

Effects of External Whistleblower Rewards on Internal Reporting

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Abstract

Many have argued that rewards for external whistleblowing on corporate crimes to regulatory agencies could discourage internal reporting in companies, but this issue has not yet been fully analyzed. Based on the observations of past trends in whistleblower cases, this paper develops a model based on the hypotheses that internal reporting helps a company's internal governance system prevent crime through the exercise of internal control and that external whistleblowing helps a regulatory agency deter crime through the threat of sanctions. The model shows the amount of external whistleblower rewards has a non-monotonic relationship with the probability of internal reporting occurring: As the amount of rewards increases, the probability of internal reporting first increases and, after reaching a maximum, decreases to zero. The socially optimal amount of external whistleblower rewards is determined by considering a trade-off between internal reporting as a means of prevention and external whistleblowing as that of deterrence.

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1 Introduction

If employees in corporations receive monetary rewards for whistleblowing on corporate crimes to regulators, does that discourage them from reporting the misconduct internally and undermine internal governance systems? This is a newly emerged question that has been discussed in countries that have introduced or contemplated the introduction of whistleblower reward legislation.¹ Despite the growing debate on the effects of external whistleblower rewards on internal reporting, this issue has not yet been fully analyzed. To analyze this issue, this paper develops a formal model and provides a new explanation of the relative roles that internal reporting and external whistleblowing play in the public and private enforcement of laws against corporate crimes.

To model internal and external reporting behavior, we need to understand how these actions occur in practice. Many surveys show that a majority of whistleblowers first report internally before blowing the whistle externally even if internal reporting is not a prerequisite for receiving rewards.² For example, in the case of Pfizer, a U.S. pharmaceutical company, its then employee found that the company was illegally marketing its drug Bextra for uses that the U.S. Food and Drug Administration (FDA) declined to approve because of safety concerns.³ He reported his concerns internally, but the company did not stop illegal marketing. Therefore, he filed a qui tam lawsuit under the False Claims Act, which led to federal and state investigations. Eventually, the company settled with the U.S. Department of Justice and paid \$2.3 billion, and this whistleblower received a reward of approximately

¹We discuss this in detail Section 2.1. For arguments in the U.S., see, for example, Business Roundtable 2010; Association of Corporate Counsel 2010. For arguments in the U.K., see, for example, Bank of England Financial Conduct Authority and Prudential Regulation Authority 2014, p. 2.

²We discuss this in detail in Section 2.2. See, for example, Kesselheim et al (2010, p. 1834); National Whistleblowers Center (2010, p. 5); SEC (2017, p. 17).

³The description in this paragraph is based on the press release by the U.S. Department of Justice (DOJ) and the allegations of the former employee in the company. For details, see DOJ (2009); Lipman (2012, pp. 45-56).

\$51.5 million.

There are several reasons why employees may report corporate crimes internally to corporate compliance departments and then, if all else fails, to an outside enforcement agency. What has been overlooked is that collecting evidence of crime takes time and efforts and that the standard of proof applied in external whistleblowing is higher than that applied in internal reporting; Employees often cannot collect evidence that meets the standard of proof for external whistleblowing at the early stages of crime. In addition, employees often have non-pecuniary motivation for their reporting actions, such as the feelings of guilt or virtue related to social welfare, in addition to pecuniary motivation.⁴ These factors seem to create a typical structure in which employees first report internally, and if their concerns are not addressed, they blow the whistle externally.

Based on these observations, we consider a model with two players, a corporation and an employee, and three stages. In the first stage, the employee observes an imminent or ongoing corporate crime in the workplace and decides whether to report the issue to an internal compliance department, which is objective or incorruptible, by bearing a personal cost. The employee suffers a non-pecuniary loss from social harm caused by the crime and thus avoids the loss if social harm is prevented. If internal reporting occurs, the internal compliance department takes measures to reduce the net benefit of crime to the corporation. In the second stage, the corporation decides whether to commit the crime. If the corporation commits the crime, the employee decides whether to blow the whistle to a regulatory agency seeking a reward while bearing a personal cost in the third stage. If external whistleblowing occurs, the corporation gets sanctioned.

The model captures the primary functions of internal reporting and external whistleblowing, which can be characterized in terms of the standard

⁴We discuss this in detail in Section 2.2. See, for example, Kesselheim et al (2010, pp. 1834-35); Government Accountability Project (2016, p. 24).

classification of legal intervention (For the detail of classification, see Shavell 1993, pp. 257-8. See also Arlen and Kraakman 1997; Arlen 2012). Internal reporting works as a means of *prevention*—intervention to reduce the net benefit of crime to wrongdoers by removing or reducing crime opportunities rather than by using the threat of sanctions. External whistleblowing works as a means of *deterrence*—intervention to increase the cost of crime by using the threat of sanctions.

With this setup, this paper shows (i) that the amount of external whistleblower rewards has a non-monotonic relationship with the probability of internal reporting occurring: As the amount of rewards increases, the probability of internal reporting occurring first increases and, after reaching a maximum, decreases to zero. The paper also shows (ii) that the socially optimal amount of external whistleblower rewards is determined by considering a trade-off between internal reporting as a means of prevention and external whistleblowing as that of deterrence. It is also shown that similar results continue to hold even if we assume that the crime can be detected by enforcement agents as well as external whistleblowing.

The reason for the first result is as follows. When the reward is low, employees do not have enough incentive to report externally, and thus the threat of external whistleblowing is not credible. Because of little threat of sanctions, a firm commits a crime regardless of whether employees report internally, and thus employees have little incentive to report internally. By contrast, when the reward is in an intermediate range, employees have enough incentive to report externally, and thus the threat of external whistleblowing is credible. In this circumstance, if employees report internally to prevent the crime, the probability that the firm does not commit the crime increases. If the firm does not commit the crime, employees lose the opportunity to receive the reward, but they can avoid the non-pecuniary loss in return. For employees who face low costs of internal reporting, this avoidable non-pecuniary loss more than compensates for the net reward they may lose plus

the cost of internal reporting. However, if the reward is high beyond a certain critical value, most employees withhold reporting internally (*crowding-out effect*). Reporting internally, now they lose too much reward relative to the size of the avoidable non-pecuniary loss.

The reason for the second result is as follows. Social welfare is affected by social harm caused by the crime and therefore by the probability of crime occurring. The probability of crime occurring is affected by external whistleblower rewards in two ways: through internal reporting or external whistleblowing. While an increase in the reward encourages employees' external whistleblowing and thus reduces the probability of crime occurring, it might discourage employees' internal reporting when the reward is high enough to cause the crowding-out effect. Hence, the marginal social loss resulting from a decrease in the probability of internal reporting should be equal to the marginal social benefit resulting from an increase in the probability of external whistleblowing.

This paper contributes to the literature on whistleblowing mechanisms. This topic has been studied for decades in fields such as management, ethics, sociology, and psychology (see Miceli, Near, and Dworkin 2008 for surveys). In legal literature, Howse and Daniels (1995) argued that external whistleblower rewards would not undermine internal compliance systems in companies with informal analysis. Feldman and Lobel (2010) studied the effects of different regulatory regimes on whistleblowing behavior with experimental surveys. In economic literature, Heyes and Kapur (2009) presented a formal model of whistleblower policy in which whistleblowers are not rewarded. Givati (2016) presented a formal model to analyze the optimal size of whistleblower rewards and the optimal policy choice between policing and whistleblowing. While these two models considered only external whistleblowing, this paper considered both internal reporting and external whistleblowing and focused on the interaction between them under a whistleblower reward law.

This paper also contributes to the study of the relationship between public and private enforcement of law. This topic has been studied in a broad context, not limited to corporate crime (see, for example, Shavell 1991, 1993; Polinsky and Shavell 2007). Public enforcement of law has often limitations on its effectiveness to prevent and deter crimes. In such circumstances, private enforcement can play a complementary role. In the context of corporate crimes, the role of firms to prevent and deter crimes has been studied in determining the optimal structure of corporate and individual liability (Polinsky and Shavell 1993; Arlen and Kraakman 1997; Arlen 2012). However, internal reporting and external whistleblowing have not attracted much attention in this context. This paper provides a new explanation about the relative roles that internal reporting and external whistleblowing play in private and public enforcement of laws against corporate crimes.

Section 2 provides justifications for the main assumptions of the model by providing an overview of whistleblower laws and presenting facts on whistleblowers. Section 3 develops the model. Section 4 discusses the robustness of the model and the empirical implications of the model results. Section 5 presents the conclusions of this paper and discusses the policy implications of the model. Proofs are in the Appendix.

2 Whistleblower Laws and Facts

2.1 Whistleblower Laws: Protection and Rewards

Whistleblowing is usually more efficient than public policing in the detection of corporate crimes. Regulatory authorities often cannot easily detect corporate crimes because of the information asymmetry between corporations and outsiders. In these cases, whistleblowers—organizational members who disclose illegal practices under the control of their employers to persons or organizations that may be able to take effective actions (see Near and Micelle 1985, p. 4 for the definition of whistleblowing)—play a critical role in de-

tecting corporate crimes. This paper calls disclosing behavior using internal channels *internal reporting* and disclosing behavior using external channels *external whistleblowing*.

Organizations often retaliate against whistleblowers for several purposes, such as to stop whistleblowers from collecting criminal evidence and to prevent subsequent whistleblowers from appearing. With the growing recognition of the need to protect whistleblowers, many countries passed whistleblower protection laws from the 1990s to the 2010s. For example, most (27 out of 32) OECD countries have whistleblower protection laws (OECD 2016, p. 21). A typical whistleblower protection law prohibits the disadvantageous treatment of whistleblowers, including dismissal and salary cuts, when their whistleblowing meets the requirements of the law.

In addition to protecting whistleblowers, some countries such as the U.S. and Canada (OSC Policy 15-601) have started to incentivize them. The U.S. is a leading country in the use of whistleblower rewards. Examples in the U.S. include a *qui tam* provision in the False Claims Act and reward programs at the Securities and Exchange Commission (SEC), Internal Revenue Service (IRS), and Commodity Futures Trading Commission (CFTC). Among such programs is the recently introduced SEC whistleblower reward program under the Dodd-Frank Act (15 U.S.C. §78u-6). In this program, whistleblowers can receive a monetary reward when they come forward with high-quality original information that leads to a commission enforcement action in which over \$1,000,000 in sanctions is ordered. Whistleblower rewards range from 10 percent to 30 percent of the money collected. Since the establishment of this program in 2011, the SEC has paid approximately \$160 million to 46 whistleblowers (SEC 2017, p. 16).

By contrast, other countries such as the U.K. have rejected whistleblower rewards on the grounds that rewards could discourage internal reporting in corporations.⁵ Even in the U.S., when the SEC whistleblower reward pro-

⁵See, for example, Bank of England Financial Conduct Authority and Prudential Reg-

gram was introduced, it attracted many criticisms from business or legal experts, such as CEOs and in-house lawyers, and even two of the five SEC Commissioners.⁶ The current program does not require employees in companies to first report internally before going to the SEC. The criticism of this structure has argued that, since the enactment of the Sarbanes-Oxley Act of 2002, many companies have established effective internal reporting and compliance systems, but the current program could undermine these systems by not requiring internal reporting as a prerequisite for rewards. The final rule reflected the criticism to some extent, and it allows the SEC to decrease the reward if whistleblowers interfere with a company's internal compliance system, intentionally delay whistleblowing to the SEC, or engage in the underlying misconduct (SEC 2017, p. 14).

2.2 Facts: Internal Reporting Prior to External Whistleblowing

Given these, what do the data of past whistleblower cases show about internal reporting under whistleblower reward programs? Many surveys show that a significant majority of whistleblowers first report internally before blowing the whistle externally even if internal reporting is not a prerequisite for receiving rewards.

Kesselheim et al (2010) conducted interviews with whistleblowers who filed the U.S. federal qui tam lawsuits against pharmaceutical companies settled between January 2001 and March 2009. Under the qui tam law, whistleblowers are not required to first report internally before filing suit. However, approximately 82 percent of the whistleblowers who were employees of the defendant company (18 of 22) first reported their concerns internally (Kessel-

ulation Authority 2014, p. 2 for a case in the U.K.

⁶See, for example, Business Roundtable 2010; Association of Corporate Counsel 2010. Two of the five SEC Commissioners expressed concerns in voting against the final rule of the whistleblower reward program (Casey 2011; Parades 2011).

heim et al 2010, p. 1834). According to another survey, approximately 90 percent of employees who filed a federal qui tam lawsuit between 2007-2010 (96 of 107) first reported their concerns internally, either to their supervisors or internal compliance departments (National Whistleblowers Center 2010, p. 5). Moreover, according to the SEC's data, in the SEC whistleblower reward program, approximately 83 percent of reward recipients who were current or former employees of the reported entities first reported their concerns internally or understood that their supervisors or internal compliance departments knew of potential violations before going to the SEC (SEC 2017, p. 17).

We cannot draw decisive conclusions from these data, but we can learn at least the following fact: When employees blow the whistle externally in a reward program under which internal reporting is not a prerequisite for receiving rewards, they nevertheless first report internally.

Few empirical surveys exist on the reasons for this, but this paper hypothesizes that the main reason is that the availability of evidence of crime affects the timings of internal reporting and external whistleblowing. In practice, it takes time and efforts for employees to collect evidence before they report internally or externally (see, for example, Government Accountability Project 2016, p. 10 and p. 25). In addition, the standard of proof applied in external whistleblowing is higher than that applied in internal reporting; employees need more evidence in terms of quality to have regulatory authorities commence an investigation when compared to the case of an internal control or compliance department in companies. This is because regulatory authorities have to allocate their limited resources to those cases for which more specific and credible evidence has been submitted (see, for example, SEC 2017, p. 17). Therefore, employees need more time to collect evidence of crime for external whistleblowing than for internal reporting.

Even if employees find it easier to collect evidence of crime for internal reporting, why do employees first report internally despite the fact that they

may lose the opportunity to receive external whistleblower rewards if their internal reporting prevent crime occurring? The reason is likely that employees have both non-pecuniary and pecuniary motivation for their reporting behavior, and they engage in internal reporting because of non-pecuniary motivation. The key fact here is that social harm caused by a corporate crime usually increases during the time an employee collects evidence in order to blow the whistle externally; in such circumstances, employees may be able to reduce social harm by first reporting internally.⁷

If employees fail to reduce social harm when they can do so and this leads to a decrease in social welfare, they may feel guilt and suffer a disutility, or if employees reduce social harm and this leads to an increase in social welfare, they may feel virtue and receive a positive utility. Prior literature has studied this assumption (see, for example, Kaplow and Shavell 2007 and Shavell 2012). In fact, according to the previously cited study, which conducted interviews with *qui tam* whistleblowers, the primary motivation for filing suit includes the feelings of guilt or virtue related to social welfare (Kesselheim et al 2010, pp. 1834-35).

2.3 Prevention and Deterrence

Given these observations of past trends in whistleblower cases, this paper argues that, based on the standard classification of legal intervention (Shavell 1993; Arlen and Kraakman 1997; Arlen 2012), we can generally characterize internal reporting as a means of prevention—intervention to reduce the net benefit of crime to wrongdoers by removing or reducing crime opportunities rather than by using the threat of sanctions—and external whistleblowing as a means of deterrence—intervention to increase the cost of crime by using the threat of sanctions—in the following manner.

Employees often have opportunities to observe imminent or ongoing cor-

⁷For example, in the cited case of Pfizer, if the company had stopped illegal marketing when internal reporting occurred, harm could have been mitigated.

porate wrongdoings in their daily jobs. While it is usually difficult for one employee alone to stop a likely wrongdoing, they can report their concerns internally to those who may be able to take effective actions in a corporate department such as internal control or compliance. After receiving internal reports about suspicious persons or activities, the internal control or compliance department may remove or reduce opportunities to commit crimes through the exercise of internal control (prevention). If employees' concerns are not addressed nonetheless, they can blow the whistle externally. External whistleblowing usually occurs in order to help regulators detect and sanction illegal activities (deterrence).

The classification between a means of prevention and that of deterrence is not an either-or one because intervention triggered by internal reporting or external whistleblowing sometimes has both aspects of prevention and deterrence, but this classification captures the primary roles of internal reporting and external whistleblowing.

Internal reporting usually occurs before or during crimes, and this enables companies' internal governance systems to take timely and proactive actions to remove or reduce opportunities for wrongdoings. In many cases, public enforcement of laws against corporate crimes has limitations on its effectiveness. Regulatory agencies usually find it difficult to take preventive measures because they have limited knowledge of each firm's business and preventive measures are costly if these measures require enforcement agents. Therefore, public enforcement often relies on deterrence rather than prevention; however, because of factors such as a low probability of detection, the limited wealth of wrongdoers, and considerations of fairness, the expected sanction might not be large enough to deter crimes. In such circumstances, private enforcement by companies can play a complementary role if their internal governance systems work effectively.

To illustrate, consider the case of Beech-Nut, a U.S. baby food company (United States v. Beech-Nut Nutrition Corporation, 871 F.2d 1181 (2nd Cir.

1989); Jennings 2014, pp. 328-33). In this case, an employee in the company discovered and reported internally that it was likely that the company’s supplier was providing sugar syrups as pure apple concentrates. These syrups were used in the company’s bottled apple juices that were labeled and advertised as pure fruit juice without added sugar, and this could be violation of food safety regulations. At the time of that discovery, only the supplier was involved in the adulteration of apple concentrates, and the company was not involved. Despite the employee’s internal reporting, the company did not stop purchasing from the supplier and kept selling the adulterated juices; therefore, the employee reported externally. Yet, if the company’s internal governance system had worked effectively, it would have taken preventive actions such as changing suppliers, which could have removed opportunities to keep selling the mislabeled juices and prevented the crime from occurring.

By contrast, external whistleblowing usually occurs after or at relatively later stages of crimes. While regulatory agencies may not make timely interventions, they have direct authority to punish wrongdoers. Therefore, the primary role of external whistleblowing is to trigger intervention by regulatory agencies for detecting and sanctioning illegal activities.

3 Model

3.1 Setup

We consider a model with two players, a corporation and an employee, and three stages. Let us define the following notation:

- h = social harm caused by the corporate crime;
- θ = parameter for the employee’s disutility from social harm; $\theta \in (0, 1)$;
- c_i = cost to the employee from internal reporting; $c_i \in [0, \infty)$;
- $Z(\cdot)$ = cumulative distribution of c_i ;
- $z(\cdot)$ = probability density of c_i ;

b = benefit to the corporation from committing the crime;
 \bar{b} = upper bound of b ; $b \in [0, \bar{b}]$; $h \in (\bar{b}, \infty)$;
 $G_n(\cdot)$ = cumulative distribution of b when internal reporting is not done;
 $G_i(\cdot)$ = cumulative distribution of b when internal reporting is done;
 $g_n(\cdot)$ = probability density of b when internal reporting is not done;
 $g_i(\cdot)$ = probability density of b when internal reporting is done;
 s = expected sanction imposed on the corporation; $s \in (0, \infty)$;
 R = expected reward for external whistleblowing; $R \in [0, \infty)$;
 c_e = cost to the employee from external whistleblowing; $c_e \in [0, \infty)$;
 $F(\cdot)$ = cumulative distribution of c_e ;
 $f(\cdot)$ = probability density of c_e ;
 Ψ = incremental benefit to the employee from internal reporting.

In the first stage, the employee observes an imminent or ongoing corporate crime in the workplace and learns the personal cost of internal reporting c_i that has the cumulative distribution function $Z(\cdot)$ on the full support $[0, \infty)$.⁸ Then, the employee decides whether to report the issue to an internal compliance department, which is objective or incorruptible. The employee suffers a loss of θh whenever the crime is committed, where $\theta \in (0, 1)$ is the parameter for the employee's disutility from social harm and h is social harm caused by the corporate crime.

In the second stage, the corporation learns its benefit from committing the crime of $b \in [0, \bar{b}]$ where \bar{b} is the upper bound of b and then decides whether to commit the crime. This benefit of b should be interpreted as the net benefit from committing crime: the benefit of crime minus the cost necessary to complete crime, except for the cost arising from the expected sanction.⁹

⁸The cost of internal reporting c_i includes the cost of collecting evidence and the cost arising from retaliation from wrongdoers.

⁹For simplicity, we assume that $b \in [0, \bar{b}]$, but we can allow b to be negative. This does not alter our conclusion.

If the employee reports internally in the first stage, then the internal compliance department takes some actions to make it costly to commit the crime, which leads to the reduction of b through the change of its distribution: $G_i(b) > G_n(b)$ for all $b \in (0, \bar{b})$ where $G_i(b)$ is the cumulative distribution function of b when internal reporting is done and $G_n(b)$ is the cumulative distribution function of b when internal reporting is not done on the full support $[0, \bar{b}]$. In other words, $G_n(b)$ has the first-order stochastic dominance over $G_i(b)$.¹⁰ As explained later in solving the model, this means that internal reporting reduces the probability of crime occurring except for the cases at the end points where the crime occurs with probability 100 percent because of no threat of sanctions or the crime is already perfectly deterred by the threat of sanctions posed by external whistleblowing. For simplicity, we assume that the crime is always socially undesirable, $\bar{b} < h$.

The corporation receives an expected sanction of $s \in (0, \infty)$ if the crime is detected in the third stage. We allow a possibility that $s < \bar{b}$; in these cases, the expected sanction is less than the upper bound of benefit from committing the crime for some reasons such as the limited wealth of wrongdoers, considerations of fairness, and uncertainty in the process of imposing sanctions.

In the third stage, if the corporation commits the crime in the second stage, the employee learns the personal cost of external whistleblowing c_e that has the cumulative distribution function $F(\cdot)$ on the full support $[0, \infty)$ and decides whether to blow the whistle to a regulatory agency.¹¹ For simplicity, we assume that the employee can obtain evidence that may meet the standard of proof for external whistleblowing only in the third stage. The employee receives an expected reward of $R \in [0, \infty)$ for external whistleblowing. We

¹⁰In the usual meaning of the first-order stochastic dominance, $G_i(b) \geq G_n(b)$ for all b , with strict inequality at some b . Since this makes the proofs of propositions longer, the paper assumes in the way mentioned in the text.

¹¹As with the cost of internal reporting c_i , the cost of external whistleblowing c_e includes the cost of collecting evidence and the cost arising from retaliation from wrongdoers.

assume that c_i and c_e are independently distributed and that the employee learns c_i in the first stage but does not learn c_e until the third stage.

3.2 The Third Stage: External Whistleblowing

Given the setup, we solve the model by backward induction. In the third and final stage, the employee decides whether to blow the whistle to the regulatory agency if the corporation commits the crime in the second stage.

The employee blows the whistle externally if the personal cost from doing so is equal to or less than the expected benefit:

$$c_e \leq R. \tag{1}$$

The probability that the employee blows the whistle in the third stage can be written as follows:

$$Pr(c_e \leq R) = F(R). \tag{2}$$

This is the conditional probability given that the crime has been committed in the second stage. Since $F(\cdot)$ has the full support $[0, \infty)$, $F'(R) = f(R) > 0$. The conditional probability of external whistleblowing is monotonically increasing in R : As the reward increases, the conditional probability of external whistleblowing occurring always increases.

3.3 The Second Stage: Corporate Crime

In the second stage, the corporation decides whether to commit the crime. If the corporation commits the crime, it receives the benefit of b , but it gets exposed to the expected sanction of $F(R)s$, that is, the probability of external whistleblowing occurring times the expected sanction at the time of the third stage.

The corporation commits the crime if the benefit from committing the

crime is equal to or greater than the expected sanction:

$$b \geq F(R)s. \quad (3)$$

The probability that the corporation commits the crime in the second stage can be written as follows:

$$Pr(b \geq F(R)s) = 1 - G_j(F(R)s), j \in \{i, n\}. \quad (4)$$

In this expression, $1 - G_i(F(R)s)$ is the conditional probability of crime occurring given that the employee has reported internally in the first stage, and $1 - G_n(F(R)s)$ is the conditional probability of crime occurring given that the employee has not reported internally in the first stage. If the reward amount $R = 0$, $G_j(F(R)s) = 0$, and thus $1 - G_j(F(R)s) = 1$: The corporation always commits the crime regardless of whether the employee reports internally. Since $G_j(\cdot)$ has the full support $[0, \bar{b}]$, $\partial[1 - G_j(F(R)s)]/\partial R = -g_j(F(R)s) < 0$. The probability of crime occurring in both cases of internal reporting and no-internal reporting is monotonically decreasing in R : As the reward increases, the probability of crime occurring decreases in both cases.

3.4 The First Stage: Internal Reporting

In the first stage, the employee observes the imminent or ongoing corporate crime in the workplace and decides whether to report it internally.

The employee's net benefit from reporting internally can be written as follows:

$$[1 - G_i(F(R)s)] \left[-\theta h + \int_0^R (R - c_e) dF(c_e) \right] - c_i. \quad (5)$$

In this expression, $1 - G_i(F(R)s)$ is the probability that the crime is committed, conditional on the employee having reported internally. If the crime is committed, the employee suffers a non-pecuniary loss of θh but gains

the expected reward minus the expected cost of external whistleblowing, $\int_0^R (R - c_e)dF(c_e)$. Regardless of whether the crime is committed, the employee bears the personal cost of internal reporting c_i .

By contrast, the employee's net benefit from not reporting internally can be written as follows:

$$[1 - G_n(F(R)s)] \left[-\theta h + \int_0^R (R - c_e)dF(c_e) \right]. \quad (6)$$

In this expression, $1 - G_n(F(R)s)$ is the probability that the crime is committed, conditional on the employee not having reported internally. The differences between expression (5) and expression (6) are the difference in the probability of crime occurring and whether the personal cost of internal reporting occurs.

The employee reports internally if the net benefit from doing so is equal to or greater than the net benefit from not doing so. Using expressions (5) and (6), we obtain the following expression. The employee reports internally if the cost of internal reporting is equal to or less than the incremental benefit brought by internal reporting Ψ :

$$\begin{aligned} c_i &\leq \Psi(R; s, \theta, h) \\ &= \underbrace{[G_i(F(R)s) - G_n(F(R)s)]}_{(A)} \underbrace{\left[\theta h - \int_0^R (R - c_e)dF(c_e) \right]}_{(B)}. \end{aligned} \quad (7)$$

The right hand side of expression (7) represents the incremental benefit to the employee from internal reporting. The underlined portion (A) represents how much internal reporting reduces the probability of crime occurring. The underlined portion (B) represents the net benefit that can be gained after the second stage if internal reporting is successful: θh represents an avoidable non-pecuniary loss by internal reporting, in other words, a non-pecuniary

benefit from internal reporting, and $-\int_0^R (R - c_e)dF(c_e)$ represents the expected lost reward plus the expected avoidable cost of external whistleblowing.

The underlined portion (A), the reduction in the probability of crime occurring caused by internal reporting, is positive except for the cases at the end points where $G_i(F(R)s) = G_n(F(R)s) = 0$ or 1 by the assumption that $G_n(b)$ has the first-order stochastic dominance over $G_i(b)$. This means that internal reporting reduces the probability of crime occurring to some degree except for the cases at the end points where the crime occurs with probability 100 percent because of no threat of sanctions or the crime is already perfectly deterred by the threat of sanctions posed by external whistleblowing.

The underlined portion (B), the net benefit that can be gained after the second stage in case of successful internal reporting, can be positive or negative depending on whether the non-pecuniary benefit from internal reporting is larger or smaller than the absolute value of the expected lost reward plus the expected avoidable cost of external whistleblowing. Note that the underlined portion (B) is monotonically decreasing in R : $\partial \left[\theta h - \int_0^R (R - c_e)dF(c_e) \right] / \partial R = -F(R) \leq 0$. This means that, as the reward increases, the net benefit obtainable after the second stage in case of successful internal reporting decreases monotonically.

The important property of Ψ , which is the product of the underlined portion (A) and (B), is that it is non-monotonic in R : If $R = 0$, the underlined portion (A) is equal to zero; therefore, $\Psi = 0$. If $0 < R < \infty$, the underlined portion (A) is positive in a certain interval of R and we can always find some R at which the underlined portion (B) is positive. Hence, at that R , $\Psi > 0$. If $R \rightarrow \infty$, the underlined portion (B) in the expression is non-positive; therefore, $\Psi \leq 0$. We note that Ψ is also non-monotonic in s because of the non-monotonicity of the underlined portion (A) in s . We also note that Ψ is monotonic in θ and h : The increase in the size of avoidable non-pecuniary loss by internal reporting will increase the incremental benefit from internal

reporting monotonically.

The probability that the employee reports internally in the first stage can be written as follows:¹²

$$Pr(c_i \leq \Psi(R)) = Z(\Psi(R)). \quad (8)$$

We can now analyze the effects of external whistleblower rewards on internal reporting.

Proposition 1: *The amount of external whistleblower rewards R has a non-monotonic relationship with the probability of internal reporting occurring Z : If $R = 0$, $Z = 0$; if $0 < R < \infty$, $Z > 0$ at some R ; and if $R \rightarrow \infty$, $Z \rightarrow 0$. If R is sufficiently small, Z is increasing, and if R is sufficiently large, Z is weakly decreasing.*

Proof: See the Appendix.

The intuition of the proof is as follows. In the model, when $R = 0$, no external whistleblowing occurs and no threat of sanctions exists, and thus, the crime occurs with probability 100 percent. In this case, the underlined portion (A)—the reduction in the probability of crime occurring caused by internal reporting—is equal to zero, and therefore, the incremental benefit from internal reporting of Ψ is equal to zero. Hence, no employee reports internally: $Z = 0$. In other words, internal reporting works effectively only when sufficient threat of sanctions posed by external whistleblowing exist.

As R increases, the probability of external whistleblowing occurring increases and the threat of sanctions also increases. Because of this threat of sanctions, if employees report internally to prevent the crime, the probability of crime occurring decreases. In this case, the underlined portion (A) becomes positive, and the underlined portion (B)—the net benefit obtainable after the second stage in case of successful internal reporting—is also

¹²For notational simplicity, hereafter, we omit the parameters s , θ , and h in writing Ψ .

positive at some R ; therefore, the incremental benefit from internal reporting of Ψ is positive. Hence, some employees who face relatively low costs of internal reporting report internally: $Z > 0$. This means that some employees can receive enough incremental benefit by internal reporting even if internal reporting incurs the personal cost: If internal reporting prevents the crime, employees lose the opportunity to receive the reward, but they can avoid the non-pecuniary loss in return; for employees who face low costs of internal reporting, this avoidable non-pecuniary loss more than compensates for the net reward they may lose plus the cost of internal reporting.

However, if R becomes high beyond a certain critical value, the underlined portion (B) becomes small and eventually becomes zero or negative; therefore, the incremental benefit from internal reporting of Ψ also becomes small and eventually becomes zero or negative. If employees report internally, now they lose too much reward relative to the size of the avoidable non-pecuniary loss. Hence, the probability of internal reporting occurring decreases and reaches to zero: $Z = 0$ (crowding-out effect).

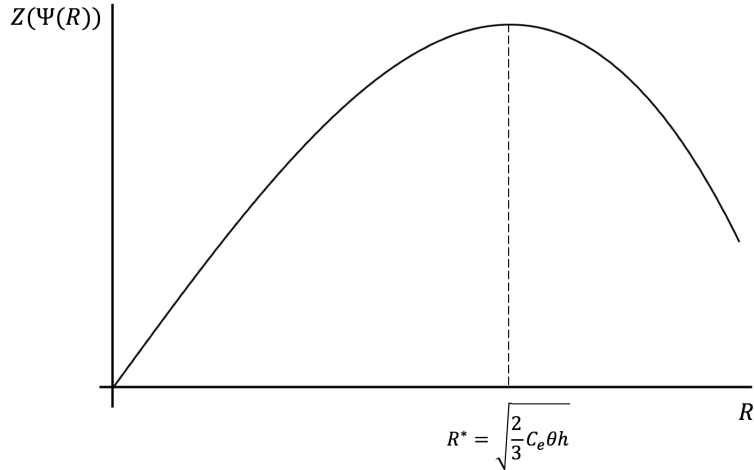
3.5 Example: Uniform Distribution

To understand Proposition 1 graphically, let us consider the case where the distribution of the random variables c_i , b , and c_e is the uniform distribution. We additionally assume the following: $c_i \sim U[0, C_i]$, where C_i is the upper bound of c_i ; $b \sim U[0, B_n]$ if internal reporting is not done, where B_n is the upper bound of b in that case; $b \sim U[0, B_i]$ if internal reporting is done, where B_i is the upper bound of b in that case and $B_i \leq B_n$; and $c_e \sim U[0, C_e]$, where C_e is the upper bound of c_e .

Under the assumption of the uniform distribution, the probability that the employee reports internally in the first stage can be written as follows:

$$Z(\Psi(R)) = \frac{1}{C_i} \left(\frac{1}{B_i} - \frac{1}{B_n} \right) \frac{s}{C_e} \left(\theta h R - \frac{1}{2C_e} R^3 \right). \quad (9)$$

Figure 1: The Probability of Internal Reporting and the Expected Reward Amount



This equation (9) is the third degree equation for R . Since the sign of R^3 is negative, this function is concave in the range $R \geq 0$.

Let R^* be the expected reward amount that maximizes the probability of internal reporting occurring $Z(\Psi(R))$. By taking the first derivative of equation (9), setting it to zero, and solving for R , we find

$$R^* = \sqrt{\frac{2}{3}C_e\theta h}. \quad (10)$$

As we see, R^* is determined by the parameters C_e , θ , and h .

Figure 1 shows the relationship between the probability of internal reporting occurring and the expected reward amount. Under the assumption of the uniform distribution, the probability of internal reporting occurring can be expressed as a single-peaked graph.

There is a wide misperception that rewards for external whistleblowing discourage employees from internal reporting. However, as shown in Figure 1, internal reporting and external whistleblowing are not mutually exclusive if the reward amount falls within a certain range.

3.6 Socially Optimal Reward

Next, let us consider how the socially optimal reward is determined given that the amount of external whistleblower rewards has a non-monotonic relationship with the probability of internal reporting occurring.

Let SW be social welfare. The social welfare maximization problem with respect to the reward amount R can be written as follows:

$$\begin{aligned} \max_R SW &= \int_0^{\Psi(R)} \left\{ \int_{F(R)_s}^{\bar{b}} \left[b - h - \int_0^R c_e dF(c_e) \right] dG_i(b) - c_i \right\} dZ(c_i) \\ &+ \int_{\Psi(R)}^{\infty} \int_{F(R)_s}^{\bar{b}} \left[b - h - \int_0^R c_e dF(c_e) \right] dG_n(b) dZ(c_i). \end{aligned} \quad (11)$$

The first term in the right hand side represents the net social benefit when the employee reports internally, and the second term represents the net social benefit when the employee does not report internally. Regardless of whether internal reporting is done, if the crime is committed, the corporation receives the benefit of b from committing the crime, and the society suffers a loss of h . We assume that h includes the employee's non-pecuniary loss of θh for simplicity. In addition, the employee bears the expected cost of external whistleblowing, $\int_0^R c_e dF(c_e)$. In case of internal reporting, the cost of internal reporting c_i needs to be considered in calculating the net social benefit.

Proposition 2: *The socially optimal amount of external whistleblower rewards is determined by considering a trade-off between internal reporting and external whistleblowing.*

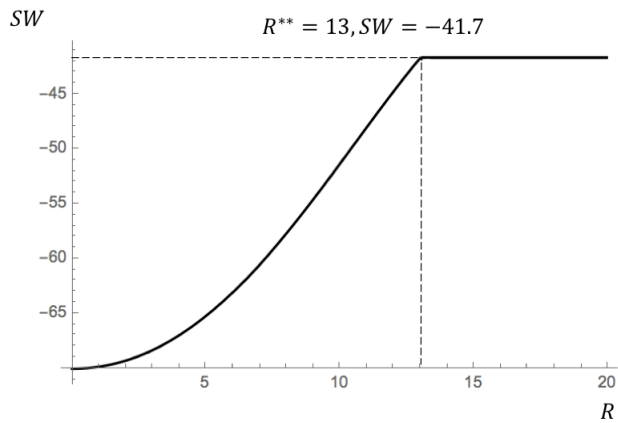
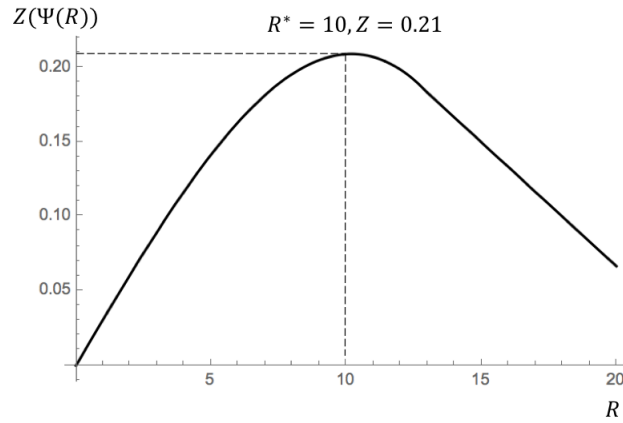
Proof: See the Appendix.

The intuition of the proof is as follows. Social welfare is affected by the probability of crime occurring, and there are two channels where the probability of crime occurring is affected by external whistleblower rewards: through internal reporting or external whistleblowing. While an increase in

the reward encourages employees' external whistleblowing and thus reduces the probability of crime occurring, it might discourage employees' internal reporting when the reward is high enough to cause the crowding-out effect. Hence, at the social optimum, the marginal social loss resulting from a decrease in the probability of internal reporting should be equal to the marginal social benefit resulting from an increase in the probability of external whistleblowing.

To understand Proposition 2 graphically, let us consider again the case where the distribution of the random variables c_i , b , and c_e is the uniform distribution. As we previously defined, R^* is the expected reward amount that maximizes the probability of internal reporting occurring $Z(\Psi(R))$. We additionally define R^{**} as the socially optimal amount of the reward. Under the assumption of the uniform distribution, the first order condition for the maximization problem (11) is the five degree equation for R . Therefore, to find R^{**} , there is no algebraic solution to the equation by Abel–Ruffini theorem. Yet, we can solve the equation numerically. Figure 2 shows the result of calculation for R^* and R^{**} with the following parameters: $\theta = 0.1$, $h = 120$, $s = 50$, $C_i = 15$, $B_n = 100$, $B_i = 50$, $C_e = 13$.

Figure 2: Numerical Example



While the probability of internal reporting occurring $Z(\Psi(R))$ reaches the maximum of 0.21 with $R^* = 10$, the social welfare SW reaches the maximum of -41.7 with $R^{**} = 13$. Therefore, $R^* \neq R^{**}$. In this case, the reward should be increased beyond R^* even if internal reporting is discouraged to some degree because the additional social benefit realized by an increase in the probability of external whistleblowing exceeds the additional social loss caused by a decrease in the probability of internal reporting.

In this setting, since $s < B_n$, that is, the expected sanction is less than the upper bound of the benefit from committing the crime, even if the employee blows the whistle externally with probability 100 percent, it is impossible to deter the crime perfectly. Therefore, after reaching the maximum, social welfare does not change even if the reward is increased. This is because, even if the reward is further increased, the social harm cannot be reduced anymore.

If $s \geq B_n$, it may occur that it is socially optimal to increase the reward up to the point where external whistleblowing occurs with high probability but no internal reporting occurs because of a huge monetary incentive. Yet, that situation may not occur in reality because it is usually difficult to increase the expected sanction up to the point where the crime is perfectly deterred for variety of reasons such as the limited wealth of wrongdoers, considerations of fairness, and uncertainty in the process of imposing sanctions.

3.7 Baseline Probability of Crime Detection by Policing

So far we have assumed that the crime can be detected only by external whistleblowing. We now assume that the crime can be detected by enforcement agents as well as external whistleblowing. This subsection shows that the main conclusions of the model continue to hold under the new assumption.¹³

We change the assumption about the third stage and assume that enforcement agents detect the crime with a probability $p > 0$ independently of the employee's external whistleblowing in the third stage. A similar proposition to Proposition 1 holds under the new assumption if the probability of crime detection by public policing p is small. Typically, governments contemplate the introduction of whistleblower rewards when the probability of crime detection by public policing is small, and thus the extension of the model in

¹³This paper does not discuss the optimal policy choice between policing and whistleblowing, which was analyzed by Givati (2016).

this subsection resembles a more realistic situation.

Proposition 3: *Suppose that the crime can be detected by enforcement agents as well as external whistleblowing. If the probability of crime detection by enforcement agents p is sufficiently small, then the amount of external whistleblower rewards R has a non-monotonic relationship with the probability of internal reporting occurring Z : If R is sufficiently small, Z is increasing, and if R is sufficiently large, Z is weakly decreasing.*

Proof: See the Appendix.

The intuition of the proof is as follows. When there is a certain possibility of crime detection by public policing, even if no reward exists and no external whistleblowing occurs, the threat of sanctions is credible to some degree. Thus, if employees report internally to prevent the crime, the probability that the firm does not commit the crime increases. Therefore, employees who face low cost of internal reporting have incentive to report internally seeking for the non-pecuniary benefit from preventing crime.

If public policing does not have enough deterrence (i.e. p is small) and external whistleblowing can make it stronger, external whistleblower rewards can increase deterrence. By introducing rewards, the threat of sanctions increases because now both the threat of public policing and the threat of external whistleblowing exist. In this circumstance, if employees' non-pecuniary incentive for internal reporting is not crowded out by the pecuniary incentive, external whistleblower rewards can enhance employees' internal reporting behavior: As the reward increases, the probability of internal reporting increases until the crowding-out effect appears.

We now consider a similar proposition to Proposition 2.

Proposition 4: *Suppose that the crime can be detected by enforcement agents as well as external whistleblowing. If the probability of crime detection by enforcement agents p is sufficiently small, then the socially optimal amount of external whistleblower rewards is determined by considering a*

trade-off between internal reporting and external whistleblowing.

Proof: See the Appendix.

The intuition of the proof is the same with that of Proposition 2. Even if we assume that the crime can be detected by enforcement agents as well as external whistleblowing, if the probability of crime detection by enforcement agents p is small, from Proposition 3, the amount of external whistleblower rewards R has a non-monotonic relationship with the probability of internal reporting occurring Z , and the introduction of the reward R can increase social welfare. While an increase in the reward encourages employees' external whistleblowing and thus reduces the probability of crime occurring, it might discourage employees' internal reporting when the reward is high enough to cause the crowding-out effect. Therefore, at the social optimum, the marginal social loss resulting from a decrease in the probability of internal reporting should be equal to the marginal social benefit resulting from an increase in the probability of external whistleblowing.

4 Discussion

4.1 Robustness of the Model

Let us now comment on the robustness of the model. The non-monotonicity of the probability of internal reporting occurring with respect to the external whistleblower reward comes from the key assumptions that the timing of internal reporting is earlier than the timing of external whistleblowing and that the social harm caused by the crime increases during the time of internal reporting and the time of external whistleblowing. Whether the type of crime is imminent or ongoing does not alter our conclusion. As long as these key assumptions are maintained, our conclusions hold to continue even if we make different assumptions about the other parts of the model. As explained in Section 2, the standard of proof applied in external whistleblowing is higher

than that applied in internal reporting, and thus the key assumptions would be maintained in many cases.

Let us consider some examples of different assumptions about the other parts of the model. For example, we can make different assumptions about the role of the internal compliance department. We assumed that, after internal reporting, the internal compliance department takes some actions to make it costly to commit the crime, which leads to the reduction of b through the change of its distribution. However, we can instead assume that the internal compliance department increases the probability of crime detection. This does not alter our conclusion.

We can also make alternative assumptions about the employee's preferences. We assumed that the employee suffers a loss whenever the crime is committed, but we can instead assume that the employee receives a benefit whenever the crime is not committed. We can even assume that the size of the avoidable loss or the benefit from internal reporting changes depending on the size of the social harm that is prevented.

4.2 Empirical Implications

We next comment on the empirical implications of the model results. Recent empirical studies have examined interactions between monetary and non-monetary incentives in whistleblowing with experiments (see, for example, Feldman and Lobel 2010 and Butler et al 2017), and the number of studies in this topic is likely to grow. In designing experiments that focus on the relationship between internal reporting and external whistleblowing, it is important to understand how employees' these actions occur in practice. Employees engage in internal reporting and external whistleblowing under constraints. Among them, important constraints are that collecting evidence of crime takes time and efforts and that the standard of proof applied in external whistleblowing is higher than that applied in internal reporting. These constraints generate the difference between the timings of internal reporting

and external whistleblowing. The model predicts that this difference will be important for employees' decision-making. Experimental designs without considering this point may draw wrong conclusions.

In determining whether monetary incentives crowd out non-monetary incentives, the answer depends also on what types of non-monetary benefits employees can receive. Based on the previous studies mentioned in Section 2.2, we have assumed that employees suffer a non-pecuniary loss from social harm caused by crimes in their workplaces, and thus they can receive a non-pecuniary benefit by preventing the harm from increasing. Unlike the case where employees derive utility from reporting behavior itself for ethical reasons, under this hypothesis, the important thing is to what extent employees can prevent or mitigate social harm by their reporting actions, which affects the degree to which the crowding-out effect occurs. In designing treatments in experiments, this point should be considered.

5 Conclusion and Policy Implications

Whistleblower reward laws have relatively short histories; debates on the effectiveness of these laws have been growing. While some countries such as the U.S. and Canada have adopted whistleblower reward programs, other countries such as the U.K. have rejected the idea on the grounds that external whistleblower rewards could discourage internal reporting in companies and undermine internal compliance systems.

Previous whistleblowing cases and statistical data show that internal reporting usually occurs prior to external whistleblowing and prior to or during crimes and this implies that the primary function of internal reporting is to help companies' internal governance systems remove or reduce the opportunities for illegal activities and the primary function of external whistleblowing is to help regulatory agencies detect and sanction illegal activities. Therefore, internal reporting can be characterized as a means of prevention and external

whistleblowing as that of deterrence based on the standard classification of legal intervention.

We have developed a model based on this fact and have showed that rewards for external whistleblowing promote internal reporting as well as external whistleblowing if a reasonable range of rewards is established. Private enforcement by firms plays a complementary role to reduce corporate crimes when the threat of sanctions posed by public enforcement exists sufficiently.

We also need to note that the socially optimal level of external whistleblower rewards is determined by considering a trade-off between internal reporting as a means of prevention and external whistleblowing as that of deterrence. As long as the additional social benefit realized by an increase in the probability of external whistleblowing exceeds the additional social loss caused by a decrease in the probability of internal reporting, it is effective for regulatory authorities to raise the reward amount even if internal reporting is discouraged to some degree.

In order for whistleblower reward programs to work effectively, governments need to establish laws that enable companies to create effective internal governance systems and laws that appropriately protect whistleblowers from the disadvantageous treatment including company retaliation. As the model shows, the probability of internal reporting occurring will be affected by factors such as the effectiveness of an internal control or compliance system, the costs of internal reporting and external whistleblowing, and the reward amount.

It might be worth considering for companies whether it is effective to offer rewards for internal reporting. However, given the fact that many employees are likely to have enough non-pecuniary incentives for internal reporting, the first step for companies would be to establish an effective internal control or compliance system in which employees can receive immediate and appropriate supports to their internal reporting and are protected from the disadvantageous treatment, which increases the net benefit from internal re-

porting.

Appendix

Proof of Proposition 1

The proof is simple and directly derived from the property of Ψ . As we saw already, Ψ is non-monotonic in R . Since c_i has the cumulative distribution function $Z(\cdot)$ on the full support $[0, \infty)$, Z is non-monotonic in R as well, that is, *if $R = 0$, $Z = 0$; if $0 < R < \infty$, $Z > 0$ at some R ; and if $R \rightarrow \infty$, $Z \rightarrow 0$* . By continuity of Z , if R is sufficiently small, Z is increasing, and if R is sufficiently large, Z is weakly decreasing. \square

Proof of Proposition 2

The first order condition for the social welfare maximization problem is $\partial SW/\partial R = 0$. By rearranging this equation, we obtain the following equation.

$$\begin{aligned}
& \left\{ \int_{F(R)s}^{\bar{b}} \left[b - h - \int_0^R c_e dF(c_e) \right] dG_n(b) \right\} z(\Psi(R))\Psi'(R) \\
& \quad - \left\{ \left[\int_{F(R)s}^{\bar{b}} b - h - \int_0^R c_e dF(c_e) \right] dG_i(b) - \Psi(R) \right\} z(\Psi(R))\Psi'(R) \\
& = \int_0^{\Psi(R)} \left\{ \left[h - \int_0^R (s - c_e) dF(c_e) \right] g_i(F(R)s)f(R)s - \int_{F(R)s}^{\bar{b}} [f(R)R] dG_i(b) \right\} dZ(c_i) \\
& \quad + \int_{\Psi(R)}^{\infty} \left\{ \left[h - \int_0^R (s - c_e) dF(c_e) \right] g_n(F(R)s)f(R)s - \int_{F(R)s}^{\bar{b}} [f(R)R] dG_n(b) \right\} dZ(c_i). \quad (12)
\end{aligned}$$

The left hand side of this equation represents the marginal social cost of increasing the reward R : the marginal social loss resulting from a decrease in the probability of internal reporting and the right hand side represents the marginal social benefit of increasing the reward R : the marginal social benefit resulting from an increase in the probability of external whistleblow-

ing. Therefore, the socially optimal reward is determined by considering a trade-off between internal reporting and external whistleblowing. \square

Proof of Proposition 3

For simplicity, we assume that the event that enforcement agents detect the crime and the event that the employee blows the whistle externally are mutually exclusive. In this case, the crime is detected with probability $p + F(R)$: the sum of the probability of crime detection by policing p and the probability of crime detection by external whistleblowing $F(R)$. The new assumption does not affect the employee's decision-making about external whistleblowing in the third stage, but it affects the corporation's decision-making about committing the crime in the second stage and the employee's decision-making about internal reporting in the first stage.

In the second stage, as with the basic model, the corporation commits the crime if the benefit from committing the crime is equal to or greater than the expected sanction, but expression (3) changes as follows.

$$b \geq [p + F(R)] s. \quad (13)$$

Similarly, expression (4) changes, and the probability that the corporation commits the crime in the second stage can be written as follows:

$$Pr(b \geq [p + F(R)] s) = 1 - G_j((p + F(R)) s), j \in \{i, n\}. \quad (14)$$

Accordingly, in the first stage, expression (7) changes, and the condition for internal reporting can be written as follows:

$$\begin{aligned} c_i &\leq \Psi(R; p, s, \theta, h) \\ &= \underbrace{[G_i((p + F(R)) s) - G_n((p + F(R)) s)]}_{(A')} \underbrace{\left[\theta h - \int_0^R (R - c_e) dF(c_e) \right]}_{(B')}. \end{aligned} \quad (15)$$

As with the basic model, the employee reports internally if the cost of internal reporting is equal to or less than the incremental benefit brought by internal reporting Ψ . However, now the employee reports internally even when the reward amount $R = 0$. If $R = 0$, the underlined portion (A'), the reduction in the probability of crime occurring caused by internal reporting, is positive: $G_i(ps) - G_n(ps) > 0$ by the assumption that $G_n(b)$ has the first-order stochastic dominance over $G_i(b)$. This is because that, when there is possibility that enforcement agents may detect the crime, the threat of sanctions exist even if no external whistleblowing occurs. Therefore, internal reporting works with the threat of sanctions posed by public policing. Since the underlined portion (B') is positive as well, $\Psi > 0$, and thus $Z > 0$: the employee reports internally when $R = 0$.

If the probability of crime detection by policing p is sufficiently small, the following expression holds:

$$\left. \frac{\partial \Psi(R)}{\partial R} \right|_{R=0} = \theta h f(0) s [g_i(ps) - g_n(ps)] > 0. \quad (16)$$

In R is sufficiently small, Ψ is increasing. In this expression, it always holds that $\theta h f(0) s > 0$. Therefore, as long as $g_i(ps) - g_n(ps) > 0$, the employee's incremental benefit from internal reporting Ψ does not reach a maximum value at $R = 0$ and reaches a maximum at some $R \neq 0$. The condition $g_i(ps) - g_n(ps) > 0$ means that the marginal decrease in crime caused by an increase in the expected sanction is made larger by internal reporting. If p is sufficiently small, the condition $g_i(ps) - g_n(ps) > 0$ always holds by the assumption that $G_n(b)$ has the first-order stochastic dominance over $G_i(b)$.

If $R \rightarrow \infty$, the underlined portion (B') in expression (15) is non-positive; therefore, $\Psi \leq 0$. Hence, by continuity of Ψ , if R is sufficiently large, Ψ is weakly decreasing. It follows that $Z(\Psi(R))$ is non-monotonic in R : If R is sufficiently small, Z is increasing, and if R is sufficiently large, Z is weakly decreasing. \square

Proof of Proposition 4

We assume that the cost of employing enforcement agents in advance to achieve the probability of crime detection p is $P(p) > 0$. If p is sufficiently small, from Proposition 3, the amount of external whistleblower rewards R has a non-monotonic relationship with the probability of internal reporting occurring Z , and the introduction of the reward R can increase social welfare.

The social welfare maximization problem with respect to the reward amount R can be written as follows:

$$\begin{aligned} \max_R SW &= \int_0^{\Psi(R)} \left\{ \int_{(p+F(R))s}^{\bar{b}} \left[b - h - \int_0^R c_e dF(c_e) \right] dG_i(b) - c_i \right\} dZ(c_i) \\ &+ \int_{\Psi(R)}^{\infty} \int_{(p+F(R))s}^{\bar{b}} \left[b - h - \int_0^R c_e dF(c_e) \right] dG_n(b) dZ(c_i) - P(p) \end{aligned} \quad (17)$$

This equation is similar to equation (11) but differs in that the probability of crime detection changes from $F(R)$ to $p + F(R)$ and that the cost of policing $P(p)$ needs to be considered. By the assumption, employing enforcement agents in advance to keep a certain probability of crime detection p always incurs the cost $P(p)$. The first order condition for the social welfare maximization problem is $\partial SW / \partial R = 0$. By rearranging this equation, we obtain the following equation.

$$\begin{aligned} &\left\{ \int_{(p+F(R))s}^{\bar{b}} \left[b - h - \int_0^R c_e dF(c_e) \right] dG_n(b) \right\} z(\Psi(R)) \Psi'(R) \\ &\quad - \left\{ \int_{(p+F(R))s}^{\bar{b}} \left[b - h - \int_0^R c_e dF(c_e) \right] dG_i(b) - \Psi(R) \right\} z(\Psi(R)) \Psi'(R) \\ &= \int_0^{\Psi(R)} \left\{ \left[h - ps - \int_0^R (s - c_e) dF(c_e) \right] g_i((p + F(R))s) f(R)s - \int_{(p+F(R))s}^{\bar{b}} [f(R)R] dG_i(b) \right\} dZ(c_i) \\ &+ \int_{\Psi(R)}^{\infty} \left\{ \left[h - ps - \int_0^R (s - c_e) dF(c_e) \right] g_n((p + F(R))s) f(R)s - \int_{(p+F(R))s}^{\bar{b}} [f(R)R] dG_n(b) \right\} dZ(c_i). \end{aligned} \quad (18)$$

As with the proof of Proposition 2, the left hand side of this equation represents the marginal social loss resulting from a decrease in the probability of internal reporting and the right hand side represents the marginal social benefit resulting from an increase in the probability of external whistleblowing. Therefore, the socially optimal reward is determined by considering a trade-off between internal reporting and external whistleblowing. \square

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