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Whistle-blowing and the incentive to hire

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Abstract

We consider a previously neglected cost of whistle-blower awards: employers may base their hiring decisions, on the margin, not on the productivity of an employee but rather on the probability that the employee will become a whistle-blower. We develop a three-stage model to examine how productivity losses due to distortions at the hiring stage influence optimal whistle-blower rewards. We characterize optimal rewards for whistle-blowing, and show that when rewards can be chosen according to either the benefits of the employer from offending or the productivity of the worker being hired, productivity-based rewards are superior to benefit-based rewards.

KEYWORDS
crime, deterrence, hiring incentives, whistle-blowing

JEL CLASSIFICATION
K2, K31, K42, M5, J00

1 | INTRODUCTION

Many forms of illegal behavior—from bribery of officials, to cheating on taxes, to environmental violations—can be difficult for outsiders to detect. Over the last decades, policy makers have increasingly used whistle–blowing incentives aimed at curtailing such behavior.[1] While there are obvious efficiency advantages attached to discovering crimes by eliciting already existing information from witnesses rather than obtaining new information through costly investigations, whistle-blowing schemes also come at a cost. Two types of costs have received a great deal of attention, both in the academic literature and in the popular press.[2]

First, whistle-blowers bear a personal cost mainly due to social ostracism and a reduction in their future employment prospects. Second, whistle-blowing may induce fraudulent reports based on false or fabricated information. In this article we focus on a hitherto neglected cost of whistle-blowing schemes: at the hiring stage, employers may base their decisions, on the margin, not on the productivity of the employee but on the probability that the employee will become a whistle-blower. Consequently, whistle-blowing schemes do not only carry the risk that employees will be fired after they blow the whistle, these schemes may also cause some high productivity employees to not get hired in the first place.

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Before proceeding, we note the difficulty in locating empirical support for the key assumption that drives our analysis, namely that employers make hiring decisions, on the margin, based on how likely they think an applicant may become a whistle-blower. The difficulty arises because managers have no incentives to disclose this type of hiring practice, and to the contrary, may have strong incentives to keep it hidden. However, a frequently raised concern by legal scholars lends support for this assumption: former whistleblowers experience increased difficulties when they apply for new jobs (Eisenstadt & Pacell, 2018). This reluctance of employers to hire ex-whistleblowers is presumably driven by fear that these individuals may blow the whistle in their new positions, as well, and cause business losses.[3] Therefore, employers may seek to avoid such losses by not hiring people whom they believe to carry greater expected whistle-blowing costs than the added productivity they afford to their business. Although our analysis is exclusively theoretical and takes this assumption as given, in Section 6, we discuss how our analysis, in conjunction with recent empirical work, can be used to detect employers' who do engage in behavior consistent with our assumption.

Thus, the central question of this article is how productivity losses due to distortions at the hiring stage may influence optimal whistle-blowing rewards, when employers try to mitigate business losses caused by whistle-blowers. To examine this issue, we develop a stylized model with one employer and one (potential) employee. In the first stage, the employer decides whether to hire the employee. In the next stage, the employer chooses whether or not to violate the law. If the employer hires the employee in the first stage, the employee may then report the employer's violation, in which case the whistle-blower obtains a reward and the employer is sanctioned. Anticipating this possibility, the employer may decide against hiring a productive worker out of fear that the worker may become a whistle-blower and cause the employer to incur criminal liability. Due to this reason, increasing the rewards for whistle-blowing reduces the frequency with which firms hire workers, and leads to productivity losses.

With this basic setup we identify the determinants of the optimal whistle-blower reward. Following the theoretical law enforcement literature, we first consider the case where rewards cannot be conditioned on the employer's or employee's type (either because these types are not observable to regulators or because it would be too costly to verify them). We find that the optimal reward increases with the social harm of violating the law, decreases with the punishment for crime, and decreases as the employer's hiring decisions become relatively more responsive compared to its offending decisions. Some of these results contradict the existing literature, as discussed in Section 2. Subsequently, we extend our basic setup to examine how the optimal reward schedule is structured when rewards can be chosen according to either the employer's benefit from offending or the productivity of the worker being hired. Interestingly, we find that productivity-based rewards are superior to benefit-based rewards. Intuitively, a productivity-based regime removes the perverse incentives for employers to refrain from hiring workers whereas benefit-based rewards are incapable of accomplishing the same.

Overall, the objective of our study is to draw attention to the potential impact of whistle-blower regimes over a margin that has not received much attention yet: the hiring phase. Our claim is that regulation at the whistle-blowing stage may distort employee's hiring decisions. We use a very simple model to formalize this possibility, which relies on a number of simplifying assumptions. We discuss these assumptions in footnotes throughout our analysis,[4] and we discuss how our model can be extended in Section 6.

We proceed as follows. In Section 2 we review the related literature.[5] In Section 3 we develop the model, which we use in Section 4 to conduct a welfare analysis. In Section 5 we compare productivity based rewards and benefit based rewards. In Section 6 we discuss our findings and conclude.

2 | LITERATURE REVIEW

To the best of our knowledge the issue of distortions at the hiring stage has not been examined in the economic literature, neither from an informal nor from a formal perspective. Howse and Daniels (1995) informally discuss a whole range of costs of whistle-blowing schemes: (1) Whistle-blowing rewards may distort optimal information flows and decision-making structures within the corporation. Senior managers may recast organizational routines and decision-making systems with the purpose of restricting the access of potential whistle-blowers to information that suggests any wrongdoing. This can of course inflict substantial costs on the productive efficiency of the firm: (2) With the purpose of increasing the downside costs of whistle-blowing, senior managers may want lower-level employees to over-invest in firm- or industry-specific capital; (3) The practice of whistle-blowing could have deleterious effects on trust and team spirit within corporations[6]; (4) Whistle-blower rewards could make corporations vulnerable to false claims made by opportunistic whistle-blowers who may attempt to force corporations into settlements in order to avoid

the negative reputational effects caused by public, though ill-founded, allegations.[7] (5) Whistle-blowers may be subject to retaliation by fellow employees or by the corporation itself. Retaliatory actions may include dismissal, demotions, inordinate scrutiny and surveillance in and outside the workplace, and psychological pressures, among other things. Ferziger and Currell (1999) and Depoorter and De Mot (2006) discuss a whole range of issues related to the optimal design of bounty schemes, but distortions at the hiring stage is not part of their analysis.

Among the existing formal economic analyses of whistle-blowing, Heyes and Kapur (2009) examine how responsive regulators should be to whistle-blower tip-offs and how severe the sanctions for wrongdoers detected by whistle-blowers should be. In contrast to our model however, whistle-blowers are not rewarded in their set-up. They find that the optimal policy depends on the motives of the whistle-blower (to maximize social welfare, to impose costs, or to clean one's conscience).

Friebel and Guriev (2012) show that whistle-blower rewards can undermine the incentives of lower level managers to exert effort. When the top management of a firm has short-term incentives and inflates earnings reports, top management may offer a bribe to a lower level manager to prevent the manager from blowing the whistle. Friebel and Guriev further argue that subordinates are more likely to possess information about earnings overreporting when their own performance is low. Consequently, the availability of whistle-blower rewards provides the lower level manager with an additional pay-off when his division's output is low and thus distorts internal incentives.

Our model is closest in spirit to Givati (2016), who also studies the determinants of optimal whistle-blower rewards in a set-up with one employer and one employee. The model we develop is however different in several aspects: First, while Givati focuses on the personal costs that whistle-blowers bear and the risk of encouraging false reports, our focus is on efficiency losses due to hiring distortions. Our model consequently introduces an additional stage. Moreover, in addition to our results with respect to productivity losses, we make a distinction between situations in which the violator's gain is observable for the regulator and situations in which this gain is unobservable.[8] In Givati's model, these gains are always observable. In such a setting, he finds that the optimal reward does not depend on the social harm from crime, and that the optimal reward increases with the employer's gain from violating the law.[9] In reality however, the government does not always know the employer's gain, and a more complicated set-up may be necessary.[10] We show that in a setting with unobservable benefits, the optimal reward is (weakly) increasing in harm, and does not necessarily increase with the (average) employer's gain of violating the law. Finally, we also show that in the case of observability, productivity based rewards are superior to benefit based rewards.

More recently, Mechtenberg et al. (2020) study the impact of whistle-blower protection measures both theoretically and experimentally. They find that these protections increase whistle-blowing, as expected, but the benefits that one would expect from these increased whistle-blowing activities in the form of increased deterrence and detection is not observed in their experiment. These results could be driven by experiment participants who are assigned to the role of prosecutors not being as responsive to reports of misconduct when whistle-blowers are afforded protection.[11] Additionally, Mechtenberg et al. (2020) predicts heterogeneity in whistle-blowing among employees with differing productivity: lower productivity employees are (weakly) more likely to report misconduct, and may misreport even when the employer commits no misconduct.

Some empirical studies have examined the effects of whistle-blower reward programs. Dyck et al. (2010) use data on all reported corporate fraud cases in large U.S. companies between 1996 and 2004. They find that fraud is uncovered much more often due to employees blowing the whistle in sectors in which whistle-blower awards are available via the False Claim Act than in sectors in which such rewards are not available.[12] Call et al. (2017)[13] find that the involvement of whistle-blowers in enforcement actions related to financial misrepresentation is correlated with larger monetary sanctions for the wrongdoing corporation. Whistle-blower involvement also increases the likelihood that criminal sanctions are imposed and the jail time for culpable executives. Some experimental studies find that monetary awards are effective in increasing the number of individuals that blow the whistle (e.g., Breuer, 2013; Butler et al., 2020; Schmolke & Utikal, 2016; Stikeleather, 2016).

Finally, our article is also related to the literature on detection avoidance. The conventional economic model of enforcement (Becker, 1968 and others) focuses on the cost and the effect of the state's detection activities. It does not take evidentiary misconduct into account. More recent contributions in the field have however argued that the probability that wrongs and offenses are detected does not only depend on the government's effort at detecting violations, but also on the violator's effort at avoiding detection.[14] Several authors have shown that the framework of the conventional enforcement model changes significantly when detection avoidance is incorporated (e.g., Friehe & Miceli, 2017; Innes, 2001; Langlais, 2008; Malik, 1990; Mungan, 2020; Mungan & Samuel, 2019; Nussim & Tabbach, 2009; Sanchirico, 2006; Snyder, 1990; Tabbach, 2010). Intuitively, avoidance introduces a positive marginal cost for raising the level of the sanction.

The decision of an employer not to hire a productive employee to reduce the likelihood of their illegal conduct being discovered can be seen as a form of avoidance. Thus, we add to this literature by studying the properties of a specific kind of avoidance activity. The costs of avoidance, in this specific context, can be characterized as forgone worker contributions.[15]

3 | MODEL

A regulator (referred to as she), chooses whistle-blower rewards to influence the interactions that take place between an employer (a firm; referred to as it) and a potential employee (a worker; referred to as he) who are both risk-neutral. These interactions involve three periods. In period one, the employer decides whether or not to hire the worker. In period two, the employer confronts a criminal opportunity, and decides whether or not to commit crime. If the worker is hired and the employer decides to commit crime, then, in period three, the worker decides on whether or not to blow the whistle. The decisions made by the two actors depend on the following costs and benefits:

π: the worker's productivity, which is defined as the profit increase the firm experiences as a result of hiring the employee;
r: the reward offered to whistle-blowers by the regulator;
c: the cost an employee incurs by blowing the whistle;
b: the employer's benefit from committing crime; and
s: the exogenously determined punishment for committing crime.[16]

Among these values, s, π, and r are known by both the employer and the employee, but b and c are private knowledge. In particular, prior to the first period, the employer draws its criminal gain from a cumulative distribution function $K(b)$ with probability density function $k(b) > 0$ and support $[0, \infty)$. Similarly, prior to the first period, workers draw their productivity from a cumulative distribution function $F(\pi)$ with probability density function $f(\pi)$ and support $[0, \infty)$. Workers also differ in their whistle-blowing costs. We assume that the employer cannot directly impact the magnitude of these costs to any given worker due to the presence of effective anti-retaliation laws. Instead, these costs capture the impacts of social ostracism, and their distribution are described by the cumulative distribution function $G(c)$ and a probability distribution function $g(c)$ with support $[0, \bar{c}]$.[17] Because c is unobservable to the employer, its estimate of the probability of whistle-blowing in case it commits crime after hiring the employee is $G(r)$. Moreover, it is too costly or impossible for the regulator to observe the employee's and employer's characteristics, and therefore r cannot be conditioned on these characteristics, and is independent of particular draws. We relax this assumption to some extent in the next section where we consider rewards that can be conditioned on the specific π-draw or specific b-draw.

Our analysis proceeds by backward induction. In period three, a hired worker who observes crime blows the whistle, if he draws a cost $c < r$.[18] This happens with probability $G(r)$. Consequently, in period 2, an employer who hires the worker commits crime if $b \geq G(r)s$.[19] On the other hand, an employer who has not hired a worker always commits crime.[20] In period one, an employer with criminal benefit $b \geq G(r)s$ faces a total net-expected benefit of $b + \pi - G(r)s$ associated with hiring the worker, and an expected benefit of b associated with not hiring him. Thus, the employee hires the worker if $\pi \geq G(r)s$, and otherwise does not.[21] On the other hand, an employer with $b < G(r)s$ faces a pay-off of π from hiring the worker, since it knows that it will not commit crime in the second period. Thus, it hires the worker if $\pi \geq b$, since it knows that it will commit crime if it does not hire the worker. These decisions are summarized in Table 1 below, and the conditions leading to these decisions are illustrated in Figure 1 below.

Figure 1 illustrates the fact that the size of whistle-blower rewards determine the worker-employee type combinations that lead to the three possible outcomes.[22] Thus, rewards can be chosen to affect the welfare impacts associated with hiring and crime decisions. Next, we analyze these effects.

TABLE 1 Behavior of the employer.

(1)	Hire and commit crime	if	$\pi \geq G(r)s$	and	$b \geq G(r)s$
(2)	Hire and Don't commit crime	if	$\pi \geq b$	and	$b < G(r)s$
(3)	Don't hire and commit crime	if	$\pi < G(r)s$	and	$b \geq G(r)s$

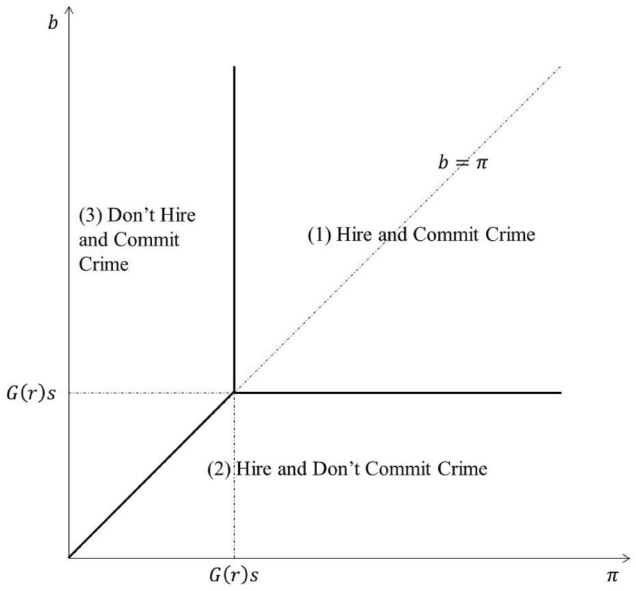

FIGURE 1 Employer's decisions.

4 | WELFARE ANALYSIS

Assessing the welfare consequences of policies requires us to specify our assumptions regarding the costs associated with crime, the benefits associated with hiring decisions, and the costs associated with whistle-blowing. We denote by $h > s$ the harms caused by crime. We impose the assumption that $h > s$ only for purposes of focusing on the more often studied case in the law enforcement literature where sanctions are not enough to generate first-best (or over-) deterrence. To simplify the analysis, we assume that the hiring of the worker increases social welfare by exactly π. This would be the case, for instance, if the employee was only paid his cost of working. Finally, in order to focus on the trade-off between productivity losses and deterrence gains, we assume that both s and r are transfers, and that whistle blowing generates a net social cost of zero.[23] This would be the case if the cost incurred by the whistle-blower is transferred in its entirety as a benefit to a third party (e.g., another worker). We note that the main implications of our analysis continue to hold as long as whistle-blowing costs are small relative to other considerations, like the harm from crime or worker's expected productivity.

Given these assumptions, we can separately express the impact of whistle-blowing rewards on the two components of welfare, namely productivity and criminal harm.[24] We can express expected productivity as

$$\Pi - \Lambda(r) \tag{1}$$

where $\Pi \equiv \int_0^\infty \int_0^\infty \pi k(b) dbf(\pi) d\pi$ denotes the productivity that would be obtained if the employer always hired the worker, and

$$\Lambda(r) \equiv \int_0^{G(r)s} \pi(1 - K(\pi)) f(\pi) d\pi \tag{2}$$

is the loss in productivity generated by whistle-blowing rewards.

Similarly, expected criminal losses can be expressed as

$$H - \Delta(r) \tag{3}$$

where $H = \int_0^\infty \int_0^\infty (h - b) k(b) dbf(\pi) d\pi$ denotes the criminal harm that would be obtained if the employer were never deterred from committing crime, and

$$\Delta(r) = \int_0^{G(r)s} (h-b)(1-F(b))k(b)db \tag{4}$$

represents the reduction in criminal harm obtained due to whistle-blowing.

Using these expressions, total welfare can be expressed as[25]

$$W(r) = \Pi - H + \Delta(r) - \Lambda(r) \tag{5}$$

Thus, the marginal impact of whistle-blowing rewards r on welfare, $W_r = \Delta_r - \Lambda_r$, is given by

$$\begin{aligned} W_r \quad &= \overbrace{\underbrace{[h - G(r)s]}_{\substack{net-harm\\ from\ marginal\\ offense}} \times g(r)s\underbrace{[1 - F(G(r)s)]k(G(r)s)}_{\substack{change\ in\ expected\\ frequency\ of\ crime}}}^{Expected\ Deterrence\ Related\ Changes} \\ &- \overbrace{\underbrace{G(r)s\times}_{\substack{productivity\\ of\ marginal\\ worker}} \quad g(r)s\underbrace{(1-K(G(r)s))f(G(r)s)}_{\substack{change\ in\ expected\\ frequency\ of\ hiring}}}^{Expected\ Productivity\ Loss} \end{aligned} \tag{6}$$

These effects are also graphically illustrated via Figure 2, below.

An investigation of Equation (6) reveals that using some whistle-blowing rewards is optimal (i.e., $W_r(0) > 0$), since expected productivity losses are negligible when $r = 0$. On the other hand, maximal rewards (i.e., $r = \overline{c}$) can potentially be optimal. To investigate this possibility, and to characterize optimal interior rewards when they exist, we re-arrange Equation (6) which reveals that $W_r \geq 0$ if, and only if

$$\frac{h - G(r)s}{G(r)s} \geq \frac{\lambda^{\pi}(G(r)s)}{\lambda^{b}(G(r)s)} \tag{7}$$

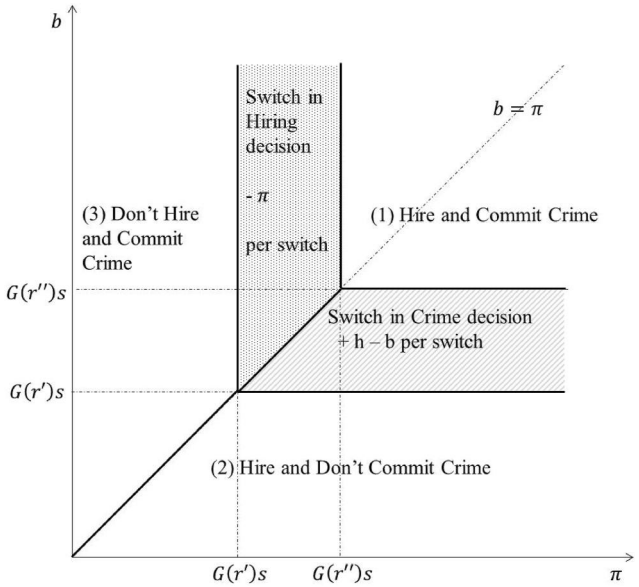

FIGURE 2 Welfare impacts of increasing rewards from r' to r''.

where

$$\lambda^{\pi}(\pi) \equiv \frac{f(\pi)}{1-F(\pi)} \text{ and } \lambda^{b}(b) \equiv \frac{k(b)}{1-K(b)} \tag{8}$$

are the hazard rate functions associated with the distribution of π and b.

Whether increasing rewards leads to social benefits depends on a comparison between (i) the left hand side of Equation (7): the ratio between the gains from deterring a marginal offender (i.e., $h - G(r)s$) and the losses from deterring the hiring of a worker with marginal productivity (i.e., $G(r)s$), and (ii) the right hand side of Equation (7): the ratio between the hazard rates of π and b, which capture the relationship between the expected frequencies with which greater rewards will deter hiring versus crime.

The relative magnitude of deterrence gains versus productivity losses captured by the left hand side of Equation (7) is naturally decreasing in rewards. On the other hand, the impact of higher rewards on the hazard rate ratio depends entirely on the distribution of workers' productivity and employer benefits from offending. When this ratio is large around the maximum reward, it follows that the optimal reward is interior. Thus, we may express a sufficient condition for an interior reward, as well as a summary of our prior findings, as follows.

Lemma 1 *The optimal reward, r*, is positive and it is interior, i.e.* $r^* \in (0, \bar{c})$*, as long as*

$$\frac{h}{s} < \frac{\lambda^{\pi}(s)}{\lambda^{b}(s)} + 1 \tag{9}$$

and is characterized by

$$\frac{h}{G(r^*)s} = \frac{\lambda^{\pi}(G(r^*)s)}{\lambda^{b}(G(r^*)s)} + 1 \tag{10}$$

The proof of this lemma and the next two propositions are relegated to an Appendix in the end.

When the optimal reward is interior, it naturally follows that $W_r = 0$, and, thus, the optimal reward r^* is characterized by Equation (10). Next, we use this observation to question how the harm from the offense and the sanction for its commission affect the optimal reward. A simple comparative static analysis reveals the following.

Proposition 1 *The optimal interior reward r* is increasing in the harm from crime and decreasing in the sanction, i.e.* $r^*_s < 0 < r^*_h$.

Proposition 1 reveals that the sanction and the reward act as substitutes in the maximization of welfare, and formalizes the intuitive result that greater rewards are called for when the harm from crime increases. Absent further restrictions on the distributions of criminal benefits and worker productivity, it is difficult to make statements about how the employer's responsiveness to rewards may affect the optimal reward.

To provide some insight to this question, we consider the special case where π and b are distributed exponentially. This greatly simplifies the analysis, since then the hazard rates associated with π and b are constant, and Equation (10) can be expressed as

$$\frac{h}{G(r^*)s} = \frac{\lambda^{\pi}}{\lambda^{b}} + 1 \tag{11}$$

where λ^{π} and λ^{b} are the constant *rate parameters* associated with the exponential distributions of π and b, respectively. In our current setting, one can think of λ^{π} and λ^{b} as parameters capturing the relative responsiveness of the employers' hiring versus crime decisions to changes in rewards. Next, we note how the optimal reward responds to these parameters.

Proposition 2 *Suppose* π *and* b *are both exponentially distributed. Then,* $r^*_{\lambda^{\pi}} < 0 < r^*_{\lambda^{b}}$.

In line with intuition, Proposition 2 suggests that the optimal reward is reduced as the employer's hiring decisions become relatively more responsive compared to its offending decisions and vice versa.

The case where productivity and benefits are both distributed exponentially is also useful for highlighting the lack of a clear relationship between infra-marginal considerations, such as averages, and the optimal reward. For instance, intuition might suggest that greater rewards would be necessary to deter the employer when his average benefit from committing crime is increased. This conjecture is misleading because it confuses increases in the employer's marginal incentives with his average characteristics, and the employer makes decisions based on the former. To highlight this point, we denote the averages of b and π, as μ_b and μ_π, respectively, and note the following corollary of Proposition 2.

Corollary 1 *Suppose π and b are both exponentially distributed. Then, $r^*_{\mu^\pi} > 0 > r^*_{\mu^b}$.*

This corollary reveals that the conjecture just described is false, and it follows immediately from the fact that the mean of an exponential distribution is the inverse of its rate parameter, that is, $\mu^i = \frac{1}{\lambda^i}$ for $i \in \{b, \pi\}$. Our objective in reporting this result is to highlight that when ascertaining the optimal reward, it is important to focus on the relative responsiveness of the employer's hiring decisions, on the margin, as opposed to other infra-marginal considerations.

Next, we note that our analysis in this section assumes that rewards cannot be chosen according to either the benefits of the employer or the productivity of the worker. In the next section, we question how the optimal reward schedule is structured when the reward can be based on one of these two values.

5 | BENEFIT-BASED REWARDS VERSUS PRODUCTIVITY-BASED REWARDS

In this section, we identify the optimal reward when either type is observable, and subsequently compare the maximum expected welfare obtainable when rewards are based on the employer's versus the worker's type. Our analysis reveals that the deterrence benefits and hiring distortions caused by whistle-blower rewards are better balanced by imposing rewards that depend on the worker's productivity rather than the employer's benefit from crime. This is because the former type of rewards are capable of keeping the expected potential criminal liability below the worker's productivity, and thereby minimizing hiring losses. This result in contrast to many existing incentive schemes, in which the reward is based on the characteristics of the offense, and are therefore more likely to related to the benefit of the offender, rather than the productivity of the worker.[26]

5.1 | Benefit-based rewards

When the regulator can condition the size of the reward on the employer's benefit from crime, she chooses a reward schedule, $r(b)$, instead of a single reward. For each b, there are two meaningfully distinct categories of reward sizes: small rewards which fail to deter an employer who has hired a worker from committing crime (i.e., $G(r)s \leq b$); and large rewards which deter a similar employer $G(r)s > b$. The optimal benefit-based reward regime refrains from using any rewards at all when it cannot deter the employer, and uses large rewards when it can deter the employer. We formalize this result, as follows.

Lemma 2 *There is a threshold benefit b', such that: The optimal benefit-based reward regime uses no rewards if the employer has benefits exceeding b'; otherwise it uses rewards large enough to deter the employer from committing crime (i.e., $G(r(b))s > b$).*

Proof If the regulator chooses a small reward, the employer is never deterred from committing crime, and the only choice it has to make is whether or not to hire the worker. When $\pi \geq G(r)s$, which happens with probability $1 - F(G(r)s)$, the employer hires the worker, who subsequently blows the whistle with probability $G(r)$. This implies welfare of $b - h + \pi$. If, however, $\pi < G(r)s$, which happens with probability $F(G(r)s)$, the employer does not hire the worker and thus welfare equals $b - h$. Consequently, conditional on choosing small rewards, it is optimal to set the reward equal to 0, because this maximizes expected productivity by causing the employer to always hire the worker. Thus, the maximum expected welfare obtainable through small rewards (of 0) for any realization of b equals:

$$b - h + \mu^{\pi} \tag{12}$$

where μ^{π} is the expected productivity of the worker.

We note that, for employers with $b \geq s$, all rewards are small, since they cannot be deterred by even the largest reward. This implies that $r^*(b) = 0$ for all $b \geq s$. What remains is the determination of optimal rewards for employers with benefits smaller than the sanction.

When $b < s$, the regulator has the option of using large rewards (i.e., r such that $G(r)s > b$). If she does so, it is never desirable for the firm to hire the worker and subsequently commit crime, since this option is dominated by hiring the worker and not committing crime. Thus, the firm's choice is between hiring and committing crime, which naturally depends on a comparison between π and b. If $\pi \geq b$, which happens with probability $1 - F(b)$, the employer hires and doesn't commit crime, and welfare thus equals π. With a probability of $F(b)$, the worker's productivity is lower than the benefit from crime, that is, $\pi < b$, in which case the employer does not hire and commits crime, and welfare equals $b - h$. Consequently, expected welfare equals

$$F(b)(b - h) + \int_{b}^{\infty} \pi f(\pi) d\pi \tag{13}$$

which does not depend on the specific (large) reward size.

Comparing Equations (12) and (13) reveals that large rewards are (weakly) preferable to small rewards if

$$B(b) \equiv (h - b)(1 - F(b)) - \int_{0}^{b} \pi f(\pi) d\pi > 0 \tag{14}$$

The first term is decreasing in b whereas the second term is increasing in it. The inequality clearly holds when $b = 0$, and it is ambiguous whether it holds for the largest benefits within this case, namely $b = s$. Thus, there are two possibilities: either there exists $b'' < s$, such that Equation (14) holds if and only if $b \leq b''$, or the inequality holds for all $b < s$. Thus, the threshold b' in Lemma 2 can be defined as:

$$b' = \begin{cases} s & \text{if} \quad B(b) > 0 \text{ for all } b < s \\ b'' & \text{if} \quad \text{there exists } b'' < s \text{ such that } B(b'') = 0 \end{cases} \tag{15}$$

■

We summarize our analysis of this case by graphically illustrating the optimal policy as a function of the employer's criminal benefits, as well as the welfare obtained by employing the optimal policy as a function of the employer's and worker's types in Figure 3, below.

5.2 | Productivity-based rewards

When the regulator can observe the worker's type instead of the employer's type, she has the ability to choose rewards as a function of π instead of b. As in the benefit-based rewards case, there are two meaningful categories of rewards for any given π: small rewards ($G(r)s \leq \pi$) and large rewards ($G(r)s > \pi$).

For any given π, when the rewards are small, the employer always finds it worthwhile to hire the worker. Thus, his only decision is between committing crime, and not. This means that, conditional on using small rewards, it is socially desirable to use the largest one possible, since this enhances expected deterrence, which can be expressed by the critical benefit $G(r)s$. When the worker's productivity is small, this amounts to setting a reward that sets the expected sanction to the employer equal to the worker's productivity, that is, $G(r)s = \pi$. However, when the worker's productivity is so high that even the largest reward is insufficient to equate the expected sanction to the worker's productivity, the maximum small reward is naturally the highest reward. Thus, we may define this reward as

$$\widehat{r}(\pi) \equiv G^{-1}\left(\min\left\{\frac{\pi}{s}, 1\right\}\right) \tag{16}$$

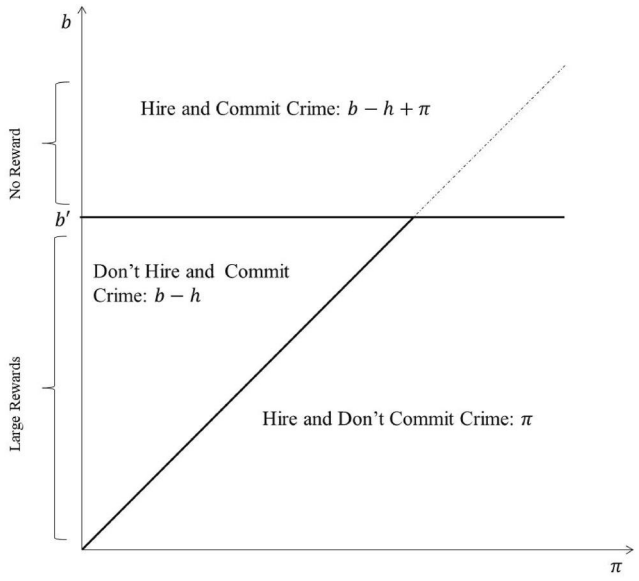

FIGURE 3 Optimal benefit-based rewards and welfare.

which generates expected welfare of

$$\pi + \int_{G(\widehat{r})_s}^{\infty} (b - h)k(b)db \tag{17}$$

When $\pi < s$, the regulator also has the ability to use large rewards. If the regulator chooses to do so, the employer never opts to commit crime subsequent to hiring the worker, since doing so is dominated by the option of not hiring and committing crime. Hence, large rewards cause the employer to hire when $\pi \geq b$, and to commit crime when $\pi < b$. Therefore, expected welfare associated with large rewards equals

$$K(\pi)\pi + \int_{\pi}^{\infty} (b - h)k(b)db \tag{18}$$

Note that for $\pi < s$, the welfare maximizing small reward is given by $G^{-1}\left(\frac{\pi}{s}\right)$, which implies that these small rewards lead to the same level of deterrence as large rewards, but guarantee that the employer hires the worker. This reveals that large rewards can never be optimal.

We summarize these observations through Lemma 3, whose proof follows from the above observations.

Lemma 3

When the regulator uses productivity-based rewards, the optimal reward is $\widehat{r}(\pi) = G^{-1}\left(\min\left\{\frac{\pi}{s}, 1\right\}\right)$.

We illustrate our findings via Figure 4, below, which depicts the employer's response to optimal productivity based rewards as well as welfare as a function of the employer's and worker's types.

5.3 | Comparison of benefit-based versus productivity-based rewards

Here, we compare the expected welfare obtainable with benefit-based rewards versus productivity-based rewards. A simple comparison of Figures 3 and 4 reveals two important observations. First, supposing $b' = s$, the only effect of a move from benefit-based rewards to productivity-based rewards is to convert the instances in which the employer refuses to hire the worker and commit crime to instances in which it hires the worker and subsequently commits crime. This move enhances expected welfare through an increase in expected productivity. Second, in cases where $b' < s$, a switch to the productivity-based optimal reward also converts some cases where the employer hires the worker and

commits crime into cases where it hires the worker but refrains from committing crime, which leads to deterrence benefits. Since the case where $b' < s$ is harder to visualize, we produce a graphical representation of it in Figure 5, below.

We note that regardless of the relation between b' and s, productivity-based optimal rewards are always superior to benefit-based optimal rewards. We summarize this finding through our last proposition, below.[27]

Proposition 3 *Optimal productivity-based rewards are superior to optimal benefit-based rewards.*

The intuition behind the dynamics that leads to proposition 6 becomes apparent by making two related observations. First, employers with large benefits from crime are undeterred under both regimes. Thus, the primary difference between the welfare impacts of optimal rewards under the two regimes arises from the different decisions that an

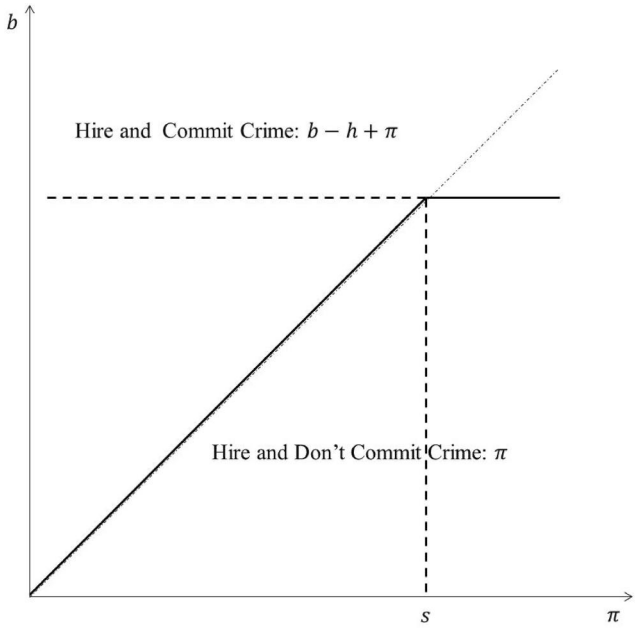

FIGURE 4 Optimal productivity-based rewards and welfare.

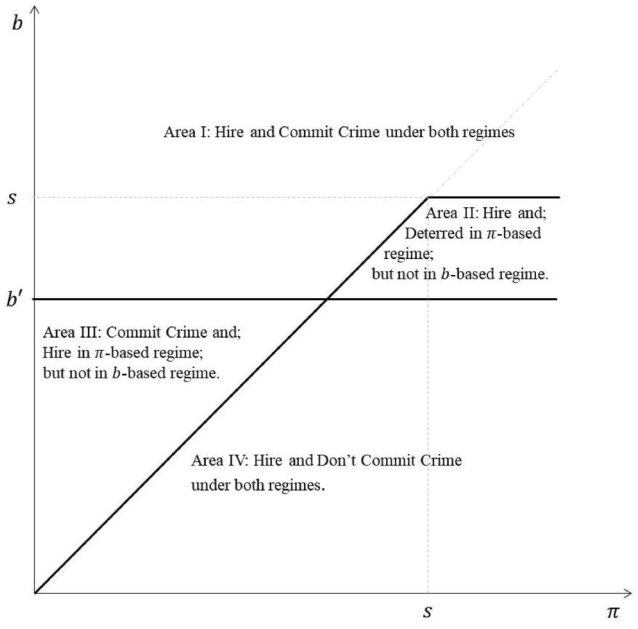

FIGURE 5 Comparison of benefit-based and productivity based rewards.

employer with small benefits makes when faced with optimal benefit-based versus reward-based regimes. Next, we explain in more detail the choices faced by an employer with low benefits to make these dynamics more clear.

In the benefit-based regime, the regulator has two options when confronted with a low-benefit employer: she can either not utilize rewards, which causes the employer to hire the worker and commit crime; or she may use large rewards that make it unprofitable for the employer to commit crime after hiring the worker. Choosing the latter option generates a lottery in terms of welfare consequences: either the employer faces a highly productive worker, hires him, and commits no crime; or, the employer faces a less productive worker, chooses not to hire him, and commits crime. However, since the employer has low benefits from crime, it is very likely that the productivity of the worker it encounters is greater than the criminal benefits it would need to forgo by hiring the worker. The most important fact to be highlighted here is that the regulator can only force the low benefit employee to face a trade-off between hiring and committing crime.

On the other hand, in the productivity-based regime, the regulator induces the employer to always hire the worker by choosing rewards that are small enough to make the expected liability from whistle-blowing lower than the benefit from hiring the worker. This regime, like the benefit-based regime, is incapable of deterring an employer with high benefits from crime. For low benefit employers, this generates a similar welfare lottery as in the benefit-based regime, but with different outcomes. As in the optimal benefit-based regime, when the employer faces a highly productive worker, it hires him and chooses not to commit crime. When the employer faces a low productivity worker, again as in the optimal benefit-based regime, the employer commits crime, but this time it is not deterred from hiring the worker. The regulator is able to provide these incentives in the productivity-based regime precisely because she is able to tailor the rewards to the worker's productivity such that it is always desirable for the employer to hire him, regardless of whether it intends to commit crime. Thus, the optimal productivity-based regime dominates the benefit-based regime by removing the perverse incentives generated for employers to refrain from hiring workers.

6 | DISCUSSION AND CONCLUDING REMARKS

Whistle-blowing schemes have virtues, but they come at a cost. Some of these costs are obvious, such as the personal costs whistle-blowers bear. Other costs are more subtle, but could be substantial nonetheless. In this article, we have argued that whistle-blower awards may lead employers to decide not to hire some high productivity employees and have examined how productivity losses due to distortions at the hiring stage influence optimal whistle-blower rewards. The most important insight revealed by our analysis is that there is a previously unappreciated cost associated with whistle-blower rewards, namely productivity losses caused by a reduction in employers' willingness to hire workers. We constructed a simple model to explain how a trade-off may emerge between reducing these costs and the primary benefits that whistle-blower rewards seek to generate, namely reducing wrongful behavior by firms.

Our analysis and insights from prior scholarship can be combined in future research in an attempt to detect employers who more actively seek to avoid potential whistle-blowers at the hiring stage. For instance, there is a sizable literature seeking to identify the determinants of whistle-blowing behavior, including individual characteristics (Brewer & Selden, 1998; Miceli & Near, 1988). Specifically, an employer who engages in such attempts would attach a "whistle-blowing premium" to workers based on how likely they are to become whistle-blowers. Hence, an employer with such concerns would prefer to hire a worker with lesser productivity than another worker who is significantly less likely to become a whistle-blower. Whether employers' engage in this type of discrimination can be empirically investigated by studying the productivity and perceived whistleblowing tendency of workers hired by these employers to ascertain whether employers act as if they perceive whistle-blowing premia.

We also note some of the simplifying assumptions we made to focus on the hiring-deterrence trade-off. For instance, we took the cost of whistle-blowing for workers to be exogenously determined, we focused on whistle-blower rewards as the only policy variable, we assumed away the possibility of false-whistle blowing reports, and we assumed that workers' types are unobservable.[28] Although we noted the potential implications of relaxing some of these assumptions throughout our analysis,[29] explicitly incorporating these considerations in subsequent work may reveal additional insights. In addition, the simple framework we considered can be extended in several ways.

It is possible, for instance, that whistle-blower rewards may cause an increase in the firm-specific-investments that workers may make to signal to their prospective employers that they are unlikely to blow the whistle on them. This possibility, akin to that raised in by Howse and Daniels (1995), may have implications regarding the optimal size and use of whistle-blower rewards, and can be formalized and studied further by modifying our model to allow workers to

send costly signals to employers. Similarly, firms may try to reduce the likelihood of whistle-blowing by increasing the opportunity costs of whistle-blowing. This can be accomplished, for instance, by increasing the wages offered to workers, or by changing the wage structure to incorporate higher firm performance-based bonuses. The broader implication of our analysis is that whistle-blower rewards, may have the effect of distorting employers' incentives in an undesirable manner, and, these effects should be borne in mind when discussing the social desirability of policies that pertain to whistle-blowers.

Another interesting dynamic may emerge when one incorporates the principal-agent problems that may emerge within a firm. For instance, businesses may implement internal monitoring and incentive mechanisms in cases where there is a fear that the management may engage in illegal acts which are harmful to the firm. In these cases, the firm may have internal human resources (HR) practices which sort in favor of workers who are *more* likely to blow the whistle to keep the management in check. The interactions between whistle-blowing rewards and firms' hiring practices may then exhibit the opposite of the dynamics we have identified here, because firms' criminal conduct decisions and hiring decisions would be made by two distinct entities. The HR department may be inclined to hire more frequently, because doing so would not add to the productivity of the firm, but also contribute to the internal enforcement mechanism of the firm. Because firms differ in the extent to which HR departments have control over hiring decisions, the relevance of this observation will naturally depend on the firms being studied. But, this heterogeneity suggests that extending our analysis to incorporate HR control over hiring decision may be particularly fruitful. This type of analysis could form the basis for empirical investigations which study whether the degree of HR control over hiring decisions mediates the impact of whistle-blowing rewards on observables of interest, including the frequency of whistle-blowing and hiring practices.

Our discussion here is meant to illustrate the potential impacts of whistle-blowing rewards on the behavior of employees and employers that stem from distortions caused by these rewards at the hiring stage. We hope that future research focusing on these and related issues will shed light on the previously unappreciated impacts of whistle-blowing rewards.

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DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analyzed in the current study.

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ENDNOTES

[1] In the United States, laws that reward whistle-blowers have been adopted both at the federal and the state level. Some of the most important federal laws include the Tax Relief and Health Care Act of 2006, Pub. L. No. 109–432, 120 Stat. 2922 (directing the Internal Revenue Service to reward whistle-blowers rewards in the range of 15–30 percent of the collected proceeds), the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010, Pub. L. No. 111–203, 124 Stat. 1376 (directing the Securities and Exchange Commission to reward whistle-blowers rewards in the range of 10–30 percent of the monetary sanctions collected), and the False Claims Act, 31 U.S.C. §§ 3729–3733 (2012) (rewarding individuals who provide information on fraud that was committed against the government). Under this Act, the whistle-blower must initiate litigation against the defrauder, after which the government may decide to take over the litigation. If the government takes over the litigation, whistle-blowers are entitled to 15–25 percent of the recovery. If the government does not take over, the whistle-blower obtains 25–30 percent. Note that more than 20 other federal Acts do not provide whistle-blowers with financial rewards, but rather protect them from retaliation by employers (e.g., laying off employees or demoting them). In this article, we focus on rewards and not on these protections.

[2] See for example, Howse and Daniels (1995); The New York Times, February 12, 1995, "Paying the Price for Blowing the Whistle," available via http://www.nytimes.com/1995/02/12/nyregion/paying-the-price-for-blowing-the-whistle.html?pagewanted=all; The Washington Post, April 14, 2015, "Isolated. Harassed. Their Personal Lives Investigated. That's life as a VA Whistleblower, Employees Tell Congress," available via https://www.washingtonpost.com/news/federal-eye/wp/2015/04/14/isolated-harassed-their-personal-lives-investigated-thats-life-as-a-va-whistleblower-employees-tell-congress/?utm_term=.28acc80ee0ce.

[3] Eisenstadt and Pacella (2018, p. 666) make a similar point: "prospective employers may avoid hiring known whistleblowers altogether due to the perception that they are 'disloyal.'"

[4] These discussions can be found in notes [16–18, 20, 22–25, 27], and [28], below.

[5] In this section, we focus on economic contributions. There is also a vast literature on whistle-blowing in other fields such as psychology, public administration, and sociology. See for example, Miceli and Near (1992) and Miceli et al. (2008) for an overview.

[6] Howse and Daniels strongly nuance this argument: "Whistleblowing incentives will not undermine a corporate culture that is based on honesty and fair play; rather, it will jeopardize only those cultures that are based on a perverse commitment to conspire against the public weal." (Howse & Daniels, p. 532).

[7] Howse and Daniels qualify this cost by noting that the whistle-blower's settlement leverage has little to do with the availability of an award, but rather with the ability to do reputational harm to the corporation or its managers before the claim can be judicially scrutinized (Howse & Daniels, p. 541).

[8] More precisely, we study three situations: one in which neither the employer's benefit from crime nor the employee's productivity is observable, one in which only the employer's benefit from crime is observable, and one in which only the employee's productivity is observable.

[9] Givati finds a formula for the optimal reward, and a condition for whether this reward should be offered or not. Both depend on the gain from violating the law, and only the latter reflects the social harm.

[10] This is perhaps why the standard law enforcement models as summarized by Polinsky and Shavell (2007) have focused and continue to focus on situations where the criminal's benefit is private knowledge.

[11] Chassang and Miquel (2019) identify an alternative, less direct, protection policy. They note that if enforcement policies are too well-aligned with whistle-blowing reports, this can cause whistle-blowers to be revealed and retaliated against. Thus, Chassang and Miquel (2019) note an alternative mechanism to protecting whistle-blowers to those discussed in Mechtenberg et al. (2020): a deliberate reduction in the informational match between whistleblowing reports and enforcement decisions.

[12] In the health industry, fraud is uncovered through employees blowing the whistle in 41 % of cases. In industries without whistle-blower rewards, the percentage is only 14%.

[13] The authors analyze Occupational Safety and Health Act claims between 2002 and 2010.

[14] For an overview of the literature on detection avoidance, see Sanchirico (2012).

[15] Note that there is also some informal literature on paying witnesses in general, which we do not discuss here (e.g., Friedman & Kontorovich, 2011; Levmore & Porat, 2012; Posner, 1999). For a brief overview, see Givati (2016). There are also some formal economic contributions on rewards programs for accomplice-witness whistleblowers (see e.g., Aubert et al., 2006; Spagnolo, 2004). Such programs are very different from the types of schemes we consider in this article (financial rewards for employees who are not involved in the violation and do not obtain any benefit from it).

[16] In the current model, the main instrument of interest, namely r, acts as a perfect substitute for s in terms of its incentive effects. Most of the analysis would therefore be unaffected by whether the regulator has a single instrument (r) or two instruments which act as perfect substitutes (s and r). However, in a more complicated setting where it is costly to use these two instruments, endogenizing the sanction can have more interesting implications.

[17] We note that the support could include a negative range if, for instance, some worker's obtained intrinsic benefits from reporting wrongdoings that more than off-set the costs we have described. This can cause whistle-blowing rewards to be inefficient all together. Our assumption rules out this possibility, and allows us to focus on cases where whistle-blowing rewards are optimal.

[18] This rules out the possibility of false reports by employees. Consistently with Mechtenberg et al. (2020), the possibility of false reports are likely to dilute the deterrence effects associated with whistle-blower reports. This is because the opportunity costs associated with committing crimes is reduced when the employer knows that it can be falsely punished for crimes even when it commits no offense (see, e.g., Lando & Mungan, 2018 and Mungan, 2017, discussing the conditions under which this dynamic emerges). Moreover, with false reports, even firms which do not intend to commit offenses may be deterred from hiring some workers, because they may expect them to file misreports. Therefore, this possibility is likely to push the optimal rewards, discussed below, downwards.

[19] We assume indifferent employees commit crime.

[20] A more realistic case is one where there is a baseline probability of punishment for committing crime and hiring a worker increases this probability. In these cases, some employers would not commit crime even if they do not hire employees. This consideration does not impact our analysis, and we therefore assume a zero probability of detection absent hiring.

[21] We assume that indifferent employees hire workers.

[22] We note that the effects associated with whistle-blowing rewards would be relatively straightforward if π were also private knowledge. In this case, the employer could not distinguish between workers ex-ante, and would have to make decisions based on $E[\pi]$, the average productivity of workers. For small r, that is, $G(r)s \leq E[\pi]$, the employer would always hire the worker, and commit crime if $b \geq G(r)s$. On the other hand, when $G(r)s > E[\pi]$, an employer commits crime without hiring the worker if $b \geq E[\pi]$, and hires the worker and refrains from crime otherwise. Therefore, small changes in r would have no effect on outcomes. In this case, it would be optimal to choose rewards such that $G(r)s = E[\pi]$, since this would maximize deterrence. Any further increases in the rewards would result in unnecessary hiring distortions.

[23] If these assumptions are violated, then additional costs such as punishment costs, rewarding costs, and whistle-blowing costs, would appear in the welfare function. These costs can generate counter-intuitive trade-offs, as noted in the existing literature on law enforcement

(e.g., Kaplow (1990) notes the possibility optimal corner solutions when imprisonment is costly; similar dynamics are discussed in Fluet & Mungan 2022). Thus, to focus on the trade-off between deterrence and productivity losses, we abstract from these considerations. However, in Section 5, we note the possible effects of including non-transferable whistleblowing costs with respect to the comparison between benefit-based and productivity-based rewards.

[24] We note that we are using a conventional welfare function which aggregates the benefits and costs of all parties involved. The inclusion of offender benefits in the welfare function has been contested, see, for example, Curry and Doyle (2016). As noted in Raskolnikov (2020), some prior work addresses this problem by separately analyzing the cases where welfare includes and excludes criminal benefits, respectively. In many instances, this choice has no impact on results (see, e.g., Mungan, 2014; Mungan, 2021) But, in other cases results differ depending on the welfare function used (e.g., Miceli & Bucci, 2005). Here, we expect our results to be robust to the exclusion of criminal benefits from welfare, since its main effect would be to alter the left hand side of Equation (7) to $\frac{h}{G(r)s}$, which would only affect the magnitude of optimal rewards, and would cause the addition of 1 that appears on the right hand sides of Equations (9)–(11) to disappear.

[25] We note that if whistle-blowing did not result in mere transfers, but involved real costs, then there would be additional gains in the form of reduced whistle-blowing costs associated with increasing rewards. This is because higher rewards would cause the probability with which employers hire the worker and subsequently commit crime. This can be formalized by letting $\psi(c)$ denote the non-transferable cost incurred by a whistleblower with $\psi' > 0$. It then follows that welfare would also have to account for whistle-blowing costs which equal

$$\Psi(r) \equiv [(1 - F(G(r)s))(1 - K(G(r)s))] \int_0^r \psi(c)g(c)dc$$

How these costs change as a function of rewards is ambiguous, because the term in squared brackets and the integral term move in opposite directions as a function of r. Thus, without further restrictions, it is impossible to ascertain the impact of these costs on the optimal reward.

[26] See note [1], above, providing a brief review of existing reward schemes.

[27] We note that this result is fairly robust to whether whistle-blowing generates costs which appear in the social welfare calculus. This is because whistle-blowing costs are incurred only when the worker is hired and the firm commits crime. This can happen under productivity-based rewards, despite not happening under benefit-based rewards, only if the worker is hired under the former regime but not the latter (e.g., in area III in Figure 5). However, in these cases, productivity-based rewards generate productivity gains which are likely to off-set whistleblowing costs.

[28] An interesting dynamic may emerge when employers can make inferences, although imperfectly, about employees' tendencies to blow the whistle when they witness criminal acts. In this type of setting, employers can (imperfectly) discriminate between employees based on their whistle-blowing tendencies. If, in addition, employees' whistle-blowing tendencies are positively correlated with their productivity, then employers may be unwilling to hire highly-productive workers who are also more likely to become whistle-blowers, and instead hire low-productivity workers to reduce their likelihood of being held liable for committing violations. The impact of increasing whistle-blowing rewards on employer behavior in this context is, a priori, ambiguous. This is because such increases are likely to increase both worker types' incentives to blow the whistle; and an important question is which worker types' incentives are affected more, on the margin, relative to their productivity. The answer to this question would determine the impact of an increase in whistle-blowing rewards on the productivity of the marginal worker hired by the employer.

[29] See notes [16–18, 20, 22–25, 27], and [28] above.

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SUPPORTING INFORMATION

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APPENDIX

Proof of Lemma 1

It follows that $W_r(0) > 0$ from Equation (6) and $W_r(\bar{c}) < 0$ when Equation (9) holds, since then the inequality in Equation (7) does not hold. Thus, when Equation (9) holds, W has an interior maximum with $W_r = 0$. Therefore, Equation (7) holds with equality at r^*, in which case we have the equality in Equation (10).■

Proof of Proposition 1

Let

$$A(r,h,s) = \frac{h}{G(r)s} - \frac{\lambda^{\pi}(G(r)s)}{\lambda^{b}(G(r)s)} - 1 \tag{19}$$

It follows that $W_r \geq 0$ if $A \geq 0$, and, thus, $A(r^*, h, s) = 0$ and $A_r(r^*, h, s) < 0$. Next, note that $r_h^* = -\frac{A_h}{A_r} > 0$, since $A_h = \frac{1}{G(r^*)s} > 0$ and $A_r < 0$. Similarly, $r_s^* = -\frac{A_s}{A_r} < 0$, since A_s and A_r have the same sign.■

Proof of Proposition 2

Note that $A_{\lambda^{\pi}} = -\frac{1}{\lambda^b} < 0 < \frac{\lambda^{\pi}}{(\lambda^b)^2} = A_{\lambda^b}$, where $A(r, h, s)$ is defined via Equation (19) in the proof of Proposition 1. Thus, $r^*_{\lambda^{\pi}} = -\frac{A_{\lambda^{\pi}}}{A_r} < 0 < -\frac{A_{\lambda^b}}{A_r} = r^*_{\lambda^b}$, since $A_r < 0$.■