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Trustworthy Criminals

Organized Crime, Reliability and Snitching

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Abstract

This paper investigates the relationship between leniency programs, reliability, and career trajectories in the context of organized crime. I propose a model in which a boss can employ criminals as foot soldiers or lieutenants. These criminals differ in their reliability. By observing a criminal's decision to snitch or remain silent after a conviction, the boss can obtain information about his reliability. This provision of information can make promotion possible and, therefore, promote profitability of the criminal enterprise. The analysis provides two key insides. (1) Criminal organization should not fully incentivize their members not to snitch. It can even be profitable to rehire known snitches. (2) An optimal leniency program balances the damage it causes to criminal enterprises (bright side) with the provision of information (dark side). In practice, this means leniency should increase with a criminal's position and time spend in the organization.

Keywords: *Organized Crime, Incentives Mechanisms, Leniency Programs.*

Contents

1 Introduction

In the battle against organized crime, a commonly practiced strategy is to use small fish to catch the big fish. Law enforcement is lenient to low-level criminals to obtain information on criminals higher up the chain. The decision to cooperate with law enforcement can contain a valuable signal about the reliability of the criminal. Jankowski (1991) finds that Los Angeles gangs consider it almost vital that a member was incarcerated in order to progress within the gang. Similarly, the old wisdom that "snitches get stitches" suggests that being known for snitching can end one's criminal career, or worse. This is not alway true; in Norway and Germany, examples have been found where criminals were still willing to cooperate with known snitches (von Lampe & Johansen, 2004).

This paper investigates the informational effect of imprisonment on the criminal career trajectory. I propose a two-period model in which a boss can hire criminals either as foot soldiers (low-level) or lieutenants (high-level). In deciding on the job level, the boss has to balance increased productivity in the high-level job with increased potential damage from snitching. Criminals differ in their reliability, which is private information. More reliable criminals are less likely to snitch if they are offered a deal after a conviction. Snitching can serve as an informative signal about one's reliability.

I find that there exists no wage structure in which only reliable criminals accept the job. If the boss wants to hire any criminals, she must accept that some snitch with a positive probability. To reduce snitching, the boss should, therefore, offer a bonus, conditional on being convicted and subsequently not snitching. In determining the optimal bonus, the boss faces a tradeoff. The more she rewards loyalty, the fewer criminals cooperate with law enforcement. Payment of he bonus not the only cost of this incentive structure. As fewer criminals snitch, on average, non-snitches are less reliable. This may prohibit otherwise profitable promotions of non-snitches from foot soldiers to lieutenants. After all, the boss should only promote criminals if she knows them to be sufficiently reliable to mitigate the increased damage of snitching in the high-level job.

The possibility to snitch provides valuable information to criminal organizations, which may stabilize the internal organization and promote profitability. This raises questions about an optimal leniency program from the perspective of a benevolent policymaker. If law enforcement aims to minimize societal damages of crime (i.e., reduce criminal productivity), an optimal leniency program will not be as lenient as possible. Instead, an optimal leniency program has to balance the increased damage to the organization and increased organizational stability due to the information provided by leniency. I find that the optimal policy is reasonably lenient but less lenient than it would be in the absence of this informational effect. Moreover, law enforcement should be more lenient towards criminals higher up in the organization and criminals with a longer career.

The paper is structured as follows. The next section introduces a more formal description of the model. Then, section 3 presents the analysis. Section 4 contains some extensions. Finally, section 5 concludes. The remainder of this section discusses some practicalities concerning the assumptions driving this model and contains a brief overview of previous literature on optimal leniency programs.

Two fundamental assumptions make the results of this model possible. The first is that the boss observes whether or not a criminal cooperates with law enforcement. At first glance, this seems like an extreme assumption. Law enforcement should protect the identity of informants. However, in practice, this is less true. A 2016 survey of threats of harm to informants (over the period 2012-2015) shows significant sources by which a criminal's status as an informant can become public knowledge (Williams, Stienstra, & Astrada, 2016). The most significant source are publicly available criminals records. These can be accessed with ease by virtually anyone. Both plea agreements, as well as §5k1.1 and rule 35(b) motions provide valuable insights.[1] There are also more informal sources, the survey finds. Once a criminal is known as a snitch, their details are often posted on Facebook pages, websites like rats.com, or flyers spread around a neighborhood. In prison, the status of an informant is also likely to get out, a Florida federal judge finds: "new inmates are routinely required by other inmates to produce dockets or case documents in order to prove whether or not they cooperated. If new inmates refuse to produce the documents, they are punished." (Hodges, 2016, as cited in Cohen, 2016)

The second assumption is that the expected damage from snitching is more considerable for high-level jobs. This can either be the case because the damage of snitching is larger, or the probability is higher (or both). An analysis of almost 4000 federal drug-related criminal proceedings in the US during the fiscal year 2016 provides proof for this statement. The study finds that cooperating with law enforcement is strongly correlated with job profile (United States Sentencing Commission, 2017). For example, the propensity of snitching is approximately 20% for couriers and wholesalers, whereas it is only 10% for low-level employees. The study attributes this to the availability of information (and, thus, the ability to cut a deal) and higher associated sentences (resulting in higher incentives to snitch). Also interesting to note is that leaders and management of the organization rarely receive any lenience (approximately 2%).

[1] USSG §5K1.1 departure motions and Federal Rule of Criminal Procedure 35(b) motions are both submitted by prosecutors during or after criminal proceedings to request a reduced sentence for providing substantial assistance to the government.

This paper is closely related to previous economic literature on optimal government leniency. Motta and Polo (2003) are the first to consider the effects of leniency programs on cartel formation and stability in oligopolistic markets. They introduce the dark side of leniency: increased leniency can promote cartel formation by reducing the expected sanction. Later studies have a more in-depth focus on mechanism design and optimality of different leniency programs (see, for example, Aubert, Rey, & Kovacic, 2006, Chen & Rey, 2013, and, Landeo & Spier, 2020). However, these studies are less applicable to organized crime. For one, cartels are considered to be horizontal organizations contrary to criminal organizations, which are often - or at least, tend to be modeled as - vertically organized. Additionally, leniency programs in antitrust law often focus on whistleblowers, a far-fetched construction in the context of organized crime.

A growing body of literature on leniency in the context of organized crime is being developed. Acconcia et al. (2014) provide the first analysis of optimal leniency when government officials can be corrupt. They find that leniency can mitigate the effects of corruption. Moreover, they highlight the bright and dark sides of leniency. On the one hand, leniency promotes snitching, which hurts the criminal organization. On the other hand, increased leniency reduces the expected sanction for criminals. This, in turn, lowers the wage the criminal organization is required to pay and, thus, promotes profitability. Intuitively, this is very similar to the work by Motta and Polo (2003).

Piccolo and Immordino (2017) expand on this literature. In their model, criminals are homogeneous *ex ante*. They are are offered a job by a boss who has all bargaining power. During their illicit activity, criminals acquire a random amount of information. If they decide to cooperate with law enforcement, the conviction probability of the boss is an increasing function of the amount of information. If a criminal snitches, but the boss is acquitted, the boss retaliates. Retaliation is free for the boss but lowers the criminal's utility. Again, this paper highlights the bright and dark side of leniency. In this case, the dark side is caused by an informational rent for well-informed criminals. After all, more information reduces the probability of retribution. This lowers the cost of snitching. The boss will anticipate this and internalize the informational rent by setting a lower wage.

More recently, Immordino, Piccolo, and Roberti (2020) highlight the importance of organizational structure and leniency. In their model, they endogenize the choice of organizational structure. Organizations can be vertical or horizontal. Internal cohesion, productivity, and leniency determine the optimal organizational structure. As law enforcement policy becomes more lenient, strong hierarchical organizations are replaced by weak partnerships. At first, this reduces criminal productivity. However, as leniency increases further, the expected sanction is reduced, which promotes illegal activity. Criminal productivity increases again. For partnerships, this effect starts at a lower level of leniency compared to vertical organizations. Consequently, governments should be less lenient if the organizational choice is endogenous.

This paper adds to this body of literature in two major ways. First, I show that even in strictly vertical organizations, endogenous organizational design significantly impacts optimal leniency. Secondly, both Acconcia et al. (2014) and Piccolo and Immordino (2017) require *ex ante* homogeneity of criminals for the dark side of leniency to exist. I show that even if criminals are *ex ante* heterogeneous, the dark side of leniency exists. I offer a novel theory for the dark side of leniency, which is based on the informational effect of snitching. This information allows the organization to promote the most reliable criminals. The organization could also internalize part of the rent of snitching if it rehires known snitches.

2 Model

Consider a population of risk-neutral criminals and a risk-neutral boss. For clarity, I refer to the boss as female and criminals as male. The model consists of two periods t, $t \in 1, 2$. At the start of every period, the boss can decide to make a job offer. Criminals can choose to accept or reject. Additionally, in each period, criminals can be caught during their illicit activities. If that happens, they are convicted and subsequently offered an additional choice: to cooperate with law enforcement (i.e., snitch) or remain silent.

The criminal organization has two types of jobs; high-level (for instance, lieutenants) and low-level jobs (for instance, foot soldiers). Let $j \in \{H, L\}$ denote job type where H and L correspond to high- and low-level jobs, respectively. In her job offer, the boss decides on the job level and a wage, $w_{j,t}$, which corresponds to the job level and period. The wage is only paid if the criminal is not convicted. There exist two exogenous differences between the job levels. Firstly, productivity, θ_j, is higher in a high-level job than in a low-level job, i.e., $\theta_H > \theta_L$. Secondly, the damage to the boss, d_j, is larger if a criminal snitches when he works in a high-level job compared to a low-level job, i.e., $d_H > d_L$. These are intuitive assumptions; criminals in high-level positions are likely to have more knowledge about the criminal operation, making them more productive in their job. However, this comes at a cost. When such a criminal snitches, law enforcement obtains more information, increasing the damage to the boss. Lastly, in the second period, the boss can pay a bonus, B, to convicted criminals conditional on not snitching. I assume that at the start of period 1, the boss can make a credible commitment to pay the bonus. Without this assumption, it would be a sub-game perfect strategy not to pay the bonus during the second period. This assumption could easily be internalized by using an infinitely repeated game.

Each criminal i, $i \in \{1, ..., n\}$ has outside option V. If a criminal accepts the job offer, he works for the criminal organization and performs an illicit activity. With some positive probability ρ, the criminal is caught and convicted. All criminals are homogeneous except for their reliability, r_i. Reliability is private information and only known by the criminal himself. Reliability is independent and identically distributed across the population according to PDF $f(x)$ and CDF $F(x)$.

If a criminal is convicted, he faces a penalty $-P_j$, with $P_j > 0$. The punishment depends on a criminal's job level so that a high-level criminal receives a larger punishment ($P_H > P_L$).

If he snitches, the penalty is reduced to $-p$, with $p > 0$ and $P_L \geq p$.[2] However, the criminal experiences disutility from snitching equal to his reliability. His total payoff from snitching is given by $-(p+r_i)$. The boss observes the choice to cooperate or remain silent. X_i is an indicator variable; $X_i = 0$ corresponds to snitching and $X_i = 1$ to remaining silent.

Both the boss and criminals discount the future with discount factor $\delta \in (0, 1]$. Let r denote the boss' *a priori* belief about a criminal and $\hat{r}_i$ her updated belief. Finally, let $\bar{r}_{j,t}$ denote the lowest level of reliability for which a criminal does not cooperate with law enforcement in job level j at time t. Hence, the boss' expected payoff of employing criminal i in job j at time t is given by:

$$E[\pi_{i,j,t}] = (1-\rho)(\theta_j - w_{j,t}) + \rho(\Pr[r_i < \bar{r}_{j,t}](-d_j)) - Z_{i,t} * B \tag{2.1}$$

where $Z_{i,t} = 1$ if the boss has to pay a bonus to criminal i at time t. Similarly, a criminal's expected utility from working for the organisation at t=1 and t=2, respectively, is given by:

$$E[U_{i,j,1}(X_i)] = (1-\rho)w_{j,t} + \rho\Big[X_i(-P_j + \delta B) + (1-X_i)(-[p+r_i])\Big] \tag{2.2}$$

$$E[U_{i,j,2}(X_i)] = (1-\rho)w_{j,t} + \rho\Big[X_i(-P_j) + (1-X_i)(-[p+r_i])\Big] \tag{2.3}$$

The solution concept is a perfect Bayesian equilibrium in pure strategies.

[2] One could argue that the reduced punishment should also depend on the job level. After all, criminals in high-level jobs can provide more information and, therefore, law enforcement could be more lenient to persuade a criminal to snitch. However, this effect already exists in the model. The benefit of snitching is given by: $-(p+r_i) - (-P_j)$ which is increasing in P_j. Since the punishment for high-level jobs already is larger, the benefit of snitching is too. One of the punishment levels needs to depend on job level, not both.

3 Analysis

To condense the analysis, I limit myself to interesting cases. That is, I exclude two potential scenarios.

Assumption 1 *To limit the analysis to interesting cases, assume that:*

1.1 the boss' a priori belief is sufficiently low so that she prefers not to employ criminals in a high-level job without any additional information;

1.2 the a priori belief is sufficiently high so that boss is willing to employ criminals in a low-level job without any additional information.

These two assumptions ensure the existence of a criminal organization in which going to jail serves as an informative signal. Without the first assumption, all criminals would serve in a high-level job. Jail would not be a signal that could lead to promotion. This is contradictory to criminology literature. Criminals work their way up through the organization, and jail time tends to support this (Jankowski, 1991). The second assumption guarantees the existence of the organization. Without it, the boss would never make an offer - clearly, an uninteresting case.

To solve the model, I now proceed by backward induction.

3.1 Incentives at $t = 2$

At $t = 2$, the boss has to decide on three different kinds of job offers: (1) non-convicted criminals, (2) convicted criminals that snitched, and (3) convicted criminals that did not snitch. The job offer to the first group is straightforward. The boss has learned nothing about the reliability of these criminals and is, thus, not willing to promote them to a high-level job. For this group, only the participation constraint needs to be binding, that is:

$$E[U_{i,L,2}] = (1-\rho)w_{L,2} + \rho\Big[X_i(-P_L) + (1-X_i)(-p-r_i)\Big] \geq V \tag{3.1}$$

Importantly, if the participation constraint for non-snitches ($X_i = 1$) is binding, the participation constraint for snitches ($X_i = 0$) is always satisfied. This is intuitive: if one decides to snitch, this is because the payoff of cooperating is larger compared to remaining silent. Therefore, criminals that do not snitch are worse off per definition (as depicted in figure 1). This is an important observation as it excludes self-selection. It is impossible to find a wage structure in which potential snitches would sort into their outside option. This observation holds for

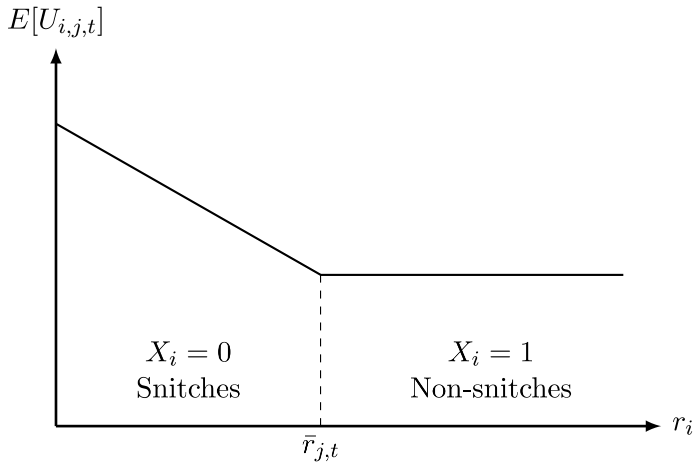

Figure 1: Expected utility as a function of r_i

all participation constraints across time. Hence, the boss must hire criminals that, with some positive probability, will snitch. Using this fact, it is possible to derive the reservation wage $w_{L,2}$:

$$w_{L,2} = \frac{V + \rho P_L}{1 - \rho} \tag{3.2}$$

Secondly, the boss has to decide on the job offer for snitches. After their conviction and cooperation, the boss has made a downward adjustment of her belief of reliability. Still, the expected profit from hiring these criminals may be sufficiently large to hire them in the low-level job. This can happen if either the probability of being caught or the damage of snitching is low, or both. In section 4.1, I explore the possibility of rehiring snitches in more detail. I discuss a wage scheme in which the boss can increase profits by rehiring only the most unreliable snitches. I also show that this possibility does not alter equilibrium behavior of criminals. Hence, to simplify and focus the analysis, I assume that the boss fires a criminal after snitching.

Finally, consider the case of convicted non-snitches. The boss updates her beliefs about their reliability upward. In the second period, she pays a bonus B and decides on the job level. For clarity, I assume that the bonus always comes on top of the reservation wage.[3] She is willing to

[3] Of course, in doing so, the model loses some nuance. It would be possible to lower the wage and still satisfy the participation constraint as the bonus increases. However, the current assumption significantly simplifies the analysis at period $t = 1$; irrespective of job level, a non-snitch has an expected utility of at least V+B at $t = 2$. Relaxing this assumption would not result in different qualitative results. However, it would require two separate derivations for $t = 1$: one for each possible job level in period 2.

Additionally, note that there may be non monetary benefits to a promotion. For instance, criminals may value their reputation. Including these benefits would relax the participation constraint for a high-level job, and thus relax the condition in equation (3.6). Again, this would just result in a quantitative difference.

employ these criminals in a high-level job if:

$$E[\pi_{i,H,2}] \geq E[\pi_{i,L,2}] \tag{3.3}$$

$$(1-\rho)(\theta_H - (w_{H,2})) + \rho(\Pr[\hat{r}_i < \bar{r}_{H,2}](-d_H)) - B \geq (1-\rho)(\theta_L - (w_{L,2})) + \rho(\Pr[\hat{r}_i < \bar{r}_{L,2}](-d_L)) - B \tag{3.4}$$

Note that the bonus on the left- and right-hand side of the equation is the same. Later, I show that the optimal bonus depends on the promotion decision. Yet, this is irrelevant to the promotion in the second period. After all, the boss commits to the bonus at the start of period 1. Therefore, it is a constant at $t = 2$.

To simplify the constraint, the wage for a high-level job needs to be derived. As before, the boss sets the wage such that the participation constraint of the least reliable non-snitch is binding. Doing so yields:[4]

$$w_{H,2} = \frac{V + \rho P_H}{1-\rho} \tag{3.5}$$

So that the boss is willing to promote the group non-snitches if:

$$\frac{1-\rho}{\rho}(\theta_H - \theta_L) - (P_H - P_L) \geq \Pr[\hat{r}_i < \bar{r}_{H,2}]d_H - \Pr[\hat{r}_i < \bar{r}_{L,2}]d_L \tag{3.6}$$

That is, if the relative productivity benefit of a high-level job is sufficiently large compared to the change in expected damages of snitching, it is worthwhile to promote criminals. This condition holds if and only if the boss updates her belief about reliability sufficiently.[5]

3.2 Incentives at $t = 1$

By assumption 1, the boss wants to employ all criminals in the low job level. To attract all criminals, she must set the reservation wage such that the participation constraint of a criminal, who expects not to snitch, is binding. Additionally, note that expected period 2 utilities equal the outside option and a bonus after conviction. The relevant participation constraint is given by:

$$(1-\rho)(w_{L,1} + \delta V) + \rho(-P_L + \delta[V + B]) \geq (1+\delta)V \tag{3.7}$$

[4]Put differently, the wage in the high-level job equals the low-level wage plus a premium for increased risk:

$$w_{H,2} = w_{L,2} + \frac{\rho}{1-\rho}(P_H - P_L)$$

[5]This conclusion intuitively follows from assumption 1.1

Which yields:

$$w_{L,1}(B) = \frac{V + \rho(P_L - \delta B)}{1 - \rho} \tag{3.8}$$

3.3 Optimal bonus policy

Finally, consider the optimal bonus. Let $\phi_{L,1}(B)$ denote the *a priori* probability of snitching in period 1, $\phi_{L,2}$ the *a priori* probability of snitching in period 2, and $\hat{\phi}_{j,2}(B)$ the updated belief after a criminal has been convicted but did not snitch and works in job j. Note that $\phi_{L,1}(B)$ decreases in B whereas $\hat{\phi}_{j,2}(B)$ increases. This is intuitive. As the reward for remaining silent increases, there is a stronger incentive not to snitch so that individuals with progressively lower reliability remain silent in period 1. However, this also means more unreliable criminals remain within the organization. The boss' expected profit is given by:

$$\begin{aligned} E[\pi_{i,j}(B)] = (1-\rho)\Big[\theta_L - w_{L,1}(B) + \delta\big((1-\rho)(\theta_L - w_{L,2}) + \rho\phi_{L,2}(-d_L)\big)\Big] \\ +\rho\Big[\phi_{L,1}(B) * (-d_L) + \big(1 - \phi_{L,1}(B)\big)\delta\big((1-\rho)(\theta_j - w_j) + \rho\hat{\phi}_{j,2}(B) * (-d_j) - B\big)\Big] \quad \forall\ j \in \{H, L\} \end{aligned} \tag{3.9}$$

So that the optimal bonus can be found by:

$$\begin{aligned} \frac{\partial E[\pi_{i,j}(B)]}{\partial B} = -(1-\rho)\frac{\partial w_{L,1}}{\partial B} + \rho\frac{\partial \phi_{L,1}(B)}{\partial B}(-d_L) \\ - \rho\frac{\partial \phi_{L,1}(B)}{\partial B}\delta\Big[(1-\rho)(\theta_j - w_j) + \rho\hat{\phi}_{j,2}(B) * (-d_j) - B\Big] \\ + \rho\big(1 - \phi_{L,1}(B)\big)\delta\left[\rho\frac{\partial \hat{\phi}_{j,2}(B)}{\partial B}(-d_j) - 1\right] = 0 \end{aligned} \tag{3.10}$$

There are five clear forces when increasing the bonus. First of all, the bonus reduces the wage bill in the first period (+). Secondly, the bonus also reduces expected damage from snitching in the first period (+). Additionally, it increases the probability that a criminal is active for the criminal organization during the second period (+/−). During the second period, the wage bill increases (−) as bonuses have to be paid. Lastly, the bonus increases expected damage from snitching in the second period (−). In other words, the boss faces an inter-temporal tradeoff; a higher bonus reduces cost during the first period but increases them during the second period. The additional cost of the bonus during the second period can be offset by an increased retention of convicted criminals. However, this can also be a cost if the bonus is larger than the added profit of these additional criminals.

Contrary to common belief, the boss may not want to incentivize remaining silent too much. Besides the standard, direct costs of paying a bonus, it also reduces the amount of information the boss acquires. If the bonus is sufficiently high, it may prohibit promotion to a high-level job according to equation (3.6). Depending on the profitability of the high-level task, this can be the more important cost.

This intuition is more general. It also applies to other incentives against snitching, such as retaliation against snitches. Retaliation also reduces snitching in the current period at the cost of reduced information gathering. Even though many criminal organizations have the reputation of punishing snitches (von Lampe, 2016), this may not be an optimal strategy.

This is an interesting and important observation. Was the common belief true, no criminal would ever snitch. Criminals cooperating with law enforcement should be a rarity. Nevertheless, approximately 30% of criminals convicted of a drug-related offense subject to a mandatory minimum sentence in the United States in 2016 received relief for providing substantial assistance to the government (Pryor et al., 2017). Apparently, criminal organizations do, in practice, not provide sufficient incentives to prohibit snitching. This can be either the consequence of the organization's unwillingness or inability to do so. The latter situation can occur if the boss' promise to pay a bonus or threat to punish is not credible (see for instance Acconcia et al., 2014). This paper takes the former approach. Even if the boss can credibly commit to incentivizing criminals to remain silent, she may not find it profitable to do so. Snitching is not only a cost, but it can also be a benefit as it provides information.

3.4 Solving the equilibrium: a uniform example

To solve the equilibrium and prove that an equilibrium, as described before, exists, the partial derivatives in equation (3.10) need to be specified. In order to do so, I assume that reliability of criminals is uniformly distributed, that is, $r \sim \mathcal{U}(\underline{r}, \overline{r})$. In doing so, I lose some generality, however, it allows me to derive the boss' beliefs. Beliefs are as follows. During the first period, the probability of snitching equals:

$$\phi_{L,1}(B) = \frac{(P_L - p) - \delta B - \underline{r}}{\overline{r} - \underline{r}} \tag{3.11}$$

In the second period, the updated belief for a convicted non-snitch working in job $j \in \{L, H\}$ is:

$$\hat{\phi}_{j,2} = \frac{(P_j - p) - \underline{r}}{\overline{r} - \bar{r}_{L,1}} = \frac{(P_j - p) - [(P_L - p) - \delta B]}{\overline{r} - [(P_L - p) - \delta B]} \tag{3.12}$$

A full derivation of these probabilities is provided in the appendix. Using these beliefs, the derivative of the profit function has a unique solution that gives the global maximum of the profit function:

$$B^*(j^*) = \begin{cases} \dfrac{(P_L - p) - \underline{r} + d_L + \delta[(1-\rho)\theta_j - \rho(P_{j^*} + d_{j^*}) - V]}{2\delta} & \text{if } \phi_{L,1}(B^*) > 0 \\ \dfrac{(P_L - p) - \underline{r}}{\delta} & \text{otherwise} \end{cases} \tag{3.13}$$

Note that the optimal bonus is a function of j^*: the equilibrium job level in which the boss employs a convicted non-snitch in period 2. Also, note that for some parameter values, the optimal bonus results in a negative $\phi_{L,1}(B^*)$. The profit function is not continuous in the bonus. At some point, the probability of snitching in the first period is unaffected by the bonus as it is already zero. This also implies that the boss does not update her second-period beliefs as she cannot gather any information about reliability. As long as assumption 1.1 holds, the boss does not promote any criminals. Once $\phi_{L,1}(B^*) = 0$, profits do not depend on the bonus. After all, the reduction in the wage of period 1 is exactly equal to the discounted value of the bonus. Hence, the boss sets the bonus such that $\phi_{L,1}(B*) = 0$.

The described discontinuity in the profit function and bonus is not an inherent part of this model. It is the consequence of using a lower bound on reliability. Using another distribution of reliability, in which $\underline{r}$ is unbounded, $\phi_{L,1}$ has a limit at a minimum of zero. There is always a marginal effect of the bonus on the probabilities of snitching in both the first and second periods. However, this effect would approach 0 for large values of B and, therefore, result in a similar intuition as in the uniform case.

From equation (3.13) it is clear that the bonus increases as law enforcement is more lenient towards snitches (i.e., a lower p). It decreases as the population of criminals becomes more reliable. The optimal bonus while $\phi_{L,1} > 0$ also clearly depicts the previously described tradeoff between reducing damages and information. The bonus increases as the damage of snitching increases in period 1. Higher productivity in period 2 also has a positive effect as this makes the retention of convicted criminals more critical. On the other hand, if the damage to the organization due to snitching increases in period 2, this lowers the optimal bonus as information gathering is more important. An increased wage bill during the second period (i.e., increases in P_j and V) also reduces the bonus as the net benefit of retaining criminals is reduced.

Figure 2 also depicts this relation. This example shows the effects of leniency on optimal bonuses for the two promotion regimes. In this example, the bonus is higher when the boss does not promote criminals after being convicted as the need for information is lower for the low job than the high job. The kink in the graph is caused by the change in bonus policy once $\phi_{L,1}(B^*) = 0$ is reached.

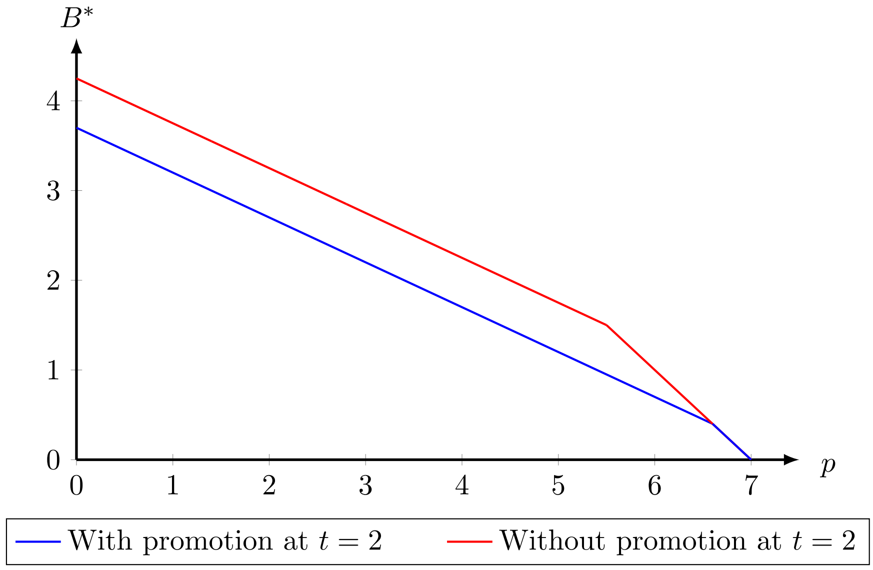

Figure 2: Numeric example of the effect of leniency on the optimal bonus.
Used parameter values: $r \sim \mathcal{U}(0, 10)$, $\delta = 1$, $\rho = 0.5$, $V = 0$, $d_L = 2$, $d_H = 10$, $\theta_L = 8$, $\theta_H = 16$, $P_L = 7$, $P_H = 9.2$

3.5 Profitability, social welfare, and optimal leniency program

In this section, I analyze the effects of leniency on both profitability and social welfare. To do so, I distinguish - contrary to the base model - between leniency during the first and second periods (denoted by p_1 and p_2, respectively). The reason for doing so is as follows. In the second period, leniency, or the lack thereof, does not affect the provision of information; it only directly affects the organization's profitability and need for information. This is different for the first period. The direct effect on profits still exists. However, a change in leniency also results in more or less information gathering about the reliability of criminals. Hence, to clearly show the informative effects of law enforcement policies, the two periods must be considered separately.

I assume that a benevolent policymaker publicly commits to a leniency program (p_1, p_2) at $t = 0$. The boss and criminals observe this decision. Hence, the leniency program affects both the promotion regime and optimal bonus. The goal of the policy maker is not necessarily to minimize profitability of the criminal organization. After all, this also a function of redistribution between the boss and her criminals. Instead, I consider two potential social welfare functions that the policymaker may want to maximize: $SW_1(p_1, p_2) = -E[\theta(p_1, p_2)]$ and $SW_2(p_1, p_2) = -E[\theta(p_1, p_2) - d(p_1, p_2)]$. That is, the policy aims to minimize either expected productivity

$$\min_{p_1,p_2} E[\theta(p_1, p_2)] = \min_{p_1,p_2} (1-\rho)\Big[\big(1 + \delta(1-\rho)\big)\theta_L\Big] + \rho\Big[\big(1 - \phi_{L,1}(p_1)\big)\delta(1-\rho)\theta_{j^*}\Big] \tag{3.14}$$

or expected producitivity net of damages

$$\min_{p_1,p_2} E[\theta(p_1,p_2)] = \min_{p_1,p_2}(1-\rho)\Big[\theta_L + \delta\big((1-\rho)(\theta_L) + \rho\phi_{L,2}(p_2) * (-d_L)\big)\Big] \\ + \rho\Big[\phi_{L,1}(p_1) * (-d_L) + \big(1-\phi_{L,1}(p_1)\big)\delta\big((1-\rho)(\theta_{j^*}) + \rho\hat{\phi}_{j^*,2}(p_1,p_2) * (-d_{j^*})\big)\Big] \quad (3.15)$$

The appropriate choice for the social welfare function depends on the interpretation of the damage to the organization due to snitching. An interpretation consistent with the first social welfare function is that the damage is an increase in the expected sanction of the boss (for instance, because a subordinate snitches, the boss is more likely to be convicted). In this case, the damage due to snitching does not reduce the expected harm to society. An alternative interpretation of the damage is that snitching allows law enforcement to intervene in the organization's operations. As a consequence, the damage consists of reduced productivity. In such a case, the second social welfare function would be more appropriate.

Both social welfare functions depend on the equilibrium promotion regime, j^*, which is determined by p_1 and p_2. Therefore, the analysis of an optimal leniency program starts with the effects of leniency on profitability. First, consider the effect of second-period leniency on profits. In the context of this model, this is unambiguous. Increased leniency in the second period promotes snitching and lowers profits. Additionally, the boss will want to acquire more information if she aims to promote convicted non-snitches. Even if she does not promote non-snitches, she will find it optimal to acquire more information. Therefore, the boss should lower the bonus at the cost of increased snitching in period 1. This reduces period 1 profits. In the uniform case, this latter effect is not always present. For a given promotion regime, period 2 leniency does affect the optimal bonus. If and only if p_2 changes the promotion decision, there will be an effect on the optimal bonus and period 1 profitability. An increased level of period 2 leniency reduces the range in which promotion is possible and lowers profitability. This relationship depicts the bright side of leniency.

The effect of first period leniency on profits is less intuitive. On the one hand, higher leniency (i.e., lower p_1) increases the probability of snitching during the first period, which lowers profits. On the other hand, if more criminals snitch during the first period, fewer do so in the second period. After all, the least reliable criminals are fired. Moreover, the bonus - which is also a function of p_1 - affects profits. Figure 3 shows the relationship between period 1 leniency and profits under both promotion regimes. The provision of information outweighs the damage of snitching during period 1. It becomes possible to promote convicted criminals to a high-level job at high levels period 1 leniency. This increases the profitability of the organization. In other

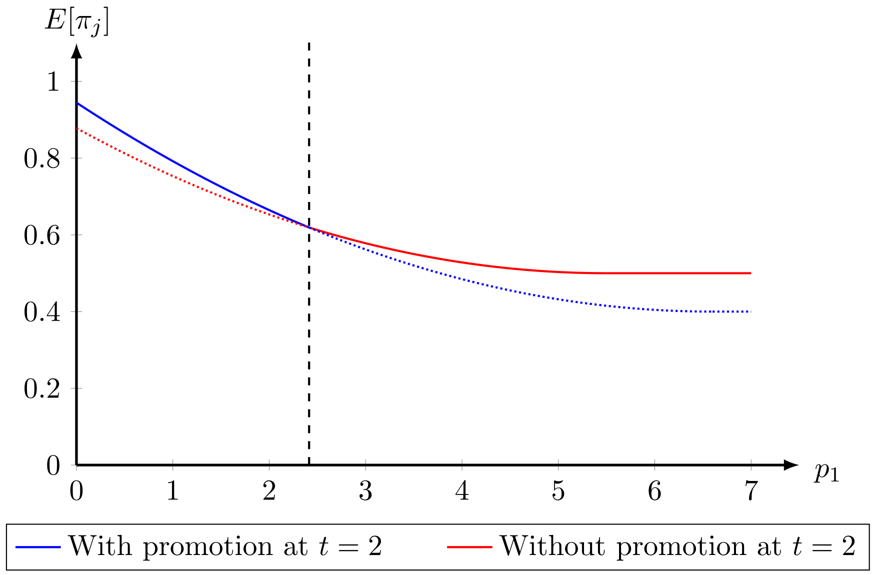

Figure 3: Numeric example of the effect of leniency on profits. The dashed line indicates the change in promotion policy at $t = 2$.
Used parameter values: $r \sim \mathcal{U}(0, 10)$, $\delta = 1$, $\rho = 0.5$, $V = 0$, $d_L = 2$, $d_H = 10$, $\theta_L = 8$, $\theta_H = 16$, $P_L = 7$, $P_H = 9.2$, $p_2 = 2$

words, high leniency during the first period stabilizes the organization; this is the dark side of leniency. Beyond the promotion decision, profits are clearly non-increasing in p_1. The appendix provides proof for this statement.

Given the non-decreasing nature of profits, the game can have a corner solution if assumption 1.2 is relaxed. For sufficiently low values of p_2 and high values of p_1, the profit can fall below zero. This would obviously constitute the optimal leniency program. If expected profits are negative, the boss will not start her organization. Consequently, productivity and, thus, the damage to society will be zero.

If the above exception does not apply, the game has a unique internal solution in which an optimal leniency program balances the bright and dark sides of leniency. Again, the optimal level of period 2 leniency is clear-cut as it only has a bright side. First of all, period 2 leniency increases the damage of snitching (+). Secondly, it reduces the range of p_1 for which promotion is viable (+). Lastly, it increases the need for information and reduces the retention of criminals (+; however, as previously discussed, this effect is not present in the uniform example). Damages to society are minimized by maximizing period 2 leniency.

The balancing act between the bright and dark side of leniency must take place during the first period. Figure 4 depicts both expected productivity and expected productivity net of damages as a function of period 1 leniency. In the case of productivity, the optimal level of leniency is obvious: leniency should be set to the lowest value such that the organization is not willing to promote criminals in the second period. Increasing leniency would only marginally

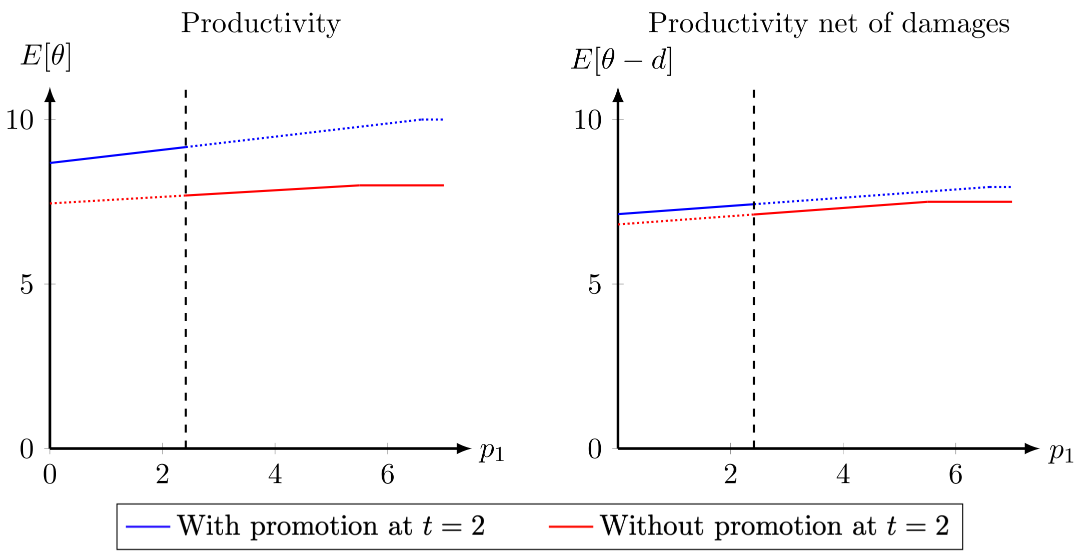

Figure 4: Numeric example of the effect of leniency on productivity and productivity net of damages. The dashed line indicates the change in promotion policy at $t = 2$ based on expected profits. Used parameter values: $\delta = 1$, $\rho = 0.5$, $V = 0$, $d_L = 2$, $d_H = 10$, $\theta_L = 8$, $\theta_H = 16$, $P_L = 7$, $P_H = 9.2$, $p_2 = 2$

increase the damage from snitching, while productivity would jump significantly due to the possibility for promotion. Hence, the described p_1 maximizes the bright side of leniency while minimizing the impact of the dark side.

In the case of productivity net of damages, the solution is more complicated. In the example of figure 4, optimal leniency is unaffected compared to the productivity case. However, if the damage of snitching is sufficiently large compared to productivity, maximum leniency may minimize societal damage even if it facilitates promotion. This is only the case if the expected difference in productivity net of damages is sufficiently small between the two job levels.

Alternatively, the policymaker could differentiate leniency between job levels instead of the duration of employment. Similar considerations apply. Law enforcement should be less lenient to criminals in a low-level position than in a high-level. Reduced leniency for the low-level job can prohibit promotion and, thus, lower productivity. The government will never grant leniency for a high-level criminal, as no criminal will be promoted. However, leniency for the high-level job should still be as lenient as possible as this minimizes the expected profits of promotion. As long as assumption 1.1 holds, there always exists a leniency program that can prohibit promotion.

To conclude, an optimal leniency program minimizes the damages of crime to society. This is achieved by increasing leniency both in time and a criminal's position within the criminal organization. If a reduction in leniency can sufficiently destabilize a criminal enterprise to make it unprofitable, law enforcement should do so.

4 Extensions

4.1 Rehiring snitches

Before, I assumed that the boss is not willing to rehire a known snitch. Now, consider the possibility of rehiring these snitches. An important observation is that known snitches always snitch if they are caught again. To see why, first consider that all members of the group snitches have snitched in period 1 so that $\hat{r}_i^s < \bar{r}_{L,1}$. Secondly, in the first period, the boss could incentivize criminals with a bonus in period 2. This is not possible in the second period so that $\bar{r}_{L,2} > \bar{r}_{L,1}$. Therefore, $\hat{r}_i^s < \bar{r}_{L,2}$ and $Pr[\hat{r}_i^s < \bar{r}_{L,2}] = 0$.

The boss can introduce a wage structure in which she offers a lower wage to snitches (denoted by $w^s_{L,2}$), which is strictly less than $w_{L,2}$. By doing so, she can potentially rehire some snitches. Recall that the participation constraint is weaker for lower levels of r_i. Therefore, only the least reliable criminals accept this offer. If the boss sets the wage equal to:

$$w^s_{L,2} = \frac{V + (p + r^s)}{(1 - \rho)} \tag{4.1}$$

all snitches with $r_i < r^s(w^s_{L,2})$ accept. Hence, her expected profit from rehiring snitches equals:

$$E\big[\pi^s_{i,L,2}(w^s_{L,2})\big] = \Pr[r_i \leq r^s(w^s_{L,2})|r_i \leq \bar{r}_{L,1}]\big((1 - \rho)(\theta_L - w^s_{L,2}) + \rho(-d_L)\big) \tag{4.2}$$

Maximizing profits with respect to $w^s_{L,1}$ yields:

$$w^s_{L,1} = \frac{V + \rho(p + \underline{r} - d_L)}{2(1 - \rho)} + \frac{1}{2}\theta_L \tag{4.3}$$

The boss sets a higher wage if productivity increases. This is intuitive; as productivity increases, the benefit of retaining snitches increases. Similarly, if the risk of hiring snitches decreases (i.e., if d_L falls), the boss also increases the wage to retain a larger share. Interestingly, the more lenient the leniency program is, the more profitable it becomes to rehire snitches. This is not trivial. Contrary to regular criminals, snitches always snitch. Therefore, changes in leniency do not affect the risk of rehiring them. However, it weakens the participation constraint and thus, lowers cost.

Do note that the boss is not unambiguously willing to offer this wage. After all, the global maximum of expected profits could be negative. She is willing to offer this lower wage if and only if

$$(1 - \rho)(\theta_L - w^s_{L,2}) \geq \rho d_L \Leftrightarrow (1 - \rho)\theta_L \geq V + \rho(d_L + p + \underline{r}) \tag{4.4}$$

Intuitively, this is similar to the previous discussion. The boss is willing to rehire snitches if the expected productivity is high, the expected damage from snitch is low, or the participation constraint is weak.

While this wage structure can increase profitability of the criminal organization, it does not alter the analysis of equilibrium behavior of criminals. After all, only criminals with $r^s \leq r_{L,1}$ are willing to accept the wage. Incentives for the marginal criminal (i.e., $r_i = \bar{r}_{L,1}$) are unaffected. There can be an effect on the optimal bonus. If the boss rehires all known snitches, the marginal benefit of the bonus is reduced. Recall that retention of criminals was one of the five forces that determined the optimal bonus. This becomes less important. Consequently, the boss will set a lower bonus. If, however, the wage for snitches is sufficiently low such that some prefer their outside option, this effect is not present; the indifferent criminal and optimal bonus are unaffected by the possibility to rehire snitches.

Nevertheless, this discussion is not merely a theoretical exercise. Not only can this model explain why some criminals do snitch, but also why these snitches can keep working as criminals. Both Reuter (1983) and von Lampe and Johansen (2004) report on cases where known snitches never faced any retribution and instead kept cooperating with other criminals for years. The reasons for continued cooperation "can be manifold, including a lack of motivation, capacity or positive incentive [...] for seeking retribution. But it may also be the case that" there was "no alternative to continued cooperation" (von Lampe & Johansen, 2004, p. 176-177). This model offers a novel explanation for the continued employment of snitches: known snitches are inexpensive to hire.

4.2 Retirement: symmetric bonuses

Next, assume that at the start of period 2, the boss can also commit to pay a bonus (or retirement package). This makes the game more symmetric. Not only can the boss incentivize criminals to remain silent in the first period, but she can now also do so in the second period. I assume the boss pays a retirement package $S^{nc} \geq 0$ to criminals that were not convicted in period 1. She pays $S^{ns} \geq$ to convicted criminals that did not snitch during period 1. Both S^{nc} and S^{ns} are similar to the bonus after period 1 in that the boss pays them conditional on being convicted and not snitching in the second period. I first consider the effects for non-convicted criminals, then for non-snitches.

Similar to the wage in period 1, the possibility to pay a retirement package after period 2 allows the boss to lower the wage. Therefore, the reservation wage for non-convicted criminals is:

$$w^{nc}_{L,2}(S^{nc}) = \frac{V + \rho(P_L - \delta S^{nc})}{1-\rho} \tag{4.5}$$

This result implies that S^{nc} does not affect incentives during the first period. After all, the expected payoff of being employed during period 2 still is equal to V. The boss' expected profit of hiring a non-convicted criminal in period 2 is equal to:

$$E\big[\pi^{nc}_{i,L,2}(S^{nc})\big] = (1-\rho)\Big[\theta_L - w^{nc}_{L,2}(S^{nc})\Big] + \rho\Big[\phi_{L,2}(S^{nc})*(-d_L) + \big(1-\phi_{L,2}(S^{nc})\big)\delta*(-S^{nc})\Big] \tag{4.6}$$

Which she maximizes with respect to S^{nc}:

$$\frac{\partial E\big[\pi^{nc}_{i,L,2}(S^{nc})\big]}{\partial S^{nc}} = (1-\rho)\frac{\partial w^{nc}_{L,2}(S^{nc})}{\partial S^{nc}} + \rho\Bigg[\frac{\partial \phi_{L,2}(S^{nc})}{\partial S^{nc}}(-d_L) - \frac{\partial \phi_{L,2}(S^{nc})}{\partial S^{nc}}\delta * (-S^{nc}) - \big(1-\phi_{j,2}(S^{nc})\big)\delta\Bigg] = 0 \tag{4.7}$$

Ultimately, this is a quite simple tradeoff. There are four forces. First, a larger retirement package reduces the wage bill due to a lower wage (+). Secondly, it reduces snitching (+). However, increasing the retirement package increases the probability of actually having to pay it (−). And, lastly, a larger retirement package simply increases the cost of the package (−). Do note that the net effect on the wage bill can never be negative. After all, the period 2 wage bill is reduced with $\rho\delta S^{nc}$ whereas the retirement package only costs $\rho\delta\big(1-\phi_{L,2}(S^{nc})\big)S^{nc}$.

Next, consider the effect of a retirement package on non-snitches. The analysis is very similar to the previous case. The period 2 reservation wage is equal to:

$$w^{ns}_{j,2}(S^{ns}) = \frac{V + \rho(P_j - \delta S^{ns})}{1-\rho} \tag{4.8}$$

Such that expected profits equal:

$$E\big[\pi^{ns}_{i,j,2}(S^{ns}, B)\big] = (1-\rho)\Big[\theta_j - w^{ns}_{j,2}(S^{ns})\Big] + \rho\Big[\hat{\phi}_{j,2}(S^{ns}, B)*(-d_j) + \big(1-\hat{\phi}_{j,2}(S^{ns}, B)\big)\delta*(-S^{ns})\Big] - B \tag{4.9}$$

Which she also maximizes with respect to S^{ns}:

$$\frac{\partial E\big[\pi^{ns}_{i,j,2}(S^{ns})\big]}{\partial S^{ns}} = (1-\rho)\frac{\partial w^{ns}_{j,2}(S^{ns})}{\partial S^{ns}} + \rho\Bigg[\frac{\partial \hat{\phi}_{j,2}(S^{ns},B)}{\partial S^{ns}}(-d_j) - \frac{\partial \hat{\phi}_{j,2}(S^{ns},B)}{\partial S^{ns}}\delta * (-S^{ns}) - \big(1-\hat{\phi}_{j,2}(S^{ns},B)\big)\delta\Bigg] = 0 \quad (4.10)$$

A very similar effect to equation (4.7). However, there is one major difference: the probability of snitching also depends on B. A more reliable population has a lower probability of snitching. As discussed before $\frac{\partial \hat{\phi}_{j,2}(S^{ns},B)}{\partial B} > 0$. From this, it intuitively follows that $\frac{\partial \hat{\phi}_{j,2}(S^{ns},B)}{\partial S^{ns}\partial B} \geq 0$. If the population of non-snitches is less reliable - due to a higher bonus - S^{ns} has a larger effect on the probability of snitching. The optimal retirement fund for non-snitches, thus, is a function of the period 1 bonus: $S^{ns}(B)$. A higher bonus, *ceteris paribus*, results in a larger retirement package for non-snitches (i.e., $\frac{\partial S^{ns}(B)}{\partial B} > 0$). This is a vital observation. The possibility of retirement affects the equilibrium as it alters the optimal bonus in period 1. The overall effect and change in B is ambiguous. On the one hand, the possibility of paying a retirement package reduces the need for information about reliability. This has a positive effect on B and period 1 profits. On the other hand, a higher bonus can hurt period 2 profitability because the boss will either suffer more often from the damage of snitching or have to pay a larger retirement package. This effect is likely negative, but could also be beneficial if the net effect on the wage bill is sufficiently large. In the most likely scenario, the possibility to pay a retirement package introduces two opposing forces for the optimal bonus.

4.3 Kinship and ethnicity

Kinship and ethnicity are strong predictors for criminal cooperation (Ayling, 2009). Often, members of criminal enterprises have shared characteristics like ethnic backgrounds of familiar relationships. However, there also exist criminal organizations in which members lack such a shared background. For instance, both ethnically heterogeneous gangs and hybrid gangs (i.e., ethnically diverse) are observed in United States suburbs (Starbuck, Howell, & Lindquist, 2001). A potential explanation for the existence of these different types of criminal enterprises lies in assumption 1.

Consider a set-up of the model in which there are two groups of criminals: an in-group and an out-group. The in-group shares a common characteristic (for instance, ethnicity or kinship). Members of the in-group will experience a larger disutility from snitching. On average, the in-group is more reliable. Consequently, assumption 1 can apply differently to the in- and out-group. For instance, it is possible that assumption 1.2 only holds for the in-group, giving rise to an ethnically homogenous gang. After all, if assumption 1.2 does not hold for the out-group, the boss will not find it profitable to hire these criminals. If, for instance, the probability of conviction is reduced, it may also become possible to hire the out-group, changing the criminal enterprise into a hybrid gang. Still, the career trajectory for the in-group can differ from the out-group. It is possible that assumption 1.1 does not hold for in-group but does hold for the out-group. The boss will always promote members of the in-group. She may also promote members of the out-group, but only if she can update her belief about reliability sufficiently. This can explain why criminal enterprises may prefer to promote family members or members of the core ethnic group of a gang.

Paoli (2004) provides another example of these organizational differences. In her analysis of organized crime in Italy, she finds three distinct types of organization. The first type she observes is the classic mafia structure like the Sicilian Cosa Nostra and the Calabrian 'Ndrangheta. These groups have robust, hierarchical organizational designs. Members come from heterogeneous backgrounds as "only men born either in Sicily or in Calabria or descending from mafia families can be admitted" (Paoli, 2004, p. 23). This organization can provide a clear example of the dynamic described in this paper. By maintaining a heterogeneous group of criminals, internal coherence is sufficiently strong such that the organization can trust its members. Over time, as the organization learns more about its members' reliability (for instance, by the mechanism described in this paper), promotion becomes a viable option.

Paoli (2004) also describes two newer and less organized types of criminal organizations. These are (1) more profitable family operations and (2) less profitable loose groups based on friendship or just locality. Again, the model offers an intuitive explanation for the difference in profitability. Trust within the family business is likely sufficiently high such that assumption 1.1 does not apply; all members work in high-level positions. This is different for the groups based on friendship (some trust) or locality (little trust). After all, these relationships are primarily opportunistic. It is likely that criminals insufficiently update beliefs about reliability to make promotion possible. This difference in career trajectory could explain the difference in profitability between these loose groups and family businesses.

5 Concluding remarks

This paper investigated the relationship between leniency programs, reliability, and career trajectories within criminal organizations. Interestingly, it does not only hurt criminal enterprises. It can, in fact, benefit criminal organizations due to the provision of information about a criminal's reliability. Contrary to common belief, criminal organizations should not fully incentivize their employees not to snitch. These enterprises can even further increase their profits by rehiring known snitches. Doing so does not increase the likelihood of snitching.

Consequently, the often practiced policy of being lenient to low-level gang members to obtain information on the big fish may not be optimal. A better strategy would be to offer (1) only minimal leniency to low-level cooperating criminals and (2) significant leniency for higher-level cooperating criminals. Similarly, leniency should increase with the time spent as a criminal. This reduces the organization's stability in two ways. First, it reduces information gathering about reliability and, second, it increases the need for this information when making the promotion decision.

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Appendix

A.1 Derivation of updated beliefs

During the first period, a convicted criminal is willing to snitch iff

$$-(p+r_i)+\delta V \geq -P_L+\delta(V+B) \Leftrightarrow \bar{r}_{L,1} \equiv r_i \leq (P_L-p)-\delta B \tag{A.1}$$

Using a uniform distribution, the probability of snitching equals:

$$\phi_{L,1}(B)=\Pr[r_i<\bar{r}_{L,1}]=\frac{\bar{r}_{L,1}-\underline{r}}{\overline{r}-\underline{r}}=\frac{(P_L-p)-\delta B-\underline{r}}{\overline{r}-\underline{r}} \tag{A.2}$$

Similarly, in the second period, convicted criminals are willing to snitch iff

$$-(p+r_i)\geq -P_j \Leftrightarrow \bar{r}_{j,2} \equiv r_i \leq (P_j-p) \tag{A.3}$$

such that prior beliefs for a criminal working in job $j \in \{L,H\}$ are:

$$\phi_{j,2}=\Pr[r<\bar{r}_{j,2}]=\frac{\bar{r}_{j,2}-\underline{r}}{\overline{r}-\underline{r}}=\frac{(P_j-p)-\underline{r}}{\overline{r}-\underline{r}} \tag{A.4}$$

The composition of the group convicted non-snitches is different. After all, only criminals with $r_i > \bar{r}_{L,1}$ do not snitch after being convicted at $t=1$. Hence, reliability of this group is distributed over a smaller set of reliabilities, i.e., $r \sim \mathcal{U}(\bar{r}_{L,1},\overline{r})$. Therefore, updated beliefs equal:

$$\hat{\phi}_{j,2}=\Pr[\hat{r}_i<\bar{r}_{j,2}]=\frac{\bar{r}_{j,2}-\bar{r}_{L,1}}{\overline{r}-\underline{r}}=\frac{(P_j-p)-\underline{r}}{\overline{r}-\bar{r}_{L,1}}=\frac{(P_j-p)-[(P_L-p)-\delta B]}{\overline{r}-[(P_L-p)-\delta B]} \tag{A.5}$$

A.2 Effect of leniency on profits

Expected profits are increasing in p_1. While $\phi_{L,1}(B^*(p_1))>0$ the first-order condition of the profit function w.r.t. p_1 is

$$\frac{\partial \pi_j}{\partial p_1}=\frac{-\rho*(P_L-p_1-d_L-\underline{r}+\delta[V+\rho(P_j+d_j)-(1-\rho)\theta_j])}{2(\overline{r}-\underline{r})} \tag{A.6}$$

This implies that profits are decreasing in p_1 iff

$$p_1<P_L-d_L-\underline{r}+\delta[V+\rho(P_j+d_j)-(1-\rho)\theta_j] \tag{A.7}$$

For the relevant range of p_1 this condition is satisfied per definition as

$$\phi_{L,1}(B^*(p_1)) = 0 \Leftrightarrow p_1 = P_L - d_L - \underline{r} + \delta[V + \rho(P_j + d_j) - (1-\rho)\theta_j] \tag{A.8}$$

As soon as $\phi_{L,1}(B^*(p_1)) = 0$, profits are independent of p_1. Hence, profits are non-increasing in p_1.

Expected profits are strictly increasing in p_2. The first-order condition of the profit function w.r.t. p_2 is

$$\frac{\partial \pi_j}{\partial p_2} = \frac{\rho\delta\big[(1-\rho)d_L + \rho d_j\big]}{\overline{r} - \underline{r}} > 0 \tag{A.9}$$

This is true for both $\phi_{L,1}(B^*(p_1)) > 0$ and $\phi_{L,1}(B^*(p_1)) = 0$.