Corruption and Leniency: Should criminals be forgiven?

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Abstract

We build a game theoretical model to evaluate Leniency Programmes (LPs): forgiving self-reporting criminals. We consider a society of heterogeneous criminals and heterogeneous bureaucrats. Social welfare goes up immediately in the short run after LP is introduced when the supply of the bureaucrats is fixed. Introduction of LP affects a major source of income (bribe) of a proportion of corruptible bureaucrats. As a result, in the intermediate run the size and composition of the bureaucrats vary leading to a low welfare situation. This effect may cause policy makers to pessimistically withdraw LPs. Our analysis contributes at this junction by showing that in the long run welfare is higher after the introduction of the LP than without LP. We point out that time horizon is crucial while evaluating LPs.

Keywords: corruption, leniency programme, criminals, bayesian game

JEL Classification: C70, C73, C79, L44, L49

1 Introduction

It is widely known that organised crime and corruption are a threat to the society and hinder its development with huge economic costs. For an overview of the literature on corruption and its effects, see Bardhan (1997), Shleifer and Vishny (1993), Mauro (1995), Tanzi (1998), Bardhan and Mookherjee (2000), Bardhan (2002), Fisman and

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Wei (2004), Reinikka and Svensson (2004) and Olken (2005). Economists have been investigating optimal amount of law enforcement to curtail criminal activities since the seminal paper by Becker (1968). However, the corruptibility of law enforcers themselves also remains a huge problem (Burlando and Motta, 2016) and there are bureaucrats who often rely on bribe as one of the major sources of their income. Any attempt to clamp down on corruption is going to affect the income of the corruptible bureaucrats (Banerjee and Hanna, 2012). In this chapter we focus on one type of anti-corruption policies, the Leniency Programme (LP): forgiveness given to self-reporting criminals who engaged in corruption with the bureaucrats. A previously unexplored line of analysis in the theoretical literature on Leniency Programmes is the time horizon within which they are implemented and the consequent dynamic welfare implications. We offer such theoretical investigation in our chapter. In this chapter, we evaluate the Leniency Programme in light of corruptible bureaucrats.

In our chapter, in the model that we build to evaluate LPs, we have potential criminals and bureaucrats hired by an agency responsible for stopping crime. Criminals potentially commit a crime and can offer to bribe a bureaucrat (described as corruption) and risk detection by the monitoring mechanism of the agency. We consider a heterogeneity among the potential criminals. This heterogeneity comes in two dimensions. One is the value of the crime itself to the criminals and the other is how much they value their future relationship with the bureaucracy. Whether or not a criminal is inclined to bribe and take advantage of this LP and report on the bureaucrats will depend on these two values: the crime and the possibility of their continuation with the bureaucracy. We address potential criticisms in theoretical literature in our model by taking both these dimensions into account.

Secondly, we also consider heterogeneity among bureaucrats in this chapter. There is a supply of bureaucrats and whether or not they join the agency depends on the income they can get in outside job opportunities. The LP is going to affect the income of the bureaucrats differentially. The bureaucrats who are more inclined to be corruptible have a higher tendency to remain in the bureaucracy. There is a systematic way in which the composition of the bureaucracy is affected. Since all corruptible bureaucrats cannot be detected and punished, the bureaucrats will be affected differentially and adversely. The more corruptible bureaucrats are the ones who see a lesser fall in their income. This can have an effect on the efficacy of the LP and this is what we investigate in

our model. We start with a benchmark case, that is, the case as soon as the LP is introduced where the composition and size of the bureaucrats is fixed. We evaluate the welfare after the introduction of the LP in this short run. However as we mentioned earlier some of the bureaucrats will leave as their income from corruption is affected and that will change the effectiveness of the LP. If one evaluates the LP at that point, they will find a pessimistic view. We show that in the long run the composition of the bureaucrats is changed and now the LP can perform better. We show conditions under which the LP is properly evaluated.

There is also a third effect. There are some criminals who will actually take advantage of the LP in the way it is designed to work. They commit the crime and report. Not all of the bureaucrats will be deterred from asking for bribes. Not all criminals stop giving the bribe, some continue offering the bribe and are incentivized to commit the crime. We do take into account in our welfare comparison about all these forces and account for all possible types of criticisms.

In the following part of this section, we look at some related literature and discuss the findings of our work. Organized illegal transactions and crime networks involve more than one party and are often required to trust other wrongdoers. Traditionally, one way in which law enforcement agencies have been fighting organised crime is by shaping incentives of these parties to play against one another thereby undermining the trust in between them. Law enforcers undermine the trust among wrongdoers by awarding leniency. Leniency could take the form of reduced or fully waived legal sanctions to self-reporting wrongdoers that help convict their fellow wrongdoers (Buccirossi and Spagnolo, 2006).

The last two decades have seen an increasing amount of antitrust enforcement. Leniency Programmes (LPs) have been used to fight cartels and organised crime like drug dealing, terrorism and the Sicilian Mafia (Spagnolo, 2006). Malik (1993) uses a principal-agent framework in the context of environmental regulations which require firms to self-report their compliance, to derive and compare incentive-compatible regulatory policies with and without self-reporting. He finds the firm needs to be audited less often when self-reporting is required, but punished more often. Kaplow and Shavell (1994) add self-reporting to the model of probabilistic law enforcement and show that schemes with self-reporting are superior to schemes without self-reporting due to reduced enforcement costs. Motta and Burlando (2007) find that the government is able to increase welfare

and self reporting fully eliminates any dead-weight losses that arise from the incentive schemes when inspectors are risk averse.

Motta and Polo (2003) investigate the effect of Leniency Programmes when the Antitrust Authority has limited resources. Innes (2000) studies the merits of self-reporting when violators face heterogeneous probabilities of apprehension. He finds that even when self-reporting enjoys none of the advantages identified elsewhere, efficiency can often be enhanced by inducing those violators who have a sufficiently high risk of apprehension to self-report. In their recent paper, 'Trust, leniency and deterrence', Bigoni et al. (2014) present experimental evidence for leniency being crucial to the design of optimal law enforcement.

However, the existing literature in Leniency Programmes has not explored the timing effect, effect on the corruption income of the bureaucrats and the change in their composition. All of these have consequences for the working of the Leniency Programme and consequently on social welfare.

A relevant example for the model in this chapter is tax evasion by citizens. Bureaucrats audit citizens who could be potential tax evaders. The citizen who is audited has a choice to corrupt the bureaucrat and evade tax. As mentioned earlier, we find that not all criminals take advantage of the Leniency Programme in the way it is designed to work. One type of criminals with certain valuation of crime continue to commit crimes and do not report thereby retaining the possibility of committing future crimes. There are also a proportion of criminals that did not offer the bribe in the first place in the no Leniency case, but are incentivised to commit crimes after the introduction of the LP just to report on the bureaucrats. Our rich model with heterogeneous criminals and the supply fluctuation of bureaucrats allows for a variety of interesting effects.

We find that in the immediate short run after the introduction of Leniency Programme when the supply of bureaucrats is still fixed, social welfare is high with reduced crime and corruption. After allowing for some time to pass, self-selection of bureaucrats happens as the expected income from corruption to a proportion of bureaucrats falls to zero and they leave for outside job offers. The size and composition of the bureaucrats vary. In this intermediate run after the introduction of the Leniency Programme, those bureaucrats who are relatively less corruptible leave the agency as they experience a higher loss in their income. We find that the welfare after the introduction of the LP in the intermediate run falls below than that in the no leniency regime. This system-

atic adverse effect might persuade policy makers to pessimistically cancel the LP. Here is where our analysis strikes a cautionary note to policy makers and law enforcement agencies. We propose that while evaluating LPs, timing is crucial. The changing composition of the bureaucrats leaves the agency with surplus budget. The agency thus announces increase in wages in the long run and welfare goes up compared to that in the no Leniency. In particular, the condition which facilitates this effect leads to a situation where the interaction of self-reporting criminals with bribe taking bureaucrats increases thereby leading to increased welfare after the introduction of the Leniency Programme in the long term.

The remainder of the analysis is organised as follows. Section 1.2 describes the model and sets up the no leniency and the Leniency Programme corruption games. We also characterize the equilibria in both regimes. Section 1.3 analyses the welfare in both regimes and with varying time horizon and changing composition of the bureaucrats. Section 1.4 concludes and discusses possible future extensions.

2 Model

We consider a society in which a population of potential criminals have an opportunity to commit a crime. So, there is potential crime. There is an agency in charge of checking the potential criminals and stopping the crime. This agency is a branch of a higher administration that is responsible for the overall welfare of the society. The higher administration endows the agency with a given budget which the agency uses to hire bureaucrats. The welfare of the agency will be illustrated after we have characterized the corruption games in the two alternative policy regimes of no leniency and the Leniency Programme. Bureaucrats can only check a certain number of potential criminals, given the resource constraints. Each bureaucrat has the power to prevent the crime of just one potential criminal. However there is scope for corruption if the criminal manages to corrupt(bribe) the bureaucrat. The agency has a monitoring mechanism to detect the corruption. We denote with $\alpha \in [0, 1]$ the exogenous probability that corruption is detected. If corruption is detected by the monitoring mechanism, the agency collects fines $F_C > 0$ and $F_B > 0$ from the potential criminals and bureaucrats who engaged in corruption, respectively. The mode in which the Leniency Programme works in our model will be shown in detail later on. Henceforth potential criminals are just called

criminals.

The current value of the crime to a criminal, v, is private information to the criminal. v is distributed on $[0, \overline{v}]$ according to the cumulative distribution $\Phi(v)$. Each criminal also values his or her reputation with the bureaucracy and the criminal world. Preserving the reputation allows a criminal to commit crimes in the future. The intensity of a criminal's expectation of future crime is measured by $\gamma > 0$ which is private information to the criminal. A criminal will lose reputation if and only if in the Leniency Programme regime, he or she reports the corruption. We formalize a criminal's value of preserving reputation and being in a position of committing a crime in the future by $G(v, \gamma)$ which is common knowledge. $G(v, \gamma)$ is monotonically increasing in the current value of the crime, v and in $\gamma > 0$. For simplicity, we assume that there are only two types of criminals, high and low types which differ in their future value of the criminal activity characterized by γ_i,$i = \{\ell, h\}$ where $\gamma_h > \gamma_\ell$. Henceforth we specify $G(v, \gamma_i)$ as $\gamma_i v$.

2.1 Beliefs of bureaucrats and criminals

There is also heterogeneity among the bureaucrats with respect to the assessment of the probability of encountering a high type criminal (with respect to γ_h). This heterogeneity in bureaucrats comes in only two types namely optimistic and pessimistic types. The optimistic bureaucrats believe that with probability, λ^o they meet a high type criminal. The pessimistic bureaucrats are those who believe that with probability λ^p they meet a high type criminal. We assume $\lambda^o > \lambda^p$. The bureaucrats' beliefs about the type of criminals in general are denoted by λ^i, $i = \{o, p\}$.

Criminals also differ in their assessment of the probability of encountering an optimistic bureaucrat given by μ. μ may differ according to the criminal's type. However, as our analysis shows later criminal's beliefs will not play any role.

2.2 No Leniency: Corruption game without the Leniency Programme

In this sub section, we look at a game where potential criminals of any type are audited by bureaucrats(of any type). For the basic game we analyze here, we have bureaucrats auditing criminals for which the bureaucrats are paid a certain wage by the agency. The criminals who are being audited have two options. One option is to offer the bribe, if the

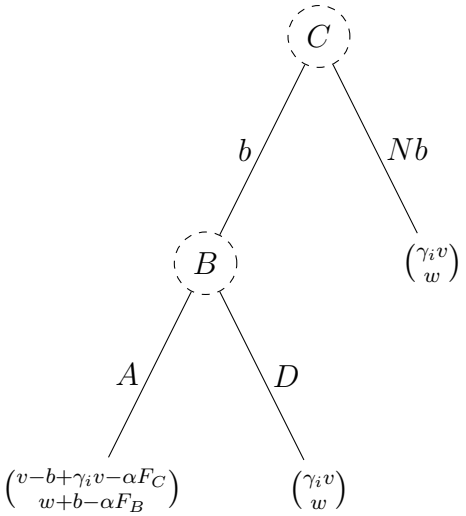

Figure 1: No Leniency game tree

bureaucrat accepts the bribe, then commit the crime thereby risking detection by the monitoring mechanism of the agency. Another option is to not offer the bribe and not commit the crime thereby losing the current value of the crime however retaining the possibility of committing a future crime. When the bribe has been offered, bureaucrats have two choices: either to accept the bribe and allow the criminal to commit the crime also risking detection by the agency or to decline the bribe and stop the criminal from committing the crime in the current period.

The basic game tree for this analysis is shown in figure (1). At the first node, the criminals, denoted by C, have a choice to offer the bribe (b), or not offer the bribe (Nb). For the present model, we take the bribe, $b \geq 0$ as exogenously given. Note at branch Nb, that is, if the criminal does not offer the bribe to the bureaucrat, (bureaucrats are denoted by B), bureaucrats stop the crime in which case the criminal loses the current value of the crime, v. However, he retains the option value of committing future crime, $\gamma_i v$. The bureaucrat's payoff is w, wage paid by the agency. Now in branch b, that is, if the criminal offers the bribe to the bureaucrat, the bureaucrat has two choices - to accept the bribe (A) or decline (D) it. If the bureaucrat declines the bribe (branch D), it means that the crime is stopped. The criminal loses the current value of the crime, v but retains $\gamma_i v$. In the other branch A, the bribe is offered and accepted. So corruption happens and crime is committed. Recall that the agency detects corruption with a probability α and in the event that it is detected, the agency extracts fine of F_B

from bureaucrats and a fine F_C from the criminals. Hence by accepting the bribe, the bureaucrat gets expected income from engaging in corruption(accepting the bribe) and the wage given by the agency. The expected income from accepting the bribe is $b-\alpha F_B$, that is the value of the bribe, b net of the fine, αF_B if the corruption is detected. The expected income from corruption part to the bureaucrat is 0 if he does not engage in corruption. If the bribe is accepted, the criminal gets a payoff of $v - b + \gamma_i v - \alpha F_C$.

To solve the game by backward induction, let us look at the final node. The bureaucrat compares the expected payoffs of accepting the bribe($w + b - \alpha F_B$) versus not accepting the bribe(w). The condition for the bureaucrat to accept the bribe is given by

$$b \geq \alpha F_B \tag{1}$$

Assume condition (1) holds, then all bureaucrats of all types accept the bribe. Therefore, if the criminal offers the bribe, the payoff of the criminal is $v - b + \gamma_i v - \alpha F_C$. If the criminal does not offer the bribe, he or she gets $\gamma_i v$.

The comparison for offering the bribe versus not offering it is thus given by

$$v - b + \gamma_i v - \alpha F_C \geq \gamma_i v$$

. that is,

$$v \geq b + \alpha F_C$$

which, for notational convenience, rewritten as

$$v \geq v_b \tag{2}$$

where $v_b \equiv b + \alpha F_C$. The criminal types who are above the threshold value v_b strictly prefer to offer the bribe. The condition for a fraction of criminals to not offer the bribe is $0 < v_b < \overline{v}$. In our analysis, we focus on an equilibrium where there is crime and corruption and the monitoring mechanism is weak to tackle all the crime and corruption. A crucial condition, $v_b < \overline{v}$ ensures that some degree of crime and corruption is present.

The expected surplus from engaging in corruption for the two types of bureaucrats is calculated using the same threshold, v_b. Both optimistic and pessimistic bureaucrats work with the same cut off,v_b, so their expected surpluses are also same. Assume equation (1) holds, then all the bureaucrats will be better off accepting the bribe.

We collect the results from the above discussion and characterise the equilibrium of the No Leniency case in the following corollary.

Corollary 2.1 *Suppose* $0 < v_b < \overline{v}$, $b \geq \alpha F_B$, *then in equilibrium the following holds*

1. *All bureaucrats, that is, bureaucrats of every type, accept the bribe when it is offered*
2. *The types of criminals who offer the bribe have a valuation of* $v \geq b + \alpha F_C$.

2.3 The Leniency Programme

We analyze what happens when an option for forgiveness is given to the criminals who self-report corruption. To introduce the Leniency Programme, the agency announces that if the criminals who have engaged in corruption come forward and self-report it, then the fine F_C will be completely waived for the self-reporting criminals.

The Leniency Programme game is exactly the same game as in no leniency but with the additional option of reporting given to the criminals. Bureaucrats audit the criminals. Criminals have an option to offer the bribe and commit the crime or not offer the bribe losing the current value of the crime. If criminals choose to offer the bribe, the bureaucrats have the option of accepting the bribe or declining it. If the bureaucrats decline the bribe, the crime is stopped. If the bureaucrats choose to accept the bribe, they allow the criminals to commit the crime. If the bribe is accepted, the criminals now have the option of reporting corruption and getting a waiver on their punishment. However they lose reputation with the bureaucracy and hence the possibility of committing future crime. On the other hand, the criminals may choose to not report the corruption and save their future reputation with the bureaucrats and the criminal world. The game tree in figure (2) represents corruption game after the introduction of the Leniency Programme.

We solve the game by backward induction. At the last decision node, C_2, provided the bribe has been offered and it has been accepted, a criminal now has two choices: to report (R) or not report(N). If he reports the corruption, the criminal is forgiven the fine but he loses the option value of committing future crime and that explains the payoff $v - b$. The criminal will not report if the following condition holds.

$$v - b + \gamma_i v - \alpha F_C \geq v - b$$

That is

$$\gamma_i v \geq \alpha F_C \tag{3}$$

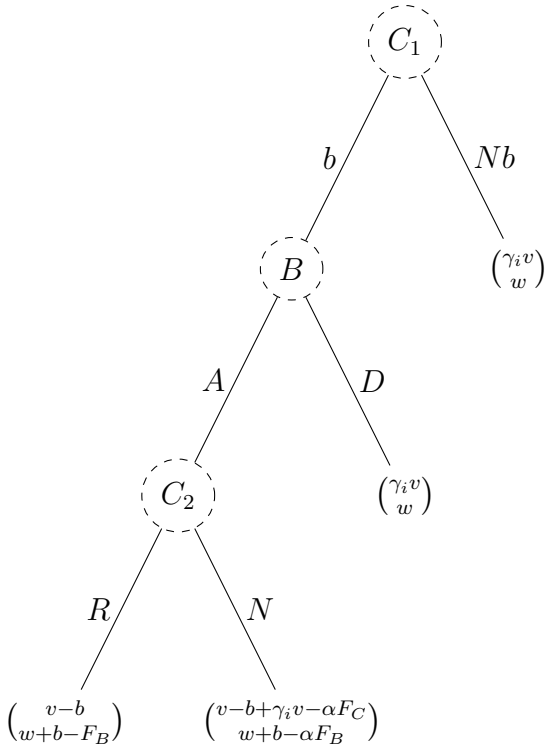

Figure 2: The Leniency Programme game tree

If on the contrary, the condition given by equation(3) does not hold, that is, $\gamma_i v < \alpha F_C$, then the criminals choose to report (R) on reaching the end node. Now as per backward induction, we consider at node B where the bureaucrats decide whether to accept the bribe (A) or not accept, that is decline (D).

At this decision node, B, the bureaucrats face the task of updating their beliefs about criminals who offer the bribe at the first node, C_1. Each type of bureaucrat has some strategy. It will be easier to understand as to what strategy the bureaucrat follows once we determine which criminals offer the bribe and which do not at the first stage. So we first analyze this part of the game where criminals decide to offer or not offer the bribe by assuming some conjecture about the equilibrium strategy of the bureaucrats in the second decision node, B. We now see what happens if the criminals plan to report on reaching the end node. Given the bureaucrat's response, let θ be the probability that the bribe offered by the criminal is accepted by whichever type of bureaucrat he encounters. [1]

Now if the bribe is offered and accepted and criminal reports, he gets $v - b$. If the criminal does not offer the bribe he gets $\gamma_i v$. On the other hand, if the bribe is not accepted, the criminal gets $\gamma_i v$. The comparison of offering and not offering the bribe for the criminal who is planning to report is thus given by

$$\theta(v - b) + (1 - \theta)(\gamma_i v) \geq \gamma_i v$$

That is,

$$v - b \geq \gamma_i v \tag{4}$$

The equation (4) is the condition for offering the bribe if the criminal plans to report. The conjecture of the criminals about the equilibirum strategy of the bureaucrats is washed out. We now derive the condition to offer the bribe, for the criminals who are planning not to report. If the bribe has been offered and accepted and if the criminals do not report, they get $v - b + \gamma_i v - \alpha F_C$. If the criminal does not offer the bribe he gets $\gamma_i v$. The comparison for offering versus not offering the bribe for a criminal planning to

[1] If x^o and x^p are the probabilities that the bribe is accepted by optimistic and pessimistic bureaucrats respectively, and as we already know μ gives the probability of the criminals meeting an optimistic bureaucrat. So, θ , the compound probability of any type of type bureaucrat accepting the bribe given the bureaucrat's response is given by $\theta = \mu x^o + (1 - \mu)x^p$.

not report is thus given by

$$\theta(v - b + \gamma_i v - \alpha F_C) + (1 - \theta)(\gamma_i v) \geq \gamma_i v$$

That is,

$$v - b \geq \alpha F_C \tag{5}$$

The equation (5) is the condition for offering the bribe if the criminal plans to not report on reaching the end node. To summarize,
For the criminals to offer the bribe and report , the following conditions must hold true.

$$\gamma_i v < \alpha F_C \tag{6}$$

$$v - b \geq \gamma_i v \tag{7}$$

For the criminals to offer the bribe and not report , the following conditions must hold true.

$$\gamma_i v \geq \alpha F_C \tag{8}$$

$$v - b \geq \alpha F_C \tag{9}$$

Notice that the beliefs of the criminals are washed away in both the cases. Irrespective of the equilibrium strategy followed by the bureaucrats, the criminals decide whether to offer the bribe or not according to the above conditions and here the criminals' beliefs drop out.

We look at how the Leniency Programme works to affect the equilibrium strategies of the two types of criminals. It will be useful to analyze a case where one type of criminals value their future reputation highly and hence does not report whereas the other type of criminals have a comparatively lower valuation of their future reputation and offer the bribe only to take advantage of the Leniency Programme and report. So for simplicity of analysis and presentation, we focus on a case in the Leniency Programme where the high type never reports and where low type criminals with valuation such that conditions (6) and (7) are simultaneously satisfied, offer the bribe only to report. We assume $\gamma_h > 1$ to have the high type of criminals never reporting and $\gamma_\ell < 1$ to have a fraction of the

low type criminals with valuation as specified in equations (6) and (7) offering the bribe only to report.[2]

Using conditions derived in equations (6), (7), (8) and (9), we plot a graph to analyze the case just described. For the case we are analyzing, that is, $\gamma_h > 1$ and $\gamma_\ell < 1$, we have the line $\gamma_h v$ not intersecting $v - b$ below αF_C and $\gamma_\ell v$ intersecting $v - b$ below αF_C.

What follows is a discussion about the threshold value of crime to high type criminals who offer the bribe and never report and the threshold value of crime for low type criminals offering the bribe only to report. We implicitly assume that the threshold value of low type criminals to offer the bribe is lower than the threshold value of high type criminals to offer the bribe and assume these are lower than the threshold for a low type criminal to offer the bribe and not report.

In the figure 3, it is clear that with $\gamma_h > 1$, conditions (6) and (7) can never be satisfied for a high type criminal which means that a high type criminal who offers the bribe will never report at the last node. Consider the lines $\gamma_h v$, αF_C and $v - b$ for a high type criminal from the figure 3. The relevant conditions for a high type criminal are (8) and (9) which are clearly satisfied for $v = b + \alpha F_C$. Hence high type criminals will offer the bribe and do not report when the current value of the crime exceeds the same threshold as in the no leniency regime, v_b. Otherwise, he does not offer the bribe.

For the low type criminals with valuation such that conditions (6) and (7) are satisfied and $\gamma_\ell < 1$, from figure 3, consider the lines $\gamma_\ell v$, αF_C and $v - b$. Let $v_{b,\ell}$ denote the threshold value of a low type criminal to offer the bribe. It is clear from condition (7), if the valuation of the low type criminal is such that $v \in [0, v_{b,\ell}]$, then he does not offer

[2]There are other combinations of cases in which both the types of criminals can possibly behave. However, those cases might not provide much insight into the working of the Leniency Programme. It is clear that if criminals of both types value their future reputation (option value of committing a crime in future) highly, then no criminal of any type would report. That is, if the intensity of the expected value of committing future crime, γ_i is high for both types of criminals, then no type takes advantage of the Leniency Programme and report. It is therefore uninteresting to look at a case where neither type of criminals report.

It is possible to have a fraction of both types of criminals to have low valuation for their future criminal activity. It makes sense to look at a case where we have a positive fraction of both high and low types of criminals who report. Such a case might be interesting for welfare calculations but again it will not help in understanding the working of the Leniency Programme.

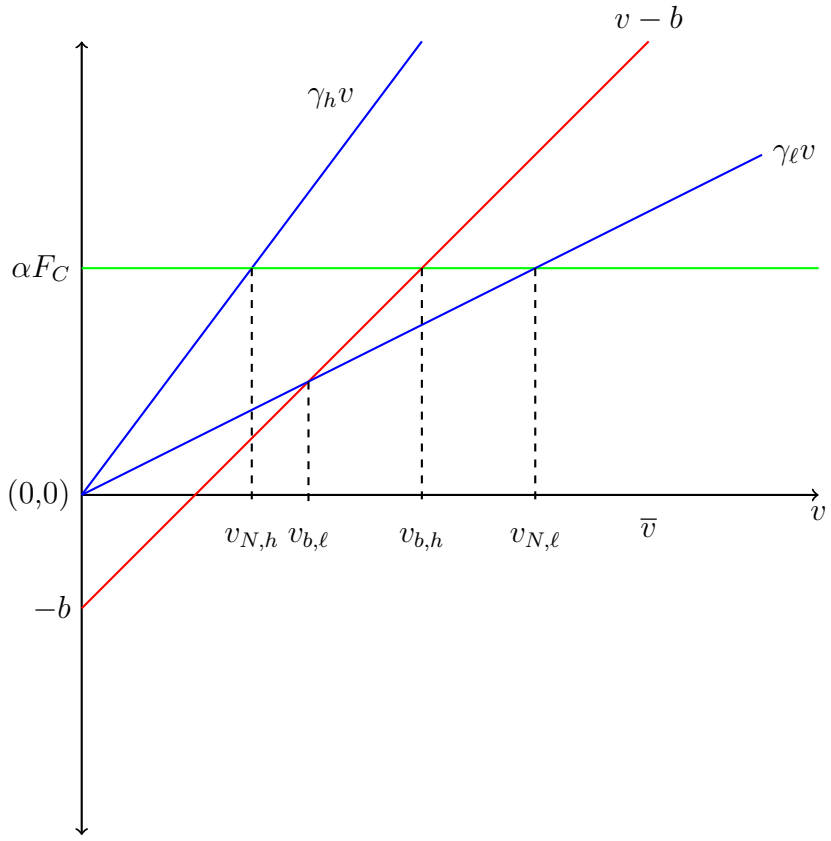

Figure 3: The Cut-offs

the bribe.

The threshold for a low type criminal to offer the bribe and not report is denoted by $v_{N,\ell}$. As seen from conditions (8) and (9), If the valuation of the low type criminal is such that $v \in [v_{N,\ell}, \overline{v}]$, then he finds it optimal to not report if he offers the bribe. If the valuation of the low type criminal is such that $v_{b,\ell} < v < v_{N,\ell}$, he reports if he were to offer the bribe. From the graph, this is exactly the region where $\gamma_\ell v < \alpha F_C$ and $v - b \geq \gamma_\ell v$. Recall that from equations (6) and (7), we have the conditions for the case of a criminal to offer the bribe and report. From (7), we have that at the threshold value $v_{b,\ell}$ for a low type criminal

$$v_{b,\ell} - b = \gamma_\ell v_{b,\ell}$$

That is,

$$v_{b,\ell} - \gamma_\ell v_{b,\ell} = b$$

$$v_{b,\ell} = \frac{b}{1-\gamma_\ell} \tag{10}$$

Similarly, from the equation (6), for a low type criminal at the threshold value $v_{N,\ell}$,

$$\gamma_\ell v_{N,\ell} = \alpha F_C$$

$$v_{N,\ell} = \frac{\alpha F_C}{\gamma_\ell} \tag{11}$$

The above discussion was made implicitly assuming that the ranking $v_{b,\ell} < v_{b,h} < v_{N,\ell} < \overline{v}$ holds. A condition needs to be imposed on the size of b for the ranking to hold true and that is $b < \frac{1-\gamma_\ell}{\gamma_\ell}\alpha F_C$, proof of which follows.

Lemma 2.1 *Suppose* $b < \frac{1-\gamma_\ell}{\gamma_\ell}\alpha F_C$. *Then* $v_{b,\ell} < v_{b,h} < v_{N,\ell}$.

Proof

$$b < \frac{1-\gamma_\ell}{\gamma_\ell}\alpha F_C$$

That is,

$$\frac{b}{1-\gamma_\ell} < \frac{\alpha F_C}{\gamma_\ell}$$

From equation (10), we know that $v_{b,\ell} = \frac{b}{1-\gamma_\ell}$ and from (11), we have $v_{N,\ell} = \frac{\alpha F_C}{\gamma_\ell}$ Therefore,

$$v_{b,\ell} < v_{N,\ell} \tag{12}$$

Rearranging $b < \frac{1-\gamma_\ell}{\gamma_\ell}\alpha F_C$, we have

$$b\gamma_\ell = \alpha F_C - \alpha F_C \gamma_\ell$$

$$(b + \alpha F_C)\gamma_\ell < \alpha F_C$$

$$b + \alpha F_C < \frac{\alpha F_C}{\gamma_\ell}$$

Therefore,

$$v_{b,h} < v_{N,\ell} \tag{13}$$

From the inequality (13), we have

$$b + \alpha F_C < \frac{\alpha F_C}{\gamma_\ell}$$

$$b\gamma_\ell + \alpha F_C \gamma_\ell < \alpha F_C$$

$$b + b\gamma_\ell + \alpha F_C \gamma_\ell < b + \alpha F_C$$

$$b < b(1 - \gamma_\ell) + \alpha F_C(1 - \gamma_\ell)$$

$$\frac{b}{1 - \gamma_\ell} < b + \alpha F_C$$

Therefore,

$$v_{b,\ell} < v_{b,h} \tag{14}$$

Hence from (12), (13) and (14) we have that

$$v_{b,\ell} < v_{b,h} < v_{N,\ell} \tag{15}$$

□

From equation (1) and the assumption $b < \frac{1-\gamma_\ell}{\gamma_\ell}\alpha F_C$, we have the following condition imposed on the size of the bribe, b. That is

$$\alpha F_B < b < \frac{1 - \gamma_\ell}{\gamma_\ell}\alpha F_C \tag{16}$$

Suppose the assumption $b < \frac{1-\gamma_\ell}{\gamma_\ell}\alpha F_C$ is reversed, that is $b \geq \frac{1-\gamma_\ell}{\gamma_\ell}\alpha F_C$. Then even the low types criminals with valuations in the region $v_{b,\ell} < v < v_{N,\ell}$ behave as high type criminals who offer the bribe and do not report and both types of criminals behave as in the no leniency. All the three threshold values $v_{b,\ell}$, $v_{b,h}$, $v_{N,\ell}$ will collapse to the same threshold value v_b in the no leniency, that is, $v_{b,\ell} = v_{b,h} = v_{N,\ell} = v_b$.

Recall that the analysis of bureaucrats' decision was not yet discussed. We now characterize the behaviour of the bureaucrats. To know the optimal strategy of the bureaucrats, it is useful to compute the probability of not being reported conditional on being offered the bribe. It is given by the following expression.

$$Prob[NBR/Bribe] = \frac{\lambda^i(1-\Phi(v_{b,h})) + (1-\lambda^i)(1-\Phi(v_{N,\ell}))}{\lambda^i(1-\Phi(v_{b,h})) + (1-\lambda^i)(1-\Phi(v_{b,\ell}))}$$

Let it be denoted by η^i, the notation we used before where i can denote optimistic or pessimistic type of bureaucrat. Then, the conditional probability of being reported on being offered the bribe is given by

$$1-\eta^i = 1 - \frac{\lambda^i(1-\Phi(v_{b,h})) + (1-\lambda^i)(1-\Phi(v_{N,\ell}))}{\lambda^i(1-\Phi(v_{b,h})) + (1-\lambda^i)(1-\Phi(v_{b,\ell}))} \tag{17}$$

After the introduction of the LP, the optimistic bureaucrats accept the bribe and the pessimistic bureaucrats do not. It is therefore, useful to rank η^o and η^p. The following lemma does that.

Lemma 2.2 *The conditional probability of not being reported for optimistic bureaucrats is strictly greater than the conditional probability of not being reported for the pessimistic bureaucrats, that is,* $\eta^o > \eta^p$.

Proof The following two equations give the probability of not being reported conditional on being offered the bribe for optimistic and pessimistic bureaucrats respectively.

$$\eta^o = \frac{\lambda^o(1-\Phi(v_{b,h})) + (1-\lambda^o)(1-\Phi(v_{N,\ell}))}{\lambda^o(1-\Phi(v_{b,h})) + (1-\lambda^o)(1-\Phi(v_{b,\ell}))}$$

$$\eta^p = \frac{\lambda^p(1-\Phi(v_{b,h})) + (1-\lambda^p)(1-\Phi(v_{N,\ell}))}{\lambda^p(1-\Phi(v_{b,h})) + (1-\lambda^p)(1-\Phi(v_{b,\ell}))}$$

Recall here the assumption, $\lambda^o > \lambda^p$. We know that $v_{b,\ell} < v_{b,h} < v_{N,\ell}$. So, $\Phi(v_{b,h}) < \Phi(v_{N,\ell})$ which implies that $(1-\Phi(v_{b,h})) > (1-\Phi(v_{N,\ell}))$ and also since $\lambda^o > \lambda^p$, we can say that the numerator of η^o is greater than the numerator of η^p. Using the same reasoning ($v_{b,\ell} < v_{b,h}$ which means $\Phi(v_{b,\ell}) < \Phi(v_{b,h})$ implying that $(1-\Phi(v_{b,h}) < (1-\Phi(v_{b,\ell}))$), we can say that the denominator of η^o is less than the denominator of η^p. The preceding analysis allows us to rank η^o and η^p in the following way

$$\eta^o > \eta^p \tag{18}$$

□

Now, we proceed to find the expected payoffs to the bureaucrat from accepting or not accepting the bribe.
The equation below gives the expected payoff to the bureaucrat from accepting the bribe
.

$$Ep_A = \eta^i(w + b - \alpha F_B) + (1 - \eta^i)(w + b - F_B)$$

$$Ep_A = w + b - F_B(\alpha\eta^i + 1 - \eta^i) \tag{19}$$

Expected payoff to the bureaucrats from not accepting the bribe is w.
In general , the condition for bureaucrat to accept the bribe is given by

$$w + b - F_B(\alpha\eta^i + 1 - \eta^i) > w$$

$$b > F_B(\alpha\eta^i + 1 - \eta^i)$$

$$\frac{b}{F_B} > \alpha\eta^i + 1 - \eta^i \tag{20}$$

η^i is the probability that the bureaucrat is not being reported conditional on accepting the bribe. If η^i is 1, then it is the no leniency case where no one is reporting.

As a consequence of the lemma 2.1, we have the ranking $\eta^o > \eta^p$. We assume $\frac{b}{F_B}$ to lie in the between $\alpha\eta^o + 1 - \eta^o$ and $\alpha\eta^p + 1 - \eta^p$ which is consistent with the ranking of η^o and η^p.

It is interesting to look at the case where at least one type of bureaucrats being corrupt and some bureaucrats prevent the crime. Such a case also addresses one of the criticisms of the LP that not all the bureaucrats stop being corrupt. This is why we focus on the equilibrium where the optimistic type of bureaucrats accept the bribe and the pessimistic type of bureaucrats do not accept the bribe. The equilibrium we are looking in the LP is characterized in the following proposition

Proposition 2.1 *Suppose $\lambda^o > \lambda^p$, $\gamma_h > 1$ and $\gamma_\ell < 1$. Suppose also that*

$$\alpha\eta^o + 1 - \eta^o < \frac{b}{F_B} < \alpha\eta^p + 1 - \eta^p < 1$$

and

$$\alpha F_B < b < \frac{1 - \gamma_\ell}{\gamma_\ell}\alpha F_C$$

. Then in equilibrium, the following holds.

1. *Optimistic bureaucrats accept the bribe and pessimistic bureaucrats do not accept the bribe;*
2. *The high type criminals will offer the bribe and do not report only if their valuation is such that* $v > v_{b,h}$ *and do not offer the bribe otherwise,*
3. *The low type criminals do not offer the bribe if* $v < v_{b,\ell}$*, they offer the bribe and report if* $v_{b,\ell} < v < v_{N,\ell}$*, and offer the bribe and not report if* $v > v_{N,\ell}$*.*

Note that if the left hand side of the inequality given by $\alpha F_B < b < \frac{1-\gamma_\ell}{\gamma_\ell}\alpha F_C$ is violated, the first and third points of proposition 2.1 are no longer valid. On the other hand if the bribe, b is very big violating the right hand side of the inequality, then point 3 of the proposition 2.1 would still hold true but it is no more interesting.

2.4 Notes on the two equilibria

This section highlights the criticisms about Leniency Programmes in the literature and how we address them in our paper.

Criticisms: One of the main criticisms of the Leniency Programme is that not all criminals will take part in it. Another criticism is that the anticipation of forgiveness might incentivize some criminals to start committing crimes. Yet another criticism is that Leniency Programmes are not effective in the sense that not all bureaucrats stop taking the bribe even after the Leniency Programme is introduced.

Analysis in the model: As pointed out in the proposition 2.1 that characterizes the equilibrium of the Leniency Programme regime, high type criminals who have valuations $v \in [v_{b,h}, \overline{v}]$ continue to commit crimes and do not report thereby retaining the future possibility of committing crimes. Thus, they do not take advantage of the Leniency Programme as they place more weight on the future criminal activity. On the other hand, as characterized in proposition 2.1, low type criminals (with valuation such that $v_{b,\ell} < v < v_{N,\ell}$) that did not offer the bribe in the no leniency regime who after the introduction of the Leniency Programme are incentivized to commit crimes just to report on the bureaucrats. They however lose the option value of committing future crimes. There are some criminals who offered the bribe in no leniency regime and did not report. But in the Leniency Programme regime, they offer the bribe only to report losing the possibility of committing future crimes. Another effect as pointed out in proposition 2.1 is that the pessimistic bureaucrats stop taking the bribe only after the Leniency

Programme is introduced and prevent crimes. However, the optimistic bureaucrats continue to take the bribe. Our analysis which is based on the heterogeneity of criminals and bureaucrats allows for these rich set of effects.

From the discussion above, the welfare implications are not straightforward and this is precisely what we look at in our next section.

3 Welfare Analysis

In this section, we discuss the welfare implications of the Leniency Programme to the agency and compare the welfare in both the regimes - no leniency and the Leniency Programme. Recall from the description of the model that we indicated that the agency is responsible for the overall welfare of the society. In what follows, we analyse welfare of the agency and we make no distinction between agency and society. However, there is no apriori reason to believe that the welfare of the agency will reflect the welfare of the society. Keeping this caveat in mind, henceforth we call the agency's payoff as society's(or social) payoff. We establish a sufficiency condition which helps us to unambiguously sign the welfare effects of the two regimes. For the sake of understanding, this section is organized in to two sub sections. *a*) Static Welfare Effects: where the number of bureaucrats who join the force is assumed to be exogenously given. *b*) Dynamic Welfare Effects: where the endogenous supply of the bureaucrats is discussed and wherein how the Leniency Programme endogenously affects the composition of bureaucrats who join the bureaucracy is also considered.

3.1 Static Welfare Effects of the Leniency Programme

In this subsection, we assume that the supply of the bureaucrats is fixed and call it the Short Run. This is when the Leniency Programme has just been introduced. Criminals value the current crime committed as v and not being able to commit it as loss of v. Society may value stopping the crime differently from what the criminals value committing the crime. We consider that the society values the crime not committed as sv where s measures the share to the society from the prevention of crime. Similarly, the criminals and society may differ about how they value future crime. That is, the payoff to the society from stopping the possibility of a criminal of both types committing

future criminal activity may be different from the criminals' payoff of having the option of committing future crime. In our analysis so far, we defined criminal's option value of committing future crime as $\gamma_i v$(where $i = \ell, h$). Now, we define the society's payoff of preventing the future criminal activity as $\gamma_{i,s} v$.

Let n be the number of potential criminals and m the number of bureaucrats who join the bureaucracy. For the short run case, we take m as exogenously given. We consider the case of $m \leq n$ - this is a relevant case where the agency has scarce resources to tackle crime. In which case, m number of criminals are audited by the bureaucrats. So $n - m$ gives the number of undetected crimes.

Let m_o and m_p denote the number of optimistic and pessimistic bureaucrats respectively and we know that $m = m_o + m_p$.

Recall that λ is the agency's belief about the proportion of high type criminals.

3.1.1 Welfare in No Leniency regime in the Short Run

For welfare calculations in the no leniency, the two possibilities whenever the criminals are audited are that the criminals offer the bribe or they do not. Amongst the criminals who are audited, those criminals of low and high type who have a cut-off $v \leq v_b$ do not offer the bribe and do not commit crimes. So, the society recovers the current value of the crime, sv. The payoff to the society when criminals do not offer the bribe is thus given by $m \left\{ s \int_0^{v_b} v \, d\Phi(v) \right\}$.

Recall here from the equilibrium characterized in corollary 2.1 in the no leniency that when $b \geq \alpha F_B$, all types of bureaucrats accept the bribe when offered. The low type and high type criminals offer the bribe when $v \geq v_b$ and it is accepted by the bureaucrats of both types whoever is encountered by the criminal. Hence number m_p and m_o do not matter in this calculation. Crime is committed in the current period. If corruption is detected by the monitoring mechanism, then F_C and F_B are the fines collected by the agency from the criminals and bureaucrats respectively. The payoff to the agency when the criminals offer the bribe in the no leniency regime is thus given by $m \{\alpha(F_C + F_B)(1 - \Phi(v_b))\}$. The agency collects nothing when the criminals are unaudited.

Hence, the welfare to the agency in the No Leniency (R_{NL}) is given by

$$R_{NL} = (n-m)(0) + m\left\{ s\int_0^{v_b} v\, d\Phi(v) \right\} + m\left\{\alpha(F_C+F_B)(1-\Phi(v_b))\right\}$$

As discussed above, numbers m_o and m_p don't matter in the welfare calculation in the no Leniency regime and the following expansion shows the same

$$\begin{aligned} R_{NL} = & \\ & m_p\left\{ s\lambda\int_0^{v_b} v\, d\Phi(v) + s(1-\lambda)\int_0^{v_b} v\, d\Phi(v) \right\} \\ & + m_o\left\{ s\lambda\int_0^{v_b} v\, d\Phi(v) + s(1-\lambda)\int_0^{v_b} v\, d\Phi(v) \right\} \\ & + m_p\left\{\lambda[\alpha(F_C+F_B)(1-\Phi(v_b))] + (1-\lambda)[\alpha(F_C+F_B)(1-\Phi(v_b))]\right\} \\ & + m_o\left\{\lambda[\alpha(F_C+F_B)(1-\Phi(v_b))] + (1-\lambda)[\alpha(F_C+F_B)(1-\Phi(v_b))]\right\} \end{aligned} \tag{21}$$

3.1.2 Welfare in the Leniency Programme regime in the Short Run

In the LP among the criminals who are audited, there are some high type and low type criminals who do not offer the bribe in which case it does not matter which type of bureaucrat they encounter. The current crime is stopped and the society's payoff is the value from stopping the current crime, sv.

Recall the equilibrium characterization of the Leniency Programme. Due to the introduction of the Leniency Programme, the incentives of both types of criminals and both types of bureaucrats change. The pessimistic bureaucrats always reject the bribe when offered by either a high type or low type criminal, hence resulting in the prevention of current crime and a payoff of sv to the society. The optimistic bureaucrats accept the bribe when offered by high type or low type of criminal. There are various effects happening here. Described below are the sub cases where two types of criminals encounter optimistic bureaucrats.

There are some low type criminals who did not offer the bribe in the no leniency but do so now only to take advantage of the Leniency Programme and report. There are yet some more low type criminals who offered the bribe in the no leniency and committed crimes, but now offer the bribe only to report. The low type criminals who report lose

their optional value of committing future crime and this results in a payoff of $\gamma_{\ell,s}v$ to the society: a crucial payoff to the society. Society also collects fines F_B from the optimistic bureaucrats who are being reported. Some low type criminals do not report on offering the bribe and society will not be able to extract their optional value of future criminal activity. High type criminals behave in the same way now in the LP as they did in the no leniency. The high type criminals who offer the bribe do not report and commit current crime and also have the option value of committing future crime. The only payoff to the society in such a case comes through fines F_B and F_C in the event of detection of corruption.

When any type of criminal who is audited does not offer the bribe to bureaucrat of any type, the crime is stopped. Society's payoff is the current value of the crime being stopped. The payoffs to the society when each type of criminal encountering the pessimistic and optimistic bureaucrats is discussed below.

3.1.3 Criminal encounters a pessimistic bureaucrat

When a criminal high type or low type encounters a pessimistic bureaucrat and offers the bribe, the crime is stopped. In the case where the criminal does not offer the bribe, the crime is stopped as well. The payoff to the agency is given by $m_p \left\{ s \int_0^{\overline{v}} v \, d\Phi(v) \right\}$.

3.1.4 Criminal encounters an optimistic bureaucrat

There are three possibilities in this case.

(a) Criminals do not offer the bribe: Low type criminals who have a valuation $v \in [0, v_{b,\ell}]$ and high type criminals who have a valuation $v \in [0, v_{b,h}]$ do not offer the bribe. In this case when any type of criminal does not offer the bribe, the payoff to the agency is given by $m_o s \left\{ \lambda \int_0^{v_{b,h}} v \, d\Phi(v) + (1-\lambda) \int_0^{v_{b,\ell}} v \, d\Phi(v) \right\}$.

(b) Criminals offer the bribe and report: Low type criminals with valuation $v \in [v_{b,\ell}, v_{N,\ell}]$ offer the bribe and report losing the possibility of future criminal activity which is the crucial recovery by the agency. Also a fine F_B is collected from the bureaucrats who are being reported. The payoff to the agency in this case is given by
$m_o \left\{ (1-\lambda)[\Phi(v_{N,\ell}) - \Phi(v_{b,\ell})]F_B + (1-\lambda) \left[\int_{v_{b,\ell}}^{v_{N,\ell}} \gamma_{\ell,s} v \, d\Phi(v) \right] \right\}$.

(c) Criminals offer the bribe and do not report: If the valuation for a high type

criminal is such that $v > v_{b,h}$, he offers the bribe and does not report. A low type criminal with valuation $v > v_{N,\ell}$ offers the bribe and does not report. Crime is committed and the criminals also retain their future possibility of committing crimes. Fines F_C and F_B are collected from the criminals and bureaucrats detected in corruption respectively. In this case, payoff to the agency is given by
$m_o \{\lambda(1-\Phi(v_{b,h})) + (1-\lambda)(1-\Phi(v_{N,\ell}))\} \{\alpha(F_B + F_C)\}$.
Hence, the welfare of the agency for the Leniency Programme case, R_S is given by

$$\begin{aligned} R_S = & \\ & m_p \left\{ s \int_0^{\overline{v}} v \, d\Phi(v) \right\} \\ & + m_o s \left\{ \lambda \int_0^{v_{b,h}} v \, d\Phi(v) + (1-\lambda) \int_0^{v_{b,\ell}} v \, d\Phi(v) \right\} \\ & + m_o \left\{ (1-\lambda)[\Phi(v_{N,\ell}) - \Phi(v_{b,\ell})] F_B + (1-\lambda) \left[\int_{v_{b,\ell}}^{v_{N,\ell}} \gamma_{\ell,s} v \, d\Phi(v) \right] \right\} \\ & + m_o \{\lambda(1-\Phi(v_{b,h})) + (1-\lambda)(1-\Phi(v_{N,\ell}))\} \{\alpha(F_B + F_C)\} \end{aligned} \tag{22}$$

3.1.5 Welfare Comparison between No Leniency and the Leniency Programme in the Short Run

In this section, we compare the welfare obtained in the No Leniency and the Leniency Programme in the short run case where the supply of bureaucrats is fixed. A note about s before we proceed further. As already discussed, the benefit to the society of preventing current criminal activity is sv. Notice this incorporates the fact that society may value stopping of crime differently from what the criminals value committing the crime. Similarly, the payoff to the society from stopping future crime, given by $\gamma_{i,s}v$ may be different from the criminals' value of having the option of committing future crime, given by $\gamma_i v$. There is an interesting welfare comparison between the two policies even if they value it in the same way. So, we first investigate the case where both the society and criminals value it in same way. We set $s = 1$ and $\gamma_{i,s} = \gamma_i$.

When s is some value other than 1, the comparison might lead to other interesting results; the analysis of which is deferred to later sections.

Rewriting the R_{NL} from equation (21), we have

$$
\begin{aligned}
R_{NL} = & \\
& m_p \left\{ \lambda \int_0^{v_b} v \, d\Phi(v) + (1-\lambda) \int_0^{v_b} v \, d\Phi(v) \right\} \\
& + m_o \left\{ \lambda \int_0^{v_b} v \, d\Phi(v) + (1-\lambda) \int_0^{v_b} v \, d\Phi(v) \right\} \\
& + m_p \left\{ \lambda[\alpha(F_C + F_B)(1 - \Phi(v_b))] + (1-\lambda)[\alpha(F_C + F_B)(1 - \Phi(v_b))] \right\} \\
& + m_o \left\{ \lambda[\alpha(F_C + F_B)(1 - \Phi(v_b))] + (1-\lambda)[\alpha(F_C + F_B)(1 - \Phi(v_b))] \right\}
\end{aligned}
\tag{23}
$$

Rewriting the R_S from equation (22), we have

$$
\begin{aligned}
R_S = & \\
& m_p \left\{ \int_0^{\overline{v}} v \, d\Phi(v) \right\} \\
& + m_o \left\{ \lambda \int_0^{v_{b,h}} v \, d\Phi(v) + (1-\lambda) \int_0^{v_{b,\ell}} v \, d\Phi(v) \right\} \\
& + m_o \left\{ (1-\lambda)[\Phi(v_{N,\ell}) - \Phi(v_{b,\ell})] F_B + (1-\lambda) \left[\int_{v_{b,\ell}}^{v_{N,\ell}} \gamma_\ell v \, d\Phi(v) \right] \right\} \\
& + m_o \left\{ \lambda(1 - \Phi(v_{b,h})) + (1-\lambda)(1 - \Phi(v_{N,\ell})) \right\} \left\{ \alpha(F_B + F_C) \right\}
\end{aligned}
\tag{24}
$$

A brief note on what the comparison yields. Society gets a higher payoff after the introduction of the LP compared to no leniency in the short run provided a certain sufficient condition is satisfied, which is discussed in detail further in this subsection. Society gets a higher payoff after the introduction of the LP from the encounter of a pessimistic bureaucrat with a high type or low type criminal than in the no leniency. Society gets the same payoff in both the Leniency Programme and no leniency from the encounter of optimistic bureaucrats with high type criminals. Society gets a higher payoff after the introduction of the Leniency Programme from the encounter of an optimistic bureaucrat with low type criminals than that in no leniency provided a sufficiency condition is satisfied.

3.1.6 Welfare comparison - High type or low type criminals encounter a pessimistic bureaucrat

The payoff from high type or low type criminals encountering pessimistic bureaucrats in the no leniency in the short run (from equation (23)) is $\int_0^{v_b} v\, d\Phi(v) + \{\alpha(F_C + F_B)(1 - \Phi(v_b))\}$ and that from the Leniency Programme in the short run, that is from equation(24) is $\int_0^{\overline{v}} v\, d\Phi(v)$ which is

$$\int_0^{\overline{v}} v\, d\Phi(v) = \int_0^{v_b} v\, d\Phi(v) + \int_{v_b}^{\overline{v}} v\, d\Phi(v)$$

Taking the difference between these payoffs from the Leniency Programme and that from the no leniency in the short run yields

$$\int_{v_b}^{\overline{v}} v\, d\Phi(v) - [1 - \Phi(v_b)][\alpha(F_C + F_B)]$$

which is

$$\int_{v_b}^{\overline{v}} [v - \alpha(F_C + F_B)]\, d\Phi(v)$$

For every, $v \in [v_b, \overline{v}]$, we have

$$v - b \geq \alpha F_C$$

$$v \geq b + \alpha F_C$$

Recall here the equilibrium condition in corollary 2.1, which is $b \geq \alpha F_B$. From $b \geq \alpha F_B$ and $v \geq b + \alpha F_C$, we have that $v \geq \alpha(F_B + F_C)$. So in this case, the payoff to the society is always higher after the introduction of the LP than that in the no leniency in the short run when the criminals of any type encounter a pessimistic bureaucrat. Hence we have $R_S - R_{NL} > 0$ for this sub case.

Now, we look at the payoff to the society for the encounter between both types of criminals and an optimistic bureaucrat after the introduction of the LP and compare it with that obtained in the no leniency.

3.1.7 Welfare comparison - High type or low type criminals encounter an optimistic bureaucrat

The encounter of any type of criminal with an optimistic bureaucrat in the short run gives different payoffs according to the different valuations of criminal types. It is broken down into the following sub cases.

3.1.8 Welfare comparison - High type criminals encounter an optimistic bureaucrat

The payoff to the society from the optimistic bureaucrats meeting a high type criminal in the no leniency (from equation (23)) is

$$m_o.\lambda \left\{ \int_0^{v_b} v \, d\Phi(v) + (1 - \Phi(v_b))\alpha(F_C + F_B) \right\}$$

.

The payoff to the society from the optimistic bureaucrats meeting a high type criminal after the introduction of the LP (from equation (24)) is

$$m_o.\lambda \left\{ \int_0^{v_{b,h}} v \, d\Phi(v) + (1 - \Phi(v_{b,h}))\alpha(F_C + F_B) \right\}$$

But recall that the threshold value v_b in the no leniency is just equal to the $v_{b,h}$ after the introduction of the LP. Hence, the payoff to the society from the optimistic bureaucrats meeting a high type criminal is same in the no leniency and after the introduction of the LP in the short run.

3.1.9 Welfare comparison - Low type criminals encounter an optimistic bureaucrat

The payoff obtained in the no leniency when low type criminals of valuation $v \in [0, v_{b,\ell}]$ meet an optimistic bureaucrat is

$$m_o.(1 - \lambda) \left\{ \int_0^{v_{b,l}} v \, d\Phi(v) \right\}$$

and the payoff after the introduction of the LP from the encounter of low type criminals of valuation $v \in [0, v_{b,\ell}]$ meet an optimistic bureaucrat is

$$m_o.(1-\lambda)\left\{\int_0^{v_{b,l}} v\, d\Phi(v)\right\}$$

So, payoff to the society when a low type criminal with valuation $v \in [0, v_{b,\ell}]$ meets an optimistic bureaucrat is exactly the same in the no leniency and the Leniency Programme.

A similar comparison in the no leniency and the Leniency Programme when the low type criminal with valuation $v \in [v_{N,\ell}, \overline{v}]$ shows that they are exactly the same, that is

$$m_o.(1-\lambda)(1-\Phi(v_{N,\ell}))\alpha(F_B+F_C)$$

. The only difference in the payoffs comes from the encounter of low type criminals and optimistic bureaucrats when the valuation of the low type criminals is such that $v_{b,\ell} < v < v_{N,\ell}$. This region of valuation be broken down into two parts. *a)* $v \in [v_{b,\ell}, v_{b,h})$, and *b)* $v \in [v_{b,h}, v_{N,\ell}]$.

When the valuation of the low type criminals is $v \in [v_{b,\ell}, v_{b,h})$, previously in the no leniency, criminals did not offer the bribe and now after the Leniency Programme is introduced they are better off by offering the bribe and reporting.

In the no leniency, the payoff to the society when a low type criminal of valuation $v \in [v_{b,\ell}, v_{b,h})$ encounters an optimistic bureaucrat is

$$m_o.(1-\lambda)\left\{\int_{v_{b,\ell}}^{v_b} v\, d\Phi(v)\right\}$$

and after the introduction of the LP,

$$m_o.(1-\lambda)\left\{[\Phi(v_{b,h})-\Phi(v_{b,\ell})]F_B+\int_{v_{b,\ell}}^{v_{b,h}} \gamma_\ell v\, d\Phi(v)\right\}$$

If we look at the difference $R_S - R_{NL}$ for an encounter of an optimistic bureaucrat with a low type criminal when $v \in [v_{b,\ell}, v_{b,h})$, it is given by

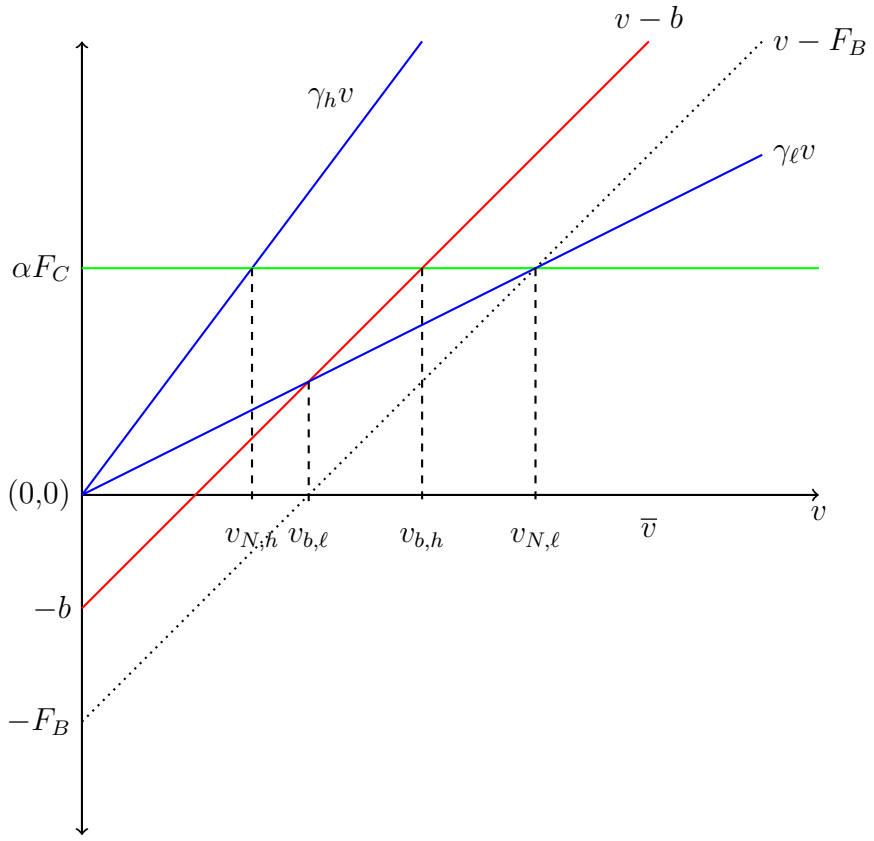

Figure 4: The Cut-offs for welfare comparison

$$Z_1 = m_o.(1-\lambda)\left\{\int_{v_{b,\ell}}^{v_{b,h}} (F_B + \gamma_\ell v - v)\, d\Phi(v)\right\} \tag{25}$$

When the valuation of the low type criminals is such that $v \in [v_{b,h}, v_{N,\ell}]$, in the no leniency, they offer the bribe, whereas after the introduction of the LP, they offer the bribe and report.

In the no leniency, the payoff to the society when a low type criminal of valuation $v \in [v_{b,h}, v_{N,\ell})$ encounters an optimistic bureaucrat is

$$m_o.(1-\lambda)(1-\Phi(v_{b,h}))\alpha(F_C + F_B)$$

and after the introduction of the LP,

$$m_o.(1-\lambda)\left\{[\Phi(v_{N,\ell}) - \Phi(v_{b,h})]F_B + \int_{v_{b,h}}^{v_{N,\ell}} \gamma_\ell v\, d\Phi(v)\right\}$$

If we look at the difference $R_S - R_{NL}$ for an encounter of an optimistic bureaucrat with a low type criminal when $v \in [v_{b,h}, v_{N,\ell}]$, it is given by

$$Z_2 = m_o.(1-\lambda)\left\{\int_{v_{b,h}}^{v_{N,\ell}} (F_B + \gamma_\ell v - \alpha(F_B + F_C))\, d\Phi(v)\right\} \tag{26}$$

If we have to sign $R_S - R_{NL}$ in the short run in both the regions, that is essentially signing Z_1 and Z_2, a sufficient condition is

$$F_B \geq v_{N,\ell} - \alpha F_C \tag{27}$$

From the welfare comparison of the Leniency Programme and no leniency in the short run, we see that the payoff to the society after the introduction of the LP from the encounter of pessimistic bureaucrats with any type of criminals is higher than that in the no leniency. However, we are unable to determine if the payoff to the society from the encounter of optimistic bureaucrats with all types of criminals after the introduction of the LP is higher than that in the no leniency or not. We prove that if the condition given by equation (27) holds, then society also gains from the interaction of optimistic bureaucrats and the two types of criminals, that is for every value of v of criminals

and for all l, h. Sufficiency condition given by the inequality (27) requires that the fine levied on the bureaucrats be sufficiently higher than the difference between the low type criminal's valuation of crime in the no leniency and the fine he should pay on being caught.

The following proposition characterizes the welfare effects of the Leniency Programme and no leniency in the short run.

Proposition 3.1 *Assume the conditions of Corollary 2.1 and proposition 2.1 hold in particular such that the equilibrium in the no leniency and the Leniency Programme are as described in corollary 2.1 and proposition 2.1 respectively. Suppose further that* $F_B \geq v_{N,\ell} - \alpha F_C$ *and that* $s = 1$*, then*

In the Short Run, the Leniency Programme is unambiguously better than no leniency, that is $R_S > R_{NL}$*.*

Proof Equation (27) is a sufficient condition because of the following reasons. If (27) holds and when the valuation of a low type criminal is such that $v \in [v_{b,\ell}, v_{b,h})$, then for every v, $\gamma_l v$ is bigger than $v - F_B$, that is $F_B + \gamma_\ell v - v < 0$. For this reason, we have Z_1 as positive. So, when the low type criminal with valuation $v \in [v_{b,\ell}, v_{b,h})$ meets an optimistic bureaucrat, if the condition given by (27) holds, then the payoff to the society is strictly greater after the introduction of the LP than in the no leniency.

Now, we look at the difference Z_2. Once again, we try to determine, if the payoff to the society after the introduction of the LP is greater than that in the no leniency when a low type criminal now with a valuation $v \in [v_{b,h}, v_{N,\ell}]$ encounters an optimistic bureaucrat.

As a consequence of the conditions in proposition 2.1, we have $F_B > b$. When the valuation of a low type criminal is such that $v \in [v_{b,h}, v_{N,\ell}]$, the payoff to the society in the no leniency is $\alpha F_B + \alpha F_C$. After the introduction of the LP when the low type criminal meets an optimistic bureaucrat the payoff is $\gamma_\ell v + F_B$. Given the sufficient condition, $\gamma_\ell v_{N,\ell} + F_B \geq v_{N,\ell}$ and since $v \geq \alpha F_B + \alpha F_C$, it follows that $\gamma_\ell v + F_B \geq \alpha F_B + \alpha F_C$. So, for this sub case, the payoff to the society after the introduction of the LP is greater than the payoff in the no leniency. □

To summarize, we have that when the high type and low type criminals meet pessimistic bureaucrats, payoff to the society after the introduction of the LP is strictly greater than

the payoff to the society in the no leniency. When high type criminals meet optimistic bureaucrats, there is no difference in the payoff to the society after the introduction of the LP and no leniency. Similarly, when the low type criminals with valuation $v \in [0, v_{b,\ell}]$ and $v \in [v_{N,\ell}, \overline{v}]$ meet optimistic bureaucrats, there is no difference in the payoffs to the society after the introduction of the LP and no leniency. The only difference in the payoffs to the society after the introduction of the LP and no leniency occurs when the low type criminals with valuation $v \in [v_{b,\ell}, v_{b,h})$ and $v \in [v_{b,h}, v_{N,\ell}]$ encounter optimistic bureaucrats. We proved that this difference is greater after the introduction of the LP than in the no leniency given the sufficiency condition (27) holds.

Note in particular under the sufficient condition, we can have a stronger result than proposition 3.1. The result is that

For all types of criminals, that is for every value of v of criminals and for all l, h, society's payoff after the introduction of the LP is strictly greater than the payoff in the no leniency in the short run irrespective of the type of the bureaucrat the criminals are audited by.

If the sufficiency condition is violated, society incurs a loss after the introduction of the LP in the short run from each encounter of the low type of criminals in the valuation region $v \in [v_{b,\ell}, v_{N,\ell}]$ with an optimistic bureaucrat. So in order to determine if the Leniency Programme is better than no leniency or if the opposite is true, that is, if the net effect is positive or negative, we need to know the size of that region. We need to know precisely the number of low type criminals with valuation $v \in [v_{b,\ell}, v_{N,\ell}]$. If this number is very large, then the gain in the payoff to the society from the pessimistic bureaucrats after the introduction of the LP is not enough to compensate the loss in the payoff from the optimistic bureaucrats.

3.2 Dynamic Welfare Effects of the Leniency Programme

Throughout the previous subsection, the welfare calculations have been done by taking the supply of the bureaucrats as exogenously given. In this subsection, we look at the welfare after the introduction of the LP against that in the no leniency when enough time has passed after the introduction of the Leniency Programme for the size and composition of the bureaucrats to vary. We call this stage the intermediate run where the supply of the bureaucrats is endogenous. Let M be a fixed amount of money allocated

to the agency for the purpose of hiring the bureaucrats. The budget constraint of the agency is

$$M = m.w \tag{28}$$

where m is the number of bureaucrats hired at wage, w per bureaucrat. Let K denote the total population of bureaucrats looking for jobs. The bureaucrats draw outside wage offers from the distribution $H(w)$ where $w \in [\underline{w}, \overline{w}]$. The total expected income of every bureaucrat accepting the agency offered job is $w+e$, where e is the expected income from engaging in corruption. Not engaging in corruption means $e = 0$. The bureaucrats who join the agency are those that have outside wage offers lower than $w + e$. Hence,$w + e$ is the cut-off wage. If K is the total general population of bureaucrats, then out of that K, $H(w + e)$ is the fraction of bureaucrats who accept the agency offered job. The total number of bureaucrats hired by the agency, m, is therefore given by the expression, $K.H(w + e)$.

In the general population of bureaucrats,K, the two types are half each(half are optimistic and half are pessimistic, that is $K/2$ each). Here an additional point is being made, that is in the original population the composition of bureaucrats consists of half optimistic bureaucrats and the other half is pessimistic bureaucrats. In the no leniency, since the bureaucrats face the same incentives in equilibrium, they join the force at the same rate. So, among the bureaucrats hired into the agency, half of them are optimistic and half are pessimistic, that is $m_p = m_o = m/2$.

Recall that the incentives for the two types of bureaucrats joining the agency are to accept the bribe in the no leniency equilibrium and in this case, $e = (b-\alpha F_B)(1-\Phi(v_b))$. In the case of no leniency (R_{NL}) , the following are the number of pessimistic (m_{pN}) and optimistic bureaucrats (m_{oN}) hired respectively.

$$m_{pN} = m_{oN} = \frac{K}{2}.H(w + (b - \alpha F_B)(1 - \Phi(v_b)))$$

In the Leniency Programme case, in the short run (R_S), that is just after the policy is introduced, the bureaucrats who are in the bureaucracy are the same as in the no leniency, that is $\frac{K}{2}.H(w + (b - \alpha F_B)(1 - \Phi(v_b)))$

However, when certain time is allowed from the introduction of the Leniency Programme, the expected incomes of the pessimistic and optimistic bureaucrats change and

the composition of the bureaucrats starts changing. The expected income from corruption to the pessimistic bureaucrats after the introduction of the LP equilibrium is 0 in the intermediate run. So, some of them start leaving based on the outside job offers. Hence the total number of bureaucrats in the intermediate run (discussion of which is postponed to the later subsections) is lower than that in the short run. So, the budget constraint is no longer satisfied. There is some money left over. The agency can now announce a wage rise which we call as the long run. In the long run (R_L), agency announces an increase in the wages of bureaucrats by an amount $\triangle w$. In the Leniency Programme long run, the number of pessimistic and optimistic bureaucrats is given by

$$m_{p3} = \frac{K}{2}.H(w + \triangle w)$$

$$\begin{aligned} m_{o3} = & \\ & \frac{K}{2}.H(w + \triangle w \\ & + \lambda^o(b - \alpha F_B)(1 - \Phi(v_b)) \\ & + (1 - \lambda^o)[(b - \alpha F_B)(1 - \Phi(v_{N,\ell})) \\ & + (b - F_B)(\Phi(v_{N,\ell}) - \Phi(v_{b,\ell}))]) \end{aligned}$$

The expression for welfare after the introduction of the LP in the long run denoted

by R_L can be given as

$$
\begin{aligned}
R_L = & \\
& \frac{K}{2}.H(w+\triangle w)\left\{\int_0^{\overline{v}} v\, d\Phi(v)\right\} \\
& + \frac{K}{2}.H(w+\triangle w+\lambda^o(b-\alpha F_B)(1-\Phi(v_b)) \\
& + (1-\lambda^o)[(b-\alpha F_B)(1-\Phi(v_{N,\ell}))+(b-F_B)(\Phi(v_{N,\ell})-\Phi(v_{b,\ell}))]) \\
& \left\{\lambda\int_0^{v_{b,h}} v\, d\Phi(v)+(1-\Phi(v_{b,h}))\right\}+(1-\lambda)\left\{\int_0^{v_{b,\ell}} v\, d\Phi(v)\right\} \\
& + [\Phi(v_{N,\ell})-\Phi(v_{b,\ell})]F_B+\int_{v_{b,\ell}}^{v_{N,\ell}} \gamma_\ell v\, d\Phi(v) \\
& + (1-\Phi(v_{N,\ell}))\alpha(F_B+F_C)
\end{aligned}
\tag{29}
$$

Let the payoff to the society from the pessimistic bureaucrats encountering all types of criminals in the Leniency Programme be a_L and that from the optimistic bureaucrats encountering all types of criminals be $b_L+c_L+d_L$ in the Leniency Programme (where b_L is a payoff to the society resulting from the encounter of optimistic bureaucrats and high type criminals , c_L - payoff from optimistic bureaucrats encountering low type criminals with valuation $v \in [v_{b,\ell}, v_{N,\ell}]$, d_L - payoff from optimistic bureaucrats encountering low type criminals with valuation $v \in [0, v_{b,\ell}]$ and $v \in [v_{N,\ell}, \overline{v}]$).

$$a_L = \int_0^{\overline{v}} v\, d\Phi(v)$$

$$b_L = \lambda\left\{\int_0^{v_{b,h}} v\, d\Phi(v)+(1-\Phi(v_{b,h}))(\alpha(F_B+F_C))\right\}$$

$$c_L = (1-\lambda)\left\{\int_0^{v_{b,\ell}} v\, d\Phi(v)+[\Phi(v_{N,\ell})-\Phi(v_{b,\ell})]F_B+\int_{v_{b,\ell}}^{v_{N,\ell}} \gamma_\ell v\, d\Phi(v)\right\}$$

$$d_L = (1-\lambda)(1-\Phi(v_{N,\ell}))\alpha(F_B+F_C)$$

$$
\begin{aligned}
R_L - R_S = & \\
& \frac{K}{2}.H(w+\triangle w)(a_L) \\
& + \frac{K}{2}.H(w+\triangle w+\lambda^o(b-\alpha F_B)(1-\Phi(v_b)) \\
& + (1-\lambda^o)[(b-\alpha F_B)(1-\Phi(v_{N,\ell})) \\
& + (b-F_B)(\Phi(v_{N,\ell})-\Phi(v_{b,\ell}))])(b_L+c_L+d_L) \\
& - \frac{K}{2}.H(w+(b-\alpha F_B)(1-\Phi(v_b)))(a_L) \\
& - \frac{K}{2}.H(w+(b-\alpha F_B)(1-\Phi(v_b)))(b_L+c_L+d_L)
\end{aligned} \tag{30}
$$

The budget constraint in the long run would look like

$$
\begin{aligned}
M = & \\
& (\frac{K}{2}.H(w+\triangle w) \\
& + \frac{K}{2}.H(w+\triangle w+\lambda^o(b-\alpha F_B)(1-\Phi(v_b)) \\
& + (1-\lambda^o)[(b-\alpha F_B)(1-\Phi(v_{N,\ell})) \\
& + (b-F_B)(\Phi(v_{N,\ell})-\Phi(v_{b,\ell}))]))(w+\triangle w)
\end{aligned} \tag{31}
$$

It is the same budget we expressed in the equation (28) using the number of bureaucrats in the no leniency. Equating that with the budget in equation (31) and re-arranging, the number of optimistic bureaucrats in the long run can be expressed as

$$
\begin{aligned}
\frac{K}{2}.(H(w+\triangle w+\lambda^o(b-\alpha F_B)(1-\Phi(v_b)) & \\
& + (1-\lambda^o)[(b-\alpha F_B)(1-\Phi(v_{N,\ell})) \\
& + (b-F_B)(\Phi(v_{N,\ell}) \\
& - \Phi(v_{b,\ell}))]) = \\
& \frac{K}{2}.(2H(w+(b-\alpha F_B)(1-\Phi(v_b))\frac{w}{w+\triangle w} \\
& - H(w+\triangle w))
\end{aligned} \tag{32}
$$

Rewriting the expression for $R_L - R_S$ gives

$$\begin{aligned} R_L - R_S = & \\ & \frac{K}{2}.(2H(w + (b - \alpha F_B)(1 - \Phi(v_b))\frac{w}{w + \triangle w} \\ & - H(w + \triangle w))(b_L + c_L + d_L) \\ & + \frac{K}{2}.H(w + \triangle w)(a_L) \\ & - \frac{K}{2}.H(w + (b - \alpha F_B)(1 - \Phi(v_b)))(a_L) \\ & - \frac{K}{2}.H(w + (b - \alpha F_B)(1 - \Phi(v_b)))(b_L + c_L + d_L) \end{aligned} \tag{33}$$

$$\begin{aligned} R_L - R_S = & \\ & \frac{K}{2}.\{H(w + (b - \alpha F_B)(1 - \Phi(v_b))) \\ & \{\frac{w - \triangle w}{w + \triangle w}(b_L + c_L + d_L) - a_L\} \\ & + H(w + \triangle w\{a_L - (b_L + c_L + d_L)\}\} \end{aligned} \tag{34}$$

Now, comparing the welfare after the introduction of the LP in short run (R_S) and that in long run (R_L) gives the result that

Proposition 3.2 *Suppose the sufficiency condition given by equation* (27) *and the assumption* $a_L > b_L + c_L + d_L$*(that is, in the Leniency Programme, payoff from the pessimists encountering all types of criminals of all valuations is greater than payoff from the optimists encountering all types of criminals of all valuations) hold, then welfare in the short run is greater than that in the long run, that is,* $R_S > R_L$.

Proof In the equilibrium in the Leniency Programme that we look at, surplus income of the pessimistic bureaucrats is 0 as opposed to a positive surplus optimistic bureaucrats get. It is impossible for the agency to have more pessimists than there are optimists. The surplus income of pessimists in the Leniency Programme is 0 and is lesser than that in the no leniency. Hence there are lesser pessimists in the Leniency Programme long run than there are in the Leniency Programme short run. If the budget constraint has to be maintained, it is also impossible that the agency hires more total number of bureaucrats in the Leniency Programme long run giving higher wages simultaneously

than in the no leniency.

par The agency is losing pessimists, if it also loses optimists thus having less total number of bureaucrats in the Leniency Programme long run than in the short run (case: $\triangle w < (b - \alpha F_B)(1 - \Phi(v_b))$ and $\triangle w < \lambda^o(b - \alpha F_B)(1 - \Phi(v_b)) + (1 - \lambda^o)[(b - \alpha F_B)(1 - \Phi(v_{N,\ell})) + (b - F_B)(\Phi(v_{N,\ell}) - \Phi(v_{b,\ell}))]$), then it is proved that the Leniency Programme short run is better than the Leniency Programme long run, that is, $R_S > R_L$.

Another case which is possible is that there are more number of optimists in the the Leniency Programme long run than there are in the short run which is a case where: $\triangle w < (b - \alpha F_B)(1 - \Phi(v_b))$ and $\triangle w > \lambda^o(b - \alpha F_B)(1 - \Phi(v_b)) + (1 - \lambda^o)[(b - \alpha F_B)(1 - \Phi(v_{N,\ell})) + (b - F_B)(\Phi(v_{N,\ell}) - \Phi(v_{b,\ell}))]$. Taking the difference between the welfares after the introduction of the LP in the short run and that in the long run, provided the conditions given by equation (27) and the assumption that $a_L > b_L + c_L + d_L$ hold, we have $R_S - R_L > 0$. Hence, welfare after the introduction of the LP in the short run is better than that in the long run. □

Comparison between welfare in the no leniency(R_{NL}) and welfare in the long run(R_L): If welfare in the long run is lower than that in the no leniency, then it would be best to not introduce the Leniency Programme in the first place.

par The difference in welfare after the introduction of the LP in the long run and that in the no leniency is

$$\begin{aligned} R_L - R_{NL} = & \\ & \frac{K}{2}.\{(2H(w + (b - \alpha F_B)(1 - \Phi(v_b))\frac{w}{w + \triangle w} \\ & - H(w + \triangle w))(b_L + c_L + d_L) \\ & + H(w + \triangle w)(a_L) \\ & - H(w + (b - \alpha F_B)(1 - \Phi(v_b)))(b_N + c_N + d_N) \\ & - H(w + (b - \alpha F_B)(1 - \Phi(v_b)))(a_N)\} \end{aligned} \tag{35}$$

where $b_N + c_N + d_N$ is the payoff obtained from the meeting between optimistic bureaucrats and all types of criminals, low and high of all valuations v in the no leniency (where b_N is a payoff to the society resulting from the encounter of optimistic bureaucrats and high type criminals , c_N - payoff from optimistic bureaucrats encountering low type criminals with valuation $v \in [v_{b,\ell}, v_{N,\ell}]$, d_N - payoff from optimistic bureaucrats encountering low type criminals with valuation $v \in [0, v_{b,\ell}]$ and $v \in [v_{N,\ell}, \overline{v}]$) and a_N is

the payoff obtained from the meeting between pessimistic bureaucrats and all types of criminals in the no leniency. Also, $b_N + c_N + d_N = a_N$

$$a_N = \int_0^{v_{b,h}} v\, d\Phi(v) + (1 - \Phi(v_{b,h}))(\alpha(F_B + F_C))$$

$$b_N = \lambda \left\{ \int_0^{v_{b,h}} v\, d\Phi(v) + (1 - \Phi(v_{b,h}))\alpha(F_C + F_B) \right\}$$

$$c_N = (1 - \lambda) \left\{ \int_{v_{b,\ell}}^{v_{b,h}} v\, d\Phi(v) + (1 - \Phi(v_{b,h}))\alpha(F_C + F_B) \right\}$$

$$d_N = (1 - \lambda)(1 - \Phi(v_{N,\ell}))(\alpha(F_B + F_C))$$

Rearranging the equation (35), we have

$$\begin{aligned} R_L - R_{NL} = & \\ & \frac{K}{2}.\{(2H(w + (b - \alpha F_B)(1 - \Phi(v_b))) \\ & \{(b_L + c_L + d_L)\frac{w}{w + \triangle w} - (b_N + c_N + d_N)\} \\ & + H(w + \triangle w)\{a_L - (b_L + c_L + d_L)\}\} \end{aligned} \tag{36}$$

Now, comparing the welfare after the introduction of the LP in the long run (R_L) and that in no leniency (R_{NL}) gives the result that

Proposition 3.3 *Suppose the sufficiency condition given by equation* (27)*, the assumptions* $a_L > b_L + c_L + d_L$ *and* $(b_L + c_L + d_L)\frac{w}{w+\triangle w} > (b_N + c_N + d_N)$ *hold, then welfare after the introduction of the LP in the long run is greater than that in the no leniency (that is,* $R_L > R_{NL}$*).*

Proof Recall the proof of proposition 3.2. There are fewer number of pessimists than there are optimists in the bureaucracy after the introduction of the LP in the long run than in the no leniency. With the same budget constraint, it is also the case that there are never more total number of bureaucrats after the introduction of the LP in the long run than there were in the no leniency. The number of optimists could be greater or lesser after the introduction of the LP in the long run than in the no leniency. If $a_L > b_L + c_L + d_L$, in the Leniency Programme long run, payoff from the pessimists is

greater than that from the optimists. The sufficiency condition given by (27) tells us that payoff from the optimists meeting all types of criminals after the introduction of the LP is greater than that in the no leniency. If the scale effect is dominated by the individual gain from the optimists ($(b_L + c_L + d_L)\frac{w}{w+\triangle w} > (b_N + c_N + d_N)$), then the welfare after the introduction of the LP in the long run will be greater than that in the no leniency. □

We now look at the welfare after the introduction of the LP in the intermediate run,(R_M). The number of pessimistic and optimistic bureaucrats in this run are given by

$$m_{p2} = \frac{K}{2}.H(w)$$

$$\begin{aligned} m_{o2} = \frac{K}{2}.H(w + \lambda^o(b - \alpha F_B)(1 - \Phi(v_b)) \\ + (1 - \lambda^o)[(b - \alpha F_B)(1 - \Phi(v_{N,\ell})) \\ + (b - F_B)(\Phi(v_{N,\ell}) - \Phi(v_{b,\ell}))]) \end{aligned}$$

The expression for welfare after the introduction of the LP in the intermediate run is

$$\begin{aligned} R_M = \\ & \frac{K}{2}.H(w)(a_L) \\ & + \frac{K}{2}.H(w + \lambda^o(b - \alpha F_B)(1 - \Phi(v_b)) \\ & + (1 - \lambda^o)[(b - \alpha F_B)(1 - \Phi(v_{N,\ell})) \\ & + (b - F_B)(\Phi(v_{N,\ell}) - \Phi(v_{b,\ell}))])(b_L + c_L + d_L) \end{aligned} \tag{37}$$

$$\begin{aligned} R_S - R_M = \\ & \frac{K}{2}.\{\{H(w + (b - \alpha F_B)(1 - \Phi(v_b))) - H(w)\}(a_L) \\ & + \{H(w + (b - \alpha F_B)(1 - \Phi(v_b))) \\ & - H(w + \lambda^o(b - \alpha F_B)(1 - \Phi(v_b)) \\ & + (1 - \lambda^o)[(b - \alpha F_B)(1 - \Phi(v_{N,\ell})) \\ & + (b - F_B)(\Phi(v_{N,\ell}) - \Phi(v_{b,\ell}))])\}\}(b_L + c_L + d_L) \end{aligned} \tag{38}$$

Comparison of the welfare after the introduction of the LP in the short run with that in the intermediate run can be summarized in the following proposition

Proposition 3.4 *Welfare after the introduction of the LP in the short run is greater than that in the intermediate run, that is,* $R_S > R_M$.

Proof The expected surplus to the pessimists after the introduction of the LP in the intermediate run is 0, less than that in the no leniency(and the Leniency Programme short run). The expected surplus of the optimists after the introduction of the LP in the intermediate run is also lower compared to that in the no leniency. So there are less total number of bureaucrats in the intermediate run giving the same payoff as that in the short run. Because of the size effect or the scale effect here (reduced total number of bureaucrats), the welfare after the introduction of the LP falls in the intermediate run when compared to that after the introduction of the LP in the short run. □

When we compare welfare after the introduction of the LP in the intermediate run(R_M) with that in the no leniency (R_{NL}), the result is unambiguous. This is because although the collective payoff from pessimists and optimists after the introduction of the LP is greater than that in the no leniency ($a_L + b_L + c_L + d_L > a_N + b_N + c_N + d_N$), there are lesser total number of bureaucrats now in the intermediate run. So, $R_M > R_{NL}$ is the case if the scale effect is overcome by the income from the two types of bureaucrats.

Comparing welfare after the introduction of the LP in the long run and that in the intermediate run gives the following result

Proposition 3.5 *Welfare after the introduction of the LP in the long run is greater than that in the intermediate run, that is,* $R_L > R_M$.

Proof The expected income of both types of bureaucrats is greater in the long run with the wage rise, ($\triangle w > 0$). Thus there are more total number of bureaucrats after the introduction of the LP in the long run than there were in the intermediate run. Hence the welfare goes up in the long run compared to that in the intermediate run. □

So far, it has been assumed that the sufficiency condition given by equation (27) holds true. It is interesting to look at the welfare comparisons when it is not the case, that is, when it is reversed. Then we can see that the Leniency Programme is bad in the short

run than it was in the no leniency. And in the long run, the welfare could be greater or lesser than it was in the no leniency based on the scale effect of the bureaucrats.

If the sufficiency condition given by (27) is violated, then $b_L + c_L + d_L < b_N + c_N + d_N$. Comparing the welfare in the no leniency and that after the introduction of the LP in the short run gives

$$\begin{aligned} R_S - R_{NL} & \\ &= \frac{K}{2}.H(w + (b - \alpha F_B)(1 - \Phi(v_b))) \\ &\{a_L + b + L + c_L + d_L - (a_N + b_N + c_N + d_N)\} \end{aligned} \tag{39}$$

If $b_L + c_L + d_L < a_N + b_N + c_N + d_N - a_L$(if the payoff from the optimistic bureaucrats meeting all types of criminals of all valuations in the Leniency Programme is very less compared to that in the no leniency and this negative payoff dominates the positive difference in payoffs from the pessimistic bureaucrats after the introduction of the LP compared to that in the no leniency), then the welfare after the introduction of the LP in the short run is worse compared to that in the no leniency.

It is interesting to see if the welfare goes up in the long run (R_L). If that is the case, it is good to continue with the policy without getting disappointed with the initial decrease in welfare. However, if it is the case that it is worser in the long run, then it is best to not introduce the policy.

Comparing the welfare after the introduction of the LP in the long run and the Leniency Programme short run (reusing (34)) gives

$$\begin{aligned} R_L - R_S = & \\ &\frac{K}{2}.\{H(w + (b - \alpha F_B)(1 - \Phi(v_b))) \\ &\{\frac{w - \triangle w}{w + \triangle w}(b_L + c_L + d_L) - a_L\} \\ &+ H(w + \triangle w\{a_L - (b_L + c_L + d_L)\}\} \end{aligned} \tag{40}$$

Under the assumption that $a_L > b_L + c_L + d_L$, we get that $R_L < R_S$.
If $\frac{w - \triangle w}{w + \triangle w}(b_L + c_L + d_L) > a_L$, then we have that welfare after the introduction of the LP in the long run is higher than that in the short run, that is, $R_L > R_S$.
The number of optimists can be lower or higher after the introduction of the LP in the long run than that in the short run. The number of pessimists is lower after the

introduction of the LP in the long run compared to that in the short run. If the number of both types of bureaucrats are lower in the long run of the LP than that in the short run, then it is the case that welfare after the introduction of the LP in the long run is lower than that in the short run ($R_L < R_S$). If on the other hand however, there are less total number of bureaucrats but more number of optimists after the introduction of the LP in the long run than that in the short run, there is a possibility that if the payoff from these optimists overcomes the scale effect coming from the pessimists, then the welfare after the introduction of the LP in the long run might be better than that in the short run.

Reusing the equation (36) to compare the welfare after the introduction of the LP in the long run and that in the no leniency.

$$\begin{aligned} R_L - R_{NL} = & \\ & \frac{K}{2}.\{(2H(w + (b - \alpha F_B)(1 - \Phi(v_b))) \\ & \{(b_L + c_L + d_L)\frac{w}{w + \triangle w} - (b_N + c_N + d_N)\} \\ & + H(w + \triangle w)\{a_L - (b_L + c_L + d_L)\}\} \end{aligned} \tag{41}$$

With the violation of sufficiency condition, we have that welfare after the introduction of the LP in the long run is worse than that in the no leniency ($R_L < R_{NL}$)

The calculations and comparisons with respect to welfare after the introduction of the LP in the intermediate run, R_M still give the same results. There is a dip in the welfare from the Leniency Programme short run to intermediate and then there is a rise from intermediate run to the long run.

To summarise the results of our analysis, when we compare the No Leniency regime and the Leniency Programme in the short run, we find a rise in the welfare. The short run is when the size of the bureaucracy is kept unchanged. However after certain time is allowed to pass after the introduction of LP, we observe a change in the size and composition of the bureaucrats. This is because a proportion of the bureaucrats, in particular those who are less inclined to be corrupt leave the agency as they experience a loss in their bribe income. Those bureaucrats who are more inclined to be corrupt do not experience a huge loss and they are more likely to stay behind in the agency. This differential effect in the size and composition of the bureaucrats in the agency leads to a systematic adverse effect and this stage is what we call the intermediate run. As a result

of this adverse effect the welfare after the introduction of the LP is worse than in the no leniency programme. However, because of the decrease in the number of bureaucrats the agency will have excess money and they can announce a wage raise in the long run. We show that welfare after the introduction of the LP in the long run could be better than in the no leniency.

It is possible that even in the intermediate run the Leniency Programme might be working when the scale effect of bureaucrats is overcome by the income from two types of bureaucrats (less likely and more likely to be corrupt). However, it is also quite possible that the reverse will be true in which case the outcome in the intermediate run is lower than in the no leniency. So evaluation of LP at that stage will give a pessimistic view of the LP. Here, it is important to consider that if the agency were to anticipate that the Leniency Programme without a corresponding wage change may have the kind of adverse effect that we found in the intermediate run.

These Leniency programmes by themselves might be effective but actually what policy makers need to keep in mind is that the programme of Leniency combined with wage increase might give good effects. Instead of just introducing LP , we propose that the policy makers need to think creatively about how combination of policies which are feasible within the budget can give a much better outcome. The agency doesn't have to wait for bureaucrats to leave. It is possible that combining LPs and other rewarding schemes which are budget feasible can give rise to better outcomes. Simply changing the wage is one tool but it may not be the best tool at the disposal of the agency. We will postpone this discussion until the conclusion section.

4 Conclusion

Since the last couple of decades, we have seen an increase in the detection and prosecution of cartels and organised crime networks by law enforcement agencies in the light of the Leniency Programme. The law enforcement agencies implementing these Leniency Programmes do it with the help of bureaucrats. A proportion of the bureaucrats who are responsible for monitoring and preventing crime turn out to be corruptible. They engage in bribery (corruption) and not report a violation of law and let criminals have the possibility of committing future crimes. Our paper analyses and evaluates the Leniency Programme in the presence of corruptible bureaucrats. Bribe forms a major source

of income for this section of the bureaucrats. In the immediate short run after the introduction of the Leniency Programme, we find that social welfare is higher than without the Leniency Programme, when the supply of bureaucrats is still fixed. But in the intermediate run when enough time for adjustment to LP is given, we find that LP affects the source of income of the bureaucrats differentially. This is to say that those bureaucrats who are less inclined to be corrupt experience a greater loss in their source of income earned through corruption. These type of bureaucrats are more likely to exit the bureaucracy leading to a systematic adverse effect. This leads to a change in the size and composition of bureaucrats thereby creating a low welfare situation than in the no leniency programme. Our analysis contributes at this junction to warn policy makers of potentially withdrawing a LP without waiting for the adjustment in the supply of bureaucrats to happen. We get a situation where the interaction of self-reporting criminals with bribe taking bureaucrats increases thereby leading to increased welfare in the long term. Thus we point out that while evaluating the merits of LPs, the time horizon is crucial.

In our analysis, the increase in wage was rewarding both optimistic and pessimistic bureaucrats equally. That is, it is rewarding the bureaucrats who are more inclined to continue with corruption and those who are not in the same way. For LP to have maximal effect what we need is a differential rewarding scheme that rewards the two types differently. For example, one could have think of a system of bonus payment for a bureaucrat who has no criminal charges and the bureaucrat with charges doesn't get the bonus. We propose to policy makers that combining LP along with other programmes can be more effective. There are other programmes than what we looked at in this the chapter that we think can achieve this. But we postpone a complete analysis of these programmes for future research.

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