‘Leniency’ as a Strategy for Controlling Corruption in a Bureaucracy*

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Abstract

The paper attempts to answer a very important policy question: whether ‘punishment for corruption’ coupled with ‘leniency for the whistle-blower’ is efficient in controlling collusion in a bureaucracy where an official enjoys monopoly power of distributing a public service among the deserving or qualified applicants. The results are sensitive to penalty threshold constructed for different types of bribery and it is interesting to note that the mere announcement of leniency may not be sufficient in eliminating collusion. The success of the policy depends on the combination of enforcement parameters. The paper finds out the combination of enforcement parameters that constructs a certain penalty range which eradicates the incidence of collusion from a bureaucracy and also analyses the effect of leniency on the welfare of the economy.

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1. Introduction

Corruption has been identified as the largest obstacle to social and economic development (‘Clean Business is Good Business’ (2008)). In most of the developing nations corruption is entrenched and is thought to generate negative externality to the society by violation of law. The existing literature on corruption discusses various potential anticorruption strategies to control corruption. The strategies, on one hand, include introduction of competition among officials in a corrupt bureaucracy (Becker and Stigler (1974), Rose Ackerman (1978), Shleifer and Vishny (1993)); and on the other, introduction of punishment for erring officials (Becker and Stigler (1974)). Since corruption distorts the legal framework and leads to negative externalities most nations criminalize the exchange of bribes. The bribe associated with an illegal transaction can be of two different types: extortion and collusion. In provision of public services, extortion takes place when a corrupt official charges bribe from a deserving applicant. Collusion on the other hand is a side contract between an undeserving applicant and a corrupt official in return for the service. Collusion is considered more harmful of the two on two different counts. First, it creates a negative externality through the misallocation of resources which is harmful to the society due and second, even as it is harmful to the society, it goes mostly unreported to the higher authority since on successful conviction both the parties will face punishment and hence neither involved in the crime has any incentive to reveal information about it. The leniency policy which offers immunity to the bribe-giver from the burden of punishment for revealing the secret information is often thought as an antidote to the collusion problem. This paper discusses the effectiveness of leniency for collusion as an anti-corruption strategy in an economy with persistent corruption where both the collusion and extortion are present. In particular, we ask, as leniency is announced, do all colluding agents respond to the
incentive? Is the announcement of leniency policy sufficient to eliminate the occurrence of collusion in an economy?

The most commonly discussed case of leniency arises in the literature on Industrial Organization theory where the leniency policy is implemented by antitrust authorities to break collusion or price fixing cartels that limit competition among firms. The policy provides immunity to the ‘whistle blowing’ firm in the form of reducing sanctions when a firm voluntarily confesses the illegal behavior and self-reports to authorities (Park (2014), Luz and Spagnolo (2016), Choi and Gerlach (2012), Lefouili and Roux (2012) etc.). The leniency alleviates the cost of ‘whistle blowing’. In the present paper, however, leniency appears as a potential anti-corruption strategy in a bureaucracy for breaking the bribe-exchange that mars the equity and efficiency of public service delivery. The few papers like Buccirossi and Spagnolo (2006), Basu, Basu and Cordella (2014), Abbink and Wu (2017), Abbink, Dasgupta, Gangadharan and Jain (2014) that exist in this literature do not discuss about extortion and collusion together. Buccirossi and Spagnolo (2006) deal with entrepreneurs with investment opportunity yielding a net present value which is realized if bureaucrats perform a certain illegal action. In this case corruption is defined by collusion where the bureaucrat needs to perform the illegal action and the entrepreneur needs to pay the bribe. The authors then show that bureaucrat’s lack of commitment in this type of one-shot illegal interaction may jeopardize the deal and therefore reduce the scope of bribery. The leniency policy, however, can alleviate the commitment problem and counter-intuitively may increase the scope of collusive-bribery in the economy. Abbink and Wu (2017) perform an experimental analysis of collusion where both the client and the corrupt official would be rewarded on self-reporting. Results show that considering a perfect judicial system collusive bribery is most effectively deterred when both parties whistle-blow. Basu,
Basu and Cordella (2014) discusses leniency for the entrepreneurs as an incentive to whistle-blow in the case of extortion. The authors assume there is a cost of whistle blowing similar to the industrial organization literature mentioned above that influences the probability of successful detection and the results derived in the paper show that multiple bribery equilibrium may exist where successful elimination of extortion bribes requires a low cost of whistle blowing and a sufficiently high probability of detection of the bribery.

The present paper starts with a theoretical model on corruption where some firms with potential revenue $r_i$ following a distribution with a pdf $g(r_i)dr_i$ apply for a production license. The firms attain eligibility for the license by investing in a clean technology. The license is administered in a monopoly bureaucracy with multiple non-competing officials who can be honest or dishonest. An honest official grants a license only to an eligible firm whereas a dishonest official will grant a license to any firm in exchange for a bribe. Thus in this context, extortion takes place when a dishonest official demands a bribe from an eligible firm and collusion occurs through a bribe exchange between a dishonest official and an ineligible firm. As punishment is introduced for corruption the paper differs in its scope from the literature above on different accounts. Unlike the literature this paper considers both extortion and collusion together. We start with asymmetric punishment in case of extortion similar to Basu, Basu and Cordella (2014) but unlike them, do not consider a cost of whistle-blowing in this paper. In case of collusion in the pre-leniency regime, both the bribe payer and the bribe taker are equally punished on successful conviction. The difference with Buccirossi and Spagnolo (2006) is clearly observed as leniency is introduced. Firstly, although similar to Buccirossi and Spagnolo (2006) under leniency for collusive bribery the punishment of the firm is relaxed partially but this paper assumes away the commitment problem and avoids the
channel used in their paper through which leniency raises the level corruption in an economy\(^1\). Secondly unlike Buccirossi and Spagnolo (2006) who arrive at conditions where leniency increases the incidence of collusion for a given penalty, the present paper goes on to show the construction of a penalty range which successfully eliminates collusion. At the same time, all colluding applicants do not respond to whistle-blowing. Taking into account the applicants who in fact whistle-blow, the paper also argues that an optimal combination of enforcement parameters viz. probability of successful conviction and amount of penalty is necessary to obtain the penalty range that successfully deters collusion. Any other combination of the parameters fails to construct the collusion eliminating range of penalty. Extortion however continues to exist. Following the analysis of leniency the welfare effects of extortion and collusion are analyzed across the regimes with and without leniency. An ineligible firm which does not invest in clean technology and obtains the license through collusion creates a negative externality of amount \(r_i + lc\) where \(i > 0\) as it produces. Extortion on the other hand, generates no such negative externality. Results show that although it seems that a successful leniency policy is welfare improving since it eliminates the source of negative externality, it may not be so once we consider the extensive margin of firms. Leniency may not be unambiguously welfare improving.

The plan of the paper is as follows. Section 2 and 3 discusses the model and derives the results and section 4 focuses on the impact of leniency on the welfare of the economy. The section following concludes.

\(^1\)In fact, Tirole (1992) argues that the commitment problem does not exist in case of the most commonly observed form of corruption in countries with persistent corruption which is the petty corruption. Most of these countries do not practice leniency either. For example, in India the ‘Prevention of Corruption (Amendment) Bill’, 2018 introduces equal punishment for both the bribe giver and the bribe taker.
2. The model

There are \( n \) firms who are involved in a production process. However, a firm needs to obtain a license to continue the production process. Licenses are administered through a monopoly bureaucracy consisting of several officials, a fraction \( h \) of which are honest (\( o_h \)) and (1-\( h \)) fraction are dishonest (\( o_{dh} \)). The extensive form game played between the firms and bureaucracy consist of the following stages and is represented in Figure 1.

**Stage 1:** A firm \( i \) denoted as \( F_i \) has three options. It chooses to invest in clean energy technology in order to reduce pollution and apply for a license (\( I_a \)) or not-to-invest but apply (\( NI_a \)) or not-to-invest and not apply (\( NI_{na} \)). The investment in clean technology eliminates a negative externality like pollution that is generated as a by-product of the production process. The investment cost is \( c \). A firm-\( i \) undertakes this investment only if its revenue \( r_i \) is not less than the cost, that is, \( r_i \geq c \). We assume that \( r_i \) follows a distribution \( g(r_i) \) over the interval \( r_i \in [0, \infty) \). The negative externality generated by a firm is constructed following Drugov (2010) which imposes a cost to the society and it is of the form \( r_i + lc \), where \( l > 0 \).

**Stage 2:** The application for the license is submitted to a bureaucracy consisting of several officials. A fraction \( h \) of the officials are honest and (1-\( h \)) fraction is dishonest. So probability of the application being reviewed by an honest official (denoted as \( o_h \)) is \( h \) and (1-\( h \)) is the probability that a dishonest official (denoted as \( o_{dh} \)) reviews the application.

If a firm has chosen \( I_a \) and an honest official reviews the application then firm receives the license and the game ends. The payoffs of the firm and the official are \( \pi_i(I_a) = r_i - c \) and \( \pi_{oh}(I_a) = 0 \). If a firm has chosen \( NI_a \) and an honest official reviews the application then the firm is given a chance to invest. If the firm chooses to invest, which it does if \( r_i \geq c \), then his payoff is \( \pi_i(NI_a, I_a) = \delta(r_i-c) \). If \( r_i < c \) then the firm chooses \( NI_{na} \) so its payoff is \( \pi_i(NI_a, NI_{na}) = 0 \). The honest official’s payoff remains as \( \pi_{oh} = 0 \). If a dishonest official reviews the application then the game proceeds to stage 3.
Figure 1: The Game Tree
**Stage 3 (Bribery Stage):** The dishonest official may not seek a bribe (NB) or may seek a bribe (B). This choice depends upon the penalty on corruption. If the dishonest official chooses NB then the game ends and payoffs are identical to that in stage 2 of the game, that is:

\[ \pi_i(I_a, NB) = r_i - c \]

\[ \pi_{o_b}(I_a, NB) = 0 \]

\[ \pi_i(NI_a, I_a) = \delta(r_i - c) \text{ if } r_i \geq c \]

\[ \pi_i((NI_a, NI_{ma}), NB) = 0 \text{ if } r_i < c \]

\[ \pi_{o_b}((), NB) = 0 \]. If the dishonest official chooses B then the bribe offer is the Nash Bargaining solution and the game proceeds to Stage 4.

**Stage 4 (Accept or Reject Bribe stage):** A firm can either reject or accept the bribe offer.

1) Suppose \( F \) has chosen \( I_a \) is stage 1.

Then he can reject and self-report (\( R' \)) or accept and self-report (\( A' \)). Since the firm has chosen to invest in the clean technology and has all the evidence of the investment, therefore, reporting bribery is costless. We assume that the legal system is imperfect in the sense that even with full evidence of the investment, the dishonest official may be convicted (C) with probability \( \lambda \) or may not be convicted (NC) with probability \( 1 - \lambda \).

If the firm chooses \( R' \) and the dishonest official is convicted then he is penalized with a fine \( F \) and the firm receives the license. Hence, the payoffs given that the official is convicted are \( \pi_i((I_a, R'), B; C) = r_i - c \) and \( \pi_{o_b}((I_a, R'), B; C) = -F \). If the dishonest official is not convicted then the firm does not get the license and hence loses the investment cost. So the payoffs given NC are \( \pi_i((I_a, R'), B; NC) = -c \) and \( \pi_{o_b}((I_a, R'), B; NC) = 0 \). So the expected payoffs from choosing \( R' \) which forms the disagreement payoffs for the Nash Bargaining solution are given in equation (1a).

\[
E\pi_i((I_a, R'), B) = \lambda r_i - c \\
E\pi_{o_b}((I_a, R'), B) = -\lambda F
\]  

\[(1a)\]
If the firm chooses \( A' \) then the firm pays the bribe and self-reports. If the dishonest official is convicted then he is penalized with a fine \( F \) and the bribe is refunded to the firm who receives the license. So the payoffs are 
\[
\pi_i((I_a, A'), B; C) = r_i - c \quad \text{and} \quad \pi_{o_d}((I_a, A'), B; C) = -F.
\]
If the dishonest official is not convicted then the firm receives the license but loses the bribe amount to the official. So the payoffs are 
\[
\pi_i((I_a, R'), B; NC) = r_i - c - b \quad \text{and} \quad \pi_{o_d}((I_a, A'), B; NC) = b.
\]
Hence, the expected payoffs from choosing \( A' \) which forms the agreement payoffs for the Nash Bargaining solution are
\[
\begin{align*}
E\pi_i((I_a, A'), B) &= r_i - c - (1 - \lambda)b \\
E\pi_{o_d}((I_a, A'), B) &= (1 - \lambda)b - \lambda F
\end{align*}
\]

(2) **Suppose \( F_i \) has chosen \( NI_a \) is stage 1.**

In this case the firm \( F_i \) and the dishonest officer \( o_{dh} \) collude in the act of corruption because the firm has not invested in the clean technology and yet applied for the license and the dishonest officer is seeking a bribe in return for the license. Hence, there is no self-reporting by the firm and he chooses either to reject \( (R) \) or accept \( (A) \) the Nash Bargaining bribe offer. If he rejects, then the payoffs, which constitute the disagreement payoffs, are as follows.
\[
\begin{align*}
\pi_i((NI_a, R), B) &= 0 \\
\pi_{o_d}((NI_a, R), B) &= 0
\end{align*}
\]

If \( F_i \) accepts the bribe offer then there is a possibility that corruption is detected and convicted with probability \( \gamma \) and not convicted with probability \( (1 - \gamma) \). The probability of conviction in the case of collusion is less than that when the firm chooses \( I_a \) because in that case the firm has the incentive to self-report. So we assume that \( \gamma < \lambda \). If conviction is successful then the payoffs are 
\[
\pi_i((NI_a, A), B; C) = -b - F \quad \text{and} \quad \pi_{o_d}((NI_a, A), B; C) = b - F.
\]
Note that as opposed to the scenario where \( F_i \) chooses \( I_a \) and \( A' \), the bribe was collected from the dishonest officer and returned back to the firm. This not the case when \( F_i \) chooses \( NI_a \) and \( A \). The firm loses the bribe due to the collusive nature of corruption. If conviction is not successful then the firm receives the license and the officer retains the bribe. Hence, the payoffs are
\[ \pi_i((NI_a, A), B; NC) = r_i - b \quad \text{and} \quad \pi_{o_a}((NI_a, A), B; NC) = b. \] So the expected payoffs from accepting the bribe are given in equation (2b).

\[
\begin{align*}
E\pi_i((NI_a, A), B) &= (1 - \gamma)r_i - \gamma F - b \\
E\pi_{o_a}((NI_a, A), B) &= b - \gamma F
\end{align*}
\]

These constitute the agreement payoffs for Nash Bargaining.

2 Equilibrium Analysis

We solve for the subgame perfect equilibrium using the method of backward induction. To do this we first analyze the subgame where \( F_i \) chooses \( I_a \) and then analyse the subgame where \( F_i \) chooses \( NI_a \).

2.1 Analysis of the subgame where \( F_i \) chooses \( I_a \)

Stage 4 analysis where \( F_i \) chooses \( A' \) or \( R' \)

From equations (1a) and 1(b) we see that the firm chooses \( A' \) if the following individual rationality (IR) and incentive compatibility (IC) conditions are satisfied.

\[
\begin{align*}
E\pi_i((I_a, A'), B) &\geq 0 \Rightarrow r_i - c - (1 - \lambda)b \geq 0 \\
E\pi_i((I_a, A'), B) &\geq E\pi_i((I_a, R'), B) \Rightarrow r_i \geq b
\end{align*}
\]

Let \( b_e \) be the Nash Bargaining solution. We call this *extortion bribe* because this is bribery when the firm has invested in clean energy and should have received the license. It is akin to Framing in Polinsky and Shavell (2001). Then using equations (1a) and (1b) we get the following Nash Bargaining solution.

\[ b_e = \arg \max_b \left\{ (E\pi_i((I_a, A'), B) - E\pi_i((I_a, R'), B)) - (E\pi_{o_a}((I_a, A'), B) - E\pi_{o_a}((I_a, R'), B)) \right\} \]

Using the expressions of the agreement and disagreement payoffs from equations (1a) and (1b) we get the solution as

\[ b_e = \frac{r_i}{2} \] (2.1.1)
Clearly, \( b_e = \frac{r_i}{2} \) satisfies the IC condition. The IR condition is satisfied if

\[
E\pi_i((I_a, A'),B) = r_i - c - (1 - \lambda)b_e = \left(\frac{1 + \lambda}{2}\right)r_i - c \geq 0 ,
\]

which implies the fulfillment of the following condition.

\[
r_i \geq \frac{2c}{1 + \lambda} \equiv \overline{r} \tag{2.1.2}
\]

**Stage 3 analysis where \( o_{th} \) chooses \( B \) or \( NB \)**

The dishonest officer chooses bribery if \( E\pi_{o_{th}}((I_a, A'), B) \geq E\pi_{o_{th}}((I_a, A'), NB) \).

Using \( b_e = \frac{r_i}{2} \) we get this condition as:

\[
\left(\frac{1 - \lambda}{2\lambda}\right)r_i \equiv F_e \geq F \tag{2.1.3}
\]

Conditions (2.1.2) and (2.1.3) together forms the bribery condition. This and its implications are stated in Lemma 1.

**Lemma 1.**

(i) The bribery conditions are \( r_i \geq \overline{r} \) where \( \overline{r} \equiv \frac{2c}{1 + \lambda} \) and \( F \leq F_e \) where \( F_e \equiv \left(\frac{1 - \lambda}{2\lambda}\right)r_i \).

(ii) The presence of extortion bribery reduces the extensive margin for clean energy investment and this margin is increasing in the probability of successful conviction.

(iii) An increase in the probability of successful conviction reduces the threshold penalty below which extortion bribery exists, thereby, reducing possibility of extortion.

**Proof of Lemma 1 and Implications.**

(i) This follows from conditions (1e) and (1f).

(ii) \( \overline{r} \equiv \frac{2c}{1 + \lambda} > c \) because \( \lambda \in [0,1] \). Diagrammatically this can be shown as follows.
Figure 2: Ranking of \( c \) and \( \overline{F} \)

This means firms with \( c \leq r_i < \overline{F} \) may not choose to invest in clean technology when the extortion bribery conditions are satisfied though their returns exceed the cost of such investment, that is \( r_i > c \). \( \overline{F} \) is decreasing in \( \lambda \) which means that \( \overline{F} \) approaches \( c \) as \( \lambda \) increases thus increasing the extensive margin.

(iii) This is evident from the expression \( F_c = \left( \frac{1 - \lambda}{2\lambda} \right) r_i \). It means that an increase in the probability of successful conviction reduces the threshold penalty below which extortion bribery holds. It implies that as the legal system becomes perfect (\( \lambda \to 1 \)) a very low penalty can deter extortion corruption.

Stage 2 analysis

In this stage the application is reviewed either by an honest official \( o_h \) with probability \( h \) or by a dishonest official \( o_{dh} \) with probability \( (1 - h) \). If \( F > F_c \) then there is no extortion corruption irrespective of the type of officer and thus the payoffs are \( \pi_i (I_a : F > F_c) = r_i - c \) and \( \pi_j (I_a : F > F_c) = 0; j = h, dh \). If \( F \leq F_c \) then there is extortion if the application is reviewed by a dishonest official. In this case the expected payoffs are as follows.

\[
E\pi_i(I_a,B : F \leq F_c) = h\pi_i(I_a) + (1-h)E\pi_i((I_a,A^*),B) = \frac{r_i}{2} \left[ (1 + \lambda) + h(1 - \lambda) \right] - c
\]

\[
E\pi_{o_{dh}}(I_a,B : F \leq F_c) = (1 - \lambda)\left( \frac{r_i}{2} \right) - \lambda F
\]

2.1.4

\[\pi_{o_{dh}} = 0\]

Stage 1 analysis

From the above analysis we get the stage 1 expected profit of \( F_i \), given \( r_i \geq \overline{F} \), which is as follows.
\[
E\pi_i(I_a) = \begin{cases} 
E\pi_i(I_a, B) = h\pi_i(I_a) + (1-h)E\pi_i((I_a, A^*), B) = \frac{r_i}{2}[(1+\lambda) + h(1-\lambda)] - c, \text{if } F \leq F_c \\
E\pi_i(I_a, NB) = h\pi_i(I_a) + (1-h)E\pi_i((I_a, A^*), NB) = r_i - c, \text{if } F > F_c 
\end{cases}
\]

A firm \( F_i \) with \( c < r_i < \bar{r} \) may choose \( I_a \) if and only if \( F > F_c \) because of the following reason. The condition \( r_i < \bar{r} \) implies that its stage 4 expected payoff from choosing \( A^* \) is negative \( E\pi_i((I_a, A^*), B) = \frac{1+\lambda}{2}r_i - c < 0 \).

Now \( E\pi_i((I_a, A^*), B) - E\pi_i((I_a, R^*), B) = \frac{1-\lambda}{2}r_i > 0 \) which implies \( E\pi_i((I_a, R^*), B) < 0 \). So a firm \( F_i \), with \( c < r_i < \bar{r} \), will never choose \( I_a \) if the penalty for corruption allows extortion bribery even though \( r_i > c \).

### 2.2 Analysis of the subgame where \( F_i \) chooses \( NI_a \)

#### Stage 4 analysis where \( F_i \) chooses \( A \) or \( R \)

From equations 2(a) and 2(b) we see that the firm chooses \( A \) if \( E\pi_i((NI_a, A), B) \geq E\pi_i((NI_a, R), B) \) which implies \( (1-\gamma)r_i - \gamma F - b \geq 0 \). Let \( b_c \) be the collusive bribe, which is as follows.

\[
b_c = \arg\max_b \left\{ E\pi_i((NI_a, A), B) - E\pi_i((NI_a, R), B) \right\} = \left\{ E\pi_o((NI_a, A), B) - E\pi_o((NI_a, R), B) \right\} \]

Then using the expressions from equations 2(a) and 2(b) we get,

\[
b_c = \frac{(1-\gamma)r_i}{2} \quad (2.2.1)
\]

This bribe must satisfy the condition \( (1-\gamma)r_i - \gamma F - b \geq 0 \) for \( F_i \) to choose \( A \). Using equation (2.2.1) this condition can be written as,

\[
\left( \frac{1-\gamma}{2\gamma} \right)r_i = F_c \geq F \quad (2.2.2)
\]

This condition implies that collusive bribery exists when the penalty does not exceed the threshold level \( F_c \).
Stage 3 analysis where $o_{dh}$ chooses $B$ or $NB$

In this stage the dishonest officer $o_{dh}$ chooses $B$ given that it is accepted by the firm if $E\pi_{o_{dh}}((NI_a, A), B) \geq E\pi_{o_{dh}}((NI_a, R), B)$ which means $b_c - \gamma F \geq 0$. Using the expression for $b_c$ as given in equation (2.2.1) this condition becomes $\left(\frac{1-\gamma}{2\gamma}\right) r_i \equiv F_c \geq F$ which is identical to condition given in (2.2.2). This implies that if $F \leq F_c$ the dishonest officer will choose bribery and the firm will accept it.

Stage 2 analysis

In this stage the application is reviewed either by an honest official $o_h$ with probability $h$ or by a dishonest official $o_{dh}$ with probability $(1-h)$. We need to consider two types of firms; one type of firm with $r_i - c > 0$ and a second type of firm with $r_i - c \leq 0$. Henceforth, we will refer the firms with $r_i - c > 0$ as qualified firms and their payoffs will be denoted as $\pi_i^q$. The firms with $r_i - c \leq 0$ will be referred to as unqualified firms and their payoffs will be denoted as $\pi_i^{uq}$. This is for notational simplicity.

There is no collusive corruption when $F > F_c$. In this case the qualified firms with $r_i - c > 0$ who initially do not invest in clean energy but applies, will subsequently invest and apply for the license, which it will obtain. This is because $\delta(r_i - c) > 0$. So the qualified firms will choose $(NI_a, I_a)$. However, the unqualified firms will not subsequently invest because for them $\delta(r_i - c) < 0$ and hence, their choice will be $(NI_a, NI_{na})$. Thus the payoffs of the two types of firms when there is no collusive corruption are given in equation (2.2.3)

$$\pi_i^q(NI_a) = \pi_i^q(NI_a, I_a) = \delta(r_i - c)$$
$$E\pi_i^{uq}(NI_a) = \pi_i^{uq}(NI_a, NI_{na}) = 0$$

(2.2.3)

There is collusive corruption when $F \leq F_c$. An honest official reviews the application with probability $h$ and a dishonest official reviews the same with probability $(1-h)$. A qualified firm’s payoff when reviewed by an honest official is
\( \pi^i_a(NI_a, I_a) = \delta(r_i - c) \). An unqualified firm when reviewed by an honest official will subsequently choose not to invest and not to apply because its application will be rejected and it has no incentive to subsequently invest. So his payoff will be \( \pi^m_a(NI_a, NI_{un}) = 0 \). The expected payoff of a qualified or an unqualified firm when reviewed by a dishonest official, as given in equation (2b) becomes

\[
E\pi^i_a((NI_a, A), B) = \left( \frac{1 - \gamma}{2} \right) r_i - \gamma F \text{ where } k = q, uq.
\]

Thus the expected payoffs of a qualified and an unqualified firm from choosing not-to-invest and apply \( (NI_a) \) when \( F \leq F_c \) and there is collusive corruption are as follows.

\[
E\pi^i_a(NI_a) = h\pi^i_a(NI_a, I_a) + E\pi^i_a((NI_a, A), B) = h\delta(r_i - c) + (1 - h) \left( \frac{1 - \gamma}{2} \right) r_i - \gamma F \quad (2.2.4)
\]

\[
E\pi^m_a(NI_a) = h\pi^m_a(NI_a, NI_{un}) + E\pi^m_a((NI_a, A), B) = (1 - h) \left( \frac{1 - \gamma}{2} \right) r_i - \gamma F
\]

**Stage 1 analysis**

From the stage 2 analysis using equations (2.2.3) and (2.2.4) we can get the stage 1 expected profit of the firms as follows.

\[
E\pi^i_a(NI_a) = \begin{cases} 
\pi^i_a(NI_a, I_a), & \text{if } F > F_c \\
h\pi^i_a(NI_a, I_a) + (1 - h)E\pi^i_a((NI_a, A), B), & \text{if } F \leq F_c
\end{cases}
\quad (2.2.5a)
\]

\[
E\pi^m_a(NI_a) = \begin{cases} 
\pi^m_a(NI_a), & \text{if } F > F_c \\
h\pi^m_a(NI_a, NI_{un}) + (1 - h)E\pi^m_a((NI_a, A), B), & \text{if } F \leq F_c
\end{cases}
\quad (2.2.6a)
\]

Using the expressions from the equations (2.2.3) and (2.2.4), the above equations become

\[
E\pi^i_a(NI_a) = \begin{cases} 
\delta(r_i - c), & \text{if } F > F_c \\
h\delta(r_i - c) + (1 - h) \left( \frac{1 - \gamma}{2} \right) r_i - \gamma F, & \text{if } F \leq F_c
\end{cases}
\quad (2.2.5b)
\]

\[
E\pi^m_a(NI_a) = \begin{cases} 
0, & \text{if } F > F_c \\
(1 - h) \left( \frac{1 - \gamma}{2} \right) r_i - \gamma F, & \text{if } F \leq F_c
\end{cases}
\quad (2.2.6b)
\]
Note that for \( F \leq F_e \), \( E\pi^t_x (NI_a) > E\pi^{w}y (NI_a) \) since in case of firms with \( r_i < c \), \( \delta(r_i - c) < 0 \). As firms with \( r_i < c \) meet a corrupt official, they behave exactly as firms with \( r_i > c \) who do not invest in stage 1 and meet a corrupt official in stage 2.

### 2.3. Subgame Perfect Equilibrium

The subgame perfect equilibrium analysis requires a comparison of the extortion and collusive bribes and also a comparison of the threshold levels of penalties above which extortion corruption or collusive corruptions are deterred. This result is summarized in Lemma 2.

**Lemma 2.**

(i) The extortion bribe is higher than the collusive bribe, that is, \( b_e > b_c \).

(ii) The threshold penalty above which collusive corruption is deterred is higher the threshold penalty above which extortion corruption is deterred, that is, \( F_c > F_e \).

**Proof of Lemma 2.**

(i) \( b_e - b_c = \frac{\gamma r_i}{2} > 0 \). (ii) \( F_c - F_e = \left( \frac{\lambda - \gamma}{2\lambda \gamma} \right) r_i > 0 \) because \( \lambda > \gamma \). Q.E.D.

The intuition is as follows. The use of asymmetric punishment for extortion is to ensure self-reporting by the extorted firms which takes place with certainty due to the absence of cost of self-reporting. The punishment for extortion entails not only penalty for the corrupt official alone but a compensation to the victim as well through the reversal of the bribe amount from the official to the firm. This generates a higher expected surplus resulting in a higher bribe compared to when a firm chooses not to invest but apply in stage 1 where there is no possibility of self-reporting. Part (ii) of Lemma 2, which is diagrammatically represented in Figure 3, implies that there is a lower tolerance level for extortion corruption compared to collusive corruption.

<table>
<thead>
<tr>
<th>( F_e )</th>
<th>( F_c )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extortion &amp; Collusive Corruption</td>
<td>Collusive Corruption</td>
</tr>
</tbody>
</table>
Figure 3: Penalty ranges for different types of corruption

We will use Figure 3 to determine the subgame perfect equilibrium for the different penalty levels. For convenience we will label them as follows.

(i) $F > F_c$ is the high penalty level where there is no form of corruption.

(ii) $F_e < F \leq F_c$ is the intermediate penalty level where there is only collusive corruption.

(iii) $F \leq F_e$ is the low penalty level where there are both forms of corruption.

2.4 Analysis of the Subgame Perfect Equilibrium when $F \in (F_e, F_c)$

Following figure 3, for a penalty $F \in (F_e, F_c)$ there is no existence of extortion. However there exists collusive bribery. The expected payoff functions are defined below. Since there is no extortion the expected payoff of a firm with $r_i > c$ that chooses to undertake investment in stage 1 becomes:

$$E\pi_i(I_a) = r_i - c$$

(2.4.1)

Since there is collusion, following equation (2.2.5b) the expected payoff of a firm with $r_i > c$ that chooses not to undertake investment in stage 1 is:

$$E\pi^u_i(NI_a) = h\delta(r_i - c) + (1 - h)\left[\frac{1 - \gamma}{\gamma}r_i - \gamma F\right]$$

(2.4.2)

Following equation (2.2.6b) the expected payoff of a firm with $r_i < c$ is:

$$E\pi^w_i(NI_a) = (1 - h)\left[\frac{1 - \gamma}{\gamma}r_i - \gamma F\right]$$

(2.4.3)

It clearly follows from equations (2.4.2) and (2.4.3) that $E\pi^w_i(NI_a)$ is completely dominated by $E\pi^u_i(NI_a)$ for all $r_i > 0$. Thus firms with $r_i < c$ will never apply since they do not have the incentive to undertake investment given the possibility of being reviewed by an honest official. Since the penalty range comprises only collusive bribery, we need to compare the expected payoffs of firms with $r_i > c$ who invest in stage 1 against the ones who do not. It is important to note that
\[ \frac{\partial E\pi^q_i(NI_a)}{\partial F} = -(1-h)\gamma < 0 \] whereas \( E\pi_i(I_a) \) is independent of \( F \). Since \( F < F_c \), comparing \( E\pi_i(I_a) \) and \( E\pi^q_i(NI_a) \) at \( F = F_c \) leads to the following outcomes:

**Case 1**

If at \( F = F_c \), \( E\pi^q_i(NI_a, F_c) > E\pi_i(I_a) \) then it follows that at \( F = F_c \), \( E\pi^q_i(NI_a) > E\pi_i(I_a) \) since \( E\pi^q_i(NI_a) \) is decreasing in \( F \) and hence attains its maximum at \( F = F_c \). The difference is expected payoffs at \( F = F_c \) is however:

\[ E\pi^q_i(NI_a, F_c) - E\pi_i(I_a) = -(r_i - c)(1 - \delta h) < 0 \]

Thus we need to compare \( E\pi^q_i(NI_a, F_c) \) and \( E\pi_i(I_a) \) which brings us to case 2.

**Case 2**

The difference is expected payoffs are given as:

\[ E\pi^q_i(NI_a, F_c) - E\pi_i(I_a) = (1 - h) \frac{r_i(\lambda - \gamma)}{2\lambda} - (r_i - c)(1 - \delta h) \] (2.4.4)

Since the RHS of equation (2.4.4) can be positive or negative we have two possible outcomes as follows:

**Case 2a**

From equation (2.4.4) if \( E\pi^q_i(NI_a, F_c) > E\pi_i(I_a) \) there exists a critical \( \overline{F} \) for which:

\[ E\pi^q_i(NI_a) > E\pi_i(I_a) \text{ for } F < \overline{F} \]

\[ E\pi^q_i(NI_a) < E\pi_i(I_a) \text{ for } F > \overline{F} \text{ such that at } \overline{F}, E\pi^q_i(NI_a) = E\pi_i(I_a) \].
Case 2a

From equation (2.4.4) if $E\pi_i(NI_a, F_c) < E\pi_i(I_a)$, $E\pi_i(NI_a)$ is totally dominated by $E\pi_i(I_a)$.

Case 2b

The analysis of this subgame perfect equilibrium can be summarized as:
(i) If \( E\pi^a_t(\text{NI}_x,F_c) > E\pi_i(I_a) \) then for \( F \in (F_c, \bar{F}) \), firms with \( r_i > c \) will not undertake investment in clean technology in stage 1 but will eventually do otherwise in stage 2 if it is reviewed by an honest official. However, there will be collusive bribery in stage 2 if reviewed by a dishonest official.

(ii) If \( E\pi^a_t(\text{NI}_x,F_c) > E\pi_i(I_a) \) then for \( F \in (\bar{F}, F_c) \) firms with \( r_i > c \) will undertake investment in clean technology in stage 1 and receives the license without extortion bribe.

(iii) If \( E\pi^a_t(\text{NI}_x,F_c) < E\pi_i(I_a) \) then for \( F \in (F_c, F_v) \) firms with \( r_i > c \) will undertake investment in clean technology in stage 1 and receive the license without extortion bribe.

2.5 Analysis of the Subgame Perfect Equilibrium when \( F \in (0, F_c) \)

Following figure 3, if a penalty \( F \in (0, F_c) \) there exists both extortion and collusive bribery. The behavior of firms with based on their revenue potential \( r_i \) are summarized as:

i) Firms with \( r_i > \bar{r} \) invest in stage 1. If they invest in stage 1 they are extorted in stage two if the reviewing official is dishonest. Otherwise, license is obtained without extortion. The expected payoff in this case is \( E\pi_i(I_a) = hr_i + (1 - h)(1 + \lambda) \frac{r_i}{2} - c \).

(ii) Firms with \( c < r_i < \bar{r} \) will never undertake investment in stage 1 and this directly follows from Lemma 1. These firms will invest in stage 2 if reviewing official is honest. Otherwise license is obtained through collusive bribery. The expected payoff is given by \( E\pi^q_i(\text{NI}_x) = h(\delta)(r_i - c) + (1 - h)[(1 - \gamma)\frac{r_i - \gamma F}{\gamma}] \).

(iii) Firms with \( r_i < c \) who never undertake investment but apply, obtain a license only if official is dishonest. The expected payoff is given by \( E\pi^{aq}_i(\text{NI}_x) = (1 - h)[(1 - \gamma)\frac{r_i - \gamma F}{\gamma}] \).
Following the analysis in 2.4, $E\pi^{\text{eq}}(NI_a)$ is completely dominated by $E\pi^q(I_a)$ for all $r_i > 0$. Thus firms with $r_i < c$ will never apply.

**Analysing bribery for $F \in (0, F_c)$**

For $F \in (0, F_c)$ there is both extortion and collusion. At $F = F_c$ the expected payoff of a firm with $r_i > c$ who do not invest in stage 1 is given by

$$E\pi^q(I_a, F_c) = h\delta(r_i - c) + (1 - h) \frac{r_i}{2\lambda} (\lambda - \gamma) \quad (2.4.5)$$

Firms with $c < r_i < \bar{r}$ will never undertake investment in stage 1. The expected payoff in that case remains same as (2.4.5).

Since there exists extortion, the expected payoff of a firm that undertakes investment in stage 1 is:

$$E\pi_i(I_a) = hr_i + (1 - h)(1 + \lambda) \frac{r_i}{2} - c \quad (2.4.6)$$

**Lemma 3**

*If $E\pi^q(I_a, F_c) < E\pi_i(I_a)$ there exists a critical $\hat{F}$ for which there exists collusion for $F < \hat{F}$ and extortion for $F > \hat{F}$.²*

**Proof of Lemma 3.**

The expected payoff functions are:

$$E\pi^q(I_a, F_c) = h\delta(r_i - c) + (1 - h) \frac{r_i}{2\lambda} (\lambda - \gamma) \quad (2.4.7)$$

$$E\pi_i(I_a) = hr_i + (1 - h)(1 + \lambda) \frac{r_i}{2} - c \quad (2.4.8)$$

Now we have $\frac{\partial E\pi^q(I_a)}{\partial F} = -(1 - h)\gamma < 0$ whereas $E\pi_i(I_a)$ is independent of $F$.

Thus for $F \in (0,F_c)$ there exists a critical $\hat{F}$ for which:

² Alternatively we can have at $F = F_c$, $E\pi^q(I_a) > E\pi_i(I_a)$ where firms do not undertake investment in stage 1 and collusion exists with probability $(1 - h)$. 

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\[ E\pi_i(I_\alpha) < E\pi_i(NI_\alpha) \text{ for } F < \hat{F} \]

\[ E\pi_i(I_\alpha) > E\pi_i(NI_\alpha) \text{ for } F > \hat{F} \text{ such that at } F = \hat{F}, E\pi_i(I_\alpha) = E\pi_i(NI_\alpha). \]

\[ E\pi_i^\theta(NI_\alpha), E\pi_i(I_\alpha) \]

![Figure 5: Extensive margin of extortion and collusion for \( F \in (0, F_\varepsilon) \)](image)

The subgame perfect equilibrium thus becomes:

(i) For \( F \in (0, \hat{F}) \) firms with \( r_i > c \) do not invest in stage 1. In stage two if reviewed by a dishonest official license is obtained through collusive bribery. Otherwise firms invest in stage 2 and receive license without bribery.

(ii) For \( \hat{F} < F < F_\varepsilon \) firms with \( r_i > c \) invest in stage 1. In stage two if reviewed by a dishonest official there will be extortion bribery. Otherwise license is obtained without bribery.

(iii) Firms with \( c < r_i < \bar{r} \) who never undertake investment in stage 1 behaves exactly as firms with \( r_i > c \) who do not invest in stage 1. They undertake investment in stage 2 if reviewed by a honest official. Otherwise license is obtained through collusive bribery.
3. Whistle-Blowing and Leniency

Among the two different types of bribery, collusive bribery is more harmful given the associated negative externality and at the same time it is also more difficult to detect given neither the colluding firm nor the dishonest official has any incentive to reveal information on the illegal transaction. To tackle this problem of information hiding, we introduce the concept of leniency in punishment where we provide an incentive to a firm that has obtained the license through collusion to whistle-blow on the collusive agreement and analyse whether it is an effective anti-corruption measure to deter collusion. The incentive works through a partial relaxation of the firm’s sanction on successful conviction while keeping the dishonest official’s sanction unchanged. The introduction of whistle-blowing and leniency does not affect the decisions of a firm that chooses $I_a$ and thus for extortion, penalty threshold and the bribe amount remains unaffected. The modified extensive form game under leniency is illustrated below.
Figure 6: The Game Tree under Leniency
If firms commit to whistle-blowing the probability of successful conviction increases from $\gamma$ to $\gamma_i$ but remains less than the probability of successful conviction of extortion i.e. $\gamma < \gamma_i < \lambda$. If the firm commits to whistle-blowing, on successful conviction the penalty on the firm is reduced to $\alpha F$ where $\alpha \in (0,1)$. With probability $(1-\gamma_i)$ the transaction goes undetected and the firm retains the license obtained through collusion. Under leniency, the dishonest official’s punishment remains same as before. We use superscript $l$ to denote leniency wherever applicable. Since the characteristics of a firm choosing $I_a$ remains unchanged with leniency, let us analyse the situation where the firm chooses $NI_a$.

**Suppose $F_i$ has chosen $NI_a$ in stage 1.**

In this case as before a firm applies for the license without investing in clean technology. If the reviewing official is dishonest and the firm accepts to pay the bribe license is obtained through collusion. If the firm rejects the bribe offer the disagreement payoffs of the firm and the official remain same as equation 2(a) which is zero. Now, if $F_i$ accepts the bribe offer, there is a possibility of whistle-blowing (WB) given the leniency regime. If the firm commits to whistle-blowing, on successful conviction the firm’s payoff becomes $\pi'_i((NI_a, A), B; C) = -b - \alpha F$ and the official’s payoff is $\pi'_{o_a}((NI_a, A), B; C) = b - F$ as before. If $F_i$ accepts the bribe offer but does not commit to whistle-blowing, the payoffs remain same as equation 2(b). In either case if the transaction is not successfully convicted the payoffs remain $\pi'_i((NI_a, A), B; NC) = r_i - b$ and $\pi'_{o_a}((NI_a, A), B; C) = b$ as before. Thus, the expected payoffs under whistle-blowing are given in equation 3a.

$$E\pi'_i((NI_a, A), B) = (1-\gamma_i)r_i - \alpha \gamma_i F - b$$

$$E\pi'_{o_a}((NI_a, A), B) = b - \gamma_i F$$

These constitute the agreement payoffs for Nash Bargaining under whistle-blowing.

**3. Equilibrium Analysis Under Whistle-Blowing**
As before we solve for the subgame perfect equilibrium using backward induction. To do this we first look at the subgame where $F_i$ chooses $NI_a$ under the possibility of whistle-blowing. In doing so we also look at the conditions under which $F_i$ commits to whistle-blowing. The analysis of the subgame where $F_i$ has chosen $I_a$ remains same as before.

3.1 Analysis of subgame where $F_i$ chooses $NI_a$ under WB.

Stage 4 analysis where $F_i$ chooses WB over NWB and then chooses A or R under WB.

Denoting the collusive bribe under whistle-blowing as $b^I_e$ if a firm commits to whistle-blowing the expected payoff is obtained from equation (3a) i.e. $E \pi_i((NI_a, A), B) = (1 - \gamma_i) r_i - \alpha \gamma_i F - b^I_e$. If the firm does not commit to whistle-blowing the expected payoff of the firm remains as that of the subgame in 2.2 i.e. $E \pi_i((NI_a, A), B) = (1 - \gamma) r_i - \gamma F - b_e$.

Note that under leniency although the penalty $F$ on a firm that selects $NI_a$ in stage 1 is partially reduced, it loses the revenue both with and without leniency and the collusive bribe paid is a sunk cost. Thus, the condition under (3b) implies if the loss in terms of revenue and bribe, with and without leniency is dominated by the expected penalty saved, the firm will choose WB over NWB.

For the purpose of the paper, let us assume that the condition under (3b) is satisfied. It follows from equations 3(a) and 2(a) that a firm which chooses WB under leniency, will choose A if $E \pi_i((NI_a, A), B) > E \pi_i((NI_a, R), B)$ which implies $(1 - \gamma_i) r_i - \alpha \gamma_i F - b_e \geq 0$. Let $b_e$ be the collusive bribe under leniency which is as follows.

$$b_e^I = \text{argmax}_b \{(E \pi_i((NI_a, A), B) - (E \pi_i((NI_a, R), B))\} \{(E \pi_o((NI_a, A), B) - (E \pi_o((NI_a, R), B))\}

Substituting for the expected payoffs we get:

$$b_e^I = \frac{(1 - \gamma_i) r_i + (1 - \alpha) \gamma_i F}{2} \quad (3.1.1)$$

Using equation (3.1.1) this condition can be written as,
\[
\frac{r_i(1 - \gamma_i)}{\gamma_i(1 + \alpha)} \equiv F_c' \geq F
\] (3.1.2)

The condition in equation (3.1.2) implies that under leniency regime with a possibility of whistle-blowing collusive bribery will exist when penalty does not exceed threshold \(F_c'\). Note that \(F_c'\) is decreasing in both \(\alpha\) and \(\gamma_i\). An increase in the probability of successful conviction \((\gamma_i)\) and the share of fine paid \((\alpha)\) lowers the tolerance towards collusion by lowering the penalty threshold.

From (3.1.1) note that \(\frac{\partial b_i'}{\partial \alpha} < 0; \frac{\partial b_i'}{\partial \gamma_i} > 0\) if \((1 - \alpha)F > r_i\) and \(\frac{\partial b_i'}{\partial \gamma_i} < 0\) if \((1 - \alpha)F < r_i\)

An increase in \(\alpha\) reduces the expected penalty save i.e. \((1 - \alpha)F\) thereby lowering the bribe surplus. The collusive bribe under leniency will thus decrease as \(\alpha\) increases. The effect of an increase in \(\gamma_i\) on post leniency collusive bribe is not unambiguous. As \(\gamma_i\) increases, \(b_i'\) will increase if the expected penalty saved exceeds the potential revenue since the bribe surplus increases in that case. If expected penalty saved is less than the potential revenue a lower bribe surplus pull down the collusive bribe.

**Proposition 1:** A firm with \(r_i > c\) that chooses NI in stage 1 commits to whistle-blowing if \(F \leq F_w'\) where \(F_w' = \frac{2\delta(h_i - c) + (1 - h)(1 - \gamma_i) r_i}{\gamma_i(1 - h)(1 + \alpha)} > 0\). However, collusion may continue to exist even under credible threat of whistle-blowing.

**Proof:**

\(F_w'\) is obtained by substituting the value of \(b_i'\) in equation (3a).

\[
F_c' - F_w' = -\frac{2\delta(h_i - c)}{\gamma_i(1 - h)(1 + \alpha)} < 0
\]

A firm that selects NI in stage 1 and colludes will whistle-blow only if \(F\) is below a certain threshold. The intuition is simple. Setting too high a penalty threshold also implies a higher expected fine to be paid by the firm for any given \(\alpha\). This may demotivate a colluding firm to whistle-blow under leniency. From (3.1.2) we know that under leniency collusion exists for \(F \leq F_c'\). Now since \(F_c' < F_w'\), for \(F \in (0, F_c')\), collusion continues to exist even though whistle-blowing is a credible threat. For
\( F \in (F_i^l, F_i^w) \) whistle-blowing is a credible threat and collusion is eliminated. For \( F > F_i^w \) collusion no longer exists despite whistle-blowing being a credible threat.

**Lemma 4.**

(i) As leniency is introduced, penalty threshold for collusion would be less tolerant with \( WB \) i.e. \( F_i^l < F_i \) if \( \gamma_i > \frac{2\gamma}{1+\alpha + \gamma(1-\alpha)} \).

(ii) \( \frac{\partial F_i^l}{\partial \alpha} < 0 ; \frac{\partial F_i^l}{\partial \gamma_i} < 0 \)

**Proof of Lemma 4.**

(i) \( F_i^l - F_i = 2\gamma - \gamma_i[\gamma(1-\alpha) + (1+\alpha)] \).

(ii) \( \frac{\partial F_i^l}{\partial \alpha} = -\frac{1}{(1+\alpha)^2} \left[ \frac{2\alpha h(r_i - c)}{\gamma_i(1+h)} + \frac{r_i(1-\gamma_i)}{\gamma_i} \right] < 0 \)

\( \frac{\partial F_i^l}{\partial \gamma_i} = -\frac{1}{(\gamma_i)^2} \left[ \frac{2\alpha h(r_i - c)}{(1+h)(1+\alpha)} + \frac{r_i}{(1+\alpha)} \right] < 0 \)

Q.E.D.

Let us look at the intuition behind Lemma 4.

(i) The idea of announcing leniency is to ensure that bribe givers self-report and collusion is successfully deterred. However, \( F_i^l - F_i > 0 \) implies a higher tolerance towards collusion through a higher penalty threshold which is undesirable. Thus in order to be less tolerant towards collusion we need \( F_i^l - F_i < 0 \) which holds for \( \gamma_i > \frac{2\gamma}{1+\alpha + \gamma(1-\alpha)} \).

(ii) An increase in the share of fine to be paid on successful conviction needs to be accompanied by a low penalty threshold to incentivize colluding firms to whistle-blow. Similarly, an increase in the probability of conviction itself implies higher chances of losing the license. Thus a lower penalty threshold will be needed to offset the loss and motivate colluding firms to commit to whistle-blowing.
Lemma 5.

(i) \( b^l_c - b_e \geq 0 \) as \( F(1 - \alpha) \geq \gamma_i \)

(ii) \( b^l_e - b_c \geq 0 \) as \( \gamma_i F(1 - \alpha) - (\gamma_i - \gamma) \gamma_i \geq 0 \)

(iii)(a) \( b^l_c > b_e > b_c \)

(iii)(b) \( b^l_c < b_c < b_e \)

(iii)(c) \( b_e > b^l_c > b_c \)

Proof of Lemma 5.

(i) \( b^l_c - b_e = \frac{\gamma_i F(1 - \alpha) - r_i}{2} > 0 \) if \( F(1 - \alpha) - r_i > 0 \) since \( \gamma_i > 0 \)

(ii) \( b^l_e - b_c = \frac{\gamma_i F(1 - \alpha) - (\gamma_i - \gamma) \gamma_i}{2} > 0 \) if \( \gamma_i F(1 - \alpha) - (\gamma_i - \gamma) \gamma_i > 0 \)

(iii)(a) From Lemma 2 we have \( b_e > b_c \). (i) > 0 \( \Rightarrow b^l_c > b_e > b_c \)

(iii)(b) (i) < 0 and (ii) < 0 \( \Rightarrow b^l_c < b_c < b_e \)

(iii)(c) (i) < 0 and (ii) > 0 \( \Rightarrow b_e > b^l_c > b_c \)

QED.

Stage 3 analysis where \( o_{dh} \) chooses B or NB under WB

Under the possibility of whistle-blowing a dishonest official \( o_{dh} \) chooses B provided the bribe offer is accepted by \( F_i \) if \( E \pi_{o,a}((N_{I_a}, A), B) \geq (E \pi_{o,a}((N_{I_a}, R), B) \) which implies \( b^l_c - \gamma_i F \geq 0 \). Substituting for \( b^l_c \) from equation (3.1.1) the condition is identical to equation (3.1.2) which implies that for \( F \leq F^l_i \) a dishonest official will choose bribery which the firm will accept, given the possibility of whistle-blowing.

Stage 2 analysis

Since leniency does not affect firms who invest in stage 1, the payoffs of firms who choose \( I_{a} \) in stage 1 remains same as shown in equation (2.1.4) i.e.

\[ E \pi_i(I_{a}, B : F \leq F^l_i) = \frac{r_i}{2}(1 + \lambda) + h(1 - \lambda)) - c \]. Under leniency there is no collusive corruption when \( F > F^l_i \). As before qualified firms with \( r_i - c > 0 \) who initially do not invest in clean energy but applies, will subsequently invest and apply for the license, which it will obtain and hence will choose \( (N_{I_{a}}, I_{a}) \). However, the unqualified firms
will not subsequently invest and their choice will be \((NI_a, NI_{na})\). Thus the payoffs of the two types of firms when there is no collusive corruption remain same as equation (2.2.3) i.e.

\[
\pi^h_i (NI_a) = \pi^h_i (NI_a, I_a) = \delta(r_i - c)
\]
\[
E\pi^h_i (NI_a) = E\pi^h_i (NI_a, NI_{na}) = 0
\]

There is collusive corruption when \( F < F^i_c \). An honest official reviews the application with probability \( h \) and a dishonest official reviews the same with probability \((1 - h)\). When reviewed by an honest official the payoff of a **qualified** and an **unqualified** firm remains same as before. A **qualified** firm’s payoff when reviewed by an honest official is \( \pi^h_i (NI_a, I_a) = \delta(r_i - c) \). The payoff of an **unqualified** firm when reviewed by an honest official is \( \pi_i^{unq} (NI_a, NI_{na}) = 0 \). The expected payoff of a **qualified** or an **unqualified** firm when reviewed by a dishonest official, as given in equation (3a) becomes

\[
E\pi^h_i ((NI_a, A), B) = \frac{r_i(1 - \gamma_i) - \gamma_i F(1 + \alpha)}{2}
\]

where \( k = q, uq \).

Thus the expected payoffs of a **qualified** and an **unqualified** firm from choosing not-to-invest and apply \((NI_a)\) when \( F < F^i_c \) and there is collusive corruption are as follows.

\[
E\pi^h_i (NI_a) = h\pi^h_i (NI_a, I_a) + E\pi^h_i ((NI_a, A), B) = h\delta(r_i - c) + (1 - h)\left\{\frac{r_i(1 - \gamma_i) - \gamma_i F(1 + \alpha)}{2}\right\}
\]
\[
E\pi_i^{unq}(NI_a) = h\pi_i^{unq}(NI_a, NI_{na}) + E\pi_i^{unq}((NI_a, A), B) = (1 - h)\left\{\frac{r_i(1 - \gamma_i) - \gamma_i F(1 + \alpha)}{2}\right\}
\]

(3.1.3)

**Stage 1 analysis**

From the stage 2 analysis we can thus get the stage 1 expected profit of the firms as follows.

\[
E\pi^h_i (NI_a) = \begin{cases} 
\delta(r_i - c), & \text{if } F > F^i_c \\
(h\delta(r_i - c) + (1 - h)\left\{\frac{r_i(1 - \gamma_i) - \gamma_i F(1 + \alpha)}{2}\right\}), & \text{if } F \leq F^i_c
\end{cases}
\]  

(3.1.3a)
\[ E_{x_i}^{\text{lin}}(NI_x) = \begin{cases} 0, & \text{if } F > F_e^i \\ (1-h) \left( \frac{r_i(1-\gamma_i) - \gamma_iF(1+\alpha)}{2} \right), & \text{if } F \leq F_e^i \end{cases} \]  

(3.1.3b)

3.1. Subgame Perfect Equilibrium

As leniency is introduced we once again compare the extortion and collusive bribes and the threshold levels of penalties above which extortion corruption or collusive corruptions are deterred to analyse the subgame perfect equilibrium under leniency. The results are summarized in Lemma 6.

**Lemma 6.**

*The threshold penalty above which collusive corruption is deterred under leniency is lower than the threshold penalty above which extortion is deterred, that is*

\[ F_e^i < F_e \]

**Proof of Lemma 6.**

\[ F_e^i - F_e = \frac{r_i}{2\lambda \gamma_i(1+\alpha)} [2\gamma_i - \gamma_i \{ \lambda(1-\alpha) + (1+\alpha) \}] < 0 \]

if \( \gamma_i > \frac{2\lambda}{\lambda(1-\alpha) + (1+\alpha)} \).

Note that \( F_e^i - F_e < 0 \) if \( \gamma_i > \frac{2\gamma}{\gamma(1-\alpha) + (1+\alpha)} \)

We also have \( \frac{2\gamma}{\gamma(1-\alpha) + (1+\alpha)} = \frac{2\lambda}{\lambda(1-\alpha) + (1+\alpha)} > 0 \)

\( \Rightarrow F_e^i - F_e < 0 \) if \( F_e^i - F_e < 0 \)

The intuition is as follows. As leniency is introduced, there is a possibility of self-reporting in the form of whistle-blowing even in collusion. This possibility of whistle-blowing creates a threat which lowers the post-leniency penalty threshold for collusion below the penalty threshold for extortion. This implies that a leniency in punishment comes with a threat which pulls down the tolerance towards collusion even lower than the tolerance towards extortion.

Lemma 6, is diagrammatically represented in Figure 7.
Figure 7: Penalty ranges for different types of corruption under leniency

(i) $F > F_e^I$ is the high penalty level where there is no form of corruption.

(ii) $F_e < F \leq F_e^I$ is the intermediate penalty level where there is only extortion.

(iii) $F \leq F_e^I$ is the low penalty level where there are both forms of corruption.

Proposition 2: Announcement of leniency is not sufficient to deter collusion. Under leniency, there exists a specific feasible penalty range where collusion is successfully eliminated i.e. $F \in (F_e^I, F_e)$ contingent on the probability of successful conviction i.e.

\[
\text{when the probability of successful conviction } \gamma > \frac{2\gamma}{\gamma(1-\alpha)+(1+\alpha)}.
\]

Proof: Follows from Lemma 6.

As leniency is introduced, the possibility of whistle-blowing increases collusion at the intensive margin through an increase in the collusive bribe amount. At the same time, it becomes instrumental in successfully deterring collusion at the extensive margin as the tolerance for collusion is sufficiently reduced which holds following Lemma 4 for

\[
\gamma > \frac{2\gamma}{\gamma(1-\alpha)+(1+\alpha)}.
\]

Tolerance for collusion is lowered to the extent such that it is less than extortion for a penalty $F \in (F_e^I, F_e)$ collusion ceases to exist and the source of the negative externality is wiped out. Extortion however continues to exist.

3.2 Analysis of the Subgame Perfect Equilibrium when $F \in (F_e^I, F_e)$

Note that prior to leniency, collusive bribery existed for $F \in (0, F_e)$. As leniency is introduced, following figure 7a, $F_e$ shifts to $F_e^I$ and there is no existence of collusion for a penalty $F \in (F_e^I, F_e)$. Clearly, the extensive margin for collusion shrinks.
However, extortion exists. The expected payoff functions are defined below. Since there is no collusion the expected payoff of a firm with \( r_i > c \) that chooses not to undertake investment in stage 1 becomes:

\[
E\pi_i^{bi}(NI_a) = \delta(r_i - c) \tag{3.2.1}
\]

Firms with \( r_i < c \) will never undertake investment. Following equation (3.2.1) given there is no collusion for \( F \in (F_c^l, F_c) \) the expected payoff of these firms is given by

\[
E\pi_i^{bi}(NI_a) = 0. \text{ Clearly, } E\pi_i^{bi}(NI_a) > E\pi_i^{bi}(NI_a). \text{ Thus firms with } r_i < c \text{ will never invest and never apply.}
\]

Since there is extortion, the expected payoff of a firm that chooses to undertake investment in stage 1 is:

\[
E\pi_i(I_a) = \frac{r_i}{2}[1 + \lambda] + h(1 - \lambda)] - c \tag{3.2.2}
\]

### 3.3 Analysis of the Subgame Perfect Equilibrium when \( F \in (0, F_c^l) \)

Leniency on the other hand may fail to eliminate collusion if the penalty \( F \) is set too low allowing high tolerance for collusion. Following figure 7(a), for a low penalty \( F \in (0, F_c^l) \) there exists both extortion and collusive bribery under leniency. The behavior of firms with based on their revenue potential \( r_i \) are summarized as:

i) Firms with \( r_i > c \) can either invest in stage 1 or in stage 2. If they invest in stage 1 they are extorted in stage two if the reviewing official is dishonest. Otherwise, license is obtained without extortion. The expected payoff in this case is

\[
E\pi_i(I_a) = hr_i + (1-h)(1 + \lambda) \frac{r_i}{2} - c. \text{ If firms with } r_i > c \text{ do not invest in stage 1, they subsequently do in stage 2 if reviewing official is honest. Otherwise license is obtained through collusive bribery. The expected payoff under leniency becomes}
\]

\[
E\pi_i^{bi}(NI_a) = h\delta(r_i - c) + (1-h)[\frac{r_i(1-\gamma_i) - \gamma_i(1+\alpha)F}{2}]
\]

(ii) Firms with \( c < r_i < \tilde{r} \) will never undertake investment in stage 1 and this directly follows from Lemma 1. These firms will invest in stage 2 if reviewing official is honest.
Otherwise license is obtained through collusive bribery. The expected payoff is given by $E\pi_i^{bl}(NI_a) = h\delta(r_i - c) + (1-h)\left[\frac{r_i(1-\gamma_i) - \gamma_i(1+\alpha)F}{2}\right]$.

(iii) Firms with $r_i < c$ never undertake investment and obtain a license only if official is dishonest. The expected payoff is given by $E\pi_i^{bu}(NI_a) = (1-h)\left[\frac{r_i(1-\gamma_i) - \gamma_i(1+\alpha)F}{2}\right]$.

Clearly $E\pi_i^{bu}(NI_a)$ is completely dominated by $E\pi_i^{bl}(NI_a)$ for all $r_i > 0$. Thus firms with $r_i < c$ will never apply.

**Analyzing bribery for** $F \in (0,F^-)$

At $F = F^-$, the expected payoff of a firm with $r_i > c$ who do not invest in stage 1 is given by

$$E\pi_i^{bl}(NI_a,F^-) = h\delta(r_i - c) > 0 \quad (3.3.1)$$

The expected payoff of a firm that undertakes investment in stage 1 is given by

$$E\pi_i(I_a) = hr_i + (1-h)(1+\lambda)\frac{r_i}{2} - c \quad (3.3.2)$$

**Lemma 7**

If at $F = F^-$, $E\pi_i^{ql}(NI_a) < E\pi_i(I_a)$ then for $F \in (0,F^-)$ there exists a critical $\tilde{F}$ for which there exists collusion for $F < \tilde{F}$ and extortion for $F > \tilde{F}$.

**Proof of Lemma 7.**

Note we have $\frac{\partial E\pi_i^{ql}(NI_a)}{\partial F} = -(1-h)\frac{\gamma_i(1+\alpha)}{2} < 0$ whereas $E\pi_i(I_a)$ is independent of $F$.

Thus for $F \in (0,F^-)$ if $E\pi_i(I_a) > E\pi_i^{ql}(NI_a)$ then there exists a critical $\tilde{F}$ for which:

---

3 Alternatively at $F = F^-$ we can have $E\pi_i(I_a) < E\pi_i^{ql}(NI_a)$ such that firms do not invest in stage 1 and $E\pi_i^{ql}(NI_a)$ dominates for $F \in (0,F^-)$ and there is possibility of collusion with probability $(1-h)$.  

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$E \pi_i(I_a) < E \pi_i^q(NI_a)$ for $F < \tilde{F}$

$E \pi_i(I_a) > E \pi_i^q(NI_a)$ for $F > \tilde{F}$ such that at $F = \tilde{F}$, $E \pi_i(I_a) = E \pi_i^q(NI_a)$.

Figure 8: Extensive margin of extortion and collusion for $F \in (0, F_c^{-1})$

The penalty threshold $\tilde{F}$ is decreasing in both $\alpha$ and $\gamma_i$. An increase in the share of penalty to be paid on conviction or the probability of conviction itself lowers the tolerance for collusion.

**Proposition 3:** As leniency is introduced, the sub-game perfect penalty threshold that successfully deters collusion is given by $F \in (\hat{F}, F_c)$ and there exists a trade-off between extortion and collusion. At the same time it is desirable to obtain $\tilde{F} < \hat{F}$ to ensure a higher extent of fall in collusive bribery at the extensive margin.

**Proof:** As leniency is introduced, the penalty threshold for collusive corruptions changes from $F_c$ to $F_c^{-1}$. The penalty threshold for extortion remains unchanged at $F_c$. From Lemma 3 we obtained that for $F \in (0, F_c)$ there exists a critical $\hat{F}$ such that collusion exists for $F \in (0, \hat{F})$ and extortion exists for $F \in (\hat{F}, F_c)$. From Lemma 7 we obtained for $F \in (0, F_c^{-1})$ there exists a critical $\tilde{F}$ for which there exists collusion for $F \in (0, \tilde{F})$ and extortion for $F \in (\tilde{F}, F_c)$. A comparison of $\hat{F}$ and $\tilde{F}$ gives us both the possibilities: (i) $\tilde{F} < \hat{F}$ and (ii) $\tilde{F} > \hat{F}$. Compared to (ii), under (i) the extensive margin
of collusion is smaller but at the same time under (ii) a bigger extensive margin of collusion is coupled with a smaller extensive margin of extortion. However, despite this tradeoff if it is the minimization of collusion is deemed necessary due to its tendency to generate negative externality (i) is surely seen as a better outcome compared to (ii). Recall that from Lemma 4 and Lemma 6 we obtained that the extensive margin of collusion shrinks under leniency as the tolerance towards collusion is lowered. Now, considering possibility (i) for $\tilde{F} < \hat{F}$, the extensive margin of extortion increases under leniency along with the decrease in extensive margin of collusion. The outcomes can be represented graphically below.

![Figure 9: Sub-game Perfect Equilibrium Before Leniency](image)

![Figure 10: Sub-game Perfect Equilibrium After Leniency](image)
Proposition 4: As leniency is implemented since there is no collusive bribery for \( F \in (\widehat{F}, F_c) \) but extortion continues to exist, it is sensible to invest in stage 2. This outcome holds for a high cost of investment and low reapplication cost i.e. if \( c > \tilde{c} \) and \( \delta < \overline{\delta} \) where 
\[
\tilde{c} = \frac{r_i[2h + (1 - h)(1 + \lambda) - 2\delta]}{2(1 - \delta)} \quad \text{and} \quad \overline{\delta} = \frac{2h + (1 - h)(1 + \lambda)}{2}
\]
such that \( 0 < \overline{\delta} < 1 \).

Proof:

We have obtained from Proposition 1 that there can be a possible tradeoff between extortion and collusion depending on the relative magnitude of \( \widehat{F} \) and \( \widehat{F} \). Collusion is minimized if \( \widehat{F} < \widehat{F} \) and the same is successfully eliminated for \( F \in (\widehat{F}, F_c) \). However, extortion continues to exist. The expected payoffs of firms who invest in stage 1 and stage 2 respectively are given as:

\[
E\pi_i^I(I_a) = \delta(r_i - c) > 0
\]

\[
E\pi_i(I_a) = hr_i + (1 - h)(1 + \lambda)\frac{r_i}{2} - c
\]

Since there is extortion, firms that invest in stage 1 will have to pay extortion bribe if the official is corrupt. However, due to elimination of collusion, firms that do not invest in stage 1 obtain their license if they invest in stage 2 without any collusive bribe. Thus it is more sensible to invest in stage 2 and obtain the license without any bribery.

Comparing the expected payoffs above this outcome is obtained if:

\[
E\pi_i^I(I_a) > E\pi_i(I_a)
\]

\[
\Rightarrow \overline{\delta} > \frac{r_i[2h + (1 - h)(1 + \lambda) - 2\delta]}{2(1 - \delta)} < c
\]

Note \( \overline{\delta} > 0 \) if \( [2h + (1 - h)(1 + \lambda) - 2\delta] > 0 \)

\[
\Rightarrow \overline{\delta} > \frac{2h + (1 - h)(1 + \lambda)}{2} > \delta \text{ where } 0 < \overline{\delta} < 1.
\]

Intuitively, a high cost of investment coupled with a low cost of reapplication will enable firms to postpone their investment decisions such that the given penalty range deters collusion and firms obtain their license through investment in stage 2 without extortion or collusive bribe. Proposition 3 is graphically represented below.
4. Welfare

As leniency is implemented, we have seen from Proposition 3 that collusion is eliminated for $F \in (\hat{F}, F_e)$ thereby extinguishing the source of negative externality. At the same time the extortion increases at the extensive margin and continues to exist for $F \in (\hat{F}, F_e)$. Extortion, however does not entail any negative externality. Thus we perform an exercise to observe the impact of introducing leniency on welfare.

A firm with $r > c$ that undertakes investment in clean technology in stage 1 generates a welfare of amount $r - c > 0$. On the other hand a firm with $r > c$ that does not invest in stage 1, obtains the license through collusion in stage 2 if the reviewing official is dishonest. In this case, the firm generates a negative externality of amount $r + lc > 0$. The welfare generated in this case is $- lc < 0$. In stage 2, if reviewed by an honest official the firm undertakes investment and generates a welfare of amount $\delta(r - c) > 0$. Bribes are considered as pure transfers and hence do not reflect in the welfare analysis.
Let us define $W$ and $W'$ as the welfare level generated by participating firms before and after the introduction of leniency respectively.

$$W = \int_{0}^{\tilde{h}} (\tilde{h} - c - (1 - h)lc) g(r) d(r) + \int_{F}^{\tilde{h}} (r - c) g(r) d(r) + \int_{F}^{\tilde{h}} (\tilde{h} - c - (1 - h)lc) g(r) d(r)$$

$$W' = \int_{r_c}^{\infty} (r - c) g(r) d(r) + \int_{r_c}^{\tilde{h}} (\tilde{h} - c - (1 - h)lc) g(r) d(r)$$

**Proposition 5:** The effect of leniency on the level of welfare in an economy characterised by both extortion and collusion is not unambiguous. The net effect on welfare will depend on the extensive margin of firms and ex-ante welfare.

**Proof:**

From equations 4.1 and 4.2 we have:

$$W - W' = \int_{\tilde{h}}^{\tilde{h}} (\tilde{h} - 1)(r - c) g(r) d(r) + \int_{F}^{\tilde{h}} (\tilde{h} - c - (1 - h)lc) g(r) d(r)$$

$$W - W' > 0 \text{ if } \tilde{h}(r - c) > (1 - h)lc > 0 \text{ and }$$

$$\int_{F}^{\tilde{h}} (\tilde{h} - c - (1 - h)lc) g(r) d(r) > \int_{\tilde{h}}^{\tilde{h}} (\tilde{h} - 1)(r - c) g(r) d(r)$$

$$W - W' < 0 \text{ if } \tilde{h}(r - c) > (1 - h)lc < 0$$

Let us explain the intuition behind this analysis. It is clear from the analysis so far that leniency reduces collusion at the extensive margin of declines but at the same time entails an increase in the extensive margin of extortion. The welfare generated depends on the negative externality generated by firms who do not invest in stage 1 and on the positive surplus generated by firms who invest in stage 1 i.e. $r_i - c > 0$. As leniency is introduced the decline in the extensive margin of collusion implies a decline in the
frequency of firms generating negative externality. However, it also entails the fact that the number of firms who do not enter the application process increases which can be interpreted as a cost of leniency in terms of loss in the expected surplus \( r_i - c > 0 \). Thus, the net effect on welfare due to leniency remains ambiguous.

5. Conclusion

This paper analyses the impact of introducing punishment as a potentially effective anti-corruption strategy in a monopoly bureaucracy with persistent corruption comprising both extortion and collusion. For our purpose we have used a theoretical model where a production license is delivered through bureaucrats only to firms who undertake qualifying investment in a clean technology. An honest bureaucrat grants the license only to firms using clean technology without any bribe but if he is corrupt the license is given in exchange for a bribe regardless of the firms’ investment decision. On interaction with a corrupt official a firm with investment in clean technology is extorted where the firm pays extortion bribe and a firm without the clean technology colludes with the corrupt official and collusive bribe is exchanged. Unlike extortion, collusion is a victimless crime and leads to negative externality to the society through the distortion of the prevailing laws. Also, the information about collusive agreements are hardly revealed making it all the more difficult to detect the same. In order to combat the problem of detecting collusion, most nations resort to a leniency policy as an incentive to whistle-blow on the collusive agreement.

In this paper we compare two different equilibrium, before and after a leniency policy is implemented and observe whether both the favorable outcome where collusion is successfully eliminated and the undesirable situation where the leniency policy fails to do the same. As we introduce punishment for corruption, before the implementation of leniency, extortion and collusion are successfully convicted with exogeneous
probabilities $\lambda$ and $\Upsilon$ respectively. We introduce asymmetric punishment for extortion where on successful conviction the bribe amount is confiscated from the corrupt official and returned to the qualified firm. Along with it, the corrupt official also pays a lump sum fine $F$. Prior to the implementation of leniency, both the firm and the corrupt official are punished on successful conviction of collusion. The punishment involves confiscating the revenue form the unqualified firm. Additionally both the firm and both the official and the firm pay a lump sum fine $F$ each. As we introduce leniency for collusion as an incentive for a colluding firm to whistle-blow the penalty $F$ levied on the firm is partially waived off on successful conviction whereas the corrupt official’s punishment remains unchanged. We do not introduce leniency for extortion since qualified firms who are extorted will always have an incentive to self-report given they are a victim of the illegal exchange. We observe that as an immediate impact of leniency points colluding firms commit to whistle-blowing only if the penalty is below a threshold i.e. $F < F^*$ and the collusive bribe amount for the whistle-blowing firms increase as leniency is introduced. The extortion bribe rate remains unaffected under leniency.

This paper then works its way to show that the mechanism of leniency works creating an incentive to whistle-blow that acts as a threat such that the tolerance towards collusion is lowered. The success of a leniency policy turns out to be sensitive to an optimal combination of enforcement parameters $\lambda$, $\gamma$, $\alpha$ and $F$ which creates a specific range of penalty that successfully eliminates collusion. There lies a tradeoff between the two types of corruption since the extensive margin of extortion increases along with the decline in the extensive margin of collusion. However, at the same time unlike collusion, extortion has no distortionary effect on welfare.
Thus, a leniency policy which attempts to prevent collusion but leaves extortion unaffected has interesting welfare implications. We have observed that leniency reduces the extensive margin of collusion thereby reducing negative externality at the extensive margin. Interestingly, leniency increases the extensive margin of extortion which also implies that more firms generate positive welfare. At the same time a decline in the number of participating firms implies a loss in terms of expected positive surplus. The aggregate effect on welfare thus depends on the number of firms participating in extortion and collusion and on the ex-ante welfare generated by the same. Thus the net impact on welfare remains ambiguous. In a nutshell for now it suffices to conclude that just as the success of a leniency policy is not obvious, one cannot definitively conclude that the same is welfare improving even when it successfully eliminates collusion.

One can also check robustness of the results derived in the present paper with differential punishment rates for collusion and extortion, which remains our future research agenda.

References


