CONTROLLING CORRUPTION: ROLE OF BUREAUCRATIC COMPETITION, PUNISHMENT AND MEDIA

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Certified that the Thesis entitled

Controlling Corruption: Role of Bureaucratic Competition, Punishment and Media submitted by me for the award of the degree of Doctor of Philosophy in Arts at Jadavpur University is based upon my own work carried out under the supervision of Dr. Vivekananda Mukherjee, Professor, Department of Economics, Jadavpur University and Dr. Dyuti S. Banerjee, Professor, Department of Economics, Monash University. And that neither this thesis nor any part of it has been submitted before for any degree or diploma anywhere/elsewhere.

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“Statement of Originality”

I, ***Panchali Banerjee***, registered on ***30th July, 2015*** do hereby declare that this thesis entitled ***“*Controlling Corruption: Role of Bureaucratic Competition, Punishment and Media*”*** contains literature survey and original research work done by the undersigned candidate as part of Doctoral studies.

All information in this thesis have been obtained and presented in accordance with existing academic rules and ethical conduct. I declare that, as required by these rules and conduct, I have fully cited and referred all materials and results that are not original to this work.

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Dedicated to,

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My mother Mitra Ray who personified non-conformity and never lost faith in me;

My husband Ritayan Mukherjee for being a democratic companion and having my back through thick and thin;

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CHAPTER 1

INTRODUCTION

1.1 Backdrop

Corruption in economics literature is defined as the misuse of public office for private gain. Corruption can take various forms including large political scams to petty corruption in routine activities. For instance, in nineteenth-century, American urban governments were found to heavily overpay for basic services like street cleaning and construction, in exchange for kickbacks collected by elected officials and gave away public services for nominal official fees and lumpsum bribes (Glaeser and Goldin, 2006). Instances of "police corruption" were widespread in Hong Kong in 1960s where incidences ranged from routine petty corruption to large-scale bribery at the institutional level. Transparency International (2011) reports that 54 percent of respondents of their survey conducted in India had to pay a bribe to obtain a public service. Corruption can also take the form of embezzlement of government allocation in different welfare schemes. In India, based on a survey on NREGS[1] beneficiaries, who receive job card from the government in guaranteed employment program, in different districts of Orissa and Andhra Pradesh, it was found that 70 to 80 percent of the NREGS labour budget was embezzled before it reached the beneficiaries[2]. Similarly, 44 percent of food grain under Targeted Public Distribution System in India was found to be leaked before it reaches the intended beneficiaries (Khera, 2011). Historically, corruption has come down drastically in the developed part of the world over the last century; but it is still quite rampant at the developing countries and considered as a major obstacle to their development[3].

The form of corruption that is prevalent in routine activities in the developing world is perhaps bureaucratic corruption involving bribery. The bribery may take two alternative

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[1] National Rural Employment Guarantee Scheme.

[2] See Niehaus and Sukhtankar (2013a, 2013b).

[3] See Bardhan (1997).

forms: (i) extortion, where an agent meets a required compliance criterion to be eligible to obtain a government service but is forced to pay a bribe by the administering bureaucrat/official; and (ii) collusion, where a non-complying agent and an official enter a mutually beneficial bribe agreement. An example from Mishra (2006) can be used to differentiate between these two concepts. Taxi owners in India must undergo a periodical compliance inspection to ensure that the emission is below the permissible level. This compliance requires a fixed investment, which the taxi owners may or may not choose to make. Collusion refers to the case where a taxi-owner has not invested in emission control and the inspector takes a bribe from the polluting taxi-owner to issue the clearance certificate. Alternatively, the inspector may be able to submit an unfavourable report or credibly threaten to report a non-polluting taxi as a polluting one. In such a case, bribery may still occur, but as a form of extortion. Bertrand et al (2007) provides another example of the two types of bribery in the context of driving license applications in India where officials have been found to arbitrarily fail applicants in the driving test so as to procure bribe, which is a case of extortion and on the other hand, it is also not uncommon to find applicants obtain the license without knowing how to drive, in exchange for a bribe which is a case of collusion. Instances of extortion were also prevalent in Hong Kong in 1960s as government officials demanded "tea money" for providing essential services to the deserving ones. For example, ambulance crews would ask for tea money before picking up a sick person or hospital attendants asked for "tips" before giving patients a bedpan or a glass of water[4].

The two forms of bribery also have implications for social welfare, which must also be clear from the examples cited above. While extortion is undesirable in terms of victimization of complying agents and has distributional implication, it does not generate

[4] See Hseih (2017).

any negative externality to the society. On the other hand, collusion does not have a victim, but violates compliance generating negative externality. It also has distributional implication. Accordingly, a literature has evolved that studies the incidence of the two forms of bribery and discusses the anti-corruption strategies for controlling them. However, the interdependence between extortion and collusion has been rarely studied, even though they typically coexist in a bureaucracy. It is expected that the strategies for controlling one would affect the incidence of the other. Therefore, the question arises that what happens to extortion and collusion as we implement alternate anti-corruption strategies? What would be the best strategy to prevent occurrence of both extortion and collusion? Is there any conflict between corruption-control strategies and welfare maximization objective of a government? Beyond the standard strategies of enforcement and bureaucratic reform, what role judicial efficiency and compliance cost plays in controlling extortion and collusion? This thesis focuses on answering these questions in a framework that allows for coexistence of both extortion and collusion.

Within the ambit of strategies to control corruption, some have direct impact on corruption, and some have indirect impact. The strategies having direct impact include prize and punishment in the form of efficiency wage[5] and both formal and informal checks and balances where any agent involved in corruption can be sued thereby making corruption costly. Based on the definitions of extortion and collusion, since the former refers to a situation where an agent complies with the legal requirement, in this case it is the bribe-taker who violates the law. In contrast, in collusive corruption both the bribe giver

[5] See Becker and Stigler (1974). That raising civil service wages can effectively deter corruption has later been tested by Rijckeghen and Weder (2001) empirically who find a statistically significant negative relation between corruption and relative civil service wages. The results are later confirmed by An and Kweon (2017) where the effect is found to be particularly significant for non-OECD countries characterised by high corruption.

and bribe taker violate the law. Conventionally enforcement has taken different forms for extortion and collusion. In a bureaucracy characterised by extortion, since the bribe giver is the victim, there is always a possibility of self-reporting by the same, and an asymmetric punishment is often advocated where the bribe taker alone is punished (Basu et.al. (2016)). Collusion on the other hand is victimless and neither the bribe taker nor the bribe giver has any incentive to self-report which makes it more difficult to detect. In this case, the incidence may be discovered by a third party such as media. However, one of the two parties involved can also turn out to be a whistle blower and call out the corrupt act. The consequences of leniency in enforcement for the whistle blower in case of collusive corruption has also been discussed in the literature (Buccirossi and Spagnolo, 2005). However, question remains that since societies generally experience both extortion and collusion together, what happens to these when formal enforcement for both, in the form of penalty, is introduced. Do enforcement strategies for controlling corruption differentially affect collusion and extortion outcomes, thus having a *corruption distribution effect*? Are maximal penalties socially optimum? These questions are addressed in the third chapter of the thesis which broadly looks at the impact of introducing a penalty as a corruption mitigation strategy on extortion and collusion and goes on to analyze social welfare maximizing penalty.

Beyond enforcement, indirect factors such as morality of the parties involved, and their peer effect, also matter in persistence of corruption.[6] Moral costs that arise from the failure to adhere to the norms existing in the society may have important implications for occurrence of corruption as they deter one from participation in bribery. Some recent papers in experimental economics like Barfot et al. (2019), Gachter and Schulz (2016) suggest that intrinsic honesty of the officials also matters in this respect. Further, within the indirect

[6] See Andvig and Moene (1990) and Dhillon et al (2017).

factors that influence corruption, the existing literature points out that media-freedom plays an important role in controlling corruption[7]. To understand whether higher media freedom can influence bureaucratic corruption which entails both extortion and collusion is an interesting research question. The fourth chapter of the thesis takes up this issue.

Considering both direct and indirect factors that influence corruption, it is interesting to analyse how extortion and collusion incidences affected if morality and enforcement interact. Is there a peer effect/network effect on the officials that work differently for extortion and collusion? What happens to the moral standard of a society in a country which experiences greater media freedom? These questions are addressed in the fourth chapter of the thesis, which also brings out the importance of compliance cost, efficient judiciary and reapplication cost in designing strategies for controlling corruption.

Apart from strategies like enforcement, media freedom, compliance cost, reapplication cost discussed above, a bureaucratic reform that changes administrative structure has also been considered as an effective anti-corruption strategy. It is often argued that introduction of competition among officials in delivery of public services may reduce corruption in the same way introduction of competition between the firms ensures market efficiency. A monopoly bureaucracy is thought to breed corruption given the indispensability of the government official in delivery of a service. Introducing competition among officials could reduce corruption by eliminating this indispensability as beneficiaries would have outside options. The price competition among officials to retain their customer drives the bribe rate down to zero and corruption is eliminated[8]. However, it is important to note that as the bribe rate falls, participation in bribery becomes less costly. This expands the extensive margin of corruption. Chapter 2 studies the impact on

[7] See Starke et al. (2016).

[8] See Rose Ackerman (1978) and Shleifer and Vishny (1993).

introduction of competition in a bureaucracy on both the intensive and the extensive margin of extortion and collusion. Does a competitive bureaucracy unambiguously reduce both extortion and collusion? It uses various measures of corruption to answer the question. It also looks at the welfare impact of introduction of competition in a bureaucracy and checks whether the corruption and the welfare move in the same direction or in the opposite direction.

In the next section we review the literature relevant to our study.

1.2 Survey of Literature

The existing literature on corruption, as defined earlier, is diverse. Svensson (2005) and Bardhan (1997) have discussed various aspects of corruption. The authors discuss role of corruption in development process focusing on aspects of growth and efficiency. Commonly advocated anti-corruption mechanisms such as competition and monetary incentives in the form of higher wages for bureaucrats, have also been discussed.

In terms of measuring corruption, while there are popular perception and survey-based measures[9] that have been used in the empirical literature, Mendez and Sepulveda (2010) have discussed three alternate objective corruption measures: corruption incidence, relative corruption incidence and corruption rents in a theoretical model of bribery and investment. Foster, Horowitz and Mendez (2013) provide the axiomatic foundations for the measures of corruption mentioned above. One of these measures of corruption has been widely used in Cadot (1987), Mookherjee and Png (1995), Bliss and Di Tella (1997), Guriev (2004) and Barron and Olken (2009). In the present thesis, we use the corruption incidence and corruption rent measures following Mendez and Sepulveda (2010).

In the context of bureaucratic corruption, there exists a literature that addresses the interplay between collusion and extortion. However, the treatment of extortion in this interplay differs from the one in this thesis. For instance, Polinsky and Shavell (2001) consider a general setting of law enforcement, where corruptible officers can leverage their ability to frame innocent civilians in order to impose fraudulent charges and extract extortionary payments. While the authors advocate maximal penalties for collusion and reward to officials for honest behavior, extortion is advised to be left unsanctioned since otherwise it might lead to an increase in the bribe rate or increase in the risk of innocent civilians being framed. This finding is different from that in our thesis where extortion is

[9] See Svensson (2005).

also punished in equilibrium. In a recent paper, Banerjee and Vaidya (2019), extortion appears purely in the form of over assessment of taxable income due to an officer's inherent spiteful behavior when an under-reporting taxpayer rejects his bribe offer. Hindriks et.al. (1999) focus on similar mix of policy instruments as Polinsky and Shavell (2001) to examine the equity and efficiency implications of taxation systems in which officers can extract bribes and also threaten to extort citizens with over assessment of taxable income. They show that poorer agents are vulnerable to extortion while the rich are vulnerable to collusion. This is in contrast to our thesis where collusion is a low-revenue firm phenomenon and extortion is experienced by high-revenue firms.

Becker and Stigler (1974) discuss monetary incentives to improve the quality of enforcement to control crime or violation. The authors advocate raising the salaries of enforcers beyond what they can derive from elsewhere, such that on successful conviction, the difference in salaries creates dismissal cost which can more than offset the gain from malfeasance. Dhillon, Nicolo, and Xu (2017) show that raising monetary compensation may perversely incentivize reputation-concerned public officials to behave corruptly. Marjit and Shi (1998) point to the ineffectiveness of such bonuses when the tax officer's monitoring effort is endogenous. Mookherjee (1997) also shows that a policy mix aimed at inducing law-abiding behavior needs to be comprehensive, an integral part of which is rewards to law enforcers. Tirole (1986) and Mookherjee and Png (1995) also examine the role of incentives for bureaucrats in mitigating corruption. Das-Gupta and Mookherjee (1998) mention the difficulty in achieving such all-encompassing reforms under decentralized regulatory structure. For example, the tax administration is often not granted autonomy over its personnel management and has to comply with the general rules governing employment of civil servants across all government agencies. Furthermore, higher rewards to tax officers may discourage tax evasion and bribery but has the credible threat of extortion in the form of over assessment of taxable income.

There is another strand of the literature that only considers extortionary corruption where bribe is sought from citizens in spite of them acting lawfully, for example Basu et.al. (2016). The central question in this chapter is who should be penalized for corruption. They find that imposing a penalty on the bribe-taker incentivizes the honest citizen to report such malfeasant act and do have the possibility of reducing this practice. Abhink et.al (2014) provides experimental support to this outcome.

Ackerman (2010) cites country wise instances of nature of penalties on firms and officials based on the type of offense. In 1990s in Chile, while bribe giving was a criminal offense, accepting the same was not unless it followed an act of wrongdoing. The current Chilean law treats both bribe giver and taker symmetrically. However, if the bribe payer responds to a bribe demand rather than volunteering the payment, the maximum prison sentence is reduced. Similarly, Romania does not sanction the bribe payer if the same had to respond to an extortion demand.

Apart from penalty and reward, other strategies to mitigate corruption have also been considered in the literature. These include introduction of leniency policy for either parties involved in corruption (Spagnolo and Buccirossi, 2005), or a reward to one or both parties involved in collusive bribery for self-reporting (Abbink and Wu, 2017).

The current thesis differs from the enforcement literature along the following lines. First, in defining extortion. Unlike framing or harassment due to spite, the thesis considers pure extortion i.e., a situation when a compliant agent is denied a good/service by a corrupt bureaucrat to extract a bribe. Second, it considers implementation of penalty when both extortion and collusion co-exist. Third, in the treatment of punishment, instead of letting extortion go unsanctioned, the thesis considers punishment for extortion also but only for the bribe giver alone like Basu et.al. (2019). No leniency is considered for collusion and both parties involved are punished.

In a theoretical framework of crime, Becker (1968), advocates that the optimum penalty rate be decided by balancing the marginal benefit and marginal cost of crime to the society. Since for petty crimes the social marginal benefit of reduced crime may not catch up to the social marginal cost of strict enforcement, whereas for severe crimes, the marginal benefit of maximum penalty far exceeds the marginal cost of enforcement. Results derived in chapter 3 of the thesis are broadly aligned with these findings where we obtain that for low intensity of negative externality the social marginal benefit of reduced negative externality and the social marginal cost of undertaking higher qualifying investment balances at an intermediate range of penalty. For high intensity of the negative externality the marginal benefit of increased penalty far exceeds the marginal cost, and the welfare function becomes monotonically rising, producing 'Becker's Conundrum'.

While formal enforcement includes checks and balances put in place by legal institutions, there are also external factors that exercise informal control on corruption such as the media. Starke et al. (2016) explain six different ways in which a free press helps to combat corruption. First, by acting as watchdogs which leads to investigations by official bodies followed by convictions of corrupt political actors; second, by increasing the effectiveness of anti-corruption institutions by exposing their flaws; third, by providing a civic platform to lodge and voice complaints thereby contributing to the formation of public opinion; fourth, by enhancing general transparency by providing information about corruption, which reduces both individual and systemic corruption (Kolstad & Wiig (2009), Lindstedt and Naurin (2010)); fifth, as a deterrent by increasing the likelihood of exposure of the corrupt act and hence of punishment or reputation loss; sixth, in intangible ways (Stapenhurst, 2000) through "enhanced political pluralism, enlivened public debate and greater sense of accountability among politicians, public bodies and institutions". The US has been considered to achieve significant reduction in its 19th century political corruption through media-freedom and judicial efficiency (Glaeser and Goldin, 2006). The existing empirical literature (Chowdhury (2004), Bhattacharya and Hodler (2015), Kalenborn and Lessmann (2013) etc.) show that media-freedom plays an important role in controlling political corruption, which is essentially collusive in nature.

There are also case studies on countries, which have successfully reduced corruption, that highlight the role of the factors mentioned above. For instance, Singapore, Hong Kong seems to have succeeded to reduce corruption in its police force through stricter enforcement ((Quah (2007) and Hseih (2017)), the US has been considered to achieve the same through media-freedom and judicial efficiency (Glaeser and Goldin (2006)).

Another strand of literature exists that focuses solely on the impact of a change in the bureaucratic regime on corruption. Susan Rose-Ackerman (1978) suggested to introduce competition among officials receiving bribes to reduce corruption. On bribe demand, the existence of competing officials to reapply to would bid down the corruption at equilibrium.

Becker and Stigler (1974) also discuss that competition among enforcers can reduce punishment and hence deterrence to crime if the amount paid in bribes is significantly less than the monetary equivalent of the punishment as competition among enforcers lowers the market price of bribes and in turn bribery reduces punishment and thus deterrence.

Shleifer and Vishny (1993) consider a theoretical model where the supply of a government produced good can be artificially restricted by public officials who have the power to extract bribes. In this case, structures of government institutions and political process are important determinants of corruption. For instance, if two complementary goods are disbursed by two independent monopoly agencies, each ignores the effect of raising its bribe demand on the other agency's demand for the bribe. Accordingly, each set a higher bribe leading to lower output and thus a lower aggregate bribe. Alternatively, if each one of the goods can be supplied by at least two government agencies, given collusion between several agents is difficult, bribe competition between the agencies will drive the level of bribes down to zero.

Ahlin and Bose (2007) examine bribery in a dynamic setting with a partially honest bureaucracy. The authors argue that introducing competition among officials, such that applicants can leave one official and search for another can lead to inefficiencies. The option of re-applying lowers the efficient applicants' willingness to pay a bribe and delays or denies them licenses. It also allows corrupt officials to license more inefficient candidates. The authors conclude that when ability to pay the bribe is widespread, monopolistic licensing is more efficient than competitive licensing.

Drugov (2010) studies the welfare consequences of introducing competition between bureaucrats in a theoretical model, in presence of both extortion and collusion. Identical firms are considered that can improve the production process at a lumpsum cost by undertaking an investment to eliminate negative externalities of production which is an outcome of collusive corruption. Results show that introducing a competitive bureaucracy creates more ex-ante incentives for firms to invest. On the other hand, in terms of welfare monopoly regime is better at implementing ex post allocation i.e., given the investment decisions of the firms. If firms are heterogeneous in their cost, the total effect on welfare becomes ambiguous as introducing competition has two opposing effects: while more firms invest in a better technology the firms that still do not invest decrease the welfare. However, how extortion and collusion individually might be affected by the cost of investment remains unexplored.

The literature that explores the effect of a change in the bureaucratic regime on corruption unanimously agrees on the lowering of corruption in terms of bribe rate as a competitive bureaucracy is introduced. This thesis contributes to this strand of literature by exploring what happens to corruption when we distinguish between extortion and collusion and take into account both the extensive and intensive margin, in a competitive bureaucracy. Further, it also looks at the simultaneous movement of incidence of extortion and collusion and social welfare and discusses the role of investment/compliance cost as a potential policy instrument to control corruption.

The existing literature have discussed that the morality and peer effect of the participants matter in persistence of corruption. Andvig and Moene (1990) study the interaction of monetary incentive, enforcement, and morality in determination of extent of corruption in an economy. They conclude that there can be multiple self-fulfilling corruption equilibria for different distributions of moral cost in a framework where both supply and demand of corrupt acts are considered. Dhillon et al (2017) study the interaction of monetary incentive, enforcement and morality in determination of extent of corruption in an economy. Traxler (2010) considers morality in context of conditional cooperative tax evasion where tax morale is a social norm for tax compliance and find that the strength of the norm is shaped endogenously, depending on the share of evaders in the society. Results show that taxpayers' decision to evasion depends on the others' compliance. Fisman and Miguel (2007) empirically studied the relation between corruption and non-compliance and concluded that corruption norms present in a country predict the tendency to violate rules. Specifically, they collected data on parking violations by United Nations diplomats living in New York City during 1997 to 2002, to find that the diplomats from low (high) corruption countries have lower (higher) number of violations. The authors also found a significant reduction in violations following the implementation of legal enforcement in 2002.

The next section discusses the outline of the chapters.

1.3 Outline of the Chapters

The thesis contains three core chapters. This section provides a brief description of the chapters in the thesis.

Chapter 2 studies the impact of introducing competition among officials in a bureaucracy on extortion and collusion at both the intensive and extensive margin. It uses two alternate objective measures of corruption: CI (corruption incidence) and CR (corruption rent) as discussed in Mendez and Sepulveda (2010) and Foster, Horowitz and Mendez (2013) for its purpose. The theoretical model constructed in this chapter assumes that firms, who apply for a production license differ in terms of their revenue potential and must adopt an emission reducing clean technology at a cost, to be qualified to produce. The licenses are administered by both inherently honest and inherently corrupt officials with exogenously determined shares. The scope of corruption appears when a corrupt official disburses the license as she would grant license to any firm in exchange of a bribe. Consequently, two types of bribes are possible: (1) extortion: when a qualified firm pays bribe; (ii) collusion: when an unqualified firm pays bribe and while collusion has negative welfare implication as it creates pollution, extortion has no such problem. The chapter, first, considers a monopoly bureaucracy, where each firm is assigned to a single official who administers the license. Having full indispensability, a corrupt official demands the same amount of bribe for both extortion and collusion. As competition among the officials is introduced, several officials disburse the same license and firms have outside option. Reapplication is possible in both regimes, however, unlike monopoly in a competitive regime the firms can either stick to the same official or reapply to a different official chosen randomly in the next period. Although reapplication involves a cost of delay, it increases the bargaining strength of the firm and reduces the bribe rate compared to monopoly and at the same time, differs for qualified and unqualified firms, the former being lower than the later. Thus, while a competitive bureaucracy lowers corruption by lowering the bribe rate, leads to more of the firms get incentive to qualify under competitive bureaucracy at the time of application itself, increasing the frequency of extortion. The chapter specifically analyses what happens to extortion and collusion and overall corruption as a competitive bureaucracy is introduced. Social welfare implications are then discussed.

Chapter 3 introduces monetary penalties for corruption and explores the effect on both extortion and collusion following which the socially optimal penalty is obtained. In doing so, it considers, like Chapter 2, a heterogeneous set of firms whose revenue follows a uniform distribution. The government enforcement agency moves first to choose an anti-corruption penalty. As compliance, a firm needs to incur a costly emission reducing investment and apply for a license that enables it to continue production without generating a negative externality. The firm can also choose not to invest but apply, in which case it generates a negative externality on production. In the third stage a reviewing officer from a monopoly bureaucracy reviews the application and decides to engage in corruption or not and correspondingly extortion and collusion follow. In the fourth stage a firm decides whether to accept or reject the Nash Bargaining bribe offer by the officer. We assume that while the cost of emission reducing investment is fixed, the cost of the negative externality generated by a polluting firm is proportional to its revenue. Penalties are implemented to arrest corruption, and as penalties increase, more firms decide to undertake the investment in emission reducing technology. This increases the cost to society in terms of the costly aggregate investment. However, the cost to society in terms of negative externality is lowered as less firms collude. The social welfare maximizing penalty is then obtained following this trade-off. Correspondingly, the subgame perfect equilibrium corruption distribution is then determined. An imperfect legal system is considered such that an investing firm always chooses to self-report extortionary corruption irrespective whether it accepts or rejects the bribe demand but, conviction is not certain. The probability of conviction of collusion is also lower than that of extortion, as it is a mutually beneficial side contract and hence, is not self-reported but it has the possibility of being discovered by the media or some other third party. Offenders involved in both forms of corruption are punished with symmetric penalty conditional on successful conviction. The socially optimal penalty and the resultant subgame perfect equilibrium of corruption distribution, that is, the pattern of corruption that exists for different revenue levels are correspondingly determined.

Chapter 4 models a situation where a firm irrespective of its size needs to undertake a costly qualifying investment to be eligible for a production license. The scope of extortion and collusion arises as the firm faces an official for delivery of the license. While in extortion, a qualified firm is charged with a bribe; the collusive bribe hides the violation. The probability of conviction is higher in extortion than collusion since the firm, being extorted, reports the incident on its own. In the case of collusion both the sides have incentive to hide the deal. A collusion can be uncovered only by a watchful media. Since both the sides are guilty in the case of collusion, the penalty falls symmetrically on both; but in the case of extortion the penalty falls only on the official. The official is corruptible, torn between the net expected benefit that he can receive from bribery and the moral cost that he suffers from his act. He participates in corruption if the former overpowers the later. There is a moral standard in the administration, which appears as a cost for individual officials for their involvement in bribery. It depends on the proportion of officials involved in corruption. Although, it is not that all the officials are equally sensitive to the moral standard, a high moral standard throws a spanner on an official’s behaviour in terms of peer effect/network effect.

The chapter derives different sensitivity thresholds of officials for participation at extortion and collusion and shows, given a moral standard, the penalty threshold that prevents occurrence of extortion is lower than the penalty threshold that prevents occurrence of collusion. The chapter endogenously determines the total number of corrupt officials at equilibrium, who are engaged in both extortion and collusion. It goes to show, from a policy perspective increases in penalty, and probability of conviction of collusion play a significant role in mitigating corruption.

The chapter discusses the participation of the firm in compliance and also shows the corruption outcomes for different ranges of compliance cost, coupled with the reapplication cost. A high compliance cost induces the firm to avoid the investment and indulge in collusion. Thus, in this case a higher reapplication cost is required to counter this incentive. The chapter shows that under a high compliance cost, the scope of extortion is much more restricted than the scope of collusion. As the cost of qualification falls, the scope of collusion falls, but the scope of extortion rises.

The chapter then discusses the impact of policy instruments: penalty and conviction probabilities of extortion and collusion on the firm's compliance participation and shows that increase in penalty and conviction probabilities of extortion and collusion increases the firm's incentive to invest in compliance. Interestingly the chapter finds that in case of high compliance cost, an increase in the conviction probability of collusion is more effective in reducing the equilibrium number of corrupt officials compared to an increase in the penalty. This has important implications for the role of media in controlling corruption and raising the society's moral standard. Since conviction probability of collusion increases with active media watch, the effect of role of media as a watchdog has serious policy implications for reducing corruption. The chapter also provides an anecdotal evidence in support of the above claim. Using cross-country data, it also provides an anecdotal evidence highlighting the relation between non-compliance and media-freedom.

In the next section we summarize the results derived in the three core chapters of the thesis and contribution to the literature.

1.4 Results and Contribution to the Literature

Chapter 2 studies the effect of introducing competition among officials in a corrupt bureaucracy on extortion and collusion. Specifically, we ask whether extortion and collusion are uniformly affected due to an administrative regime change from monopoly to competition. The results show that under a competitive bureaucracy the frequency of extortion rises as per corruption incidence (CI) measure but, due to lower extortion bribe rate the same cannot be concluded for the corruption rent (CR) measure. The chapter also argues, both CI and CR of collusion falls under competitive regime. Both extortion and collusion taken together CI remains the same and CR falls as competition is introduced in a bureaucracy. The chapter also discusses the social welfare implications and shows that replacing monopoly if competition introduced in a bureaucracy through an administrative reform, the corruption and welfare measures of the economy may not move in the same direction. There can be outcomes where welfare increases as competition is introduced in a bureaucracy but at the same time corruption also increases. The chapter contributes to the literature by pointing out that the two different types of bribery that is present in an economy viz. collusion and extortion can be differentially affected by introduction of bureaucratic competition: in fact, one can substitute the other. So, the net outcome of introduction of bureaucratic competition on corruption-measures of an economy is not obvious. Among other exogeneous factors, it also depends on the way corruption is quantified and the conventional wisdom that the corruption falls with introduction of competition in bureaucracy does not necessarily survive. It shows that the type of conclusion we draw depends on the type of corruption we are looking at and the type of measure we are using. Another contribution of this chapter is in showing that with introduction of competition in a monopoly bureaucracy the corruption measure and the welfare measure of an economy may move in different directions.

In chapter 3, in response to government's choice of anti-corruption penalty, firms decide whether to invest in emission-reducing technology or not and we explore the effect of a monetary penalty on the distribution of corruption for various penalty ranges. Results show that an increase in the penalty leads to a non-monotonic *corruption distribution*. We show that when the extent of negative externality is low, the socially optimal penalty is within a "*very low*" range. Low revenue firms choose not to invest and indulge in collusion while high revenue firms choose to invest but encounter extortion. An increase in the extent of negative externality causes the optimal penalty to increase within this range and consequently some of the low revenue firms switch from no-investment to investment. This reduces the incidence of collusion, but the corruption distribution remains the same. When the extent of the negative externality reaches a critical level, the optimal penalty jumps from the "*very low*" range to a "*medium range*". This results in a further reduction in the incidence of collusion and some of the low revenue firms who switch from no investment to investment interestingly face no corruption because for them the penalty is above their threshold penalty levels that sustain collusion and extortion. The low revenue firms that stick to no-investment continues to indulge in collusion while the high revenue firms continue investing but face extortion. Strengthening of negative externality causes an increase in the optimal penalty within this range and this further reduces the incidence of collusion. As the extent of negative externality becomes very high, the cost imposed by it also becomes very high. Therefore, it becomes imperative to eliminate the negative externality by eradicating collusion. Consequently, the optimal penalty becomes high enough to eliminate collusion and all firms choose to invest. However, extortion remains as a high-revenue phenomenon. All forms of corruption are eliminated only when the penalty becomes prohibitively high. These findings suggest that for low negative externality, a penalty that eliminates collusion and hence negative externality is not socially optimal. The contribution of the chapter is novel and counterintuitive. First, we simultaneously characterize extortion and collusion equilibrium at alternative penalty ranges and show non-monotonicity of extortion incidence, which is counterintuitive. Second, it matches the collusion and extortion incidence with the revenue distribution of the firms. While collusion is a low-revenue firm phenomenon, extortion is that of a high revenue firm. Third, we show that the elimination of extortion may not be the social welfare-maximizing choice for a society. The welfare maximization under certain situations may demand existence of either one or both types of corruption.

In chapter 4 we theoretically consider the interaction between enforcement and morality, with four distinct points of departure from the earlier literature: (i) it makes a distinction between sensitivity to moral standard and moral standard itself, while the former is an intrinsic value to an official, the latter is function of the size of network of corrupt officials. (ii) it clearly demarcates how the sensitivity to moral standard differs for extortion and collusion leading to different incidences of the same. (iii) it brings out the importance of penalty, media-freedom and judicial efficiency in influencing the number of corruptible officials the corresponding network effects it generates. (iv) it analyses how penalty, compliance cost, media-freedom, efficient judiciary and reapplication cost are important policy instruments for designing strategies to control corruption.

The officials with their sensitivity lower than morality thresholds, endogenously determined in the model, participate in corruption if and only if the punishment levels are also below certain thresholds, also endogenously determined in the model. The chapter shows that under reasonable assumptions, both the morality threshold and punishment threshold for extortion lie below the similar thresholds for collusion, and the scope of extortion is more restricted compared to the scope of collusion. At low compliance cost, however, extortion prevails.

At low and medium penalty ranges, while media-watch plays an important role in controlling both types of corruption, the efficiency of judiciary matters if only extortion prevails in the bureaucracy. While discussing the policy implications, we have highlighted the role of penalty, compliance cost, cost of reapplication and conviction probabilities of extortion and collusion. In presence of high compliance cost, the number of corrupt officials at equilibrium is decreasing in both penalty and the probability of conviction of collusion.

The latter, which depends on media-watch is however more effective in lowering the number of corrupt officials and correspondingly in raising the societal moral standard. The model predicts that the countries with less media activism is expected to see more violation of law and provides an anecdotal evidence to support this prediction. It supplements the widely cited study by Fisman and Miguel (2007) with cross-country media-freedom data for this purpose. It takes the country rank of Fisman and Miguel (2007) on violation of parking norm and find its Spearman's rank correlation with ranking of the countries on the basis of their average media-freedom score in 1997-2002, calculated from Press Freedom scores provided by Freedom House. The outcome is consistent with the theoretical prediction of the model that the diplomats from the countries with lower media freedom were more prone to rule-violations.

The chapter makes several contributions to the existing literature. First, it shows, how monetary penalty, moral standard and individual-specific sensitivity to moral standard interact to determine the scope extortion and collusion in a bureaucracy. Second, it shows, how changes in penalty and conviction probability of collusion generates a network effect of corruption by influencing the number of corrupt officials. Third, since bureaucratic corruption is associated with execution of laws, this chapter suggests a greater role of media-freedom may arrest the violations in execution of law and the associated corruption. The chapter focuses on the role of media-watch in determination of the size of the network, the moral standard. It also analyses how media-watch and the compliance cost determine the extent of violation of law. Fourth, the chapter suggests the way policies can be designed in medium and low penalty bureaucracies for controlling its corruption by appropriate use of compliance cost, media-freedom, judicial efficiency against extortion cases and reapplication fees, which is new to the literature.

In the next section we present a plan of the thesis.

1.5 Plan of the Thesis

The rest of the thesis is organized as follows.

Chapter 2 analyses the impact of a competitive bureaucracy in an economy characterised by extortion and collusion in a theoretical framework. It also looks at the movement of corruption and welfare.

Chapter 3 studies the distribution of extortion and collusion across alternate penalty ranges for firms heterogeneous in their revenues. It also obtains the socially optimal penalty for varying intensities of negative externality.

Chapter 4 explores the interaction between enforcement and individual-specific sensitivity to moral standard in determining the scope of extortion and collusion in a bureaucracy consisting of corruptible officials and discusses policy variables like compliance cost, media freedom, judicial efficiency in convicting extortion and reapplication cost. It also provides an anecdotal evidence in favour of a theoretical prediction of the model on the relation between media freedom and compliance with laws in cross-country data.

Chapter 2*

Corruption and Welfare:

Monopoly vs. Competitive Bureaucracy

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2.1 Introduction

It is well known in economic theory that competition improves the functioning of the private sector. However, whether the same holds true for the public sector, especially in delivery of public goods and services, is an interesting research question. As far as the corrupt bureaucracies are concerned, the conventional theories suggest, if competition is introduced among bureaucrats for delivery of public goods and services, corruption falls (Rose Ackerman 1978; Shleifer and Vishny 1993) since Bertrand like competition among several non-colluding agents in bribes drives down the equilibrium bribe to zero[10]. But the conventional theory fails to recognize the fact that the change in intensive margin of bribes is not the only outcome of bureaucratic competition: the extensive margin can also change along with it. As the bribe rate changes along with frequency of illegal transactions, such an administrative reform would have its effect in terms of both corruption and welfare of the economy. In real life such competitions have already been introduced in many countries in case of delivery of passports, driving licenses, police investigation[11]. The papers like Ahlin and Bose (2007) and Drugov (2010) discuss the effect of bureaucratic competition on welfare and show that it may lead to fall in welfare of an economy. However, in both these papers the corruption incidence and the welfare incidence of introduction of such a bureaucratic reform has not been differentiated clearly. What happens to welfare and corruption measures of an economy as competition is introduced in its bureaucracy for delivery of a public good or service? The present chapter addresses this question and shows that the welfare measure and corruption measures may

[10] Menes (1999, 2003) argues that an important contributing factor to declining municipal corruption in the United States during the turn of the 19th century was the expansion of American Frontier and development of railroads, which raised the 'elasticity' of the local revenue base to bribe rates.

[11] In India, a FIR (First Investigation Report) can be registered at any police station, not necessarily at the jurisdiction where the crime has taken place.

not always move in the same direction: in terms of some corruption measures corruption may rise with introduction of competitive bureaucracy while welfare improves under certain conditions.

In doing so, the present chapter distinguishes between two types of bribery: extortion and collusion. While both involves bribery, the collusion delivers by violation of law, the extortion is a forced collection from an honest agent. Although the collusion benefits both the official and the bribe payer, extortion harms only the payer. Further, collusion entails a cost to society in terms of a negative externality it creates which is absent in the case of extortion. This chapter follows Mishra (2006), to differentiate between the two concepts using an emission control example from the taxi industry in Kolkata, India. Taxi owners are required to undergo a periodical compliance inspection of their vehicle to ensure that emission is below the stipulated level. This requires a fixed investment in the form installation of new filters or other gadgets. *Collusion* refers to the scenario where a taxi-owner has not invested in emission control and the inspecting officer engages in bribery to issue the clearance certificate. Alternatively, the taxi-owner invests but the officer seeks a bribe in lieu of the issuance of the certificate. Thus, corruption takes the form of *extortion*[12]. So extortion may incentivise an honest taxi-owner to act unlawfully. Hence, both forms of corruption have distortionary effects[13].

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[12] Mishra (2006) also refers to an intermediate case of corruption, where a non-polluting firm needs a clearance certificate. The inspector may not actually report this firm as a polluting firm but can simply stall or delay the issue of the certificate. This is a case of harassment and bureaucratic red tape. The motive is similar to extortion and the client needs to pay a bribe to get the clearance certificate.

[13] Bertrand et al (2007) clearly distinguishes between collusion and extortion in their study of driving-license distribution in India. The officials have been found to arbitrarily fail applicants in the driving test to procure bribe, which would be a case of extortion. On the other hand, it is also not uncommon to find applicants obtain the license without knowing how to drive, in exchange for a bribe, which would be a case of collusion. Klitgaard (1988) also provide examples of both extortive and collusive corruption in the Philippine tax system. For extortion, the tax inspector assesses an unrealistically high due and since appeal is costly in the

For its purpose, the present chapter adopts the framework of Drugov (2010) and applies the alternative corruption measures as discussed in Mendez and Sepulveda (2010), Foster, Horowitz and Mendez (2013) in it. These measures are Incidence of Corruption (CI) and Corruption Rents (CR). While CI measures the number of times a bribe transaction takes place; CR measures the total amount of rents collected by corrupt public officials from bribe transactions[14]. The model presented in the chapter assumes that the firms differ from each other in terms of their revenue potential[15]. Each of them can either use an old polluting technology for production which generates negative externality to the society in the form of pollution, or they can adopt in a clean technology. As per legislation, only the firms investing in the clean technology are qualified to produce. But the adoption of clean technology is costly. There are both honest and corrupt officials in the bureaucracy with exogenously determined shares. The identity of an official and an applicant is disclosed at the time of their interaction[16]**.** The honest officials grant licenses only to qualified firms and do not charge a bribe, but the corrupt officials would grant license to any firm in exchange

Philippine legal framework, and taxpayers are often uncertain about the exact due, the tax inspector takes advantage by extorting a payment in exchange for the correct assessment. Collusive bribery is witnessed in "arreglo" (arrangement) which occurred when a tax inspector discovers a taxpayer reporting understated income or too many deductions. The taxpayer would then perhaps pay half the actual tax and of the other half, two-thirds is paid to the inspector as collusive bribe and the rest is kept by the taxpayer himself. Transparency International (2011 South Asia Barometer) reports that 54 percent of respondents in India had to pay a bribe to obtain a public service; the bribes primarily being extortionary.

[14] One of these measures of corruption has been widely used (Cadot 1987; Mookherjee and Png 1995; Bliss and Di Tella 1997; Guriev 2004; Barron and Olken 2009). One can also think about additional alternative measures of corruption like Relative Rent which is defined as the amount of bribe paid as a proportion the value of the firm's license. We do not discuss it separately here as it gives identical results to the comparison of CR measure. Also, the axiomatic foundation of such a measure remains to be checked.

[15] In Drugov (2010) they differ with each other in terms of their cost of production.

[16] See Ahlin and Bose (2007) and Bhattacharya and Mukherjee (2019) for models where the information about the firm remains private even at the time of interaction. While both papers discuss red tape, the former concentrates on the effect of introduction of bureaucratic competition on welfare of such an economy.

of a bribe. Thus, there exists two different types of bribes: (1) extortion: when a qualified firm pays bribe; (ii) collusion: when an unqualified firm pays bribe. The bribe is determined through Nash Bargaining[17]**.** While collusion has negative welfare implication as it creates pollution, extortion has no such problem. Under monopoly regime, a single official administers the license and the firms do not have choice to avoid her. Thus, having full authority to refuse an applicant, corrupt official charges the same amount of bribe to both qualified and unqualified firms.

Under competitive regime, several officials disburse the same license. In both monopoly and competition regimes, the firms can reapply for the license in the next period. However, unlike monopoly regime in a competitive regime the firms can either stick to the same official or they can randomly choose an official to reapply in the next period[18]. Reapplication leads to delay and reduces profit of the firm[19]. But the possibility of reapplication under competitive regime increases the bargaining strength of the firm and reduces the bribe rate, which differs between a qualified firm and an unqualified firm, the former being lower than the later. So, under competitive bureaucracy more of the firms with high revenue potential get incentive to get qualified at the time of application itself and the frequency (CI) of extortion rises. However, due to lower bribe rate the same cannot be concluded for the CR measure. The chapter also argues, both CI and CR of collusion falls under competition regimes. For the economy as a whole CI remains the same and CR

[17] As opposed to Nash Bargaining, one can think of a take-it-or-leave-it bribe offer (TIOLI) where firms have no bargaining power. Although TIOLI bribe offer changes the bribe amounts, the results of the chapter that compares a monopoly bureaucracy with a competitive bureaucracy qualitatively remain unaffected.

[18] In this chapter we assume the number officials in the bureaucracy is sufficiently large. An interesting extension of this chapter will be the case of a small bureaucracy where the game will have a finite horizon. We discuss the heuristics of the finite horizon case in footnote 11 below.

[19] In the present model, officials and firms discount the delay at the same rate. However, Drugov (2007) discusses the case where the firms have a cost of reapplication different from cost of delay.

falls. The chapter also discusses the social welfare implications and shows that replacing monopoly if competition introduced in a bureaucracy through an administrative reform, the corruption and welfare measures of the economy may not move in the same direction. There can be outcomes where welfare increases as competition is introduced in a bureaucracy but at the same time corruption also increases.

The difference of the present chapter with the literature cited above is in pointing out that the two different types of bribery that is present in an economy viz. collusion and extortion can be differentially affected by introduction of bureaucratic competition: in fact, one can substitute the other. So, the net outcome of introduction of bureaucratic competition on corruption-measures of an economy is not obvious. Among other exogeneous factors, it also depends on the way corruption is quantified. The present chapter uses two different frequently used measures of corruption to conclude, the conventional wisdom that the corruption falls with introduction of competition in bureaucracy does not necessarily survive. It shows that the type of conclusion we draw depends on the type of corruption we are looking at and the type of measure we are using. Another contribution of the present chapter is in showing that with introduction of competition in a monopoly bureaucracy the corruption measure and the welfare measure of an economy may move in different directions, something that has not been discussed in the existing literature.

Section 2.2 reproduces Drugov (2010) model in a new parametric framework. Section 2.3 first derives the welfare results regarding introduction of bureaucratic competition and then, derives the results regarding corruption measures and compare the direction of change in the two measures. Section 2.4 concludes.

2.2 The Model

Consider an economy where firms are heterogeneous in terms of their revenue potential r that follows a probability distribution $g(r)$. The cdf corresponding to $g(\cdot)$ is given by $G(r)$. We assume $G(r)$ is monotonically increasing and continuously differentiable. Legally each firm must invest $x > 0$ in adopting clean technology that would make them eligible for production. A firm with revenue r_i that qualifies by investing in clean technology generates a welfare of $(r_i - x) \geq 0$, an unqualified firm that creates a pollution cost lr_i where $l > 0$ by producing, generates a welfare of $r_i(1 - l) \gtreqless 0$ as $1 \gtreqless l$.

Let us now discuss the two regimes in detail, starting with the monopoly regime.

2.2.1 Monopoly Regime

Let the bribe charged for qualified and unqualified firms in monopoly regime is denoted by b_m^q and b_m^u respectively[20]**.**

Lemma 1: *[Drugov (2010)]* $b_m^q = b_m^{uq} = b_m^u = b_m = \frac{1}{2} r_i$.

Given the non-discriminatory bribe rate, the investment alternatives of a firm are:

(i) investing in period 1 itself, with expected profit:

$$\pi_m^q = hr_i + (1 - h)\frac{1}{2}r_i - x; \tag{1}$$

(ii) investing in period 2 if official met in period 1 is honest, with expected profit:

$$\pi_m^{uq} = h\delta(r_i - \text{x}) + (1 - h)\frac{1}{2}r_i; \tag{2}$$

(iii) never investing and hoping to obtain the license from one of the corrupt officials, with expected profit:

[20] Notice that monopoly bribe rate is non-discriminatory. The qualified firm is forced to pay the same bribe as the unqualified firm because the qualifying investment is sunk. The monopoly official while negotiating bribe does not care about whether the firm has undertaken qualifying investment or not. Anticipating this, a firm (with potential revenue R_i) adopts investment decision in such a way that its profit is maximized.

$$\pi_m^u = (1-h)\frac{1}{2}r_i. \tag{3}$$

A firm decides to be qualified in period 1 itself if and only if $\pi_m^q - \pi_m^{uq} \geq 0$. Substituting from equations (1) and (2) this implies if its revenue $r_i \geq r_1^m$ where $r_1^m = \frac{x(1-\delta h)}{h(1-\delta)}$. On the other hand, the firm decides to be qualified after meeting an honest official if and only if $\pi_m^{uq} - \pi_m^u \geq 0$. Substituting from equations (2) and (3) this implies it takes such a decision if and only if $r_i \geq x$. A firm with $r_i < x$ remains unqualified forever. Thus, all firms with $r_i \geq 0$ enter the industry. A firm with $r_i \in [0, x)$, never undertakes qualifying investment. A firm with $r_i \in [x, r_1^m)$ remains unqualified initially but qualifies if the official met in period 1 is honest; and a firm with $r_i \in [r_1^m, \propto)$, qualifies in period 1 itself. While all firms in $[0, \propto)$ pay bribe-amount $\frac{1}{2}r_i$ if met with a corrupt official; the firms with $r_i \in [0, r_1^m)$ pay for collusion, the firms with $r_i \in [r_1^m, \propto)$ pay for extortion.

Lemma 2: *$r_1^m > x$ and r_1^m is monotonically falling in h.*

Proof: See the appendix.

Since investment is costly, a firm having $r_i < x$ never invests. Among the firms with $r_i \geq x$, since there is a positive probability that an honest official can be met in period 1, the firms with their revenue potential above the threshold level of r_1^m invests in first period itself to avoid the delay in reapplication process. The higher is the proportion of honest officials in the bureaucracy, the lower is the revenue threshold r_1^m; given the revenue distribution, higher is the chance that a firm qualifies in period 1 itself.

2.2.2 Competitive Regime

With investment in period 1 itself, the firm's expected profit is:

$$\pi_c^q = hr_i + (1-h)\left(r_i - b_c^q\right) - x. \tag{4}$$

If the firm invests in period 2 after meeting an honest official in period 1, its expected profit is:

$$\pi_c^{uq} = \delta h(r_i - x) + (1-h)\big(r_i - b_c^{uq}\big). \tag{5}$$

If the firm never invests, its expected profit is:

$$\pi_c^{u} = \delta h \pi_c^{u} + (1-h)(r_i - b_c^{u}) \,. \tag{6}$$

Lemma 3: [*Drugov* (2010)]

(i) $b_c^q = \frac{r_i(1-\delta)}{2-\delta+\delta h}$, $b_c^u = \frac{r_i(1-\delta)}{2-\delta-\delta h}$ and $b_c^{uq} = \frac{r_i - \delta^2 h(Ri-C) - \delta r_i(1-h)}{2-\delta+\delta h}$

(i) $b_c^q < b_c^{uq} < b_c^u < b_m$.

The bribe amount depends on relative bargaining strength of the parties involved in bribe negotiation which in turn is determined by their disagreement payoffs[21].

Substituting the values of b_c^q , b_c^{uq} and b_c^u in equations (4), (5) and (6) respectively we calculate the equilibrium values of expected profit π_c^q, π_c^{uq} and π_c^u. It turns out that for all values of $r_i \geq 0$, $\pi_c^u \geq 0$. So, like monopoly, all firms enter the market in the competitive regime irrespective of their revenue potential. A firm invests in period 1 itself if and only if $\pi_c^q - \pi_c^{uq} \geq 0$ which implies if and only if its revenue $r_i \geq r_1^c$ where $r_1^c = \frac{x[2-\delta(1+h)]}{2h(1-\delta)} > 0$. Similarly, if $\pi_c^{uq} - \pi_c^u \geq 0$ a firm under bureaucratic competition remains

[21] Note here depending on the regime type and their own period 1 investment decision it is the disagreement payoff of the firms that changes. Also, that the assumption of availability of large number of officials in the bureaucracy and infinite reapplication possibility plays an important role in determination of bribes in competition regime. For realizing this clearly, consider the case of a firm which has decided never to invest in qualifying technology. There is a possibility that it meets a corrupt official and obtains the license immediately. However, it may meet an honest official and on denial of the license reapplies to a randomly chosen official in the next period. In period 3 the same situation may arise again, and the sequence can be repeated for infinitely large number of periods. Thus, the expected profit of the firm becomes $(1-h)(r_i - b_c^u) + \delta h[(1-h)(r_i - b_c^u) + \delta h(1-h)(r_i - b_c^u) + \cdots]$. With each reapplication the expected profit of the firm decreases and the bribe surplus falls but at a diminishing rate. Consequently, the bribe rate falls. In a bureaucracy with small number of officials, the bribe surplus and the bribe rate are expected to be higher than the bribe rates presented in lemma 3 above. In each case the bargaining surplus is equally divided between the firm and the corrupt official in determination of bribe.

initially unqualified and invests once it meets an honest official. Note that this happens for all firms having $r_i \geq r_2^c$ where $r_2^c = \frac{x[2-\delta(1+h)]}{(1+h)(1-\delta)} > 0$.

Lemma 4: (i) $r_1^c > r_2^c$; (ii) *Both* r_1^c *and* r_2^c *are monotonically falling in* h.

Proof: Since $(1 + h) > 2h$, it follows from expressions of r_1^c and r_2^c defined above.

Part (i) of Lemma 4 has the same intuition as lemma 2. Part (ii) shows with competition, in a more corrupt bureaucracy with lower values of h, more firms with lower revenue potential choose to adopt the 'never invest' decision due to higher expectation of eventually meeting a corrupt official in the reapplication process; the other firms with higher revenue potential invest in qualifying technology once an honest official is met. In a relatively honest bureaucracy with higher values of h at the equilibrium only two investment strategies of the firms expected to prevail: the firms with $r_i < x$ never invests; all other firms invest and get qualified in period 1 itself.

Using the discussion above and lemma 4 we shall now summarize the features of competition regime equilibrium as:

All the firms with $r_i \geq 0$ enter the industry. A firm having its revenue in $[0, r_2^c)$ never invests in clean technology. A firm with its revenue in $[r_2^c, r_1^c)$ invests and becomes qualified if an honest official is met, and a firm in $[r_1^c, \propto)$ invests to be qualified in period 1 itself. All firms in $[0, \propto)$ pay bribe if met with a corrupt official; the firms in $[0, r_1^c)$ pay collusive bribe and the firms in $[r_1^c, \propto)$ pay extortion bribe.

2.3 Comparison of the Regimes

Lemma 5: $r_1^m > r_1^c$; $(r_1^m - r_1^c)$ *is monotonically falling in* h.

Proof: See the appendix.

The higher qualifying threshold in monopoly regime is due to a lower extortion bribe in competition regime (from lemma 3 above) which induces more firms become qualified in period 1 itself in competition. As h rises (falls) both r_1^m and r_1^c falls (rises) as suggested by lemma 2 and 4 above. Lemma 5 suggests that the rate of fall (rise) in r_1^m is higher (lower) than that of fall (rise) in r_1^c.

Lemma 6:$r_2^c > x$.

Proof: See the appendix.

Unlike the competitive regime a firm cannot afford to remain unqualified in monopoly regime if an honest official is met and hence the qualification threshold is lower in the monopoly regime compared to the competitive regime.

Lemma 7: $(r_1^m - x) > (r_1^c - r_2^c)$.

Proof: Since $r_1^c > r_2^c$ from lemma 4, the statement of the lemma follows directly from lemma 5 and 6 above. $\square$

Using lemma 2, 4, 5, 6and 7 in figure 2.1 below we compare the revenue thresholds under the two regimes as:

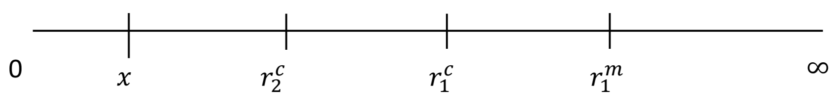

Figure 2.1: Comparison of revenue thresholds in monopoly and competition regimes

In this chapter, the above figure is central to comparison of corruption measures and welfare measures across the two regimes. It should be noted that in either regime an unqualified firm would strike a collusive bribe deal immediately as it meets a corrupt official and a qualified firm would be paying up the extortion bribe. In monopoly this happens due to lack of options and in competition this happens in order to avoid delay. In monopoly given the lack of outside option, on meeting an honest official, an unqualified firm is compelled to invest in clean technology. On the contrary competition provides better chances of collusion and at the same time better ex-ante investment incentives. However, monopoly bribes dominate competitive bribes and hence it is important first to look at the frequency of extortion and collusion across regimes and thereafter to look at the combined effect of bribe amount along with the corruption incidence. A lower bribe amount does not necessarily guarantee lower corruption in aggregate terms and the comparison of corruption under the two regimes turn out to be a non-trivial problem. Since the qualified firms generate non-negative welfare and the unqualified firms generate negative welfare to the society, the welfare comparison also becomes non-trivial.

2.3.1 Comparison of Welfare

Let W denote the expected welfare level of an economy consisting of both extortion and collusion. The welfare under monopoly bureaucracy is:

$$W_m = \int_0^x (1-h)r(1-l)g(r_i)dr_i + \int_x^{r_1^m}[h(r_i - x) + (1-h)r_i(1-l)]g(r_i)dr_i + \int_{r_1^m}^{\infty}(r_i - x)g(r_i)dr_i. \quad (7)$$

Similarly, the expected welfare in the competition regime is given by:

$$W_c = \int_0^{r_2^c} \frac{(1-h)r(1-l)}{1-\delta h} g(r_i)dr_i + \int_{r_2^c}^{r_1^c}[h(r_i - x) + (1-h)r_i(1-l)]g(r_i)dr_i + \int_{r_1^c}^{\infty}(r_i - x)g(R_i)dR_i - X. \quad (8)$$

Notice from (7) and (8) that in either of the two regimes the negative effect on the welfare can arise only from a sufficiently high effect of negative externality i.e. $l > 1$ caused by unqualified investment through collusive bribery.

We assume, the administrative cost of introducing bureaucratic competition is given by X. As explained in footnote 2 above, we assume $X \approx 0$.

From equation (7) and (8):

$$W_m - W_c = -\int_0^x \frac{(1-h)r(1-l)\delta h}{1-\delta h} g(r)dr + \int_x^{r_2^c}\left[h(r-x) + \{(1-h)r(1-l) - \frac{(1-h)r(1-l)}{1-\delta h}\}\right] g(r)dr + \int_{r_1^c}^{r_1^m}(1-h)(x - lr)g(r)dr. \quad (9)$$

Proposition 1: *In presence of corruption,*

$W_m - W_c \gtreqless 0$ *if and only if* $x \gtreqless \bar{x}$, *where*

$$\bar{x} = \frac{\frac{-(1-h)(1-l)\delta h[\int_0^{r_2^c} G(r)dr - r_2^c G(r_2^c)]}{1-\delta h} + h[\int_x^{r_2^c} G(r)dr + xG(r_2^c)] + (1-h)l[\int_{r_1^c}^{r_1^m} G(r)dr + r_1^m G(r_1^m) + r_1^c G(r_1^c)]}{(1-h)[G(r_1^m) - G(r_1^c)]}.$$

Proof: See the appendix.

The introduction of competition in a monopoly bureaucracy creates two different types of welfare costs: (i) more unqualified firms procure licenses through collusion and therefore, generates negative externality to the society; (ii) more firms enter after incurring the costly qualifying investment. Proposition 1 suggests that if the cost of qualifying investment is substantially high, the introduction of competition reduces welfare. If the externality cost is high i.e. $l > 1$, $[\frac{-(1-h)(1-l)\delta h[\int_0^{r_2^c} G(r)dr - r_2^c G(r_2^c)]}{1-\delta h}]$ becomes negative reducing the value of $\bar{x}$. In such a situation, the welfare loss associated with competition regime is more likely. For a sufficiently high value of l, there is a possibility that $\bar{x} < 0$. Then, the competition always reduces the welfare of the economy independent of the cost of qualifying investment.

We analyse the movement of corruption and welfare in section 3.3.

2.3.2 Comparison of Corruption Measures

Following Mendez and Sepulveda (2010) we use two alternative measures of corruption, which are as follows:

Corruption Incidence (CI): measures the number of licenses administered through bribes.

Total Corruption Rents (CR): measures the total amount of rents collected by corrupt public officials in the form of bribes.

Now we first compare the above measures for the cases of extortion and collusion separately, and then look at their combined effect on the economy. The subscripts j, k and l represents the 'type of corruption', administrative regime and investment decision respectively where E and S represent the respective cases of extortion and collusion. Using the lemmas derived above we have:

$$CI_k^j = (1-h)\int_t^T g(r_i)dr_i \tag{10}$$

$t = r_1^k\,; T = \infty$ for $j = E$ and $t = 0; T = r_1^k$ for $j = S$ where $k = m, c$

$$CR_k^j = (1-h)\int_{r_1^k}^{\infty} b_k^q g(r_i)dr_i \text{ when } j = E; k = m, c \tag{11.1}$$

$$CR_k^j = (1-h)\left[\int_0^{r_2^k} b_k^u g(r_i)dr_i + \int_{r_2^k}^{r_1^k} b_k^{uq} g(r_i)dr_i\right] \text{when } j = S; k = c; \text{ and} \tag{11.2}$$

$$CR_k^j = (1-h)\int_0^{r_1^k} b_m g(r_i)dr_i \text{ when } j = S; k = m$$ (11.3)[22]

Observation 1: *The CI for extortion is higher in the competitive bureaucracy compared to monopoly bureaucracy i.e.* $CI_c^E > CI_m^E$.

Proof: See the appendix.

Given the higher ex-ante investment incentives in competition regime, there are more qualified firms in this regime compared to monopoly. This immediately implies higher frequency of extortion in the competition regime given the number of corrupt officials.

Observation 2: *The CR measure of extortion i.e.* $CR_c^E \gtreqless CR_m^E$ *if and only if* $\int_{r_1^c}^{r_1^m} b_c^q\, g(r_i)dr_i \gtreqless \int_{r_1^m}^{\infty}\left(b_m - b_c^q\right) g(r_i)dr_i$.

Proof: See the appendix.

[22] One might also implement Relative Corruption Incidence (CRI) which measures the ratio of licenses involving a bribe to the total number of licenses administered. Note that since license through a bribe is delivered by the proportion of corrupt officials this measure is represented $(1-h)$ and thus is same across the regimes.

Observation 2 substantiates our claim that introducing bureaucratic competition may not necessarily reduce corruption when it is aggregated over both intensive and extensive margin. The ambiguity in the rent comparison stems from the fact that on introduction of competition extortion bribe falls as in lemma 3 but more firms get qualified in period 1 as shown in observation 1. In a bureaucracy with higher proportion of honest officials, extortion is less likely to occur and from lemma 5, $(r_1^m - r_1^c)$ falls since more firms are induced to get qualified in period 1 in both regimes. However, from lemma 3(ii) since $b_m > b_c^q$ for all values of h the difference in intensive margin prevails. Therefore, in such bureaucracies, the corruption rent in the monopoly regime is likely to dominate corruption rent in the competitive regime. On the other hand, chances of extortion increase in a more corrupt bureaucracy and $(r_1^m - r_1^c)$ expands. So, in such bureaucracies the corruption rent is likely to dominate.

Observation 3: *The CI measure for collusion under competitive bureaucracy is lower than that under monopoly bureaucracy i.e.* $CI_c^S < CI_m^S$.

Proof: See the appendix.

The observation above appears to be counterintuitive since competitive regime provides higher chances of collusion because of the outside option. However, we know from observation 1 that as competition is introduced in the bureaucracy more firms get qualified in period 1 itself which reduces the extensive margin of unqualified firms and hence given the number of corrupt officials, the frequency of collusion falls.

Observation 4: *The CR measure for collusion in the competitive bureaucracy is lower than that under monopoly bureaucracy i.e.* $CR_c^S < CR_m^S$.

Proof: See the appendix.

Since both extensive and intensive margin of collusive bribery involving unqualified firms under competitive bureaucracy is smaller than that under monopoly bureaucracy, the corruption rent in the latter is more than that under the former.

Since a typical corrupt economy finds both these cases coexisting with each other we combine the two cases discussed above to analyse overall corruption across the regimes**.**

$$CI_k = (1-h)\int_0^\infty g(r_i)\,dr_i \qquad \text{for } k = m, c; \tag{12}$$

$$CR_c = (1-h)[\int_0^{r_2^c} b_c^u g(r_i)dr_i + \int_{r_2^c}^{r_1^c} b_c^{uq} g(r_i)dr_i + \int_{r_1^c}^\infty b_c^q g(r_i)dr_i]; \tag{13}$$

$$CR_m = (1-h)[\int_0^\infty b_m g(r_i)dr_i. \tag{14}$$

Proposition 2: *In a corrupt economy where both extortion and collusion coexist, CI measure of corruption is same under both the competitive and the monopoly bureaucracy; but when CR measure is applied, corruption is higher in a monopoly bureaucracy compared to a competitive bureaucracy.*

Proof: See the appendix.

Since in a corrupt economy any firm entering the industry ends up paying either extortion or collusive bribe if a corrupt official is met, the number of bribe incidents essentially gets determined by the number of corrupt officials in the economy who strike a bribe deal with firms immediately. Therefore, the CI measure turns out to be the same in either type of bureaucracies. In addition, since the monopoly bribe exceeds the competition bribe for both extortion and collusion, it is obvious that corruption rent in the monopoly bureaucracy exceeds the same in the competitive bureaucracy.

Proposition 2 when contrasted with observations 1-6, reveals that as competition is introduced in a monopoly bureaucracy, incidence of extortion rises along with a fall in incidence of collusion, but these two balances each other to keep the overall incidence of corruption in the economy unchanged. The overall corruption rent, however, falls.

Therefore, the corruption measure of an economy, consequent on the change from monopoly bureaucracy to competitive bureaucracy, crucially depends on which type of corruption we are focussing on and the nature of the economy whether collusion or extortion is prevalent in it.

2.3.3 Corruption and Welfare

As competition is introduced in a monopoly bureaucracy, would we expect corruption to go down, as expected in the literature, and welfare to rise? In case of welfare, Drugov (2010) showed that the answer is ambiguous, as we have explained in the framework developed in the present chapter in section 3.1 above. In case of corruption, we have derived two alternative measures in section 3.2 above and shown that the answers are different for different types of corruption and different measures. Using the discussion above it is easy to show that replacing monopoly if competition introduced in a bureaucracy through an administrative reform, the corruption and welfare measures of the economy may not move in the same direction. There can be outcomes where welfare increases as competition is introduced in a bureaucracy but at the same time corruption also increases. Let us consider an example below.

Consider the case of a corrupt economy where $h \to 0$. For such an economy it follows from equation 9 that the net welfare effect depends on the extensive margin of firms with $r_i \in [r_1^c, r_1^m)$ and on the costs of investment and negative externality. Note firms with their revenue in $[r_1^c, r_1^m)$ invest in period 1 under the competitive bureaucracy and under a monopoly bureaucracy they if they meet an honest official. Now, as the share of corrupt officials increases i.e., $h \to 0$, it follows from lemma 5, $[r_1^c, r_1^m)$ expands and if the cost of investment is less than the cost of negative externality, it follows from Proposition 1 that competition is welfare improving. At the same time, as $h \to 0$ it follows from observation 2 that the extortion rent in competition dominates the extortion rent in monopoly i.e.,

$CR_c^E > CR_m^E$. Further from observation 1 $CI_c^E > CI_m^E$ for all values of h. Thus, in a relatively corrupt economy, as per the frequency and rent in context of extortion can increase even if competition turns out to be welfare improving.

2.4 Conclusions

The chapter attempts to derive the impact of introducing competition among officials in a monopoly bureaucracy in terms both welfare measure and corruption measures in a unified framework. It transforms the framework developed by Drugov (2010) in such a way that the alternative measures of corruption defined formally by Mendez and Sepulveda (2010), Foster, Horowitz and Mendez (2013) viz. Incidence of Corruption (CI) and Corruption Rents (CR) can be directly derived in it and compared with the welfare measure.

The chapter finds that with introduction of competition among officials in a bureaucracy, according to CI measure, extortion rises but collusion falls. But when CR measure is applied, though nothing definite can be concluded about extortion, collusion falls. When extortion and collusion taken care of together, CI measure remains unchanged, but CR measure falls. Therefore, the type of conclusion we draw about corruption-impact of such an administrative reform depends on the type of corruption we are looking at and the type of measure we are using. The chapter also shows that with introduction of competition in a monopoly bureaucracy the corruption measure and the welfare measure of an economy may move in different directions. Especially, in a bureaucracy where almost all the officials are expected to be corrupt, we show while introduction of competition can raise the welfare level of the economy under certain conditions, frequency of overall corruption remains unchanged while total corruption rent declines.

The impact of implementing anti-corruption strategies on corruption and welfare of an economy is often difficult to measure because of unavailability of data on corruption. Of the two types of corruption viz. extortion and collusion, the data on extortion is easier to access because it leaves with a victim who has incentive to report the extortion. This is not true for collusion which is a Pareto improving side contract between the parties. The chapter shows that the measures based on extortion may behave completely differently than the measures either based on collusion or based on the overall corruption level of the economy. This might call for a trade off when it comes to policy prescription of introduction of competition in a bureaucracy.

There is also a trade-off in terms of welfare. The introduction of competition in a monopoly bureaucracy creates two different types of welfare costs: (i) more unqualified firms procure licenses through collusion and therefore, generates negative externality to the society; (ii) more firms enter after incurring the costly qualifying investment. A more firms qualify under competition, it reduces the negative externality but at the same time generates a cost to society in terms of qualifying investment.

There can be several extensions of the present work. First, one can check robustness of the results derived in this chapter by giving freedom to the agents of excluding the official she first met at the time of reapplication or if the firm type is private information even during interaction with the bureaucrat. Second, the present chapter treats the honest officials as incorruptible. However, the introduction of bureaucratic competition may change the proportion of honest officials in the bureaucracy itself. The impact of this on the corruption and welfare measures of an economy needs to be checked. Third, one can think of introducing penalties for corruption to analyse the consequences on extortion and collusion and at the same time obtain the optimal penalty. The next chapter discusses a framework where enforcement is introduced in the form of a monetary penalty and the implications for extortion and collusion are analysed.

Appendix

Proof of Lemma 2: (i) Note that,

$$r_1^m - x = \frac{x(1-h)}{h(1-\delta)}. \tag{A.1}$$

Since $0 < \delta < 1$and $0 < h < 1$, from (A.1) $r_1^m - x > 0$.

(ii) Follows directly from the expression of r_1^m.

The statement of the lemma follows. □

Proof of Lemma 5: Using the expressions of r_1^m and r_1^c,

$$r_1^m - r_1^c = \frac{\delta x(1-h)}{2h(1-\delta)}. \tag{A.2}$$

Since $0 < h < 1, 0 < \delta < 1$, the R.H.S. of (A.2) is positive. It is also falling in h.

Hence the statement of the lemma follows. □

Proof of Lemma 6:

$$r_2^c - x = \frac{x(1-h)}{(1+h)(1-\delta)} > 0.$$

Therefore, the statement of the lemma follows. □

Proof of Proposition 1: From equation (9):

$$W_m - W_c =$$

$$\frac{(1-h)(1-l)\delta h[\int_0^{r_2^c} G(r)dr - r_2^c G(r_2^c)]}{1-\delta h} - h[\int_x^{r_2^c} G(r)dr + xG(r_2^c)] - (1 - h)l[\int_{r_1^c}^{r_1^m} G(r)dr + r_1^m G(r_1^m) + r_1^c G(r_1^c)] + (1-h)[G(r_1^m) - G(r_1^c)] \tag{A.3}$$

Since $[\int_0^{r_2^c} G(r)dr - r_2^c G(r_2^c)] < 0$ and $[G(r_1^m) - G(r_1^c)] > 0$, the statement of the proposition follows from rearrangement of the terms. □

Proof of Observation 1: From equation (9)

$$CI_c^E - CI_m^E = (1-h)[\int_{r_1^c}^{\infty} g(r_i)dr_i - \int_{r_1^m}^{\infty} g(r_i)dr_i]. \tag{A.4}$$

From lemma 5 we know that $r_1^m \geq r_1^c$, since $h \in (0,1]$which implies the R.H.S of equation (A.4) is non-negative for all values of $h \in (0,1]$.

Therefore, the statement of the observation follows. □

Proof of Observation 2: From equation (10.1):

$$CR_c^E - CR_m^E = (1-h)[\int_{r_1^c}^{\infty} b_c^q\, g(r_i)dr_i - \int_{r_1^m}^{\infty} b_m\, g(r_i)dr_i]. \quad \text{(A.5)}$$

If $h \in (0,1)$, it follows from (A.5) that the sign of $(CR_c^E - CR_m^E)$ is determined by the sign of $\left[\int_{r_1^c}^{\infty} b_c^q\, g(r_i)dr_i - \int_{r_1^m}^{\infty} b_m\, g(r_i)dr_i\right]$. Notice, since $r_1^m > r_1^c$ from lemma 5, the R.H.S of (A.5) Can also be written as:

$$\int_{r_1^c}^{\infty} b_c^q\, g(r_i)dr_i - \int_{r_1^m}^{\infty} b_m\, g(r_i)dr_i = \int_{r_1^c}^{r_1^m} b_c^q\, g(r_i)dr_i - \int_{r_1^m}^{\infty}\left(b_m - b_c^q\right) g(r_i)dr_i$$

(A.6)

From lemma 3, $b_c^q < b_m$ for all values of $h \in (0,1)$. Therefore, the statement of the observation follows. □

Proof of Observation 3: From equation (9):

$$CI_c^S - CI_m^S = (1-h)[\int_0^{r_1^c} g(r_i)dr_i - \int_0^{r_1^m} g(r_i)dr_i]. \quad \text{(A.7)}$$

From lemma 5 we know that$r_1^m > r_1^c$ and if $h \in (0,1)$, the R.H.S of (A.7) is negative. Thus, the statement of the observation follows. □

Proof of Observation 4: From equation (10.2) and (10.3):

$$CR_c^s - CR_m^s = (1-h)[\int_0^{r_2^c} b_c^u g(r_i)dr_i + \int_{r_2^c}^{r_1^c} b_c^{uq} g(r_i)dr_i - \int_0^{r_1^m} b_m g(r_i)dr_i]$$

which can be rewritten as:

$$CR_c^s - CR_m^s = (1-h)[\int_0^{r_2^c}(b_c^u - b_m)g(r_i)dr_i + \int_{r_2^c}^{r_1^c}(b_c^{uq} - b_m)g(r_i)dr_i - \int_{r_1^c}^{r_1^m} b_m g(r_i)dr_i] \quad \text{(A.8)}$$

Since $b_c^{uq} < b_c^u < b_m$ from lemma 3 and $0 < h < 1$, the R.H.S of (A.8) is negative and the statement of the observation follows. □

Proof of Proposition 2: The first part of the proposition follows immediately from equation 11.

From equations 12 and 13:

$$CR_c - CR_m = (1-h)\left[\int_0^{r_2^c} b_c^u g(r_i) dr_i + \int_{r_2^c}^{r_1^c} b_c^{uq} g(r_i)\, dr_i + \int_{r_1^c}^{\infty} b_c^q g(r_i)\, dr_i - \int_0^{\infty} b_m g(r_i)\, dr_i\right]$$

which can be rewritten as:

$$CR_c - CR_m = (1-h)[\int_0^{r_2^c} (b_c^u - b_m) g(r_i)\, dr_i + \int_{r_2^c}^{r_1^c} (b_c^{uq} - b_m) g(r_i)\, dr_i + \int_{r_1^c}^{\infty} (b_c^q - b_m) g(r_i)\, dr_i \quad \text{(A.9)}$$

From lemma 3 we know that $b_m > b_c^u > b_c^{uq} > b_c^q$. Additionally, since $h \in (0,1)$the term on the R.H.S of (A.9) is negative and therefore the statement of the proposition follows. □

Chapter 3

Optimal Penalty and Corruption Distribution

3.1 Introduction

Corruption in the form of side payment, which is typically referred to as bribery, includes both extortionary and collusive forms. The definitions of extortion and collusion follow from the previous chapter and the two alternate forms of bribery are found to generally co-exist in a bureaucracy.

Since extortion can incentivize unlawful behaviour and collusion is a direct violation of law through non-compliance, it motivates us to study the impact of using a monetary penalty as a corruption mitigation technique, on extortion and collusion. Specifically, the question that interests us is: what would be the firm size distribution of the incidence of extortion and collusion at alternative penalty rates? We also ask, whether choosing penalties that eliminate extortion, collusion, or both, would be a welfare maximizing solution.

To answer these questions, we construct a framework, where extortion and collusion coexists. In our framework, production without an emission control investment results in pollution that generates negative externality. For the purpose we consider a set of firms with heterogeneous revenue who, in response to a government's anti-corruption penalty policy, applies for a clearance certificate by either incurring a fixed emission control investment or not investing. The cost of negative externality is increasing in revenue because higher production generates higher negative externality. An officer, reviewing the application, can behave corruptibly by engaging in bribery. If a firm chooses not to invest and also indulge in bribery, then there is collusion and the negative externality from pollution exists. Alternatively, if a firm has invested and the officer seeks a bribe then there is extortion but no negative externality.

In this chapter penalty is the only corruption mitigating policy instrument[23]. It is symmetrically imposed on firms and officers involved in collusion[24]. In contrast, penalty is imposed only on the corruptible officer in the case of extortion, as in Basu et.al (2016)[25]. However, the imposition of penalty depends on the successful conviction of the offense. If a firm chooses to invest but faces extortion, then it always self-report this crime because it has the relevant valid documents. But conviction is not certain because the legal system is imperfect. Examples of the prevalence of extortion suggest the existence of such imperfection[26]. The probability of collusion conviction is less than that of extortion because it is a mutually beneficial side contract and hence, is not self-reported. However, it has the possibility of being exposed by the media or some other third party.

Using this framework, we determine the socially optimal penalty and the resultant subgame perfect equilibrium *corruption distribution*, that is, the pattern of corruption that

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[23] Corruption is considered to be a major obstacle to growth and development, Bardhan (1997).

[24] Ackerman (2010) cites country wise instances of nature of penalties on firms and officials based on the type of offense. In 1990s in Chile, while bribe payment was a criminal offense, accepting the same was not unless it followed an act of wrongdoing. The current Chilean law treats both bribe giver and taker symmetrically. However, if the bribe payer responds to a bribe demand rather than volunteering the payment, the maximum prison sentence is reduced. American law too has symmetric maximum penalty for both parties. Taiwan and Romania levy asymmetric punishment depending on type of malfeasance. In case of Taiwan paying a bribe is a crime only for obtaining illegal services and in all other cases the payer is not subject to a sanction. Romania on the other hand does not sanction the bribe payer if the same had to respond to an extortion demand. This chapter offers a punishment structure that is closest to Chilean law and Romanian law in terms of collusion and extortion, respectively.

[25] Basu et.al. (2016) examine the role of penalty as the only policy instrument but only in the context of extortion faced by law abiding citizens. They show that imposing a penalty on the bribe-taker incentivizes the honest citizen to report such malfeasant act and do have the possibility of reducing this practice. Abhink et.al (2014) provides experimental support to this outcome.

[26] In the context of issuing driving licenses in India, officials have been found to arbitrarily fail applicants in the driving test so as to procure bribe and on the other hand, it is also not uncommon to find applicants obtain the license without knowing how to drive, in exchange for a bribe (Bertrand et.al. (2007)). Transparency International (2011 South Asia Barometer) reports that 54 percent of respondents in India had to pay a bribe to obtain a public service; the bribes primarily being in the form of extortion.

exists for different revenue levels. The findings are quite novel and counter-intuitive, and this is the contribution of this chapter.

In our model, although the amount of qualifying investment is assumed to be the same for all firms, the higher revenue firms impose a higher cost of negative externality. Thus, a high penalty induces more firms to invest, which in turn increases the aggregate investment cost but reduces the cost generated by the negative externality. This trade-off determines the socially optimal penalty.

We show that when the extent of negative externality is low, which means that its cost is also low; the socially optimal penalty is within a "*very low*" range. Low revenue firms choose not to invest and indulge in collusion while high revenue firms choose to invest but encounter extortion. An increase in the extent of negative externality causes the optimal penalty to increase within this range and consequently some of the low revenue firms switch from no-investment to investment. This reduces the incidence of collusion, but the corruption distribution remains the same.

When the extent of the negative externality reaches a critical level, the optimal penalty jumps from the "*very low*" range to a "*medium range*". This results in a further reduction in the incidence of collusion and some of the low revenue firms who switch from no investment-to investment interestingly face no corruption because for them the penalty is above their threshold penalty levels that sustain collusion and extortion. The low revenue firms that stick to no-investment continues to indulge in collusion while the high revenue firms continue investing but face extortion. Strengthening of negative externality causes an increase in the optimal penalty within this range and this further reduces the incidence of collusion.

As the extent of negative externality becomes very high, the cost imposed by it also becomes very high. Therefore, it becomes imperative to eliminate the negative externality by eradicating collusion. Consequently, the optimal penalty becomes high enough to eliminate collusion and all firms choose to invest. However, extortion remains as a high-revenue phenomenon. All forms of corruption are eliminated only when the penalty becomes prohibitively high.

These findings suggest that it is not always socially optimal to eliminate corruption. If the extent of the negative externality is not high, then it is not socially optimal to eliminate collusion and negative externality. In fact, the socially optimal penalty sustains the coexistence of both collusion and extortion.

Our results follow the intuition of Becker (1968), and Becker and Stigler (1974). In Becker (1968), the optimum penalty is decided by balancing the marginal benefit and marginal cost to the society. In this chapter, for low extent of negative externality the social marginal benefit of reduced negative externality and the social marginal cost of undertaking qualifying investment balances either at the *very low* or *medium* penalty ranges, both of which sustain collusion and extortion. For high extent of negative externality, the marginal benefit of increased penalty far exceeds the marginal cost, and the welfare function becomes monotonically rising, producing 'Becker's Conundrum'. Our findings are also in alignment with Becker and Stigler (1974) who suggests that enforcement should be more intensive for crimes with higher negative externality.

Polinsky and Shavell (2001), which is closest in spirit to this chapter, consider a general setting of law enforcement, where corruptible officers can leverage their ability to frame innocent civilians in order to impose fraudulent charges and extort. They assume coordination in multiple corruption controlling instruments like penalty, incentive, and enforcement probability. Their paper makes a case in favor of an appropriate reward for law enforcers in conjunction with maximal penalties for corruption and framing but no sanction for extortion. This is because such a sanction may lead to either higher bribes or framing, thereby victimizing the innocent and reducing deterrence. This finding is different from that in this chapter where extortion is also punished in equilibrium. Their paper also points out that while higher rewards to enforcers may reduce corruption, it may also lead to more framing.

Like Polinsky and Shavell (2001), Hindriks et.al. (1999) also focus on similar policy mix to examine the equity and efficiency implications of taxation systems in which officers can extract bribes and threaten to extort citizens with over assessment of taxable income. They show that poorer agents are vulnerable to extortion while the rich are vulnerable to collusion. This contrasts with this chapter where collusion is a low-revenue firm phenomenon and extortion is experienced by high-revenue firms.

Mookherjee (1997) also shows that a policy mix aimed at inducing law-abiding behavior needs to be comprehensive, an integral part of which is rewards to law enforcers. Tirole (1986) and Mookherjee and Png (1995) also examine the role of incentives for bureaucrats in mitigating corruption. However, Das-Gupta and Mookherjee (1998) mention the difficulty in achieving such all-encompassing reforms under decentralized regulatory structure. Furthermore, higher rewards to tax officers may discourage tax evasion and bribery but has the credible threat of extortion in the form of over assessment of taxable income, (Mookherjee, 1997; Hindriks et al., 1999)[27]. Dhillon, Nicolo, and Xu (2017) also show that raising monetary compensation may perversely incentivize reputation-concerned public officials to behave corruptly.

In contrast to this literature, extortion in the form of over assessment of taxable income arises in Banerjee and Vaidya (2019) due to an officer's inherent spiteful behavior

[27] Marjit and Shi (1998) point to the ineffectiveness of such bonuses when the tax officer's monitoring effort is endogenous.

when a taxpayer rejects his bribe offer[28]. Like in this chapter, they also consider penalty to be the only anti-corruption instrument and show that it is more effective in reducing tax evasion and bribery in the presence of extortion.

Apart from penalty and reward, other strategies to mitigate corruption have also been considered in the literature. These include introduction of bureaucratic competition (Becker and Stigler (1974), Rose Ackerman (1978), Shleifer and Vishny (1993), Ahlin and Bose (2007), Drugov (2010)), and introduction of leniency policy for the parties involved in corruption (Spagnolo and Buccirossi (2005), Basu et al. (2016), Abbink et al. (2014), Abbink and Wu (2017)).

The chapter is organized as follows. In section 3.2 we develop the model and provide the equilibrium analysis of Stages 2 to 4 of the extensive form game in section 3.3. In Section 3.4 we determine the socially optimal penalty and characterize the subgame perfect equilibrium. Section 3.4 contains the concluding remarks.

[28] Abbink and Sadrieh (2009) introduce a "joy of destruction" (JOD) game where players can costlessly destroy each other's endowments and there is no pecuniary, fairness, or reciprocity motive for such activity. Despite this, they observe a substantial incidence of nasty behavior when spiteful actions can be covered by random destruction. Abbink and Herrmann (2011) examine the trade-off between the pleasure of being nasty and the associated moral cost of doing so.

3.2. The model

We consider a set of heterogeneous firms whose revenue r is uniformly distributed in the interval $r \in [x, \dot{r}]$. Profit of a firm with revenue r will be denoted as π_r. Emission free production requires a firm to incur a fixed investment x. For example, replacement of filters and other gadgets in a taxi, the cost of which is fixed. Without this investment, production generates pollution. This negative externality imposes a cost to the society, which is increasing in the firm's revenue, and is of the form lr, $l > 0$. So higher production generates higher negative externality[29].

Emission control compliance certificates are administered through a monopoly bureaucracy consisting of several officials. An official may act honestly and issue the certificate to a firm that abides this regulation. Alternatively, the officer can engage in bribery and issue the compliance certificate to a non-investing firm thus indulging in *collusion* or *extort* an investing firm by issuing the certificate only in lieu of a bribe. A government enforcement agency, hereafter, referred to as the "government", is responsible for managing corruption and penalizes any agent who indulges in collusion, and penalizes only the officer in the case of extortion.

The extensive form game played between government, firms and the bureaucracy, consist of the following stages and is represented in Figure 3.1.

Stage 1: Government chooses a social welfare-maximizing penalty (F).

Stage 2: **(Investment Stage)** A firm chooses to invest for compliance and apply for the certificate (I_a) or chooses to not-to-invest but apply (NI_a).

[29] Drugov (2010) considers a situation where the firms' revenue is constant, but the compliance cost varied across firms. Hence, in his case the negative externality is captured by the function $r + lx$.

Stage 3 (Bribery Stage): The application is submitted to the bureaucracy consisting of several officials. The reviewing officer (*O*), who is delegated to review a particular firm, chooses to act honestly and not seek a bribe (*NB*), or to act corruptly and seek a bribe (*B*). The bribe offer is the Nash Bargaining solution. The officer's payoff from choosing *NB* is always 0, that is, $\pi_O(,NB)=0$.

Suppose a firm chooses I_a in stage 2. If the officer chooses *NB,* then the game ends and the payoffs are as follows.

$$\begin{aligned}&\pi_r(I_a,NB)=r-x\\&\pi_O(I_a,NB)=0\end{aligned} \tag{1}$$

Alternatively, if the officer seeks a bribe, then there is extortion and the game proceeds to stage 3. This action and the bribe amount are denoted by B_e and b_e, where "*e*" represents extortion.

Suppose a firm chooses NI_a in stage 2 and the officer chooses *NB* and rejects the application. Since, the application will be reviewed by the same officer, the firm chooses to invest and reapply, and receives the certificate. However, because of the time delay, this firm's payoff is $\pi_r(NI_a,NB)=\delta(r-x)$, $\delta\in(0,1)$. This discounted payoff can be viewed as the cost that the firm incurs for its initial choice of NI_a. Thus, the no corruption payoffs are as follows.

$$\begin{aligned}&\pi_r(NI_a,NB)=\delta(r-x)\\&\pi_O(NI_a,NB)=0\end{aligned} \tag{2}$$

Alternatively, if the officer seeks a bribe, then there is collusion and the game proceeds to Stage 3. This action and the bribe amount are denoted B_c and the bribe amount is by b_c, where "*c*" represents collusion.

Stage 4 (Firm's decision to accept or reject bribe):

(i) Suppose a firm chooses I_a in stage 2 and official chooses B_e in stage 3. The firm can reject and self-report (R^s) or accept and self-report (A^s). Self-reporting is costless since the firm has all the valid relevant documents of investment. We assume that the legal system is imperfect, that is, even with full evidence the dishonest officer is convicted (C) with probability λ or not convicted (NC) with probability ($1-\lambda$).

If the firm chooses R^s and the officer is convicted, then he is penalized with a fine F and the firm receives the certificate. So, the payoffs are $\pi_r((I_a,R^s),B_e,C) = r - x$ and $\pi_O((I_a,R^s),B_e;C) = -F$. If there is no conviction, then the firm does not get the certificate and loses the investment cost. So, the payoffs are $\pi_r((I_a,R^s),B_e,NC) = -x$ and $\pi_O((I_a,R^s),B_e;NC) = 0$. The expected payoffs from choosing R^s, which forms the disagreement payoffs in Nash bargaining, are given in equation (3).

$$\begin{aligned} E\pi_r((I_a,R^s),B_e) &= \lambda r - x \\ E\pi_O((I_a,R^s),B_e) &= -\lambda F \end{aligned} \tag{3}$$

If the firm chooses A^s then it pays the bribe and self-reports. If convicted, the officer is penalized with a fine *F*, the bribe is refunded to the firm who receives the certificate. So, the payoffs are $\pi_r((I_a,A^s),B_e;C) = r - x$ and $\pi_O((I_a,A^s),B_e;C) = -F$. If there is no conviction, then the firm receives the certificate but loses the bribe. So, the payoffs are $\pi_r((I_a,A^s),B_e;NC) = r - x - b_e$ and $\pi_O((I_a,A^s),B_e;NC) = b_e$. The, expected payoffs from choosing A^s, which forms the agreement payoffs in Nash bargaining, are as follows.

$$\begin{aligned} E\pi_r((I_a,A^s),B_e) &= \lambda\pi_r((I_a,A^s),B_e;C) + (1-\lambda)\pi_r((I_a,A^s),B_e;NC) = r - x - (1-\lambda)b_e \\ E\pi_O((I_a,A^s),B_e) &= \lambda\pi_O((I_a,A^s),B_e;C) + (1-\lambda)\pi_O((I_a,A^s),B_e;NC) = (1-\lambda)b_e - \lambda F \end{aligned}$$

(4)

(ii) Suppose a firm chooses NI_a and officer chooses B_c. Here there is no self-reporting because both parties are colluding, so the firm either rejects (*R*) or accepts (*A*) the bribe offer. If the firm chooses *R*, then it does not get the certificate and earn zero profit. So the rejection payoffs, which form the disagreement payoffs in Nash bargaining, are as follows.

$$\begin{aligned}&\pi_r((NI_a,R),B_c)=0\\&\pi_O((NI_a,R),B_c)=0\end{aligned} \tag{5}$$

If the firm chooses *A*, then both parties may or may not get convicted with probabilities γ and (1-γ). Conviction is possible only if it is detected by a higher authority or by a third party like media. Thus, the probability of conviction under collusion is less than that under extortion since it is self-reported, that is, $\lambda > \gamma$. If conviction is successful, then both parties are penalized, and the firm loses the bribe. The payoffs are $\pi_r((NI_a,A),B_c;C)=-b_c-F$ and $\pi_O((NI_a,A),B_c;C)=b_c-F$. Without conviction no one is penalized. The payoffs are $\pi_r((NI_a,A),B_c;NC)=r-b_c$ and $\pi_O((NI_a,A),B_c;NC)=b_c$. So, the expected agreement payoffs are as follows.

$$\begin{aligned}&E\pi_r((NI_a,A),B_c)=\gamma\pi_r((NI_a,A),B_c;C)+(1-\gamma)\pi_r((NI_a,A),B_c;NC)=(1-\gamma)r-\gamma F-b_c\\&E\pi_O((NI_a,A),B_c)=\gamma\pi_O((NI_a,A),B_c;C)+(1-\gamma)\pi_O((NI_a,A),B_c;NC)=b_c-\gamma F\end{aligned} \tag{6}$$

The above game with the expected payoffs is diagrammatically represented in Figure 3.1.

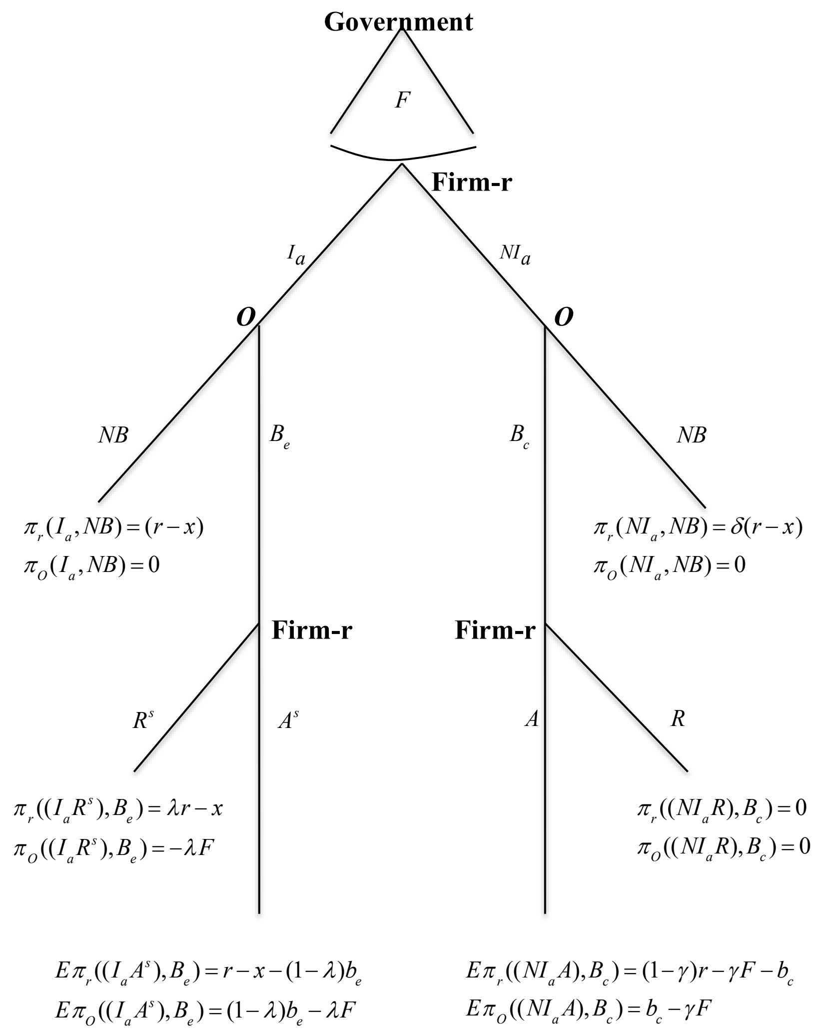

Figure 3.1: The Game Tree

3.3. Equilibrium Analyses

We use the method of backward induction to solve for the subgame perfect equilibrium. In the following subsections we analyze the different stages of the extensive form game represented in Figure 3.1.

3.3.1 Stage 4: Firm's choice to accept or reject the bribe.

This stage of the game is reached conditional on the officer seeking a bribe in Stage 3. The type of corruption that a firm face depends on its stage 2 choice of I_a or NI_a. The analysis is presented in Table 3.1.

Table 3.1: Firm-r's choice to accept or reject the official's bribe offer.

Firm chooses I_a and faces extortion	**Firm chooses NI_a and colludes**
1. A firm chooses A^s over R^s if $E\pi_r((I_a,A^s),B_e) \geq E\pi_r((I_a,R^s),B_e)$. The expressions $E\pi_r((I_a,A^s),B_e)$ and $E\pi_r((I_a,R^s),B_e)$ from equations (4) and (3), gives the *bribe acceptance criterion* as $r \geq b_e$.	**1.** A firm chooses A over R if, $E\pi_r((NI_a,A),B_c) \geq \pi_r((NI_a,R),B_c)$. The expressions $E\pi_r((NI_a,A),B_c)$ and $\pi_r((NI_a,R),B_c)$ from equations (6) and (5), gives the *bribe acceptance criterion* as $(1-\gamma)r - \gamma F \geq b_c$.
2. Using $E\pi_r((I_a,A^s),B_e)$ and $E\pi_O((I_a,A^s),B_e)$ from equation (4), and $E\pi_r((I_a,R^s),B_e)$ and $E\pi_O((I_a,R^s),B_e)$	**2.** Using $E\pi_r((NI_a,A),B_c)$ and $E\pi_O((NI_a,A),B_c)$ from equation (6) and $\pi_r((NI_a,R),B_c)$ and $\pi_O((NI_a,R),B_c)$

from equation (3), we get the Nash Bargaining bribe offer as $b_e = \frac{r}{2}$.[30]	from equation (5) we get the Nash Bargaining bribe of $b_c = \frac{(1-\gamma)r}{2}$.[31]
3. Observe that $b_e = \frac{r}{2}$ always satisfies the *bribe acceptance criterion* $r \geq b_e$.	**3.** The *bribe acceptance criterion* is $F \leq F_c(r) = \frac{(1-\gamma)r}{2\gamma}$.

In Lemma 1 we compare the extortion and the collusion bribes.

Lemma 1. *The extortion bribe $b_e = \frac{r}{2}$ is greater than the collusive bribe $b_c = \frac{(1-\gamma)r}{2}$ and both are linearly increasing in the revenue r.*

Lemma 1 follows from the fact that the probability of successful conviction under extortion (λ) is greater than that under collusion (γ). So, the possibility of being penalized is higher under extortion than collusion. Therefore, higher bribe is required to compensate the higher expected penalty under extortion.

[30] $b_e = \frac{r}{2}$ is the solution to the problem of maximizing the bribable surplus under extortion $V_e = \left[E\pi_r((I_a, A^s), B_e) - E\pi_r((I_a, R^s), B_e)\right]\left[E\pi_O((I_a, A^s), B_e) - E\pi_O((I_a, R^s), B_e)\right]$.

[31] $b_c = \frac{(1-\gamma)r}{2}$ is the solution to the problem of maximizing the bribable surplus under collusion, $V_c = \left[E\pi_r((NI_a, A), B_c) - E\pi_r((NI_a, R), B_c)\right]\left[E\pi_O((NI_a, A), B_c) - E\pi_O((NI_a, R), B_c)\right]$.

3.3.2 Stage 3: Officer's choice of bribery or no bribery.

We present the analysis in a tabular form for expositional ease.

Table 3.2: Official's choice of bribery or no bribery

Subgame where firm chooses I_a	**Subgame where firm chooses NI_a**
Officer chooses B_e if 3 $E\pi_O((I_a, A^s), B_e) \geq \pi_O((I_a,), NB)$. Substituting $b_e = \frac{r}{2}$ in $E\pi_O((I_a, A^s), B_e)$ as given in equation (4) and using $\pi_O((I_a,), NB) = 0$ we get the *bribe offer criterion* as $F \leq \frac{(1-\lambda)r}{2\lambda} = F_e(r)$.	Officer chooses B_c if, $E\pi_O((NI_a, A), B_c) \geq E\pi_O((NI_a,), NB)$. Substituting $b_c = \frac{(1-\gamma)r}{2}$ in $E\pi_i((NI_a, A), B_c)$ as given in equation (6) and using $\pi_O((I_a,), NB) = 0$ we get the *bribe offer criterion* as $F \leq \frac{(1-\gamma)r}{2\gamma} = F_c(r)$.

We summarize the properties of the threshold penalty levels $F_e(r) = \frac{(1-\lambda)r}{2\lambda}$ and $F_c(r) = \frac{(1-\gamma)r}{2\gamma}$ in Lemma 2.

Lemma 2.

(i) $F_e(r) = \frac{(1-\lambda)r}{2\lambda}$ *and* $F_c(r) = \frac{(1-\gamma)r}{2\gamma}$ *are linearly increasing in r, and* $F_c(r)$ *is steeper than* $F_e(r)$.

(ii) For any $r > 0$, *the collusion penalty threshold level is greater than the extortion penalty threshold level, that is,* $F_c(r) > F_e(r)$.

Lemma 2 implies that, for a given r, extortion is eliminated at a lower penalty level compared to collusion. This allows us to analyze two issues. One, for a firm with a given revenue, say r_i, we study the different penalty ranges for which that firm faces extortion or indulges in collusion. Two, for a given penalty we examine the set of firms that face extortion and the set of firms that engages in collusion.

We begin with the first issue. Consider a firm with revenue r_i. For this firm, the threshold penalty levels are $F_e(r_i) = \frac{(1-\lambda)r_i}{2\lambda}$ and $F_c(r_i) = \frac{(1-\gamma)r_i}{2\gamma}$. The result is summarized in Lemma 3a and diagrammatically represented in Figure 3.2a.

Lemma 3a.

Consider a firm with revenue r_i.

(i) If $F \le F_e(r_i)$ *then this firm faces extortion or engages in collusion if its stage 1 choice is either* I_a *or* NI_a*, respectively.*

(ii) If $F_e(r_i) < F \le F_c(r_i)$ *then this firm faces no extortion if its stage 1 choice is* I_a *but engages in collusion if its stage 1 choice is* NI_a.

(iii) This firm faces no corruption if $F > F_c(r_i)$.

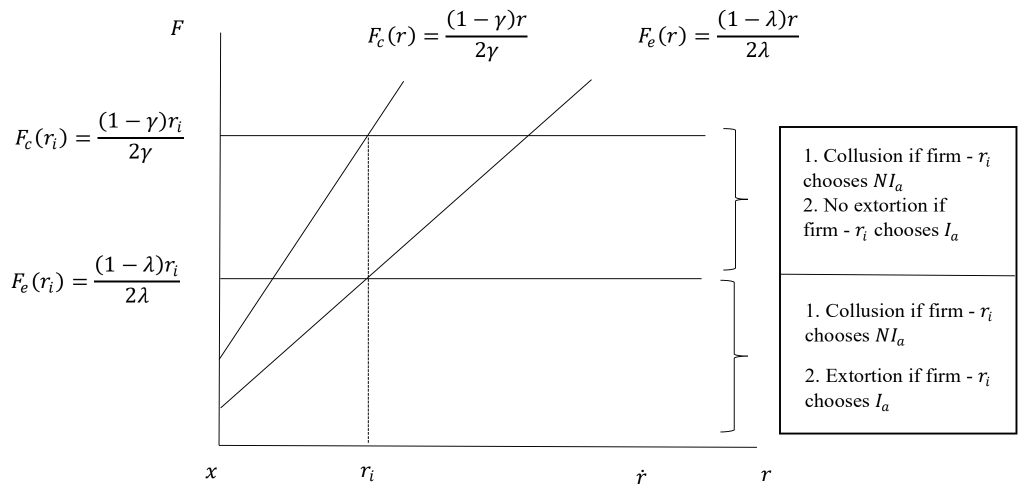

Figure 3.2a: A diagrammatic representation of the threshold penalties

Lemma 3.2 summarizes the result that for a given penalty F, the set of firms that face extortion and the set of firms that indulge in collusion. We define two threshold revenue levels $r_{e_F} = \frac{2\lambda F}{(1-\lambda)}$ *and* $r_{c_F} = \frac{2\gamma F}{(1-\gamma)}$ at which $F = F_e(r)$ and $F = F_c(r)$, respectively. This is shown in Figure 3.2b after Lemma 3b.

Lemma 3b.

Consider any penalty level F.

(i) Suppose a firm chooses I_a *in stage 2. This firm faces no corruption if* $r \in [o, r_{e_F})$ *, but encounters extortion if* $r \in [r_{e_F}, \dot{r}]$.

(ii) Suppose a firm chooses NI_a *in stage 2. There is no collusion if* $r \in [0, r_{c_F})$ *but indulges in collusion if* $r \in [r_{c_F}, \dot{r}]$.

(iii) An increase in the penalty linearly increases $r_{e_F} = \frac{2\lambda F}{(1-\lambda)}$ *and* $r_{c_F} = \frac{2\gamma F}{(1-\gamma)}$.

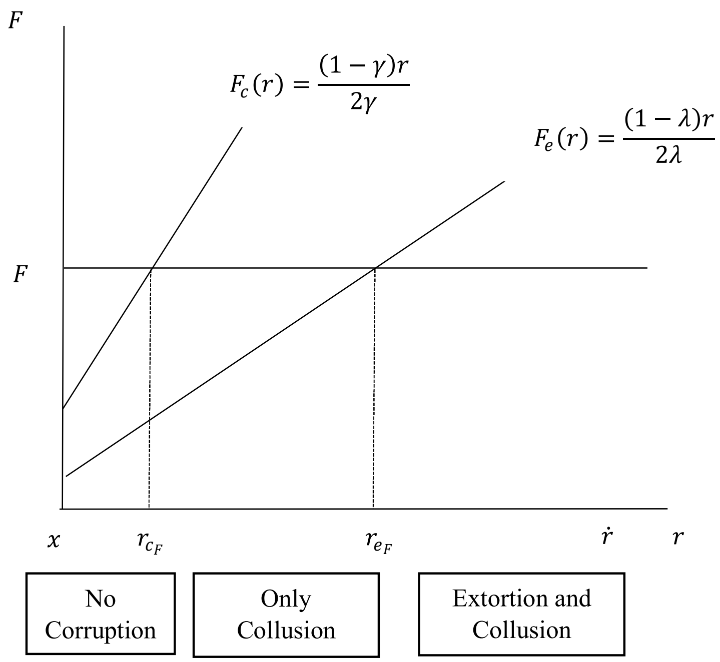

Figure 3.2b: Diagrammatic representation of corruption distribution across firms

Figure 3.2b shows that for a given penalty F, a firm with revenue:

(i) $r \in [0, r_{c_F})$ faces no corruption;

(ii) $r \in [r_{c_F}, r_{e_F})$ engages in collusion;

(iii) $r \in [r_{e_F}, \dot{r}]$ faces collusion if it chooses NI_a and extortion if it chooses I_a.

3.3.3 Stage 2: Firm's choice to invest and apply or not invest and apply.

We use Lemmas 3a and 3b, and the extortion and collusion bribes $b_e = \frac{r}{2}$ and $b_c = \frac{(1-\gamma)r}{2}$ as given in Table 3.1, to derive a firm's stage 2 expected payoffs following equations (1), (2), (4) and (6). If a firm chooses I_a in stage 2 and the penalty is in the range

$F \le F_e(r)$ then it faces extortion (Lemma 3a). Accordingly, using equations (1) and (4) we get this firm's expected payoffs from its choice of I_a as follows.

$$E\pi_r((I_a, A^s), B_e) = r - x - (1-\lambda)b_e = \frac{(1+\lambda)r}{2} - x,\ if\ F \le F_e(r) \tag{7a}$$

$$\pi_r(I_a, NB) = r - x,\ if\ F > F_e(r) \tag{7b}$$

If the firm chooses NI_a then it indulges in collusion if $F \le F_c(r)$. Alternatively, if $F > F_c(r)$ then the firm knows that collusion is not feasible, which means the official will not seek a bribe. So it is optimal for this firm to invest and apply in stage 2 and earn $\pi_r(I_a, NB) = r - x$, rather than not invest and apply because the officer will reject the application and the firm will have to subsequently reapply and earn the lower payoff $\pi_r^q((NI_a, I_a), NB) = \delta(r-x) \le (r-x)$, since $\delta \in [0,1]$. Correspondingly, this firm's expected payoffs are as follows.

$$E\pi_r((NI_a, A), B_c) = (1-\gamma)r - \gamma F - b_e = \frac{(1-\gamma)r}{2} - \gamma F,\ if\ F \le F_c(r) \tag{8a}$$

$$\pi_r(I_a, NB) = r - x,\ if\ F > F_c(r) \tag{8b}$$

Note that equation (8b) is the same as (7b). Since $F_c(r) > F_e(r)$, for all *r*, hence, for $F > F_c(r)$ there will be no corruption. So to characterize a firm's equilibrium choice conditional on the level of penalty, we have to compare the following three payoffs.

$$\pi_r(I_a, NB) = r - x, if\ F > F_c(r) \tag{I}$$

$$E\pi_r((I_a, A^s), B_e) = \frac{(1+\lambda)r}{2} - x,\ if\ F \le F_e(r) \tag{II}$$

$$E\pi_r((NI_a, A), B_c) = \frac{(1-\gamma)r}{2} - \gamma F,\ if\ F \le F_c(r) \tag{III}$$

Lemma 4 summarizes some of the properties of the above payoff functions with respect to r.

Lemma 4.

(i) $\pi_r(I_a, NB)$, $E\pi_r((I_a, A^s), B_e)$ *and* $E\pi_r((NI_a, A), B_c)$ *are linearly increasing in r.*

(ii) $\pi_r(I_a, NB) > E\pi_r((I_a, A^s), B_e)$ *for all r.*

(iii) $\pi_r(I_a, NB)$ *is steeper than* $E\pi_r((I_a, A^s), B_e)$ *which is steeper than* $E\pi_r((NI_a, A), B_c)$.

Lemma 4 implies that $\pi_r(I_a, NB)$ always lies above $E\pi_r((I_a, A^s), B_e)$ and the two never intersects. However, since $\pi_r(I_a, NB)$ and $E\pi_r((I_a, A^s), B_e)$ are both steeper than $E\pi_r((NI_a, A), B_c)$, therefore, there will be range of revenue within which $\pi_r(I_a, NB)$ and $E\pi_r((I_a, A^s), B_e)$ will intersect $E\pi_r((NI_a, A), B_c)$. Lemma 5 summarizes these results and is diagrammatically represented in Figure 3.3.

Lemma 5.

(i) An increase in F reduces $E\pi_r((NI_a, A), B_c)$ *but has no effect on* $\pi_r(I_a, NB)$ *and* $E\pi_r((I_a, A^s), B_e)$.

(ii) For $F \in [0, F_c(x)]$, *where* $F_c(x) = \dfrac{(1-\gamma)x}{2\gamma}$, $\pi_r(I_a, NB)$ *and* $E\pi_r((NI_a, A), B_c)$ *intersects at* $r_{NB_F} = \dfrac{2(x-\gamma F)}{1+\gamma}$, *which is decreasing in F.*

(iii) For $F \in \left[0, F_c\left(\dfrac{2x}{1+\lambda}\right)\right]$, *where* $F_c\left(\dfrac{2x}{1+\lambda}\right) = \left(\dfrac{1-\gamma}{2\gamma}\right)\left(\dfrac{2x}{1+\lambda}\right)$, $E\pi_r((I_a, A^s), B_e)$ *and* $E\pi_r((NI_a, A), B_c)$ *intersects at* $r_{B_F} = \dfrac{2(x-\gamma F)}{\lambda+\gamma}$, *which is decreasing in F.*

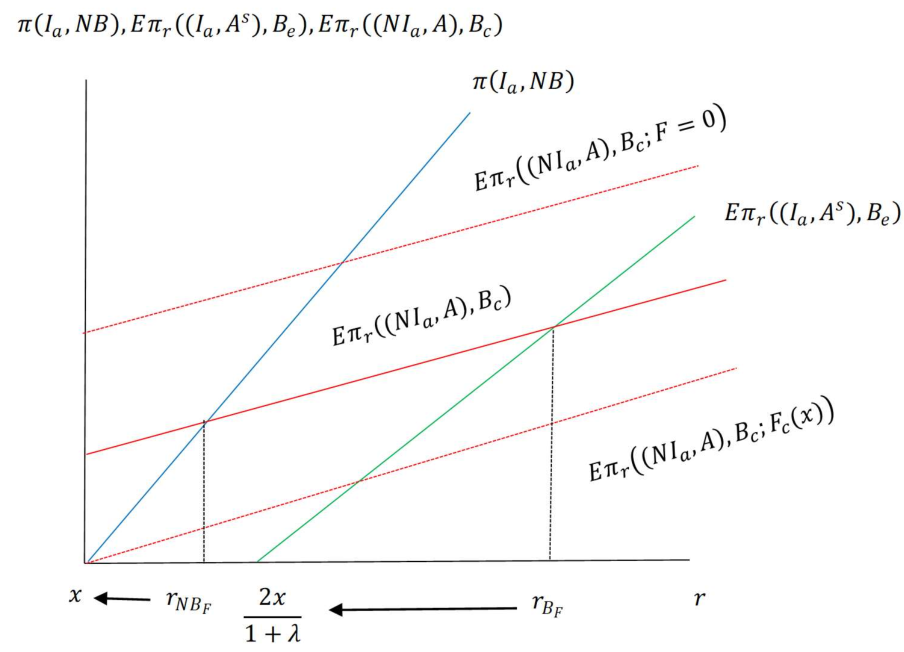

Figure 3.3: Effect of an increase in the penalty on the firms' payoffs

Since an increase in the penalty reduces $E\pi_r((NI_a, A), B_c)$, it is at its highest position when $F = 0$ as shown by the uppermost dotted line in Figure 3.3. An increase in the penalty from 0 to $F = F_c(x)$ causes $E\pi_r((NI_a, A), B_c)$ to shift down. Consequently, the intersection points r_{NB_F} and r_{B_F} move to the left towards *x* and $\frac{2x}{1+\lambda}$ which are the horizontal intercepts of $\pi_r(I_a, NB)$ and, $E\pi_r((I_a, A^s), B_e)$. We will use Figures 3.2a, 3.2b and 3.3 to characterize a firm's stage 2 equilibrium choices.

3.3.4 Firm's Stage 2 equilibrium choices conditional on penalty

We begin with the penalty range $F \in [0, F_e(x)]$, where $F_e(x) = \frac{(1-\lambda)x}{2x}$. Since $F_e(r) = \frac{(1-\lambda)r}{2\lambda}$ is increasing in r and $x \le r \le r$, therefore, $F \in [0, F_e(x)]$ implies $F \le F_e(r) < F_c(r)$ for all *r*. From Figure 3.2 we know that if a firm chooses I_a then it faces extortion, and the payoff is $E\pi_r((I_a, A^s), B_e) = \frac{(1+\lambda)r}{2} - x$ as given in (II). On the contrary, if it chooses NI_a then there is collusion, and the payoff is $E\pi_r((NI_a, A), B_c) = \frac{(1-\gamma)r}{2} - \gamma F$ as given in (III).

Next consider the penalty range $F \in \left[F_e(x), F_c(x)\right]$. We will make the following assumption.

Assumption 1. *We assume that r is sufficiently large so that $F_c(x) < F_e(\dot{r})$.*

In this penalty range it is possible for a firm to choose I_a and face no extortion thus having the payoff $\pi_r(I_a, NB) = r - x$. From Lemma 3b we know that any $F \in \left[F_e(x), F_c(x)\right]$ intersects $F_e(r) = \frac{(1-\lambda)r}{2\lambda}$ at $r_{e_F}(r) = \frac{2\lambda F}{1-\lambda}$, which is increasing in *F*. At $F = F_e(x)$, $r_{e_F} = x$. From Lemma 5 we know that $r_{NB_F} = \frac{2(x-\gamma F)}{1+\gamma}$ is decreasing in *F*.

So as the penalty increases from $F_e(x)$, r_{e_F} moves away from *x* to the right and r_{NB_F} moves leftward towards *x* as shown in Figure 3.3. Hence, there is a certain penalty $\overline{F}$ at which $r_{e_{\overline{F}}} = r_{NB_{\overline{F}}}$. Analogously, there is another penalty $\hat{F}$ at which $r_{e_{\hat{F}}} = r_{B_{\hat{F}}}$. These results are summarized in Lemma 6 and diagrammatically shown in Figure 3.4.

Lemma 6.

(i) There exists two critical penalties $\overline{F} = \frac{(1-\lambda)x}{\lambda+\gamma}$ *and* $\hat{F} = \frac{(1-\lambda)x}{\lambda^2+\gamma}$ *where* $F_e(x) < \overline{F} < \hat{F} < F_c(x)$, *such that* $r_{e_{\overline{F}}} = r_{NB_{\overline{F}}} = \frac{2\lambda x}{\lambda+\gamma} > x$ *at* $\overline{F}$ *and* $r_{e_{\hat{F}}} = r_{B_{\hat{F}}} = \frac{2\lambda x}{\lambda^2+\gamma} > \frac{2\lambda x}{\lambda+\gamma} > x$ *at* $\hat{F}$. *Further* $r_{e_{\hat{F}}} > r_{e_{\overline{F}}}$.

(ii) For any penalty in the range $F \in [F_e(x), \bar{F}]$, $r_{e_F} \le r_{NB_F} < r_{B_F}$.

(iii) For any penalty in the range $F \in [\bar{F}, \hat{F}]$, $r_{NB_F} \le r_{e_F} < r_{B_F}$.

(iv) For any penalty in the range $F \in [\hat{F}, F_c(x)]$, $r_{NB_F} < r_{B_F} \le r_{e_F}$.

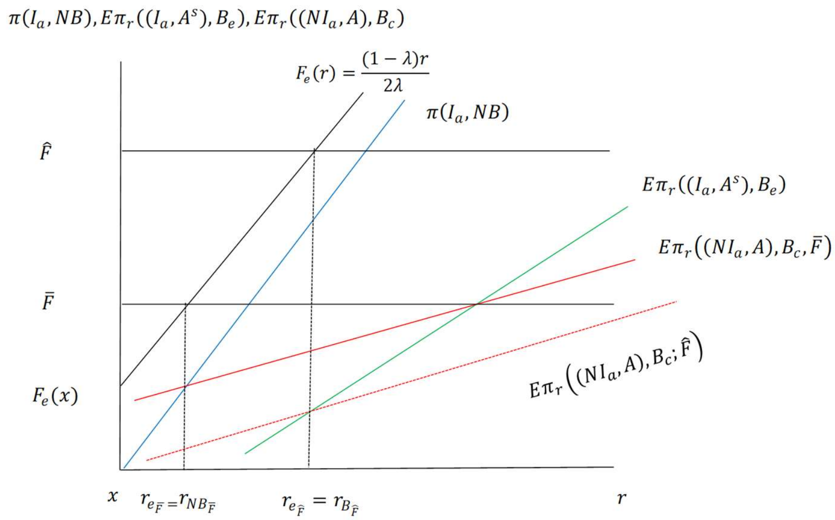

Figure 3.4: Diagrammatic representation of $\bar{F}, \hat{F}, r_{e_{\bar{F}}} = r_{NB_{\bar{F}}}$, and $r_{e_{\hat{F}}} = r_{NB_{\hat{F}}}$

Using Lemma 6 we divide the penalty into six ranges as shown in Figure 3.5.

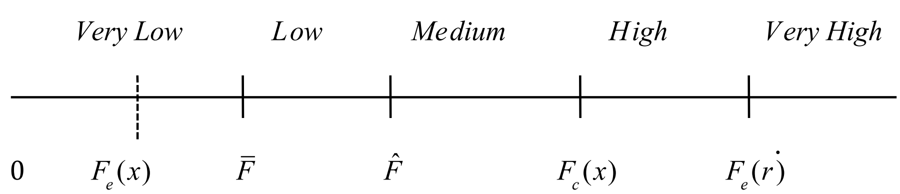

Figure 3.5: Diagrammatic representation of the penalty ranges

In the *Very High* penalty range, there is no corruption, and all firms choose I_a. So, using Figure 3.5 we characterize a firm and officer's equilibrium choices for the *Very Low*, *Low*, *Medium*, and *High* penalty ranges and the results are summarized in Propositions 1 to 4, respectively.

Proposition 1. *Consider the Very Low penalty range* $F \in [0, \bar{F}]$. *A firm with revenue in the interval:*

(i) $r \in [x, r_{B_F}]$ *chooses* NI_a *and indulge in collusion. The outcome is,* $((NI_a, A), B_c)$*;*

(ii) $r \in [r_{B_F}, \dot{r}]$ *choose* I_a *but faces extortion, and so the outcome is* $((I_a, A^s), B_e)$.

The penalty range $F \in [0, \bar{F}]$ can be divided into $F \in [0, F_e(x)]$ and $F \in [F_e(x), \bar{F}]$ because from Lemma 6 we know that $F_e(x) < \bar{F}$. We also know that in the range $F \in [0, F_e(x)]$ if a firm chooses I_a then it faces extortion, while if it chooses NI_a then it engages in collusion. Thus, the payoff $\pi_r(I_a, NB) = r - x$ is not feasible. This is diagrammatically shown in Figure 3.6a.

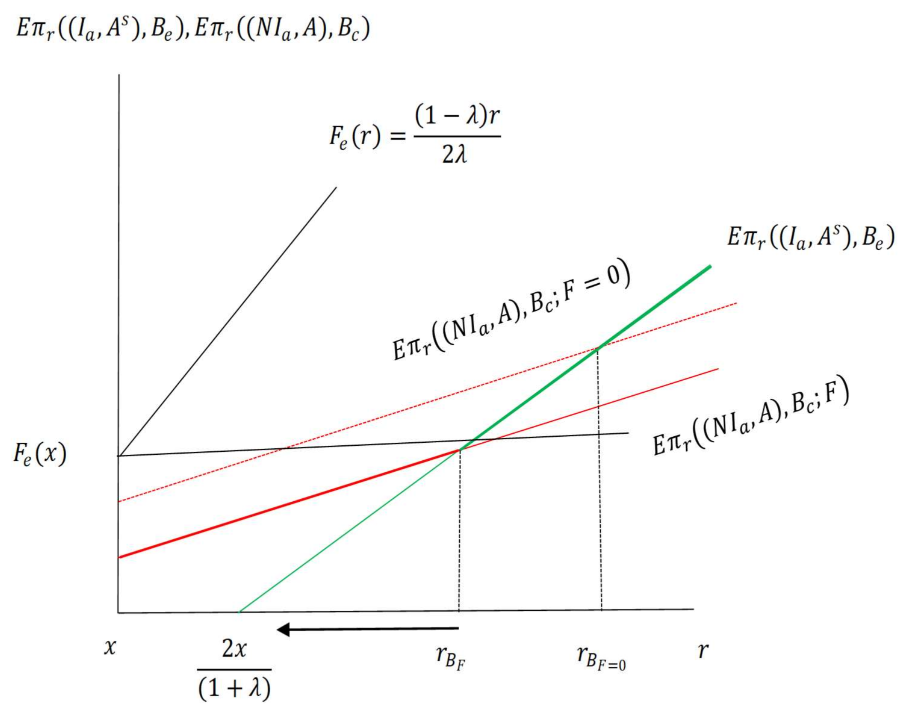

Figure 3.6a: Firms' equilibrium choice for penalty in the range $\boldsymbol{F \in [0, F_e(x)]}$

From Figure 3.6a we see that a low revenue firm with $r \in [x, r_{B_F}]$ choose NI_a and indulge in collusion because $E\pi_r((NI_a, A), B_c)$ weakly dominates $E\pi_r((I_a, A^s), B_e)$. In contrast a high revenue firm with $r \in [r_{B_F}, \dot{r}]$ choose I_a but faces extortion. The bold lines in Figure 3.6a indicate these outcomes.

In the penalty range $F \in [F_e(x), \bar{F}]$, $r_{e_F} \leq r_{NB_F} < r_{B_F}$ (Lemma 6(ii)). A firm with revenue in the interval $r \in [x, r_{e_F}]$ have the option of choosing I_a and not face extortion because for this revenue interval, $F \geq F_e(r)$. So, the payoff $\pi_r(I_a, NB) = r - x$ is feasible as indicated by the line labeled $\pi_r(I_a, NB)$ in Figure 3.6b. For a firm with revenue $r > r_{e_F}$, $F < F_e(r)$. So it faces extortion if it chooses I_a. In this case the payoff $\pi_r(I_a, NB) = r - x$ is not feasible. This is shown by the dotted extension of the line labeled $\pi_r(I_a, NB)$.

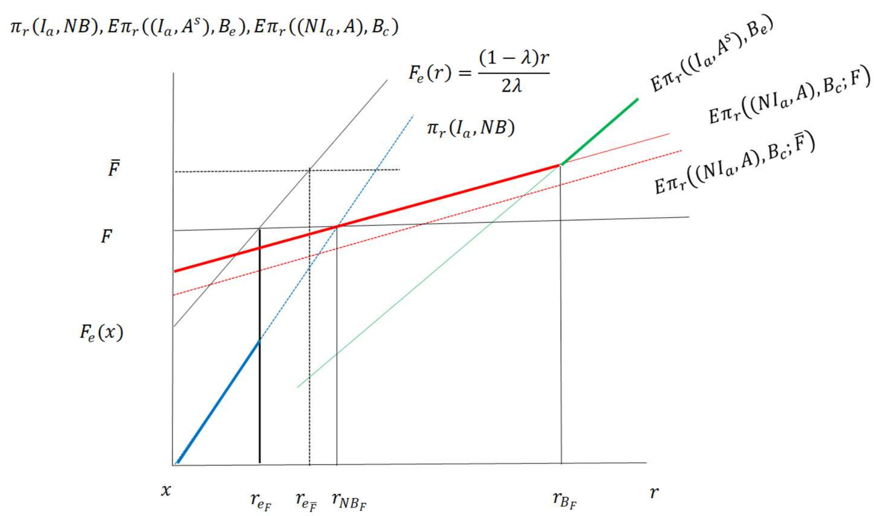

Figure 3.6b: Firms' equilibrium choice in the Very Low penalty range

Even though I_a without extortion is feasible for a firm with $r \in [x, r_{e_F}]$, yet it chooses NI_a and indulge in collusion since $E\pi_r((NI_a, A), B_c)$ strictly dominates $E\pi_r(I_a, NB)$. In fact, a firm with revenue in the range $r \in [x, r_{B_F}]$ also chooses (NI_a, A) because $E\pi_r((NI_a, A), B_c)$ weakly dominates $E\pi_r((I_a, A^s), B_e)$. However, the reverse is true when revenue is in the range $r \in [r_{B_F}, \dot{r}]$, and (I_a, A^s) is the weakly dominant strategy. These firms invest and there is extortion in equilibrium. The bold lines in Figure 3.6b show these outcomes.

Proposition 1 implies that in the *Very Low* penalty range, both collusion and extortion exist. However, as penalty within this range increases, r_{B_F} (the intersection point of $E\pi_r((I_a, A^s), B_e)$ and $E\pi_r((NI_a, A), B_c)$) moves to the left as shown in Figures 3.6a and 3.6b. This means that a firm with lower revenue switch from NI_a to I_a. Consequently, the form of corruption also switches from collusion to extortion. But, the overall frequency of corruption remains the same.

Observation 1: *An increase in the penalty within the Very Low penalty range* $F \in [0, \bar{F}]$ *fails to check the overall frequency of corruption, but extortion replaces collusion. Less negative externality is generated.*

Let us consider the *Low* penalty range $F \in [\bar{F}, \hat{F}]$, where $r_{NB_F} \leq r_{e_F} \leq r_{B_F}$ and $r_{NB_F} < r_{e_F} < r_{e_{\hat{F}}}$, but $r_{e_{\hat{F}}} < r_{B_F}$ (Lemma 6). As F increases within this range, r_{e_F} moves to the right of $r_{e_{\bar{F}}} = r_{NB_{\bar{F}}}$, and r_{NB_F} moves to the left of $r_{e_{\bar{F}}} = r_{NB_{\bar{F}}}$ as shown in Figure 3.9. However, r_{B_F} remains to the right of $r_{e_{\hat{F}}} = r_{B_{\hat{F}}}$ because $F \leq \hat{F}$. If $r \in [x, r_{e_F}]$, then F is above $F_e(r)$. Hence, this firm faces no extortion if it chooses I_a, and so the payoff $\pi_r(I_a, NB) = r - x$ is feasible. However, it is not feasible if the revenue is in the range $r \in [r_{e_F}, \dot{r}]$ because it inevitably faces a bribe offer, which follows from Table 3.2.

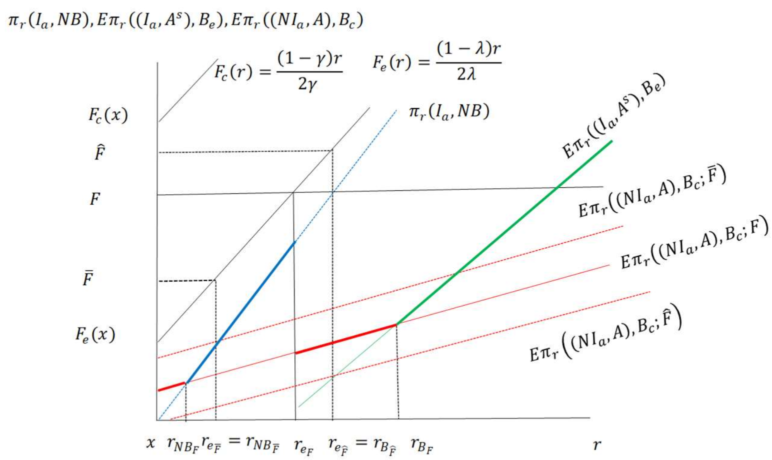

Figure 3.7: Firms' equilibrium choice in the Low penalty range

Though $\pi_r(I_a, NB) = r - x$ is feasible for a firm with revenue in the range $r \in [x, r_{NB_F}]$, yet it chooses (NI_a, A) because $E\pi_r((NI_a, A), B_c) \geq \pi_r(I_a, NB)$ as shown in Figure 3.7. The reverse, $E\pi_r((NI_a, A), B_c) \leq \pi_r(I_a, NB)$, is true for revenue in the interval $r \in [r_{NB_F}, r_{e_F}]$. So a firm chooses I_a and faces no corruption. The bold segments in Figure 3.7 show these outcomes, for the interval $r \in [x, r_{e_F}]$.

A firm with revenue in the interval $r \in [r_{e_F}, \dot{r}]$ always face either extortion or collusion depending on its choice of I_a or NI_a, because the penalty is less than $F_e(r)$ and $F_c(r)$ (Figure 3.7) and hence, both extortion and collusion conditions are satisfied. Observe from Figure 3.7 that for $r \in [r_{e_F}, r_{B_F}]$, $E\pi_r((NI_a, A), B_c) \geq E\pi_r((I_a, A^s), B_e)$, while for $r \in [r_{B_F}, \dot{r}]$, $E\pi_r((NI_a, A), B_c) \leq E\pi_r((I_a, A^s), B_e)$. The bold segments in Figure 3.7 show these outcomes, for the interval $r \in [r_{e_F}, \dot{r}]$.

The above discussion and Figure 3.7 lead us to Proposition 2.

Proposition 2. *Suppose penalty is in the Low range* $F \in [\bar{F}, \hat{F}]$. *A firm with revenue in the interval:*

(i) $r \in [x, r_{NB_F}]$ *chooses* NI_a *and indulge in collusion. The outcome is* $((NI_a, A), B_c)$

(ii) $r \in [r_{NB_F}, r_{e_F}]$ *chooses* I_a *and there is no corruption. The outcome is* (I_a, NB)

(iii) $r \in [r_{e_F}, r_{B_F}]$ *chooses* NI_a *and indulge in collusion. The outcome is* $((NI_a, A), B_c)$

(iv) $r \in [r_{B_F}, \dot{r}]$ *chooses* I_a *but face extortion. The outcome is* $((I_a, A^s), B_e)$

Proposition 2 interestingly demonstrates the non-monotonicity in the pattern of a firm's stage 2 choice and that of corruption distribution. There is lawful behavior by a firm and the officer only if the former's revenue is in the second lowest range $r \in [r_{NB_F}, r_{e_F}]$.

Furthermore, the intervals $[x, r_{NB_F}]$ and $[r_{e_F}, r_{B_F}]$ shrink as penalty increases within the range $F \in [\bar{F}, \hat{F}]$. While, the scope of collusion falls, the scope of extortion rises. However, since the interval $[r_{NB_F}, r_{e_F}]$ expands, the overall frequency of corruption falls. This result is summarized in Observation 2.

Observation 2: *As penalty increases* within *the Low range,* $F \in [\bar{F}, \hat{F}]$, *collusion falls but extortion rises, and the overall frequency of corruption falls. While more of the higher revenue firms invest at stage 2 and face extortion, more of the firms at the low or medium range of revenue invest at stage 2, but do not face any corruption. This lowers the generation of negative externality.*

Now consider the *Medium* penalty range $F \in [\hat{F}, F_c(x)]$ for which $r_{NB_F} \le r_{B_F} \le r_{e_F}$ (Lemma 6). We use Figure 3.8, to determine the equilibrium choices.

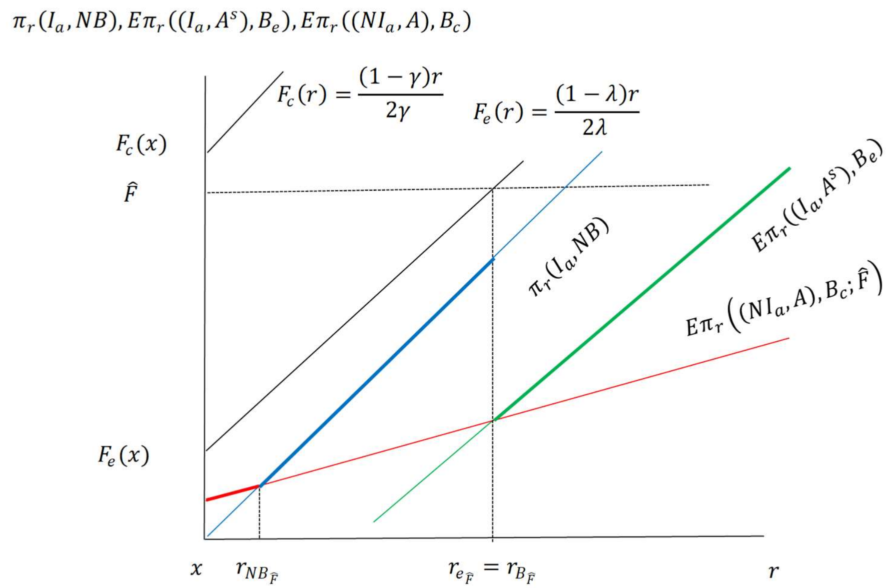

Figure 3.8: Firms' equilibrium choice in the Medium penalty range

From Lemma 6(i) we know that at $\hat{F}$, $r_{e_{\hat{F}}} = r_{B_{\hat{F}}}$ and $r_{NB_{\hat{F}}} < r_{e_{\hat{F}}} = r_{B_{\hat{F}}}$. Lemma 3b and Figure 3.2b shows that a firm with $r \in [x, r_{B_{\hat{F}}}]$ does not face extortion if it chooses I_a in stage 1 because in this revenue range the penalty is higher than their extortion threshold penalty $F_e(r)$. Therefore, $E\pi_r((I_a, A^s), B_e)$ is not feasible in this revenue range. However, a firm engages in collusion if it chooses NI_a in stage 1 because the penalty is less than the collusion threshold penalty $F_c(r)$.

Notice from Figure 3.8 that $E\pi_r((NI_a, A), B_c) \geq \pi_r(I_a, NB)$ for a firm with $r \in [x, r_{NB_{\hat{F}}}]$ and $E\pi_r((NI_a, A), B_c) \leq \pi_r(I_a, NB)$ for $r \in [r_{NB_{\hat{F}}}, r_{e_{\hat{F}}}]$. So a firm with $r \in [x, r_{NB_{\hat{F}}}]$ chooses NI_a and indulges in collusion. On the contrary, if $r \in [r_{NB_{\hat{F}}}, r_{e_{\hat{F}}})$ then it chooses I_a and there is no corruption.

For a firm with $r \in [r_{e_{\hat{F}}}, \dot{r}]$, the penalty is lower than the extortion threshold level $F_e(r)$ and hence the extortion bribery condition is satisfied. Thus, this firm always face extortion if it chooses I_a in stage 2. Thus, the payoff $\pi_r(I_a, NB)$ is not feasible. Further, $E\pi_r((I_a, A^s), B_e) \geq E\pi_r((NI_a, A), B_c)$ since the penalty has reached $\hat{F}$, as shown in Figure 3.8. So, in the interval $r \in [r_{e_{\hat{F}}}, \dot{r}]$ a firm chooses I_a in stage 2 but face extortion.

These results are summarized in Proposition 3.

Proposition 3. *Consider the Medium penalty range* $F \in [\hat{F}, F_c(x)]$. *A firm with revenue in the interval:*

(i) $r \in [x, r_{NB_{\hat{F}}}]$ *chooses* NI_a *and indulges in collusion. The outcome is* $((NI_a, A), B_c)$

(ii) $r \in [r_{NB_{\hat{F}}}, r_{e_{\hat{F}}}]$ *chooses* I_a *and there is no corruption. The outcome is* (I_a, NB)

(iii) $r \in [r_{e_{\hat{F}}}, \dot{r}]$ *chooses* I_a *but faces extortion. The outcome is* $((I_a, A^s), B_e)$.

The main difference between Propositions 2 and 3 is that the intermediate collusive corruption that was present in the *Low* penalty range $F \in [\bar{F}, \hat{F}]$ disappears in the *Medium* range $F \in [\hat{F}, F_c(x)]$. The interval $[x, r_{NB_F}]$ shrinks as the penalty increases within this range, and the scope of collusion falls. The scope of extortion also falls because $r \in [r_{e_F}, \dot{r}]$ shrinks since r_{e_F} rises. Since $(r_{NB_F}, r_{e_{\hat{F}}}]$ expands, more firms in the low revenue range invests at stage 2 but do not face extortion.

Observation 3: *As penalty increases within the Medium range* $F \in [\hat{F}, F_c(x)]$*, both collusion and extortion fall. The overall frequency of corruption falls as more firms with low revenue potential invests at stage 2 of the game and avoids corruption. Less negative externality is generated.*

Let us now consider the *High* penalty range $F \in [F_c(x), F]$. From Lemmas 5 and 6 we know that at $F_c(x)$, $r_{NB_{F_c(x)}} = x$, and $r_{B_{F_c(x)}} < r_{e_{F_c(x)}}$. It means that $\pi_r(I_a, NB)$ is above $E\pi_r((NI_a, A), B_c)$ for all *r* as shown in Figure 3.9, that is, $\pi_r(I_a, NB) \geq E\pi_r((NI_a, A), B_c)$

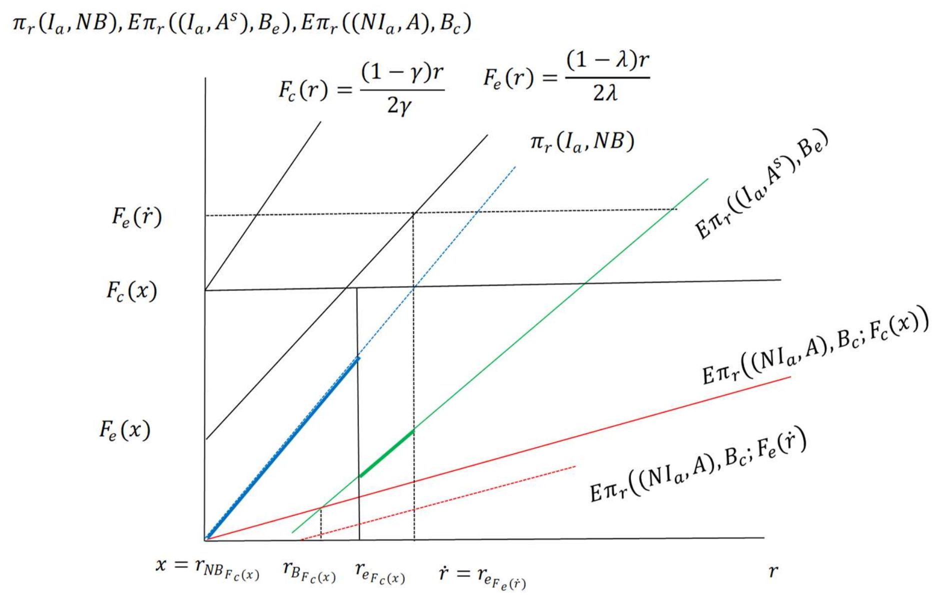

Figure 3.9: Firms' equilibrium choice in the High penalty range

$F_c(x)$ is above the extortion threshold penalty $F_e(r)$ for all $r \in \left[x, r_{e_{F_c(x)}}\right)$ as shown in Figure 3.9. So the extortion bribery condition is violated which means that the payoff $E\pi_r((I_a, A^s), B_e)$ is not feasible. Since $\pi_r(I_a, NB) \geq E\pi_r((NI_a, A), B_c)$ as shown in Figure 3.9, so a firm with $r \in \left[x, r_{e_{F_c(x)}}\right)$ chooses I_a and faces no corruption.

However, for a firm with revenue in the interval $r \in \left[r_{e_{F_c(x)}}, \dot{r}\right]$, the penalty $F_c(x)$ is below $F_e(r)$ as evident from Figure 3.9. So, for this firm, the extortion bribery condition is satisfied, hence, $\pi_r(I_a, NB)$ is not feasible. Since $r_{B_{F_c(x)}} < r_{e_{F_c(x)}}$, therefore,

$E\pi_r((I_a, A^s), B_e) \geq E\pi_r((NI_a, A), B_c)$. So, this firm chooses I_a and there is extortion in equilibrium.

Thus, when the penalty reaches $F_c(x)$, collusion is eliminated, and all firms chooses I_a. While firms with $r \in \left[x, r_{e_{F_c(x)}}\right)$ face no corruption while those with $r \in \left[r_{e_{F_c(x)}}, \dot{r}\right]$ faces extortion. This revenue interval shrinks as the penalty increases beyond $F_c(x)$ and reaches $F_e(\dot{r})$, and thus extortion is eliminated[32]. This is because r is the highest possible revenue and so $F \geq F_e(\dot{r})$ means that the penalty exceeds the extortion bribery threshold for all firms.

We use the above discussion to summarize firms' and officer's equilibrium choices for any penalty in the range $F \in [F_c(x), F]$ in Proposition 4.

Proposition 4. *Consider the High penalty range* $F \in [F_c(x), F]$. *Any firm with revenue in the range* $r \in [x, r]$ *chooses* I_a. *A firm with revenue in the range:*

(i) $r \in [x, r_{e_F})$ *faces no corruption. The outcome is* (I_a, NB)*;*

(ii) $r \in [r_{e_F}, \dot{r}]$ *faces extortion. The outcome is* $((I_a, A^s), B_e)$.

From proposition 4 we observe the following:

Observation 4. *An increase in the penalty in the High range* $F \in [F_c(x), F]$*, eliminates collusion. Since* $r_{e_{\hat{F}}} < r_{e_{F_c(x)}}$*, extortion falls. The overall frequency of corruption falls also and no negative externality is generated.*

---

[32] From assumption 1 we know that $F_e(\dot{r}) > F_c(x)$.

We will use the findings in Propositions 1 to 4 and Observations 1 to 4 to determine the social welfare-maximizing penalty and characterize the subgame perfect equilibrium corruption distribution. This is presented in the next section.

3.4. Social welfare analysis and subgame perfect equilibrium

The government chooses a penalty that maximizes social welfare, which is defined as the surplus of all agents in the model (Becker, 1968). Since bribes and fines are transfer payments, they do not appear in the social welfare function. It therefore consists of the firms' aggregate surplus net of the investment cost or the cost of negative externality, whichever applies. Using Propositions 1 to 4 we present the social welfare function for the different penalty ranges in Table 3.3.

Table 3.3: Social welfare function for the different penalty ranges

Penalty range	Outcomes and social welfare functions
Very Low $0 \le F \le \bar{F}$	(i) For $r \in [x, r_{B_F}]$, the equilibrium is $((NI_a, A), B_c)$. (ii) For $r \in [r_{B_F}, \dot{r}]$, the equilibrium is, $((I_a, A^s), B_e)$. $SW_{VL} = \dfrac{1}{(\dot{r}-x)}\left[\int_x^{r_{B_F}} (1-l)(1-\gamma) r\,dr + \int_{r_{B_F}}^{\dot{r}} (r-x)\,dr\right]$
Low $\bar{F} \le F \le \hat{F}$	(i) For $r \in [x, r_{NB_F}]$, the equilibrium is $((NI_a, A), B_c)$. (ii) For $r \in [r_{NB_F}, r_{e_F}]$, the equilibrium is (I_a, NB). (iii) For $r \in [r_{e_F}, r_{B_F}]$, the equilibrium is $((NI_a, A), B_c)$. (iv) For $r \in [r_{B_F}, \dot{r}]$, the equilibrium is $((I_a, A^s), B_e)$.

	$SW_L = \frac{1}{(\dot{r}-x)}\left[\int_{x}^{r_{NB_F}} (1-l)(1-\gamma)r\,dr + \int_{r_{NB_F}}^{r_{e_F}} (r-x)\,dr + \int_{r_{e_F}}^{r_{B_F}} (1-l)(1-\gamma)r\,dr + \int_{r_{B_F}}^{\dot{r}} (r-x\right.$
Medium $\hat{F} \le F \le F_c(x)$	(i) For $r \in [x, r_{NB_F}]$, the equilibrium is $((NI_a, A), B_c)$. (ii) For $r \in [r_{NB_F}, r_{e_F}]$, the equilibrium is (I_a, NB). (iii) For $r \in [r_{e_F}, \dot{r}]$, the equilibrium is $((I_a, A^s), B_e)$. $SW_M = \frac{1}{(\dot{r}-x)}\left[\int_{x}^{r_{NB_F}} (1-l)(1-\gamma)r\,dr + \int_{r_{NB_F}}^{\dot{r}} (r-x)\,dr\right]$
High $F_c(x) \le F \le F_e(\dot{r})$	(i) For $r \in [x, r_{e_F})$, the equilibrium is (I_a, NB). (ii) For $r \in [r_{e_F}, \dot{r}]$, the equilibrium is $((I_a, A^s), B_e)$. $SW_H = \frac{1}{(\dot{r}-x)}\int_{x}^{\dot{r}} (r-x)\,dr$
Very High $F \ge F_e(\dot{r})$	For $r \in [x, \dot{r}]$ the equilibrium is (I_a, NB). $SW_{VH} = \frac{1}{(\dot{r}-x)}\int_{x}^{\dot{r}} (r-x)\,dr$

Observe from Table 3.3 that the social welfare functions for the *High* and *Very High* penalty ranges are identical and constant because all firms choose to invest and there is no negative externality. Only extortion exists in the *High* range. This is not the case for the *Very Low*, *Low* and *Medium* penalty ranges where, for different revenue intervals there is either collusion or extortion or no corruption. Hence, these social welfare functions are functions of *F* as well as *l*. Using Table 3.3 we get the overall social welfare function, which is given in equation (9).

$$SW=\begin{cases} SW_{VL}=\dfrac{1}{\dot{r}-x}\left[\dfrac{(1-\gamma)(1-l)\{(r_{B_F})^2-(x)^2\}}{2}+\dfrac{(\dot{r})^2-(r_{B_F})^2}{2}-x(\dot{r}-r_{B_F})\right] \\ SW_{L}=\dfrac{1}{\dot{r}-x}\left[\displaystyle\int_{x}^{r_{NB_F}}(1-l)(1-\gamma)r\,dr+\int_{r_{NB_F}}^{r_{e_F}}(r-x)\,dr+\int_{r_{e_F}}^{r_{B_F}}(1-l)(1-\gamma)r\,dr+\int_{r_{B_F}}^{\dot{r}}(r-x)\,dr\right] \\ SW_{M}=\dfrac{1}{\dot{r}-x}\left[\dfrac{(1-\gamma)(1-l)\{(r_{NB_F})^2-(x)^2\}}{2}+\dfrac{(\dot{r})^2-(r_{NB_F})^2}{2}-x(\dot{r}-r_{B_F})\right] \\ SW_{H}=\dfrac{1}{\dot{r}-x}\left[\dfrac{(\dot{r}-x)^2}{2}\right]=\dfrac{(\dot{r}-x)}{2} \\ SW_{VH}=\dfrac{1}{\dot{r}-x}\left[\dfrac{(\dot{r}-x)^2}{2}\right]=\dfrac{(\dot{r}-x)}{2} \end{cases} \tag{9}$$

In Proposition 5 we summarize some of the important properties of the social welfare function as given in equation (9). The proof is included in the Appendix.

Proposition 5.

(i) *SW is continuous in the penalty F.*

(iia) SW_{VL}, which is defined in the Very Low penalty range $F \in [0,\bar{F}]$, is non-monotonic and concave in F and is maximized at $F_{VL}=\begin{cases} 0, & \text{if } l \in (0,l_0] \\ F_{VL}^{*}, & \text{if } l \in [l_0,\bar{l}_{VL}] \\ \bar{F}, & \text{if } l \geq \bar{l}_{VL} \end{cases}$ *, where*

$F_{VL}^{*}=\dfrac{x}{\gamma}\left[1-\dfrac{(\lambda+\gamma)}{2[1-(1-l)(1-\gamma)]}\right]$. *$SW_{VL}$ and F_{VL}^{*} are monotonically decreasing in l.*

(iib) SW_L, which is defined in the Low penalty range $F \in [\bar{F},\hat{F}]$, is monotonically increasing in F and is maximized at $\hat{F}$. SW_L is also decreasing in l.

(iic) SW_M*, which is defined for the Medium penalty range* $F \in [\hat{F}, F_c(x)]$*, is concave and non-monotonic in F and is maximized at* $F_M = \begin{cases} \hat{F}, & \text{if } l \in (0, \hat{l}_M] \\ F_M^*, & \text{if } l \in [\hat{l}_M, 1] \\ F_c(x), & \text{if } l \geq 1 \end{cases}$ *, where* $F_M^* = \dfrac{x}{\gamma}\left[1 - \dfrac{(1+\gamma)}{2[1-(1-l)(1-\gamma)]}\right]$*.* SW_M *and* F_M^* *are monotonically decreasing in l.*

The continuity of the social welfare function follows from the fact that the values of its different components are the same at end point of the different penalty intervals. Recall that SW_{VL}, SW_L and SW_M are defined for penalty ranges that sustain extortion and collusion. The latter generates negative externality, an increase in which, therefore, reduces the above three components of *SW*. We use Figure 3.10 to demonstrate this and other properties of SW_{VL}, SW_L and SW_M stated in Proposition 5.

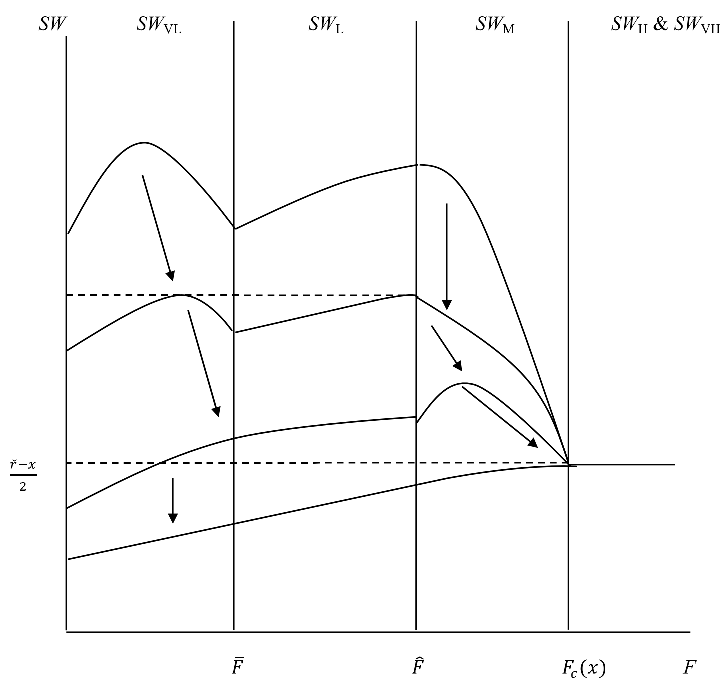

Figure 3.10: A diagrammatic representation of properties of the SW components

In the *Very Low* penalty range $F \in [0, \bar{F}]$, we know from Proposition 1 that low revenue firms indulge in collusion while high revenue firms face extortion. Recall that the negative externality cost is proportional to the revenue. Thus, for low *l*, $l \in [0, l_0]$, it is costly to reduce the negative externality by imposing a penalty, that induces firms to invest and face extortion (Observation 1). Thus for $l \in [0, l_0]$, $F_{VL} = 0$ maximizes SW_{VL}. SW_{VL} shifts down as *l* increases and when it surpasses l_0 the SW_{VL} maximizing penalty increases from 0 to F_{VL}^* which is an interior solution. This follows from the tradeoff between elimination of the negative externality through a high penalty and the consequential higher aggregate investment cost. As *l* increases in the range $l \in [l_0, \bar{l}_{VL}]$, F_{VL}^* increases as shown by the downward sloping arrow in the middle section of the SW_{VL} panel in Figure 3.10. As *l* reaches $\bar{l}_{VL}$ F_{VL}^* reaches $\bar{F}$, which is the upper bound of the *Very Low* penalty range, and continues to remain at that point for any further increases in *l*. This is because the cost of the negative externality becomes high, and therefore, to counter this effect the penalty needs to be high. Consequently, we see that for $l \geq \bar{l}_{VL}$, where $0 < \bar{l}_{VL} < 1$, SW_{VL} becomes monotonically increasing in *F* as shown in Figure 3.10.

However, in the *Low* penalty range, $F \in [\bar{F}, \hat{F}]$, we know from Proposition 2 that the corruption distribution is non-monotonic. That is, firms in the low and intermediate revenue range indulge in collusion and generate negative externality. Therefore, the cost imposed by the negative externality is quite high. Thus, in this penalty range, SW_L is monotonically increasing in the penalty, and therefore, the upper bound $\hat{F}$ maximizes SW_L. In the *Medium* penalty range, $F \in [\hat{F}, F_c(x)]$, the properties of SW_M are similar to SW_{VL}.The intuition is also similar because, recall from Proposition 3 that in this penalty range, there is collusion in the low revenue range, no corruption in the intermediate revenue range, and extortion in the high revenue range. Hence, for low *l*, $l \in [0, \hat{l}_M]$, the SW_M maximizing penalty is at its lower bound, $\hat{F}$. In fact, increases in *l* in this range does not alter the optimum but reduces SW_M. As *l* reaches $\hat{l}_M$, the optimum becomes F_M^* which is an interior solution, and it increases with *l* within the range $l \in [\hat{l}_M, 1]$. This is shown in the SW_M panel in Figure 3.10 by the downward sloping arrows. As *l* exceeds 1 then SW_M is maximized at the upper bound $F_c(x)$, because SW_M becomes monotonically increasing in *F*.

It is important to note that SW_{VL} becomes monotonically increasing in *F* before SW_M because $0 < \bar{l}_{VL} < 1$. It implies that an increase in *l* causes SW_{VL} to fall at a faster rate than SW_M. This is because SW_{VL} is defined for the *Very Low* penalty range, and hence, there is considerable degree of collusion. In contrast, a penalty in the *Medium* range, $F \in [\hat{F}, F_c(x)]$, is considerably higher and therefore, the extent of collusion and negative externality is relatively lower.

The result that an increase in *l* reduces SW_{VL} at a higher rate than SW_M, eliminates that possibility of any penalty in the *Low* range $F \in [\bar{F}, \hat{F})$ being the equilibrium candidate, for the following reasons.

Suppose *l* is quite low, $l \approx 0$, for which SW_{VL} and SW_M are maximized at 0 and $\hat{F}$. There are two possibilities: (i) $SW_{VL}(F_{VL} = 0; l \approx 0) > SW_M(F_M = \hat{F}; l \approx 0)$, and (ii) $SW_{VL}(F_{VL} = 0; l \approx 0) \leq SW_M(F_M = \hat{F}; l \approx 0)$. Suppose the first inequality holds. Since an increase in *l* causes SW_{VL} to fall at a higher rate than SW_M, there exists a critical l', such that, $SW_{VL}(F_{VL};l') = SW_M(F_M;l')$, where $F_{VL} \in [0,\bar{F})$ and $F_M \in [\hat{F}, F_c(x))$. This is shown by the horizontal dotted line in the middle section of Figure 3.10. Thus at l', the socially optimal penalty jumps from $F_{VL} \in [0,\bar{F})$ to $F_M \in [\hat{F}, F_c(x))$. If the second inequality holds then SW_M lies above SW_{VL} for all values of *l*. In this case any penalty in the *Very Low* and *Low* ranges is never a candidate for social optimum. Using F^{SW} to denote the socially optimal penalty we characterize the subgame perfect equilibrium for the above two cases in Propositions 6a and 6b.

Proposition 6a. *Suppose* $SW_{VL}(F_{VL}=0; l \approx 0) > SW_M(F_M = \hat{F}; l \approx 0)$. *Then there exists an* l'*, such that* $SW_{VL}(F_{VL};l') = SW_M(F_M;l')$*, where* $F_{VL} \in [0,\bar{F})$ *and* $F_M \in [\hat{F}, F_c(x))$

(i) If $l \in (0, l')$*, then the socially optimal penalty is in the Very Low range, that is,* $F^{SW} = F_{VL} \in [0,\bar{F})$. *Low revenue firms choose* NI_a *and indulge in collusion while high revenue firms choose* I_a *and face extortion.*

(ii) If $l \in [l', 1)$*, then the socially optimal penalty is in the Medium range, that is,* $F^{SW} = F_M \in [\hat{F}, F_c(x))$. *Low revenue firms choose* NI_a *and indulge in collusion, intermediate revenue firms choose* I_a *and face no corruption, while the high revenue firms also choose* I_a *but face extortion.*

(iii) If $l \geq 1$*, then the optimal penalty is* $F^{SW} \geq F_c(x)$. *All firms choose* I_a. *If* $F^{SW} \in [F_c(x), F_e(\dot{r}))$ *then the high revenue firms face extortion while the low revenue firms no corruption. Extortion is eliminated if* $F^{SW} \geq F_e(\dot{r})$.

Let us intuitively explain Proposition 6. In our model, although the amount of qualifying investment is the same for all firms, the higher revenue firms impose a higher cost of negative externality. From Observations 1 to 4 we know that a high penalty induces firms to switch from no-investment to investment, which reduces the negative externality but increases the aggregate investment cost. This trade-off plays the crucial role in determining the socially optimal penalty.

Thus, when l is rather low, a relatively low penalty that lies in the *Very Low* penalty range becomes socially optimal. It incentivizes the high revenue firms to invest and not generate the higher negative externality but face extortion, while the low revenue firms do not invest and continue to generate the negative externality. The latter set of firms indulges in collusion while the higher revenue firms face extortion. An increase in l increases the cost of negative externality and thus the optimal penalty increases to counter this adverse effect. Consequently, some of the firms switch from no-investment to investment (Observation 1). However, the pattern remains the same as above till l reaches the critical level l'.

At this level, the optimal penalty jumps up from the *Very Low* to the *Medium* range. The exact point of the jump cannot be specified. However, this jump results in a reduction in the incidence of collusion (Observation 3) because some of the low revenue firms switch from no-investment to investment and interestingly they face no corruption, because for this set of firms the penalty is above the threshold penalties for collusion and corruption. The low revenue firms that stick to no-investment continue indulging in collusion while the high revenue firms that continue investing face extortion. The optimal penalty in the *Medium* range increases in response to an increase in l, for the same reason as mentioned before. Consequently, more firms switch from no-investment to investment (Observation 3). This continues till l reaches the value 1.

It then becomes imperative to eliminate negative externality by eliminating collusion, because the high extent of negative externality imposes a significantly high cost which outweighs the aggregate investment cost when all firms invest. Therefore, the optimal penalty reaches the upper bound of the *Medium* penalty range $F_c(x)$, and collusion and negative externality is eliminated. Further increases in *l* does not have any impact on the investment decision but the existence of extortion depends on whether the penalty is in the *High* range where extortion exists or in the *Very High* range where all forms of corruption is eliminated. We provide a diagrammatic illustration of Proposition 6a in Figure 3.11.

In this diagram we measure penalty (F) along the vertical axis where we also indicate the different penalty ranges as *VL, L, M, H* and *VH*. Along the horizontal axis we measure the extent of the negative externality. The bold lines indicate the socially optimal penalties for different ranges of the negative externality. The consequent equilibrium corruption patterns, as described in Propositions 1, 3, and 4 are shown below the horizontal axis that has the following interpretations.

(i) $\underset{Collusion-Extortion}{\Longleftrightarrow}$ means low revenue firms choose NI_a and engage in collusion while high revenue firms choose I_a and face extortion.

(ii) $\underset{Collusion-NC-Extortion}{\Longleftrightarrow}$ means low revenue firms choose NI_a and engage in collusion, intermediate revenue firms choose I_a and face no corruption (*NC*), while the high revenue firms choose I_a but face extortion.

(iii) $\underset{NC-Extortion}{\Longleftrightarrow}$ means all firms choose I_a but the low revenue firms face no corruption while the high revenue firms face extortion.

(iv) $\underset{NC}{\Leftrightarrow}$ means all firms choose I_a and there is no corruption.

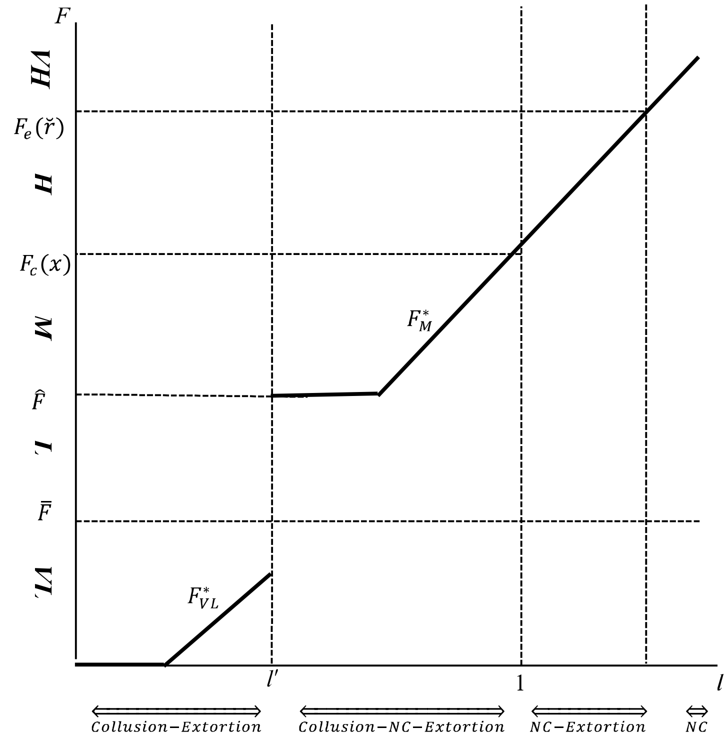

Figure 3.11: Diagrammatic representation of Proposition 6a

Figure 3.11 demonstrates that no penalty is the social optimum for a certain range of the negative externality range, as indicated by the bold horizontal line on the horizontal axis. After that F_{VL}^* becomes the equilibrium, which increases as *l* increases to l'. Then the social optimum jumps to $\hat{F}$ and stays there for a certain range of *l* before the equilibrium becomes F_M^* which is increasing in *l*. When *l* exceeds 1 then any penalty above $F_c(x)$ becomes the optimal and the existence of extortion depends on whether the optimal penalty is in the *High* or *Very High* range.

Let us now characterize the subgame perfect equilibrium for the second possibility $SW_{VL}(F_{VL}=0;l\approx 0)\le SW_M(F_M=\hat{F};l\approx 0)$. The equilibrium for $l\ge 1$ is identical to that in Proposition 6a(iii). So we only state the equilibrium for $l<1$ in Proposition 6b, which is diagrammatically represented in Figure 3.12.

Proposition 6b. *Suppose* $SW_{VL}(F_{VL}=0;l\approx 0)\leq SW_{M}(F_{M}=\hat{F};l\approx 0)$.

(i) If $l\in(0,\hat{l}_{M}]$*, then the socially optimal penalty is* $F^{SW}=\hat{F}$*. Low revenue firms choose* NI_{a} *and indulge in collusion, intermediate revenue firms choose* I_{a} *and face no corruption, while the high revenue firms also choose* I_{a} *but face extortion.*

(ii) If l is in the range $l\in[\hat{l}_{M},1]$ *then the socially optimal penalty is* $F^{SW}=F_{M}^{*}$ *and it is increasing in l. Firms' choices and the equilibrium corruption distribution pattern remains the same as in (i).*

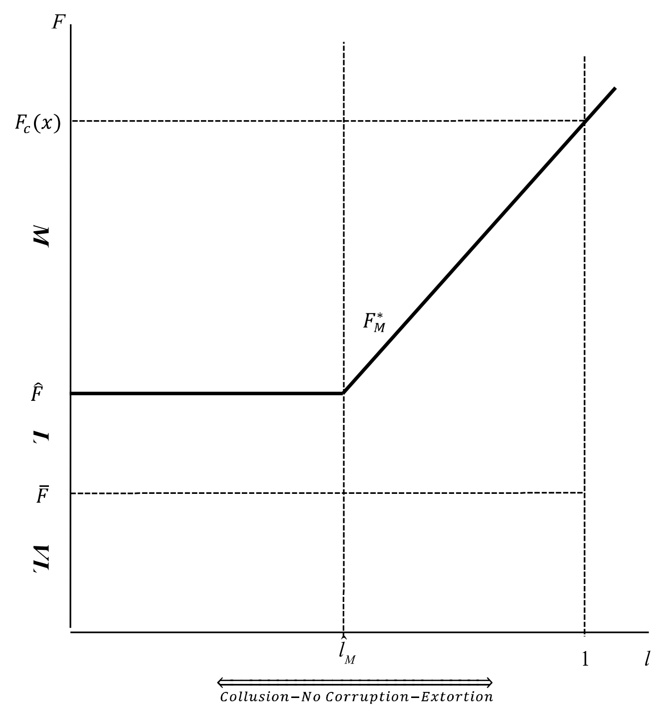

Figure 3.12: Diagrammatic representation of Proposition 6b

In contrast to Proposition 6b, we observe that when the condition $SW_{VL}(F_{VL}=0;l\approx 0)\leq SW_{M}(F_{M}=\hat{F};l\approx 0)$ holds then for $l<1$, the socially optimal penalty fully lies in the *Medium* range. The firms' choices and the resultant subgame perfect equilibrium corruption distribution follows from Proposition 3. Furthermore, while in

Proposition 6a we could only specify the optimal penalty ranges, in Proposition 6b we can precisely specify the exact socially optimal penalty for each l. Like Proposition 6a, in Proposition 6b we also observe that when $l<1$ then the socially optimal penalty is such that both collusion and extortion coexist.

3.5. Conclusions

In this chapter we considered a framework where a set of firms decides whether to apply for a compliance certificate by incurring a costly emission reducing investment or not investing. If production continues without the investment, then it generates a negative externality in the form of pollution, which imposes a cost to the society. An officer reviewing the compliance application may choose to behave honestly and grant the certificate only to an investing firm or behave corruptibly by seeking a bribe. In the latter case if the firm has not invested then the corruption takes the form of collusion. If the firm has invested and the officer threatens to issue the certificate only in lieu of a bribe, then corruption takes the form of extortion.

We assume that while the cost of emission reducing investment is fixed, the cost of the negative externality generated by a polluting firm is proportional to its revenue. This creates the following trade-off. A higher penalty, that induces more firms to undertake the investment, raises the aggregate investment cost but it lowers the aggregate cost imposed by the negative externality. This trade-off determines the socially optimal penalty, which in turn determines the subgame perfect equilibrium corruption distribution.

We show that when the extent of the negative externality is low then the socially optimal penalty is also "very low". In this case low revenue firms do not invest and indulge in collusion, while high revenue firms invest but faces extortion. The optimal penalty increases as the extent of the negative externality increases in order to counter adverse effect of higher negative externality.

As the negative externality transits from a low to a medium level, the optimal penalty jumps to a "medium level" and stays in that range for a certain extent. The higher penalty incentivizes some of the low revenue firms to switch their decision from no-investment to investment, which results in the following corruption distribution. The remaining low revenue firms continue not to invest and indulge in collusion and the high revenue firms continue to invest and face extortion. The low revenue firms that switched from no-investment to investment face no corruption. The optimal penalty in the "medium" range increases in response to an increase in the extent of negative externality and this reduces the incidence of collusion.

As this extent becomes quite strong then the cost imposed by the negative externality becomes quite high and it becomes imperative for the government to reverse this by implementing a high penalty that eliminates collusion and hence, the negative externality. However, extortion may still exist, and its elimination is possible only when the penalty becomes prohibitively high.

These findings suggest that if the extent of the negative externality is not high then it is not optimal to eliminate collusion and negative externality. In fact, the socially optimal penalty sustains the coexistence of both collusion and extortion the pattern of which depends on the socially optimal penalty. Thus, it is not always optimal to eliminate corruption.

In the present chapter we have analysed how formal enforcement through a monetary penalty influences the bureaucrat's decision to be corrupt thereby determining extortion and collusion incidences. However, beyond enforcement non-monetary factors such as social norms can also influence corruption incidence. Moral costs that arise from the failure to adhere to such norms may have important implications for corruption. The next chapter incorporates morality in the enforcement framework to determine the scope of extortion and collusion.

Appendix

Proof of Lemma 1. The proof follows from the fact that $0 \le \gamma < 1$.

Therefore, the statement of the lemma follows. □

Proof of Lemma 2.

(i) That $F_e(r) = \frac{(1-\lambda)r}{2\lambda}$ and $F_c(r) = \frac{(1-\gamma)r}{2\gamma}$ are linearly increasing in r is evident from their expressions. Now $\frac{(1-\gamma)}{2\gamma} > \frac{(1-\lambda)}{2\lambda}$ because by assumption $\lambda > \gamma$.

(ii) Consequently, for any $r > 0$, $F_c(r) = \frac{(1-\gamma)r}{2\gamma} > F_e(r) = \frac{(1-\lambda)r}{2\lambda}$.

Therefore, the statement of the lemma follows. □

Proof of Lemma 3a.

We prove Lemma 3 using the *bribe offer* and *bribe acceptance* conditions as shown in Tables 3.1 and 3.2. Suppose a firm with revenue r_i chooses I_a in stage 1. Then it may potentially face extortion. From Table 3.2 we know that the bribe offer condition is $F \le \frac{(1-\lambda)r_i}{2\lambda} \equiv F_e$. From Table 3.1 we know that if this condition is satisfied then the extortion bribe acceptance criteria, $r_i \ge b_e$, is always satisfied since $b_e = \frac{r_i}{2}$. It then follows that if the penalty is above the threshold level F_e then there is no extortion. If firm r_i chooses NI_a in stage 1, then there may be collusive corruption. Tables 3.1 and 3.2 show that the collusive bribe offer and bribe acceptance criterion are the same, which is $F \le \frac{(1-\gamma)r_i}{2\gamma} \equiv F_c$, and so in this case there is collusive corruption. Lemma 2 shows that $F_e < F_c$ for all *r*. So there is no corruption of any form if $F > F_c$.

Therefore, the statement of lemma 3a follows. □

Proof of Lemma 3b.

(i) Observe from Figure 2b, that for any F, a firm with $r \in [0, r_{e_F})$, do not face extortion, if it chooses I_a in stage 2 because $F_e(r) < F$ for all $r \in [0, r_{e_F})$, and hence, the extortion bribe offer and acceptance conditions are not satisfied. However, if $r \in [r_{e_F}, \dot{r}]$, then $F_e(r) \geq F$, and so the extortion bribe offer, and acceptance conditions are satisfied. Hence, if a firm chooses I_a in stage 2, it faces extortion.

(ii) For any penalty F, a firm with $r \in [0, r_{c_F})$ does not face collusive corruption because $F_c(r) < F$, and so the collusive bribe offer, and acceptance condition is not satisfied. Hence, if the firm chooses NI_a in stage 2, it does not face collusive corruption. However, for firm-r with $r \in [r_{c_F}, \dot{r}]$, $F_c(r) \geq F$. So, the collusive bribe offer and acceptance conditions are satisfied. Hence, if firm-r chooses NI_a in stage 2, it faces collusive corruption.

(iii) That r_{e_F} and r_{c_F} are increasing F is evident from their expressions.

Therefore, the statement of the lemma follows. □

Proof of Lemma 4.

(i) It is evident from their expressions as given in equations (I), (II) and (III).

(ii) $\pi_r(I_a, NB) > E\pi_r((I_a, A^s), B_e)$ since $0 < \lambda < 1$.

(iii) $\dfrac{d\pi_r(I_a,NB)}{dr}=1$, $\dfrac{dE\pi_r((I_a,A^s),B_e)}{dr}=\dfrac{(1+\lambda)}{2}$ and $\dfrac{dE\pi_r((NI_a,A),B_c)}{dr}=\dfrac{(1-\gamma)}{2}$.

Now $1>\dfrac{(1+\lambda)}{2}$ because $0<\lambda<1$ and $\dfrac{(1+\lambda)}{2}>\dfrac{(1-\gamma)}{2}$ because $0<\gamma<1$ and $\lambda>\gamma$.

Hence, $\dfrac{d\pi_r(I_a,NB)}{dr}>\dfrac{dE\pi_r((I_a,A^s),B_e)}{dr}>\dfrac{dE\pi_r((NI_a,A),B_c)}{dr}$.

Therefore, the statement of the lemma follows. □

Proof of Lemma 5.

(i) An increase in the penalty *F* reduces $E\pi_r((NI_a,A),B_c)$ is evident from its expression $E\pi_r((NI_a,A),B_c)=\dfrac{(1-\gamma)r}{2}-\gamma F$ as given in (III). An increase in the penalty *F* has no effect on $\pi_r(I_a,NB)$ and $E\pi_r((I_a,A^s),B_e)$ is also evident from their expressions given in (I) and (II).

(ii) $r_{NB_F}=\dfrac{2(x-\gamma F)}{1+\gamma}$ is the solution to $\pi_r(I_a,NB)=E\pi_r((NI_a,A),B_c)$ and it is evident that r_{NB_F} is decreasing in F. At $F=0$, $r_{NB_F}=\dfrac{2x}{1+\gamma}$ and at $F=F_c(x)=\dfrac{(1-\gamma)x}{2\gamma}$, $r_{NB_F}=x$. For $F>F_c(x)=\dfrac{(1-\gamma)x}{2\gamma}$, $r_{NB_F}<0$. Hence the relevant penalty interval for a non-negative point of intersection is $F\in[0,F_c(x)]$.

(iii) $r_{B_F}=\dfrac{2(x-\gamma F)}{\lambda+\gamma}$ is the solution to $E\pi_r((I_a,A^s),B_e)=E\pi_r((NI_a,A),B_c)$ which is decreasing in *F*. At $F=0$, $r_{B_F}=\dfrac{2x}{\lambda+\gamma}$ and at $F_c\left(\dfrac{2x}{1+\lambda}\right)=\left(\dfrac{1-\gamma}{2\gamma}\right)\left(\dfrac{2x}{1+\lambda}\right)$, $r_{B_F}=\dfrac{2x}{1+\lambda}$. For

$F > F_c\left(\frac{2x}{1+\lambda}\right)$, $r_{B_F} < 0$. Hence the relevant penalty interval for a non-negative point of intersection is $F \in \left[0, F_c\left(\frac{2x}{1+\lambda}\right)\right]$.

Therefore, the statement of lemma 5 follows. □

Proof of Lemma 6.

(i) Equating $r_{e_F} = \frac{2\lambda F}{1-\lambda}$ to $r_{NB_F} = \frac{2(x-\gamma F)}{1+\gamma}$, we get $\bar{F} = \frac{(1-\lambda)x}{\lambda+\gamma}$. Equating $r_{e_F} = \frac{2\lambda F}{1-\lambda}$ to $r_{B_F} = \frac{2(x-\gamma F)}{\lambda+\gamma}$ we get $\hat{F} = \frac{(1-\lambda)x}{\lambda^2+\gamma}$. Substituting the expressions for $\bar{F}$ and $\hat{F}$ in $r_{e_F} = \frac{2\lambda F}{1-\lambda}$ we get $r_{e_{\bar{F}}} = r_{NB_{\bar{F}}} = \frac{2\lambda x}{\lambda+\gamma}$ and $r_{e_{\hat{F}}} = r_{NB_{\hat{F}}} = \frac{2\lambda x}{\lambda^2+\gamma}$. By assumption $\lambda > \gamma$. So, $F_c(x) > \hat{F} > \bar{F} > F_e(x) > 0$. Also $r_{e_{\hat{F}}} - r_{e_{\bar{F}}} = \frac{2\lambda x}{\lambda^2+\gamma} - \frac{2\lambda x}{\lambda+\gamma} = \frac{2\lambda x(1-\lambda)}{(\lambda^2+\gamma)(\lambda+\gamma)} \geq 0$ because by assumption, $\lambda \in [0,1]$.

(ii) The proof follows from the fact that $r_{e_F} = \frac{2\lambda F}{1-\lambda}$ is increasing in *F* while $r_{NB_F} = \frac{2(x-\gamma F)}{1+\gamma}$ and $r_{B_F} = \frac{2(x-\gamma F)}{\lambda+\gamma}$ are decreasing in *F*. So as *F* increases from $F_e(x)$ towards $\bar{F}$, r_{e_F} increases from *x* towards $r_{e_{\bar{F}}}$ and r_{NB_F} decreases towards $r_{e_{\bar{F}}}$. So in the interval $F_e(x) \leq F < \bar{F}$, r_{e_F} remains less than r_{NB_F}. So $r_{e_F} < r_{NB_F} < r_{B_F}$.

(iii) As the penalty increases beyond $\bar{F}$ and approaches $\hat{F}$, r_{NB_F} decreases and crosses $r_{e_{\bar{F}}}$ which increases as F increases. So we have $r_{NB_F} < r_{e_F}$. Since *F* is less than $\hat{F}$, therefore, r_{NB_F} remains greater than r_{e_F}. So for any penalty in the range $\bar{F} \le F < \hat{F}$, $r_{NB_F} \le r_{e_F} < r_{B_F}$.

(iv) By similar reasoning as the penalty increases from $\hat{F}$ towards $F_c(x)$ we have $r_{NB_F} < r_{B_F} \le r_{e_F}$

Therefore, the statement of the lemma follows. □

Proof of Proposition 5.

(i) We prove the continuity of the *SW* function by showing that the value of the different components of this function as shown in equation (9) at the corner points are the same points are the same. Simplification of SW_L yields the following.

$$SW_L = \frac{(1-\gamma)(1-l)\{(r_{NB_F})^2 + (r_{B_F})^2 - (r_{e_F})^2 - (x)^2\}}{2(\dot{r}-x)} + \frac{(\dot{r})^2 + (r_{e_F})^2 - (r_{NB_F})^2 - (r_{B_F})^2}{2(\dot{r}-x)} - \frac{x(\dot{r} + r_{e_F} - r_{NB_F} - r_{B_F})}{(\dot{r}-x)}$$

At $\bar{F}$, $r_{e_{\bar{F}}} = r_{NB_{\bar{F}}}$. Using this we get

$SW_L(\bar{F}) = \dfrac{(1-\gamma)(1-l)\{(r_{B_{\bar{F}}})^2 - (x)^2\}}{2(\dot{r}-x)} + \dfrac{(\dot{r})^2 - (r_{B_{\bar{F}}})^2}{2(\dot{r}-x)} - \dfrac{x(\dot{r} - r_{B_{\bar{F}}})}{(\dot{r}-x)} = SW_{VL}(\bar{F})$. At $\hat{F}$, $r_{e_{\hat{F}}} = r_{B_{\hat{F}}}$. Using this we get $SW_L(\hat{F}) = \dfrac{(1-\gamma)(1-l)\{(r_{NB_{\hat{F}}})^2 - (x)^2\}}{2(\dot{r}-x)} + \dfrac{(\dot{r})^2 - (r_{NB_{\hat{F}}})^2}{2(\dot{r}-x)} - \dfrac{x(\dot{r} - r_{NB_{\hat{F}}})}{(\dot{r}-x)} = SW_M(\hat{F})$. At $F_c(x)$, $r_{NB_F} = x$. Using this we get $SW_M(F_c(x)) = \dfrac{(\dot{r}-x)}{2} = SW_H = SW_{VH}$. It is evident from the expressions of SW_{VL}, SW_L and SW_M that these functions are decreasing in *l*.

(iia) In the *Very Low* penalty range, $F \in [0, \bar{F}]$, where $\bar{F} = \dfrac{(1-\lambda)x}{\lambda+\gamma}$, the relevant social welfare is SW_{VL}. $\dfrac{dSW_{VL}}{dF} = \dfrac{1}{\dot{r}-x}\left[\{(1-\gamma)(1-l)-1\}r_{B_F} + x\right]\dfrac{dr_{B_F}}{dF}$. $r_{B_F} = \dfrac{2(x-\gamma F)}{\lambda+\gamma}$ and $\dfrac{dr_{B_F}}{dF} = \dfrac{-2\gamma}{\lambda+\gamma}$ gives $\frac{dSW_{VL}}{dF} = \frac{1}{r-x}[\{(1-\gamma)(1-l)-1\}+x]\left[\frac{-2\gamma}{\lambda+\gamma}\right]$. SW_{VL} is concave because $\frac{d^2 SW_{VL}}{dF^2} = \frac{1}{r-x}[(1-\gamma)(1-l)-1]\left[\frac{-2\gamma}{\lambda+\gamma}\right]^2 < 0$ since $\gamma \leq 1$ and $\left[(1-\gamma)(1-l)-1\right] < 0$

for all l. The solution to $\frac{dSW_{VL}}{dF} = 0$ is $F_{VL}^* = \frac{x}{\gamma}\left[1 - \frac{(\lambda+\gamma)}{2[1-(1-l)(1-\gamma)]}\right]$, which is increasing in

l as evident from the expression. $l_0 = \frac{\lambda-\gamma}{2(1-\gamma)}$ and $\bar{l}_{VL} = 1 - \frac{\lambda(1-\lambda)+(\lambda-\gamma^2)}{2\lambda(1-\gamma^2)}$ are the

solutions to $F_{VL}^* = 0$ and $F_{VL}^* = \bar{F}$ respectively. Now $1 > \bar{l}_{VL} > l_0 > 0$, F_{VL}^* is increasing in l,

$(\lambda-\gamma) < 2(1-\gamma)$, and $0 < \frac{\lambda(1-\lambda)+(\lambda-\gamma^2)}{2\lambda(1-\gamma^2)} < 1$. Therefore, $F_{VL} = \begin{cases} 0, & \text{if } l \in [0, l_0] \\ F_{VL}^*, & \text{if } l \in [l_0, \bar{l}_{VL}] \\ \bar{F}, & \text{if } l \geq \bar{l}_{VL} \end{cases}$.

(b) In the L*ow Penalty* range, $F \in [\bar{F}, \hat{F}]$, the social welfare function is SW_L.

$$\frac{dSW_L}{dF} = \frac{\left((1-\gamma)(1-l)-1\right)}{(r-x)}\left\{r_{NB_F}\frac{dr_{NB_F}}{dF} + r_{B_F}\frac{dr_{B_F}}{dF} - r_{e_F}\frac{dr_{e_F}}{dF}\right\} + \frac{x}{(r-x)}\left\{\frac{dr_{NB_F}}{dF} + \frac{dr_{B_F}}{dF} - \frac{dr_{e_F}}{dF}\right\}$$

This can be rewritten as

$$\frac{dSW_L}{dF} = \frac{1}{(r-x)}\left\{\left[\left((1-\gamma)(1-l)-1\right)r_{NB_F} - x\right]\frac{dr_{NB_F}}{dF} + \left[\left((1-\gamma)(1-l)-1\right)r_{B_F} - x\right]\frac{dr_{B_F}}{dF} - \left[\left((1-\gamma)(1-l)-1\right)r_{e_F} - x\right]\frac{dr_{e_F}}{dF}\right\}$$

Now $\left((1-\gamma)(1-l)-1\right) < 0$, $r_{NB_F} > x$, $r_{B_F} > x$, and $r_{e_F} > x$. From $r_{NB_F} = \frac{2(x-\gamma F)}{1+\gamma}$,

$r_{B_F} = \frac{2(x-\gamma F)}{\lambda+\gamma}$ and $r_{e_F} = \frac{2\lambda F}{1-\lambda}$, we get $\frac{dr_{NB_F}}{dF} = \frac{-2\gamma}{1+\gamma} < 0$, $\frac{dr_{B_F}}{dF} = \frac{-2\gamma}{\lambda+\gamma} < 0$, and

$\frac{dr_{e_F}}{dF} = \frac{2\lambda}{1-\lambda} > 0$. So all the square bracketed terms are negative. Therefore, $\frac{dSW_L}{dF} > 0$.

(c) In the medium penalty range, $F \in [\hat{F}, F_c(x)]$ the social welfare function is SW_M

.

Using $\frac{dr_{NB_F}}{dF}=\frac{-2\gamma}{1+\gamma}$ we get $\frac{dSW_M}{dF}=\frac{1}{r-x}\left[\{(1-\gamma)(1-l)-1\}r_{NB_F}+x\right]\frac{dr_{NB_F}}{dF}=\frac{1}{r-x}[\{(1-\gamma)(1-l)-1\}r_{NB_F}+x]\left[\frac{-2\gamma}{1+\gamma}\right]$. Since $\left[(1-\gamma)(1-l)-1\right]<0$, therefore, $\frac{d^2SW_M}{dF^2}=\frac{1}{r-x}[(1-\gamma)(1-l)-1]\frac{dr_{NB_F}}{dF}\left[\frac{-2\gamma}{1+\gamma}\right]=\frac{1}{r-x}[(1-\gamma)(1-l)-1]\left[\frac{-2\gamma}{1+\gamma}\right]^2<0$.

So SW_M is concave in *F*. The solution to $\frac{dSW_M}{dF}=0$ is $F_M^*=\frac{x}{\gamma}\left[1-\frac{(1+\gamma)}{2[1-(1-l)(1-\gamma)]}\right]$ and it is increasing in *l* as evident from the expression. Let $\hat{l}_M$ and $l_M(x)$ be the solution to $F_M^*=\hat{F}$ and $F_M^*=F_c(x)$, where $\hat{F}=\frac{(1-\lambda)x}{\lambda^2+\gamma}$ and $F_c(x)=\frac{(1-\gamma)x}{2\gamma}$ are the upper and lower bounds of the interval $F\in[\hat{F},F_c(x)]$ over which SW_M is defined. Equating $F_M^*=F_c(x)$ yields $1-(1-l)(1-\gamma)=1$. The solution to this is $l=1$ given $\gamma\in(0,1)$. Thus $l_M(x)=1$. The solution to $F_M^*=\hat{F}$ is $\hat{l}_M=1-\frac{\lambda^2+2\lambda\gamma-\gamma\lambda^2-\gamma-\gamma^2}{2\lambda(1-\gamma)(\lambda+\gamma)}$. Now $1>\hat{l}_m$ because F_m^* is increasing in *l*. Therefore, $F_M=\begin{cases}\hat{F}, & \text{if } l\in[0,\hat{l}_M]\\ F_M^*, & \text{if } l\in[\hat{l}_M,1]\\ F_c(x), & \text{if } l\geq 1\end{cases}$.

(iid) $\frac{dSW_{VL}}{dl}=\frac{-(1-\gamma)\{(r_{B_{F\in[0,\bar{F}]}})^2-(x)^2\}}{2(r-x)}$ and $\frac{dSW_M}{dl}=\frac{-(1-\gamma)\{(r_{NB_{F\in[\hat{F},F_c(x)}})^2-(x)^2\}}{2(r-x)}$.

Hence, $\left|\frac{dSW_{VL}}{dl}\right|-\left|\frac{dSW_M}{dl}\right|=\frac{(1-\gamma)\{(r_{B_{F\in[0,\bar{F}]}})^2-(r_{NB_{F\in[\hat{F},F_c(x)}})^2\}}{2(r-x)}$. From Lemma 6(ii) we know that $r_{NB_F}=\frac{2(x-\gamma F)}{1+\gamma}$ and $r_{B_F}=\frac{2(x-\gamma F)}{\lambda+\gamma}$ are decreasing in *F*. Therefore, $(r_{NB_{F\in[0,\bar{F}]}})^2>(r_{NB_{F\in[\hat{F},F_c(x)}})^2$. We also know from Lemma 6(ii) that in the interval

$F_e(x) \le F < \bar{F}$, $r_{e_F} < r_{NB_F} < r_{B_F}$. Hence, $r_{B_{F\in[0,\bar{F}]}} > r_{NB_{F\in[0,\bar{F}]}}$, which means $(r_{B_{F\in[0,\bar{F}]}})^2 > (r_{NB_{F\in[\hat{F},F_c(x)}})^2$. Therefore, $\left|\frac{dSW_{VL}}{dl}\right| > \left|\frac{dSW_M}{dl}\right|$, which implies an increase in l causes SW_L to fall at faster rate than SW_M.

Therefore, the statement of the proposition follows. □

Proof of Proposition 6a.

Suppose $SW_{VL}\big|_{l\approx 0}(F_{VL}=0) > SW_M\big|_{l\approx 0}(F_M=\hat{F})$ holds and consider the range $l<1$. From Proposition 5 we know that an increase in l causes SW_L to fall at faster rate than SW_M. We also know from Proposition 5 that $SW_{VL}(F_{VL})$ reaches its lowest value at $\bar{F}$, which is, $SW_{VL}(\bar{F})$. That is, SW_L reaches its lowest optimum value $SW_{VL}(\bar{F})$, which occurs at $l=\bar{l}_{VL}<1$. Thus as l increases from $l\approx 0$ to $\bar{l}_{VL}$, the optimum value of SW_L falls from its highest level $SW_{VL}(F_{VL}=0)$ to its lowest level $SW_{VL}(\bar{F})$. From Proposition 5 we know that $SW_M(F_M)$ attain its lowest value $SW_M(F_c(x))$ at $l=1$. Thus for all l, $SW_M(F_M) > SW_{VL}(\bar{F})$. Thus starting from $l\approx 0$, as l increases, SW_L falls at a faster rate than SW_M, and there exists $l' \in (0,\bar{l}_{VL})$ such that $SW_{VL}\big|_{l'}(F_{VL}) = SW_M\big|_{l'}(F_M)$, where $F_{VL}\in[0,\bar{F})$ and $F_M \in [\hat{F}, F_c(x))$.

(i) Since SW_L is decreasing in l, hence, for $l\in(0,l')$, $SW_{VL}(F_{VL}) > SW_M(F_M)$. Therefore, the social welfare-maximizing penalty is $F^{SW} = F_{VL} \in [0,\bar{F})$. The corresponding subgame perfect equilibrium corruption distribution is low revenue firms choose NI_a and indulge in collusion while and high revenue firms choose I_a and face extortion, which follows from Proposition 1.

(ii) Since SW_L falls at higher rate than SW_M as l increases so for $l \in [l',1)$, $SW_M(F_M) \geq SW_{VL}(F_{VL})$. Therefore, $F^{SW} = F_M \in [\hat{F}, F_c(x))$ and the subgame perfect equilibrium firms' choices and the corruption distribution follows from Proposition 3.

(iii) If $l \geq 1$, then all the components of *SW* function become monotonically increasing in *F*. Thus any penalty $F \geq F_c(x)$ maximizes social welfare. All firms now choose I_a. If $F^{SW} \in [F_c(x), F_e(\dot{r}))$ then from Proposition 4 we know that low revenue firms do not face corruption and high revenue firms face extortion. If $F^{SW} \geq F_e(\dot{r})$, then corruption is eliminated.

Therefore, the statement of the proposition follows. □

Proof of Proposition 6b.

In this case since, $SW_{VL}\big|_{l\approx 0}(F_{VL} = 0) \leq SW_M\big|_{l\approx 0}(F_M = \hat{F})$ and since SW_L falls at higher rate than SW_M as *l* increases, therefore, $SW_M(F_M) \geq SW_{VL}(F_{VL})$ for all *l*. Thus for $l < 1$, $F^{SW} = F_M \in [\hat{F}, F_c(x))$ and the subgame perfect equilibrium firms' choices and the corruption distribution follows from Proposition 3.

Therefore, the statement of the proposition follows. □

Chapter 4

Extortion and Collusion under Peer-effect and Media-watch

4.1. Introduction

Corruption, defined as "the abuse of entrusted power for private gain" by a public official in delivery of public services, may take alternative forms like collusion and extortion. Historically, corruption has come down drastically in the developed part of the World over the last century; but it is still quite rampant at the developing countries and considered as a major obstacle to their development[33]. Therefore, the question that has intrigued the economists over the years is, what are the most effective instruments for fighting corruption? The investigation in economic theory, starting with the pioneering paper by (Becker and Stigler, 1974) suggests that monetary incentives along with enforcement can be effective in solving the problem. The papers like Andvig and Moene (1990), Dhillon et al (2017) on the other hand have shown that the morality and peer effect also matter in persistence of corruption. They study the interaction of monetary incentive, enforcement, and morality in determination of extent of corruption in an economy.

The case studies on the countries, which have successfully reduced corruption, also highlight the role of the factors mentioned above. While Singapore, Hong Kong seems to have succeeded to reduce corruption in its police force through stricter enforcement[34], the US has been considered to achieve the same through media-freedom and judicial efficiency[35]. However, it is not clearly understood why different strategies proved to be effective in different countries. Some recent papers in experimental economics like Barfot et al. (2019), Gachter and Schulz (2016) suggests that intrinsic honesty of the officials also matters in this respect. The present chapter theoretically reconsiders the interaction between enforcement and morality, with four distinct points of departure from the earlier literature:

[33] See Bardhan (1997).

[34] See Quah (2007) and Hseih (2017) for detailed case studies of Singapore and Hong Kong respectively.

[35] See Glaeser and Goldin (2006).

(i) it makes a distinction between sensitivity to moral standard and moral standard itself, while the former is an intrinsic value to an official, the latter is function of the size of network of corrupt officials[36]. (ii) it clearly demarcates how the sensitivity to moral standard differs for extortion and collusion leading to different incidences of the same. (iii) it brings out the importance of penalty, media-freedom and judicial efficiency in influencing the number of corruptible officials the corresponding network effects it generates. (iv) it analyses how penalty, compliance cost, media-freedom, efficient judiciary and reapplication cost are important policy instruments for designing strategies to control corruption.

The chapter models a situation where a firm irrespective of its size needs to undertake a costly qualifying investment to be eligible for a production license. The scope of extortion and collusion arises as the firm faces an official for delivery of the license. While in extortion, a qualified firm is charged with a bribe; the collusive bribe hides the violation. The probability of conviction is higher in extortion than collusion since the firm, being extorted, reports the incident on its own. In the case of collusion both the sides have incentive to hide the deal. A collusion can be uncovered only by a watchful media. Since both the sides are guilty in the case of collusion, the penalty falls symmetrically on both; but in the case of extortion the penalty falls only on the official. The official is corruptible, torn between the net expected benefit that he can receive from bribery and the moral cost that he suffers from his act. He participates in corruption if the former overpowers the later. There is a moral standard in the administration, which appears as a cost for individual officials for their involvement in bribery. It depends on the proportion of officials involved in corruption. The higher is the proportion, the lower is the moral standard. Although, it is

[36] Here the chapter closely follows Traxler (2010) from the tax-evasion literature.

not that all the officials are equally sensitive to the moral standard, a high moral standard throws a spanner on an official's behaviour in terms of peer effect/network effect.

The chapter shows that given a moral standard, the sensitivity threshold in participation at extortion is lower than the sensitivity threshold in participation of collusion. It also shows, given a moral standard, the penalty threshold that prevents occurrence of extortion is also lower than the penalty threshold that prevents occurrence of collusion. The chapter endogenously determines the total number of corrupt officials at equilibrium, who are engaged in both extortion and collusion. It goes to show that increase in penalty, and probability of conviction of collusion reduces the equilibrium number of corrupt officials and generate network effects which raises the moral standard. In contrast an increase in the probability of conviction of extortion, only reduces the equilibrium number of officials engaged in extortion and hence, does not generate network effect. Thus, from a policy perspective although increases in both penalty and probability of conviction of collusion play a significant role in mitigating corruption, the later seems to be a more effective policy instrument than the former.

The chapter discusses the participation of the firm in compliance and also derives the corruption outcomes for different ranges of compliance cost, coupled with the reapplication cost. A high compliance cost induces the firm to avoid the investment and indulge in collusion. Thus, in this case a higher reapplication cost is required to counter this incentive, which leads us to a positive relationship between reapplication cost and compliance cost. The chapter shows that under a high compliance cost, the scope of extortion is much more restricted than the scope of collusion. As the cost of qualification falls, the scope of collusion falls, but the scope of extortion rises. However, extortion does not exist for a medium penalty range but, can prevail if the penalty is in the low range.

Following this, the chapter discusses the impact of policy instruments: penalty and conviction probabilities of extortion and collusion on the firm's compliance participation. The chapter shows that increase in penalty and conviction probabilities of extortion and collusion increases the firm's incentive to invest in compliance, and interestingly the chapter finds that in case of high compliance cost, an increase in the conviction probability of collusion is more effective in reducing the equilibrium number of corrupt officials compared to an increase in the penalty. This has important implications for the role of media in controlling corruption and raising the society's moral standard. Since the active media watch increases the likelihood of discovery of collusive acts, higher media watch weakens the network effect of corruption by lowering the number of corrupt officials in the bureaucracy. Accordingly, the moral standard improves which ensures higher compliance. In presence of low compliance cost, it depends on the efficiency of judiciary in convicting extortion.

This chapter also provides an anecdotal evidence in support of the claim that intense media-watch reduces non-compliance with law. It supplements the widely cited study by Fisman and Miguel (2007) with cross-country media-freedom data for this purpose. Fisman and Miguel collected data on parking violations by United Nations diplomats living in New York City during 1997 to 2002, to find that the diplomats from low (high) corruption countries have lower (higher) number of violations. They concluded that the home country corruption norms predicted the diplomats' tendency to violate rules. The present chapter through its theory claims that the media freedom at the home country determines the moral standard and the home country corruption norm: a greater freedom of media leads to lower number of corrupt officials, higher moral standard and more compliance with law in a country. Therefore, the chapter takes the country rank of Fisman and Miguel (2007) on violation of parking norm and find its Spearman's rank correlation with ranking of the countries on the basis of their average media-freedom score in 1997-2002, calculated from Press Freedom scores provided by Freedom House. The outcome is consistent with the theoretical prediction of the model that the diplomats from the countries with lower media freedom were more prone to rule-violations.

In the literature on interaction between corruption and media-activism, Starke et al. (2016) explain six different ways in which a free press helps to combat corruption. First, by acting as watchdogs which leads to investigations by official bodies followed by convictions of corrupt political actors; second, by increasing the effectiveness of anti-corruption institutions by exposing their flaws; third, by providing a civic platform to lodge and voice complaints thereby contributing to the formation of public opinion; fourth, by enhancing general transparency by providing information about corruption, which reduces both individual and systemic corruption (Kolstad & Wiig (2009), Lindstedt and Naurin (2010)); fifth, as a deterrent by increasing the likelihood of exposure of the corrupt act and hence of punishment or reputation loss; sixth, in intangible ways (Stapenhurst, 2000) through "enhanced political pluralism, enlivened public debate and greater sense of accountability among politicians, public bodies and institutions". In the present chapter, the first one where the media works as watchdog in exposing collusion, plays a defining role, since all others influence both extortion and collusion equally. Although the existing empirical literature (Chowdhury (2004), Bhattacharya and Hodler (2015), Kalenborn and Lessmann (2013) etc.) show that media-freedom plays an important role in controlling political corruption, which is essentially collusive in nature, it does not make a distinction between extortion and collusion, which falls in the realm of bureaucratic corruption. Since political corruption shows up in making of laws and bureaucratic corruption in execution of laws, the present chapter suggests a greater role of media-freedom may arrest the violations in execution of law and the associated corruption.

The chapter makes several contributions in the existing literature. First, it shows, how monetary penalty, moral standard and individual-specific sensitivity to moral standard interact to determine the scope extortion and collusion in a bureaucracy. Under reasonable assumptions, it shows that the scope of extortion is much more restricted than the scope of collusion at a high compliance cost; at a low compliance cost extortion prevails. Second, it shows, how the network effect working among the officials in a bureaucracy influences the scope of collusion vs. extortion. Third, it highlights the role of media-watch in determination of the size of the network, the moral standard. The media-watch and the compliance cost determine the extent of violation of law. Fourth, while the chapter suggests the way policies can be designed in medium and low penalty bureaucracies for controlling its corruption by appropriate use compliance cost, media-freedom, judicial efficiency against extortion cases and reapplication fees, which is new to the literature and show that under high compliance cost compared to a penalty media-watch has greater impact in reducing corruption and raising the moral standard in a bureaucracy.

The next section of the chapter develops the model. Section 3 characterizes the equilibrium and derives the results. Section 4 discusses the policy instruments and the role of media as watchdog in controlling corruption. Section 5 provides an anecdotal evidence to the theoretical prediction of the model on the relation between media freedom and noncompliance in countries. Section 6 concludes with a summary of the policy implications.

4.2. The Model

Consider an economy, where a firm with revenue $r > 0$ is required by regulation to invest $x > 0$ in adopting clean technology to be qualified for production. We assume, $r > x$. Compliance to the adoption of clean technology holds significance since production without investment harms the society by generating a negative externality.

The eligibility to continue production is reviewed by a monopoly bureaucracy consisting of several officials. Monopoly bureaucracy implies that a specific officer is delegated to review the application of a firm. It means that if the application is rejected and the firm reapplies it will again be reviewed by the same official[37]. We assume the measure of number of officials to be 1.

The corruptibility of an official is subject to his morality (m) and the extent of corruption that is prevailing in the bureaucracy. We assume that the individual specific morality m is uniformly distributed in the interval $m \in [0, 1]$. Let n be the number of corrupt officials which is endogenously determined in the chapter. So the moral cost of a type-m official is $mC(n)$, where $C(n)$ captures the strength of the anti-corruption norm existing in the bureaucracy, and m represents individual specific degree of internalization of the norm38. We assume $C(n) > 0$, $C'(n) < 0$ and $\phi'(n) = C(n) + nC'(n) > 0$.

Using this framework we consider the following extensive form game played between a firm with revenue r and an official is as follows. The subscripts o and r represent the official and the firm, respectively.

[37] Drugov (2010) models a situation where the licenses can also be administered in a competitive bureaucracy where on denial the firm can reapply to a different official.

[38] Our modelling of moral cost is like Traxler (2010), which also discusses other approaches towards modelling of moral cost.

Stage 1. Nature chooses the type-*m* of an official.

Stage 2. A firm with revenue *r* chooses to invest *x* for compliance and apply (I_a) or not invest but apply (NI_a). We assume that the firm's revenue net of the compliance cost is not very low i.e. $(r-x)>1$.

The application is submitted to a monopoly bureaucracy.

Stage 3 (Bribery Stage): The firm's application is submitted to the bureaucracy consisting of n corruptible officials. The reviewing official chooses either to act morally which is akin to being honest and not seek a bribe (*NB*), or chooses to act immorally akin to being corrupt and seek a bribe (*B*). In the latter case the bribe amount is determined by Nash Bargaining.

If firm-r chooses I_a in stage 2 and the official chooses *NB* then the game ends and the payoffs are as follows.

$$\begin{aligned} \pi_r(I_a, NB) &= r - x \\ \pi_0(I_a, NB) &= 0 \end{aligned} \tag{1}$$

Alternatively, the official indulges in corruption and seeks a bribe. This is the case of *extortion* (*e*) where the firm is qualified for receiving the license yet faces a bribe demand by the official. This action will be denoted as B_e and the bribe amount by b_e.

If the firm chooses NI_a in stage 1 and the official chooses *NB,* the application is rejected. Since each firm interacts with one designated official, following this the firm-r may choose to invest and reapply in which case it receives the license. However, reapplication involves a cost captured by $\mu = 1 - \delta$ where $\delta \in (0,1)$. A low δ implies a high μ and hence a higher cost of re-application. There is no bribery in this case and payoffs are as follows.

$$\begin{aligned} \pi_r((NI_a, I_a), NB) &= \delta(r - x) \\ \pi_0(I_a, NB) &= 0\,. \end{aligned} \tag{2}$$

Alternatively, the official can behave immorally and seek a bribe. We call this *collusion* since the official issues the license to an ineligible firm in exchange of a bribe. This action and the collusive bribe amount will be denoted by as B_c and as b_c.

Stage 4 (Firm's decision to accept or reject bribe). There are the following possibilities.

(i) Firm-r chooses I_a in stage 2 and official chooses B_e in stage 3. The firm can reject the bribe demand and self-report (R^s) or accept the bribe demand and self-report (A^s). In this case reporting the incident of bribery is costless since the firm has chosen I_a and has all the evidence of the investment. Because of imperfection in the legal system, the corrupt official is convicted (C) with probability λ or not convicted (NC) with probability $(1-\lambda)$.

If the firm chooses R^s and the official is convicted, the official is penalized with a fine F and the firm receives the license without paying the extortion bribe. Thus, the payoff of the firm is $\pi_r\big((I_a, R^s), B_e, C\big) = r - x$. If there is no conviction, the firm does not receive the license and loses the investment cost whereas the official gets nothing. The payoff of the firm is $\pi_r\big((I_a, R^s), B_e, NC\big) = -x$. The official receives $\pi_o\big((I_a, R^s), B_e, C\big) = -F - mC(n)$ and $\pi_o\big((I_a, R^s), B_e, NC\big) = -\,mC(n)$ in the two cases respectively as the official, involved in bribery, incurs moral cost of $mC(n)$. Thus, the expected payoffs from choosing (R^s) which forms the disagreement payoffs in bribe negotiation are given in equation (3).

$$\begin{aligned} E\pi_r\big((I_a, R^s), B_e\big) &= \lambda r - x \\ E\pi_O\big((I_a, R^s), B_e\big) &= -\lambda F - mC(n) \end{aligned} \tag{3}$$

If the firm chooses (A^s) then it pays the extortion bribe and then self-reports. On successful conviction, only the official is penalized with a fine F and the bribe is refunded to firm who receives the license. The payoff of the firm is $\pi_r\big((I_a, A^s), B_e, C\big) = r - x$. If there is no conviction, the firm receives the license but fails to retrieve the bribe amount. The payoff of the firm is $\pi_r\big((I_a, A^s), B_e, NC\big) = r - x - b_e$. The payoff of the official in the above two situations are $\pi_O\big((I_a, A^s), B_e, C\big) = -F - mC(n)$ and $\pi_O\big((I_a, A^s), B_e, C\big) = b_e - mC(n)$ respectively. Hence, the expected payoffs from choosing (A^s) which become the agreement payoffs in the bribe negotiation, are written in equation (4).

$$E\pi_r\big((I_a, A^s), B_e\big) = \lambda\pi_r\big((I_a, A^s), B_e, C\big) + (1-\lambda)\pi_r\big((I_a, A^s), B_e, NC\big) = r - x - (1-\lambda)b_e$$
$$E\pi_O\big((I_a, A^s), B_e\big) = \lambda\pi_O\big((I_a, A^s), B_e, C\big) + (1-\lambda)\pi_O\big((I_a, A^s), B_e, NC\big) = (1-\lambda)b_e - F - mC(n) \tag{4}$$

(ii) Suppose firm-r chooses NI_a and official chooses B_c. Here there is no self-reporting because both parties are colluding. The firm-r either rejects (R) or accepts (A) the bribe demand. If firm-r chooses R, then it does not receive the license and earns zero payoff. The same holds true for the official. So, the rejection payoffs, which form the disagreement payoffs in the bribe negotiation, are as follows.

$$\begin{aligned} &\pi_r\big((NI_a, R), B_c\big) = 0 \\ &\pi_O\big((NI_a, R), B_c\big) = -mC(n) \end{aligned} \tag{5}$$

If firm-r chooses A, the colluding parties are convicted with probability γ. Conviction is possible only if it is detected by a third party like media. Recall that, we have assumed, $\lambda > \gamma$. In case of conviction, both the parties are penalized with a fine F and firm-r also loses the license and the bribe. Therefore, he payoffs are $\pi_r\big((NI_a, A), B_c; C\big) = -b_c - F$ and $\pi_O\big((NI_a, A), B_c; C\big) = b_c - F - mC(n)$. If there is no conviction, then no one is penalized. The payoffs are $\pi_r\big((NI_a, A), B_c; NC\big) = r - b_c$ and $\pi_O\big((NI_a, A), B_c; NC\big) = b_c - mC(n)$. So, the expected agreement payoffs are as follows.

$$E\pi_r\big((NI_a, A), B_c\big) = \gamma\pi_r\big((NI_a, A), B_c; C\big) + (1-\gamma)\pi_r\big((NI_a, R), B_c; NC\big) = (1-\gamma)r - \gamma F - b_c$$
$$E\pi_o\big((NI_a, A), B_c\big) = \gamma\pi_o\big((NI_a, A), B_c; C\big) + (1-\gamma)\pi_o\big((NI_a, A), B_c; NC\big) = b_c - \gamma F - mC(n) \tag{6}$$

This game is diagrammatically represented in Figure 4.1.

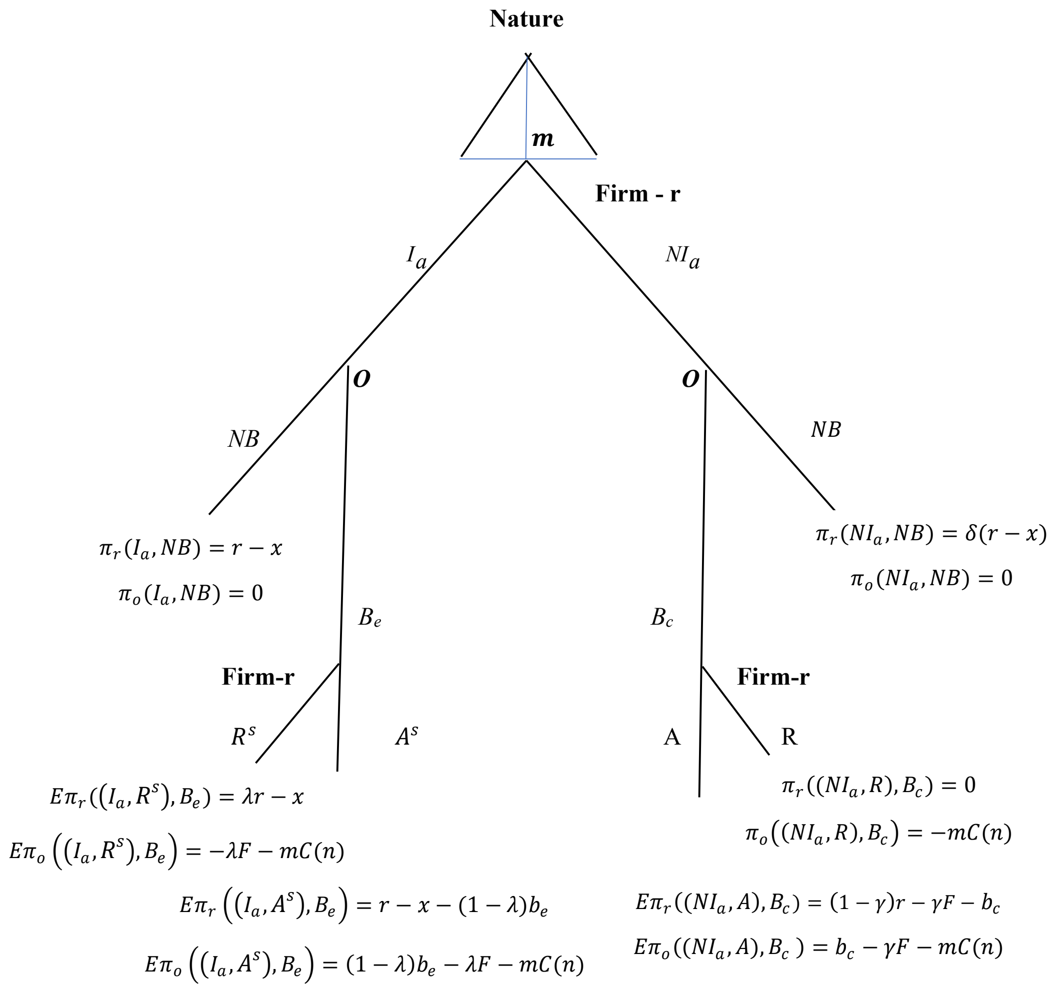

Figure 4.1: The Game Tree

4.3. Equilibrium Analysis

We use the method of backward induction to solve for the equilibrium of the game.

Stage 4. Firm's decision to accept or reject bribe.

Firm-r has the potential to face extortion, or it can indulge in collusion depending on its choice of stage 1 choice of I_a or NI_a. The analysis of determination of bribe rate in either case and the bribe acceptance criteria of either type of firms are presented in Table 4.1 below.

Table 4.1: Firm-r's choice of acceptance or rejection of the official's bribe demand

Firm-r chooses I_a and faces extortion	**Firm-r chooses NI_a and colludes**
1. Firm-r chooses A^s over R^s if $E\pi_r\left((I_a, A^s), B_e\right) \geq E\pi_r\left((I_a, R^s), B_e\right)$ Using these expression from equations (3) and (4) we get the *bribe acceptance criterion* as $r \geq b_e$	**1.** Firm-r chooses A over R if, $E\pi_r\left((NI_a, A), B_c\right) \geq \pi_r\left((NI_a, R), B_c\right)$ Using these expressions from (5) and (6) we get the *bribe acceptance criterion* as $(1-\gamma)r - \gamma F \geq b_c$.
2. Using $E\pi_r\left((I_a, A^s), B_e\right)$, $E\pi_o\left((I_a, A^s), B_e\right)$, $E\pi_r\left((I_a, R^s), B_e\right)$ and $E\pi_0\left((I_a, R^s), B_e\right)$ we get the Nash Bargaining bribe as $b_e = \frac{r}{2}$,[39] which always satisfies the bribe acceptance criteria.	**2.** Using $E\pi_r\left((NI_a, A), B_c\right)$, $E\pi_o\left((NI_a, A), B_c\right)$, $\pi_r\left((NI_a, R), B_c\right)$ and $\pi_0\left((NI_a, R), B_c\right)$ we get the Nash Bargaining bribe as $b_c = \frac{(1-\gamma)r}{2}$. 40 So the bribe acceptance criterion is $\frac{r(1-\gamma)}{2\gamma} \geq F$.

[39] $b_e = \frac{r}{2}$ is the solution to the problem that maximizes:
$V_e = \left[E\pi_r\left((I_a, A^s), B_e\right) - E\pi_r\left((I_a, R^s), B_e\right)\right]\left[E\pi_o\left((I_a, A^s), B_e\right) - E\pi_0\left((I_a, R^s), B_e\right)\right]$.

[40] $b_c = \frac{(1-\gamma)r}{2}$ is the solution to the problem that maximizes: $V_c = \left[E\pi_r\left((NI_a, A), B_c\right) - \pi_r\left((NI_a, R), B_c\right)\right]\left[E\pi_o\left((NI_a, A), B_c\right) - \pi_0\left((NI_a, R), B_c\right)\right]$

Stage 3. Bribery Stage

We examine the participation constraint of an official in the bribery game in Table 4.2.

Table 4.2: Official's choice of bribery or no bribery

Subgame where firm chooses I_a	**Subgame where firm chooses NI_a**
An official chooses B_e if $E\pi_o((I_a, A^s), B_e) \geq \pi_o(I_a, NB)$. Using $b_e = \frac{r}{2}$ in $E\pi_o((I_a, A^s), B_e)$ and $\pi_o(I_a, NB) = 0$, gives the *bribe demand criterion*, $F \leq F_e(r, m, n) = \frac{\frac{r(1-\lambda)}{2} - m\ (n)}{\lambda}$.	If $\frac{r(1-\gamma)}{2\gamma} \geq F$, an official chooses B_c if $E\pi_o((NI_a, A), B_c) > \pi_o(NI_a, NB)$. Using $b_c = \frac{(1-\gamma)r}{2}$ in $E\pi_o((NI_a, A), B_c)$ and $\pi_o(NI_a, NB) = 0$, gives the *bribe demand criterion* $F \leq F_c(r, m, n) = \frac{\frac{r(1-\gamma)}{2} - m\ (n)}{\gamma}$.

Table 4.2 shows that a compliant firm is extorted by an official if $F \leq F_e(r, m, n)$. This follows from Table 4.1 that the extortion bribe $b_e = \frac{r}{2}$ always satisfies the bribe acceptance criteria, whenever it is demanded by the official. Similarly, a non-compliant firm engages in collusive bribery if $F \leq F_c(r, m, n)$, because the bribe acceptance criterion is stronger than the bribe demand criterion as evident from Tables 4.1 and 4.2. Lemma 1 summarizes the properties of $F_e(r, m, n)$ and $F_c(r, m, n)$. All proofs are provided in the Appendix.

Lemma 1.

(i) $F_e(r, m, n)$ *is monotonically decreasing in* m *and at* $m_e = \frac{(1-\lambda)r}{2C(n)}$, $F_e(r, m, n) = 0$.

(ii) $F_c(r, m, n)$ *is monotonically decreasing in* m *and* $m_c = \frac{(1-\gamma)r}{2C(n)}$, $F_c(r, m, n) = 0$.

(iii) $m_e < m_c$.

(iv) For all m, $F_e(r,m,n) < F_c(r,m,n)$, *and* $F_e(r,m,n) \leq \frac{r(1-\lambda)}{2\lambda}$ *and*

$F_c(r,m,n) \leq \frac{r(1-\gamma)}{2\gamma}$.

Proof: See the appendix.

From Table 4.2 we observe that that the extortion and collusion threshold penalty levels depend on the sensitivity to moral standard m. Lemma 1 implies that due to the presence of moral cost of corruptible behaviour, not all types of officials participate in bribery. The higher is the sensitivity, the lower are the threshold penalties $F_c(r,m,n)$ and $F_e(r,m,n)$. Thus Lemma 1 highlights the trade-off between sensitivity to moral standard and the penalty to mitigate extortion and collusion.

From Lemma 1 we know that $F_e(r,m,n) \leq \frac{r(1-\lambda)}{2\lambda}$, $F_c(r,m,n) \leq \frac{r(1-\gamma)}{2\gamma}$, and $F_e(r,m,n) < F_c(r,m,n)$. Using this we divide the penalty into the following three ranges: *low range* $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$, *medium range* $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$, and *high range* $F_H > \frac{(1-\gamma)r}{2\gamma}$. In the high penalty range all bribery conditions are violated and hence, there is no corruption. Lemma 1 is diagrammatically represented in Figure 4.2.

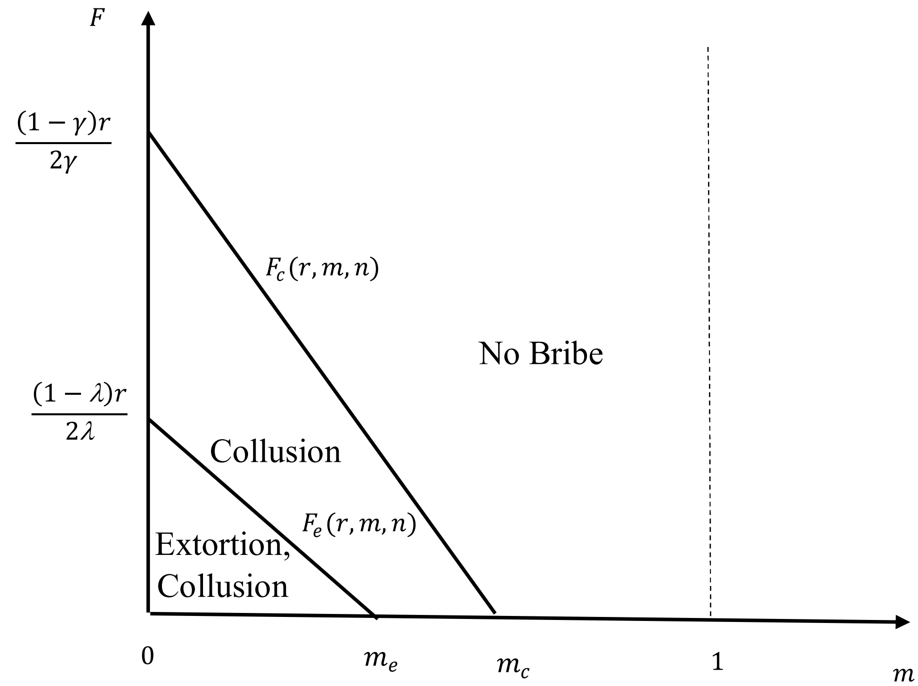

Figure 4.2: Diagrammatic representation of Lemma 1

Lemma 1 and Figure 4.2 helps us to determine the equilibrium number of corrupt officials, and the result is summarized in Proposition 1.

Proposition 1. *Consider any penalty F in the range* $F \in \left[0, \frac{(1-\gamma)r}{2\gamma}\right]$.

(ia) The equilibrium number of corrupt officials is $n^{F^*} = m_c^F \in [0, m_c]$ *where* m_c^F *satisfies* $F = F_c(r,m,n)$.

(ib) If $F \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$ *and the firm has chosen* I_a *in stage 2, then there is only extortion and the equilibrium number of officials engaged in this form of corruption is* $m_e^F \in [0, m_e]$ *that satisfies* $F = F_e(r,m,n)$. *However, the total number of corruptible officials remains at* m_c^F *which exceeds* m_e^F.

(ic) $m_c^{F_L} > m_c^{F_M}$, *where* $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$, *and* $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$.

(ii) An increase in F and γ reduces m_c^F and m_e^F, while an increase in r increases both of them.

(iii) An increase in λ reduces m_e^F but does not affect m_c^F.

(iv) The maximum number of corrupt officials for a given r and γ is $n_{max}^F = m_c^F = \frac{r(1-\gamma)}{2C(m_c^F)}$. It is increasing in r but decreasing in γ.

Proof: See the appendix.

We use Figure 4.2 to explain Proposition 1 and highlight the implications. From this figure, observe that any $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$ intersects F_e and F_c at $m_e^{F_L} \in [0, m_e]$ and $m_c^{F_L} \in [0, m_e]$. As shown in Figure 4.2, $m_e^{F_L} < m_c^{F_L}$, because $F_e < F_c$ for all *m*. So, all officials with sensitivity to moral standard less than $m_c^{F_L}$ are corrupt because they indulge in any form of corruption. By assumption the mass of officials is 1 of which *n* are corrupt, and *m* is uniformly distributed in the interval $m \in [0, 1]$. Therefore, when the penalty is F_L the equilibrium number of corrupt officials is ${n^{F_L}}^* = m_c^{F_L}$. Similarly, if the firm chooses to invest in compliance in stage 2 then equilibrium number of officials that indulge in extortion, is $m_e^{F_L}$. However, the equilibrium number of corruptible officers remain at ${n^{F_L}}^* = m_c^{F_L}$. There is no extortion in the medium penalty range $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$ because the penalty is above the extortion threshold penalty level F_e for all *m* as evident from Figure 4.2. There is only collusive corruption and the optimal number of corrupt official is $m_c^{F_M}$.

Thus, for any $F \in \left[0, \frac{(1-\gamma)r}{2\gamma}\right]$ the equilibrium number of corrupt officials is ${n^F}^* = m_c^F$. The general expression for this is given in equation (7).

$$F = F_c \Longrightarrow F = \frac{1}{\gamma}\left[\frac{r(1-\gamma)}{2} - m_c^F C(m_c^F)\right] \tag{7}$$

Using $\phi(m_c^F) = m_c^F C(m_c^F)$ we can rewrite equation (7) as follows.

$$\phi(m_c^F) = \frac{r(1-\gamma)}{2} - \gamma F \qquad (7a)$$

If the penalty is in the interval, $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$ then there is the possibility of extortion. The equilibrium number of officials engaging in this form of corruption satisfies the following.

$$F_L = F_e \Longrightarrow F_L = \frac{1}{\gamma}\left[\frac{r(1-\gamma)}{2} - m_e^{F_L} C(m_c^{F_L})\right] \qquad (8)$$

In this case, the equilibrium number of corrupt officials that extort is $m_e^{F_L}$ which is less than the total number of corrupt officials, $n^{F_L*} = m_c^{F_L}$. Thus, the moral standard $C(n)$ is $C(m_c^{F_L})$ and it is multiplied with $m_e^{F_L}$ and this product becomes the cost of engaging in extortion.

From Lemma 1(ii) we know that $F_c(r, m, n)$ is decreasing in *m* as shown in Figure 4.2. Therefore, an increase in $F \in \left[0, \frac{(1-\gamma)r}{2\gamma}\right]$ reduces m_c^F which implies a decrease in n^*. Therefore, the equilibrium number of corruptible officials in the low penalty range $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$ is higher than that in the medium penalty range $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$, that is, $m_c^{F_L} > m_c^{F_M}$.

While a change in *F* causes a movement along the F_c curve, any change in *r* and γ shifts this curve as evident from its expression $F_c(r, m, n) = \frac{\frac{r(1-\gamma)}{2} - m\ \ (n)}{\gamma}$ as given in Table 4.2. Similarly, a change in *F* causes a movement along the $F_e(r, m, n) = \frac{\frac{r(1-\lambda)}{2} - mC(n)}{\lambda}$ whereas a change in r and λ shifts this curve.

As evident from the expressions, an increase in *r* shifts up the F_c curve in Figure 4.2 and increases the equilibrium number of corruptible officers because any $F \in \left[0, \frac{(1-\gamma)r}{2\gamma}\right]$ intersects the higher F_c curve at a higher m_c^F. A higher *r* also shifts up the F_e and for similar reasons m_e^F increases but only when the penalty is in the low range.

The impact of an increase in γ is very different from that of an increase in λ. An increase in γ implies an increase in the collusion conviction possibility. So the F_c curve in Figure 4.2 shifts down and this results in a reduction of the equilibrium number of corrupt officials m_c^F. This raises the moral standard captured by $C(m_c^F)$. Though the extortion threshold is unaffected by the increase in γ, however, the increase in moral standard reduces the number of officials involved in extortion. That is, m_e^F also falls.

In contrast, an improvement in the legal system that increases λ shifts down the F_e curve in Figure 4.2 and thus reduces the equilibrium number of officials indulging in extortion, m_e^F. However, the F_c curve remains unchanged and hence the equilibrium number of corrupt officials $n^* = m_c^F$ remains unchanged.

Thus, from the analysis of the impact of changes in F, γ and λ it follows that increases in the first two reduces the equilibrium number of corrupt officials as a result of which these two changes generate network effects. Specifically, reduction in the equilibrium number of corrupt officials raises the moral standard due to an increase in $C(m_c^F)$ since by assumption $C'(n) < 0$. Therefore, these two changes affect m_c^F, as well as m_e^F via $C(m_c^F)$. In contrast an increase in λ only reduces the equilibrium number of officials engaged in extortion (m_e^F) but leaves the equilibrium of corruptible officials (m_c^F) unaltered. Thus, an increase in λ do not generate network effect. So, from a policy perspective increases in F, and γ play a significant role in mitigating corruption. In Section 4 we compare the effects of these two changes. The marginal effects of these changes on m_c^F and m_e^F are given in equations (9) and (10). The derivation of these expressions is provided in the proof of Proposition 1 in the Appendix.

$$\begin{aligned} \frac{dm_c^F}{dF} &= -\frac{\gamma}{\phi'(m_c^F)} < 0 \\ \frac{dm_c^F}{d\gamma} &= -\frac{1}{\gamma\phi'(m_c^F)}\left[\frac{r(1-\gamma)}{2} - \phi(m_c^F) + \frac{r}{2\gamma}\right] < 0 \end{aligned} \qquad (9)$$

$$\frac{dm_e^F}{dF} = -\frac{\lambda\left[1 - m_e^F C'(m_c^F)\frac{\gamma}{\phi'(m_c^F)}\right]}{C(m_c^F)} < 0$$
$$\frac{dm_e^F}{d\gamma} = -\frac{m_e^F C'(m_c^F)\frac{dm_c^F}{d\gamma}}{C(m_c^F)} < 0 \tag{10}$$

Stage 2. Firm's investment decision.

Having determined the equilibrium number of corrupt officials in stage 3, we now proceed to the analysis of the equilibrium investment decision of a firm for the different penalty ranges and the resultant form of corruption that emerges.

1. Low penalty range $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$

If the firm chooses I_a, then from Table 4.2 and Lemma 2, we know that there is extortion if $m \in [0, m_e^{F_L}]$ because for this range $F_L \leq F_e$ and $m \leq m_e$. There is no extortion if $m > m_e^{F_L}$. So the firm's expected profit is $E\pi_r^L(I_a) = Pr\big(m \leq m_e^{F_L}\big)\, E\pi_r\big((I_a, A^s), B_e\big) + Pr(m > m_e^{F_L})\pi_r(I_a, NB)$. This expression as given in equation (11) is obtained by using the assumption that *m* is uniformly distributed in the interval $m \in [0,1]$, and using the expressions for $\pi_r(I_a, NB)$ and $E\pi_r\big((I_a, A^s), B_e\big)$ from equations (1) and (4).

$$E\pi_r^{F_L}(I_a) = (r - x) - m_e^{F_L}\left(\frac{r(1-\lambda)}{2}\right) \tag{11}$$

Suppose the firm chooses NI_a. From Table 4.2 and Figure 4.2 we know that there is collusive bribery if $m \in [0, m_c^{F_L}]$ because for this range $F \leq F_c(r, m, n)$ and $m \leq m_c^{F_L}$. However, the collusive bribery condition is violated when $m > m_c^{F_L}$. In this case, since an officer acts honestly, the firm will have to reapply after investing in compliance. So a firm's expected profit is,

$E\pi_r^{F_L}(NI_a) = Pr\big(m \leq m_c^{F_L}\big)\, E\pi_r\big((NI_a, A), B_c\big) + Pr(m > m_c^{F_L})\pi_r\big((NI_a, I_a), NB\big).$

We know from equation (2) that $\pi_r\big((NI_a, I_a), NB\big) = \delta(r-x)$. Using $\mu = 1-\delta$, this can be rewritten as $\pi_r\big((NI_a, I_a), NB\big) = (1-\mu)(r-x)$. Substituting this and $E\pi_r\big((NI_a, A), B_c\big)$ from equation (6) in the above expression, we get the following.

$$E\pi_r^{F_L}(NI_a) = m_c^{F_L}\left[\frac{r(1-\gamma)}{2} - \gamma F_L\right] + \left(1 - m_c^{F_L}\right)(1-\mu)[r-x] \qquad (12)$$

The firm chooses I_a if $E\pi_r^{F_L}(I_a) \geq E\pi_r^{F_L}(NI_a)$. Using equations (10) and (11), the *compliance condition* for choosing I_a in the low penalty range can be written as follows.

$$\mu \geq \mu^{F_L} = \frac{1}{\left(1-m_c^{F_L}\right)(r-x)}\left[m_e^{F_L}\left\{\frac{r(1-\lambda)}{2}\right\} + m_c^{F_L}\left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\}\right] - \frac{m_c^{F_L}}{\left(1-m_c^{F_L}\right)} \qquad (13)$$

If $\mu < \mu^{F_L}$ then the compliance condition is violated and the firm chooses NI_a. Now $\mu^{F_L} > 0$ if $m_e^{F_L}(\frac{r(1-\lambda)}{2}) - m_c^{F_L}\left[(r-x) - \left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\}\right] > 0$, which on simplification yields the following.

$$x > x^{F_L} = r - \left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\} - \frac{m_e^{F_L}}{m_c^{F_L}}\frac{r(1-\lambda)}{2}. \qquad (14)$$

2. Medium penalty range $\boldsymbol{F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]}$

Suppose the firm chooses I_a. In this penalty range the extortion bribe demand criteria is violated because $F_M > F_e$ as evident from Figure 4.2. Therefore, a firm's payoff is as follows.

$$E\pi_r^{F_M}(I_a) = \pi_r(I_a, NB) = r - x \qquad (15)$$

Suppose the firm chooses NI_a. In this case, as observable from Figure 4.2, the collusive bribe demand criteria is sustained for $m \leq m_c^{F_M}$ since for this range $F_M \leq F_c(r, m, n)$. However, this condition is violated for $m > m_c^{F_M}$ and a firm initially choosing NI_a will subsequently have to invest and reapply, since an official will behave honestly. So a firm's expected profit from choosing NI_a is, $E\pi_r^{F_M}(NI_a) = Pr\big(m \leq$

$m_c^{F_M}) E\pi_r((NI_a, A), B_c) + Pr(m > m_c^{F_M}) E\pi_r((I_a, NI_a), NB)$. Using the relevant expressions, we get the following.

$$E\pi_r^{F_M}(NI_a) = m_c^{F_M}\left[\frac{r(1-\gamma)}{2} - \gamma F_M\right] + \left(1 - m_c^{F_M}\right)(1-\mu)[r-x] \qquad (16)$$

The firm chooses I_a if $E\pi_r^{F_M}(I_a) \geq E\pi_r^{F_M}(NI_a, I_a)$. Using equations (15) and (16) this *compliance condition* for choosing I_a in the medium penalty range can be written as follows.

$$\mu \geq \mu^{F_M} = \frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)(r-x)}\left[\frac{r(1-\gamma)}{2} - \gamma F_M\right] - \frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)} \qquad (17)$$

The compliance condition is violated if $\mu < \mu^{F_M}$ and the firm chooses NI_a. Now $\mu^{F_M} > 0$ if $r - x - \left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} < 0$ which can be rewritten as follows.

$$x > x^{F_M} = r - \left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} \qquad (18)$$

3. High penalty range $F_H > \frac{(1-\gamma)r}{2\gamma}$.

In the high penalty range both extortion and collusion bribe demand criteria are violated. Regardless of his sensitivity to moral standard, an official never indulges in any kind of corruption and behave honestly by granting the license only to an investing firm. Therefore, if a firm chooses I_a in stage 2, its payoff is $E\pi_r^{F_H}(I_a) = r - x$. In contrast, if it chooses NI_a then the payoff is $E\pi_r^{F_H}(NI_a) = \delta(r-x)$. Since $\delta < 1$, therefore, a firm always choose I_a.

Having outlined the firm's payoffs for the different penalty ranges let us state some of the properties of x^{F_L}, x^{F_M}, μ^{F_L} and μ^{F_M} in Lemma 2.

Lemma 2.

(i) μ^F is increasing in x, where $F = F_L, F_M$; and $\frac{d\mu^{F_L}}{dx} > \frac{d\mu^{F_M}}{dx}$.

(ii) $x^{F_M} > x^{F_L}$ and $\mu^{F_M} < \mu^{F_L}$.

(iiia) If $x > x^{F_M}$, then $\mu^{F_L} > 0$ and $\mu^{F_M} > 0$.

(iiib) If $x^{F_M} \geq x > x^{F_L}$, then $\mu^{F_L} > 0$ and $\mu^{F_M} < 0$.

(iiic) If $x < x^{F_L}$, then both $\mu^{F_L} < 0$ and $\mu^{F_M} < 0$.

Proof: See the appendix.

Recall that μ^F $(F = F_L, F_M)$ is the threshold reapplication cost at which the firm is indifferent between choosing I_a and NI_a in the low and medium penalty ranges. A higher compliance cost *x*, incentivises the firm to choose NI_a. Therefore, a higher reapplication cost is required to counter this incentive, and hence there is a positive relationship between μ^F and *x*. Recall that x^F $(F = F_L, F_M)$ is the compliance cost at which $\mu^F = 0$. A penalty in the medium range is higher than that in the low range. Thus, a lower reapplication cost can incentivise a firm to invest when the penalty is in the medium range compared to that in the low range. This means that even a higher compliance cost can sustain this incentive in the medium penalty range than in the low range. This explains part (ii) of Lemma 5. Part (iii) of this lemma follows from the above two results.

We will use Lemmas 1 and 2 to analyse the firm's stage 2 choice. We will state the result for the $x > x^{F_M}$ in Proposition 2 because it is the general case. The results for $x^{F_M} \geq x > x^{F_L}$ and $x < x^{F_L}$ will be summarized in Proposition 3 because they are subcases of $x \leq x^{F_M}$. These results are stated only for the low and medium penalty ranges because in the high penalty range there is no corruption of any form.

Proposition 2. *Suppose the compliance cost is relatively high, that is, $x > x^{F_M}$.*

(i) A decrease in x reduces the scope of collusion.

(ii) Consider any penalty in the low range, $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$.

(a) If $\mu \geq \mu^{F_L}$ then the firm chooses I_a. There is extortion if the official's sensitivity to moral standard is, $m \leq m_e^{F_L}$. Otherwise there is no extortion.

(b) If $\mu < \mu^{F_L}$ then a firm chooses NI_a. There is collusion if the official's sensitivity to moral standard is, $m \leq m_c^{F_L}$. If $m > m_c^{F_L}$ then the officer behaves honestly, and the firm reapplies by choosing I_a.

(iii) Consider any penalty in the medium range, $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$.

(a) A firm chooses I_a if $\mu \geq \mu^{F_M}$ and there is no extortion

(b) A firm chooses NI_a if $\mu < \mu^{F_M}$. There is collusion if the sensitivity to moral standard is, $m \leq m_c^{F_M}$. If $m > m_c^{F_M}$ then the officer behaves honestly and the firm reapplies by choosing I_a.

Proof: See the appendix.

Figure 4.3 provides a diagrammatic representation of the firm's investment decision and corruption outcomes for different penalty levels when $x > x^{F_M}$, as stated in Proposition 1.

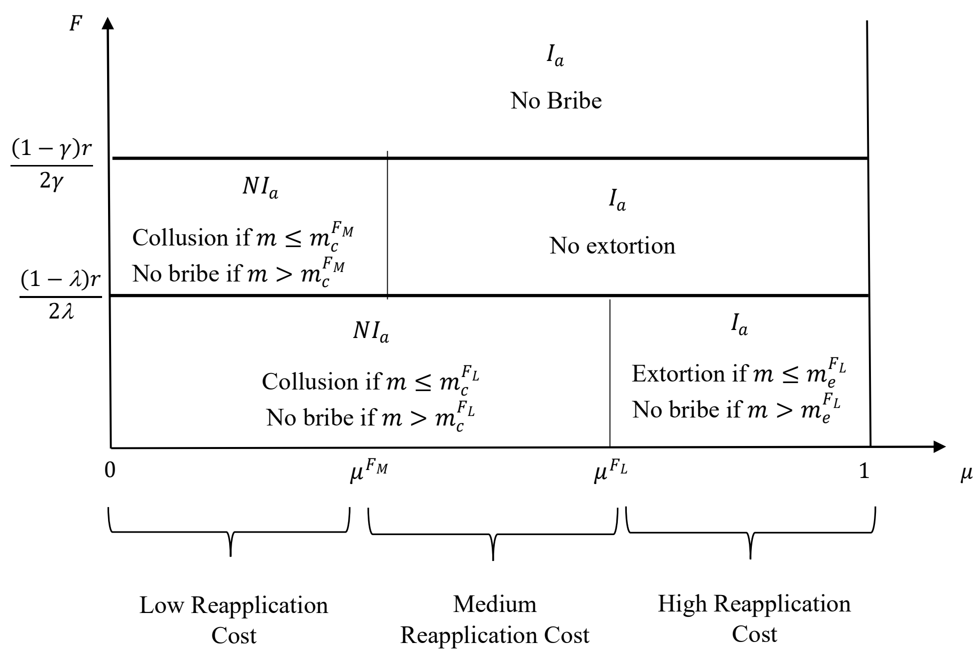

Figure 4.3: Firm's investment decision and corruption outcomes for $x > x^{F_M}$

As shown in Figure 4.3, for high compliance cost $x > x^{F_M}$, the threshold levels of reapplication costs are positive, that is, $\mu^{F_L} > 0$ and $\mu^{F_M} > 0$. Hence, depending on this cost, Figure 4.3 shows that the firm can choose I_a or NI_a in Stage 2. As stated in Proposition 1 and shown in Figure 4.3, extortion exists if, $\mu \geq \mu^{F_L}$ that incentivises the firm to choose I_a, and, $m \leq m_e^{F_L}$, and $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$. For all $\mu < \mu^{F_L}$, the firm chooses NI_a in Stage 2 and collusion exists for $m \leq m_c^{F_L}$. If $m > m_c^{F_L}$ then the bribery condition is violated and the firm which initially do not invest subsequently chooses to invest.

In the medium penalty $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$, the threshold reapplication cost falls from μ^{F_L} to μ^{F_M} as stated in Lemma 2. So the range $\mu < \mu^{F_M}$ is less than the range $\mu < \mu^{F_L}$. Now a firm chooses NI_a if $\mu < \mu^{F_M}$ and indulges in collusion if the sensitivity to moral standard is quite low, $m \leq m_c^M$. This sensitivity range is lower than $m \leq m_c^{F_L}$ as can be seen in Figure 4.3. It implies that in the medium penalty range the scope of collusion is less than that in the low range. In contrast if $\mu \geq \mu^{F_M}$ then the firm chooses I_a, and there is no extortion because the bribery condition is violated.

Let us examine the firm's decision for the moderate and low compliance cost ranges, which are, $x^{F_M} \geq x > x^{F_L}$ and $x^{F_L} \geq x$. These results are summarized in Proposition 3 and we provide an intuitive discussion of its proof.

Proposition 3.

(i) Suppose the compliance cost is in the moderate range $x^{F_M} \geq x > x^{F_L}$. If the penalty is in the medium range $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$ then the firm chooses I_a and there is no extortion. If the penalty is in the low range $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$ then the results are qualitatively similar to Proposition 1(ii).

(ii) If the compliance cost is quite low, $x < x^{F_L}$, then a firm always choose I_a. If the penalty is in the medium range then the firm do not face extortion. However, if the penalty is in the low range then the firm faces extortion only if $m \leq m_e^{F_L}$.

Proof: See the appendix.

In the moderate compliance cost range, $x^{F_M} \geq x > x^{F_L}$, we know from Lemma 2 (iiib) that $\mu^{F_L} > 0$ and $\mu^{F_M} < 0$. This means that for $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$ the investment criterion $\mu \geq \mu^{F_M}$ always hold because $\mu \in [0, 1]$. So the firm always invest and there is no extortion because $F_M > F_e(r, m, n)$ for all m, and the bribe offer condition as specified in Table 4.2 is violated. The analysis for the low penalty range $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$ is qualitatively the same as discussed in Proposition 1(ii) because $\mu^L > 0$ for both $x > x^{F_M}$ and $x^{F_M} \geq x > x^{F_L}$.

In the low compliance cost range $x^{F_L} \geq x$, we know from Lemma 2(iiic) that $\mu^{F_L} < 0$ and $\mu^{F_M} < 0$. Hence, the investment criteria $\mu \geq \mu^{F_L}$ and $\mu \geq \mu^{F_M}$ for the low and medium penalty ranges are satisfied since $\mu \in [0, 1]$. So, for both these penalty ranges, the firm chooses to invest and there is no collusion. In the medium penalty range the firm do not face extortion because $F_M > F_e(r, m, n)$ for all m. However, in the low range $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$, we know from Figure 4.2 that an official with $m \leq m_e^{F_L}$, for whom $F_L \leq F_e(r, m, n)$ indulges in extortion. In contrast, an official with $m > m_e^{F_L}$ behaves honestly because the extortion bribery condition is violated.

4.4. Policy instruments and the role of media watch

In this section we examine the marginal impact of increases in F, γ, and λ on the firm's participation incentive to invest in compliance and corruption outcomes. We also analyse the comparative effectiveness of higher F and γ in inducing firm's compliancy and on the official's corruptible behaviour. We will do this for the case $x > x^{F_M}$ because of the following reasons. In Proposition 3(i) we have shown that when the compliance cost is in the moderate range $x^{F_M} \geq x > x^{F_L}$ then the result is qualitatively the same as in the case $x > x^{F_M}$ when penalty is in the low range. If the penalty is in the medium range, then there is no corruption. If the compliance cost is quite low, $x < x^{F_L}$ then the firm always choose to invest but may face extortion only if the penalty is in the low range. Thus, an examination of $x > x^{F_M}$ covers all the cases.

From equations (13) and (17) we can rewrite the compliance investment participation constraints for the low and medium penalty range as follows.

$$\mu^{F_L} = \mu^{F_L}(F_L, \gamma, \lambda, m_c^{F_L}, m_e^{F_L}) = \frac{1}{\left(1-m_c^{F_L}\right)(r-x)}\left[m_e^{F_L}\left\{\frac{r(1-\lambda)}{2}\right\} + m_c^{F_L}\left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\}\right] - \frac{m_c^{F_L}}{\left(1-m_c^{F_L}\right)}$$

$$\mu^{F_M} = \mu^{F_M}(F_M, \gamma, m_c^{F_M}) = \frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)}\left[\frac{1}{(r-x)}\left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} - 1\right]$$

Observe, that since there is no extortion in the medium penalty range, hence, there is no λ and $m_e^{F_M}$ in the second equation.

Total differentiation of $\mu^{F_L} = \mu^{F_L}(F_L, \gamma, \lambda, m_c^{F_L}, m_e^{F_L})$ with respect to $z = F_L,\ \gamma, \lambda$, and total differentiation of $\mu^{F_M} = \mu^{F_M}(F_M, \gamma, m_c^{F_M})$ with respect to $z = F_M, \gamma$, gives us the following.

$$d\mu^{F_L} = \frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\frac{\delta m_c^{F_L}}{\delta z}dz + \frac{\delta\mu^{F_L}}{\delta m_e^{F_L}}\frac{\delta m_e^{F_L}}{\delta z}dz + \frac{\delta\mu^{F_L}}{\delta z}dz \Rightarrow \frac{d\mu^{F_L}}{dz} = \frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\frac{\delta m_c^{F_L}}{\delta z} + \frac{\delta\mu^{F_L}}{\delta m_e^{F_L}}\frac{\delta m_e^{F_L}}{\delta z} + \frac{\delta\mu^{F_L}}{\delta z}$$
$$d\mu^{F_M} = \frac{\delta\mu^{F_M}}{\delta m_c^{F_M}}\frac{\delta m_c^{F_M}}{\delta z}dz + \frac{\delta\mu^{F_M}}{\delta z}dz \Rightarrow \frac{d\mu^{F_M}}{dz} = \frac{\delta\mu^{F_M}}{\delta m_c^{F_M}}\frac{\delta m_c^{F_M}}{\delta z} + \frac{\delta\mu^{F_M}}{\delta z} \quad (19)$$

Observe that in the low penalty range, a change in $z = F_L, \gamma, \lambda$ has a direct effect captured by $\frac{\delta\mu^{F_L}}{\delta z}$ and indirect effects via $m_c^{F_L}$ and $m_e^{F_L}$ captured by $\frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\frac{\delta m_c^{F_L}}{\delta z}$ and $\frac{\delta\mu^{F_L}}{\delta m_e^{F_L}}\frac{\delta m_e^{F_L}}{\delta z}$. It is important to mention that a change in λ, has no impact on $m_c^{F_L}$ as discussed earlier. So, $\frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\frac{\delta m_c^{F_L}}{\delta\lambda} = 0$. Likewise, in the medium penalty range a change in $z = F_M, \gamma$ also has direct and indirect effects captured by $\frac{\delta\mu^{F_M}}{\delta z}$ and $\frac{\delta\mu^{F_M}}{\delta m_c^{F_M}}\frac{\delta m_c^{F_M}}{\delta z}$. Using this we summarize the result for the impact of the policy variables on the firm's compliance participation in Proposition 4a and 4b.

Proposition 4a. *For high compliance cost i.e., $x > x^{F_M}$*

(i) In the low penalty range, $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$, increases in F_L, γ, and λ, reduces μ^{F_L} and increases the firm's incentive to invest in compliance.

(ii) In the medium penalty range $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$, increases in F_M and γ, reduces μ^{F_M} and increases the firm's incentive to invest in compliance.

Proof: See the appendix.

Let us intuitively discuss Proposition 4. We will only do this by considering an increase in the penalty in the low penalty range because the explanation for the medium penalty range is similar. The explanations for the effects of higher γ and λ are similar because their effects on $m_c^{F_L}$ and $m_e^{F_L}$ follows the same direction as the change in the penalty.

Suppose the enforcement becomes stricter which is captured by an increase in F_L. From Proposition 1 we know that this lowers the equilibrium number of corruptible officials, that is, $\frac{\delta m_c^{F_L}}{\delta F_L} < 0$. Therefore, a marginal increase in the penalty switches the marginal corrupt officer to behave non-corruptibly. The fall in $m_c^{F_L}$ reduces the threshold reapplication cost μ^{F_L}, that is, $m_c^{F_L}$ and μ^{F_L} are positively related, hence, $\frac{\delta \mu^{F_L}}{\delta m_c^{F_L}} > 0$. Let us intuitively look at the positive effect of a lowering of the scope of corruption on the threshold reapplication cost via the increase in penalty. As the penalty increases the optimal number of corruptible officers decrease as shown in Proposition 1 and hence the scope of corruption decreases. The lower scope of corruption incentivises firms to comply which is possible if the threshold of reapplication cost is lowered and hence, we have $\frac{\delta \mu^{F_L}}{\delta m_c^{F_L}} > 0$. Therefore, the overall effect is negative, that is, $\frac{\delta \mu^{F_L}}{\delta m_c^{F_L}} \frac{\delta m_c^{F_L}}{\delta F_L} < 0$.

From Proposition 1 we also know that an increase in F reduces $m_e^{F_L}$, $\frac{\delta m_e^{F_L}}{\delta F_L} < 0$. This is because, an increase in F reduces the equilibrium number of corruptible officers which raises the moral standard captured by $C(m_c^{F_L})$. Hence, the marginal officer switches from extortion to no extortion. This fall in $m_e^{F_L}$ reduces μ^{F_L}, that is, $\frac{\delta \mu^{F_L}}{\delta m_e^{F_L}} > 0$. Again, the overall effect is negative, that is, $\frac{\delta \mu^{F_L}}{\delta m_e^{F_L}} \frac{\delta m_e^{F_L}}{\delta F_L} < 0$.

An increase in F has a negative effect on μ^{F_L} as can be seen from equation (13). Hence, the direct effect of an increase in penalty is also negative, that is, $\frac{\delta \mu^{F_L}}{\delta F_L} < 0$. Combining this with the two indirect negative effects of an increase in F via $m_c^{F_L}$ and $m_e^{F_L}$, we the overall effect of an increase in the penalty to be negative. The explanation is the same for γ and λ.

Proposition 4b. *For moderate compliance cost i.e.,* $x^{F_M} \geq x > x^{F_L}$ *a firm's participation in compliance investment is determined by* μ^{F_L} since $\mu^{F_M} < 0$.

(i) In the medium penalty range $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$, *the firm always invest and there is no extortion.*

(ii) In the low penalty range, $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$, *increases in* F_L, γ, *and* λ, *reduces* μ^{F_L} *and increases the firm's incentive to invest in compliance.*

For moderate compliance cost i.e., $x^{F_M} \geq x > x^{F_L}$, we have $\mu^{F_M} < 0$ and $\mu^{F_L} > 0$. For a medium penalty range $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$, a firm's participation in compliance investment criterion $\mu \geq \mu^{F_M}$ always hold because $\mu \in [0,1]$. Thus, the firm always invests and there is no extortion because $F_M > F_e(r,m,n)$ for all m, and the bribe offer condition as specified in Table 4.2 is violated.

It follows from the proof of Proposition 4a that for low penalty $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$, $\frac{\delta\mu}{\delta m_c^{F_L}} > \mu^{F_L} > 0$ and hence for low penalty range the results remain same as Proposition 4a(i).

In the low compliance cost range $x^{F_L} \geq x$, we know from Lemma 2(iiic) that $\mu^{F_L} < 0$ and $\mu^{F_M} < 0$. Hence, the investment criteria $\mu \geq \mu^{F_L}$ and $\mu \geq \mu^{F_M}$ for the low and medium penalty ranges are satisfied since $\mu \in [0,1]$. Hence, the results remain qualitatively same as Proposition 3(ii). For both low and medium penalty ranges, a firm chooses to invest and there is no collusion. Extortion is ruled out in the medium penalty range as $F_M > F_e(r,m,n)$ for all m. However, in the low range $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$, an official with $m \leq m_e^{F_L}$ indulges in extortion. For $m > m_e^{F_L}$ the extortion bribery condition is violated.

Proposition 1 showed that increases in the penalty (*F*) or probability of convicting collusion (γ) reduces the incidence of corruption. In Proposition 4a and 4b we show that these increases also improves the firm's participation in compliance investment. However, from a policy perspective it is important to examine and compare the relative effectiveness of these two instruments. The result is stated in Proposition 5.

Proposition 5. *Consider any penalty in the range* $F \in \left[0, \frac{(1-\gamma)r}{2\gamma}\right]$ *and the compliance cost satisfies* $x > x_M$.

(i) *An increase in the collusion conviction probability* γ *is more effective in reducing the equilibrium number of corrupt officials than an increase in the anti-corruption penalty* F.

(ii) *If the condition* $\gamma\left[1 - \frac{C\left(m_c^{F_L}\right)}{C\left(m_c^{F_L}\right)+m_c^{F_L}C'\left(m_c^{F_L}\right)}\right] > \frac{\lambda}{(1-\lambda)}$ *holds, then unequivocally an increase in* γ *is more effective in increasing the firm's compliance than an increase in* F.

Proof: See the appendix.

From Proposition 1 we know that increases in F and γ both reduce the equilibrium number of corrupt officials, that is, m_c^F falls. Consequently, the scope of corruption falls. However, the two effects are different because of the following reason. An increase in F results in a movement along the F_c line in Figure 4.2. This causes a decrease in the optimum number of corruptible officers m_c^F. In contrast, an increase in γ has two effects. From Table 4.2 we know that $F_c(r,m,n) = \frac{\frac{r(1-\gamma)}{2} - mC(n)}{\gamma} = \frac{r(1-\gamma)}{2\gamma} - \frac{mC(n)}{\gamma}$. So, an increase in γ reduces the vertical intercept which shifts down the F_c curve in Figure 4.2. It also reduces the absolute value of the slope of this curve, thus making it flatter. Therefore, the marginal effect of an increase in γ on the optimal number of corruptible officers is greater than the marginal effect of an increase in penalty. So γ is more effective in reducing corruption than F. This in turn plays an important role on the firm's incentive to participate in compliance.

From Proposition 4 we know that $\frac{d\mu^F}{dF} < 0$ and $\frac{d\mu^F}{d\gamma} < 0$. So, to show that γ is more effective than F, we need to prove $\left|\frac{d\mu^F}{d\gamma}\right| > \left|\frac{d\mu^F}{dF}\right|,\ F = F_L, F_M$. This we do by using equation (19) and taking the pairwise difference of the terms with the coefficients $\frac{\delta\mu^F}{\delta m_c^F}$ and $\frac{\delta\mu^F}{\delta m_e^F}$ where $F = F_L, F_M$. So the proof of $\left|\frac{d\mu^F}{d\gamma}\right| > \left|\frac{d\mu^F}{dF}\right|,\ F = F_L, F_M$, requires the following set of conditions to be satisfied.

(1) The conditions when penalty is in the low range are as follows.

(a) $\frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\left[\left|\frac{\delta m_c^{F_L}}{\delta\gamma}\right| - \left|\frac{\delta m_c^{F_L}}{\delta F}\right|\right] > 0 \Rightarrow \left[\left|\frac{\delta m_c^{F_L}}{\delta\gamma}\right| - \left|\frac{\delta m_c^{F_L}}{\delta F}\right|\right] > 0$, since $\frac{\delta\mu^{F_L}}{\delta m_c^{F_L}} > 0$;

(b) $\frac{\delta\mu^{F_L}}{\delta m_e^{F_L}}\left[\left|\frac{\delta m_e^{F_L}}{\delta\gamma}\right| - \left|\frac{\delta m_e^{F_L}}{\delta F}\right|\right] > 0 \Rightarrow \left[\left|\frac{\delta m_e^{F_L}}{\delta\gamma}\right| - \left|\frac{\delta m_e^{F_L}}{\delta F}\right|\right] > 0$, since $\frac{\delta\mu^{F_L}}{\delta m_e^{F_L}} > 0$;

(c) $\left[\left|\frac{\delta\mu^{F_L}}{\delta\gamma}\right| - \left|\frac{\delta\mu^{F_L}}{\delta F}\right|\right] > 0$.

(2) The conditions when penalty is in the medium range are as follows.

(a) $\frac{\delta\mu^{F_M}}{\delta m_c^{F_M}}\left[\left|\frac{\delta m_c^{F_M}}{\delta\gamma}\right| - \left|\frac{\delta m_c^{F_M}}{\delta F}\right|\right] > 0 \Rightarrow \left[\left|\frac{\delta m_c^{F_M}}{\delta\gamma}\right| - \left|\frac{\delta m_c^{F_M}}{\delta F}\right|\right] > 0$, since $\frac{\delta\mu^{F_M}}{\delta m_c^{F_M}} > 0$.

(b) $\left[\left|\frac{\delta\mu^{F_M}}{\delta\gamma}\right| - \left|\frac{\delta\mu^{F_M}}{\delta F}\right|\right] > 0$.

The satisfaction of conditions (1a) and (2a) directly follow from Proposition 5(i). Conditions (1c) and (2b) are also satisfied. However, the fulfilment of condition (1b) requires the following sufficient condition. Using $\phi'\left(m_c^{F_L}\right) = C\left(m_c^{F_L}\right) + m_c^{F_L}C'\left(m_c^{F_L}\right)$, for any F_L, $\left|\frac{\delta m_e^{F_L}}{\delta\gamma}\right| - \left|\frac{\delta m_e^{F_L}}{\delta F}\right| > 0$, if $\frac{1}{C\left(m_c^{F_L}\right)}\left[-\lambda - (1-\lambda)\left\{m_e^{F_L}C'\left(m_c^{F_L}\right)\frac{\gamma}{\phi'\left(m_c^{F_L}\right)}\right\}\right] > 0.$

Rearranging terms gives the expression $\gamma\left[1 - \frac{m_e^{F_L}C'\left(m_c^{F_L}\right)}{\phi'\left(m_c^{F_L}\right)}\right] > \frac{\lambda}{(1-\lambda)}$.

Observe that $\left[1-\frac{m_e^{F_L}C'\left(m_c^{F_L}\right)}{\phi'\left(m_c^{F_L}\right)}\right]>0$ because $C'\left(m_c^{F_L}\right)<0$ and $\phi'\left(m_c^{F_L}\right)\ >0.$ Further, $\frac{\lambda}{(1-\lambda)}$ increases as λ increases. However, the L.H.S of the inequality also increases because an increase in λ causes $m_e^{F_L}$ to fall.

The above findings and discussions show that improvement of conviction probability of collusive corruption is more effective than stricter anti-corruption penalty in reducing corrupt behaviour by officials and also enhances firm's participation in compliance investment, has serious policy implications. Specifically, while extortion has the scope of being self-reported by the victim, collusive bribery can only be discovered by an external third party through peer-reporting or media watch. This immediately thus brings forth the importance of media watch on control of non-compliance. Below we provide an anecdotal evidence to support our finding that media watch may control non-compliance.

4.5. Role of media watch on non-compliance: An anecdotal evidence

Unlike extortion, collusive bribery is not self-reported since both the firm and the official cooperate in the corrupt act. The media watch reveals the collusion and helps conviction. Proposition 5 derived above shows that the media watch under certain condition can be more effective in incentivizing compliance than punishment.

In an earlier paper, Fisman and Miguel (2007) studied the relation between corruption and non-compliance. Specifically, they collected data on parking violations by United Nations diplomats living in New York City during 1997 to 2002, to find that the diplomats from low (high) corruption countries have lower (higher) number of violations. Prior to November 2002, UN diplomats and their families enjoyed diplomatic immunity, which allowed them to avoid paying parking fines. Any parking violation though recorded could go unpaid leaving only a paper trail of offenses. It was only in November 2002 that a pivotal change in legal enforcement took place which allowed the State Department, New York City to confiscate the official diplomatic license plates of vehicles with three or more unpaid violations. They concluded from their data that home country corruption norms predicted the diplomats' tendency to violate rules.

As an anecdotal evidence in support of the relation between media watch and compliance in our chapter, we take the country rank of Fisman and Miguel (2007) for 145 countries on violation of parking norm and find its Spearman's rank correlation with ranking of the countries on the basis of their average media-freedom score in 1997-2002, calculated from Press Freedom scores provided by Freedom House. The details of country ranks are available in Table A1 in the appendix. As per Fisman and Miguel (2007), countries with higher number of violations are ranked higher. According to Freedom House ranking, a lower score for media freedom implies a freer media and hence a higher rank.

Therefore, the Spearman's rank correlation is expected to be negative. Table 4.3 below reports the Spearman's rank correlation results.

Table 4.3: Spearman's Rank Correlation

Number of Countries: 145	
Violations and Media Freedom	
Spearman's ρ	-0.30
SE	0.08
P-Value	0.000264

The Spearman's rank correlation turns out to be negative significant at 1% level implying a greater number of violations of parking rule is associated with diplomats from those countries where media freedom is less. The result is consistent with the prediction of our theoretical model.

For robustness check we also looked at the rank correlation of violation and average newspaper circulation of countries per 1000 inhabitants in 1997-2002, calculated from UNESCO Institute for Statistics, as it captures the penetration of media in a country, where higher scores are ranked higher. We obtained a negative correlation of 0.36 (0.03), the parenthesis showing the P-value. However, in this case we had only 37 countries from Fisman and Miguel's list since only for these countries we have the required circulation data.

4.6. Conclusions and Policy Implications

The chapter considers the interaction between enforcement and individual-specific sensitivity to moral standard in determining the scope of extortion and collusion in an economy. The officials with their sensitivity lower than morality thresholds, endogenously determined in the model, participate in corruption if and only if the punishment levels are also below certain thresholds, also endogenously determined in the model. The chapter shows that under reasonable assumptions, both the morality threshold and punishment threshold for extortion lie below the similar thresholds for collusion, which under high compliance cost restricts the scope of extortion at the equilibrium compared to the scope of collusion. At low compliance cost, however, extortion prevails.

A larger network of corrupt officials lowers the moral standard and relaxes the thresholds below which corruption occurs. At low and medium penalty ranges, while media-watch plays an important role in controlling both types of corruption, the efficiency of judiciary matters if only extortion prevails in the bureaucracy.

While discussing the policy implications, we have highlighted the role of penalty, compliance cost, cost of reapplication and conviction probabilities of extortion and collusion. The chapter suggests a penalty set at a high penalty range solves the problem of both extortion and collusion in a bureaucracy, in accordance with Becker (1968)[41]. However, in absence of capital punishment in most of the countries in the world, the chapter also suggests the alternatives available at the medium and low penalty ranges.

First, a low compliance cost, which can even be supported by a subsidy, solves the problem of collusion in a bureaucracy. For example, a subsidized driving lesson would

[41] However, capital punishment is not implemented in most of the countries around the world because of the possible error in the judicial process. Therefore, alternative strategies at the low and medium penalty ranges are discussed.

incentivize everyone to receive the driving lesson and would reduce the road-accidents by the individuals who would not take the lesson without such a subsidy and would receive the license through collusion. But it fails to solve the problem of extortion at a low penalty range. In such a situation, increasing efficiency of judiciary in convicting the extortion cases reduces the scope of extortion in bureaucracy.

Second, if the compliance cost cannot be lowered, at the medium and the low penalty range, the reapplication cost must be made sufficiently high such that the compliance takes place at the first instance. In such a situation, collusion gets eliminated at the medium penalty range and at the low penalty range extortion becomes the only form of corruption, which can be controlled through increasing efficiency of judiciary as mentioned above.

Third, if high reapplication cost cannot be charged, collusion is the outcome at the medium and low penalty ranges, which can be controlled through freeing up the media. More intense media-watch would reduce the scope of collusion. It seems that lowering of the qualification cost can potentially solve the problem of collusion in delivery of driving licenses in developing countries like India. In case of collusion in delivery of passports or pollution licenses, more intense media-watch seems to be the way-out. More intense media-watch would reduce m_c, μ_L and μ_M, reducing the scope of collusion. This would be case in providing the proof of citizenship during the application of passport.

One of the testable hypotheses derived from the theoretical model presented in the chapter is that the countries with higher media freedom must have lower violations of law. An anecdotal evidence in the chapter verifies this claim. However, there is scope for a detailed empirical work controlling other relevant factors for substantiating this claim.

Like all theoretical models, the model presented in the chapter has some limitations. The chapter assumes only the officials are sensitive to the moral standard, while the bribepayers are not. The papers like Andvig and Moene (1990) discuss the moral cost on both the sides. The assumption makes our model tractable. However, we believe that the relaxation of this assumption would restrict the scope of collusion in our model further without changing the main results. The chapter also assumes for simplicity that the sensitivity of moral standard has a uniform distribution in the population of officials. We did not find any compelling reason to deviate from this assumption. However, if this assumption is relaxed, one can have multiple equilibrium in terms of number of corrupt officials in our model. In such a set-up, one can discuss the policy shocks to move from a high corruption equilibrium to a low corruption equilibrium.

Appendix

Proof of Lemma 1.

(i) The solution to $F_e(r,m,n) = \frac{(1-\lambda)\frac{r}{2} - mC(n)}{\lambda} = 0$ is $m = \frac{(1-\lambda)r}{2C(n)} = m_e$.

(ii) The solution to $F_c(r,m,n) = \frac{(1-\gamma)\frac{r}{2} - mC(n)}{\gamma} = 0$ is $m = \frac{(1-\gamma)r}{2C(n)} = m_c$.

(iii) $m_e - m_c = \frac{(\gamma-\lambda)r}{2C(n)} < 0$ since $\lambda > \gamma$. (iv) $F_e(r,m,n) - F_c(r,m,n) = \frac{1}{\lambda\gamma}\left[\frac{r}{2}(\gamma-\lambda) - 2mC(n)(\lambda+\gamma)\right] < 0$ since $C(n) > 0$, $\lambda \in (0,1)$ and $\gamma \in (0,1)$ and $\gamma < \lambda$. Now $F_c(r,m,n) - \frac{(1-\gamma)r}{2\gamma} = -\frac{mC(n)}{\gamma} < 0$ and $F_e(r,m,n) - \frac{(1-\lambda)r}{2\lambda} = -\frac{mC(n)}{\lambda} < 0$ □

Proof of Proposition 1.

(i) As shown in Figure 4.2, any $F \in \left[0, \frac{(1-\gamma)r}{2\gamma}\right]$ intersects $F_c(r,m,n)$ at a unique m, say m_c^F, since $F_c(r,m,n)$ is downward sloping. From Lemma 1 (iv) we know that $F_e(r,m,n) < F_c(r,m,n)$. Hence, as shown in Figure 4.2, if $F \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$ then F intersects $F_e(r,m,n)$ at m_e^F, and $m_e^F < m_c^F$. If $F \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$ then from Figure 4.2 we know that $m_e^F < 0$ but $m_c^F > 0$. Therefore, officials with sensitivity to moral standard less than m_c^F are corrupt and indulges only in collusion if the firm has chosen NI_a in stage 2. By assumption the mass of officials is 1 of which *n* are corrupt, and *m* is uniformly distributed in the interval $m \in [0,1]$. Therefore, for any penalty in the interval $F \in \left[0, \frac{(1-\gamma)r}{2\gamma}\right]$, the equilibrium number of corrupt officials is $n^{F^*} = m_c^F = \frac{r(1-\gamma)}{2C(m_c^F)} - \frac{\gamma F}{C(m_c^F)}$. For the same reason if $F \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$ then m_e^F is the equilibrium number of officials who engage in extortion, provided the firm has chosen I_a in stage 2.

(ii) Solving $F_c(r,m,n) = F$ we get in equilibrium $F = \frac{1}{\gamma}\left[\frac{r(1-\gamma)}{2} - m_c^F C(m_c^F)\right]$. Observe that since $n^{F^*} = m_c^F$, hence $C\left(n^{F^*}\right) = C(m_c^F)$. Let $\phi(m_c^F) = m_c^F C(m_c^F)$. We can thus write the above equality as $\phi(m_c^F) = \left[\frac{r(1-\gamma)}{2} - \gamma F\right]$. The R.H.S is non-negative because $F \in \left[0, \frac{(1-\gamma)r}{2\gamma}\right]$. So $\phi(m_c^F) \geq 0$ for the above equality to hold. At $F = \frac{(1-\gamma)r}{2\gamma}$, $m_c^F = 0$ and therefore $\phi(m_c^F) = 0$. At $F = 0$, $\phi(m_c^F) = \frac{r(1-\gamma)}{2}$. So, the lower and upper bounds of $\phi(m_c^F)$ are 0 and $\frac{r(1-\gamma)}{2}$. So for $\phi(m_c^F) = \left[\frac{r(1-\gamma)}{2} - \gamma F\right]$ to hold, that is, the intersection to be at a non-negative value of $\left[\frac{r(1-\gamma)}{2} - \gamma F\right]$, it must be the case that $\phi'(m_c^F) > 0$. This is shown in Figure A1.

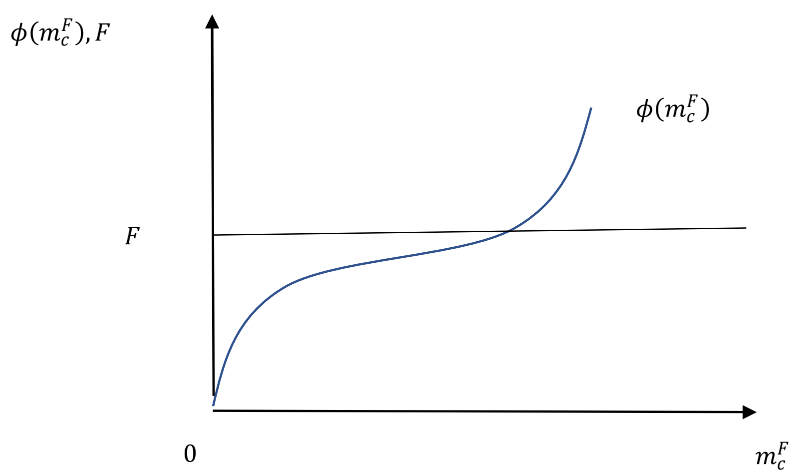

Figure A1: Property of $\boldsymbol{\phi(m_c^F)}$

Differentiating $\phi(m_c^F) = \left[\frac{r(1-\gamma)}{2} - \gamma F\right]$ with respect to F yields, $\phi'(m_c^F)\frac{dm_c^F}{dF} = -\gamma$. Since $\phi'(m_c^F) > 0$, hence, $\frac{dm_c^F}{dF} = -\frac{\gamma}{\phi'(m_c^F)} < 0$. It therefore, follows that $m_c^{F_L} > m_c^{F_M}$ since $F_M > F_L$. If $F \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$, then solving $F_e(r,m,n) = F$ we get in equilibrium $F = \frac{1}{\lambda}\left[\frac{r(1-\lambda)}{2} - m_e^F C(m_c^F)\right]$.

Differentiating with respect to F we get the following $1 = -\frac{1}{\lambda}\left[\frac{dm_e^F}{dF}C(m_c^F) + m_e^F C'(m_c^F)\frac{dm_c^F}{dF}\right]$. Using $\frac{dm_c^F}{dF} = -\frac{\gamma}{\phi'(m_c^F)}$ we get $\frac{dm_e^F}{dF} = -\frac{\lambda\left[1 - m_e^F C'(m_c^F)\frac{\gamma}{\phi'(m_c^F)}\right]}{C(m_c^F)} < 0$ because by assumption $C'(m_c^F) < 0$.

(iib) Total differentiation of $F = \frac{1}{\gamma}\left[\frac{r(1-\gamma)}{2} - \phi(m_c^F)\right]$ with respect to γ and m_c^F yields the following. $0 = -\frac{1}{\gamma^2}d\gamma\left[\frac{r(1-\gamma)}{2} - \phi(m_c^F)\right] + \frac{1}{\gamma}\left[\frac{-r}{2}d\gamma - \phi'(m_c^F)dm_c^F\right]$. This on rearrangement yields $0 = -\frac{1}{\gamma^2}\left[\frac{r(1-\gamma)}{2} - \phi(m_c^F) + \frac{r}{2\gamma}\right]d\gamma - \frac{\phi\prime(m_c^F)}{\gamma}dm_c^F$.

Now $\left[\frac{r(1-\gamma)}{2} - \phi(m_c^F)\right] > 0$ because $F_e(r, m_c^F) = \frac{1}{\gamma}\left[\frac{r(1-\gamma)}{2} - \phi(m_c^F)\right] > 0$. Hence, $\left[\frac{r(1-\gamma)}{2} - \phi(m_c^F) + \frac{r}{2\gamma}\right] > 0$. From (iia) we know that $\phi'(m_c^F) > 0$. Hence, we get $\frac{dm_c^F}{d\gamma} = -\frac{1}{\gamma\phi'(m_c^F)}\left[\frac{r(1-\gamma)}{2} - \phi(m_c^F) + \frac{r}{2\gamma}\right] < 0$. Total differentiation of $F = \frac{1}{\lambda}\left[\frac{r(1-\lambda)}{2} - m_e^F C(m_c^F)\right]$ with respect to γ and m_e^F yields $0 = -\frac{1}{\lambda}\left[C(m_c^F)dm_e^F + m_e^F C'(m_c^F)\frac{dm_c^F}{d\gamma}d\gamma\right]$. Now $c'(m_c^F) < 0$ and $\frac{dm_c^F}{d\gamma} < 0$. Therefore, $\frac{dm_e^F}{d\gamma} < 0$.

(iic) Total differentiation of $F = \frac{1}{\gamma}\left[\frac{r(1-\gamma)}{2} - m_c^F C(m_c^F)\right]$ with respect to r and m_c^F yields the following. $0 = \frac{1}{\gamma}\left[\frac{(1-\gamma)}{2}dr - m_c^F\left(\frac{C(m_c^F)}{m_c^F} + C'(m_c^F)\right)dm_c^F\right]$. Since $\left(\frac{C(m_c^F)}{m_c^F} + C'(m_c^F)\right) > 0$, therefore, $\frac{dm_c^F}{dr} > 0$. Similarly, total differentiation of $F = \frac{1}{\lambda}\left[\frac{r(1-\lambda)}{2} - m_e^F C(m_c^F)\right]$ with respect to r and m_e^F yields, $0 = \frac{1}{\lambda}\left[\left(\frac{1-\lambda}{2} - m_e^F C'(m_c^F)\frac{dm_c^F}{dr}\right)dr - C(m_c^F)dm_e^F\right]$. The term $\left(\frac{1-\lambda}{2} - m_e^F C'(m_c^F)\frac{dm_c^F}{dr}\right) > 0$ because $c'(m_c^F) < 0$ and $\frac{dm_c^F}{dr} > 0$. Therefore, $\frac{dm_e^F}{dr} > 0$.

(iii) m_c^F is independent of λ. Total differentiation of $F = \frac{1}{\lambda}\left[\frac{r(1-\lambda)}{2} - m_e^F C(m_c^F)\right]$ with respect to λ and m_e^F yields, $0 = -\left(\frac{1}{\lambda^2}\left[\frac{r(1-\lambda)}{2} - m_e^F C(m_c^F)\right] + \frac{1}{\lambda}\left[\frac{r}{2}\right]\right) d\lambda - \frac{1}{\lambda}[C(m_c^F) dm_e^F]$. Therefore, $\frac{dm_e^F}{d\lambda} < 0$.

(iv) Recall from Lemma 1 that *at* $m_e = \frac{(1-\lambda)r}{2C(n)}$, $F_e(r,m,n) = 0$ and at $m_c = \frac{(1-\gamma)r}{2C(n)}$, $F_c(r,m,n) = 0$. Further, $m_e < m_c$. So when $F_c(r,m,n) = 0$, an official with sensitivity to moral standard below m_c are corrupt. This means that for a given, γ, λ , and *r* the corrupt officials are those with $m \leq m_c$ and that when the fine is 0. Recall that the mass of officials is 1 of which *n* are corrupt. Since *m* follows a uniform distribution in the interval $m \in [0,1]$, hence the maximum number of corrupt official, is $n^{\max} = m_c$. The effects of an increase in *r* and γ on $n^{\max} = m_c$ are the same as that on $n^* = m_c^F$. □

Proof of Lemma 2.

(i) $\mu^{F_L} = \frac{1}{\left(1-m_c^{F_L}\right)(r-x)}\left[m_e^{F_L}\left\{\frac{r(1-\lambda)}{2}\right\} + m_c^{F_L}\left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\}\right] - \frac{m_c^{F_L}}{\left(1-m_c^{F_L}\right)}$.

$$\frac{d\mu^{F_L}}{dx} = \frac{1}{\left(1-m_c^{F_L}\right)(r-x)^2}\left[m_e^{F_L}\left\{\frac{r(1-\lambda)}{2}\right\} + m_c^{F_L}\left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\}\right] > 0$$

$$\mu^{F_M} = \frac{1}{\left(1-m_c^{F_M}\right)(r-x)} m_c^{F_M}\left[\frac{r(1-\gamma)}{2} - \gamma F_M\right] - \frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)}$$

$$\frac{d\mu^{F_M}}{dx} = \frac{1}{\left(1-m_c^{F_M}\right)(r-x)^2} m_c^{F_M}\left[\frac{r(1-\gamma)}{2} - \gamma F_M\right] > 0.$$

$\frac{d\mu^{F_L}}{dx} - \frac{d\mu^{F_M}}{dx} = \frac{m_e^{F_L}\left\{\frac{r(1-\lambda)}{2}\right\}}{\left(1-m_c^{F_L}\right)(r-x)^2} + \frac{m_c^{F_L}\left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\}}{\left(1-m_c^{F_L}\right)(r-x)^2} - \frac{m_c^{F_M}\left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\}}{\left(1-m_c^{F_M}\right)(r-x)^2} > 0$ because of the following reasons.

(a) $\frac{m_c^{F_L}}{\left(1-m_c^{F_L}\right)(r-x)^2} > \frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)(r-x)^2}$ since $m_c^{F_L} > m_c^{F_M}$ (Lemma 2).

(b) $\left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\} > \left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\}$ since $F_M > F_L$.

Combining the above 2 we get $\frac{m_c^{F_L}\left\{\frac{r(1-\gamma)}{2}-\gamma F_L\right\}}{\left(1-m_c^{F_L}\right)(r-x)^2} - \frac{m_c^{F_M}\left\{\frac{r(1-\gamma)}{2}-\gamma F_M\right\}}{\left(1-m_c^{F_M}\right)(r-x)^2} > 0.$

(ii) Since $F_M > F_L$, therefore,

$x^{F_M} - x^{F_L} = r - \left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} - r + \left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\} + \frac{m_e^{F_L}}{m_c^{F_L}}\frac{r(1-\lambda)}{2} = \gamma(F_M - F_L) +$

$\frac{m_e^{F_L}}{m_c^{F_L}}\frac{r(1-\lambda)}{2} > 0.$

$\mu^{F_L} = 0$ at x^{F_L}, that is, $\mu^{F_L}(x^{F_L}) = 0$. Since $\frac{d\mu^{F_L}}{dx} > 0$, therefore $\mu^{F_L}(x^{F_M}) > 0$ since $x^{F_M} > x^{F_L}$. $\mu^{F_M} = 0$ at x^{F_M} , tha is, $\mu^{F_M}(x^{F_M}) = 0$. Therefore, $\mu^{F_L}(x^{F_M}) > \mu^{F_M}(x^{F_M})$. Since $\frac{d\mu^{F_L}}{dx} > \frac{d\mu^{F_M}}{dx} > 0$, hence, $\mu^{F_L} > \mu^{F_M}$ for all x.

Parts (iiia), (iiib) and (iiic) follows from the fact that $\mu^F = 0$ at x^F and μ^F is increasing in x, where $F = F_L, F_M$ □

Proof of Proposition 2.

(i) It follows from Lemma 5(i) that μ^i is increasing in x, where $i = F_L, F_M$. So, a decrease in x reduces μ^i which increases the incentive to invest. Hence, the possibility of collusion falls.

(iia) In the low penalty range $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$, we know from equation (11) that a firm chooses I_a if the investment criterion $\mu \geq \mu^{F_L}$. From Lemma 2 we know that for each F_L there exists a unique $m_e^{F_L}$ at which $F^L = F_e(r, m, n)$. From Figure 4.2 we know that an official with $m \leq m_e^{F_L}$, $F_L \leq F_e(r, m, n)$. Therefore, such an official indulges in extortion because the bribe offer and acceptance criterion are satisfied as shown in Tables 4.1 and 4.2. In contrast, for an official with $m > m_e^{F_L}$, $F_L > F_e(r, m, n)$. Hence, this official behaves honestly because the bribery conditions are violated.

(iib) Following equation (11) we know that the investment criterion is violated if $\mu < \mu^{F_L}$, and hence a firm chooses NI_a. From Lemma 2 we know that there exists a unique $m_c^{F_L}$

at which $F_L = F_c(r,m,n)$. From Figure 4.2 we know that $F_L \leq F_c(r,m,n)$ for an official with $m \leq m_c^{F_L}$. Therefore, there is collusion because the bribe offer, and acceptance criterion are satisfied as shown in Tables 4.1 and 4.2. In contrast, $F_L > F_c(r,m,n)$ for an official with $m > m_c^{F_L}$,. Hence, this official behaves honestly because the bribery conditions are violated. Therefore, the firm chooses I_a and reapplies.

(iiia) We know from equation (13) that in the medium penalty range $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$ a firm chooses I_a if the investment criterion $\mu \geq \mu^{F_M}$ is satisfied. In this penalty range the extortion bribe demand criteria is violated because $F_M > F_e(r,m,n)$ as evident from Figure 4.2 for all m. Hence there is no extortion.

(iiib) Following equation (13) we know that the investment criterion is violated if $\mu < \mu^{F_M}$, and hence a firm chooses NI_a. From Lemma 2 we know that there exists a unique m_c^M at which $F_M = F_c(r,m,n)$. From Figure 4.2 we know that an official with $m \leq m_c^{F_M}$, $F_M \leq F_c(r,m,n)$. Therefore, there is collusion because the bribe offer and acceptance criterion are satisfied as shown in Tables 4.1 and 4.2. In contrast, for an official with $m > m_c^{F_M}$, $F_M > F_c(r,m,n)$. Hence, this official behaves honestly because the bribery conditions are violated. Therefore, the firm chooses I_a and reapplies. □

Proof of Proposition 4a.

I. Suppose $x > x^{F_M}$ and the penalty is in the low range $F_L \in \left[0, \frac{(1-\lambda)r}{2\lambda}\right]$.

$\mu^{F_L} = \frac{1}{\left(1-m_c^{F_L}\right)(r-x)}\left[m_e^{F_L}\left\{\frac{r(1-\lambda)}{2}\right\} + m_c^{F_L}\left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\}\right] - \frac{m_c^{F_L}}{\left(1-m_c^{F_L}\right)}$, which can be simplified to $\mu^{F_L} = \frac{m_e^{F_L}}{\left(1-m_c^{F_L}\right)(r-x)}\left[\frac{r(1-\lambda)}{2}\right] + \frac{m_c^{F_L}}{\left(1-m_c^{F_L}\right)}\left[\frac{\left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\}}{(r-x)} - 1\right]$. $x > x^{F_M}$ implies $\mu^{F_L} > 0$, and this means $\frac{m_e^{F_L}}{\left(1-m_c^{F_L}\right)(r-x)}\left[\frac{r(1-\lambda)}{2}\right] + \frac{m_c^{F_L}}{\left(1-m_c^{F_L}\right)}\left[\frac{\left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\}}{(r-x)} - 1\right] > 0$. From the expression of μ^{F_L} we observe that is a function of $m_c^{F_L}, m_e^{F_L}, F_L, \lambda,$ and γ, that is,

$\mu^{F_L} = \mu(m_c^{F_L}, m_e^{F_L}, F_L, \lambda, \gamma)$.

Total differentiation of μ^{F_L} with respect to $z = F_L, \lambda, \gamma$ gives us the following.

$d\mu^{F_L} = \frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\frac{\delta m_c^{F_L}}{\delta z}dz + \frac{\delta\mu^{F_L}}{\delta m_e^{F_L}}\frac{\delta m_e^{F_L}}{\delta z}dz + \frac{\delta\mu^{F_L}}{\delta z}dz \Longrightarrow \frac{d\mu^{F_L}}{dz} = \frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\frac{\delta m_c^{F_L}}{\delta z} + \frac{\delta\mu^{F_L}}{\delta m_e^{F_L}}\frac{\delta m_e^{F_L}}{\delta z} + \frac{\delta\mu^{F_L}}{\delta z}$

Let us now determine $\frac{\delta\mu}{\delta m_c^{F_L}}$ and $\frac{\delta\mu}{\delta m_e^{F_L}}$

(i) $\frac{\delta\mu^{F_L}}{\delta m_c^{F_L}} = \frac{\left(1-m_c^{F_L}\right)\left\{\frac{r(1-\gamma)}{2}-\gamma F_L\right\}+\left[m_e^{F_L}\left\{\frac{r(1-\lambda)}{2}\right\}+m_c^{F_L}\left\{\frac{r(1-\gamma)}{2}-\gamma F_L\right\}\right]}{\left(1-m_c^{F_L}\right)^2(r-x)} - \frac{1}{\left(1-m_c^{F_L}\right)^2}$ which on simplification yields $\frac{\delta\mu^{F_L}}{\delta m_c^{F_L}} = \frac{m_e^{F_L}}{\left(1-m_c^{F_L}\right)^2(r-x)}\left[\frac{r(1-\lambda)}{2}\right] + \frac{1}{\left(1-m_c^{F_L}\right)^2}\left[\frac{\left\{\frac{r(1-\gamma)}{2}-\gamma F_L\right\}}{(r-x)} - 1\right]$. By assumption $x > x^{F_M} = r - \left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\}$ means $\left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} > (r-x)$ that is $\frac{\left\{\frac{r(1-\gamma)}{2}-\gamma F_M\right\}}{r-x} > 1$. Now $\left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} < \left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\}$ because $F_M > F_L$. Therefore, $\left[\frac{\left\{\frac{r(1-\gamma)}{2}-\gamma F_L\right\}+\left[m_e^{F_L}\left\{\frac{r(1-\lambda)}{2}\right\}+m_c^{F_L}\left\{\frac{r(1-\gamma)}{2}-\gamma F_L\right\}\right]}{(r-x)} - 1\right] > 0$

Also observe, $\frac{\delta\mu}{\delta m_c^{F_L}} > \mu^{F_L}$ because of the following reasons.

(a) $\frac{m_e^{F_L}}{\left(1-m_c^{F_L}\right)^2(r-x)}\left[\frac{r(1-\lambda)}{2}\right] > \frac{m_e^{F_L}}{\left(1-m_c^{F_L}\right)(r-x)}\left[\frac{r(1-\lambda)}{2}\right]$ because $\frac{m_e^{F_L}}{\left(1-m_c^{F_L}\right)^2(r-x)} > \frac{m_e^{F_L}}{\left(1-m_c^{F_L}\right)(r-x)}$ since $\left(1-m_c^{F_L}\right)^2 < \left(1-m_c^{F_L}\right)$ because $m_c^{F_L} \in [0,1]$.

(b) $\frac{1}{\left(1-m_c^{F_L}\right)^2}\left[\frac{\left\{\frac{r(1-\gamma)}{2}-\gamma F_L\right\}+}{(r-x)} - 1\right] > \frac{m_c^{F_L}}{\left(1-m_c^{F_L}\right)}\left[\frac{\left\{\frac{r(1-\gamma)}{2}-\gamma F_L\right\}}{(r-x)} - 1\right]$ for the same reason as in (a).

These implies that since $\mu^{F_L} > 0$, therefore, $\frac{\delta\mu}{\delta m_c^{F_L}} > 0$.

(ii) $\frac{\delta\mu^{F_L}}{\delta m_e^{F_L}} = \frac{\frac{r(1-\lambda)}{2}}{\left(1-m_c^{F_L}\right)(r-x)} > 0$

(1) Consider a change in F_L. Then $\frac{d\mu^{F_L}}{dF_L} = \frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\frac{\delta m_c^{F_L}}{\delta F_L} + \frac{\delta\mu^{F_L}}{\delta m_e^{F_L}}\frac{\delta m_e^{F_L}}{\delta F_L} + \frac{\delta\mu^{F_L}}{\delta F_L}$.

From Proposition 1 we know that $\frac{\delta m_c^{F_L}}{\delta F_L} < 0$. Since $\frac{\delta\mu^{F_L}}{\delta m_c^{F_L}} > 0$, therefore, $\frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\frac{\delta m_c^{F_L}}{\delta F_L} < 0$. From Proposition 1 we know that $\frac{\delta m_e^{F_L}}{\delta F_L} < 0$. Since $\frac{\delta\mu^{F_L}}{\delta m_e^{F_L}} > 0$, therefore, $\frac{\delta\mu^{F_L}}{\delta m_e^{F_L}}\frac{\delta m_e^{F_L}}{\delta F_L} < 0$. $\frac{\delta\mu^{F_L}}{\delta F_L} = \frac{-\gamma m_c^{F_L}}{\left(1-m_c^{F_L}\right)(r-x)} < 0$.

Using all these we get, $\frac{d\mu^{F_L}}{dF_L} < 0$.

(2) Consider a change in γ. Then $\frac{d\mu^{F_L}}{d\gamma} = \frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\frac{\delta m_c^{F_L}}{\delta\gamma} + \frac{\delta\mu^{F_L}}{\delta m_e^{F_L}}\frac{\delta m_e^{F_L}}{\delta\gamma} + \frac{\delta\mu^{F_L}}{\delta\gamma}$.

From Proposition 1 we know that $\frac{\delta m_c^{F_L}}{\delta\gamma} < 0$. Since $\frac{\delta\mu^{F_L}}{\delta m_c^{F_L}} > 0$, therefore, $\frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\frac{\delta m_c^{F_L}}{\delta\gamma} < 0$. From Proposition 1 we know that $\frac{\delta m_e^{F_L}}{\delta\gamma} < 0$. Since $\frac{\delta\mu^{F_L}}{\delta m_e^{F_L}} > 0$, therefore, $\frac{\delta\mu^{F_L}}{\delta m_e^{F_L}}\frac{\delta m_e^{F_L}}{\delta\gamma} < 0$. $\frac{\delta\mu^{F_L}}{\delta\gamma} = \frac{-m_c^{F_L}\left\{\frac{r}{2}+F_L\right\}}{\left(1-m_c^{F_L}\right)(r-x)} < 0$.

Using all these we get $\frac{d\mu^{F_L}}{d\gamma} < 0$.

(3) Consider a change in λ. Then $\frac{d\mu^{F_L}}{d\lambda} = \frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\frac{\delta m_c^{F_L}}{\delta\lambda} + \frac{\delta\mu^{F_L}}{\delta m_e^{F_L}}\frac{\delta m_e^{F_L}}{\delta\lambda} + \frac{\delta\mu^{F_L}}{\delta\lambda}$.

From Proposition 1 we know that $\frac{\delta m_c^{F_L}}{\delta\lambda} = 0$. Hence, $\frac{\delta\mu^{F_L}}{\delta m_c^{F_L}}\frac{\delta m_c^{F_L}}{\delta\lambda} = 0$. From Proposition 1 we know that $\frac{\delta m_e^{F_L}}{\delta\lambda} < 0$ and since $\frac{\delta\mu^{F_L}}{\delta m_c^{F_L}} > 0$, therefore, $\frac{\delta\mu^{F_L}}{\delta m_e^{F_L}}\frac{\delta m_e^{F_L}}{\delta\lambda} < 0$. $\frac{\delta\mu^{F_L}}{\delta\lambda} = \frac{-m_e^{F_L}\frac{r}{2}}{\left(1-m_c^{F_L}\right)(r-x)} < 0$. Using all these we get, $\frac{d\mu^{F_L}}{d\lambda} < 0$.

II. Suppose $x > x^{F_M}$ and the penalty is in the medium range $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$.

In this case the investment decision is guided by $\mu \geq \mu^{F_M}$.

Now, $\mu^{F_M} = \frac{1}{\left(1-m_c^{F_M}\right)(r-x)} m_c^{F_M} \left[\frac{r(1-\gamma)}{2} - \gamma F_M\right] - \frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)} = \frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)} \left[\frac{1}{r-x}\left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} - 1\right]$ So $\mu^{F_M} = \mu(m_c^{F_M}, F_M, \gamma)$.

Total differentiation of μ^{F_M} with respect to $z = F_M, \gamma$ gives us the following.

$$d\mu^{F_M} = \frac{\delta\mu^{F_M}}{\delta m_c^{F_M}} \frac{\delta m_c^{F_M}}{\delta z} dz + \frac{\delta\mu^{F_M}}{\delta z} dz \Rightarrow \frac{d\mu^{F_M}}{dz} = \frac{\delta\mu^{F_M}}{\delta m_c^{F_M}} \frac{\delta m_c^{F_M}}{\delta z} + \frac{\delta\mu^{F_M}}{\delta z}.$$

$\frac{\delta\mu^{F_M}}{\delta m_c^{F_M}} = \frac{1}{\left(1-m_c^{F_M}\right)^2} \left[\frac{1}{r-x}\left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} - 1\right] > 0$ because by assumption

$x > x^{F_M} = r - \left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\}$ means $\left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} > (r-x)$.

(i) Consider a change in F_M. Then $\frac{d\mu^{F_M}}{dF_M} = \frac{\delta\mu^{F_M}}{\delta m_c^{F_M}} \frac{\delta m_c^{F_M}}{\delta F_M} + \frac{\delta\mu^{F_M}}{\delta F_M}$. From Proposition 1 we know that $\frac{\delta m_c^{F_M}}{\delta F_M} < 0$. Since $\frac{\delta\mu^{F_M}}{\delta m_c^{F_M}} > 0$, therefore, $\frac{\delta\mu^{F_M}}{\delta m_c^{F_M}} \frac{\delta m_c^{F_M}}{\delta F_M} < 0$. Now $\frac{\delta\mu^{F_M}}{\delta F_M} = \frac{-\gamma m_c^{F_M}}{\left(1-m_c^{F_M}\right)} < 0$. So, $\frac{d\mu^{F_M}}{dF_M} < 0$.

(ii) Consider a change in γ. Then $\frac{d\mu^{F_M}}{d\gamma} = \frac{\delta\mu^{F_M}}{\delta m_c^{F_M}} \frac{\delta m_c^{F_M}}{\delta\gamma} + \frac{\delta\mu^{F_M}}{\delta\gamma}$. From Proposition 1 we know that $\frac{\delta m_c^{F_M}}{\delta\gamma} < 0$. Since $\frac{\delta\mu^{F_M}}{\delta m_c^{F_M}} > 0$, therefore, $\frac{\delta\mu^{F_M}}{\delta m_c^{F_M}} \frac{\delta m_c^{F_M}}{\delta\gamma} < 0$. Now. $\frac{\delta\mu^{F_M}}{\delta\gamma} = -\frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)} \left[\frac{1}{r-x}\left\{\frac{r}{2} + F_M\right\}\right] < 0$. Using these we get $\frac{d\mu^{F_M}}{d\gamma} < 0$. □

Proof of Proposition 5.

(i) We know from proofs of Proposition 1(ii) and (iib) that, $\frac{\delta m_c^F}{\delta F} = -\frac{\gamma}{\phi'(m_c^F)} < 0$ and $\frac{\delta m_c^F}{\delta\gamma} = -\frac{1}{\gamma\phi'(m_c^F)}\left[\frac{r(1-\gamma)}{2} - \phi(m_c^F) + \frac{r}{2\gamma}\right] < 0$. So $\left|\frac{\delta m_c^F}{\delta\gamma}\right| - \left|\frac{\delta m_c^F}{\delta F}\right| = \frac{\gamma}{\phi'(m_c^F)}\left[\frac{1}{\gamma^2}\left\{\frac{r(1-\gamma)}{2} - \phi(m_c^F) + \frac{r}{2\gamma}\right\} - 1\right]$. From the proof of Proposition 1(ii) we know $\phi(m_c^F) = \left[\frac{r(1-\gamma)}{2} - \gamma F\right] > 0$. Therefore, $\left|\frac{\delta m_c^F}{\delta\gamma}\right| - \left|\frac{\delta m_c^F}{\delta F}\right| = \frac{\gamma}{\phi'(m_c^F)}\left[\frac{1}{\gamma^2}\left\{\gamma F + \frac{r}{2\gamma}\right\} - 1\right]$. We know from Lemma 3, if $x > x_M$, then $\mu_M > 0$. So $\mu^{F_M} = \frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)}\left[\frac{1}{(r-x)}\left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} - 1\right] > 0 \Rightarrow$ $\left[\frac{1}{(r-x)}\left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} - 1\right] > 0$. Since $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$ so, $\left[\frac{1}{(r-x)}\left\{\frac{r(1-\gamma)}{2} - \gamma F\right\} - 1\right] > 0$ for any F$\in \left[0, \frac{(1-\gamma)r}{2\gamma}\right]$. Now $\left\{\gamma F + \frac{r}{2\gamma}\right\} - \left\{\frac{r(1-\gamma)}{2} - \gamma F\right\} = \frac{r\left(1-\gamma(1-\gamma)\right)}{2\gamma} > 0$. By Assumption 1 $(r-x) > 1$ which means $\frac{1}{(r-x)} < 1 < \frac{1}{\gamma^2}$. Since $\left[\frac{1}{(r-x)}\left\{\frac{r(1-\gamma)}{2} - \gamma F\right\} - 1\right] > 0$, therefore, $\left[\frac{1}{\gamma^2}\left\{\gamma F + \frac{r}{2\gamma}\right\} - 1\right] > 0$.

$\frac{r(1-\gamma)}{2} - \phi(m_c^F) > 0$ and since by Assumption 1 $r > 2$ which means $\frac{r}{2\gamma} > \gamma^2$. Hence, $\left|\frac{\delta m_c^F}{\delta \gamma}\right| - \left|\frac{\delta m_c^F}{\delta F}\right| > 0$ for any *F* in the low and medium cost ranges.

(ii) We need to prove $\left|\frac{d\mu^F}{d\gamma}\right| > \left|\frac{d\mu^F}{dF}\right|$, $F = F_L, F_M$. Using equation (19) the proof requires proving the positivity of the pairwise difference of the terms with the coefficients $\frac{\delta \mu^F}{\delta m_c^{F_i}}$ and $\frac{\delta \mu^F}{\delta m_e^i}$ where $F = F_L, F_M$. So we need to prove the following conditions.

(1) The conditions when penalty is in the low range are as follows.

(a) $\frac{\delta \mu^{F_L}}{\delta m_c^{F_L}}\left[\left|\frac{\delta m_c^{F_L}}{\delta \gamma}\right| - \left|\frac{\delta m_c^{F_L}}{\delta F}\right|\right] > 0 \Rightarrow \left[\left|\frac{\delta m_c^{F_L}}{\delta \gamma}\right| - \left|\frac{\delta m_c^{F_L}}{\delta F}\right|\right] > 0$, since $\frac{\delta \mu^{F_L}}{\delta m_c^{F_L}} > 0$;

(b) $\frac{\delta \mu^{F_L}}{\delta m_e^{F_L}}\left[\left|\frac{\delta m_e^{F_L}}{\delta \gamma}\right| - \left|\frac{\delta m_e^{F_L}}{\delta F}\right|\right] > 0 \Rightarrow \left[\left|\frac{\delta m_e^{F_L}}{\delta \gamma}\right| - \left|\frac{\delta m_e^{F_L}}{\delta F}\right|\right] > 0$, since $\frac{\delta \mu^{F_L}}{\delta m_e^{F_L}} > 0$;

(c) $\left[\left|\frac{\delta \mu^{F_L}}{\delta \gamma}\right| - \left|\frac{\delta \mu^{F_L}}{\delta F}\right|\right] > 0$.

(2) The conditions when penalty is in the medium range are as follows.

(a) $\frac{\delta \mu^{F_M}}{\delta m_c^{F_M}}\left[\left|\frac{\delta m_c^{F_M}}{\delta \gamma}\right| - \left|\frac{\delta m_c^{F_M}}{\delta F}\right|\right] > 0 \Rightarrow \left[\left|\frac{\delta m_c^{F_M}}{\delta \gamma}\right| - \left|\frac{\delta m_c^{F_M}}{\delta F}\right|\right] > 0$, since $\frac{\delta \mu^{F_M}}{\delta m_c^{F_M}} > 0$.

(b) $\left[\left|\frac{\delta \mu^{F_M}}{\delta \gamma}\right| - \left|\frac{\delta \mu^{F_M}}{\delta F}\right|\right] > 0$.

In part (i) we have proved 1(a) and 2(a). Let us prove the other parts.

(1b) For any F_L, $\left|\frac{\delta m_e^{F_L}}{\delta\gamma}\right| - \left|\frac{\delta m_e^{F_L}}{\delta F}\right| > 0$, if $\frac{1}{C\left(m_c^{F_L}\right)}\left[-\lambda - (1-\lambda)\left\{m_e^{F_L} C'\left(m_c^{F_L}\right)\frac{\gamma}{\phi'\left(m_c^{F_L}\right)}\right\}\right] > 0$. Rearranging terms and using $\phi'\left(m_c^{F_L}\right) = C\left(m_c^{F_L}\right) + m_c^{F_L} C'\left(m_c^{F_L}\right)$ gives the expression $\gamma\left[1 - \frac{m_e^{F_L} C'\left(m_c^{F_L}\right)}{C\left(m_c^{F_L}\right) + m_c^{F_L} C'\left(m_c^{F_L}\right)}\right] > \frac{\lambda}{(1-\lambda)}$.

(1c) $\frac{\delta\mu^{F_L}}{\delta\gamma} = \frac{-m_c^{F_L}\left\{\frac{r}{2}+F_L\right\}}{\left(1-m_c^{F_L}\right)(r-x)} < 0$ and $\frac{\delta\mu^{F_L}}{\delta F_L} = \frac{-\gamma m_c^{F_L}}{\left(1-m_c^{F_L}\right)(r-x)} < 0$. So $\left[\left|\frac{\delta\mu^{F_L}}{\delta\gamma}\right| - \left|\frac{\delta\mu^{F_L}}{\delta F}\right|\right] = \frac{m_c^{F_L}\left\{\frac{r}{2}+F_L-\gamma\right\}}{\left(1-m_c^{F_L}\right)(r-x)}$. From the proof of part (i) we have shown that since $x > x_M$, then $\mu_M > 0$. So $\mu^{F_M} = \frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)}\left[\frac{1}{(r-x)}\left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} - 1\right] > 0 \Rightarrow \left[\frac{1}{(r-x)}\left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} - 1\right] > 0$. Since $F_M \in \left(\frac{(1-\lambda)r}{2\lambda}, \frac{(1-\gamma)r}{2\gamma}\right]$ so, $\left[\frac{1}{(r-x)}\left\{\frac{r(1-\gamma)}{2} - \gamma F\right\} - 1\right] > 0$ for any $F \in \left[0, \frac{(1-\gamma)r}{2\gamma}\right]$. Therefore, for the low cost range this inequality can be written as $\left[\frac{1}{(r-x)}\left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\} - 1\right] > 0$. Rewriting the term $\frac{m_c^{F_L}\left\{\frac{r}{2}+F_L-\gamma\right\}}{\left(1-m_c^{F_L}\right)(r-x)}$ gives $\frac{\gamma m_c^{F_L}}{\left(1-m_c^{F_L}\right)(r-x)}\left[\frac{1}{\gamma}\left\{\frac{r}{2} + F_L\right\} - 1\right]$. By Assumption 1 $(r-x) > 1$. Therefore, $\frac{1}{\gamma} > \frac{1}{(r-x)}$ and $\left\{\frac{r}{2} + F_L\right\} > \left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\}$. Hence, $\left[\frac{1}{\gamma}\left\{\frac{r}{2} + F_L\right\} - 1\right] > \left[\frac{1}{(r-x)}\left\{\frac{r(1-\gamma)}{2} - \gamma F_L\right\} - 1\right] > 0$.

(2b) Similarly, in the medium cost range we have $\frac{\delta\mu^{F_M}}{\delta\gamma} = -\frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)}\left[\frac{1}{r-x}\left\{\frac{r}{2} + F_M\right\}\right] < 0$ and $\frac{\delta\mu^{F_M}}{\delta F_M} = \frac{-\gamma m_c^{F_M}}{\left(1-m_c^{F_M}\right)} < 0$. From these we get the following $\left|\frac{\delta\mu^{F_M}}{\delta\gamma}\right| - \left|\frac{\delta\mu^{F_M}}{\delta F_M}\right| = \frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)}\left[\frac{1}{r-x}\left\{\frac{r}{2} + F_M\right\} - \gamma\right]$. We know from Lemma 2 that since $x > x_M$ therefore,

$\mu_M > 0$ where $\mu^{F_M} = \frac{m_c^{F_M}}{\left(1-m_c^{F_M}\right)}\left[\frac{1}{(r-x)}\left\{\frac{r(1-\gamma)}{2} - \gamma F_M\right\} - 1\right] > 0$.

Therefore, $\left|\frac{\delta\mu^{F_M}}{\delta\gamma}\right| - \left|\frac{\delta\mu^{F_M}}{\delta F_M}\right| > 0$. □

Table A1: Country Ranks

Countries	Violations per diplomat 1997-2002 Average	Violations Rank	Media Freedom Scores 1997-2002 Average	Media Freedom Rank
Albania	85.5	8	54.4	78
Algeria	25.6	32	79.8	136
Angola	82.7	9	77.4	135
Argentina	4	91	37.6	54
Armenia	10.2	60	57.6	84
Australia	0	124	10	7
Austria	2.2	105	14.8	13
Azerbaijan	0	124	74	127
Bahrain	38.2	21	72	120
Bangladesh	33.4	29	59.8	91
Belarus	2.7	101	82.4	140
Belgium	2.7	101	9.2	5
Benin	50.4	17	30	42
Bhutan	18.6	40	73.8	124
Bolivia	3.1	98	21	24
Bosnia and Herzegovina	34.9	26	58.6	87
Botswana	18.7	39	29	40

Brazil	**30.3**	**30**	**32.6**	**51**
Bulgaria	**119**	**6**	**32**	**50**
Burkina Faso	**0**	**124**	**39.2**	**57**
Burundi	**38.2**	**21**	**81.6**	**139**
Cambodia	**10**	**63**	**63.4**	**101**
Cameroon	**44.1**	**19**	**74**	**127**
Canada	**0**	**124**	**14.4**	**11**
Central African Republic	**0**	**124**	**62**	**95**
Chad	**125.9**	**4**	**72.6**	**123**
Chile	**16.7**	**42**	**26**	**33**
China	**9.6**	**67**	**80.4**	**137**
Colombia	**0**	**124**	**58.8**	**88**
Comoros	**10.1**	**62**	**39**	**56**
Congo (Brazzaville)	**7.8**	**74**	**69.6**	**114**
Costa Rica	**10.2**	**60**	**16.2**	**14**
Croatia	**6.6**	**76**	**54.4**	**78**
Cyprus	**2.5**	**103**	**17.2**	**16**
Czech Republic	**19.1**	**37**	**21.6**	**26**
Denmark	**0**	**124**	**9**	**4**
Djibouti	**6.5**	**77**	**63.4**	**101**
Dominican Republic	**0.1**	**119**	**30**	**42**

Ecuador	**0**	**124**	**40.8**	**60**
Egypt	**141.4**	**3**	**70.6**	**118**
El Salvador	**1.7**	**109**	**43.6**	**62**
Eritrea	**0.8**	**116**	**70.4**	**116**
Estonia	**10.7**	**58**	**19.6**	**23**
Ethiopia	**60.4**	**14**	**62.6**	**98**
Fiji	**15.7**	**46**	**50.8**	**71**
Finland	**0.1**	**119**	**13.8**	**10**
France	**6.2**	**78**	**23**	**29**
Gabon	**2.2**	**105**	**52.8**	**73**
Georgia	**9.8**	**66**	**53.2**	**75**
Germany	**1**	**115**	**13**	**9**
Ghana	**11.4**	**55**	**52.8**	**73**
Greece	**0**	**124**	**30**	**42**
Guatemala	**0.1**	**119**	**54.2**	**76**
Guinea	**35.2**	**25**	**71.2**	**119**
Guinea-Bissau	**10.9**	**57**	**56.4**	**83**
Guyana	**2.3**	**104**	**22.2**	**28**
Haiti	**3**	**100**	**61.2**	**94**
Honduras	**5.5**	**83**	**46.2**	**64**
Hungary	**3.3**	**96**	**27.4**	**35**
India	**6.2**	**78**	**40**	**58**
Indonesia	**36.5**	**24**	**55.8**	**81**
Iran	**15.9**	**45**	**73.8**	**124**

Ireland	0	124	19.2	20
Israel	0	124	29.2	41
Italy	14.8	47	27.2	34
Jamaica	0	124	12.2	8
Japan	0	124	19.4	22
Jordan	21.4	34	60.4	92
Kazakhstan	7.8	74	68.2	112
Kenya	249.4	1	68	110
Kuwait	249.4	1	46.8	65
Kyrgyzstan	5.2	85	63.6	103
Laos	6.2	78	69.8	115
Latvia	0	124	21.8	27
Lebanon	1.4	112	64	104
Lesotho	19.1	37	54.2	76
Liberia	13.7	48	70.4	116
Libya	8.3	73	90	145
Lithuania	2.1	107	18.8	19
Macedonia	3.3	96	43.6	62
Madagascar	8.8	71	31.8	49
Malawi	13.2	49	48	66
Malaysia	1.4	112	67.6	107
Mali	37.9	23	25.6	32
Mauritania	11.3	56	67.4	106
Mauritius	20.7	35	18.2	17

Mexico	**4**	**91**	**48.8**	**68**
Moldova	**0.7**	**117**	**58**	**85**
Mongolia	**10.3**	**59**	**30.4**	**48**
Morocco	**60.8**	**13**	**52.4**	**72**
Mozambique	**112.1**	**7**	**48**	**66**
Namibia	**4.3**	**90**	**34**	**52**
Nepal	**16.7**	**42**	**58.8**	**88**
Netherlands	**0**	**124**	**14.4**	**11**
New Zealand	**0.1**	**119**	**7.6**	**2**
Nicaragua	**4.9**	**86**	**38.4**	**55**
Niger	**20.2**	**36**	**60.8**	**93**
Nigeria	**59.4**	**15**	**62.6**	**98**
Norway	**0**	**124**	**5.8**	**1**
Oman	**0**	**124**	**72**	**120**
Pakistan	**70.3**	**11**	**59.2**	**90**
Panama	**0**	**124**	**30**	**42**
Papua New Guinea	**5.6**	**82**	**27.8**	**36**
Paraguay	**13.2**	**49**	**50.4**	**70**
Peru	**3.1**	**98**	**54.6**	**80**
Philippines	**11.7**	**54**	**30**	**42**
Poland	**1.7**	**109**	**21.2**	**25**
Portugal	**8.9**	**69**	**16.6**	**15**
Romania	**3.6**	**93**	**41.2**	**61**
Russia	**2.1**	**107**	**58.4**	**86**

Rwanda	13.1	51	74.8	130
Saudi Arabia	34.2	28	85.4	141
Senegal	80.2	10	34.4	53
Serbia and Montenegro	38.5	20	67.6	107
Sierra Leone	25.9	31	76.4	134
Singapore	3.6	93	66.8	105
Slovenia	5.3	84	24.4	30
South Africa	34.5	27	25.4	31
South Korea	0.4	118	28	37
Spain	12.9	53	18.6	18
Sri Lanka	17.4	41	63	100
Sudan	120.6	5	85.4	141
Swaziland	4.4	88	76.2	133
Sweden	0	124	9.8	6
Switzerland	0.1	119	8	3
Syria	53.3	16	74	127
Tajikistan	4.4	88	88.2	144
Tanzania	8.4	72	49.2	69
Thailand	24.8	33	30	42
Gambia	1.5	111	68	110
Togo	10	63	72	120
Trinidad and Tobago	1.4	112	28.4	38

Tunisia	**16.7**	**42**	**73.8**	**124**
Turkey	**0**	**124**	**62.4**	**97**
Turkmenistan	**5.9**	**81**	**87**	**143**
Uganda	**3.5**	**95**	**40.4**	**59**
Ukraine	**13.1**	**51**	**55.8**	**81**
United Arab Emirates	**0**	**124**	**75.6**	**131**
United Kingdom	**0**	**124**	**19.2**	**20**
Uruguay	**4.5**	**87**	**28.8**	**39**
Uzbekistan	**8.9**	**69**	**81.2**	**138**
Vietnam	**10**	**63**	**75.8**	**132**
Yemen	**9.2**	**68**	**67.6**	**107**
Zambia	**61.2**	**12**	**62.2**	**96**
Zimbabwe	**46.2**	**18**	**68.8**	**113**

Note: 'Violations per diplomat 1997 to 2002' is annual number of violations per diplomat in New York city during November 1997 to October 2002 by country from the May 1998 U.N. Bluebook used by Fisman and Miguel (2006). 'Media freedom 1997-2002 average' is 6 years average score taken from the Freedom of the Press Index by Freedom House. See https://freedomhouse.org/freedom-press-research-methodology for detail methodology behind the index. Accessed 22 June 2020. Based on the scores the freedom of press is characterised as: 0–30 = Free (F); 31–60 = Partly Free (PF); 61–100 = Not Free (NF). 'Circulation of Newspaper per 1000 population 1997-2002 Average' is the 6 years average of circulation data, provided by UNESCO Institute for Statistics. See http://data.un.org/Data.aspx?d=UNESCO&f=series%3AC_N_CDN for details. Accessed 22 June 2020.

CHAPTER 5

SUMMARY AND CONCLUSIONS

This chapter presents summary of the results and concludes the thesis.

In chapter 2 we construct a theoretical framework where both welfare-impact and corruption-impact of introduction of competition in a monopoly bureaucracy can be derived. Two different measures of corruption i.e., Incidence of Corruption and Corruption Rents have been applied to measure two different types of corruption: extortion and collusion. It transforms the framework developed by Drugov (2010) in such a way that the alternative measures of corruption defined formally by Mendez and Sepulveda (2010), Foster, Horowitz and Mendez (2013) viz. Incidence of Corruption (CI) and Corruption Rents (CR) can be directly derived in it and compared with the welfare measure. The existing literature that focuses on a change in bureaucratic regime in controlling corruption have largely looked at the intensive margin argument i.e., the size of bribe.

This chapter finds that as we look at both the intensive and extensive margin of corruption i.e., bribe size and frequency of corruption respectively, the impact of introducing a competitive bureaucracy can be different for extortion and collusion. The chapter finds that according to CI measure, extortion rises but collusion falls. But when CR measure is applied, though nothing definite can be concluded about extortion, collusion falls. When extortion and collusion taken care of together, CI measure remains unchanged, but CR measure falls. The chapter also highlights a trade-off of corruption-measures in terms of welfare. The introduction of competition in a monopoly bureaucracy creates two different types of welfare costs: (i) more unqualified firms procure licenses through collusion and therefore, generates negative externality to the society; (ii) more firms enter after incurring the costly qualifying investment. As more firms qualify under competition, it reduces the negative externality but at the same time generates a cost to society in terms of qualifying investment. The chapter also shows that under a competitive bureaucracy the under reasonable assumptions, going by certain measures of corruption, the welfare and corruption measures may not move in the same direction. Especially, in a bureaucracy where almost all the officials are expected to be corrupt, we show while introduction of competition can raise the welfare level of the economy under certain conditions, frequency of overall corruption remains unchanged while total corruption rent declines.

In chapter 3, we use a monetary penalty as the only corruption mitigation technique to analyze its impact on distribution of extortion and collusion among firms of different revenue potential. The social welfare maximizing penalties are also derived different ranges of negative externalities generated by collusion incidence. We consider a framework where a set of firms decides whether to apply for a compliance certificate by incurring a costly emission reducing investment or not investing. If production continues without the investment, then it generates a negative externality in the form of pollution, which imposes a cost to the society. A reviewing officer may choose to behave honestly and grant the certificate only to an investing firm or behave corruptibly by seeking a bribe. In the latter case if the firm has not invested then the corruption takes the form of collusion. If the firm has invested and the officer issues the certificate only in lieu of a bribe, then corruption takes the form of extortion.

The findings suggest that if the extent of the negative externality is not high then the socially optimal penalty sustains the coexistence of both collusion and extortion. In our framework, the fixed cost of emission-reducing-investment and the cost of the negative externality from emission that varies proportionately with revenue of firms, together create an interesting trade-off. A higher penalty, that induces more firms to undertake the investment, raises the aggregate investment cost but it lowers the aggregate cost imposed by the negative externality. This trade-off determines the socially optimal penalty, which in turn determines the subgame perfect equilibrium corruption distribution. We show that when the extent of the negative externality is low then the socially optimal penalty is also "very low". In this case low revenue firms indulge in collusion, while high revenue firms face extortion. The optimal penalty increases as the extent of the negative externality increases in order to counter adverse effect of higher negative externality. As the negative externality transits from a low to a medium level, the optimal penalty jumps to a "medium level" and stays in that range for a certain extent. The higher penalty incentivizes some of the low revenue firms to switch their decision from no-investment to investment, which results in the following corruption distribution. The remaining low revenue firms continue not to invest and indulge in collusion and the high revenue firms continue to invest and face extortion. The low revenue firms that switched from no-investment to investment face no corruption.

The optimal penalty in the "medium" range increases in response to an increase in the extent of negative externality and this reduces the incidence of collusion. As the extent of negative externality becomes quite strong, the cost imposed by the negative externality becomes quite high and it becomes imperative for the government to reverse this by implementing a high penalty that eliminates collusion and hence, the negative externality. However, extortion may still exist, and its elimination is possible only when the penalty becomes prohibitively high.

In chapter 4 we have explored the interaction between enforcement and individual-specific sensitivity to moral standard in determining the scope of extortion and collusion in a bureaucracy consisting of corruptible officials. The officials with their sensitivity lower than morality thresholds, endogenously determined in the model, participate in corruption if and only if the punishment levels are also below certain thresholds, also endogenously determined in the model. The chapter shows that under reasonable assumptions, both the morality threshold and punishment threshold for extortion lie below the similar thresholds for collusion, which under high compliance cost restricts the scope of extortion at the equilibrium compared to the scope of collusion. At low compliance cost, however, extortion prevails. Penalty and conviction probability of collusion play important role in setting the societal moral standard by reducing the number of corrupt official and weakening the corruption network. At low and medium penalty ranges, while media-watch plays an important role in controlling both types of corruption, the efficiency of judiciary matters if only extortion prevails in the bureaucracy.

All three core chapters have their distinct policy implications. Chapter 2 addresses the impact of a change in bureaucratic/administrative regime on corruption. It points out that the introduction of bureaucratic competition can have different implications for collusion and extortion. The chapter finds that going by a certain measure of corruption, one can substitute the other and thus the net outcome of introducing competition in bureaucracy on corruption is not obvious. Among other exogeneous factors, it also depends on the way corruption is quantified. The chapter also shows that with introduction of competition in a monopoly bureaucracy the corruption measure and the welfare measure of an economy may move in different directions. Hence, at the policy level this chapter sounds a caution in terms of implementing a competitive bureaucracy as a corruption mitigation tool.

Chapter 3 considers penalty as the only corruption mitigating policy instrument. It is symmetrically imposed on firms and officers involved in case of collusion. Penalty is imposed only on the corruptible officer in the case of extortion. Using this framework, the socially optimal penalty is determined and the resultant subgame perfect equilibrium *corruption distribution*, that is, the pattern of corruption that exists for different revenue levels is obtained. The chapter suggests that while designing anti-corruption policies it is not always socially optimal to eliminate corruption, particularly for low negative externality. For low negative externality both extortion and collusion continue to persist at the socially optimal penalty. As the extent of negative externality increases, the marginal benefit of increased penalty far exceeds the marginal cost, and the welfare function becomes monotonically rising.

Chapter 4 suggests a penalty set at s high penalty range solves the problem of both extortion and collusion in a bureaucracy, in accordance with Becker (1968). However, in absence of capital punishment in most of the countries in the world, the chapter also suggests the alternatives available at the medium and low penalty ranges. First, a low compliance cost, which can even be supported by a subsidy, solves the problem of collusion in a bureaucracy. But it fails to solve the problem of extortion at a low penalty range. In such a situation, increasing efficiency of judiciary in convicting the extortion cases reduces the scope of extortion in bureaucracy.

Second, if the compliance cost cannot be lowered, at the medium and the low penalty range, the reapplication cost must be made sufficiently high such that the compliance takes place at the first instance. In such a situation, collusion gets eliminated at the medium penalty range and at the low penalty range extortion becomes the only form of corruption, which can be controlled by increasing efficiency of judiciary as mentioned above.

Third, if high reapplication cost cannot be charged, collusion is the outcome at the medium and low penalty ranges, which can be controlled through freeing up the media. More intense media-watch would reduce the scope of collusion. It seems that lowering of the qualification cost can potentially solve the problem of collusion in delivery of driving licenses in developing countries like India. In case of collusion in delivery of passports or pollution licenses, more intense media-watch seems to be the way-out.

Going forward we would like to extend on our work presented in the chapters. In chapter 2 we can check the equilibrium if the introduction of bureaucratic competition can change the proportion of honest officials in the bureaucracy itself. We would also like to check the results by giving freedom to the agents, of excluding the official she first met at the time of reapplication. In chapter 3 we would like to allow a leniency in punishment for whistleblowing for parties engaged in collusion, to study how optimal penalties and corruption distribution might be affected. In chapter 4, we would like to explore the results by allowing the firm-type to be private information even during interaction with the bureaucrat. One of the testable hypotheses derived in this chapter is that the countries with higher media freedom must have lower violations of law. Although we provide an anecdotal evidence to verify this claim, we would like to undertake a detailed empirical work controlling other relevant factors for substantiating this claim.

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