increase, as $e_2$ goes up due to a higher $R$ and a lower $\beta$.

As a final comment, note that $\frac{\partial \beta}{\partial R} < 0$ implies that (i) $e_1$ is overpaid, as the principal gets high externalities from crime, and (ii) in an attempt to bias the agent’s effort allocation away from crime detection, the principal can not make use of $\beta$, as he can not increase $\beta$ more. In this scenario, too much incentives towards the gathering of crime evidence (i.e., successive reward increases), can put the existence of the contract at risk, as the principal may find himself better off by not hiring the agent and keeping crime in the firm. Therefore, the anti-crime authority should be cautious on the level of the reward, such that encouraging whistle-blowing without risking the existence of the contract.
6.2 The Principal’s Utility with Rewards

The introduction of rewards to whistle-blowing is profitable for the principal if his utility with rewards is higher than that without rewards; i.e., if the following condition holds:

\[ V(\alpha(R), \beta(R)) \geq \frac{y^2}{2} + (1 - \rho)(G - \rho F) \] (6)

The LHS is the principal’s utility in the presence of rewards and the RHS his utility for the benchmark case. Note that condition (6) is similar to (PCp) described in Section 5.2, but for the additional term \(\frac{y^2}{2}\) in the RHS. This term states the principal’s net utility from hiring the agent in the absence of rewards.\(^1\) This similarity suggests that the introduction of rewards implies a gain in utility for the principal if and only if those conditions for which (PCp) holds are strong enough to ensure compliance in excess over \(\frac{y^2}{2}\).

**Lemma 4** The introduction of rewards implies a gain in utility for the principal if and only if rewards do not discourage the principal from hiring the agent and crime is highly detrimental for the principal (i.e., \(G\) is low enough).

When rewards discourage the principal from hiring the agent, the principal obtains a net payoff from crime \((1 - \rho)(G - \rho F)\) with and without rewards. However, without rewards he also obtains a positive payoff from the agent’s work \((\frac{y^2}{2})\). Undoubtedly, the principal is better off without rewards.

When rewards do not discourage the principal from hiring the agent, his net payoffs from crime and from the agent’s work differ on whether there are rewards or not. In this case, the introduction of rewards implies a gain in utility for the principal if these allow him to reduce an undesired (and unprofitable) crime for him; i.e., if \(G\) is low enough.

At this point, it is worth to mention two cases in which the principal is indifferent regarding the introduction of rewards.\(^2\) First, when rewards are very low. In this case, the agent is not interested in gathering crime evidence and the principal can offer an efficient contract almost always. Provided the

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\(^1\)Without rewards, the principal always hires the agent. From Proposition 1 and Corollary 1, the principal’s utility for the benchmark case is: \(U = \frac{y^2}{2} + (1 - \rho)(G - \rho F)\) if \(y \leq 1\), and \(U = y - \frac{1}{2} + (1 - \rho)(G - \rho F)\) if \(y > 1\). Following the analysis in previous sections, and w.l.o.g., I assume \(y \leq 1\) in condition (6) and in the explanations that follow it, although the general results from this section hold for all values of \(y\).

\(^2\)These cases correspond to scenarios for which (PCp) holds with inequality and condition (6) holds with equality.
efficient contract, the principal is indifferent to the introduction of rewards.\textsuperscript{20} Second, when the principal’s net gains from crime are high enough to bias the agent’s effort allocation away from crime detection. In this case, the principal can set $\alpha$ and $\beta$ such that inducing the agent an effort allocation close to that for the benchmark case ($e_2 \to 0$ and $e_1 \to e_1^B$). Provided this contract (although not efficient as productive work is overpaid), the principal is indifferent to the introduction of rewards.\textsuperscript{21}

A second issue to discuss refers to how a reward increase affects the principal’s utility. Assuming that it is profitable for the principal to hire the agent, what if rewards go up?

**Lemma 5 (Assume contract)** A reward increase makes the principal’s utility to go up if the agent’s activities related to gathering crime evidence are profitable to the principal.

For low reward values ($R < R_0$), the principal hires the agent for his productive activities, regardless of $e_2$, and the agent devotes effort to gathering crime evidence depending on $R$: the higher the reward, the higher this effort level. In this scenario, a reward increase implies a gain in utility for the principal if and only if he is interested in crime detection.

For high reward values ($R > R_1$), the principal hires the agent for his activities related to gathering crime evidence. In this case, a reward increase always implies a gain in utility for the principal, as $e_2$ is upward sloping in $R$.

For $R \in [R_0, R_1]$, the agent devotes effort to production and to the gathering of crime evidence, and the principal underpays/overpays productive effort. In this scenario, a reward increase has two effects on the principal’s utility. First, a utility gain through a higher productive efficiency, as $\beta$ approaches $y$ with successive increases in $R$ (Corollary 2). Second, a utility change due to a higher/lower net payoff from crime: an increase in $R$ distorts the agent’s effort allocation and, through it, the probability of crime existence. When crime is undesired by the principal ($G$ is low), higher values of $R$ imply less crime and the principal’s net payoff from crime goes up. In this case, an increase in $R$ makes the principal’s utility to go up, undoubtedly. However, when crime is desired by the principal ($G$ is high), the effect of higher values of $R$ in the principal’s net payoff from crime is, a priori, unknown (it depends on the parameters of the model); and therefore so is the final effect on the principal’s utility.

\textsuperscript{20}For $R < \min \{R_0, \hat{R}\}$, the optimal contract is given by $\beta = \min \{\max \{\beta_{1a}, y\}, 1\}$ and $\alpha$ such that the principal gets all the agent’s surplus. At this contract, $(e_1, e_2) = (\beta, 0)$. The principal is indifferent regarding the introduction of rewards if these do not prevent him to offer the agent the efficient contract: $\beta = e_1 = y$ if $y \leq 1$, or $\beta = e_1 = 1$ if $y > 1$.

\textsuperscript{21}High values of $G$ allow the principal to overpay work such that inducing $e_2 \to 0$ and $e_1 \to e_1^B$. Since $\alpha$ is set such that the principal get’s all the agents surplus, the principal retrieves any overpayment and his utility from hiring the agent is that for the benchmark case.
7 Private Reward Programs

Private Reward Programs (PRPs) work as Whistle-Blower Programs (WBPs): both reward whistle-blowers to encourage the exposure of corporate crime. However, PRPs avoid the detection costs associated to the public exposure of the wrongdoing, as the whistle-blow is private to the firm. Instead, PRPs have to afford the payment of rewards.

To introduce PRPs in the model, I assume that these and WBPs are equally efficient in deterring crime. This assumption implies that the offender’s behavior with respect to crime does not depend on the formal system used by the agent to report the evidence, but, as I have assumed so far, on how much effort the agent devotes to gathering crime evidence.

In this context, the principal chooses whether to create a PRP that rewards \( r > 0 \) to the agent for the private exposure of the corporate crime and offer him a contract \( w(\alpha(r), \beta(r)) \); or, instead, to offer the agent a contract \( (\alpha(R), \beta(R)) \), without PRP \( (r = 0) \).

**The agent and the offender’s effort choices:** With PRPs, the agent and the offender’s effort choices are as described for WBPs (Section 5.1), as PRPs and WBPs are equally efficient in deterring crime. One simply has to consider \( r \) instead of \( R \).

**The principal-agent problem:** The principal’s problem consists on whether to introduce a PRP and, if so, on defining the value of \( r \).

Assuming the existence of a WBP, this problem is described as follows:

\[
\begin{align*}
\max_{\alpha, \beta, r} \quad V(\alpha, \beta, r) &= ye_1 - (\alpha + \beta e_1) + z \left( G - \rho F \right) + z \left( 1 - \rho \right) e_2 \ r \\
\text{s.t.:} \quad (e_1, e_2) &\in \arg \max_{e_1, e_2} \left\{ \alpha + \beta e_1 - \frac{(e_1 + e_2)^2}{2} + (1 - \rho) ze_2 r \right\} \quad \text{(ICa)} \\
\quad z &= (1 - \rho) (1 - e_2) \quad \text{(ICo)} \\
\quad \alpha + \beta e_1 - \frac{(e_1 + e_2)^2}{2} + z \left( 1 - \rho \right) e_2 \ r &\geq 0 \quad \text{(PCa)} \\
\quad ye_1 - (\alpha + \beta e_1) + z \left( G - \rho F \right) + z \left( 1 - \rho \right) e_2 \ r
\end{align*}
\]
≥ \max \{ V(\alpha(R), \beta(R)), (1 - \rho)(G - \rho F) \} \quad (PCp)

The principal’s outside option is his highest possible payoff for \( r = 0 \).

In the case in which there is no WBP the problem is described alike, but for the RHS of (PCp) which is given by the principal’s net payoff for the benchmark case:\(^{22}\) \( \frac{y^2}{2} + (1 - \rho)(G - \rho F) \).

Solving, the optimal contract goes as follows:

**Proposition 5** The principal creates a PRP that offers \( r > 0 \) to the agent for the private report of crime evidence if and only if:

i. (Assuming no WBP) crime is highly detrimental for him (\( G \) is low enough).

ii. (Assuming WBP) crime is highly detrimental for him (\( G \) is low enough) and public rewards are not high enough (\( R \) is low).

This contract is given by \( \beta = 0 \) and \( \alpha(R) < 0 \) such that the principal gets all the agent’s surplus.

**Corollary 5** With PRPs, \((e_1, e_2) = \left( 0, \frac{(1 - \rho)^2 r}{1 + (1 - \rho)^2 r} \right)\) and \( z = (1 - \rho)(1 - e_2) \).

Proposition 5 states that low externalities from crime can incentivize the principal to introduce a PRP in the absence of a WBP, and in its presence if the public reward is not high enough. These cases correspond to those in which the principal hires the agent only for his activities related to gathering crime evidence.

Regarding the size of the reward, note that the principal can set \( r \) as high as he desires, as he retrieves all reward payments through \( \alpha \) anyways. This analysis suggests very high values of \( r \), as the probability of crime existence (and so also the expected detection costs) is downward sloping in \( r \).\(^{23}\)

Finally, note that the introduction of a PRP implies that deterrence and the principal’s utility are maximized. The latter result is intuitive: the introduction of a PRP is voluntary, thus if the principal introduces it, it must be because this implies a gain in utility for him. For the second result consider a WBP that offers \( R \). Furthermore, assume that the parameters of the model are such that the principal hires the agent to gathering crime evidence. Hence, \( e_2 \) and

\(^{22}\)Following the analysis in previous sections, and w.l.o.g., I assume \( y \leq 1 \) in (PCp) for the benchmark case, although the general results from this section hold for all values of \( y \).

\(^{23}\)With PRP, the principal’s utility at the optimal contract is upward sloping in \( r \). Please, see the Appendix for details.
deterrence are maximum: $e_2 = \frac{\lambda + \rho}{\lambda + (1-\rho)^2 R}$ and $z = \frac{\lambda - \rho}{\lambda + (1-\rho)^2 R}$, the higher is $R$, the higher is $e_2$ and the lower is $z$. In this context, if the principal finds it $e_2$ to low, he can introduce a PRP that offers $r > R$ to induce the agent to exert more effort. Therefore, for any given $R$, the introduction of a PRP implies an increase in $e_2$ and, consequently, higher deterrence.

8 Conclusion

Whistle-blowers play an important role in fighting fraud by companies and the government, including fraud against the government. To encourage whistle-blowing, the USA legislation offers rewards to whistle-blowing on corporate crimes. What are the implications of rewarding whistle-blowing on the contract between a firm’s owner and a non-offender employee? And on deterrence? Are rewards desirable for firm owners? If so, under which conditions?

This paper gives an answer to these questions by developing a model that assumes: (i) rewards create a decision problem to a non-offender employee on how to allocate effort among productive activities and activities related to the gathering of crime evidence, (ii) effort devoted to gathering crime evidence affects the probability of crime existence which, in return, affects the expected payoff from rewards, (iii) effort devoted to production is observable (so that production can be contracted upon it), but efforts devoted to gathering crime evidence and committing crime are not, (iv) the principal is not the crime offender, but gets externalities (positive or negative) from crime, and (v) the principal can not design a law-enforceable contract with the offender to encourage/prevent crime.

Regarding the implications of rewarding whistle-blowing on contracts, two results stand out. First, effort devoted to production is overpaid (underpaid) if the principal wants to bias the agent’s effort allocation towards (away from) productive activities. The principal wants to bias the agent’s effort allocation towards productive activities when he gets high positive externalities from crime. To this end, he overpays productive activities, as this discourages the agent from gathering crime evidence. Alternatively, the principal wants to bias the agent’s effort allocation towards crime detection when he gets low externalities from crime (negative or positive but low). To this end, he underpays productive activities. As an extreme case, the principal hires the agent only for his activities related to crime detection.

Second, rewards may imply no contract between the principal and the agent. Consider the case in which the principal overpays productive activities to bias the agent’s effort allocation away from crime detection: for high reward values, the required overpayment can be unprofitable for the principal, especially if the agent’s marginal productivity from work is low. As a consequence, the principal may find himself better off by not hiring the agent, even if in the absence of rewards he would have done it.
In the light of these results, the introduction of rewards improves deterrence if and only if rewards do not discourage the principal from hiring the agent and \( e_2 > 0 \).

What is the effect of a reward increase in deterrence? And in the principal’s utility? Regarding deterrence, there is an improvement in deterrence following a reward increase if crime detection is desired by the principal (i.e., if the principal gets high negative externalities from crime), or if the principal’s externalities from crime are high enough to sustain hiring the agent in a scenario in which the agent’s effort allocation is biased towards crime detection. With respect to the effect on the principal’s utility, there is a gain in utility following a reward increase if crime detection is desired by the principal.

Finally, I also demonstrate that for low enough crime externalities, it is in the principal’s interest to create a reward-program private to the firm, regardless of the existence of a whistle-blower program. A program of this type arises when crime is highly detrimental to the principal and, if there exists a whistle-blower program, when also the public reward is not high enough to deter crime as much as the principal would like. Moreover, I demonstrate that the use of a private reward-program implies maximum deterrence.

Summing up, whistle-blower programs can improve deterrence, but at the expense of productive efficiency. The loss in efficiency is lower when the principal gets low (negative) externalities from crime, as it is associated only to less effort devoted to productive activities – and not also to the possibility of no-contract. Nevertheless, in this case, the principal may also have private incentives to create a private reward program, with higher benefits for him and for crime deterrence. In the light of this result, this paper favors the use of whistle-blower programs to deter crimes that work in favor of the interest of the principal (e.g., tax-frauds, collusion, environmental crimes, etc.) and when the agent’s work is highly important to the firm (in terms of the model, when the agent’s marginal productivity from work \( y \), is high), such that the principal finds it too costly to dispense with the agent’s activities (e.g., accountants, middle or low-level managers, executive secretaries, etc.)

Appendix

**Lemma 1:** From the partial derivative of \( O(z) \) with respect to \( z \): \( z^B = 1 - \rho \). Since \( O(z) \) is concave in \( z \), \( z^B = \arg \max \{O(z)\} \).

From the partial derivative of \( U(e_1) \) with respect to \( e_1 \): \( e_1^B = \min \{\beta, 1\} \), for \( \beta \geq 0 \) and \( e_1 \in [0, 1] \). Since \( U(e_1) \) is concave in \( z \), \( e_1^B = \arg \max \{U(e_1)\} \).

**Proposition 1:** Follows from (i) agent’s optimal effort allocation \( e_1^B \) (Lemma 1), and (ii) \( \alpha \) such that the principal gets all the agent’s surplus.
Lemma 2: The FOC from the offender’s problem is:
\[
\frac{\partial O}{\partial z} = 1 - [\rho + (1 - \rho) e_2] - z
\]  
(7)

The FOCs from the agent’s problem are:
\[
\frac{\partial U}{\partial e_1} = -e_1 - e_2 + \beta
\]  
(8)

\[
\frac{\partial U}{\partial e_2} = -e_1 - e_2 + (1 - \rho) z R
\]  
(9)

From (7), the best response \(e_2(z)\) of the offender is:
\[
e_2(z) = 1 - \frac{\rho}{1 - \rho} - z
\]
and from (8) and (9), the best response \(e_2(z)\) of the agent is:
\[
e_2(z) = \begin{cases} 
\min\{1, \max\{(1 - \rho) z R - 1, 0\}\} & \text{if } z < \frac{\beta}{1 - \rho} R \\
\min\{\max\{(1 - \rho) z R - 1, 0\}, \min\{(1 - \rho) z R, 1\}\} & \text{if } z = \frac{\beta}{1 - \rho} R \\
\min\{(1 - \rho) z R, 1\} & \text{if } z > \frac{\beta}{1 - \rho} R 
\end{cases}
\]

Solving, the equilibrium is:
\[
(e_2, z) = \begin{cases} 
(\beta_0, (1 - \rho) (1 - \beta_0)) & \text{if } \beta < \beta_0 \\
\left(1 - \frac{\beta}{(1 - \rho) z R}, \frac{\beta}{(1 - \rho) R}\right) & \text{if } \beta \in (\beta_0, \beta_1) \\
(e_2, z) & \text{if } \beta > \beta_1 
\end{cases}
\]

where \(\beta_0 = \frac{(1 - \rho)^2 R}{1 + (1 - \rho)^2 z R}\), \(\beta_1 = \min\{\beta_{1a} = (1 - \rho)^2 R, \beta_{1b} = 2\beta_0\}\), and:
\[
(e_2, z) = \begin{cases} 
(0, 1 - \rho) & \text{if } \beta_1 = \beta_{1a} \\
(\beta_{1b} - 1, (1 - \rho) (2 - \beta_{1b})) & \text{if } \beta_1 = \beta_{1b} 
\end{cases}
\]

Finally, at the equilibrium, \(e_1\) is:
\[
e_1 = \begin{cases} 
0 & \text{if } \beta < \beta_0 \\
\beta + \frac{\beta}{(1 - \rho) z R} - 1 & \text{if } \beta \in (\beta_0, \beta_1) \\
\bar{e}_1 & \text{if } \beta > \beta_1 
\end{cases}
\]

where: \(\bar{e}_1 = \min\{\beta, 1\}\) if \(\beta_1 = \beta_{1a}\), and \(\bar{e}_1 = 1\) if \(\beta_1 = \beta_{1b}\).

Proposition 2: \(\beta^*\) is linearly related to \(G\) and \(y\). Thus, there exists a unique \(G\) such that \(\beta^* > y\) if and only if \(G > G^*\).
Proposition 3: Rewrite the (PCp) as:

\[ X = ye_1 - (\alpha + \beta e_1) + z \left\{ G - [\rho + (1 - \rho) e_2] \, F \right\} - (1 - \rho) \left( G - \rho F \right) \geq 0 \quad (10) \]

The (PCp) holds if and only if \( X \geq 0 \).

(i) Assume \( R \in [R_0, R_1] \). Substituting the interior solution of the SCPA’s contract in (10), simple algebra shows that \( X \) is a polynomial of degree 2 in \( G \), with positive coefficient in the quadratic term, and \( X_{\text{min}} \geq 0 \) if and only if \( y \geq \hat{y} = \frac{(1-\rho)^2 R}{(1-\rho)^2 R + 1} \). For \( y < \hat{y} \), the roots of the polynomial are \( G_a \) and \( G_b \), with \( G_a < G_b \), such that \( X \geq 0 \) if and only if \( G / \in [G_a, G_b] \).

(ii) Assume \( R \notin [R_0, R_1] \). Efforts at the corner solution are independent of \( G \). For \( R > R_1 \) and \( R \in (\hat{R}, R_0) \), \( X \) is linear and downward sloping in \( G \). Thus, there exists a unique value of \( G \) such that \( X > 0 \) if and only if \( G \) is below this value. Denote these critical values by \( G_0 \) and \( G_1 \) for \( R > R_1 \) and \( R \in (\hat{R}, R_0) \), respectively.

For \( R < \min \left\{ R_0, \hat{R} \right\} \), \( X \geq 0 \) for all values of \( G \).

Proposition 4: Follows from Lemma 2, Corollary 3 and Proposition 3.

Lemma 3: There is a deterrence effect from a reward increase if and only if \( \frac{\partial e_2}{\partial R} > 0 \).

Assume \( R \notin [R_0, R_1] \): \( e_2 \in \{0, \beta_0, \beta_1b - 1\} \), where \( 0 < \beta_0 < \beta_1b - 1 \) and \( \frac{\partial \beta_0}{\partial R}, \frac{\partial \beta_1b}{\partial R} \geq 0 \). Thus, \( \frac{\partial e_2}{\partial R} \geq 0 \).

Assume \( R \in [R_0, R_1] \): \( e_2 = 1 - \frac{\beta}{(1-\rho)^2 R} \), with \( \beta \) upward or downward sloping in \( R \).

Taking the partial derivative of \( e_2 \) with respect to \( R \):

\[ \frac{\partial e_2}{\partial R} = \frac{1}{[(1-\rho)^2 R]^2} \left\{ \beta (1-\rho)^2 - \frac{\partial \beta}{\partial R} \frac{1}{(1-\rho)^2 R} \right\} \]

The first term in brackets is the direct effect of a higher reward in \( e_2 \), which is always positive: A reward increase encourages \( e_2 \). The second term in brackets is the indirect effect, which can be positive, negative or zero, depending on how the reward increase distorts \( \beta \).

For high values of \( G \), \( \frac{\partial \beta}{\partial R} < 0 \), thus \( \frac{\partial e_2}{\partial R} > 0 \). For low values of \( G \), instead, \( \frac{\partial \beta}{\partial R} > 0 \), thus the effect of a reward increase on \( e_2 \) depends on the parameters of the model.

Lemma 4: Rewrite condition (6) in the text as:

\[ W = ye_1 - (\alpha + \beta e_1) + z \left\{ G - [\rho + (1 - \rho) e_2] \, F \right\} - (1 - \rho) \left( G - \rho F \right) - \frac{y^2}{2} \geq 0 \quad (11) \]
The introduction of rewards improves the principal’s utility if and only if \( W \geq 0 \).

Following notation in Proposition 3: \( W = X - \frac{y^2}{2} \), \( W \) and \( X \) have the same functional form with respect to \( G \). In addition, \( W \) and \( X \) have the same coefficients with respect to \( G \), but for the independent term, which is lower for \( W \). Then:

(i) Assume \( R \in [R_0, R_1] \). Substituting the interior solution of the SCPA’s contract in (11), \( W \) is a polynomial of degree 2 in \( G \) with positive coefficient in the quadratic term and \( W_{\min} < X_{\min} \). In addition, simple algebra shows that \( W_{\min} < 0 \), with roots \( G_{W_a} \) and \( G_{W_b} \), \( G_{W_a} < G_a < G_b < G_{W_b} \), as the polynomial \( W \) equates the polynomial \( X \), but for the fact that the former has a lower independent term. Hence: given contract, the introduction of rewards improves the principal’s utility for \( G / \in \left( G_{W_a}, G_{W_b} \right) \), and reduces the principal’s utility for \( G / \in \left( G_a, G_{W_a} \right) \cap \left( G_b, G_{W_b} \right) \).

(ii) Assume \( R \notin [R_0, R_1] \). In the corner solutions, efforts are independent of \( G \).

For \( R > R_1 \) and \( R \in (\hat{R}, R_0) \), \( W \) is linear and downward sloping in \( G \). Thus, there exists a unique value of \( G \) such that \( W > 0 \) if and only if \( G \) is below this value. Denote these critical values by \( G_{W_0} \) and \( G_{W_1} \), respectively.

For \( R < R_0 \), the principal hires the agent for his productive activities, regardless of \( e_2 \). The agent devotes effort to gathering crime evidence depending on the reward value: the higher the reward, the higher the effort level \( (\partial e_2 / \partial R \geq 0) \). Two possibilities arise:

- For \( R < \hat{R} \): \( e_2 = 0 \) and \( e_1 = \beta_1 a > y \), with \( \partial e_1 / \partial R \geq 0 \). A reward increase does not distort \( e_2 \), but discourages \( e_1 \) with respect to its efficient level. There is a loss in utility following a reward increase.

- For \( R > \hat{R} \): \( e_1 = 1 \) and \( e_2 = \beta_1 b - 1 \), with \( \partial e_2 / \partial R \geq 0 \). In this case, there exists \( \hat{G} < G_1 \) such that: \( \partial V / \partial R \geq 0 \implies G < \hat{G} \).

For \( R \in [R_0, R_1] \), the agent devotes effort to production and to the gathering of crime evidence. A reward increase has two effects in the principal’s utility: a distortion in utility due to \( \beta \) approaching \( y \), and a distortion in utility due to that an increase/reduction in \( e_2 \) changes his net payoffs from crime.

\[
\frac{\partial V^*}{\partial R} = \frac{\partial \beta^*}{\partial R} (y-\beta^*) - \frac{\partial e_2^*}{\partial R} \left[ y + \frac{(y-\beta^*)}{k} \right]
\]

\( \text{Efficiency Effect} \quad \text{Crime Net Payoff Effect} \)
The Efficiency Effect is positive but for \( G \in \{ \mathcal{G}, \mathcal{G} \} \) (where it is negative), and the sign of the Crime Net Payoff Effect is assured to be positive for a high enough crime externality (\( G > \mathcal{G} \)). Hence, \( \frac{\partial V}{\partial R} \geq 0 \) if \( G > \max \{ \mathcal{G}, \mathcal{G} \} \). Otherwise, the ultimate effect of an increase in \( R \) in the principal’s utility depends on the parameters of the model.

**Proposition 5:** The principal introduces a PRP if and only if the payoff he obtains with it is higher than the one he obtains without it.

With PRP, the SCPA can be set as:

\[
\max_{\beta, r} V(\beta, r) = ye_1 - \frac{(e_1 + e_2)^2}{2} + (1 - \rho) (1 - e_2) (G - \rho F)
\]

with FOCs:

\[
\frac{\partial V}{\partial \beta} = y \frac{\partial e_1}{\partial \beta} - (e_1 + e_2) \left( \frac{\partial e_1}{\partial \beta} + \frac{\partial e_2}{\partial \beta} \right) - (1 - \rho) (G - \rho F) \frac{\partial e_2}{\partial \beta} \quad (12)
\]

\[
\frac{\partial V}{\partial r} = \frac{\partial e_2}{\partial r} \left[ -y - (1 - \rho) (G - \rho F) \right] \quad (13)
\]

Condition (13) is positive for \( G \leq G_r = \rho F - \frac{y}{(1 - \rho)} \). This implies that: (i) the principal’s utility is increasing in \( r \) for \( G \leq G_r \), and (ii) given a contract with PRP, the higher the \( r \) the higher the principal’s utility.

For the rest of the proof I assume \( G < G_r \), such that the principal finds it profitable to introduce a PRP.

From above comments and (12), the principal maximizes profits in a candidate contract with PRP with \( \beta^* = 0 \) and \( r \to \infty \). Following our assumption in the main text, \( \alpha \) is set such that the principal gets all the agents surplus.

For this candidate contract, \( e_1^* = 0 \) and \( e_2^* = \frac{(1 - \rho)^2 r}{1 + (1 - \rho)^2 r} \). The principal’s payoff is:

\[
V_{PRP}^* = \left( 1 - \rho - \frac{(1 - \rho)^3 r}{1 + (1 - \rho)^2 r} \right) (G - \rho F) - \frac{(1 - \rho)^2 r}{1 + (1 - \rho)^2 r}
\]

Principal’s participation constraint:

(i) Assume there is no WBP: the principal’s outside option is \( V_0 = (1 - \rho) (G - \rho F) + \frac{y}{2} \). Since \( V_{PRP}^* \) and \( V_0 \) are linear in \( G \), there exists \( G_{crit} \) such that the principal introduces the PRP if and only if \( G \) is low enough, i.e., \( G < \min \{ G_r, G_{crit} \} \).

(ii) Assume there exists a WBP: the principal’s outside option is \( \max \{ V_{WBP}, V_00 \} \), where \( V_{PRP}^* = V(\alpha(R), \beta(R)) \), and \( V_00 = (1 - \rho) (G - \rho F) \). Since \( V_00 \) is linear in \( G \), for \( V_00 > V_{WBP} \) the proof follows as in (i). Instead, when \( V_{WBP} > V_00 \) three cases are possible.
(a) Assume \( R > R_1 \). At the optimal contract with WBP: \( e_1^* = 0 \) and \( e_2^* = \frac{(1-\rho)^2 R}{1+(1-\rho)^2 R} \). In this context, \( V_{WBP} \) is linear in \( G \) and the proof follows as in (i).

(b) Assume \( R < R_0 \). At the optimal contract with WBP, \( e_1^* \) is maximum and \( e_2^* \) is minimum:

- For \( R_0 < \tilde{R} \): \( (e_1, e_2) = (\min \{ \max \{ \beta_{1a}, y \}, 1 \}, 0) \).
- For \( R_0 > \tilde{R} \): \( (e_1, e_2) = (1, \beta_{1b} - 1) \).

In this context, \( V_{WBP} \) is linear in \( G \) and the proof follows as in (i).

c) Assume \( R \in (R_0, R_1) \). Note that if \( V_{WBP} \) is the outside option, it is because \( V_{WBP} > V_{00} \). In this context, assume \( V_{00} > V_{PRP} \). Using arguments in (i), this inequality holds when \( G \) is high. Thus, for high values of \( G \), \( V_{WBP} > V_{PRP} \), and the principal does not introduce a PRP. On the contrary, for low enough values of \( G \), \( V_{PRP} > V_{00} \), and thus the principal may find it profitable to introduce a PRP. In this context, assume that the principal does not introduce a PRP: he obtains a positive payoff from the agent’s activities related to production and some payoff from his activities related to gathering crime evidence. However, if he introduces a PRP, he only obtains payoff from the latter (i.e., the principal sacrifices his payoff associated to production in favor of maximum deterrence). By a revealed preference argument, if the principal introduces a PRP it must be because his utility increases with higher deterrence. In other words, if the principal introduces a PRP it must be because his externalities from crime \( G \) are so low (negative), that maximum deterrence increases his utility.

References


