Alma Mater Studiorum - Università di Bologna

DOTTORATO DI RICERCA IN
ECONOMIA

Ciclo XXX

Settore Concorsulae: 13/A1

Settore Scientifico Disciplinare: SECS-P/01

Essays on Institutional Economics: On Crime and Enforcement

Presentata da: Norhan Ossama Shaaban Hafez

Coordinatore Dottorato
Prof. Marco Casari

Supervisore
Prof. Giacomo Calzolari

Esame finale anno 2018

Abstract

This thesis consists of three chapters on crime and enforcement. It emphasizes the impact of enforcement tools on two types of crime: Organized and corporate crimes.

In the first chapter "Crime, Corruption and Optimal Leniency", we emphasize the role of leniency programs as a legal tool to fight illegal activities involving the bribery of a public official. The impact of different institutional designs of leniency programs on the level of illegal activity and on the level of corruption is assessed. We show that a leniency program, that is not well designed, may have the perverse effect of increasing the level of illegal activity, and under certain institutional designs, it would imply higher levels of corruption. Furthermore, a benevolent legislator, who aims to reduce the levels of crime and the related corruption, would set the leniency rate to its minimum levels and would allow only the criminal to apply for leniency when leniency is offered after the detection of the illegal activity.

In the second chapter "On Corporate Crime, Compliance Programs and Corporate Reputation", we study the impact of the loss of corporate reputation that follows the detection of a corporate crime on the design of compliance program and the managerial incentives within the firm. We show that if the return from the crime and the reputational loss are high, the firm relies on a "window-dressing" compliance program, thus leading to inefficient investment in compliance associated with high levels of corporate misconduct. When the reputational loss is moderate, the compliance program exhibits a deterrent effect on corporate crime. If the crime leads to low (high) returns and large (low) reputational loss, the firm will not implement a compliance program, making the managerial incentives the sole tool affecting corporate crime.

In the third chapter "Corporate Crime: Incentives and Deterrents", we present a review of the economic, law and economics and managerial literature that studied the question of corporate crime. In particular, we shed light on the incentives and the deterrents that affect the firm's decision to undertake a corporate crime. We analyze, first, the determinants that stem from the agency relationship between the firm and the manager, namely the managerial incentives, organizational structure and the role of senior managers. Second, we consider the determinants that are exogenous to the firm but affect its incentives to commit the corporate crime. We focus notably on legal deterrents, corporate reputation and corporate social responsibility.

Acknowledgments

I would like to express my deep appreciation to Prof. Giacomo Calzolari for his exemplary supervision and valuable advice throughout my PhD program. I extremely appreciate all his contributions in time and ideas to make my PhD a productive experience.

I sincerely would like to thank the external evaluators, Prof. Sergio Currarini and Prof. Philip Curry, for their constructive comments and suggestions, which helped to improve the quality of the thesis. Also, I would like to thank Prof. Curry for hosting me during my visiting period at University of Waterloo.

I gratefully acknowledge the generous financial support of the Erasmus-Mundus Al-Idrisi II and the Marco Polo programs.

I am extremely grateful to the Faculty members at Department of Economics at UniBo for the beneficial discussions of research ideas during the seminars and lectures. I would like to particularly thank Prof. Matteo Cervellati for his remarkable support during the application process to the PhD program.

My sincere gratitude goes to my professors and colleagues at Cairo University who contributed to my academic career, not only as an undergraduate student, but also as a teaching assistant. In particular, I am grateful to Mona Amer, Prof. Chahir Zaki and Prof. Hala Abou Ali. A special thanks goes to Dr. Racha Ramadan for her friendship and her continuous support, she is my role model.

I am indebted to Prof. Yassine Lefouili who introduced me to the world of game theory and economic modelling. Without his encouragement and his support during and after my master program, I wouldn't have reached this step.

My experience in Bologna was enjoyable and enriching on the personal level thanks to my friends with whom I have shared unforgettable memories. I am grateful to Efşan, Nicola, Elena, Milenko, Peter, Maria Pia, Romina, Rosa, Manel, Eman, and May. I am grateful as well to the PhD administrative staff who always helped me to overcome a lot of administrative difficulties. Thanks to Silvia Fiorentini, Paola Mandelli, Lara Bianciardi, Lisa Verniti, and Antonio Trezza.

With the submission of my PhD thesis, I would like to thank my friends who were always encouraging and motivating me till I reached this stage. Thanks Maria, Sara, Riham, Nourhane, Nourane, Yasmin, Radwa, Hend, Aya, Rana, Fatma, Nahed, and Nihal.

Finally, I would like to thank my second family, Samia, Aboubakr, and Dina, who are always encouraging me to discover new worlds and to go beyond the limits I draw to myself.

To my parents, Suzanne and Ossama, to my siblings, Khaled and Nihal, who supported me unconditionally.
To my loving, encouraging and patient husband, Hassan.

Contents

List of Figures vi

1 Crime, Corruption and Optimal Leniency 1

1.1 Introduction . . . 1
1.2 The Model . . . 5
1.2.1 Set-up . . . 5
1.2.2 Timing . . . 6
1.2.3 Leniency program . . . 6
1.2.4 Benchmark: No Leniency . . . 8
1.3 Asymmetric Leniency for Corruption . . . 9
1.3.1 Equilibrium analysis . . . 9
1.3.2 Assessment of the institutional design . . . 10
1.4 Symmetric Leniency for Corruption . . . 12
1.4.1 Equilibrium analysis . . . 12
1.4.2 Assessment of the institutional design . . . 13
1.5 Optimal Leniency Program . . . 15
1.6 Conclusion . . . 16
Appendix 1.A On Assumption 1.1 . . . 17
Appendix 1.B Proofs . . . 17
1.B.1 Proof of Proposition 1.1 . . . 17
1.B.2 Proof of Proposition 1.2 . . . 18
1.B.3 Proof of Proposition 1.3 . . . 20

2 On Corporate Crime, Compliance Programs and Corporate Reputation 22

2.1 Introduction . . . 22
2.2 The Model . . . 27
2.2.1 Set-up . . . 27
2.2.2 Payoffs . . . 29
2.2.3 Timing . . . 29
2.3 Observable Ability of Using Unlawful Technology and Costless Monitoring: The Benchmark . . . 30
2.4 Non-observable Ability of Using Unlawful Technology and Costly Monitoring . . . 31
2.5 Reputational Loss, Compliance Program and Corporate Crime . . . 35
2.5.1 Tasks with low profitability . . . 36

2.5.2 Tasks with high profitability 37
2.6 Policy Implications and Discussion 39
2.6.1 Optimal fine 39
2.6.2 Liability regimes 40
2.6.3 Compliance program-based leniency 42
2.7 Conclusion 43
Appendix 2.A Proof of Proposition 2.1 45
Appendix 2.B Proof of Proposition 2.2 46
2.B.1 On constraint: $0 \leq \gamma \leq 1$ 49
Appendix 2.C Proof of Propositions 2.3 and 2.4 50
2.C.1 Proposition 2.3, 2^{nd} and 3^{rd} points of Proposition 2.4 50
2.C.2 Note on 1^{st} point of Proposition 2.4 54
Appendix 2.D Numerical Example and Graphical Representations 54
2.D.1 Functional forms and numerical vales 54
2.D.2 Graphical representations 54

3 Corporate Crime: Incentives and Deterrents **64**
3.1 Introduction 64
3.2 Opening the Black Box: Incentives and Deterrents within the Firm . 65
3.2.1 Managerial Incentives 65
3.2.2 Other Forms of Corporate Governance 69
3.3 Outside the Black Box: Incentives and Deterrents Outside the Firm . 71
3.3.1 Legal Deterrents 71
3.3.2 Non-legal Deterrents 74
3.4 Conclusion 75

Bibliography **77**

List of Figures

1.1 The game tree of the benchmark model 7

2.1 Optimal crime level $(1 - G(\widehat{\theta}^*))$, crime level at $\widehat{\theta}_I^*$ and $\widehat{\theta}_H$, $\Pi = 20000$ 55
2.2 Optimal probability of detection (γ^*), and probability of detection at $\widehat{\theta}_I^*$ (γ_I^*), $\Pi = 20000$ 55
2.3 Optimal crime level $(1 - G(\widehat{\theta}^*))$, crime level at $\widehat{\theta}_I^*$ and $\widehat{\theta}_H$, $\Pi = 50000$ 56
2.4 Optimal probability of detection (γ^*), and probability of detection at $\widehat{\theta}_I^*$ (γ_I^*), $\Pi = 50000$ 56
2.5 Optimal crime level $(1 - G(\widehat{\theta}^*))$, crime level at $\widehat{\theta}_I^*$ and $\widehat{\theta}_H$, $\Pi = 75000$ 57
2.6 Optimal probability of detection (γ^*), and probability of detection at $\widehat{\theta}_I^*$ (γ_I^*), $\Pi = 75000$ 57
2.7 Optimal crime level $(1 - G(\widehat{\theta}^*))$, crime level at $\widehat{\theta}_I^*$ and $\widehat{\theta}_H$, $\Pi = 100000$ 58
2.8 Optimal probability of detection (γ^*), and probability of detection at $\widehat{\theta}_I^*$ (γ_I^*), $\Pi = 100000$ 58
2.9 R_{min} and R_1 at $\Pi = 20000, 50000, 75000, 100000$ 59
2.10 R and R_2 at $\Pi = 20000, 50000$ 59
2.11 R_{max} and R_2 at $\Pi = 75000, 100000$ 60
2.12 R and R_{H2} at $\Pi = 20000, 50000, 75000, 100000$ 60
2.13 R and R_L at $\Pi = 20000, 50000, 75000, 100000$ 61
2.14 Optimal crime level $(1 - G(\widehat{\theta}^*))$ under a strict liability regime $(S = 0)$ and under a compound liability regime $(S = 1/2F, F)$, $\Pi = 50000$ . . 61
2.15 Optimal probability of detection (γ^*) under a strict liability regime $(S = 0)$ and under a compound liability regime $(S = 1/2F, F)$, $\Pi = 50000$ 62
2.16 Optimal crime level $(1 - G(\widehat{\theta}^*))$ under a strict liability regime $(S = 0)$ and under a compound liability regime $(S = 1/2F, F)$, $\Pi = 100000$ . . 62
2.17 Optimal probability of detection (γ^*) under a strict liability regime $(S = 0)$ and under a compound liability regime $(S = 1/2F, F)$, $\Pi = 100000$ 63

Chapter 1

Crime, Corruption and Optimal Leniency [1]

1.1 Introduction

Organized crime is prevalent in developing and post-conflict countries and generally in countries suffering from weak rule of law. It constitutes as well a concern for developed countries that adapt continuously their institutions to confront this type of crimes. According to the United Nations Convention against Transnational Organized Crime, organized crime groups are defined as "structured groups committing serious crime for profit". However, this definition could be extended to highlight other features of organized crime such as the reference to violence, the corruption of public officials, the intervention in the formal economy and in the political arena (Van Dijk, 2007). Examples of organized crime include, among others, trafficking in drugs, in humans, in firearms, in natural resources and cybercrime (UNODC, 2011).

One of the determinants of the expansion of organized crime is the level of corruption of the public sector in the economy. Indeed, Dijk and Buscaglia (2003) constructed an index for the level of organized crime and an index of public sector corruption and they identified high correlation between the two phenomena. This result is confirmed by (Van Dijk, 2007) that considers corruption and organized crime as "two sides of the same coin". Different reasons justify the interdependence between crime and corruption; criminals could bribe public officials to get higher levels of protection from law enforcement, to exploit their influence in the decision making process or to facilitate the circulation of the illegal goods. Particularly, the linkage between crime and corruption of public sector can take five forms according to Dijk and Buscaglia (2003). It ranges from "sporadic acts of bribery" which involves low ranking public officials in order to get a single favor that facilitates the illegal activity to "State's capture" where the law making and the judicial decisions can be shaped in favor of the illegal groups.

[1] I am grateful to the participants of the PhD Seminar at the University of Bologna, the Central European Program in Economic Theory (2016), the Swiss IO Day (2016), the 6^{th} Euro-African Conference in Economics and Finance and the 11^{th} Anuual Conference of the Italian Society of Law and Economics for their helpful comments.

This crime-corruption nexus suggests that when it comes to the design of law enforcement policies, both problems should not be considered separately. The policy maker should take into account the mutual impact between the two issues. Nevertheless, in terms of policies, for example, few EU members focused on the link between crime and corruption in the design of the initiatives and policies that aim to fight both problems (Gounev and Bezlov, 2010). In terms of economic literature, few papers considered the effect of policies tackling one of these issues on the other one (e.g. Kugler et al., 2005). For instance, the corruption, by definition, is a multiagent crime. Thus, a possible way to control for corruption is through exploiting the insider information between the agents involved in this act by offering a lenient treatment for the agent who discloses this information (Rose-Ackerman, 2010). This sort of leniency programs has shown a success in the fight against cartels in the antitrust (Spagnolo, 2008) as well as in the fight against organized crime (Acconcia et al., 2014). Yet, the application of a leniency program to curb corruption could have an undesired effect on the level of crimes due to the crime-corruption nexus discussed above.

The present paper investigates the impact of leniency programs on the the level of corruption and on the level of illegal activity. For this purpose, we consider, in the benchmark case, a model that consists of a criminal and a public official. On the one hand, the criminal decides whether to commit an illegal activity and to pay a bribe to the public official in order to get a higher protection from investigations or not. On the other hand, the public official's strategic decision is whether to accept or to reject the bribe, this decision depends on a private cost that he has to handle. We then extend this model by introducing two different designs of leniency programs: an asymmetric leniency program and a symmetric leniency program for corruption. Both programs allow the applicant to get a reduction in the sanctions for the corruption he was involved in. However, the main difference is that in the former only the criminal can apply for leniency, while in the latter both players can apply. These variants of the baseline model enables us to analyze the impact these reduced sanctions have on the decision of the criminal and on that of the public official. In a later step, we consider the benevolent legislator's problem in order to define the optimal design of leniency program that a benevolent would implement to reduce the levels of crime and of corruption.

We show that a leniency program that is not well designed could be exploited by the players. Particularly, leniency rates that are too high would increase the level of illegal activity, regardless of the leniency program implemented, compared to a benchmark with no leniency. This is due to the dominance of a "leniency effect" that decreases the expected sanction a criminal has to bear following his application to a leniency program. As a result, leniency programs might increase the level of illegal activity if they are not well designed. Moreover, under a symmetric leniency program, a too generous leniency program would imply higher levels of corruption. Furthermore, we show that, to maximize the social welfare function, a benevolent legislator would set the leniency rate to the minimum level and would offer the leniency only to the criminal.

This paper contributes to the existing literature on crime and corruption of public officials by considering the role of leniency programs in the control for the levels of crime and of corruption, i.e., this paper sheds light on the effectiveness of a leniency program inter-crime and intra-crime. Moreover, we introduce a heterogeneity on the level of the public official. This heterogeneity allows to endogenize the probability of corrupt public official and thus to control for the level of corruption in the economy and to identify separately the impact of different policies on the corruption and on the illegal activity. Finally, different institutional designs could be introduced to our set-up. For instance, we can consider leniency post-detection of the illegal activity or pre-detection.

Our paper is related to the literature on organized crime and the corruption of public officials. To some extent, these papers overlooked the role of sanctioning the criminal organization for bribing the public official on both the level of corruption and the level of criminal activity. For instance, Kugler et al. (2005) consider the impact of sanctioning crimes on both the level of crimes and the level of corruption in a setting where criminal organizations compete imperfectly with each other on criminal activities, while acting as local monopsonies in the corruption market. They show that when the return of crimes is relatively high compared to the cost of bribing public officials, a policy that increases the expected sanction may have the perverse effect of increasing criminal activity. Therefore, to ensure the effectiveness of law enforcement policies against crimes in an environment where the corruption is pervasive, these policies should go in parallel with measures to fight corruption.

Acconcia et al. (2014) studies the optimal design of an accomplice witnesses program in a context where the criminal activity is committed by a vertically structured organization and the public official could be corruptible. The accomplice witness program aims to reduce the level of criminal activity through increasing the probability of convicting the boss by inducing the fellow to cooperate with the law enforcer in exchange of a reduced fine. In contrast to Kugler et al. (2005), the extent of corruption is not strategically determined by the criminal organization. They show that the optimal leniency offered to the fellow is increasing with the level of corruption since the later reduces the likelihood of conviction of the boss in the absence of cooperation. A more generous leniency is thus required to compensate this reduction through increasing the level of cooperation into the program.

Our model differentiates from these models on several aspects. First, we consider sanctioning the criminal organization for corruption in addition to the measures already set to fight the criminal activity. This allows us to investigate the impact of different designs of leniency programs on both the level of illegal activity and the level of corruption. Second, in contrast to the leniency program considered in (Acconcia et al., 2014), we consider a leniency program in the case of two asymmetric interdependent crimes where only one of the accomplices have full information about both of them. Third, the relation considered between the the crime and the corruption is different; while these models consider the case of regular corruption in which the corrupt public officials are on the payroll of the criminal organization in exchange of offering regular services, we consider the corruption of high rank officials who may accept the bribe in exchange of offering long term benefit or increased protection to the criminal (Chêne, 2008).

We model the criminal organization following Buccirossi and Spagnolo (2006) in considering it as a black box, so we abstract from the vertical structure adopted in the previous models. Buccirossi and Spagnolo (2006) consider also the impact of leniency programs on illegal transactions, particularly on the occasional bilateral sequential transactions. They show that a moderate leniency program would ensure the implementation of this type of transaction since it could serve as a credible threat if the other party of the transaction did not follow the agreement. Lambsdorff and Mathias (2007) build on this model to determine the optimal design of law enforcement policies, i.e., fines and leniency rates, for each of the parties of the transaction. The illegal activity in these models is conditional on the participation of the public official and hence the idea of sequential transactions. Nevertheless, in our model, the gain from bribing the public official is reflected through an increased protection from the law enforcement. Heterogeneity in the type of the public official can thus be introduced into the model. Differently from to Buccirossi and Spagnolo (2006) and Lambsdorff and Mathias (2007) where they focus only on leniency before the detection of the illegal activity, this heterogeneity enables us to investigate the impact of post-detection and pre-detection leniency on both the level of corruption and the level of illegal activity.

Furthermore, introducing a leniency program for reporting corruption is linked to the recent literature on the asymmetric punishment of bribe (e.g. Oak, 2015; Dufwenberg and Spagnolo, 2015; Basu et al., 2016). This strand of literature studies the implications of legalizing bribe giving and increasing punishment on bribe taking. However, unlike our model, they consider the context of harassment bribes, i.e., bribes paid to get a service that the bribe giver is entailed to (Dufwenberg and Spagnolo, 2015). These models show that the reduction of the fine paid by the bribe giver may imply a perverse effect and increase the level of corruption depending on the cost of legal recourse, the efficiency of public administration or the level of law enforcement policies.

Finally, the idea of applying leniency for involvement in illegal activities builds upon the literature on leniency in antitrust (e.g. Motta and Polo, 2003; Spagnolo, 2004; Chen and Rey, 2013; Harrington, 2013). More precisely, it is related to the models that considered the impact of leniency on the sustainability of multi-market collusion (e.g. Lefouili and Roux, 2012). Indeed, in our model we study the impact of introducing different setting of leniency on the likelihood of committing two interdependent criminal activities.

The remainder of the paper is organized as follows: In section 1.2, we set-up the baseline model where there is no leniency. In section1.3 and section1.4, we consider two variants of the model and discuss their impact on the equilibrium levels of corruption and of illegal activity. In section 1.5, we introduce the legislator's problem and define the optimal leniency program. We conclude in section 1.6.

1.2 The Model

1.2.1 Set-up

We start by introducing the benchmark model where the legislator relies only on the sanctions of the illegal activity and the sanction of corruption as policy tools to achieve his objective. We consider a game of three risk neutral players: a benevolent legislator, a criminal and a public official.

The Legislator. The benevolent legislator aims to reduce the social cost driven by the illegal activity and the corruption. Thus, he designs the enforcement tools in a way to keep the illegal activity and the corruption to their minimum levels. The legislator launches an investigation and detects the evidence of the illegal activity[2] with a probability $\overline{\alpha}$. In this case, the criminal bears a sanction F^i.

We assume that the investigation on corruption follows the investigation on the illegal activity, i.e., we consider a sequential detection setting. Therefore, if the evidence of the illegal activity was found, the corruption's evidence will be detected with probability $\overline{\beta}$. Otherwise, it will be detected with probability $\underline{\beta}$, such that $\underline{\beta} < \overline{\beta}$. Indeed, the higher probability of finding the evidence of corruption could stem from the cooperation between different law enforcement departments involved in the investigation of both cases.

We focus in the model on symmetric sanctions for corruption since the bribe is paid to facilitate an illegal activity. Accordingly, the legislator sets the sanction of engaging in corruption denoted by F^b, that the criminal and the public official will face once the evidence of corruption is detected. Furthermore, following the literature, the sanctions are interpreted in monetary terms.

The Criminal. The criminal decides whether or not to commit an illegal activity, e.g., drug trafficking, money laundering,...etc. The crime yields a random monetary return, π, that is distributed following a CDF $G(.)$ and a pdf $g(.)$.

Moreover, the criminal seeks the protection of a public official by offering him a bribe, B. B is as exogenous amount that varies between $[0, \pi]$ and that satisfies the participation constraint of the criminal.

The Public Official. The public official decides whether to accept the bribe offered by the criminal or not. If he accepts the bribe, a hard evidence of the corruption is generated and is detained by the both the criminal and the public official. We will assume that the public official will always reciprocate by providing the criminal with a higher level of protection against the law enforcement, so no hold-up problem

[2] We assume that the evidence of the illegal activity is sufficient to get a successful prosecution, and thus once this evidence is detected, the criminal will be convicted.

could arise. In particular, this protection implies a lower probability of detecting the illegal activity, denoted by $\underline{\alpha}$, such that $\underline{\alpha} < \overline{\alpha}$.

By accepting the bribe, the public official faces the risk of losing his formal wage, w, whenever the corruption is detected by the law enforcer. Moreover, the involvement in corruption entails an additional cost, θ. θ is the private type of the public official. For sake of simplicity, we will assume that θ is uniformly distributed over the support $[0, 1]$. This additional cost, θ, could be interpreted as the degree of regional, ethnic or religious difference between the public official and the criminal (Kugler et al., 2005). Consequently, the more important the difference is, the more reluctant the public official will be in providing his illegal services to the criminal. This cost could be interpreted as well as the psychological cost of violating a social norm (Rotondi and Stanca, 2015).

1.2.2 Timing

The timing of the previous set-up will have the following structure:

- $\tau = 0$ The legislator sets the policy parameters: F^i, F^b, $\overline{\alpha}$ and $\underline{\beta}$.
- $\tau = 1$ The return from the crime, π, materializes. The criminal, C, decides whether to commit the crime or not. If he decides not to commit the crime, the game ends. Otherwise, by committing the crime, the criminal proceeds by offering a bribe, B, to the public official.
- $\tau = 2$ The public official, $P.O.$, observes his type, θ, and decides whether to accept the bribe, B, paid by the criminal or not. Provided that the public official accepts the bribe, a higher protection from the investigation will be guaranteed to the criminal.
- $\tau = 3$ An investigation on the illegal activity starts. If the public official accepts the bribe, the incriminating evidence is detected with probability $\underline{\alpha}$. Otherwise, the evidence is detected with probability $\overline{\alpha} > \underline{\alpha}$.
- $\tau = 4$ An investigation on the corruption starts. If the evidence of the illegal activity is discovered, the criminal and the public official will be convicted for corruption with probability $\overline{\beta}$. Otherwise, the probability of conviction will be $\underline{\beta} < \overline{\beta}$.

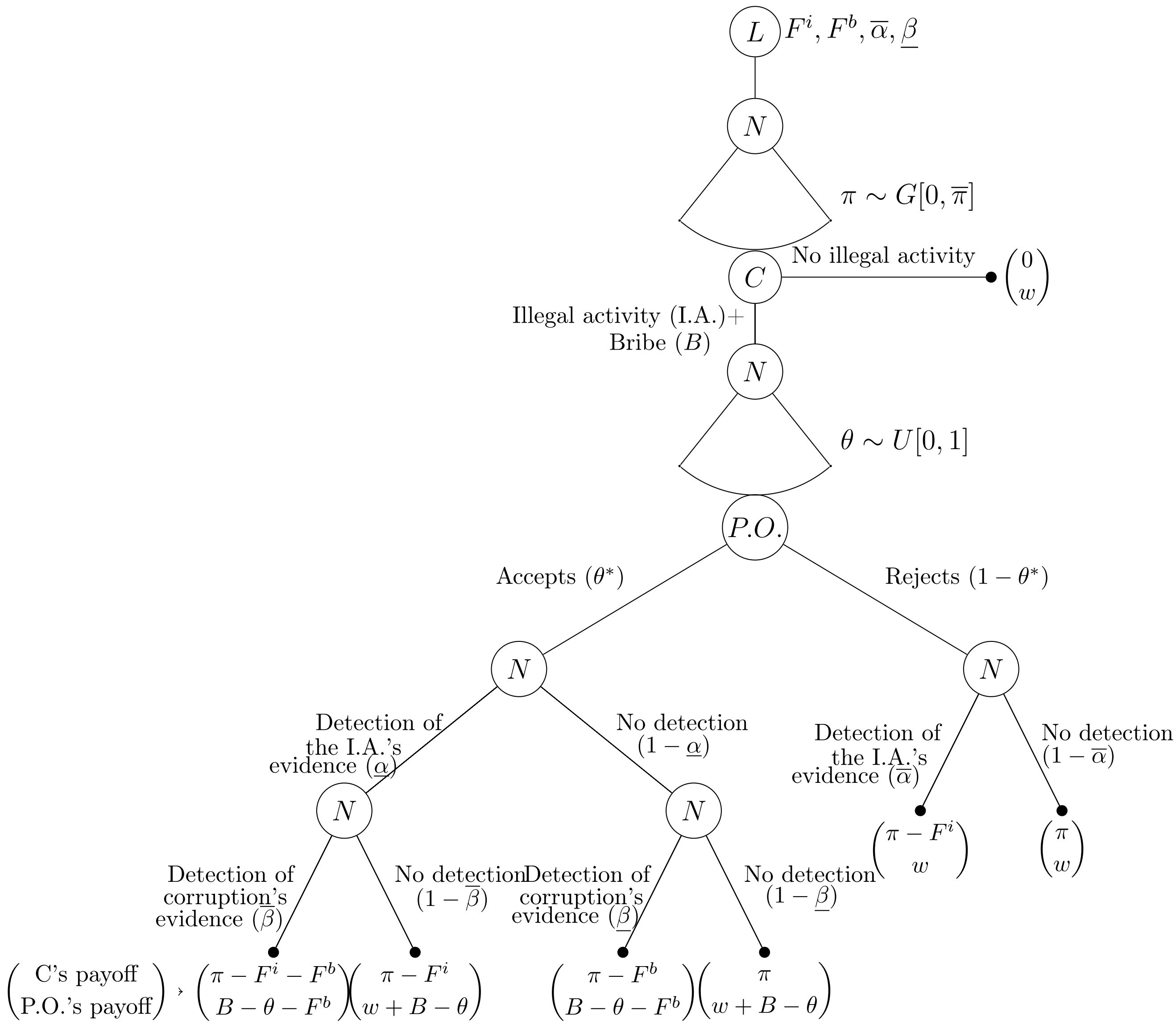
The players payoffs can be depicted through the game tree illustrated by Figure 1.1.

We look for the *subgame perfect Nash equilibrium* of the game by solving it by backward induction.

1.2.3 Leniency program

In order to determine the optimal leniency program and to assess the effectiveness of a leniency program as a tool to fight illegal activity and corruption, we study two variants of this benchmark in sections 1.3 and 1.4. Particularly, we consider two institutional designs:

Figure 1.1: The game tree of the benchmark model



Asymmetric leniency for corruption. In this setting, once the evidence of the illegal activity is detected the legislator allows only the criminal to apply for leniency. In that case, the criminal will be subject to a lenient sanction only for the act of corruption, while he will face full sanction for the illegal activity he committed.

Symmetric leniency for corruption. In this setting, both players can report the evidence of corruption if the evidence of illegal activity is detected, however only the first-informant can get a reduced sanction (Chen and Rey, 2013).

The introduction of a leniency program implies that the legislator defines a leniency rate q, such that a player who applies for leniency will bear a reduced sanction $(1-q)F^s$ where $s = i, b$. This will affect the equilibrium level of corruption and illegal activity as we will show in details in sections 1.3 and 1.4.

1.2.4 Benchmark: No Leniency

The equilibrium of the baseline model is determined by solving the previous game by backward induction. Therefore, we start by defining the public official's expected payoff if he accepts the bribe and then, we will identify the marginal type of the public official who will be indifferent between accepting and rejecting the bribe.

A public official of type θ who accepts the bribe receives the following expected payoff:

$$\pi_{po} = (B - \theta) + w - [\underline{\alpha}\overline{\beta} + (1 - \underline{\alpha})\underline{\beta}](F^b + w)$$

The first two terms of this equation represent the public official's expected gain from accepting the bribe, which is the amount of the bribe reduced by the type dependent cost, $B - \theta$, and his formal wage, w, that he will keep if the corruption remains undetected. The last term represents the public official's expected loss: When the public official is caught, he loses his formal job and will be subject to the sanction, F^b. This expected loss depends on both the likelihood that the illegal activity is detected, $\underline{\alpha}$, and the probability of detecting the corruption act, $\overline{\beta}$ or $\underline{\beta}$, respectively.

Given that that the payoff of a public official who rejects the bribe is only his formal wage, w, the marginal type of public official, i.e., the type, θ^*, that is indifferent between accepting and rejecting the bribe, is determined by the following equation:

$$\theta^* = B - [\underline{\alpha}\overline{\beta} + (1 - \underline{\alpha})\underline{\beta}](F^b + w) \tag{1.1}$$

Only a public official of type $\theta \leq \theta^*$ accepts the bribe and provides a protection the criminal. In other words, for a public official to get involved in the corruption act, the private cost of accepting the bribe, θ, needs to be sufficiently small such that the bribe would, at least, compensate him for the expected loss related to this decision. Furthermore, given our assumption that the type of the public official is uniformly distributed over the support $[0, 1]$, θ^* could be interpreted as the probability of accepting the bribe. Accordingly, this marginal type of public official could serve as a measure of the level of corruption in the economy.

Moreover, the level of the illegal activity in the economy could be captured through the profitability of the illegal activity. The expected payoff of the criminal is captured by the the following equation:

$$\pi_c = \pi - \overline{\alpha}F^i + \theta^*\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1 - \underline{\alpha})\underline{\beta}]F^b\} \tag{1.2}$$

where $\Delta\alpha = \overline{\alpha} - \underline{\alpha}$.

This expression could be divided into two parts. The first two terms reflect the criminal's payoff if he does not offer a bribe to the public official: the criminal will enjoy the return of the crime π, and will face the sanction F^i with probability $\bar{\alpha}$.

The last term represents criminal's the expected net gain from paying the bribe: Provided that the public official accepts the bribe, the criminal will enjoy an increasing level of protection, and thus his gain is the difference between the expected sanction of the illegal activity when the bribe is rejected, $\bar{\alpha}F$, and when it is accepted by the public official, $\underline{\alpha}F$. This difference is denoted by $(\Delta\alpha)F^i$. Yet, the cost of paying the bribe is the amount of the bribe offered to the public official, B, and the expected sanction of getting involved in corruption, $[\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b$. Thus, a criminal will commit an illegal activity whenever $\pi_c \geq 0$, and the level of illegal activity could be captured by $\Pr(\pi_c \geq 0)$.

For convenience, we consider the following assumption:

Assumption 1.1.

$$(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b > 0$$

which implies the criminal's participation constraint is satisfied in the baseline model. In other words, the amount of the bribe is sufficiently small such that the criminal will always have incentive to commit the illegal activity[3].

1.3 Asymmetric Leniency for Corruption

In this section, we build on the baseline model by introducing an "asymmetric leniency program for corruption". In particular, we consider an institutional design in which, after the detection of the illegal activity, the legislator allows only the criminal to get a reduced sanction if he reports the evidence of corruption. Note that a leniency program is effective if the reduced expected sanction, that the criminal enjoys by applying to the leniency program, is lower than the expected sanction he faces otherwise, namely if $F^i + (1-q)F^b \leq F^i + \overline{\beta}F^b$, which could be reduced to the condition $q \geq (1-\overline{\beta})$. Throughout the analysis, we will assume that this condition holds.

1.3.1 Equilibrium analysis

As in the baseline model, we start the equilibrium analysis by determining the marginal type of the public official and then the profitability of the illegal activity under the asymmetric leniency program for corruption.

Given the assumption on the leniency rate, q, reporting the evidence of corruption is a dominant strategy for the criminal once the illegal activity is detected by the legislator, which affects the public official's payoff. The public official's expected payoff becomes thus:

$$\pi^1_{po} = (B-\theta) + w - [1 + (1-\underline{\alpha})\underline{\beta}](F^b + w)$$

The public official's payoff can be interpreted as the difference between the expected gain and the expected cost of the public official from accepting the bribe: From the one hand, accepting the bribe entails the net gain $B-\theta$. On the other hand, he is subject to the sanction F^b and the loss of his formal wage w with probability

[3]For a discussion on this assumption, see Appendix 1.A

$[1 + (1 - \underline{\alpha})\underline{\beta}]$. Note that unlike the benchmark, the asymmetric leniency program raises the probability that the public official faces the sanction F^b when the evidence of the illegal activity is detected. Precisely, the public official will be subject to the fine with probability 1 instead of $\bar{\beta}$.

Given that the public official's payoff from rejecting the bribe, w, remains unaffected by the new institutional design. We can redefine the marginal type as follows:

$$\theta^{*1} = B - [\underline{\alpha} + (1 - \underline{\alpha})\underline{\beta}](F^b + w) \tag{1.3}$$

Thus, in equilibrium, only a public official with private cost $\theta \leq \theta^{*1}$ will accept the bribe. Indeed, the private cost of the bribe needs to be sufficiently low to ensure that the public official will receive at least the same payoff that he gets by rejecting the bribe.

At this stage, we can determine the profitability of the illegal activity under an asymmetric leniency program. This payoff is:

$$\pi_c^1(q) = \pi - \overline{\alpha}F^i + \theta^{*1}\{(\Delta\alpha)F^i - B - [\underline{\alpha}(1 - q) + (1 - \underline{\alpha})\underline{\beta}]F^b\} \tag{1.4}$$

Under the asymmetric leniency program, the criminal's payoff depends on his payoff if no bribe is offered, $\pi - \overline{\alpha}F^i$, as well as on the expected net gain from offering the bribe which the protection the criminal receives against the sanction, $(\Delta\alpha)F^i$, reduced by the amount of the bribe, B, and the expected sanction of corruption $[\underline{\alpha}(1 - q) + (1 - \underline{\alpha})\underline{\beta}]F^b$. Note that the criminal will face the sanction F^b with probability $(1 - q)$ if the evidence of the illegal activity is discovered instead $\bar{\beta}$, which reflects the reduction in the criminal's expected sanction following the implementation of the asymmetric leniency program.
In equilibrium, a criminal commits thus an illegal activity whenever $\pi_c^1(q) \geq 0$.

1.3.2 Assessment of the institutional design

In this subsection, we assess the effectiveness of the asymmetric leniency program by investigating its impact on both the level of corruption and the level of the illegal activity compared to the benchmark where non leniency program was implemented. For this purpose, we will compare the probability of accepting the bribe and the profitability of the illegal activity under both settings.

An asymmetric leniency program reduces the level of corruption compared to the benchmark case. From equations (1.1) and (1.3), we get;

$$\theta^{*1} - \theta^* = -\underline{\alpha}(1 - \overline{\beta})(F^b + w) < 0 \tag{1.5}$$

This result is derived from the fact that the leniency program is effective: Expecting that the criminal will report the evidence of corruption whenever the evidence of the illegal activity is detected, the public official accepts the bribe less likely. Indeed, the criminal's application to the program implies that the public official will bear the full sanction, F^b, and the loss of his formal wage, w, with certainty after the discovery of the illegal activity. As a result, only public official with low private cost will have incentive to engage in the bribery act and to face the higher expected fine, this will be reflected by a lower probability of accepting the bribe and thus a lower level of corruption.

Yet, the impact of the asymmetric leniency on the level of illegal activity is ambiguous; it depends on the level of the leniency rate. From equations (1.2) and (1.4) we have;

$$\pi_c^1(q) - \pi_c = (\theta^{*1} - \theta^*)\{(\Delta\alpha)F^i - B - \{[\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b\} - \theta^{*1}\underline{\alpha}[\overline{\beta} - (1-q)]F^b\}$$

The introduction of an asymmetric leniency program affects the profitability of the illegal activity through two channels:

The first channel is the "Corruption effect". It is depicted through the 1^{st} term of the previous equation. Indeed, following the introduction of a new institutional design, the change in the probability of accepting the bribe affects, in turn, the likelihood that the criminal enjoys the protection against the illegal activity's sanction, which affects his decision to undertake the illegal activity. For instance, the implementation of an asymmetric leniency program reduces the probability that a bribe is accepted by a public official, i.e. reduces the likelihood of corruption in the economy. This results in a reduction of the probability that the criminal will enjoy the net gain from the bribery, $(\Delta\alpha)F^i - B$, which undermines the expected profitability of the illegal activity compared to the benchmark of no leniency program. Thus, the corruption effect implies a negative impact on the level of the illegal activity.

The second channel is the "leniency effect", which is captured by $\{[\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b\} - \theta^{*1}\underline{\alpha}[\overline{\beta} - (1-q)]F^b\}$. This effect results from the change, basically the reduction, in the criminal's expected sanction of corruption that follows the introduction of a leniency program for a given level of corruption. As expected, the more generous a leniency program is, the higher will be this effect and thus the higher will be the profitability of the illegal activity to the criminal. This negative effect of the leniency program on the level of illegal activities has been highlighted by several models that discussed the possibility of exploiting a leniency program, (e.g. Chen and Rey, 2013).

The overall impact of an asymmetric leniency program on the level of the illegal activity in the economy is the net result of both effects. It is worthy to note that only the leniency effect depends on the design of the leniency program: The larger the leniency rate, the lower will be the criminal's expected sanction of corruption and thus the larger would be the leniency effect. Consequently, for lower levels of leniency rates, the "corruption effect" dominates the "leniency effect" resulting in lower profitability of the illegal activity compared to the case where there is no leniency. The asymmetric leniency program will exhibit thus a deterrent effect by reducing the level of illegal activity in the economy.However, a sufficiently generous leniency programs will imply the dominance of the "leniency effect" leading thus to higher levels of illegal activity.

The results of this subsection are summarized by the following proposition:

Proposition 1.1. *The introduction of an asymmetric leniency program for corruption reduces the probability that the public official accepts the bribe. However, for the profitability of the illegal activity, there exists a leniency rate, $\tilde{q}$, above which it increases with the implementation of the leniency program.*

Proof. See Appendix 1.B.1. ■

1.4 Symmetric Leniency for Corruption

In this section, we consider another design of the leniency program: a "symmetric leniency for corruption". Under this setting, once the illegal activity is detected, the legislator allows both the criminal and the public official to apply for leniency. However, the reduction in the corruption's sanctions are guaranteed only to the 1^{st} informant who reports the evidence of corruption. Therefore, the probability that each player gets the reduction in the sanction is 1/2. Table 1.2 illustrates the reporting game between the criminal and the public official. The 1^{st} line in each cell represents the criminal's expected sanction after the detection of the illegal activity while the 2^{nd} line represents the public official's expected sanction.

Table 1.2: Reporting game in a symmetric leniency program

C \ P.O.	Report	Not Report
Report	$-F^i-(1-q/2)F^b$ $-(1-q/2)F^b$	$-F^i-(1-q)F^b$ $-F^b$
Not Report	$-F^i-F^b$ $-(1-q)F^b$	$-F^i-\overline{\beta}F^b$ $-\overline{\beta}F^b$

From table 1.2, we can infer that for Report to be a dominant strategy for both players, the leniency rate needs to be sufficiently high, namely $q \geq (1-\overline{\beta})$. We assume that this condition is satisfied throughout the following analysis.

1.4.1 Equilibrium analysis

The implications of this institutional design on the analysis in the previous sections are reflected through the change in equilibrium value of the public official's marginal type, that determines the probability that corruption occurs, and the equilibrium value of the criminal's.

Under a symmetric leniency program, a public official of type θ who accepts the bribe gets the following expected payoff:

$$\pi_{po}^2 = B-\theta+w-\underline{\alpha}[(1-\frac{q}{2})F^b+w]-(1-\underline{\alpha})\underline{\beta}(F^b+w)$$

As in the previous section, this payoff can be interpreted as the difference between the public official's expected gain, $B-\theta+w$, and his expected loss, the last two terms, from accepting the bribe. it is worthy to note that unlike the previous institutional designs, the public official's payoff depends on the leniency rate, q, since the symmetric leniency program allows him to apply for lenient treatment.

The marginal type of the public official, who is indifferent between accepting and rejecting the bribe, is determined through the following equation:

$$\theta^{*2}(q) = B - (1-\underline{\alpha})\underline{\beta}(F^b + w) - \underline{\alpha}[(1-\frac{q}{2})F^b + w] \tag{1.6}$$

Accordingly, in equilibrium, a public official will get involved in corruption if his type is sufficiently low; $\theta \leq \theta^{*2}$, such that the bribe, B, compensates him for at least the expected sanction of accepting the bribe.

The expected revenue of the criminal who performs the illegal activity is:

$$\pi_c^2(q) = \pi - \overline{\alpha}F^i + \theta^{*2}\{(\Delta\alpha)F^i - B - [\underline{\alpha}(1-\frac{q}{2}) + (1-\underline{\alpha})\underline{\beta}]F^b\} \tag{1.7}$$

It reflects the criminal's net gain from the illegal activity if no bribe is accepted (1^{st} and 2^{nd} terms of the previous equation) as well as his expected net gain from offering the bribe. Clearly, this criminal's expected revenue should exceed his outside option that is normalized to zero, in order to undertake the illegal activity. Thus, the level of illegal activity, in equilibrium, would be captured by the probability $Pr(\pi_c^2 \geq 0)$.

1.4.2 Assessment of the institutional design

The comparison between the marginal type of the public official and the profitability of the illegal activity under this set-up and under the benchmark case sheds light on the effect of a symmetric leniency program on the level of corruption and the level of illegal activity.

The impact of the leniency program on the probability of accepting the bribe is captured by the following equation:

$$\theta^{*2}(q) - \theta^* = -\underline{\alpha}(1-\overline{\beta})w + \underline{\alpha}[\overline{\beta} - (1-\frac{q}{2})]F^b \tag{1.8}$$

Unlike the case of asymmetric leniency, this institutional design allows the public official to report the evidence of corruption once the illegal activity is discovered in exchange of a reduced sanction. Thus, the public official's payoff and the probability of accepting the bribe will depend on the leniency rate set by the legislator. Indeed, compared to the setting of no leniency, the probability of accepting the bribe is affected in two respects.

First, provided that the illegal activity is detected, the implementation of a leniency program implies the loss of the formal wage, w, with certainty since for an effective leniency program the evidence of corruption will be reported either by the public official or the criminal. This entails a negative effect on the probability of accepting the bribe, which is represented by the 1^{st} term of the RHS of equation (1.8).

Second, the leniency program reduces the public official's expected sanction of corruption (2^{nd} term of the RHS of equation (1.8)), which has a positive effect on the probability of accepting the bribe. This positive effect is increasing with the leniency rate.

Accordingly, for low leniency rates,$(1-\overline{\beta}) \leq q \leq \overline{q}$, the negative effect of the symmetric leniency program on the public official's expected payoff dominates the positive effect implying the reduction of the level of corruption compared to the case of no leniency. However, for relatively high leniency rates($q > \bar{q}$), the positive effect dominates and higher levels of corruption can be expected.

The impact of the symmetric leniency program on the profitability of the illegal activity is represented by the difference between equations (1.7) and (1.2) as shown below:

$$\pi_c^2(q) - \pi_c = (\theta^{*2}(q) - \theta^*)\{(\Delta\alpha)F^i - B - \{[\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b\} - \theta^{*2}(q)\underline{\alpha}[\overline{\beta} - (1-\frac{q}{2})]F^b\} \tag{1.9}$$

As in the case of an asymmetric leniency, equation (1.9), shows that a symmetric leniency program affects the profitability of the illegal activity through a "corruption effect" and a "leniency effect".

Yet, unlike the case of asymmetric leniency, the corruption effect depends on the level of the leniency rate. More precisely, for $(1-\overline{\beta}) \leq q \leq \overline{q}$, the corruption effect will imply a reduction in the expected profitability of the illegal activity since over this interval of leniency rates, the probability that a public official accepts a bribe decreases compared to the benchmark. In other words, the probability that the criminal enjoys the net gain of offering a bribe decreases reducing thus his incentive to commit the illegal activity. Nonetheless, the probability enjoying the net gain of bribe increases for $q \geq \overline{q}$, leading to the increase of the profitability of the illegal activity. The corruption effect is captured by the 1^{st} term of the RHS of equation (1.9).

As already mentioned, the "leniency effect", represented by the 3^{rd} and 4^{th} terms of the RHS of equation (1.9), is increasing in the leniency rate and it increases the profitability of the illegal activity by increasing the probability that the criminal enjoys a lenient treatment.

In a nutshell, the impact of a symmetric leniency program on the profitability of the illegal activity is the result of the net effect of the "corruption effect" and the"leniency effect" as shown by the following proposition:

Proposition 1.2. *For a given leniency rate, the impact of a symmetric leniency program on the level of corruption and illegal activity compared to the case of no leniency, can be summarized as follows:*

1. *For $(1-\overline{\beta}) \leq q \leq \underline{q}$, a symmetric leniency program reduces both the probability that the public official accepts the bribe and the profitability of the illegal activity.*

2. *For $\underline{q} < q \leq \overline{q}$, a symmetric leniency program reduces the probability of accepting the bribe while increases the profitability of the illegal activity.*

3. *For $\overline{q} < q \leq 1$, a symmetric leniency program backfires, it increases both the probability that the public official accepts the bribe and the profitability of the illegal activity.*

Proof. See Appendix 1.B.2. ■

1.5 Optimal Leniency Program

The full characterization of the equilibrium under a leniency program requires the determination of the optimal leniency rate that a benevolent legislator would select to maximize his welfare function. Indeed, we assume that the social cost of the illegal activity and the corruption are sufficiently high that a legislator's objective would be to minimize the level of both the illegal activity and the corruption. Therefore, the legislator chooses a leniency rate that makes the criminal's participation constraint to the illegal activity as stringent as possible and that reduce the public official's expected payoff from corruption such that only very low types accept the bribe. Moreover, the optimal leniency rate ensures that the leniency program is effective and that no positive rewards are allowed. The legislator's program is thus:

$$\underset{q}{\text{Min}} \, \{Pr(\pi_c^s(q) > 0) + Pr(\theta < \theta^{*s})\} \text{ where } s = 1, 2$$

$$\text{s.t. } (1 - \overline{\beta}) \leq q \leq 1$$

The full description of the equilibrium under the institutional designs studied in sections 1.3 and 1.4 is given by the following proposition:

Proposition 1.3. *The optimal leniency rate is:*

$$q^* = 1 - \overline{\beta}$$

Under an asymmetric leniency program for corruption, there exists a unique equilibrium: q^*, θ^{*1} and π_c^{*1}, where θ^{*1} is given by (1.3), and

$$\pi_c^{*1} = \pi - \overline{\alpha}F^i + \theta^*\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1 - \underline{\alpha})\underline{\beta}]F^b\}$$

Furthermore, under a symmetric leniency program, there exists a unique equilibrium given by q^*, θ^{*2} and π_c^{*2}, where

$$\theta^{*2} = B - [\underline{\alpha} + (1 - \underline{\alpha})\underline{\beta}](F^b + w) + \frac{\underline{\alpha}(1 - \overline{\beta})}{2}F^b \text{ and}$$

$$\pi_c^{*2} = \pi - \overline{\alpha}F^i + \theta^*\{(\Delta\alpha)F^i - B - [\underline{\alpha} + (1 - \underline{\alpha})\underline{\beta}]F^b + \frac{\underline{\alpha}(1 - \overline{\beta})}{2}F^b$$

Finally, at $q^* = 1 - \overline{\beta}$, we have:

$$\theta^{*1} < \theta^{*2}$$

$$\pi_c^{*1} < \pi_c^{*2}$$

Proof. See Appendix 1.B.3 ■

The 1^{st} and the 2^{nd} parts of proposition 1.3 show that a legislator will set the leniency rate at the minimum level either under an asymmetric leniency program or under a symmetric one. Indeed, in both cases, this leniency rate will be sufficient to trigger a desirable corruption effect: Under an asymmetric leniency program, the public official's payoff is independent from the leniency rate. However, the mere implementation of the asymmetric leniency program reduces the public official's expected payoff from the corruption by raising his probability of facing the corruption sanction when the illegal activity is detected. Furthermore, under a symmetric leniency program, where the public official can apply for leniency, the leniency rate $1-\bar{\beta}$ will be sufficient to deter the public official from the corruption by raising the probability of loosing his formal wage due to the race to the courthouse between the criminal and the public official. Yet, this optimal leniency rate is not high enough to make the reduction in the public official's expected sanction dominate the effect of the loss of the wage. Therefore, the optimal leniency rate, $1-q$, ensures a reduction in the level of corruption regardless of the type of leniency program applied. This in turn triggers a corruption effect that reduces the criminal's incentive to commit the illegal activity by reducing the probability that he enjoys the net gain of the bribe.

The 3^{rd} part underlines that it is optimal for a benevolent legislator to offer an ex-post leniency only for the criminal in order to minimize the level of corruption and the level of illegal activity. Indeed, for a given leniency rate, under an asymmetric leniency program, the public official never enjoys a lenient treatment and therefore his payoff from the corruption is always lower than under a symmetric leniency program. Thus, an asymmetric leniency program has a more deterrent effect on the level of corruption than a symmetric leniency program. As a result of the lower corruption level, the criminal exerts lower levels of illegal activity.

1.6 Conclusion

The interdependence between crime and corruption suggests that strategies adopted to fight them should consider this relationship. In this paper, we attempted to assess the effectiveness of leniency programs as a tool to fight illegal activities involving the corruption of the public official.

We show that a leniency program if it is not well designed could backfire. Particularly, leniency rates that are too high could increase the level of illegal activity. A too generous leniency program reduces the expected sanction that a criminal has to bear since the criminal will always exploit the leniency program and disclose the evidence of corruption to enjoy the lower fines. This "leniency effect" implies a negative effect on the level of the illegal activity. Moreover, under a symmetric leniency program, to which both the criminal and the public official can apply, a too generous leniency program would imply higher levels of corruption. Indeed, under this leniency program the public official can enjoy the fine reduction as well, which might raise his expected payoff from the corruption. Furthermore, we show that, to maximize the welfare function, a legislator would select the minimum leniency rate and would offer the leniency only to the criminal.

One of the limitation of our model is the assumption imposed on the legislator's payoff function. By assuming that the social cost of both the illegal activity and the corruption are high, we restricted the legislator's objective to the reduction of the level of both acts. We disregarded thus possible interesting cases, where the legislator can trade-off between corruption and illegal activity. Moreover, we have assumed that the leniency rate and the design of the leniency program are the only tools the legislator can manipulate to achieve his objective which is another limitation to the model. Indeed, in practice, the legislator possesses a set of tools that he can rely on such as the raising the probability of detecting the evidence or modifying the fines imposed on the players. Allowing for these alternatives in a context where the legislator has limited resources could lead to interesting results on the substituability between these different enforcement tools.

Finally, this model could open ways to future research. For instance, future research could consider the design of the optimal leniency program in different institutional settings. Examples include a "Pre-detection leniency" in which the leniency is available only before the detection of the evidence of the illegal activity; two possibilities might arise: the reduction of the fines for disclosing the illegal activity and/or a reduction of fines for disclosing the corruption. Another instance is adopting a setting of "simultaneous detection" where we the possibility of detecting evidence of both illegal activity and corruption simultaneously instead of sequentially. Moreover, we could introduce a bargaining game to determine the level of bribe paid to the public official.

Appendix 1.A On Assumption 1.1

In the baseline model, a criminal commits the illegal activity whenever his participation constraint, $\pi_c \geq 0$, is satisfied, i.e., when

$$\pi - \overline{\alpha}F^i + \theta^*\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b\} \geq 0$$

that could be rewritten as:

$$(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b \geq -\frac{1}{\theta^*}[\pi - \overline{\alpha}F^i]$$

The RHS is negative for realizations of π that are relatively high since $\theta^* \in [0,1]$. Thus, the LHS can be negative or non negative. By assumption 1.1, we restrict our attention to the cases where the bribe B is sufficiently small such that the LHS is strictly higher than zero. However, for low realizations of π, assumption 1.1 is always satisfied since the RHS will be positive in such case.

Appendix 1.B Proofs

1.B.1 Proof of Proposition 1.1

The first part of the proposition is straightforward from (1.1) and (1.3) as shown in section 1.3.

The second part of the proposition is derived from equations (1.2) and (1.4)

$$\pi_c^1(q) - \pi_c = (\theta^{*1} - \theta^*)\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b\} + \theta^{*1}\underline{\alpha}[\overline{\beta} - (1-q)]F^b$$

$\pi_c^1(q) > \pi_c$ if:

$$(\theta^{*1} - \theta^*)\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b\} + \theta^{*1}\underline{\alpha}[\overline{\beta} - (1-q)]F^b > 0$$

$$\theta^{*1}\underline{\alpha}[\overline{\beta} - (1-q)]F^b > (\theta^* - \theta^{*1})\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b\}$$

$$q > \tilde{q} = 1 - \overline{\beta} + \frac{(\theta^* - \theta^{*1})}{\theta^{*1}\underline{\alpha}F^b}\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b\}$$

By (1.5) and (1.1);

$$\frac{(\theta^* - \theta^{*1})}{\theta^{*1}\underline{\alpha}F^b}\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b\} > 0$$

Thus, $\pi_c^1(q) > \pi_c$ if $q > \tilde{q} > 1 - \overline{\beta}$ and $\pi_c^1(q) < \pi_c$ if $1 - \overline{\beta} < q < \tilde{q}$ ■

1.B.2 Proof of Proposition 1.2

The proposition is proven in two folds: First, we define the interval of leniency rates over which $\theta^{*2} < \theta^*$ and that over which $\theta^{*2} > \theta^*$. Then, we determine the interval where $\pi_c^2(q)$ exceeds π_c.

From equations (1.6) and (1.1), we get:

$$\theta^{*2}(q) - \theta^* = -\underline{\alpha}(1-\overline{\beta})w + \underline{\alpha}[\overline{\beta} - (1 - \frac{q}{2})]F^b$$

$\therefore\ \theta^{*2}(q) < \theta^*$ if:

$$\underline{\alpha}[\overline{\beta} - (1 - \frac{q}{2})]F^b < \underline{\alpha}(1-\overline{\beta})w$$

which could be rewritten as:

$$q < \overline{q} = 2(1-\overline{\beta})\frac{w + F^b}{F^b}$$

Thus, for $1 - \overline{\beta} \leq q < \overline{q}$, $\theta^{*2} < \theta^*$ and for $1 - \overline{\beta} < \overline{q} < q$, $\theta^{*2} > \theta^*$.

From equations (1.9) and (1.6), we can define the F.O.C.:

$$\frac{\delta[\pi_c^2(q) - \pi_c]}{\delta q} = \frac{\underline{\alpha}F^b}{2}\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b + \underline{\alpha}\overline{\beta} + B - (1-\underline{\alpha})\underline{\beta}(F^b + w) + w\} - (\underline{\alpha}F^b)^2(1 - q/2)$$

$$= \frac{\underline{\alpha}F^b}{2}\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b + \underline{\alpha}\overline{\beta} + B - (1-\underline{\alpha})\underline{\beta}(F^b + w) + w - \underline{\alpha}\overline{\beta}(F^b + w) + \underline{\alpha}\overline{\beta}(F^b + w)\} - (\underline{\alpha}F^b)^2(1 - \frac{q}{2})$$

$$= \frac{\underline{\alpha}F^b}{2}\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b + \underline{\alpha}\overline{\beta} + \theta^* + w + \underline{\alpha}\overline{\beta}(F^b + w\} - (\underline{\alpha}F^b)^2(1 - q/2))$$

The S.O.C. of equation (1.9) is thus:

$$\frac{\delta^2(\pi_c^2 - \pi_c)}{\delta q^2} = \frac{(\underline{\alpha}F^b)^2}{2} > 0$$

The next step is to determine whether the function $\pi_c^2(q) - \pi_c$ is increasing or decreasing over the interval $[1-\overline{\beta}, 1]$:
at $q = 1 - \overline{\beta}$, we have:

$$\frac{\delta[\pi_c^2(q) - \pi_c]}{\delta q} = \frac{\underline{\alpha}F^b}{2}\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b + \underline{\alpha}\overline{\beta} + \theta^* + w + \underline{\alpha}\overline{\beta}(F^b + w\} - (\underline{\alpha}F^b)^2(\frac{1+\overline{\beta}}{2})$$

$$= \frac{\underline{\alpha}F^b}{2}\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b + \underline{\alpha}\overline{\beta} + \theta^* + (1 + \underline{\alpha}\overline{\beta})w - \underline{\alpha}F^b$$

which is non negative for not too large values of F^b. So, we can conclude that $\pi_c^2(q) - \pi_c$ is increasing over the concerned interval.

Then, we define the sign of $\pi_c^2(q) - \pi_c$ over the interval $[1-\overline{\beta}, \overline{q}]$:
From equation (1.9), at $q = 1 - \overline{\beta}$, we get:

$$\pi_c^2(q) - \pi_c = (\theta^{*2}(q) - \theta^*)\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b\} + \theta^{*2}(q)\underline{\alpha}[\overline{\beta} - (1 - \frac{1-\overline{\beta}}{2})]F^b$$

$\because 1 - \overline{\beta} \leq q < \overline{q}$, $\theta^{*2} < \theta^*$, we can rewrite it as:

$$\pi_c^2(q) - \pi_c = -(\theta^* - \theta^{*2}(q))\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b\} - \theta^{*2}(q)\underline{\alpha}[\frac{1-\overline{\beta}}{2})]F^b < 0$$

Thus, at $q = 1 - \overline{\beta}$, $\pi_c^2(q) < \pi_c$.

At $q = \overline{q}$, $\theta^* = \theta^*2$. Hence, we get,

$$\pi_c^2(q) - \pi_c = \theta^{*2}(q)\underline{\alpha}(1 - \overline{\beta})w > 0$$

Therefore, we can conclude that over the interval $[1-\overline{\beta}, \overline{q}]$, there exists a leniency rate, $\underline{q}$, above which the profitability of the illegal activity increases under a symmetric leniency program compared to the benchmark while it decreases otherwise. Furthermore, since $\frac{\delta[\pi_c^2(q) - \pi_c]}{\delta q} > 0$, the profitability of the illegal activity under a symmetric leniency program will exceed its profitability under no leniency for any $q > \underline{q}$.■

1.B.3 Proof of Proposition 1.3

The legislator's program is:

$$\underset{q}{\text{Min}}\ \{Pr(\pi_c^s(q) > 0) + Pr(\theta < \theta^{*s})\} \text{ where } s = 1, 2$$

$$\text{s.t. } (1 - \overline{\beta}) \leq q \leq 1$$

Under an asymmetric leniency program:
From equation (1.4), the legislator's objective function could be rewritten as:

$$\underset{q}{\text{Min}}\ \{Pr(\pi > \overline{\alpha}F^i - \theta^{*1}\{(\Delta\alpha)F^i - B - [\underline{\alpha}(1-q) + (1-\underline{\alpha})\underline{\beta}]F^b\}) + Pr(\theta < \theta^{*1})\}$$

From equation (1.3), θ^{*1} is not a function of q. So, the legislator's objective function could be reduced to:

$$\underset{q}{\text{Min}}\ \{(\Delta\alpha)F^i - B - [\underline{\alpha}(1-q) + (1-\underline{\alpha})\underline{\beta}]F^b\}$$

$$\text{s.t. } (1 - \overline{\beta}) \leq q \leq 1$$

$$\text{F.O.C.:} \underline{\alpha}F^b > 0$$

The solution to this problem will be thus a corner solution: $q^{*1} = 1 - \overline{\beta}$.
We get the π_c^{*1} by substituting q^{*1} in equation (1.4).

Under a symmetric leniency program:
From equations (1.6) and (1.7), the legislator's objective function could be rewritten as:

$$\underset{q}{\text{Min}}\ \{Pr(\pi > \overline{\alpha}F^i - \theta^{*2}\{(\Delta\alpha)F^i - B - [\underline{\alpha}(1-q) + (1-\underline{\alpha})\underline{\beta}]F^b\}) + Pr(\theta < \theta^{*2})\}$$

$$\text{s.t. } (1 - \overline{\beta}) \leq q \leq 1$$

which can be reduced to:

$$\underset{q}{\text{Min}}\ \theta^{*2}(q)\{(\Delta\alpha)F^i - B - [\underline{\alpha}(1 - \frac{q}{2}) + (1-\underline{\alpha})\underline{\beta}]F^b\} + \theta^{*2}(q))$$

$$\text{s.t. } (1 - \overline{\beta}) \leq q \leq 1$$

$$\text{and } \theta^{*2}(q) = B - (1-\underline{\alpha})\underline{\beta}(F^b + w) - \underline{\alpha}[(1 - \frac{q}{2})F^b + w]$$

F.O.C.:

$$\underline{\alpha}\frac{1}{2}F^b\{(\Delta\alpha)F^i - B - [\underline{\alpha}(1-\frac{q}{2}) + (1-\underline{\alpha})\underline{\beta}]F^b\} + 1\} + \underline{\alpha}\frac{1}{2}F^b\{B - (1-\underline{\alpha})\underline{\beta}(F^b + w) - \underline{\alpha}[(1-\frac{q}{2})F^b + w]]\}$$

S.O.C.:

$$\frac{1}{2}(\underline{\alpha}F^b)^2 > 0$$

$\therefore$ F.O.C. at $q = 1 - \overline{\beta}$:

$$\underline{\alpha}\frac{1}{2}F^b\{(\Delta\alpha)F^i - B - [\underline{\alpha}\overline{\beta} + (1-\underline{\alpha})\underline{\beta}]F^b + B - [(1-\underline{\alpha})\underline{\beta} + \underline{\alpha}](w + F^b) + 1 + \underline{\alpha}F^b\} > 0$$

The solution to this problem will be thus a corner solution: $q^{*2} = 1 - \overline{\beta}$.
We get θ^{*2} and π_c^{*2} by substituting q^{*2} in (1.6) and (1.7) respectively.

The third part of the proposition consists of a comparison between $\theta^{*2}(q^{*2})$ and θ^{*1}, and between $\pi_c^{*2}(q^{*2})$ and $\pi_c^{*2}(q^{*1})$, at $q^{*1} = q^{*2} = 1 - \overline{\beta}$;

$$\theta^{*1} - \theta^{*2} = -\frac{\underline{\alpha}(1-\overline{\beta})}{2} F^b < 0$$

$$\pi_c^{*1} - \pi_c^{*2} = \underline{\alpha}(1-\overline{\beta})F^b\{\frac{1}{2}(\Delta)F^i + \frac{1}{2}(\frac{\underline{\alpha}(1-\overline{\beta})}{2})F^b + \frac{1}{2}[\underline{\alpha} + (1-\underline{\alpha}\underline{\beta})]w - B\} \geq 0$$

■

Chapter 2

On Corporate Crime, Compliance Programs and Corporate Reputation[1]

2.1 Introduction

In 2015, the United States (US) Environmental Protection Agency has accused Volkswagen Group (VW), the German automaker, for installing a "defeat device" in VW diesel-engine cars, which is known publicly as the "dieselgate". This device consists of a software that aims at detecting the time when the emission performance of a VW car is being tested by a regulatory authority, and intentionally reduce the car's CO2 emission, only during the test, in order to comply with the legal requirements. The automaker has admitted that the software has been installed in 11 million cars worldwide. As a result, the stock value of VW dropped by 22% in one day, and its CEO resigned within few weeks following that scandal (Siano et al., 2017). In US alone, this scandal has resulted in a financial loss of $20 billion, including 4.3$ billion of criminal and civil charges. Moreover, six VW executives, who are not member of the management board, are facing criminal charges for their role in this violation (Tabuchi et al., 2017). In Germany, VW is facing nearly 1600 lawsuits from investors seeking compensation for the massive drop in VW shares following its admission of the scandal (Reuters, 2018).

Interestingly, in VW's sustainability reports for the period 2012-2014, the company highlighted its ambition to become a leader in environmental sustainability, in particular in terms of CO2 emission reduction. Furthermore, it attempted to integrate the commitment to environmental sustainability as part of the corporate culture. For instance, VW employees were engaged in environmental protection projects, workshops and training sessions were organized to ensure that the employees comply with the corporate objectives. Also, the external suppliers were subject to strict requirements and constant monitoring to verify that they meet the environmental sustainability standards set by VW (Siano et al., 2017).

[1]I am grateful to Maria Pia Sacco, Paulo Vanin, Philip Curry, Lucio Picci and the participants of the PhD Seminar at the University of Bologna for their useful comments on earlier versions of the model.

The "dieselgate" provides a rich framework to analyze the different aspects of a corporate crime. First, unlike an individual crime, a corporate crime is characterized by its "agency" nature. That is, the crime is committed by a firm agent such as a manager (as in the VW case), an employee, or an independent contractor. Also, the crime consequences benefit not only the individual agent who committed the crime, but the whole firm as well (Arlen, 1994). Examples of corporate crime include public officials bribing, financial fraud, product misselling, tax avoidance, market collusion, environmental rule infringement, and human right violation.

Even if the corporate crime is committed by an agent of the firm, the whole firm as a legal entity can be subject to a corporate sanction. Indeed, holding the firm liable for its agent's misconduct is considered as a key element to deter a corporate crime since the firm can undertake several measures to prevent its agent's misconduct, such as the managerial incentives, regular audit and monitoring..etc. Hence, several jurisdictions have incorporated n their laws different scopes of corporate liability. For instance, in some countries, such as in Sweden and Russian Federation, the firm is subject to the corporate liability only if the crime was committed by a top manager, while in other countries, such as US, Italy, Korea and Japan, the firm is liable not only if the a top manager has committed the crime but also if he fails to take adequate measures to prevent it (OECD, 2016). Jurisdictions might differ as well in whether the liability should apply to only to the firm responsible of the crime (as a legal entity), or also to all the firm individuals involved in the crime. The US Antitrust Law is an example of former jurisdictions while the EU Competition Law is an example of the latter (Angelucci and Han, 2010).

The legal sanctions are not the only penalty that a firm encounters for committing a corporate crime, the firm might be also subject to market penalties or reputational loss, which can discourage the firm stakeholders to continue dealing with the firm. The reputational loss often takes the form of a drop in the firm's share's price, which differs based on the type of the crime committed. For instance, a crime that affects the stakeholders of the firm such as fraud or product recall has a remarkable impact on the firm's value, as compared to crimes that affect third parties as environmental violations (Karpoff et al., 2005).

In order to limit the harmful effects of corporate crimes, firms are encouraged to adopt compliance programs. These programs consist of a set of measures that vary between ex-ante measures (e.g., due diligence when hiring the agent, taking preventive measures, training and educating the employees) and ex-post measures (e.g., auditing and monitoring the agent, self-reporting and the cooperation with the law enforcer) (OECD, 2009). Therefore, implementing a credible and effective compliance program allows the firm to maintain a good reputation. Moreover, some jurisdictions provide lenient treatment to the firm if an effective compliance program was in place when the corporate crime has occurred, e.g. US, Canada and UK (OECD, 2016). However, as in VW case, compliance programs are not always a sign of commitment to deter corporate crime but they could serve as window-dressing policies or greenwashing that aim to gain market legitimacy and to avoid the sanctions by mimicking an effective compliance program (Krawiec, 2003).

Using a game theoretical framework, we address the question of the credibility of corporate compliance programs and the conditions under which it becomes a "window-dressing" one. In particular, we emphasize the role of corporate reputation in the design of compliance program and the managerial incentives and its impact on the level of corporate crime.

We model the corporate crime as an agency problem between the firm (the principal) and the manager (the agent)[2]. The firm hires a manager to perform a task that provides her with a surplus in exchange of a payment contract. The manager holds a private information on his ability to use an unlawful technology, which improves his chances in completing the delegated task and hence improves the principal's chance to receive the surplus. Depending on this information and the payment offered by the firm, the manager decides whether to exploit his ability or not: Indeed, by raising the payment offered to the agent, the principal raises the probability that an agent uses the unlawful technology. If the manager decides to breach the law, a hard evidence is generated.

In this model, we will focus on the features of the compliance program that could be applied ex-post, notably the monitoring. Therefore, the firm may collect the misconduct's evidence if a compliance program is implemented. The quality of the compliance program depends on the amount invested in it: The higher the amounts dedicated to the compliance program, the higher the likelihood of collecting the evidence. Whenever the incriminating evidence is detected, the firm decides whether to disclose it to the law enforcer or not. In case of disclosure, she and the manager will be subject to corporate and individual sanctions. Otherwise, the evidence can be found by the law enforcer and the firm will face a reputational loss in addition to the legal sanction. In other words, by determining the firm's ability to find the evidence, the amount invested in compliance program affects the expected corporate and individual sanctions and the probability that the firm will be subject to a reputational loss.

The amount invested in the compliance program is optimally chosen by the firm: She trades-off the higher cost of investment in compliance and the higher payments offered to compensate the manager for the higher expected sanction with the lower risk of loosing her reputation. Similarly, the optimal level of corporate crime reflects a trade-off between the higher expected surplus from one side with the higher payment to the manager needed to encourage the corporate crime and the higher expected corporate sanction from the other side.

The importance of the reputational loss, together with the profitability of the task delegated to the agent determine the principal's optimal investment in the compliance program and the principal's optimal level of corporate crime. We show that reputational losses do not always completely deter the corporate crime. Moreover, large investments in compliance are not necessarily associated with lower levels of corporate crime and that modest investments in compliance (and sometimes the absence of a compliance program at all!) are not necessarily a sign that the firm promotes corporate crime. These results stem from the interplay between the in-

[2]Along the analysis, we refer to the firm/principal using the female form (she/her) and the manager/agent by the male form (he/his).

vestment in compliance program and the managerial incentives in equilibrium.

When the reputational loss is high and the task entails a large surplus, the firm will engage in excessive monitoring allowing her to collect the incriminating evidence and to disclose it more likely. Accordingly, the monitoring provides the firm with a shield from the reputational loss alleviating thus the marginal cost of the crime. As a result, the firm finds it profitable to increase the managerial incentives to boost corporate crime and to enjoy the large surplus more likely. It is a case where the compliance program is void: Its deterrent power is diluted by the higher incentives making it a "window-dressing" program.

Interestingly, when the reputational loss is high but the surplus of the task is low, the firm reduces or even stops the investments in compliance as a response to higher levels of reputational loss. In that case, the returns from the crime are not too high and they are associated with large expected sanction. The maximization of the firm's payoff requires limiting the level of corporate crime. Relying on monitoring to control the corporate crime entails additional costs and is not rewarding enough since the reputational loss becomes less threatening due to the low levels of corporate crime. Hence, in this case, the firm prefers to rely solely on lower incentives to achieve its objective. This is a case where the deterrence of corporate crime does not depend on the compliance program.

Another instance where the firm does not implement a compliance program is when the task surplus is high while the reputational loss is low. This situation makes the corporate crime more appealing. The investment in compliance implies a reduction of the power of the managerial incentives: By investing in compliance, the principal increases the agent's expected sanction. Hence, part of the managerial incentive is used to compensate the agent for the expected sanction, making it costly for the firm to provide incentive to use the unlawful technology. The principal exploits thus the low reputational loss: She mutes the compliance program to increase the power of the managerial incentives, even though she will risk her reputation.

Finally, when the reputational loss is moderate and regardless of the profitability of the task, the investment in compliance programs becomes necessary to avoid the reputational loss. This investment makes the corporate crime less attractive: Providing incentives to the agent to breach the law becomes costly since he needs to be compensated for the higher expected sanction. Meanwhile, the investment in compliance, and hence the probability of detecting the incriminating evidence, is not high enough to guarantee a protection against the reputational loss. In that case, higher levels of reputational loss lead to lower levels of corporate crime.

The main contribution of our work is the study of the corporate crime while considering the firm's reputational loss and endogeneizing both the managerial incentives and the investment in compliance program. To our knowledge, the closest paper to our work is Angelucci and Han (2010). In this paper, they study the optimal leniency policy while considering the agency problem within the firm and the possibility of implementing a compliance program, adding thus a new level to the analysis of the design of leniency programs. The main result of the paper is that the optimal leniency program is the corporate leniency program rather than the individual one. The reason behind this is two folds. First, an individual leniency program will increase the manager's incentives to commit the corporate crime by reducing its expected cost. Second, offering a lenient sanction to the firm would increase the incentives of a firm that adopted a compliance program to cooperate with the law enforcer, which raises the expected cost of the crime to the manager.

Like Angelucci and Han (2010), we consider the design of the managerial incentives and the compliance program. However, our work departs from Angelucci and Han (2010) in several respects. First, we consider policy parameters different than those studied in Angelucci and Han (2010). Precisely, we consider the reputational loss which is a market penalty and can take any value instead of the leniency program designed by the law enforcer. Second, a main difference is that we treat the level of corporate crime and the investment in compliance program as continuous variables instead of binary ones which provides more insights on the interaction between these two elements: We can detect not only whether the principal adopted a compliance program or not, but we detect as well the effectiveness of the program. Moreover, in our model the agent's decision to commit the crime depends on his private type. Therefore, the principal can design the contract in a way to allow some types to breach the law while other types not to do so, which serves as a measure of the level of the corporate crime. These two features enable us to relate between the effectiveness of the compliance program and the level of corporate crime, which is missed in Angelucci and Han (2010)'s model. Third, we adopt a positive approach by studying the design of managerial incentives and the compliance program given different levels of reputational loss, while Angelucci and Han (2010) adopt a normative one by considering the optimal design of the policy parameters.

Our work is related as well to the strand of literature on the design of managerial incentives with harmful activities, (e.g. Aubert, 2009; Inderst and Ottaviani, 2009; Goldman and Slezak, 2006). Different corporate crimes, such as market collusion, financial fraud and misselling of products, have been considered in these studies. Our main contribution to this strand is treating the monitoring of the agent's misconduct as an endogenous variable that affects both the principal and the agent's payoffs, while other models have considered the monitoring as an exogenous variable that raises only the agent's expected sanction. Endogenizing the monitoring introduces new trade-offs to the study of the corporate crime. David Robison and Santore (2011) have studied the role of monitoring and the reputational loss that occurs upon the detection of the corporate crime. The reputational loss is thus similar to the legal sanction in our model. However, the model did not address the idea of the principal's cooperation with the law enforcer. As a result, the monitoring in David Robison and Santore (2011) plays a deterrent role by raising the manager's expected sanction from the crime and might exhibit a perverse effect as it makes the reputational loss more likely to occur. Unlike our model, this model did not capture the protective effect that the monitoring might play.

Finally, our model contributes to the monitoring literature (e.g. Arlen, 2012; Oded, 2011). Particularly, we provide a theoretical framework for the instance of adopting "window dressing" compliance programs. The question of these cosmetic programs has arose in the law and economics literature (Krawiec, 2003; Oded, 2011) but no formal analysis on the firm's incentives of adopting such programs was provided. Moreover, we add new aspects to the problem of choosing the monitoring technology, such as the profitability of the agent's task and the reputational loss.

The remainder of this chapter is organized as follows: The model set-up and the timing are presented in Section 2.2. We derive the equilibrium under full information and costless monitoring in Section 2.3, while the analysis of the case of non-observable ability of using the unlawful technology with costly monitoring is reported to Section 2.4. The main results of our model regarding the impact of the reputational loss on the equilibrium levels of monitoring and corporate crime are in Section 2.5. We provide some policy implications in Section 2.6 and conclude in Section 2.7.

2.2 The Model

2.2.1 Set-up

In order to assess the impact of corporate reputation on the optimal design of compliance programs and the optimal level of corporate crime, we refer to a game theoretical model that consists of two risk neutral players: a Principal and an Agent.

The Agent, who could be an employee, an independent contractor or a manager, decides whether to accept the task delegated by the principal or not[3]. He can use either a lawful or an unlawful technology to perform the task. The technology choice is not observable by the principal. The unlawful technology results in a corporate crime such as bribing a public official, implementing risky environmental projects or providing misleading information to customers.
If the agent proceeds lawfully, the task is accomplished with a baseline probability $\underline{p}$. If he decides to use the unlawful technology, a hard evidence is generated and his ability to use this technology, θ_i, determines the probability of accomplishing the task, $p(\theta_i) \in]0;1]$. θ_i is private information, lies within $[\underline{\theta}, \bar{\theta}]$ and is distributed with cdf $G(.)$ and pdf $g(.)$. We assume that the higher the θ_i, the higher the agent's ability level of using the unlawful technology and subsequently, the more likely he will perform the task. Moreover, we assume that the marginal increase of the probability of task completion does not depend on the agent's type, *i.e.* $\frac{\partial^2 p}{\partial \theta_i^2}(\theta_i) = 0$. The unlawful technology is at least as efficient as the lawful one, i.e. $p(\theta_i) \geq \underline{p}$, and the least skillful agent achieves the task with the baseline probability: $p(\underline{\theta}) = \underline{p}$[4].

The Principal, *e.g.* a firm, hires the agent to perform a task. If the task is

[3]For sake of simplicity, we assume that the agent has a zero outside option. The impact of a positive outside option on the results is discussed briefly in footnote 11.

[4]The model allows for the case where the unlawful technology is less efficient than the lawful one if the agent's ability to use it is sufficiently low, *i.e.* $p(\theta_i) < \underline{p}$ if $\theta_i < \check{\theta}$. Considering this case will result in shifting the lower bound of the potential criminal agents upward: The principal can never provide enough incentives to let the types $\theta_i < \check{\theta}$ engage in an unlawful activity The qualitative results of the model will remain unaltered.

accomplished, the principal receives a surplus Π. She offers a transfer to the agent that will be indicated as the contract. The transfer consists of two components: a non-contingent part $\bar{t}$ that the agent receives regardless of his performance and a contingent part, t_c, that he gets upon the completion of the task. We assume that the agent is subject to a limited liability constraint, implying that $\bar{t} \geq 0$ and $t_c \geq 0$.

Furthermore, the principal designs a compliance program. The aim of the compliance program is to detect the evidence of the agent's misconduct by monitoring the latter and conducting internal investigations. The principal's investment in monitoring determines the probability of finding hard evidence of the misconduct, denoted by $\gamma \in [0, 1]$, and costs $C(\gamma)$. To ensure that the principal's problem is well-behaved, we assume that $C(0) = 0$, $\frac{\partial C}{\partial \gamma}(0) = 0$, $\frac{\partial C}{\partial \gamma} > 0$ and $\frac{\partial^2 C}{\partial \gamma^2} > 0$. Upon the detection of the evidence, the principal decides whether to disclose the evidence to the law enforcer or not.

The institutional framework. A law enforcer launches an investigation to detect corporate crime and finds the evidence with a probability α. Whenever the misconduct is detected by the law enforcer, a strict liability regime applies[5]: A corporate fine, F, and an individual fine, f, are imposed on the principal and the agent respectively.

In addition to the legal sanctions, the principal faces a reputational loss, R, if she does not deliver the evidence of the misconduct to the law enforcer before the start of the investigations [6]. Indeed, the principal will not deliver the evidence in two circumstances: First, the principal finds the evidence of the misconduct but chooses not to bring it to the law enforcer. Second, the principal was not able to find the evidence.

In the analysis, we exclude the first reason by assuming that the reputational loss is sufficiently high that the principal prefers to cooperate with the law enforcer whenever the evidence is found[7], which can be formulated as follows:

Assumption 2.1.

$$R \geq \frac{1-\alpha}{\alpha} F$$

[5]The principal could be subject to other corporate liability regimes , *e.g.* a compound liability regime (Oded, 2011) or a composite liability regime (Arlen, 2012), that are found to be socially optimal with respect to the strict liability regime. We defer the discussion about these liability regimes to section 2.6.

[6]In the period 2002-2006, whereas 40% to 60% of the enterprises sentenced under the US Federal Guidelines have cooperated with the investigations, only 1% to 6% self-reported the corporate crime (Mullin and Snyder, 2009). Our model could accommodate ex-post cooperation. In that case, we would consider two different probabilities: α_1 as the probability of launching investigation and α_2 as the probability of finding the evidence by the law enforcer if the principal fails to report it. Moreover, the principal's decision to cooperate with the law enforcer will follow the launch of the investigation instead of self-reporting. The qualitative results of the model will not change if we consider this setting.

[7]The assumption on the principal's honesty is plausible: Under some regulations, the principal might face individual liability for failing to report the misconduct or might receive a bounty for his cooperation (Arlen, 1994). Moreover, a principal might prefer to report a violation to avoid the risk of higher corporate sanctions, if the violation is detected later (as under corporate leniency programs) which might affect the firm's value and future profits (Angelucci and Han, 2010).

2.2.2 Payoffs

The Principal. The principal receives the surplus Π if the task is completed and pays a transfer to the agent. The transfer consists of $\bar{t}$ that is independent of the agent's performance and t_c that is contingent on the completion of the task. The principal invests in compliance program, $C(\gamma)$, and with probability γ, finds the evidence of misconduct that she reports to the law enforcer to pay a corporate fine F. Otherwise, the law enforcer finds the evidence with probability α and the principal faces the sanction F and the reputational loss R.
The principal's expected payoff if the agent breaches the law is thus:

$$p(\theta_i)\,(\Pi - t_c) - \bar{t} - C(\gamma) - [\gamma\, F + (1-\gamma)\,\alpha\,(F + R)]$$

If the agent proceeds lawfully, the principal's expected payoff would be:

$$\underline{p}\,(\Pi - t_c) - \bar{t} - C(\gamma)$$

The Agent. The agent receives the transfer, and faces an individual sanction f whenever the evidence is found. Therefore, the agent's expected payoff, if he breaches the law is:

$$\bar{t} + p(\theta_i)\,t_c - [\gamma + (1-\gamma)\,\alpha]\,f$$

If he complies to the law, his payoff would be:

$$\bar{t} + \underline{p}\,t_c$$

2.2.3 Timing

The previous set-up has the following timing:

- $\tau = 1$ Knowing the surplus from the task, Π, the principal decides upon the transfer, t_c and $\bar{t}$, and the probability of finding the evidence, γ.
- $\tau = 2$ The agent observes his type, θ_i, and decides whether to reject the task and get the outside option, or to accept the task. If the task is accepted, the agent determines whether to commit the corporate crime. The task is achieved with probability $p(\theta_i)$ if he commits the crime, and with probability $\underline{p}$ otherwise .
- $\tau = 3$ The principal monitors the agent and starts an internal investigation. If a crime is committed, the evidence is found with probability γ.
- $\tau = 4$ If the principal finds the evidence of misconduct, she provides it to the law enforcer. Otherwise, the evidence is found by the law enforcer with probability α. In both cases, the sanctions F and f apply. In the latter case, the principal faces a reputational loss R and the game ends.

We look for *Subgame Perfect Nash Equilibrium* by solving the game by backward induction.

2.3 Observable Ability of Using Unlawful Technology and Costless Monitoring: The Benchmark

In a full information context, the principal perfectly observes the agent's ability to use the unlawful technology, θ_i. Furthermore, she can detect the agent's decision to commit the corporate crime and the evidence of the misconduct without incurring the costs of implementing a compliance program. These features of the full information context allow the principal to design a contract that depends on both the agent's private type and on his decision to commit the crime.

Even though the corporate crime entails some benefits to the principal, those benefits always come at a price. The unlawful technology can be perceived as a tool enabling the agent to complete the task with higher probability which benefits the principal. However, the unlawful technology is deemed not to be socially optimal, which puts the principal and the agent at risk of facing corporate and individual sanctions given the strict liability regime we are considering. Indeed, if a corporate crime is committed, the sanctions will apply with certainty: The principal, who perfectly observes the crime, collects the evidence costlessly and reports it to the law enforcer to avoid the reputational loss by assumption 2.1.

As for the transfers, to ensure that the agent undertakes the task, the principal has at least to compensate him for the costs related to it. In case the unlawful technology is used, these costs are mainly the cost of committing the corporate crime which is the individual sanction. Consequently, the principal finds it optimal to offer the agent a non-contingent transfer that is equivalent to the individual sanction, extracting thus the agent's rent. Therefore, by pushing the agent to commit the crime, the principal bears the costs of the corporate sanction and the payment offered to the agent. As a result, she prefers the unlawful technology if the agent's ability to use it is sufficiently high such that the expected surplus emanating from the task is large enough to incorporate these costs.

Accordingly, if the agent lacks the ability to manipulate the unlawful technology in a way that generates an expected surplus that is sufficiently high, the principal opts for the lawful technology, even if she obtains the surplus less likely: By proceeding lawfully, both the principal and the agent avoid legal sanctions. Moreover, the principal pays the agent a non-contingent transfer that is equal to his outside option, which is null in our model. Thanks to these lower costs, the lawful technology becomes the principal's best choice when the expected surplus is not sufficiently large.

The following proposition states the condition under which the principal opts for the unlawful technology and the optimal transfers offered to the agent when his type is observable.

Proposition 2.1. *If the agent's ability to use the unlawful technology is observable:*

The unlawful technology is adopted by the principal if the agent's ability to use it is sufficiently large: The expected surplus of the task should compensate the principal *for the sanctions resulting from the corporate crime and should be at least as equal as the expected surplus of adopting the lawful technology. This condition is satisfied if:*

$$p(\theta_i) \geq p(\tilde{\theta}) = \underline{p} + \frac{F + f}{\Pi}$$

The optimal payment contract consists of a non-contingent transfer, $t = \bar{t}$, such that:

- *If the unlawful technology is adopted ($\theta_i \geq \tilde{\theta}$), $\bar{t} = f$.*
- *If the lawful technology is adopted ($\theta_i < \tilde{\theta}$), $\bar{t} = 0$.*

The principal does not implement a compliance program.

Proof. See appendix 2.A ■

2.4 Non-observable Ability of Using Unlawful Technology and Costly Monitoring

Once the agent decides to undertake the task, his strategy consists of a binary choice: to use the unlawful technology or not. His decision depends on his ability to use the unlawful technology and on the contract offered by the principal. In other words, if the likelihood of completing the task and the transfer that the agent will receive compensate him for the expected individual sanction and leave him with a payoff at least as equal as the one he would have received by proceeding lawfully, the agent breaches the law. The payment contract is thus "the carrot" through which the principal affects the agent's decision even if she does not observe his type.

Unlike the full information benchmark, the principal can manipulate the decision of his agent through another tool; the "compliance program", which provides the principal with a monitoring technology. It can be thus considered as a "stick". The investment in compliance program determines the likelihood that the principal detects the agent's misconduct. This, in turn, defines the expected individual sanction that the agent faces.

Besides the introduction of a compliance program, the private ability and costly monitoring case departs from the benchmark in another aspect. The failure of the principal to find an existing incriminating evidence exposes her to the loss of her corporate reputation, R, if the law enforcer collects the evidence while investigating the case. R can be considered as an additional sanction that the principal incurs for failure to undertake his responsibility of ensuring the agent's compliance. It is a sanction imposed by the stakeholders.

As discussed in section 2.3, the agent's decision affects the principal's payoff in two aspects. First, it determines the probability of achieving the task and receiving the surplus. Second, if the agent breaches the law, the principal bears a corporate sanction. Therefore, the principal would prefer the unlawful technology only if the agent's ability is sufficiently high in a way that compensates her for the corporate sanction and the cost of hiring the agent. Similarly, with private ability, the principal designs her tools to induce an agent with sufficiently high ability to use the unlawful technology and to deter an agent with low ability from doing so.

In formal terms, we define a marginal ability level, $\widehat{\theta}$, at which the agent is indifferent between using the unlawful technology and proceeding lawfully: If the agent's ability is higher than the marginal level, $\theta > \widehat{\theta}$, he uses the unlawful technology. Otherwise, the agent complies with the law. The principal gets the surplus with an aggregate probability $P(\widehat{\theta}) = \underline{p} \int_{\underline{\theta}}^{\widehat{\theta}} g(\theta_i)\, d\theta_i + \int_{\widehat{\theta}}^{\bar{\theta}} p(\theta_i)\, g(\theta_i)\, d\theta_i$ and corporate crime occurs with probability $1 - G(\widehat{\theta})$. In the following analysis, we will use the symbol * to represent the principal's optimal value of the variables.

In an imperfect information setting, the marginal level of ability turns out to be the key element in the principal's payoff: It determines the aggregate probability of completing the task, as well as the principal's optimal level of corporate crime. Being a benchmark that separates between the types that use the unlawful technology and those who are deterred from doing so, the optimal marginal ability level determines the probability that a corporate crime takes place within the firm, $1 - G(\widehat{\theta}^*)$. By properly designing her tools, the principal can affect the marginal ability level in a way that maximizes her payoff.

The main purpose of the transfer, when the agent's ability is not observable, is to ensure that an agent with the marginal ability will receive the same expected payoff either when he breaches the law or when he complies to it[8]. It is only by offering a transfer that is contingent on the completion of the task that the principal can reach this target: If the transfer has been independent of the agent's performance, he would have received it regardless of his decision to use the unlawful technology. It wouldn't have thus affected the agent's strategy. But, the probability of completing the task depends on the agent's decision to commit the crime and on his ability to manipulate the unlawful technology, which makes a contingent transfer an adequate tool to ensure the marginal agent's indifference regarding the use of the unlawful technology.

The optimal transfer, t_c^*[9] is captured by the following equation:

$$t_c^* = t_c(\widehat{\theta}^*, \gamma^*) = \frac{[\gamma^* + (1-\gamma^*)\,\alpha]\, f}{p(\widehat{\theta}^*) - \underline{p}} \tag{2.1}$$

It consists of the expected individual sanction discounted by the difference in the probabilities of completing the task when the unlawful technology is used and when it is not. It accounts thus for both the costs and benefits that a corporate crime entails for an agent with the marginal ability level.

[8]As will be shown in Appendix 2.B, the principal's problem is to determine the optimal transfer and the optimal probability of detection. However, a one to one relationship exists between the transfer and the marginal ability level. We can thus exploit this relationship and switch the variables in the principal's problem without affecting the main results of the model. Therefore, by optimally choosing the marginal ability level of using the unlawful technology, the principal chooses the optimal transfer and vice-versa.

[9]In this setting, the optimal contract cannot be designed to reveal the agent's private type: The agent's decision that depends on his type is whether to use the unlawful technology. This decision is not observable by the principal, making such contract impossible to be implemented.

Importantly, the contingent transfer always leaves the agent with an information rent, which ensures his participation to the task: The contingent transfer is a necessary incentive to induce an agent with high ability to use the unlawful technology. But, an agent who proceeds lawfully would receive it too. Lacking the tools to extract it, the principal would let this agent enjoy a positive rent. The same rent is left to the marginal agent to satisfy the indifference condition. Typically, this rent is $\underline{\rho} = \underline{p}\, t_c^*$. Clearly, an agent with an ability level higher than the marginal one enjoys larger rent and the rent increases with the ability level. Namely, an agent with ability level θ_i receives $\rho_i = \underline{\rho} + [p(\theta_i) - p(\widehat{\theta}^*)]\, t^*$.

The principal cannot only affect the agent's gain from a corporate crime. She can also control the cost that he incurs from committing it. The compliance program can be viewed as a tool that affects directly the agent's expected sanction. Once the incriminating evidence is found by the principal, which occurs with probability γ, the agent will face the individual sanction with certainty. Otherwise, the agent's sanction will depend on the law enforcer's ability to collect the evidence.

Together with the transfer, the compliance program is used by the principal to satisfy the marginal agent's indifference between breaching the law and complying to it. Particularly, for a given ability level, as the probability of finding the evidence increases, so does the transfer offered to the agent in order to compensate him for the expected loss. That way the marginal agent will remain indifferent between the two available options. The stick and the carrot can be perceived thus as complements. Furthermore, the increase in the contingent transfer that follows a marginal increase in the probability of finding the evidence does not apply only to the marginal agent, but to any agent provided that he completes the task.

In addition to its impact on the agent's payoff, the investment in compliance has direct effects on the principal's payoff. Indeed, a better detection of the agent's misconduct affects the principal in two respects. First, it requires higher investments in compliance, which is translated into an increase in the cost of monitoring, $C(\gamma)$. Second, a higher probability of finding the evidence implies that the principal would cooperate with the law enforcer more likely, if a corporate crime occurs. By cooperating, the principal faces a reduced sanction: She would bear only the corporate sanction, F, and avoid the reputational loss, R, that would have taken place if she had failed to disclose the evidence.

The optimal probability of finding the evidence, γ^*, is determined by the following F.O.C.:

$$l(\widehat{\theta}^*, \gamma^*) = [1 - G(\widehat{\theta}^*)]\,[\alpha\,(F + R) - F] - \frac{\partial C}{\partial \gamma}(\gamma^*) - P(\widehat{\theta}^*)\,\frac{\partial t_c}{\partial \gamma}(\widehat{\theta}^*) = 0 \qquad (2.2)$$

The optimal probability of finding the evidence reflects a trade-off: There is the marginal gain that the principal gets by disclosing the evidence and saving her reputation if the agent breaches the law (1^{st} term in 2.2). Also, the higher cost of monitoring and the cost of the higher transfer required to compensate the marginal agent (2^{nd} and 3^{rd} terms in 2.2).

The optimal choice of the payment and the probability of detecting the misconduct affects the optimal marginal ability level and thus the principal's optimal level of corporate crime[10] . The corporate crime benefits the principal: The more important the level of corporate crime, the more likely the principal would receive the surplus. Indeed, allowing an additional type to use the unlawful technology implies that the task will be completed with probability $p(\theta_i)$ instead of the baseline probability $\underline{p}$. The result for the principal would be a higher aggregate probability of receiving the surplus, $P(\widehat{\theta})$. Yet, the principal's reward gets smaller the higher the level of corporate crime: The ability of the additional agent to use the unlawful technology decreases and so does the probability of completing the task $p(\theta_i)$.

Just as important are the downsides of the corporate crime. Each additional type that uses the unlawful technology increases the probability that the principal faces an expected sanction: F at best and $F + R$ at worst. The higher expected sanction is one of the costs that the principal has to set against the higher expected surplus that she gets by raising the corporate crime level. The other cost consists of the higher transfer to be offered to the agent: Increasing the level of corporate crime requires decreasing the marginal level of ability. The principal should thus provide higher transfer to keep the marginal agent, who receives the transfer less likely then, indifferent regarding the use of the unlawful technology. So, the principal's optimal level of corporate crime, $\widehat{\theta}^*$ is represented by the following FOC:

$$h(\widehat{\theta}^*, \gamma^*) = \frac{\partial P}{\partial \theta_i}(\widehat{\theta}^*)[\Pi - t(\widehat{\theta}^*, \gamma^*)] - P(\widehat{\theta}^*)\frac{\partial t_c}{\partial \theta_i}(\widehat{\theta}^*, \gamma^*) + \frac{\partial G}{\partial \theta_i}\{\gamma^* F + (1-\gamma^*)\alpha(F+R)\} = 0 \tag{2.3}$$

The optimal level trades-off the higher expected surplus (1^{st} term in 2.3) with the the higher transfer and higher expected sanction (2^{nd} and 3^{rd} terms in 2.3, respectively) .

The following proposition summarizes the trade-offs determining the principal's optimal marginal ability level as well as the optimal probability of finding the evidence and the optimal transfer.

Proposition 2.2. *If the agent's ability to use the unlawful technology is non-observable, there exists an equilibrium such that:*

The level of corporate crime, $1 - G(\widehat{\theta}^*)$ that maximizes the principal's payoff, balances the benefits of a marginal decrease in the agent's ability and the costs the principal incurs for doing so.

The principal's optimal probability of finding the evidence, γ^*, trades-off the benefit of saving the corporate reputation, the direct cost of monitoring and the cost of increasing the agent's transfer.

The optimal payment takes into account the marginal agent's expected individual sanction and the higher expected transfer. It consists of a contingent transfer, t_c^*[11].

[10] As noted in footnote 8, the choice of the optimal marginal ability level will lead to the optimal choice of the transfer offered to the agent due to the one to one relationship between the two variables that is described through equation 2.1.

[11] If we allow for a positive outside option and if Π is sufficiently small, the optimal transfer will consist of non-contingent and contingent payments. This type of contract allows the principal to

A positive rent is left to the agent.

Proof. See appendix 2.B. ■

2.5 Reputational Loss, Compliance Program and Corporate Crime

This section assesses the impact of reputational loss on the principal's incentives to invest in compliance program and on the principal's optimal level of corporate crime. Unlike the corporate sanction that applies whenever the crime is detected, the particularity of the reputational loss is that it is triggered by the principal's failure to disclose the incriminating evidence to the law enforcer. Therefore, its impact on the principal's choice variables is distinct from that of the legal sanctions. The following analysis will emphasize two cases: The case of tasks with low profitability and that with high profitability.

The surplus that the principal receives upon the completion of the task is one of the determinants of the level of corporate crime. An increase in the surplus implies that the task becomes more beneficial, and subsequently, the benefit of encouraging an agent with lower ability level to use the unlawful technology becomes more important (1^{st} term in 2.3). Accordingly, higher surplus results in higher levels of corporate crime and vice versa. The surplus does not affect the equilibrium level of monitoring directly, it affects it indirectly through the level of corporate crime.

The increase of the reputational loss entails a direct effect on the equilibrium levels of monitoring and corporate crime within the firm. Indeed, a higher reputational loss tends to increase the marginal benefit of monitoring: A more effective compliance program would enable the principal to find the evidence of the misconduct more likely, to cooperate and to acquire a protection against this higher sanction. Moreover, this higher penalty implies that a higher level of crime becomes more costly: The firm bears a higher expected sanction if a crime is committed. This direct effect suggests, thus, that an increase in the reputational loss is associated with a more effective compliance program and a lower level of corporate crime.

Nevertheless, this direct effect is not the only relevant factor. The increase of reputational loss affects the level of monitoring and the level of corporate crime indirectly through the feedback effects between the two variables, which might strengthen or weaken the direct effect depending on the values of the parameters as we will show in the following.

extract the agent's rent. The contingent payment ensures that the agent with the marginal ability level is indifferent between breaching the law and complying to it. The non-contingent payment extracts the expected bonus. This type of contract is viable only if the agent's outside option is positive and the bonus (and subsequently the level of crime) is not too large. Otherwise, the non-contingent payment will be negative, violating thus the limited liability constraint. Note that even though the restriction we impose on the outside option eliminate this type of contract in equilibrium, it does not alter the qualitative results of the model.

2.5.1 Tasks with low profitability

When the profitability of the delegated task is low, following an increase in the reputational loss, the principal chooses a higher level of monitoring in order to attenuate the risk of facing the higher sanction as suggested by the direct effect discussed above. By investing more in monitoring, the corporate crime becomes less attractive. Higher monitoring implies a higher probability of unveiling the incriminating evidence, which increases the expected sanction of the agent. The principal should thus provide a higher transfer, t_c, to the agent, which reduces the expected net surplus the principal gets from a higher level of corporate crime (1^{st} term in 2.3). Moreover, it becomes more costly to incentivize the agent with lower ability level to breach the law since he will face a higher expected sanction and he will receive the transfer less likely (2^{nd} term in 2.3). This increase in the marginal cost of the corporate crime that follows an increase in monitoring pushes the principal to reduce the transfer offered to the agent and thus the probability of using the unlawful technology. This indirect effect reinforces the direct effect of reputational loss on the level of corporate crime: The equilibrium level of corporate crime decreases with the reputational loss.

Note that the transfer is not the only channel through which the monitoring can affect the level of crime, the expected sanction is another one. An increase in probability of detection of the evidence means that the principal would face a reduced sanction more likely (3^{rd} term in 2.3), which reduces the marginal cost of crime and might push towards higher levels of it. When the reputational loss is not too high (i.e. the reduction in the sanction is small), the increase in the marginal cost through the transfer's channel dominates the reduction in the marginal cost of crime through expected sanction: The net impact of higher monitoring is lower levels of crime. Nevertheless, the impact of monitoring on the marginal cost of crime through the channel of expected sanction becomes more prevalent with the increase of the reputational loss[12]. Yet, even if this latter effect is dominant, the deterrent effect of the reputational loss (the direct effect) dominates the reduction of the crime's marginal cost induced by higher monitoring. This occurs when the level of monitoring is not too high: The principal ends up with lower probability of corporate crime.

As the reputational harm becomes more salient, the level of corporate crime in equilibrium becomes very low[13] and so does the marginal benefit of monitoring (1^{st} term in 2.2): The reputational loss is perceived as less threatening since it is less likely that a corporate crime occurs. The principal prefers thus to save on the costs of monitoring and reduces the investment in compliance. This is a situation where the indirect effect of reputational loss on monitoring dominates its direct ef-

[12] Formally, the dominance of the effect of monitoring on corporate crime through the expected sanction occurs if $\frac{\partial h}{\partial \gamma} = \frac{\partial l}{\partial \theta} < 0$. This condition is satisfied if:
$R > \tilde{R} = \frac{1}{\alpha} \{(1-\alpha)F - \frac{1}{\frac{\partial G}{\partial \theta}} [\frac{\partial P}{\partial \theta}(\widehat{\theta}^*) * \frac{\partial t}{\partial \gamma}(\widehat{\theta}^*) + P(\widehat{\theta}^*) \frac{\partial^2 t}{\partial \theta \partial \gamma}(\widehat{\theta}^*)]\}$.

[13] Note that the initial level of corporate crime is already not too high since the profitability of the task is low in this case.

fect leading to a decrease in the probability of detecting the evidence of misconduct. This trend continues as long as the reputational loss increases till a point where the principal finds it optimal not to implement a compliance program ($\gamma^* = 0$). Absent a compliance program and given the large reputational loss and the low surplus from the task, the principal optimally provides low incentives to the agent to deter the corporate crime. Otherwise, the principal will risk facing the large reputational harm.

In a nutshell, when the surplus from the task is small, deterring the corporate crime is the principal's response to an increase of the reputational loss: The principal relies on a harsher stick and less carrots to achieve his preferred outcome when the reputational loss is small. As the reputational loss increases, the principal gets rid of the stick but still provides less carrots to the agent.

The previous analysis is summarized in the following proposition[14]:

Proposition 2.3. *If the surplus of the task is sufficiently low, higher levels of reputational loss,R, are associated with lower levels of corporate crime, $1 - G(\widehat{\theta}^*)$. Moreover, the probability of finding the evidence, γ^*, is non-monotonic in R. There is a level of reputational loss, R_L such that:*

- *for $R \leq R_L$, $\gamma^*$is increasing with R*
- *for $R > R_L$, γ^* is decreasing with R*

Proof. See Appendix 2.C ■

2.5.2 Tasks with high profitability

When the task provides the principal with large surplus, different trade-offs come into effect to determine the impact of reputational loss on the principal's optimal level of monitoring and optimal level of corporate crime.

If the surplus is large enough and the reputational loss is low, a high level of corporate crime seems to be a natural choice for a principal who maximizes his payoff: If the agent uses the unlawful technology more likely, the principal will enjoy the high surplus while facing a low expected sanction. As a result, the principal prefers to set the monitoring to low levels. A lower investment in compliance would enable her to reduce the expected individual sanction and thus the cost of the incentives she needs to provide to the agent to induce higher levels of crime. Indeed, the principal might give up the investment in a compliance program: When the reputational loss is extremely low and the probability of committing a crime is high, the marginal increase in the transfer required by the principal to implement a more effective compliance program (3^{rd} term in 2.2) exceeds the higher marginal benefit that she might gain by doing so (1^{st} term in 2.2). In that case, the principal optimally chooses not to

[14]See Figures 2.1, 2.2, 2.3 and 2.4 for a graphical representation of the result of Proposition 2.3.

implement a compliance program[15], and she will be constrained to choose the level of corporate crime that satisfies equation 2.2 at $\gamma^* = 0$. The increase of the reputational loss relaxes this constraint, allowing the principal to choose higher levels of crime[16]. In short, a principal who expects large returns from the delegated task and will not be exposed to large reputational loss, will mute her compliance program and provide high transfer to her agent as an incentive to use the unlawful technology.

As the reputational loss grows, and given the high probability of committing the corporate crime, the marginal benefit of monitoring starts to play a role in the principal's optimal choice. For intermediate levels of reputational loss, the principal starts to invest in compliance program, raising thus the probability of detecting the incriminating evidence. As discussed in the subsection 2.5.1, the improvement in the effectiveness of the compliance program affects the principal's decision regarding the level of corporate crime in two respects.

First, the higher risk that an agent will face an individual sanction implies that a higher compensation needs to be provided to the agent for a given level of crime and that the incremental transfer necessary to convince an agent with lower ability to commit the crime becomes more important. As a result, this will discourage the principal from seeking a higher level of corporate crime, strengthening the direct effect of reputational loss on the level of corporate crime.

Second, an increase in the probability of finding the hard evidence of the misconduct, enhances the principal's chance to cooperate with the law enforcer by disclosing it, which reduces her exposure to the reputational loss. Clearly, this "protective effect" of monitoring reduces the marginal cost of the crime, providing incentive to the principal to boost the level of corporate crime by providing higher transfers to the agent. In such case, the monitoring counteracts the direct effect of the reputational loss on the level of corporate crime, particularly when the probability of detection is high.

Which effect dominates depends on the intensity of the reputational loss: On the one hand, if the reputational loss is moderate, the effect of monitoring on the transfers is the dominant one. As a result, the deterrent effect of reputational loss prevails: The principal provides lower incentives and increases the monitoring as the reputational loss increases, leading thus to lower levels of corporate crime. It is worthy to note that even if the level of corporate crime declines with the reputational loss, it will remain high enough to make it beneficial for the principal to always invest in monitoring. This is one of the differences between the tasks with high and low profitability.

On the other hand, if the reputational loss is sufficiently high, the protective effect of monitoring dominates its effect on the transfers. The reputational loss backfires,

[15] Particularly, in that case, the equilibrium is to invest negative amounts in compliance, which is not possible given the non-negativity constraint on $C(\gamma)$. Therefore, the principal relies on a corner solution according to which the investment in compliance is null.

[16] When $R < \tilde{R}$, then we have $\frac{\partial l}{\partial \theta} > 0$ (*c.f.*, footnote 12), i.e. the positive impact of higher θ on l through the marginal cost of monitoring dominates its negative impact through the marginal benefit. This implies that, when $\gamma = 0$, an increase in θ^* would be necessary to satisfy equation 2.2.

and will result into higher levels of corporate crime coupled with higher investments in monitoring. The compliance program turns to be a "window-dressing" program (Oded, 2011; Krawiec, 2003) that the principal uses as a proof of her commitment in controlling her agent to avoid the reputational loss, while she undermines this control through the incentives she provides to her agent. We have provided thus a theoretical framework for Wils (2013)'s argument that the application of a compliance program is neither a necessary nor a sufficient condition to have a real compliance. The excessive investment in monitoring dilutes thus the deterrent effect of the reputational loss.

The following proposition summarizes these observations[17]:

Proposition 2.4. *If the surplus of the task is sufficiently high, the probability of finding the evidence, γ^*, is always increasing with the reputational loss R. Furthermore, the level of corporate crime, $1 - G(\widehat{\theta}^*)$, is non-monotonic in R. There exist levels of reputational loss R_{H1} and R_{H2} such that*

- *for $R < R_{H1}$, $1 - G(\widehat{\theta}^*)$ is increasing with R*
- *for $R_{H1} \leq R < R_{H2}$, $1 - G(\widehat{\theta}^*)$ is decreasing with R*
- *for $R \geq R_{H2}$, $1 - G(\widehat{\theta}^*)$ is increasing with R*

Proof. See appendix 2.C ■

2.6 Policy Implications and Discussion

This section sheds light on some policy implications that could be derived from our model. Specifically, we will consider the impact of the reputational loss on the design of the optimal fine and on the desirability of liability regimes other than the strict liability one. We will discuss as well the compliance program-based leniency set by the *US Sentencing Guidelines*.

2.6.1 Optimal fine

The main purpose of the corporate fine is to incorporate the social harm resulting from the corporate crime into the firm's payoff. This allows the firm to adequately design the incentives provided to the manager and her policing tools to reach the socially optimal level of corporate crime (Arlen, 2012).

Garoupa (2000) suggests that the optimal fine should be adjusted downward to account for the non-legal sanctions that the firm might face. Otherwise, the corporate sanction might lead to overdeterrence. This result applies if we consider a case where the reputational loss is triggered whenever the crime is detected regardless of the firm's cooperation with the law enforcer and if the firm relies solely on the monetary incentives. However, if the severity of the reputational loss depends on the firm's cooperation with the law enforcer, our model suggests that the direction

[17] See Figures 2.5, 2.6, 2.7 and 2.8 for a graphical representation of the result of Proposition 2.4.

of the adjustment of the optimal corporate fine depends on the importance of the reputational loss. Indeed, the interplay between the design of compliance and the design of the transfers offered to the manager depends on the level of reputational harm, and it might lead to either overdeterrence or underdeterrence of the corporate crime. Accordingly, the optimal fine should be adjusted downward or upward depending on the case.

2.6.2 Liability regimes

In our model, the firm is subject to a strict liability regime: The firm is deemed liable for its agent misconduct regardless of the compliance measures it has undertaken. However, the optimality of this regime has been questioned by the law and economics literature (e.g. Arlen, 2012; Oded, 2011): If we set aside the reputational loss, the strict liability regime does not provide proper incentives to the firm neither to monitor nor to report her agents' misconduct to the law enforcer. Moreover, it entails a perverse effect on monitoring (Arlen, 1994), since a firm that detects the misconduct's evidence increases her likelihood of being liable. This perverse effect of monitoring leads to suboptimal levels of deterrence.

Therefore, other liability regimes that might be optimally superior have been suggested, *e.g.* a composite corporate liability regime (Arlen, 2012) and the compound corporate liability regime (Oded, 2011). The main idea of these regimes is that the firm should face a base sanction whenever the crime is committed and an additional sanction for failing to fulfill each of its policing duties, such as prevention, deterrence, self-reporting and cooperation with law enforcer, which provides the firm with incentives to invest in costly policing measures. Nevertheless, the main difference between the composite and the compound liability regimes remains in the condition under which the firm would be subject to the additional sanction. Whereas under a composite liability regime, there exists a due care level set by the law enforcer such that if it is reached by the firm, she avoids the additional sanction, under the compound liability regime, the additional sanction is avoided in case of self-reporting: Once the firm reports the misconduct, she receives a discount in the sanction equivalent to the variable costs of enforcement that the law enforcer would have bore to collect the evidence by himself (Oded, 2011). Yet, these studies on the optimality of the corporate liability regimes did not consider the reputational loss that the firm might encounter.

Introducing these liability regimes to our model would affect the optimal level of crime and the optimal probability of detection in a way that is worthy to note[18]. Particularly, the additional sanction suggested by these regimes might entail a perverse effect on the level of corporate crime. We might thus observe, under the compound or the composite liability regimes, levels of corporate crime that are higher than those observed under the strict liability regime for a given level of reputational loss. This is the case when the profitability of the task, Π, and the reputational loss, R,

[18] In Appendix 2.D.2, we provide a numerical example and a graphical representation illustrating this point. See Figure 2.14 and Figure 2.15 as an example of the case of tasks with low profitability and Figure 2.16 and Figure 2.17 as an illustration of the case of tasks with high profitability.

are sufficiently large.

To illustrate this, we will focus on the self-reporting as one of the policing duties of the firm. The following analysis would apply thus to a composite liability regime if we disregard the other policing duties and to a compound liability regime. Let us consider the additional sanction that the firm faces if she fails to self-report the agent's misconduct to the law enforcer and denote it by S. The impact of this additional sanction on the principal's payoff is mainly an increase of the expected corporate sanction, that becomes $[1-G(\widehat{\theta})]\{\gamma^* F+(1-\gamma^*)\,\alpha\,(F+S+R)\}$ instead of $[1-G(\widehat{\theta})]\{\gamma^* F+(1-\gamma^*)\,\alpha\,(F+R)\}$. The additional sanction S would operate thus as an increase of R by the amount S. Let us restrict our attention to the case of tasks with high profitability as it leads to the most striking results regarding the impact of this additional sanction on the level of corporate crime[19].

The introduction of the additional sanction, S, raises the sanction that the principal will face if she fails to disclose the evidence of the misconduct to the law enforcer. Consequently, to avoid the additional sanction, the principal invests more in compliance program compared to a strict liability regime. This leads to a higher probability of detecting the misconduct's evidence for a given level of reputational loss. When the reputational loss is not too large, the higher probability of detection implies that a higher transfer is required to compensate the marginal agent for the higher expected individual sanction, and that the incremental transfer necessary to incentivize an agent with a lower ability level to use the unlawful technology should increase as well, raising thus the marginal cost of the corporate crime. This increase in the transfers coupled with the higher expected corporate sanction would push the principal to reduce the transfers offered to the agent leading to lower levels of corporate crime compared to a strict liability regime. Under these circumstances, the additional sanction imposed in line with a compound or a composite liability regimes exhibits a desired deterrent effect.

However, if the firm's reputational loss will be severe, and under a strict liability regime[20], the high profitability of the task would encourage the firm to engage in costly excessive monitoring. This excessive investment in compliance program provides the firm with a "protective effect", since the firm will cooperate with the law enforcer and avoids thus the reputational loss, R, more likely. The introduction of the additional sanction, S, raises the firm's incentives to invest in compliance program which fosters this "protective effect", for a given level of R. More precisely, the higher probability of detection that results from the introduction of S when R is sufficiently large, reduces the marginal cost of raising the level of corporate crime: The higher probability of detection implies that the principal will disclose the misconduct's evidence more likely. Consequently, it is more likely that she bears only the initial legal sanction, F, and avoids both the reputational loss, R, and the additional sanction, S, that she would have incurred if she did not cooperate with the law enforcer. This reduction of the marginal cost of the crime would dominate

[19] In case of tasks with low profitability, the additional sanction, S, has a deterrent effect: It leads to lower level of corporate crime for a given level of R. See Figure 2.14 for a graphical illustration of that case.

[20] See section 2.5.2, for a detailed description of that case.

the higher marginal cost of increasing the transfers as well as the direct effect of the increase of the corporate expected sanction that follows the introduction of S. As a result, when R is sufficiently large, the additional sanction, S, will lead to a higher level of corporate crime compared to a strict liability regime where this additional sanction is absent.

Finally, as mentioned above, the additional sanction, S, would operate as an increase in the reputational loss of the principal. It would accelerate thus the perverse effect the reputational loss has on the level of corporate crime when the profitability of the task is large. Therefore, in some cases, this additional sanction might undermine the deterrent effect of R that we observe under a strict liability regime, particularly when R has intermediate values. Specifically, for intermediate values of R ($R \leq R_{H2}$), under a strict liability regime an increase of the reputational loss is associated with higher investment in compliance and lower levels of corporate crime. Yet, for the same values of R, the application of a composite or a compound liability regime results in a "window dressing" compliance program: An increase of R is associated to a higher investment in compliance and higher levels of corporate crime.

Accordingly, the additional sanction suggested by Arlen (2012) and Oded (2011) in the frame of the composite and the compound corporate liability regimes needs to be designed with caution when the reputational loss comes into play. While these regimes aim initially to incentivize the firm to monitor the agent and to report his misconduct to avoid the underdetrrence that occurs under a strict liability regime, the high levels of monitoring might end up supporting higher levels of corporate crime and undermining the deterrent effect of the reputational loss.

2.6.3 Compliance program-based leniency

Another question that is raised in the literature is whether the rule set by the *US Sentencing Guidelines* to provide a reduction of the corporate fine for implementing a "well-designed" compliance program is desirable (Krawiec, 2003; Angelucci and Han, 2010). With slight modifications, our model could provide us with the tools to evaluate the impact of such regime on the level of corporate crime.

Let's define $C(\bar{\gamma})$ as the level of investment in compliance above which the program is considered as "well-designed" by the law enforcer. Let's assume, as well, that the reputational loss, R, takes place only if the crime is detected by the law enforcer and the principal did not meet the benchmark $C(\bar{\gamma})$. We can interpret here the R as the fine reduction we are interested in[21]. In that case, the firm will not have incentive to cooperate, since the fine reduction the firm gets depends on meeting the benchmark set by the law enforcer rather than on the disclosure of the incriminating evidence. Consequently, the individual sanction will depend only on the probability that the law enforcer collects the evidence, α, rather than on the probability of detection determined by the firm's investment in compliance program

[21] By the same token and for sake of comparison, the strict liability regime considered in the previous analysis can be reinterpreted as liability regime where the firm gets a reduction for the cooperation with the law enforcer.

and so does the transfer paid to the agent. Moreover, the firm's decision to invest in compliance will not affect its expected sanction. Therefore, if the firm chooses a level of monitoring $\gamma < \bar{\gamma}$, it will be optimal to set it equal to 0 since the monitoring entails only a direct cost and does not lead to any benefit for the firm. Note that a firm will never find it optimal to choose a monitoring level above $\bar{\gamma}$. The firm will choose $\bar{\gamma}$ if the gain from avoiding the reputational loss, R, exceeds the cost of higher monitoring which is realized if R exceeds certain threshold that we can denote by $\bar{R}$ [22].

If $R < \bar{R}$, the firm's optimal level of corporate crime will be determined by substituting $\gamma^* = 0$ in equation 2.3. If the profitability of the task is low, this new liability rule leads to higher levels of corporate crime compared to a liability regime where the fine reduction is based on firm's cooperation: The absence of a compliance program reduces the marginal cost of corporate crime by reducing the cost of the transfers needed to encourage the agent to use the unlawful technology. Moreover, if the task is of high profitability, this liability rule will lead to higher levels of corporate crime as well, notably when $R < \bar{R} < R_{H2}$[23]: The higher risk of exposure to the reputational loss is dominated by the savings in the cost of transfers. However, if $R_{H2} < R < \bar{R}$, the absence of compliance program will deprive the firm of the protective effect of monitoring, pushing thus to levels of corporate crime lower than those under a liability regime where fine reduction depends on the firm's cooperation with the law enforcer.

If $R \geq \bar{R}$, the firm invests $C(\bar{\gamma})$ in compliance program. Its optimal level of corporate crime is defined through equation 2.3 if we substitute γ^* and R by 0 to capture the features of the new liability regime: The detection of the crime does not depend on the firm's ability to find the evidence and the firm avoids the reputational loss by implementing a "well-designed" compliance program. Accordingly, the optimal level of corporate crime is independent of R, and it is higher than that under the other liability regime: For the principal, the marginal cost of crime is lower due to the absence of the reputational loss and the lower incentives needed to encourage the agent to violate the law.

In sum, except for the particular case of highly profitable tasks with $R_{H2} < R < \bar{R}$, assigning a fine reduction that is based on the implementation of a "well-designed" compliance program rather than on the cooperation of the firm undermines the deterrent power of compliance programs. This finding is consistent with Angelucci and Han (2010) who find that offering a lenient sanction based on the existence of a compliance program is not optimal since it reduces the individual sanction making thus the violation of the law less costly for the agent.

2.7 Conclusion

We have presented a formal model of corporate crime. We have studied the impact of reputational loss on the level of corporate crime while considering the agency

[22] Formally, this condition is satisfied if $R \geq \bar{R} = \frac{C(\bar{\gamma})}{G(\hat{\theta})\,\alpha}$.

[23] *c.f.* proposition 2.4

problem within the firm and the firm's decision to invest in compliance program. We focused on a case where the firm suffers from the reputational loss only if she fails to deliver the incriminating evidence to the law enforcer. Although this may seem unrealistic as reputational loss usually occurs whenever the crime is detected, this assumption can be considered as a simplification of the case where the intensity of the reputational loss depends on the quality of governance within the firm (Desai and Dharmapala, 2009). In this context, the reputational loss can be perceived as the market penalty to the firm for failing to fulfill her role in controlling her agent.

We can draw several conclusions from the model. The most striking one is that the reputational loss does not always exhibit a deterrent effect on the corporate crime as expected. A perverse effect of reputational loss occurs when both the reputational loss and the principal's gain from the task delegated to the agent, hence his gain from the corporate crime, are high. In that case, the principal engages in excessive monitoring which allows her to collect the misconduct's evidence and disclose it to the law enforcer more likely, increasing thus her chances of avoiding the reputational loss. Simultaneously, she provides the agent with high-powered incentives to encourage an agent with low ability of using the unlawful technology to breach the law by compensating him for the individual sanction he might encounter. A severe reputational loss promotes thus the implementation of "window-dressing" compliance programs that aim to protect the principal against the reputational loss but do not lead to real compliance.

Moreover, we identify cases where not implementing a compliance program is an optimal choice for the firm. Particularly, if the reputational loss is large while the profitability of the task is low, the principal will face a significant loss by encouraging the violation of law. The investment in monitoring will constitute, as well, a burden on the principal's payoff. The principal relies thus only on low-powered incentives to deter the agent from committing the crime. Another instance where the principal prefers to mute the compliance program is when the reputational loss is low while the task is highly profitable. In that case, the principal optimally chooses to risk her reputation in order to increase the power of the incentives provided to the agent and thus to increase the probability that he uses the unalwful technology.

At last, the compliance program will ensure "real compliance" when either the profitability of the task is large and the reputational loss is of intermediate levels, or the task has a low profitability while the reputational loss is not too large. In that case, following an increase in the reputational loss, investment in compliance program becomes necessary to alleviate the principal's expected sanction but the probability of detection that results is not high enough to trigger a protective effect against the reputational loss. As a consequence, the principal optimally reduces the incentives provided to the agent and hence the likelihood of corporate crime.

Furthermore, some policy implications were driven from our model. In particular, we have highlighted how the reputational loss might affect the effectiveness of some enforcement tools whose primary aim is to curb the corporate crime. For instance, the ambiguous effect the reputational loss has on the level of corporate crime needs to be reflected in the design of the optimal fine: An optimal fine should account for the principal's gain from the corporate crime and for the level of the reputational loss that the firm encounters. Similarly, a liability regime that rewards the principal for self-reporting to the law enforcer should be designed carefully as it might foster the level of corporate crime instead of limiting it. Moreover, a compliance program-based leniency is inferior to a self-reporting based-leniency.

Finally, one of the limitations of our model is the assumption that the corporate crime is the only mean for the principal to raise her expected surplus from the task. Allowing for productive effort in a context where the choice of the monitoring technology by the principal is endogenous could be a venue for future research. In such a case, the transfers offered to the agent will be a double-edged sword (Goldman and Slezak, 2006) that encourage him to exert productive effort but increase the appeal of breaching the law. This conflict created by the incentives with the conflict created by the monitoring technology and the reputational loss could bring us a brighter picture of the design of incentives within the firm.

Appendix 2.A Proof of Proposition 2.1

In a full information benchmark, we assume that the principal can observe the agent's ability to use the unlawful technology, θ_i. Moreover, the monitoring technology is costless which allows the principal to observe the agent's decision to commit the crime and to collect the evidence if the law is broken by the agent. Under these assumptions, the principal can design a contract based on θ_i and on whether to use the unlawful technology or not. We get the optimal contract by solving the game in section 2.2.3 by backward induction. In the following, we will use "L" to stand for "lawful technology" and "UNL" to stand for "unlawful technology".

If the agent proceeds lawfully, the principal's problem becomes:

$$\underset{\bar{t},t_c}{\text{Max}}\ \underline{p}\,[\Pi - \ t_c] - \ \bar{t}$$

subject to:
$(PC_L) : \bar{t} + \underline{p}\, t_c \ \geq \ 0$
$(Limited\ liability) : \bar{t}\ \geq 0,\ t_c\ \geq 0$
where:
(PC_L) is the participation constraint of the agent who proceeds lawfully.

In this case, the (PC_L) binds and the optimal contract becomes: $\bar{t}^*_L\ = 0$ and $t^*_{cL} = 0$.
The principal's payoff under this contract is:

$$\underline{p}\,\Pi \tag{2.4}$$

If the agent's uses the unlawful technology, the principal will find the evidence of misconduct with certainty and will disclose it to the law enforcer by assumption 2.1. The principal's problem in this case becomes:

$$\underset{\bar{t},t_c}{\text{Max}}\ p(\theta_i)\ [\Pi - \ t_c] - \ \bar{t} - \ F$$

subject to:
$(PC_{UNL}) : \bar{t} + p(\theta_i)\, t_c - f \geq 0$
$(Limited\ liability) : \bar{t} \geq 0,\ t_c \geq 0$
where:
(PC_{UNL}) is the participation constraint of the agent who uses the unlawful technology.

Given this problem, (PC_{UNL}) binds. As a result, the non-contingent transfer is:

$$\bar{t}_{UNL} = f - p(\theta_i)\, t_c$$

Substituting $\bar{t}_{UNL}$ into the principal's problem, we get:

$$\underset{t_c}{\text{Max}}\ p(\theta_i)\, [\Pi - t_c] - f + p(\theta_i)\, t_c - F = p(\theta_i)\Pi - f - F$$

Clearly, the contingent transfer is irrelevant in this problem, it can take any value. This is because the principal can extract it completely through $\bar{t}_{UNL}$. For convenience, we will set $t_{cUNL} = 0$. The optimal non-contingent transfer becomes: $\bar{t}^*_{UNL} = f$. And the principal's payoff is:

$$p(\theta_i)\Pi - f - F \tag{2.5}$$

By comparing, 2.4 and 2.5, we can determine the condition under which the principal prefers that the agent uses the unlawful technology or not. Particularly, the principal would refer to the unlawful technology if:

$$p(\theta_i)\Pi - f - F \geq \underline{p}\,\Pi \qquad \Rightarrow \qquad p(\theta_i) \geq \underline{p} + \frac{F + f}{\Pi}$$

■

Appendix 2.B Proof of Proposition 2.2

In this section, we will study the case where the agent's ability to use the unlawful technology, θ_i, is not observed by the principal and the principal has to engage in costly monitoring, $C(\gamma)$, to discover the agent's decision to commit the crime. As discussed in section 2.4, the principal will design the contract and the investment in monitoring in a way such that any agent with an ability level above a marginal one, $\widehat{\theta}$, would commit the crime and any agent with ability level below the marginal one proceeds lawfully. The principal's problem becomes:

$$\underset{\bar{t}, t_c, \gamma}{\text{Max}}\ P(\widehat{\theta})\, (\Pi - t_c) - \bar{t} - C(\gamma) - [1 - G(\widehat{\theta})]\, [\gamma\, F + (1-\gamma)\, \alpha\, (F + R)]$$

subject to:
$(PC_L) : \bar{t} + \underline{p}\, t_c \geq 0 \qquad \forall\, \theta_i < \widehat{\theta}$
$(PC_{UNL}) : \bar{t} + p(\theta_i)\, t_c - [\gamma + (1-\gamma)\, \alpha]\, f \geq 0 \qquad \forall\, \theta_i \geq \widehat{\theta}$
$(ICC_L) : \bar{t} + \underline{p}\, t_c \geq \bar{t} + p(\theta_i)\, t_c - [\gamma + (1-\gamma)\, \alpha]\, f \qquad \forall\, \theta_i < \widehat{\theta}$

$(ICC_{UNL}) : \bar{t} + \; p(\theta_i)\, t_c - \; [\gamma + \; (1-\gamma)\, \alpha]\, f \; \geq \; \bar{t} + \underline{p}\, t_c \qquad \forall\, \theta_i \; \geq \; \widehat{\theta}$
$(Limited\;\; liability) : \bar{t} \; \geq 0,\; t_c \; \geq 0$
$0 \; \leq \gamma \; \leq 1$
where:
$P(\widehat{\theta}) = \underline{p} \int_{\underline{\theta}}^{\widehat{\theta}} g(\theta_i)\, d\theta_i \; + \int_{\widehat{\theta}}^{\bar{\theta}} p(\theta_i)\, g(\theta_i)\, d\theta_i$
(ICC_L) and (ICC_{UNL}) stand for "incentive compatibility constraint of the agent who uses the lawful and the unlawful technologies respectively.

As mentioned in footnote 9, implementing a screening mechanism according to which the principal offers a different contract for different types of agents is not feasible since the only decision that depends on the agent's type is his decision to commit the corporate crime which is not observed by the principal. Moreover, the LHS of (PC_{UNL}) is increasing with θ_i, which means that if (PC_{UNL}) is satisfied for the marginal agent, $\widehat{\theta}$, it will be satisfied for any $\theta_i \; \geq \widehat{\theta}$. The same reasoning applies to (ICC_{UNL}). For these reasons, we can restrict our attention to the (PC_{UNL}) and the (ICC_{UNL}) of the the marginal type $\widehat{\theta}$.

Furthermore, the analysis of the possible different cases shows that the only feasible case is the one where (ICC_{UNL}) and (ICC_L) bind while (PC_L) and (PC_{UNL}) do not. (ICC_{UNL}) and (ICC_L) can thus be reduced to one constraint (ICC).

The principal's problem can be rewritten as follows:

$$\underset{\bar{t}, t_c, \gamma}{\text{Max}} \; P(\widehat{\theta})\, (\Pi - t_c) - \; \bar{t} - \; C(\gamma) - \; [1 - G(\widehat{\theta})]\, [\gamma\, F + \; (1-\gamma)\, \alpha\, (F + R)]$$

subject to:
$(PC_L) : \bar{t} + \underline{p}\, t_c \; > \; 0 \qquad \forall\, \theta_i < \widehat{\theta}$
$(PC_{UNL}) : \bar{t} + \; p(\widehat{\theta})\, t_c - \; [\gamma + \; (1-\gamma)\, \alpha]\, f \; > 0$
$(ICC) : \bar{t} + \; p(\widehat{\theta})\, t_c - \; [\gamma + \; (1-\gamma)\, \alpha]\, f \; = \; \bar{t} + \underline{p}\, t_c$
$(Limited\;\; liability) : \bar{t} \; \geq 0,\; t_c \; \geq 0$
$0 \; \leq \gamma \; \leq 1$
The marginal type, $\widehat{\theta}$, can be defined from the (ICC):

$$p(\widehat{\theta}) = \frac{[\gamma + \; (1-\gamma)\, \alpha]\, f}{t_c} + \underline{p}$$

Since $\frac{\partial^2 p}{\partial \theta_i^2}(\theta_i) = 0$, there exists a one to one relationship between $\widehat{\theta}$ and t_c, we can rewrite the previous equation as follows:

$$t_c(\gamma, \widehat{\theta}) = \frac{[\gamma + \; (1-\gamma)\, \alpha]\, f}{p(\widehat{\theta}) - \underline{p}} \tag{2.6}$$

Note that $t_c(\gamma, \widehat{\theta}) > 0$ always, satisfying thus one of the (*Limited liability*) constraints. It implies, as well, that (PC_L) and (PC_{UNL}) are always satisfied.
In addition, we can note that the principal's problem is decreasing in $\bar{t}$. As a result, $\bar{t}$ can be optimally set equal to 0, which satisfies the other (*Limited liability*) constraint.

As final note, the one to one relationship between $\widehat{\theta}$ and t_c can allow us to switch those variables in the principal's problem.

The principal's problem can be reduced to:

$$\underset{\widehat{\theta},\gamma}{\text{Max}}\ P(\widehat{\theta})\,(\Pi - t_c(\gamma,\widehat{\theta})) - C(\gamma) - [1-G(\widehat{\theta})]\,[\gamma\,F + (1-\gamma)\,\alpha\,(F+R)]$$

subject to:
$0\ \leq \gamma\ \leq 1$
where $t_c(\gamma,\widehat{\theta})$ is determined by equation 2.6.

We will get back to the constraint $0\ \leq \gamma\ \leq 1$ later in subsection 2.B.1.

We can obtain an interior solution to the principal's problem by relying on the FOCs of the principal's problem with respect to γ and θ. Let's denote the optimal marginal type and the optimal probability of detection that we get from this interior solution by $\widehat{\theta}_I^*$ and γ_I^* respectively, where I stands for interior solution.

The FOCs[24] of the problem are:

$$l(\widehat{\theta}_I^*,\gamma_I^*) = [1-G(\widehat{\theta}_I^*)]\,[\alpha\,(F+R) - F] - \frac{\partial C}{\partial \gamma}(\gamma_I^*) - P(\widehat{\theta}_I^*)\,\frac{\partial t_c}{\partial \gamma}(\widehat{\theta}_I^*) = 0 \qquad (2.7)$$

$$h(\widehat{\theta}_I^*,\gamma_I^*) = \frac{\partial P}{\partial \theta_i}(\widehat{\theta}_I^*)[\Pi - t(\widehat{\theta}_I^*,\gamma_I^*)] - P(\widehat{\theta}_I^*)\frac{\partial t_c}{\partial \theta_i}(\widehat{\theta}_I^*,\gamma_I^*) + \frac{\partial G}{\partial \theta_i}\{\gamma_I^* F + (1-\gamma_I^*)\alpha(F+R)\} = 0 \qquad (2.8)$$

By solving these two conditions, we can reach the optimal level of corporate crime , $1-G(\widehat{\theta}_I^*)$ and the optimal probability of detection that determines in turn the optimal level of investment in monitoring, $C(\gamma_I^*)$.

The principal's optimal payoff is:

$$P(\widehat{\theta}_I^*)\,(\Pi - t_c(\gamma_I^*,\widehat{\theta}_I^*) - C(\gamma_I^*) - [1-G(\widehat{\theta}_I^*)]\,[\gamma_I^*\,F + (1-\gamma_I^*)\,\alpha\,(F+R)]$$

The optimal non-contingent transfer is: $\bar{t}_I^* = 0$. And from 2.6, the optimal transfer, t_{cI}^*, is:

$$t_{cI}^* = t_c(\gamma_I^*,\widehat{\theta}_I^*) = \frac{[\gamma_I^* + (1-\gamma_I^*)\,\alpha]\,f}{p(\widehat{\theta}_I^*) - \underline{p}}$$

From (PC_L), the optimal rent left to an agent with ability level, $\theta_i \leq \widehat{\theta}_I^*$, is:

$$\underline{\rho}_I^* = \underline{p}\,t_{cI}^*$$

And the optimal rent left to an agent with $\theta_i > \widehat{\theta}_I^*$ is:

$$\rho_i^* = \underline{\rho}_I^* + [p(\theta_i) - p(\widehat{\theta}^*)]\,t^*$$

[24]In the text, they correspond to equations 2.2 and 2.3, respectively

2.B.1 On constraint: $0 \leq \gamma \leq 1$

In this section, we will identify the conditions under which the constraint $0 \leq \gamma \leq 1$ is satisfied. Let's consider equation 2.7 for a given value of $\widehat{\theta}$, we can rearrange it as follows:

$$[1 - G(\widehat{\theta})]\,[\alpha\,(F + R) - F] - P(\widehat{\theta})\,\frac{\partial t_c}{\partial \gamma}(\widehat{\theta}) = \frac{\partial C}{\partial \gamma}(\gamma) \tag{2.9}$$

Let's consider the first part of the constraint: $0 \leq \gamma$. From equation 2.9, it will be satisfied if:

$$[1 - G(\widehat{\theta})]\,[\alpha\,(F + R) - F] - P(\widehat{\theta})\,\frac{\partial t_c}{\partial \gamma}(\widehat{\theta}) \geq \frac{\partial C}{\partial \gamma}(0)$$

Given the assumption that $\frac{\partial C}{\partial \gamma}(0) = 0$ and from equation 2.6, we can rewrite the previous inequality as:

$$[p(\widehat{\theta}) - \underline{p}][1 - G(\widehat{\theta})]\,[\alpha\,(F + R) - F] - P(\widehat{\theta})\,(1 - \alpha)\,f \geq 0$$

For sake of simplicity, let's assume that $\theta_i \sim U[\underline{\theta}, \bar{\theta}]$. In that case, we can observe that the LHS of the inequality is concave in $\widehat{\theta}$. The condition can thus be satisfied if the LHS has at least one root, which is the case if R exceeds certain threshold, that we will denote by R_{min}. If $R > R_{min}$, $0 \leq \gamma$ will be satisfied if $\widehat{\theta}$ lies within the roots of the LHS which we can denote by $\widehat{\theta}_L$ and $\widehat{\theta}_H$. In other words, the interior solution of the principal's problem will satisfy the condition $0 \leq \gamma$ if: $R > R_{min}$ and $\widehat{\theta}_I^* \in [\widehat{\theta}_L, \widehat{\theta}_H]$.

As for the second part of the constraint, $\gamma \leq 1$, we will follow a similar reasoning. From 2.9, the constraint is satisfied if:

$$[1 - G(\widehat{\theta})]\,[\alpha\,(F + R) - F] - P(\widehat{\theta})\,\frac{\partial t_c}{\partial \gamma}(\widehat{\theta}) \leq \frac{\partial C}{\partial \gamma}(1)$$

From equation 2.6, we can rewrite the previous inequality as:

$$[p(\widehat{\theta}) - \underline{p}][1 - G(\widehat{\theta})]\,[\alpha\,(F + R) - F] - P(\widehat{\theta})\,(1 - \alpha)\,f - [p(\widehat{\theta}) - \underline{p}]\,\frac{\partial C}{\partial \gamma}(1) \leq 0$$

The LHS of the previous inequality is concave, implying that the inequality will be satisfied if the LHS has at most one root, which the case if R is below a threshold denoted by R_{max}[25].

In order to ensure that the constraint $0 \leq \gamma \leq 1$ is satisfied in our analysis, we restricted our attention to the values of $R \in [R_{min}, R_{max}]$. Moreover, we relied on corner solutions to the principal's problem whenever $\widehat{\theta}_I^* \notin [\widehat{\theta}_L, \widehat{\theta}_H]$ to verify that $\gamma^* \geq 0$.

In short, the optimal marginal type, $\widehat{\theta}^*$, and the optimal probability of detection, γ^* of the principal's problem can be summarized as follows:

[25] The thresholds R_{min}, $\widehat{\theta}_L$, $\widehat{\theta}_H$ and R_{max} are easily specified if we consider functional forms that satisfy the different assumptions of our model, as we will show in section 2.D.1.

- $\widehat{\theta}^* = \widehat{\theta}_L$ and $\gamma^* = 0 \; \forall \, \widehat{\theta}_I^* < \widehat{\theta}_L$
- $\widehat{\theta}^* = \widehat{\theta}_I^*$ and $\gamma^* = \gamma_I^* \; \forall \, \widehat{\theta}_L \leq \widehat{\theta}_I^* \leq \widehat{\theta}_H$.
- $\widehat{\theta}^* = \widehat{\theta}_H$ and $\gamma^* = 0 \; \forall \, \widehat{\theta}_I^* > \widehat{\theta}_H$

We will show graphically in Appendix 2.D.2 that the principal's problem has corner solutions in the following cases:

1. If Π is small while R is sufficiently large, $\widehat{\theta}^* = \widehat{\theta}_H$ since $\widehat{\theta}_I^* > \widehat{\theta}_H$ or equivalently $1 - G(\widehat{\theta}_I^*) < 1 - G(\widehat{\theta}_H)$.
   We will show that $1 - G(\widehat{\theta}_H)$ is decreasing with R. (See Figure 2.1 and Figure 2.3).
2. If Π is large while R is sufficiently small ($R < R_{H1}$), $\widehat{\theta}^* = \widehat{\theta}_L$ since $\widehat{\theta}_I^* < \widehat{\theta}_L$ or equivalently $1 - G(\widehat{\theta}_I^*) > 1 - G(\widehat{\theta}_L)$.
   We will show that $1 - G(\widehat{\theta}_L)$ is increasing with R. (See Figure 2.5 and Figure 2.7)

■

Appendix 2.C Proof of Propositions 2.3 and 2.4

2.C.1 Proposition 2.3, 2^{nd} and 3^{rd} points of Proposition 2.4

In this section we provide a proof of the comparative statics of $\widehat{\theta}^*$ and γ^* with respect to R. The following proof applies as long as the solution to the problem is an interior solution. For convenience, we will drop the subscript I from $\widehat{\theta}_I^*$ and γ_I^*.

Total derivatives

The proof of the comparative statics described in section 2.5 starts from the total derivative of equations 2.7 and 2.8 with respect to R.
From equation 2.7, we get:

$$\frac{\partial l}{\partial \widehat{\theta}} d\widehat{\theta}^* + \frac{\partial l}{\partial \gamma} d\gamma^* + \frac{\partial l}{\partial R} dR = 0$$

Dividing both sides by dR, we get:

$$\frac{\partial l}{\partial \widehat{\theta}} \frac{d\widehat{\theta}^*}{dR} + \frac{\partial l}{\partial \gamma} \frac{d\gamma^*}{dR} + \frac{\partial l}{\partial R} = 0$$

which can be rearranged to be:

$$\frac{d\gamma^*}{dR} = -\frac{1}{\frac{\partial l}{\partial \gamma}} \left[\frac{\partial l}{\partial \widehat{\theta}} \frac{d\widehat{\theta}^*}{dR} + \frac{\partial l}{\partial R} \right] \tag{2.10}$$

Similarly, we can derive $\frac{d\widehat{\theta}^*}{dR}$ from 2.8:

$$\frac{d\widehat{\theta}}{dR} = -\frac{1}{\frac{\partial h}{\partial \widehat{\theta}}} \left[\frac{\partial h}{\partial \gamma} \frac{d\gamma^*}{dR} + \frac{\partial h}{\partial R} \right]$$

Substituting 2.10 in the previous equation we get:

$$\frac{d\widehat{\theta}}{dR} = \frac{-\frac{1}{\frac{\partial h}{\partial \widehat{\theta}}} \left[\frac{\partial h}{\partial R} - \frac{\partial h}{\partial \gamma} \frac{\partial l}{\partial R} \frac{1}{\frac{\partial l}{\gamma}} \right]}{1 - \frac{1}{\frac{\partial h}{\partial \widehat{\theta}}} \frac{\partial h}{\partial \gamma} \frac{\partial l}{\partial \widehat{\theta}} \frac{1}{\frac{\partial l}{\partial \gamma}}} \tag{2.11}$$

Signs of the components of equations 2.10 and 2.11

Second, to determine the sign of $\frac{d\widehat{\theta}^*}{dR}$ and thus the sign of $\frac{d\gamma^*}{dR}$, we need to study the sign of each component of the RHS of the two equations. From equations 2.7 and 2.8, we get that:

$$\frac{\partial h}{\partial \widehat{\theta}}(\gamma^*, \widehat{\theta}^*) = \frac{\partial^2 P}{\partial \widehat{\theta}^2} \left[\Pi - t(\gamma^*, \widehat{\theta}^*)\right] - 2 \frac{\partial P}{\partial \widehat{\theta}}(\widehat{\theta}^*) \frac{\partial t}{\partial \widehat{\theta}}(\gamma^*, \widehat{\theta}^*) - P(\widehat{\theta}^*) \frac{\partial^2 t}{\partial \widehat{\theta}^2}(\gamma^*, \widehat{\theta}^*) \tag{2.12}$$

$\frac{\partial h}{\partial \widehat{\theta}}(\gamma^*, \widehat{\theta}^*) < 0$ if we assume that $\theta_i \sim U[\underline{\theta}, \bar{\theta}]$.

$$\frac{\partial h}{\partial \gamma}(\widehat{\theta}^*) = \frac{\partial l}{\partial \widehat{\theta}}(\widehat{\theta}^*) = -\frac{G}{\widehat{\theta}}[\alpha R - (1-\alpha) F] - \frac{\partial P}{\partial \widehat{\theta}}(\widehat{\theta}^*) \frac{\partial t}{\partial \gamma}(\widehat{\theta}^*) - P(\widehat{\theta}^*) \frac{\partial^2 t}{\partial \widehat{\theta} \partial \gamma}(\widehat{\theta}^*) \tag{2.13}$$

$\frac{\partial h}{\partial \gamma}(\widehat{\theta}^*) = \frac{\partial l}{\partial \widehat{\theta}}(\widehat{\theta}^*) > 0$ if $R < \tilde{R}(\gamma^*, \widehat{\theta}^*) = \frac{1}{\alpha} \{(1-\alpha)F - \frac{1}{\frac{\partial G}{\partial \theta}} [\frac{\partial P}{\partial \theta}(\widehat{\theta}^*) * \frac{\partial t}{\partial \gamma}(\widehat{\theta}^*) + P(\widehat{\theta}^*) \frac{\partial^2 t}{\partial \theta \partial \gamma}(\widehat{\theta}^*)]\}$ and $\frac{\partial h}{\partial \gamma}(\widehat{\theta}^*) = \frac{\partial l}{\partial \widehat{\theta}}(\widehat{\theta}^*) < 0$ otherwise.

$$\frac{\partial h}{\partial R}(\gamma^*) = \frac{G}{\widehat{\theta}} (1 - \gamma^*) \alpha > 0 \tag{2.14}$$

$$\frac{\partial l}{\partial \gamma} = -\frac{\partial^2 C}{\partial \gamma^2} < 0 \tag{2.15}$$

$$\frac{\partial l}{\partial R}(\widehat{\theta}^*) = \alpha G(\widehat{\theta}^*) > 0 \tag{2.16}$$

Sign of $\frac{d\widehat{\theta}^*}{dR}$

From 2.11, the sign of $\frac{d\widehat{\theta}^*}{dR}$ depends on the sign of both the numerator and the denominator:

Sign of the numerator. From 2.12, the sign of the first term, $\left(-\frac{1}{\frac{\partial h}{\partial \widehat{\theta}}}\right)$, is always positive. However, from equations 2.13, 2.15, 2.16 and 2.14, the sign of the second term of the numerator will depend on the sign of $\frac{\partial h}{\partial \gamma}(\widehat{\theta}^*)$. We can thus distinguish between two cases:

1. If $R < \tilde{R}(\gamma^*, \widehat{\theta}^*)$, according to equation 2.13, $\frac{\partial h}{\partial \gamma}(\widehat{\theta}^*) > 0$. The second term is positive and the numerator is positive as well.

2. If $R < \tilde{R}(\gamma^*, \widehat{\theta}^*)$, $\frac{\partial h}{\partial \gamma}(\widehat{\theta}^*) < 0$. The second term will be positive if:

$$\frac{\partial h}{\partial R} - \frac{\partial h}{\partial \gamma} \frac{\partial l}{\partial R} \frac{1}{\frac{\partial l}{\gamma}} > 0$$

   From 2.13, we can rewrite the previous condition as follows:

$$R < R_{H2}(\gamma^*, \widehat{\theta}^*) = \tilde{R} - \frac{\frac{\partial h}{\partial R} \frac{\partial l}{\partial \gamma}}{\alpha \frac{\partial G}{\partial \theta} \frac{\partial l}{\partial R}}$$

   From 2.14, 2.15 and 2.16, $R_{H2} > \tilde{R}$

To summarize, the sign of the numerator of $\frac{d\widehat{\theta}^*}{dR}$ depends on the value of R as follows:

- If $R \leq R_{H2}(\gamma^*, \widehat{\theta}^*)$, $\left[\frac{\partial h}{\partial R} - \frac{\partial h}{\partial \gamma} \frac{\partial l}{\partial R} \frac{1}{\frac{\partial l}{\gamma}}\right]$ is positive.
- If $R > R_{H2}(\gamma^*, \widehat{\theta}^*)$, $\left[\frac{\partial h}{\partial R} - \frac{\partial h}{\partial \gamma} \frac{\partial l}{\partial R} \frac{1}{\frac{\partial l}{\gamma}}\right]$ is negative.

Sign of the denominator. Since $\frac{\partial h}{\partial \gamma}(\widehat{\theta}^*) = \frac{\partial l}{\partial \widehat{\theta}}(\widehat{\theta}^*)$, we can rewrite the denominator of $\frac{d\widehat{\theta}^*}{dR}$ as follows:

$$1 - \frac{1}{\frac{\partial h}{\partial \widehat{\theta}}} \left(\frac{\partial h}{\partial \gamma}\right)^2 \frac{1}{\frac{\partial l}{\partial \gamma}}$$

The denominator is thus positive if:

$$1 - \frac{1}{\frac{\partial h}{\partial \widehat{\theta}}} \left(\frac{\partial h}{\partial \gamma}\right)^2 \frac{1}{\frac{\partial l}{\partial \gamma}} > 0$$

which can be rewritten as:

$$-\sqrt{\frac{\partial h}{\partial \widehat{\theta}} \frac{\partial l}{\partial \gamma}} \leq \frac{\partial h}{\partial \gamma} < \sqrt{\frac{\partial h}{\partial \widehat{\theta}} \frac{\partial l}{\partial \gamma}}$$

From 2.13, this condition can be expressed as:

$$R_1(\gamma^*, \widehat{\theta}^*) = \tilde{R} - \frac{1}{\alpha \frac{\partial G}{\partial \theta}} \sqrt{\frac{\partial h}{\partial \widehat{\theta}} \frac{\partial l}{\partial \gamma}} \leq R < R_2(\gamma^*, \widehat{\theta}^*) = \tilde{R} + \frac{1}{\alpha \frac{\partial G}{\partial \theta}} \sqrt{\frac{\partial h}{\partial \widehat{\theta}} \frac{\partial l}{\partial \gamma}}$$

We will show below using numerical example and graphical representation (see Figure 2.9), that $R_1(\gamma^*, \widehat{\theta}^*) < R_{min}$, *i.e.*, $R_1(\gamma^*, \widehat{\theta}^*) < R \ \forall R \in [R_{min}, R_{max}]$.

Moreover, we will show that for large values of Π, $R_2(\gamma^*, \widehat{\theta}^*) > R_{max}$, implying thus that $R_2(\gamma^*, \widehat{\theta}^*) > R \in [R_{min}, R_{max}]$ (See Figure 2.11). However, for small values of Π, we will show that as long as we have an interior solution, *i.e.* $\widehat{\theta}^* \in [\widehat{\theta}_L, \widehat{\theta}_H]$, $R_2(\gamma^*, \widehat{\theta}^*) > R$ (See Figure 2.10).

Therefore, as long as $R \in [R_{min}, R_{max}]$ and the problem's solution is an interior solution, the denominator of $\frac{d\widehat{\theta}^*}{dR}$ is always positive. The sign of the numerator of $\frac{d\widehat{\theta}^*}{dR}$ is the only determinant to its sign.

Finally, the sign of $\frac{d\widehat{\theta}^*}{dR}$ varies based on two cases:

- If $R \leq R_{H2}(\gamma^*, \widehat{\theta}^*)$, $\frac{d\widehat{\theta}^*}{dR}$ is positive.
- If $R > R_{H2}(\gamma^*, \widehat{\theta}^*)$, $\frac{d\widehat{\theta}^*}{dR}$ is negative.

We will show later (See Figure 2.12) that R_{H2} is decreasing with Π. Therefore, for low values of Π, $R_{max} < R_{H2}(\gamma^*, \widehat{\theta}^*)$ always, we get thus $\frac{d\widehat{\theta}^*}{dR} > 0$, i.e., $1 - G(\widehat{\theta}^*)$ is decreasing with R for small values of Π.
However, for large values of Π, $\frac{d\widehat{\theta}^*}{dR}$ can be either positive or negative depending on the value of R.

Sign of $\frac{d\gamma^*}{dR}$

From equation 2.10, and equation 2.15, $\left(-\frac{1}{\frac{\partial l}{\partial \gamma}}\right)$ is positive. The sign of $\frac{d\gamma^*}{dR}$ depends thus on the signs of $\frac{d\widehat{\theta}^*}{dR}$ and $\frac{\partial h}{\partial \gamma}(\widehat{\theta}^*)$. From the previous subsection and equation 2.13, we can identify three cases:

1. If $R \leq \tilde{R}$, both $\frac{d\widehat{\theta}^*}{dR}$ and $\frac{\partial h}{\partial \gamma}(\widehat{\theta}^*)$ are positive, which implies that $\frac{d\gamma^*}{dR} > 0$.

2. If $\tilde{R} \leq R < R_{H2}$, $\frac{d\widehat{\theta}^*}{dR} > 0$ while $\frac{\partial h}{\partial \gamma}(\widehat{\theta}^*) < 0$. $\frac{d\gamma^*}{dR}$ is positive if

$$\frac{\partial l}{\partial \widehat{\theta}} \frac{d\widehat{\theta}^*}{dR} + \frac{\partial l}{\partial R} > 0$$

From 2.13 and by re-arranging the inequality, this condition can be rewritten as:

$$R < R_L(\gamma^*, \widehat{\theta}^*) = \tilde{R} - \frac{\frac{\partial l}{\partial R} \frac{\partial h}{\partial \widehat{\theta}}}{\alpha \frac{\partial G}{\partial \theta} \frac{\partial h}{\partial R}}$$

From 2.16, 2.12 and 2.14, $R_L(\gamma^*, \widehat{\theta}^*) > \tilde{R}$.

Then, $\frac{d\gamma^*}{dR}$ is positive if $R < R_L(\gamma^*, \widehat{\theta}^*)$ and is negative otherwise.

We will show later (See Figure 2.13) that $R_L(\gamma^*, \widehat{\theta}^*)$ is increasing with Π. For low values of Π, $\frac{d\gamma^*}{dR}$ might be positive or negative depending on whether R is below or above the threshold $R_L(\gamma^*, \widehat{\theta}^*)$. However, for large values of Π, $R_{max} < R_L(\gamma^*, \widehat{\theta}^*)$ always, implying that $\frac{d\gamma^*}{dR} > 0$ always.

3. If $R \geq R_{H2}$, both $\frac{d\widehat{\theta}^*}{dR}$ and $\frac{\partial h}{\partial \gamma}(\widehat{\theta}^*)$ are negative, which implies that $\frac{d\gamma^*}{dR} > 0$.

2.C.2 Note on 1^{st} point of Proposition 2.4

As noted in Appendix 2.B.1, for $R < R_{H1}$, the principal's problem has a corner solution. More precisely, $\widehat{\theta}^* = \widehat{\theta}_L$. We will show graphically in Appendix 2.D.2, that the corporate crime at $\widehat{\theta}_L$ $(1 - G(\widehat{\theta}_L))$ is increasing with R for $R < R_{H1}$.(See Figure 2.7). ■

Appendix 2.D Numerical Example and Graphical Representations

In this subsection, we will provide functional forms to our model's functions and numerical values to the variables in order to prove graphically the main points raised in this section and that have been difficult to be proven using general forms.

2.D.1 Functional forms and numerical vales

Let's consider the following functional form and numerical values for our analysis:

- $p(\theta_i) = \frac{1}{2} * \theta_i$, $\underline{\theta} = 1$ and $\bar{\theta} = 2$.
- $\theta_i \sim U[1, 2] \quad \Rightarrow \quad g(\theta_i) = 1, \quad G(\theta_i) = \theta_i - 1 \quad \Rightarrow P(\widehat{\theta}) = 1/2 + 1/2 * \widehat{\theta} - 1/4 * \widehat{\theta}^2$.
- $C(\gamma) = n\gamma^2, \quad n > 0$

Functional forms of R_{min}, $\widehat{\theta}_L$, $\widehat{\theta}_H$ and R_{max}.

Given the functional forms described in the previous section and the proof in section 2.B.1, we can express R_{min}, $\widehat{\theta}_L$, $\widehat{\theta}_H$ and R_{max} in the following functional forms:

- $R_{min} = \frac{1}{\alpha}\left[(1-\alpha)F + 3(1-\alpha)f + \sqrt{6}(1-\alpha)f\right]$.
- $\widehat{\theta}_L = \frac{3[\alpha R - (1-\alpha)F] - (1-\alpha)f - \sqrt{[\alpha R - (1-\alpha)F]^2 - 6[\alpha R - (1-\alpha)F] + 3[(1-\alpha)f]^2}}{2[\alpha R - (1-\alpha)F] - (1-\alpha)f}$.
- $\widehat{\theta}_H = \frac{3[\alpha R - (1-\alpha)F] - (1-\alpha)f + \sqrt{[\alpha R - (1-\alpha)F]^2 - 6[\alpha R - (1-\alpha)F] + 3[(1-\alpha)f]^2}}{2[\alpha R - (1-\alpha)F] - (1-\alpha)f}$.
- $R_{max} = \frac{1}{\alpha}\left[(1-\alpha)F + 3(1-\alpha)f + 2n^2 + \sqrt{3(1-\alpha)f\,[3(1-\alpha)f + 4n^2]}\right]$.

2.D.2 Graphical representations

For sake of graphical representations, let's consider the following numerical values: $\alpha = 0.6$, $n = 100$, $f = 500$ and $F = 5000$. Given these values, $R_{min} = 5149.8$ and $R_{max} = 45872$. Moreover, we will consider $\Pi = 20000$ and $\Pi = 50000$ as examples of low values of Π, while $\Pi = 75000$ and $\Pi = 100000$ as examples of large values of Π.

Figure 2.1: Optimal crime level $(1 - G(\widehat{\theta}^*))$, crime level at $\widehat{\theta}_I^*$ and $\widehat{\theta}_H$, $\Pi = 20000$

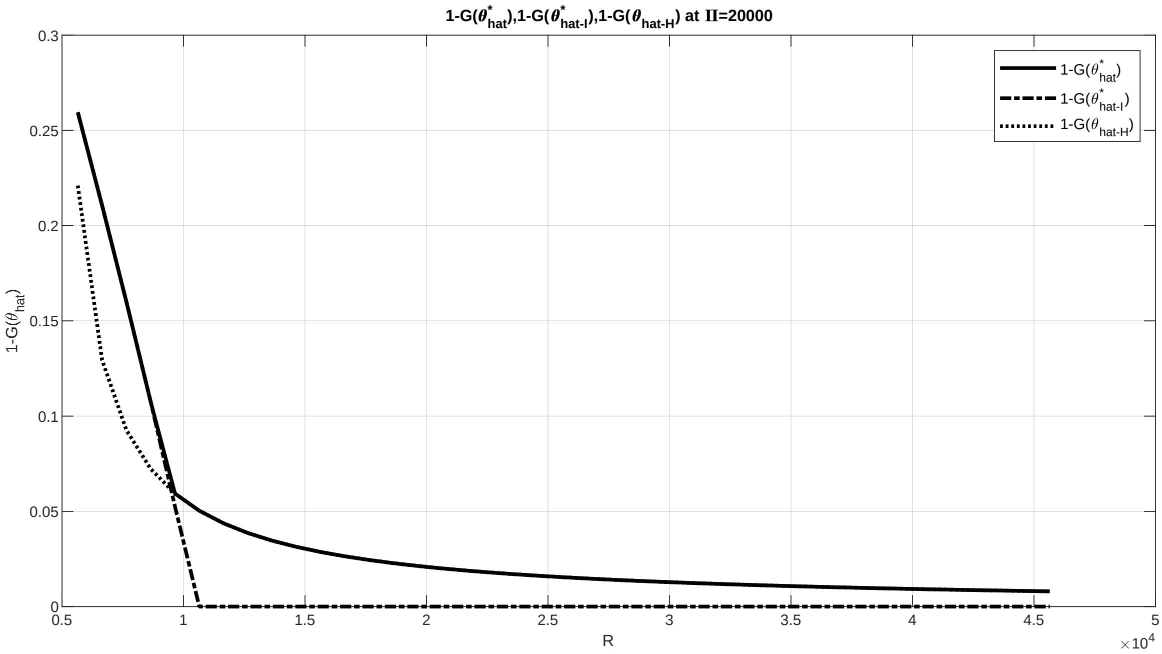


Figure 2.2: Optimal probability of detection (γ^*), and probability of detection at $\widehat{\theta}_I^*$ (γ_I^*), $\Pi = 20000$

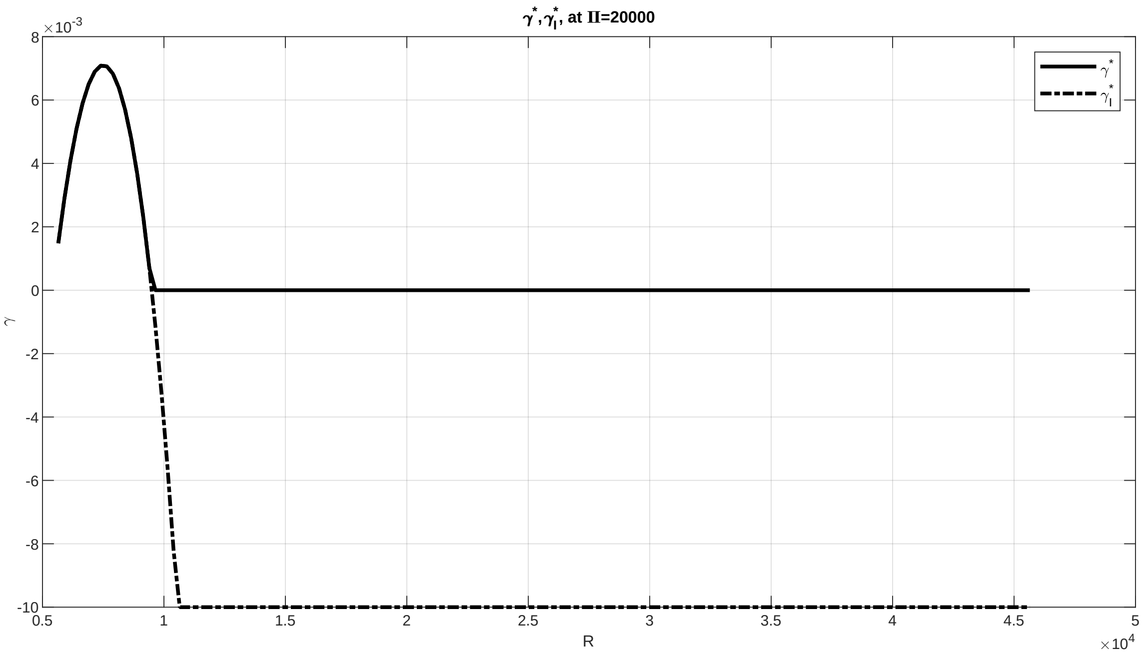


Figure 2.3: Optimal crime level $(1 - G(\widehat{\theta}^*))$, crime level at $\widehat{\theta}_I^*$ and $\widehat{\theta}_H$, $\Pi = 50000$

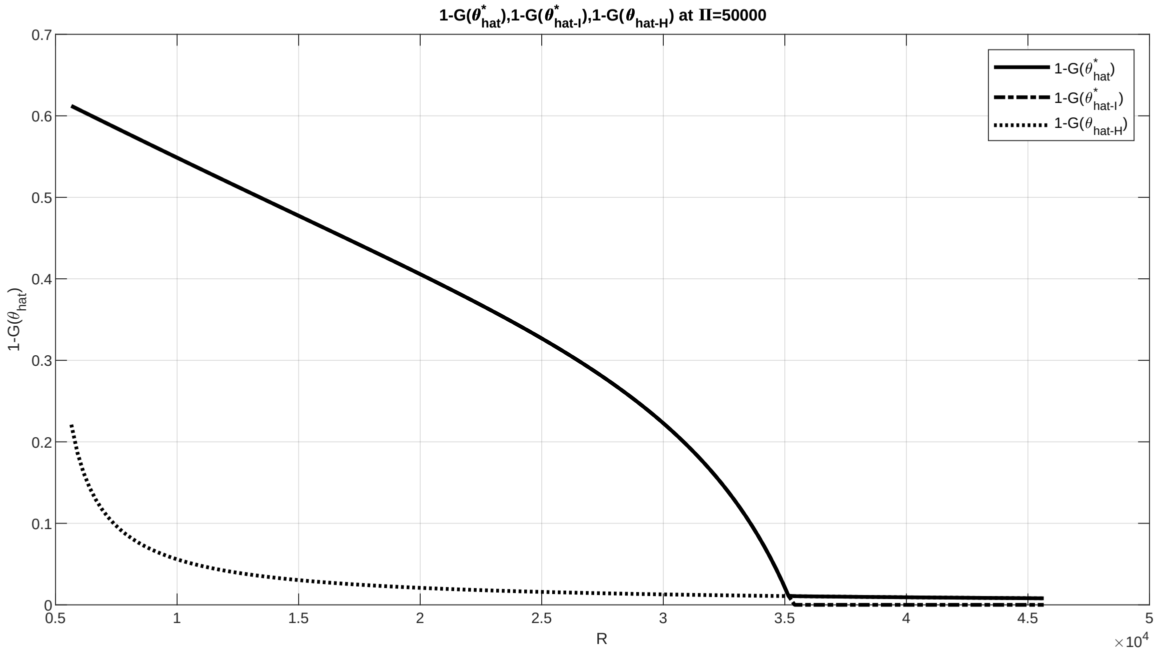


Figure 2.4: Optimal probability of detection (γ^*), and probability of detection at $\widehat{\theta}_I^*$ (γ_I^*), $\Pi = 50000$

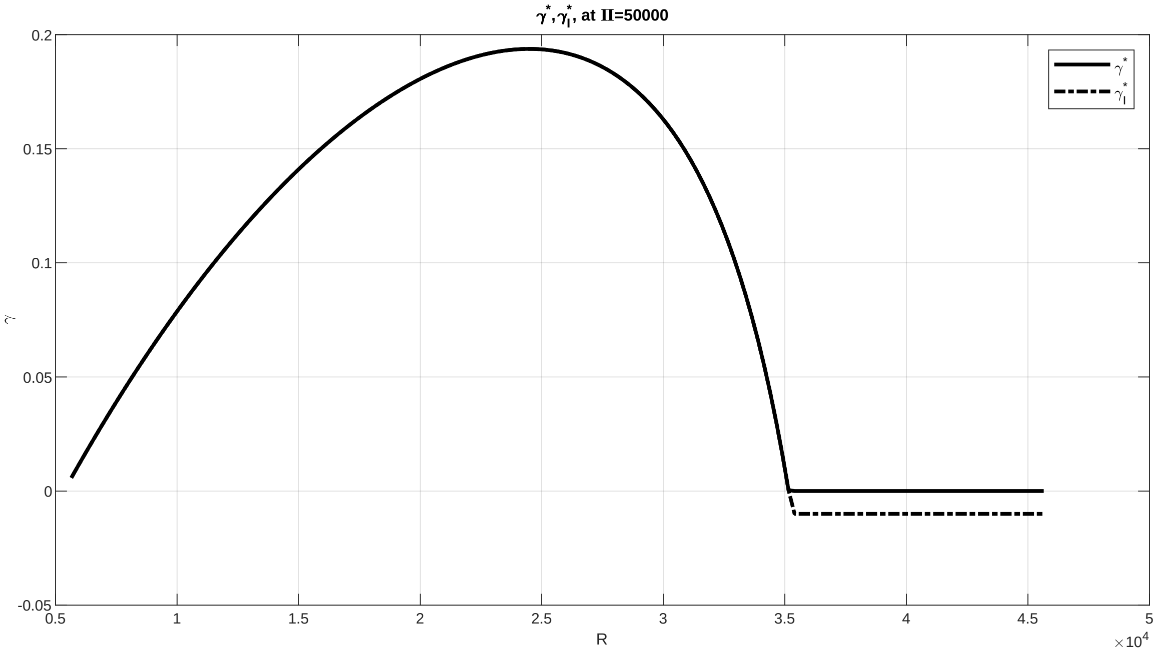


Figure 2.5: Optimal crime level $(1 - G(\widehat{\theta}^{*}))$, crime level at $\widehat{\theta}_I^{*}$ and $\widehat{\theta}_H$, $\Pi = 75000$

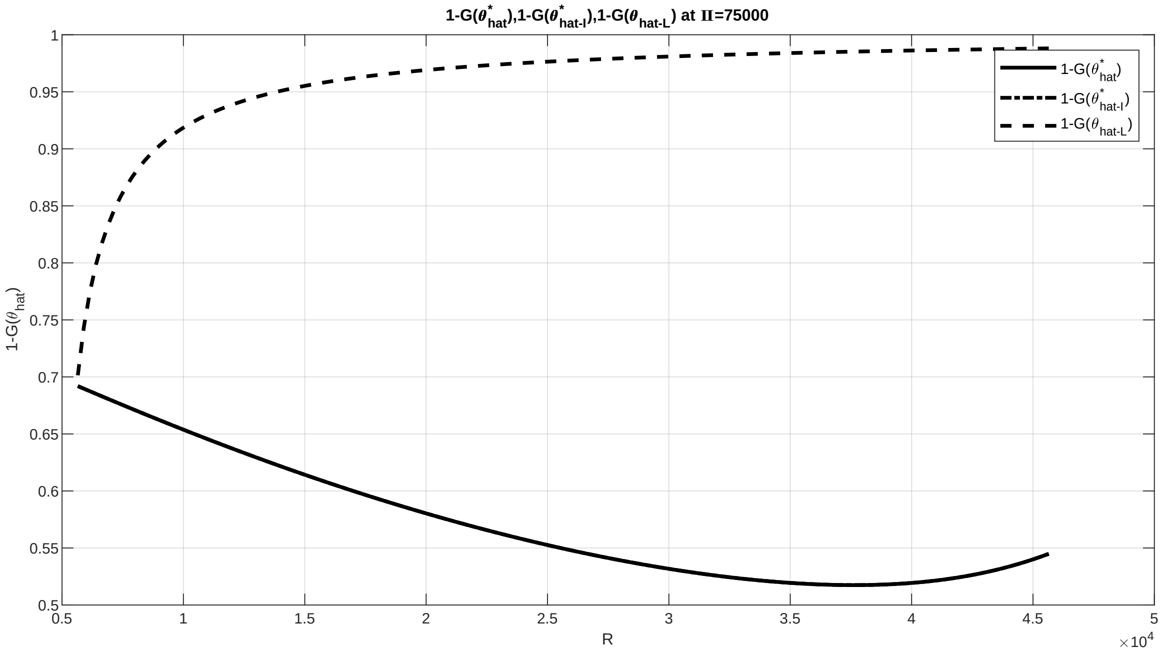


Figure 2.6: Optimal probability of detection (γ^{*}), and probability of detection at $\widehat{\theta}_I^{*}$ (γ_I^{*}), $\Pi = 75000$

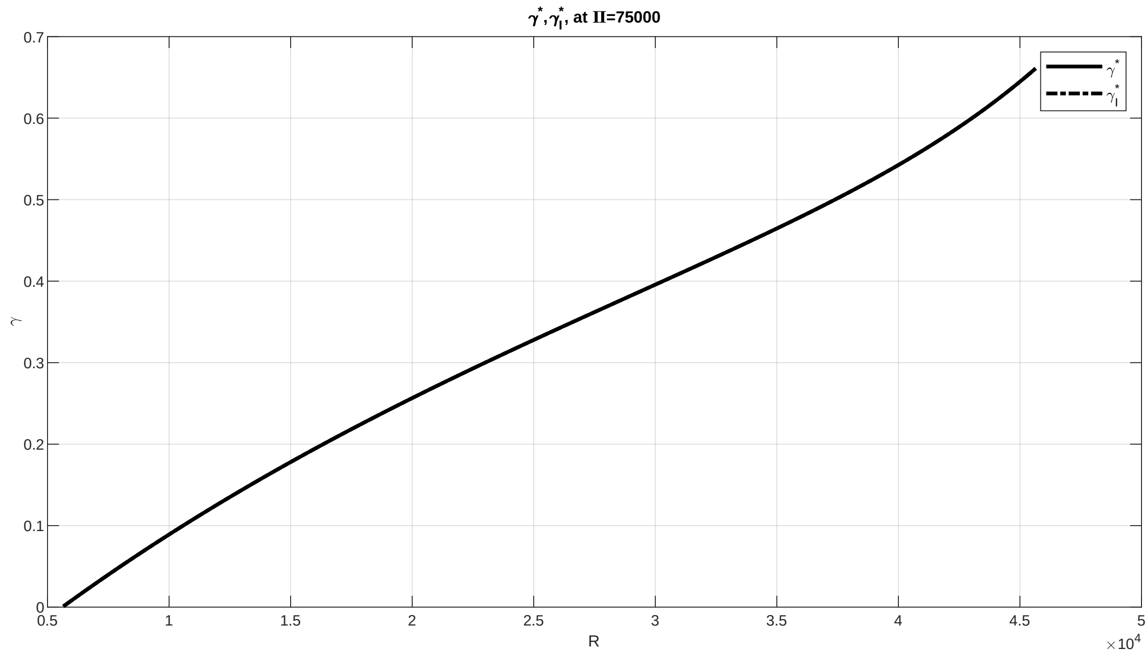


Figure 2.7: Optimal crime level $(1 - G(\widehat{\theta}^*))$, crime level at $\widehat{\theta}_I^*$ and $\widehat{\theta}_H$, $\Pi = 100000$

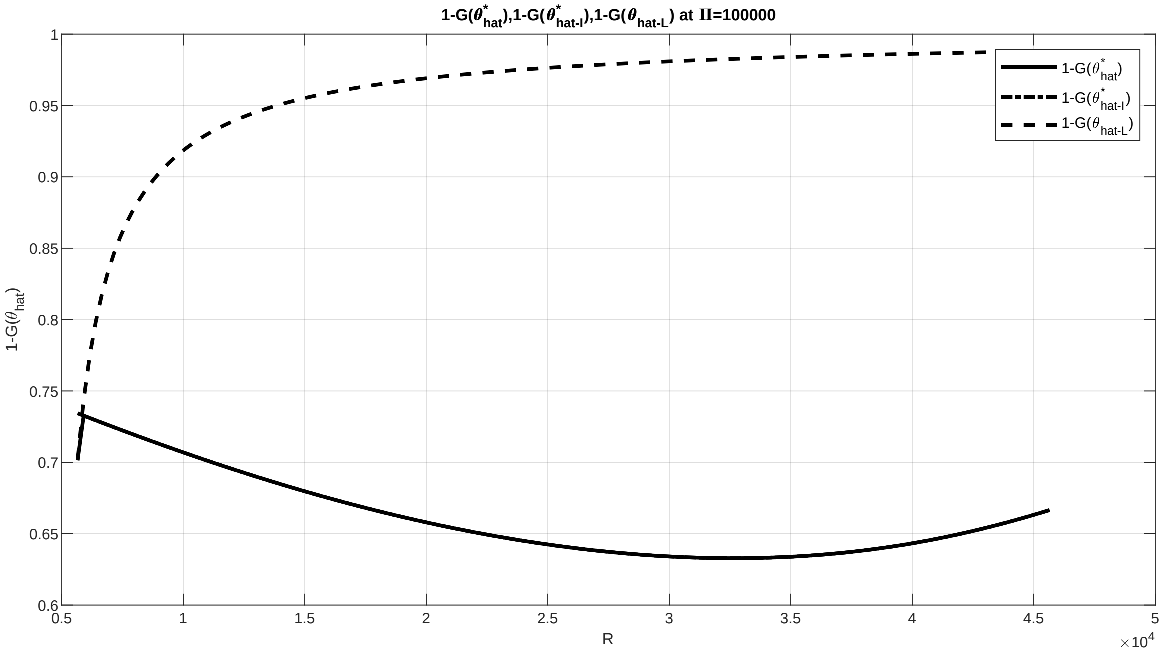


Figure 2.8: Optimal probability of detection (γ^*), and probability of detection at $\widehat{\theta}_I^*$ (γ_I^*), $\Pi = 100000$

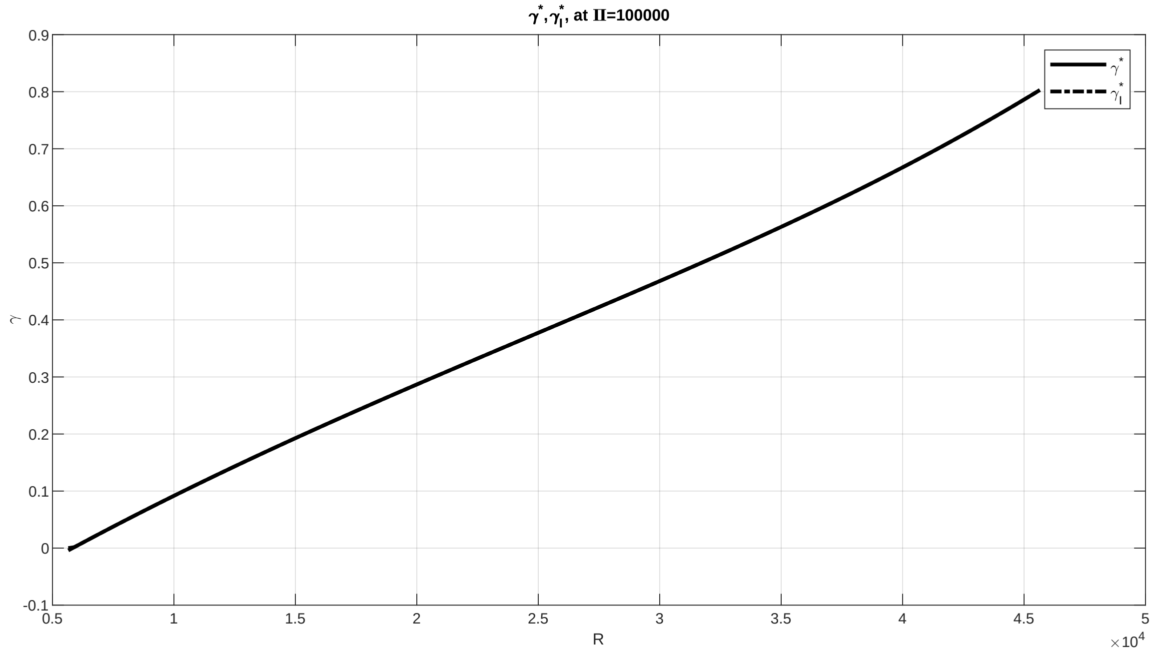


Figure 2.9: R_{min} and R_1 at $\Pi = 20000, 50000, 75000, 100000$

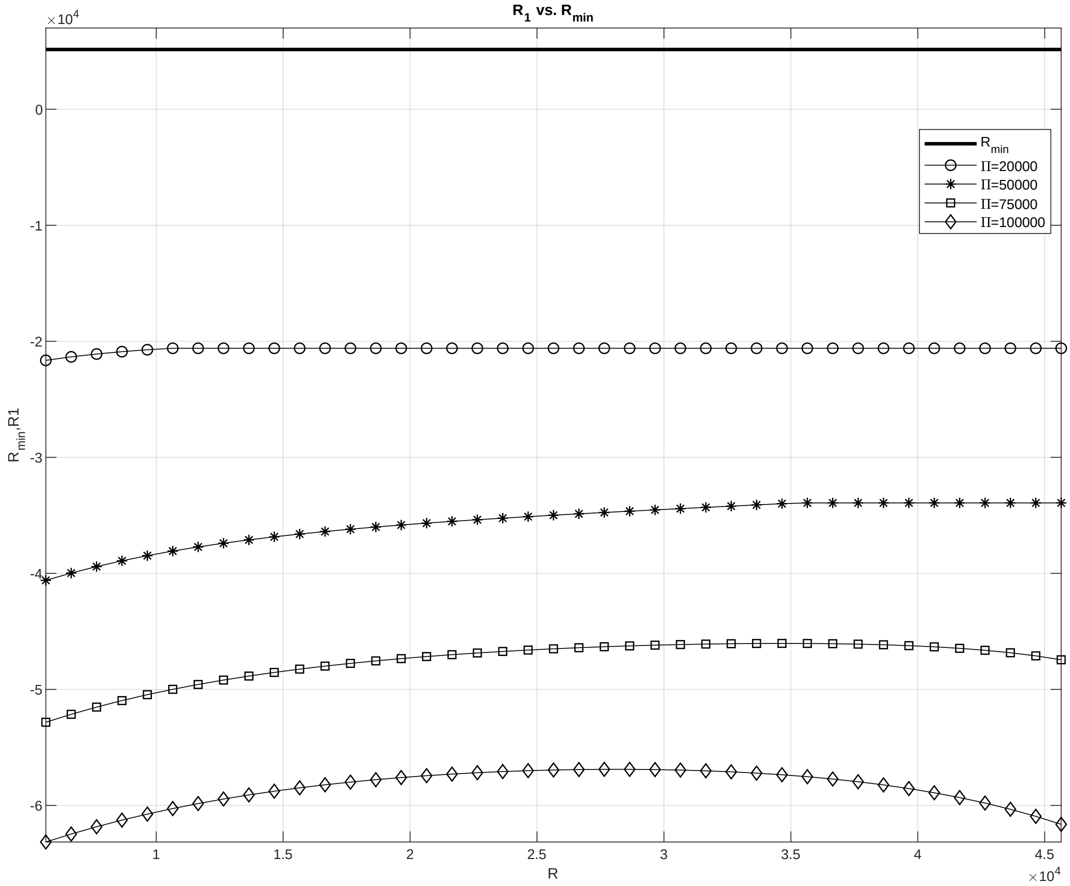


Figure 2.10: R and R_2 at $\Pi = 20000, 50000$

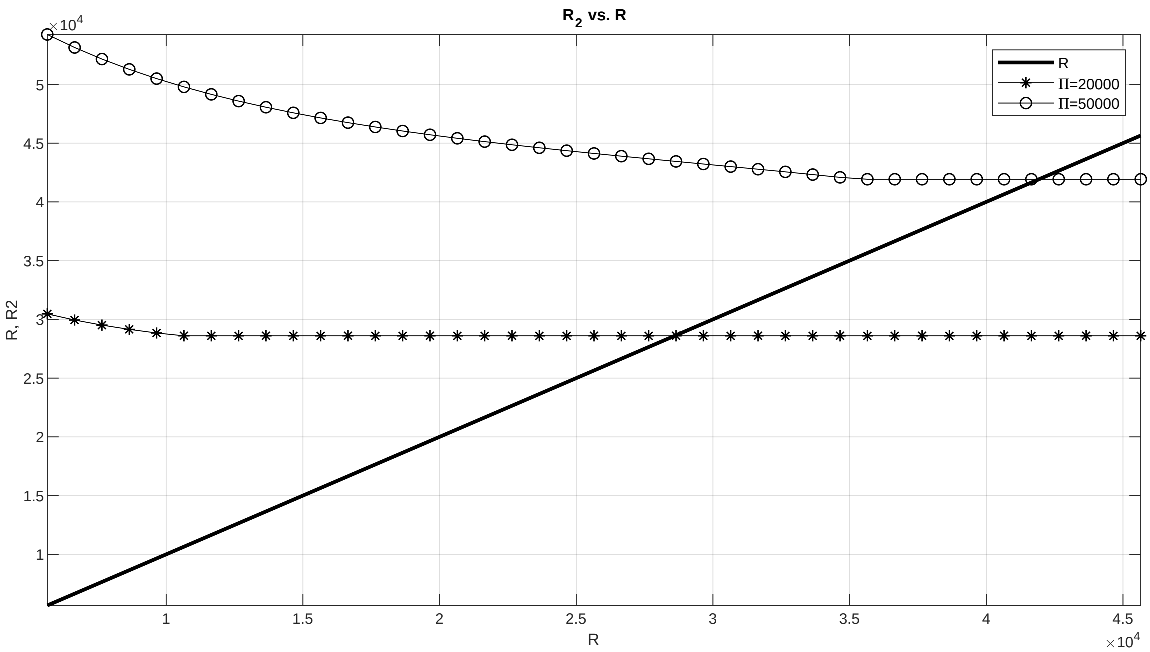


Figure 2.11: R_{max} and R_2 at $\Pi = 75000, 100000$

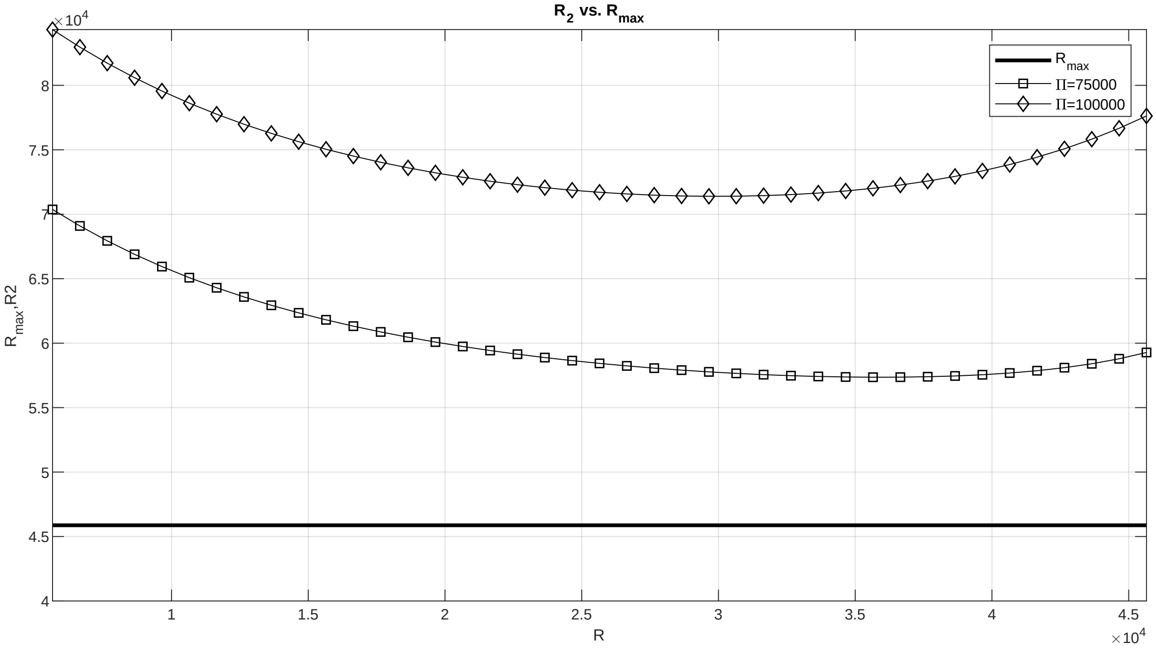


Figure 2.12: R and R_{H2} at $\Pi = 20000, 50000, 75000, 100000$

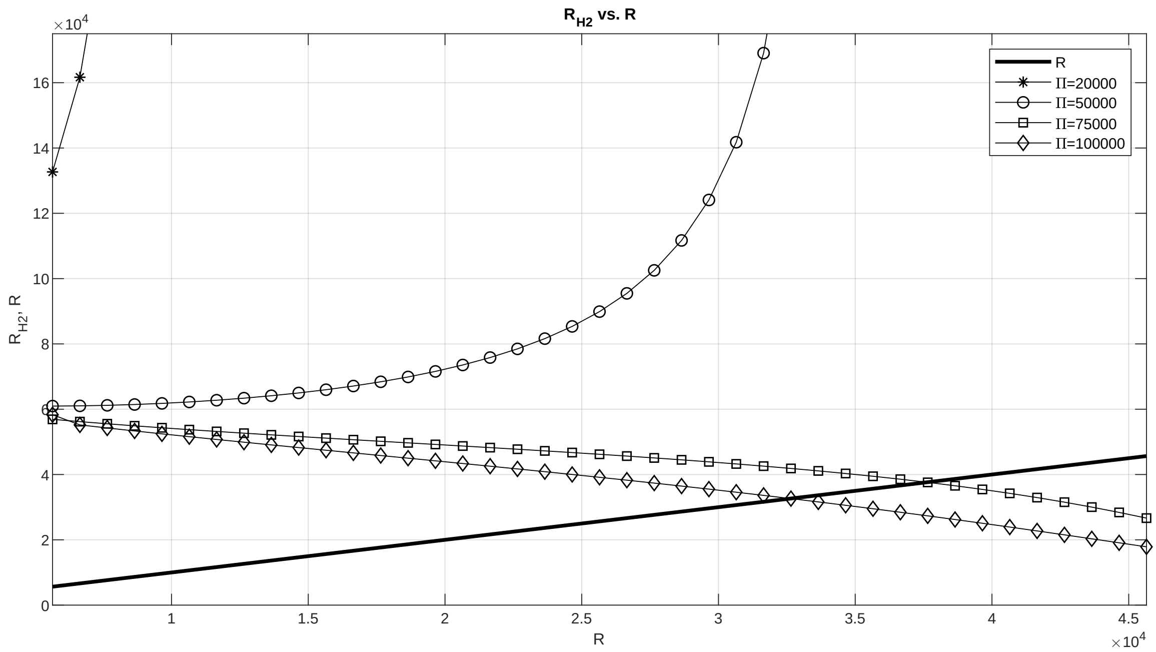


Figure 2.13: R and R_L at $\Pi = 20000, 50000, 75000, 100000$

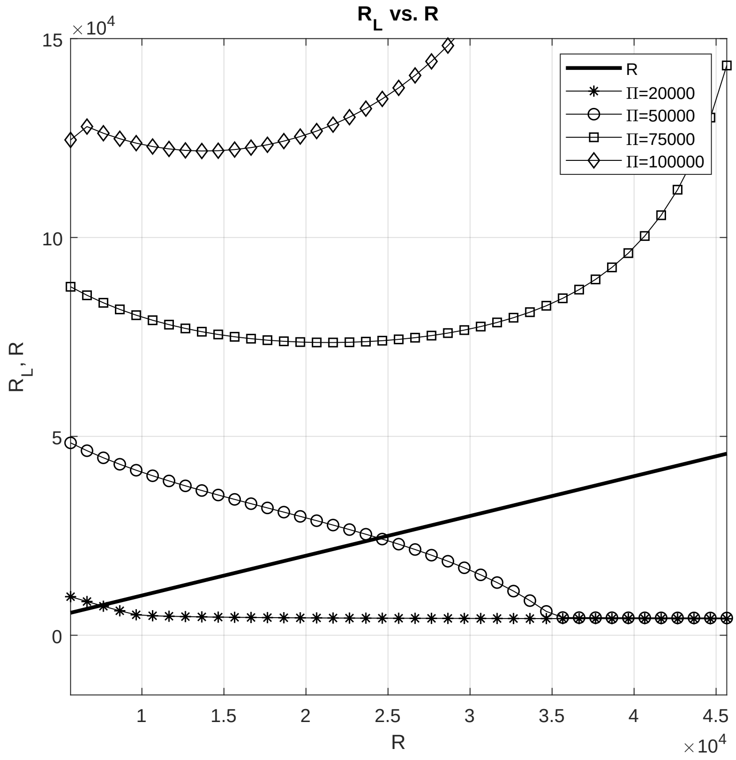


Figure 2.14: Optimal crime level $(1 - G(\widehat{\theta}^*))$ under a strict liability regime $(S = 0)$ and under a compound liability regime $(S = 1/2F, F)$, $\Pi = 50000$

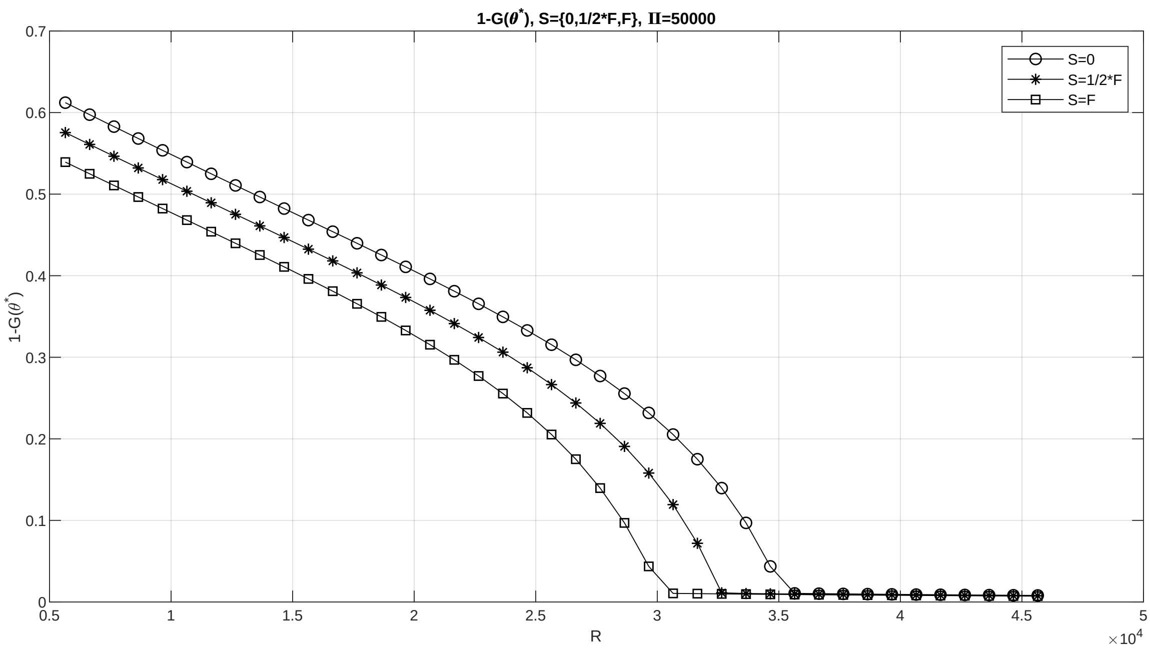


Figure 2.15: Optimal probability of detection (γ^*) under a strict liability regime ($S = 0$) and under a compound liability regime ($S = 1/2F, F$), $\Pi = 50000$

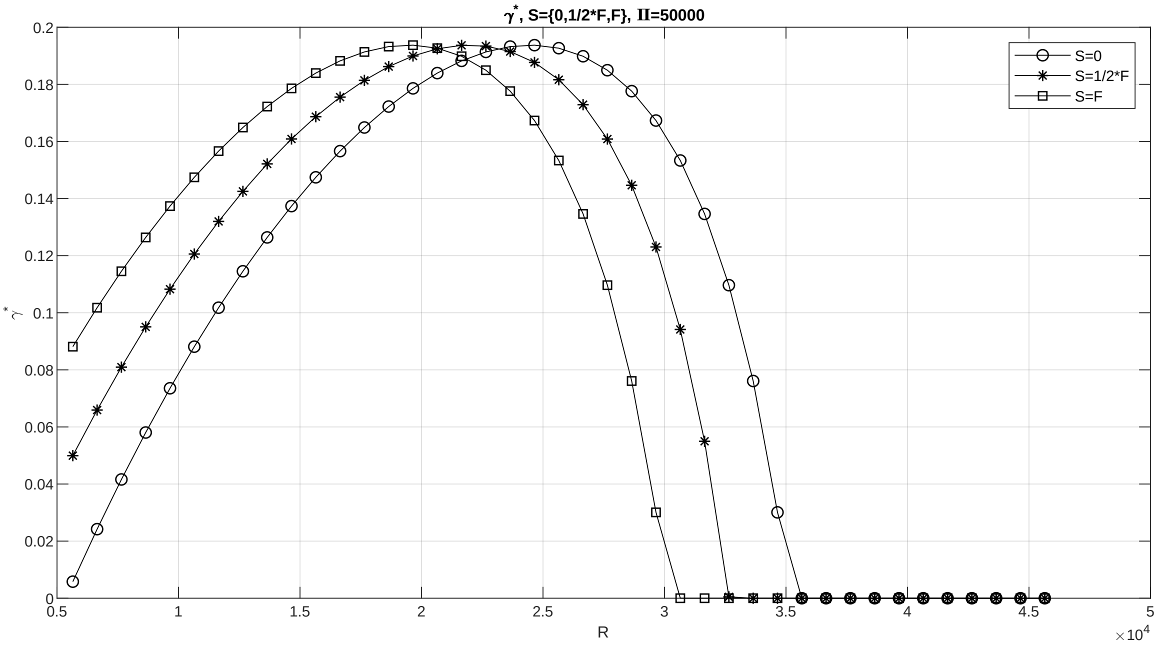


Figure 2.16: Optimal crime level ($1 - G(\widehat{\theta}^*)$) under a strict liability regime ($S = 0$) and under a compound liability regime ($S = 1/2F, F$), $\Pi = 100000$

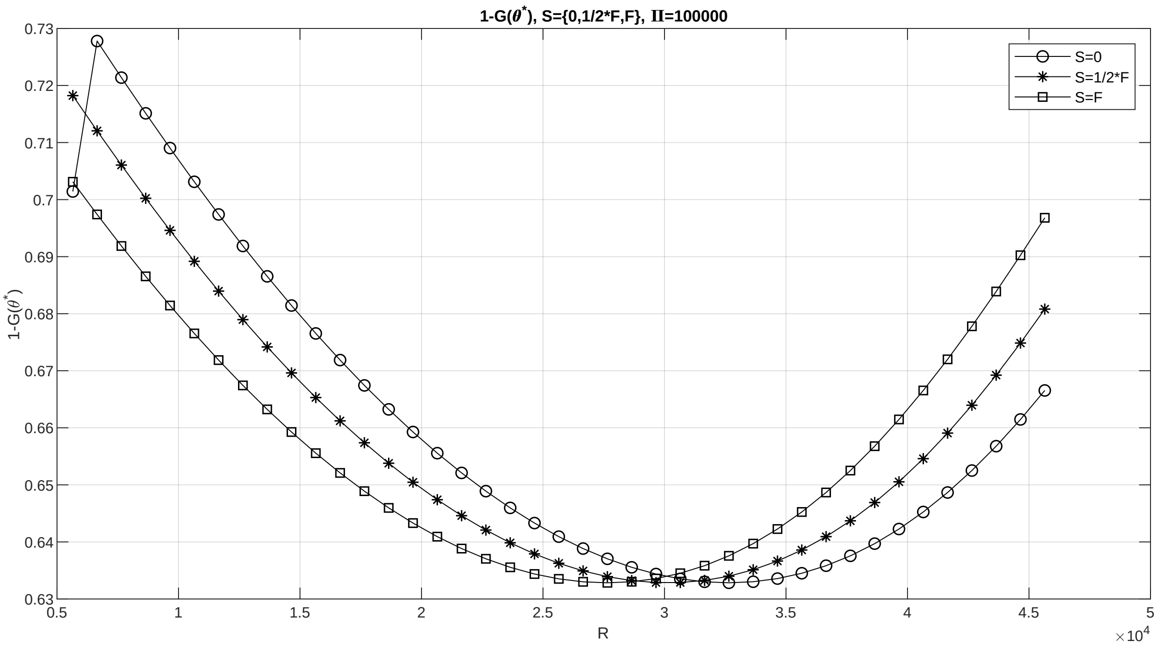
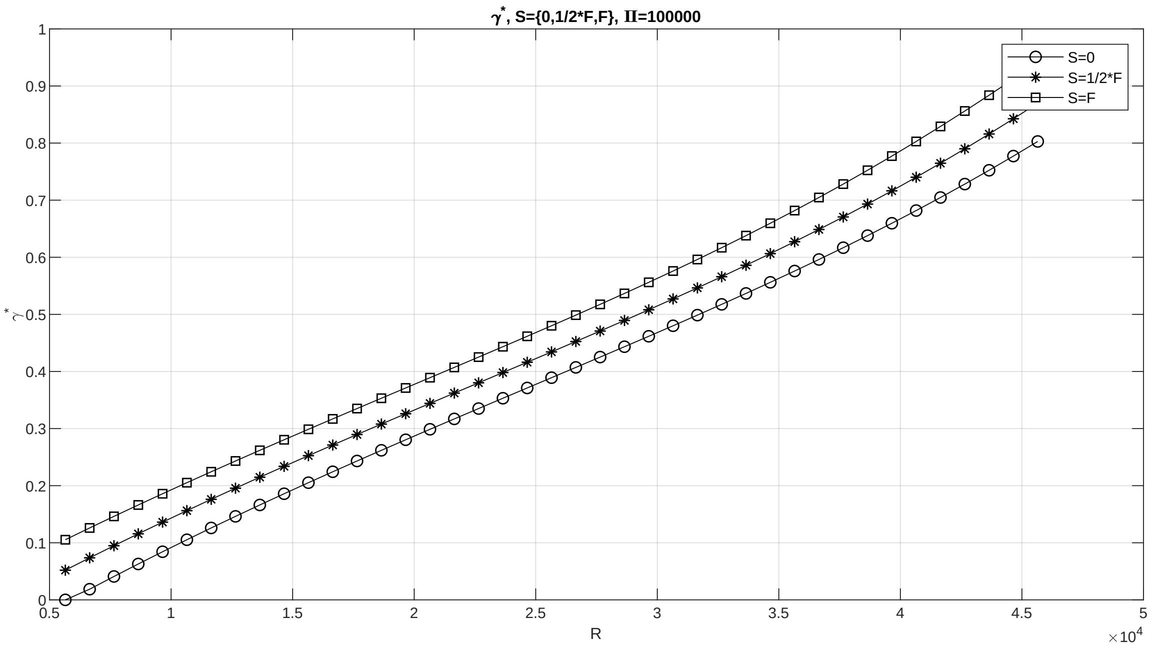


Figure 2.17: Optimal probability of detection (γ^*) under a strict liability regime ($S = 0$) and under a compound liability regime ($S = 1/2F, F$), $\Pi = 100000$



Chapter 3

Corporate Crime: Incentives and Deterrents

3.1 Introduction

The Facebook- Cambridge Analytica data scandal in 2018, the Volkswagen emission scandal in 2015, the Enron and WorldCom scandals in early 2000s are examples of crimes that have raised questions on the nature of corporate crime.

The corporate crime is distinguished from individual crime by its agency nature: Although it is committed by an agent of the firm, the firm cannot distance itself from the crime since it possesses several tools through which it can affect the agent's behavior. These tools vary between ex-ante tools, such as managerial incentives, and ex-post tools such as auditing, monitoring and self-reporting.

Moreover, the firm is not insulated from its environment. The firm's decision depends on the interaction of the firm with many institutions: the legal rules, the stakeholders' preferences are other factors that affect the firm's decision to tolerate or to fight corporate misconduct.

This survey is an attempt to understand the main determinants of the corporate crime. We will review the economics, the law and economics and the managerial literature that considered the question of the corporate crime and its determinants. The survey is organized as follows: In Section 3.2, we review the impact of corporate governance on the level of corporate crime. We will focus on the managerial incentives (Section 3.2.1) as well as the organizational structure and the role of senior managements (Section 3.2.2). In Section 3.3, we analyze the determinants of the corporate crime that are exogenous to the firm, namely the legal deterrents (Section 3.3.1) and non-legal deterrents (Section 3.3.2).

3.2 Opening the Black Box: Incentives and Deterrents within the Firm

In this section, we review the economic and managerial literature that studied the impact of corporate governance on the tendency to commit a corporate crime. Corporate governance as defined by Buccirossi and Spagnolo (2008) consists of *"the set of institutional arrangements that keep firm's agency problems under control and lead managers to pursue the shareholders' interests rather than their own goals"*. The corporate governance varies based on managerial incentives (Section 3.2.1), organizational hierarchy, corporate culture and internal enforcement (Section 3.2.2). Hence, we will open the black box of the firm and investigate how different facets of corporate governance affect the incentives of the various players within a corporation.

3.2.1 Managerial Incentives[1]

Managerial incentives play a key role in governing the agency relationship between the firm or the shareholders (the Principal) and her manager (the Agent). These incentives gain a particular importance when it comes to the corporate misconduct: If they are not properly designed, they could fuel the criminal behavior.

We can distinguish between two main strands in the literature that consider the design of managerial incentives in the context of harmful activities. The first strand assigns to the agent (the manager) the discretion to undertake a corporate crime (Section 3.2.1). In that case, breaching the law is thus a private decision of the agent, while the principal can only affect it indirectly through the incentives offered to the agent.

The other strand represents the agent as a "gatekeeper" (Section 3.2.1). The term "gatekeeper" usually refers to auditors, lawyers, insurers and banks who monitor or audit the firm independently (Mullin and Snyder, 2009). Even though, a gatekeeper does not have the discretion to commit a corporate crime, his role is crucial to facilitate the mission of the firm, e.g. by concealing the misconduct evidence (Biswas et al., 2013). In this context, the decision and intensity of the crime are solely determined by the principal who determines as well the type of contract to be offered to the gatekeeper.

Reviewing these two strands of the literature gives an overview of the main factors determining the design of the managerial incentives and the extent to which they affect the corporate crime.

The Agent as a Criminal

The idea of allowing the agent to decide upon a criminal activity has been analyzed by several papers (e.g. Inderst and Ottaviani, 2009; Goldman and Slezak, 2006; Spagnolo, 2005; Crocker and Slemrod, 2004). However, a variety of frameworks has

[1] For sake of presentation, in this section, we will refer to the firm (the principal) using the female form (she/her) and to the manager (the agent) using the male form (he/him).

been adopted to study the different aspects related to corporate crime and the design of managerial incentives.

Multitask moral hazard and the role of enforcement. A strand of the literature has studied the corporate crime through the lens of a multitask moral hazard problem. This approach can be applied to several corporate crimes, such as misselling of a product where a marketing agent provides misleading information regarding the suitability of a product to a customer (Inderst and Ottaviani, 2009), financial fraud where the manager manipulates the financial statements of a firm to inflate its value (Goldman and Slezak, 2006; David Robison and Santore, 2011; Andergassen, 2008) or market collusion where the manager engages in cartel activities (Aubert, 2009).

These models consist of three players[2]: A principal, an agent and a customer. The principal aims to maximize his profit from selling a product to the customer. For this purpose, she hires an agent in exchange of a payment contract that is based on his performance (e.g., a stock-based compensation, an equity, or a commission based on profit target). Here, the agent can affect the principal's profit by exerting two types of effort that cannot be observed by the principal: a productive effort that enhances the value of the product but it is costly and may lead to a stochastic outcome, and a criminal effort, which aims to mislead the customer about the value of the product by inflating it. Although this criminal effort does not entail a cost per se, but the agent might face an individual sanction if this criminal effort is detected. Moreover, the criminal effort might entail direct costs on the firm (e.g., through the diversion of some resources instead of using them productively), and a reputational loss that occurs in case of detection. Expecting the criminal behavior, the customer adjusts his valuation of the product to account for the expected criminal behavior, thus reducing his willingness to pay and implying lower price in equilibrium.

The principal designs the payment contract to deter any criminal effort as much as possible and provide incentives to exert productive effort. Nevertheless, the performance is an imperfect signal that depends positively on both types of effort, thus creating a conflict between them: While increasing the power of the incentives induces productive effort, it encourages the criminal one[3]. Therefore, raising the power of the incentives becomes costly for the firm, as a result of the direct costs and the expected losses that the firm might face. Accordingly, the principal reduces the power of the incentives, as compared to a situation where the agent can only rely on productive effort.

[2]In Aubert (2009), the model is slightly different: The principal's profit depends on the market strategy adopted by the manager rather than the equilibrium price that results from the supply and the demand of a product. Moreover, the criminal effort consists of adopting a market strategy different from the one recommended by the principal. However, the main results discussed in section 3.2.1 hold. Similarly, Andergassen (2008) consists of two players. The main source of conflict is that the principal and the agent's payoffs are realized in different time horizons: The agent receives his compensation at time $t = 2$ before the direct harm of the criminal effort takes place at time $t = 3$. The principal cannot thus incorporate this cost in the agent's payoff.

[3]This result holds as long as the productive and the criminal efforts are technically independent in the agent's payoff. However, if there exist interdependencies between the two efforts, the impact of increasing the power of the incentives on the level of criminal and productive efforts is not obvious (Desai and Dharmapala, 2006)

In this context, we can assess the impact of an increase in the probability of crime detection. Generally speaking, a higher probability of detection would deter the agent from exerting criminal effort. If the detection of the misconduct is not associated with a reputational loss for the principal, this deterrent effect would encourage the principal to raise the power of the incentives. However, these higher incentives may counteract the deterrent effect of the increase of the probability of detection, leading finally to higher levels of criminal effort[4](Goldman and Slezak, 2006). If the principal risks her reputation after the detection, the effect of higher probability of detection on the incentives is ambiguous. That is, in addition to the indirect effect that stems from the reduction in the criminal effort, which encourages the principal to provide high-powered incentives, a direct effect comes into play: The possibility of loosing the reputation after a detection makes it costly to raise the incentives (David Robison and Santore, 2011).

Finally, an increase in the direct costs of the criminal effort pushes the firm to lower the power of the incentives offered to her agent, in order to limit the negative impact the criminal effort has on her payoff (Andergassen, 2008).

Incentive schemes and the sustainability of collusion. What distinguishes the market collusion from other corporate crimes is its multiplayer nature. Therefore, the sustainability of collusion is not a decision of a single firm, but requires that no cartel member has incentive to deviate from the collusive agreement. Indeed, deviation depends on how much the firm discounts her future profits and the retaliation strategy supporting the agreement. If the firm delegates its market strategy to an agent, the sustainability of the collusion will depend on the payoff of the agent rather than that of the firm. Accordingly, if the agent's payoff departs from the payoff of a profit maximizing firm, we might have cases where the collusion is sustainable while it wouldn't have been so when the firm was determining its the market strategy directly.

Spagnolo (2000, 2005) analyzes this idea by abstracting from the moral hazard concerning the productive effort and disregarding the legal and direct costs that the collusion might entail. Particularly, he specifies two main instances in which the delegation of the market strategy decision helps to sustain a collusive agreement.

First, when the agent exhibits a preference for income smoothing, the collusion is more likely to be sustained. For example, if the agent is averse to the profit variance, the deviation will be less attractive since the higher profit he gets by deviating is followed by lower profits in subsequent periods. A similar effect could be perceived when particular incentives schemes are used, such as long term bonus contracts characterized by a bonus cap. In these contracts, the agent receives a fixed wage as long as the profit is below a certain threshold. When this threshold is reached, the agent starts to get a bonus. By properly defining this threshold, the principal can induce collusion at any discount factor. The reason is that, based on this contract, an agent has no incentive to deviate since he will receive a lower compensation by doing so. The same behavior can be observed based on a short term capped bonus contract or a contract consisting of offering a rent associated with a termination

[4]The net effect of the higher probability of detection on the level of criminal effort depends on the elasticity of the incentives to the probability of detection (Goldman and Slezak, 2006).

threat if a profit threshold is not achieved (Spagnolo, 2005).

Second, if the agent is offered a stock-based compensation, deviation is less likely to occur, as compared to when he receives a profit-based compensation. Indeed, the stock price captures not only the current profit but also the flow of future profits. Therefore, a stock-based compensation is affected more than a profit-based one by the deviation from a collusive agreement. This observation is true for different forms of incentives related to stock price, in both cases when the incentives are deferred or paid before the distribution of dividends. Examples of stock-based compensations include "small" compensation packages that do not affect the stock price, "large" compensation packages or stock-options where the agent can buy a certain number of shares at a predetermined price (Spagnolo, 2000).

The Agent as a Gatekeeper

This strand of literature considers an agent who plays a less active role in the decision of committing the corporate crime. However, his role remains necessary for the principal who determines not only the desirability of the crime but also its intensity. This stuy approach has been applied to corporate tax evasion, mainly to analyze the impact of gatekeeper liability on the design of the contract between the firm and the agent.

The agent in Chen and Chu (2005) is risk averse. He prepares the tax return and exerts a productive effort that affects the principal's payoff. In exchange, he receives a payment contract based on the reported income to the tax authority. The principal's decision to underreport the taxable income imposes a risk on the agent, specifically if he will be held liable for this misconduct: Due to the illegal nature of the tax evasion, the principal cannot insure the agent through a contract that is contingent on the detection of the illegal act. Alternatively, in addition to the payment contract described above, the principal would offer the agent a service contract. This latter consists of providing an additional remuneration based on the difference between the actual and the reported income and a risk premium. Therefore, if the principal desires to induce a higher level of effort, this risk premium will be the source of an additional cost, leading thus to internal control inefficiencies. In particular, compared to a case where the agent is not liable for tax evasion (i.e., the source of risk is absent), if the agent exhibits increasing risk aversion with income, the principal will reduce the power of the incentives provided to the agent, reducing the level of productive effort in equilibrium. However, decreasing risk aversion with income would implies higher power incentives with overprovision of effort. Finally, constant risk aversion with income will not alter the level of effort provided in equilibrium.

Biswas et al. (2013) consider an agent who is risk averse as well but plays a more active role in the process of tax evasion. He gets a remuneration for exerting an effort to reduce the probability of detecting the principal's misconduct. It is assumed that the effort is fully observable by the principal. Holding the agent liable exposes him to a risk. As a response, the agent engages in higher levels of effort in order to avoid the expected sanction, which benefits the principal and reduces the cost of tax evasion. Nevertheless, the higher effort requires higher compensation in addition to the compensation for the risk that the agent is facing. The result of extending the liability to the agent is thus ambiguous: On the one hand, if the agent faces high sanction or high risk aversion, the second effect dominates: The principal will prefer to reduce the level of effort by reducing the remuneration offered to the agent, and lower tax evasion will result. On the other hand, if the individual sanction is low or the agent exhibits low risk aversion, the first effect dominates, which can be interpreted then as "excessive loyalty". The higher protection that results from the higher levels of effort encourages the principal to raise the agent's remuneration and the amount of tax evaded.

3.2.2 Other Forms of Corporate Governance

The role of the corporate governance in controlling corporate crime is not limited to the managerial incentives, but it goes beyond it.

Organizational structure. The complexity of the organizational structure is one of the factors facilitating the corporate crime. By complexity we mean *"the degree of spread and segmentation in the organization's structure"* (Dugan and Gibbs, 2009). Therefore, the more complex the corporate structure is, the more difficult the coordination and the diffusion of information will be, which increases the agency cost (Abrantes-Metz and Sokol, 2013). As a result, it becomes more difficult for law enforcers to detect the crime and to prosecute the wrongdoer since the decentralization of the tasks distribute the responsibilities between several managers. This requires the adaptation of the enforcement tools to account for these aspects by encouraging whistle-blowing, improving prevention measures and coordination between several law enforcement units (Dugan and Gibbs, 2009).

Moreover, this complex structure implies that each division of the corporation aims to achieve a specific performance target. Hence, the objective function of the managers might depart from that of the shareholders and committing the corporate crime could be a tool to achieve it (Abrantes-Metz and Sokol, 2013).

Role of senior management. Senior managers play a key role in shaping the firm's objectives. They hold the power to decide upon the strategic variables of the firm (Abrantes-Metz and Sokol, 2013). Consequently, they might affect the corporate crime in several ways.

First, committing the corporate crime could be the decision of the top management as in the case of antitrust violations (Buccirossi and Spagnolo, 2008). However, this discretion regarding the corporate crime could be undermined if appropriate measures were taken by the board of directors who monitors those senior managers. Among these measures are securing the independence of the board of directors by limiting the possibility that a top manager holds the leadership of the board. In this way, the potential conflict of interest that may arise is avoided and the board of directors will pursue the objectives of the shareholders. Another measure consists of aligning the objectives of the top managers with those of the shareholders by allowing for insider ownership. However, the managers' share need to be designed with caution. Although ownership increases the senior managers' incentives to raise the firm value, a high share could create an "entrenchment effect": The managers could reject projects that do not benefit them even if they increase the firm's value (Boubakri, 2011).

Second, senior managers can affect the incentives of middle managers to commit corporate crime through the design of both the managerial incentives (See section 3.2.1), the corporate culture and compliance programs. Indeed, by dedicating financial resources to compliance programs, organizing continuous training for the middle management and providing power to compliance officers, senior managers can promote a culture of compliance in the corporation (Abrantes-Metz and Sokol, 2013).

Corporate culture. Corporate culture governs the relation between the firm and its stakeholders. Hence, it determines the extent to which the firm would pursue its economic, legal and ethical responsibilities (Maignan and Ferrell, 2001). Indeed, the dominating culture determines whether the compliance to the legal rules is an integral part of the corporation or in contrast is just a *"system to beat in pursuit of sales and commission"* (Abrantes-Metz and Sokol, 2013).

If the corporate culture underlines the ethical value of compliance, it could improve the deterrence of corporate crime. For instance, if the culture endorses compliance, the perpetrator will be subject to moral stigma upon the detection of the wrongdoing. This would definitely increase the expected cost of the crime and may discourage him from committing it. The corporate culture could thus reduce the cost of detection. Moreover, the dominance of a compliance culture could empower a whistle-blower to report the misconduct, an action he wouldn't have done otherwise since he might end up loosing his job (Abrantes-Metz and Sokol, 2013).

Compliance programs and codes of conduct. The aim of implementing compliance programs by the firms is to identify and to reduce the risk of committing a corporate crime by its agents(OECD, 2009). Compliance programs consists of ex-ante and ex-post measures. Nevertheless, the sole implementation of these programs does not guarantee its effectiveness and even large investments in compliance programs is not necessarily a sign of fighting the corporate crime[5] (Krawiec, 2003). The implementation of the program should be coupled with the dedication of adequate resources and the commitment of top management in order to fight the crime. In general, a compliance program consists of two components: First, a code of conduct that states the firm's commitment to the ethical standards and practices (OECD, 2009). A comprehensive and clear code of conduct is necessary to guide the agents about the actions that need to be avoided (Schnatterly, 2003). Second, due diligence procedures that aims to screen and investigate potential agents for possible red flags, to detail the tasks required in the contract and to monitor and audit the agent regularly (OECD, 2009).

[5] See Chapter 2 for formal analysis of this result.

3.3 Outside the Black Box: Incentives and Deterrents Outside the Firm

The incentives and the measures adopted by the firm to discipline its agent are not the only factors affecting the level of corporate crime. Indeed, other factors exogenous to the firm might determine the firm's willingness to fight the corporate crime. Some of these factors are legal (Section 3.3.1), such as the liability regime the firm is subject to and the availability of leniency programs. Other factors are non-legal (Section 3.3.2), e.g., the reputational loss, the market sanctions and the corporate social responsibility.

3.3.1 Legal Deterrents

In this section, we briefly review the main questions raised in the law and economics and the economics literature[6] regarding the legal aspects of the corporate crime. Their analysis have focused mainly on the issue of the optimal design of enforcement tools.

Corporate and individual liability. The ultimate aim of imposing liability on either the corporation or the agent is to achieve the level of corporate crime that is socially optimal by incorporating the social cost of the crime in the wrongdoers objective functions. This can be done directly by imposing an expected fine equal to the social cost of the crime to the agent as in the case of individual liability, or indirectly by inducing the firm to adjust its corporate policing measures (e.g., investigation, detection, self-reporting and cooperation with law enforcer) and the incentives offered to the agent as in the case of corporate liability (Arlen, 2012). Both types of liability are equivalent if some conditions apply. Namely, if the firm does not get any benefit from the crime, if neither the firm nor the agent face a limited liability and if the reallocation of the sanction is possible through the compensation/indemnification contracts. In case of violation of one of these conditions, imposing a joint liability will be the optimal solution (Buccirossi and Spagnolo, 2008).

For instance, if the firm is closely held or small publicly held, it is likely that the firm suffers from a limited liability. Therefore, imposing a full sanction that is equal to the social harm becomes impossible. As a consequence, the level of transfers offered to the agent will be suboptimal and will not lead to optimal deterrence. This is a case where the corporate liability should be associated with individual liability (Arlen, 2012). Similarly, in publicly held firms, the agency cost and contract inefficiencies might hinder the reallocation of the full sanction to the agent, leading to underdeterrence of the corporate crime (Crocker and Slemrod, 2004). Finally, the firm might lack the tools to impose large sanctions to the agent due to the agent's limited liability. In that case, the individual liability allows the intervention of the law enforcer who could impose harsher penalties such as imprisonment(Buccirossi and Spagnolo, 2008).

[6]For a comprehensive review of the Law and Economics literature on corporate crime, see Mullin and Snyder (2009).

By the same token, relying on the individual liability alone may not be sufficient to deter the corporate crime. Particularly, if the agent is judgment proof, the ability to internalize the social cost of the crime through the individual fines is limited. In the absence of corporate liability, the firm might be reluctant to provide the adequate incentives for the agent (Hiriart and Martimort, 2006) or to adjust the its policing tools and to invest in monitoring (Arlen, 2012) to avoid the corporate crime.

Finally, in some cases, delegating the enforcement to the firm is cost effective. Indeed, the firm is better positioned to run investigations than an outsider since it has better information on the work procedures. In addition, the firm can take several measures ex-ante (e.g., due diligence during the hiring process, design of the incentives) and ex-post (regular monitoring and audit)[7]to deter the corporate crime.

Corporate liability regime. The aim of corporate liability regimes is to induce the firm to internalize the social cost of its agent's corporate crime and to undertake optimal prevention and policing measures to achieve the socially optimal level of corporate crime as well as the socially optimal production level (Arlen and Kraakman, 1997). The literature has studied the optimality of various liability regimes, namely the strict liability regime, the duty-based liability regime, the composite liability regime (Arlen and Kraakman, 1997) and the compound corporate liability regime (Oded, 2011). In the following, we will present the main features of each of these regimes.

Under a *strict corporate liability regime*, the firm is strictly liable for the misconduct of its agent as long as the violation has occurred within the scope of the agency contract. The strict liability applies regardless of the prevention and the policing measures undertaken by the firm (Oded, 2011). The merit of this regime is that it encourages the firm to adopt optimal policing measures, which contributes to the deterrence of the crime by increasing the crime's expected cost to the agent (deterrence effect). Nevertheless, it has the perversive effect of increasing the expected liability of the firm for the undeterred crimes (liability enhancement effect) (Arlen, 1994). This latter effect undermines the firm's incentives to adopt costly policing measures (Oded, 2011).

Unlike the strict liability regime, the *duty-based liability regime* takes into consideration the prevention and policing measures implemented by the firm. Particularly, the firm is deemed liable for the corporate crimes committed by its employees only if it fails to fulfill the duties set by the law. These duties are usually related to self policing: the optimal prevention, deterrence, self-reporting and cooperation with law enforcer. The main drawback of this regime is that it does not allow the firm to internalize the social cost of the crime if it satisfies the due-care level required by the law, leading to suboptimal levels of production. Moreover, this regime requires considerable administrative costs to determine the socially optimal level of due care and to evaluate the measures taken by the firm. The asymmetry of information between the firm and the law enforcer adds to the drawbacks of this regime(Oded, 2011).

[7]We discuss these measures in details in section 3.2.2.

Arlen and Kraakman (1997) have introduced the *composite liability regime* as a regime that overcomes the drawbacks of the previous ones. This regime consists of imposing a strict liability on the firms for the misconduct of their agents if they fail to satisfy the due-care level and imposing a reduced sanction on the firms that fulfill (fully or partially) the required measures by the law (Arlen, 2012). Accordingly, it provides the firm with incentives to invest in socially optimal self-policing while internalizing the social harm of the crime. Nevertheless, like the duty-based regimes, the burden of determining the due-care level and the asymmetry of information between the firm and the law enforcer are the main concerns related to this regime.

The *compound liability regime* is similar to the composite liability regime, in sense that it imposes a base sanction on any firm violating the law and a reduced sanction on firms that satisfy optimal self-policing. The main difference is that it exploits the idea that self-reporting reduces the variable enforcement costs necessary to detect the corporate misconduct. According to this regime, a firm that is deemed liable will face a sanction equivalent to the social harm and the variable enforcement costs, while a firm that self–report will face only a sanction equal to the social harm. In that way, the firm's incentives to implement self-enforcement measures are adjusted to incorporate the social consequences of these measures (Oded, 2011).

It is worthy to note that the composite liability regime is the closest liability regime to the one adopted by the US sentencing guidelines (Oded, 2011). However, the mitigation of the sanction and the determination of the suitability of the measures undertaken by the firm are left to the discretionary power of the law enforcer (Arlen and Kahan, 2017), strengthening thus the drawbacks highlighted above.

Another feature of the liability regime adopted in practice is the possibility to impose ex-post mandates through the pre-trial diversion agreements (PDA). The PDA are usually imposed on the firms that have committed a corporate crime while having implemented an ineffective compliance program. The aim of these mandates is to induce the firm to undertake new measures to improve its self-policing strategies (e.g., by altering the internal governance, investing substantial amounts in compliance programs). These mandates are firm specific and the firm is deemed liable for failing to satisfy these new duties even if no harm has resulted. According to Arlen and Kahan (2017), these mandates are useful only if the corporate crime was due to policing agency cost, i.e., the top management benefits from the wrongdoing and from the absence of effective self-enforcement measures. Otherwise, those mandates will result into inefficient spendings.

Leniency programs. Leniency programs were shown to be effective in crimes that involve multiple parties[8]. In particular, leniency programs aim to exploit the opportunistic behavior of the involved parties by offering a fine reduction (or possibly positive rewards) in exchange of insider information. This allows the law enforcer to reduce the enforcement costs while ensuring higher deterrence rates (Spagnolo, 2008; Buccirossi and Spagnolo, 2006).

[8]In this section, we focus on the impact of leniency programs on crimes that involve a vertical relationship between the players (i.e., agency relationship). Nevertheless, leniency programs are applied as well to crimes with horizontal relationship between the players, such as market collusion. For a comprehensive review of the literature on the latter point, see Spagnolo (2008).

As discussed in the previous point, corporate liability regimes that guarantee a mitigation of the sanction when the firm self-reports, such as the composite liability or the compound liability regimes, encourage the firm to optimally invest in self-enforcement, which in turn ensures optimal level of deterrence. By the same token, Angelucci and Han (2010) find that a marginal decrease in the corporate fine (i.e., a partial corporate leniency) would increase the effectiveness of the compliance program implemented by the firm: The fine reduction encourages the firm to cooperate with the law enforcer by disclosing the information it gets by monitoring the agent. This increases the expected managerial sanction, reducing thus the manager's incentive to commit the corporate crime.

Fine reductions can be offered as well to the individuals involved in the corporate crime, which is known as individual leniency programs. However, leniency programs that target the individuals are not always effective. From the one hand, inducing the agent to breach the law becomes more expensive since higher incentives (bribes) should be provided to him to prevent his application for leniency. The corporate crime becomes even more costly when the leniency program offers positive rewards and not just a fine reduction (Aubert et al., 2006). On the other hand, inducing the agent to comply with the law becomes more costly as well: Breaching the law becomes more attractive to the agent who can breach the law and then apply for leniency to enjoy the fine reduction. Hence, higher incentives should be provided to the agent (Angelucci and Han, 2010; Aubert, 2009). Individual leniency programs should be thus designed with caution to avoid this perverse effect.

When corporate leniency programs are coupled with individual leniency programs, an improvement in the deterrence level could be observed. The implementation of both the corporate and the individual leniency programs could create a "race to the courthouse" between the firms and the agent : Each party has incentive to avoid facing the full sanction, which lead to higher deterrence levels. Moreover, some complementarity in deterrence could be perceived between corporate and individual leniency programs. For instance, if a firm deviates from the collusive agreement and its agent has the opportunity to apply for an individual leniency program. The firm will face two options: either to leave higher rent to the agent to deter him from the application to the program or to apply to the corporate leniency program once it deviates. Clearly, the presence of the individual leniency program has made the application to the corporate leniency program more appealing for the firm (Buccirossi and Spagnolo, 2008).

3.3.2 Non-legal Deterrents

In this section, we review the non-legal deterrents that affect the firm's decision to commit the corporate crime. We will focus mainly on the corporate reputation and the corporate social responsibility.

Corporate reputation. A corporation that gets involved in a corporate crime might be subject to reputational penalty. This reputational loss is a market penalty, it is translated through the fall of the stock price of the firm (Alexander, 1999). This loss in the firm's value occurs as the stakeholders of the firm, namely the customers, the lenders and the suppliers, are less likely to deal with a firm known by its criminal behavior (Arlen, 2012).

Indeed, three features characterize these reputational penalties (Arlen, 2012). First, the value and the severity of the loss depend on the type of the crime and the type of stakeholder affected. Generally speaking, crimes that concern related parties (direct stakeholders) (e.g., fraud), are more likely to induce a reputational loss than crimes that affect third parties (e.g., environmental crimes) (Karpoff et al., 2005). Other factor that might affect the severity of the reputational loss as well is the quality of the corporate governance (Desai and Dharmapala, 2009). Second, this penalty does not depend on formal conviction. Yet, it occurs once the market receives credible information about the crime. Third, the firm can take some steps to reduce the reputational loss.

It is worthy to note that the reputational loss is a kind of strict corporate liability (Arlen, 2012) and sometimes it is sufficiently high to generate the optimal total sanction (Alexander, 1999). Therefore, the optimal sanction need to be adjusted either downward (upward) to account for this reputational loss and to avoid overdeterrence (underdeterrence) (Garoupa, 2000).

Corporate social responsibility. The question of corporate social responsibility has always been studied as the tendency of the firm to "do good". However, another facet of the corporate social responsibility of the firm is to "avoid bad" (Lin-Hi and Müller, 2013). In this context corporate crime can be perceived as a form of "corporate social irresponsibility". Therefore, we can adopt the same tools used to study the firm's corporate social responsibility to understand the firm's motives to avoid the corporate crime as form of "corporate social irresponsibility". For instance, the profit maximizing firm might have incentive to deter corporate crime in order to avoid negative advertisement and negative perception by its customers, or to avoid the reduction in sales that might be led by consumers with social preference. Moreover, the firm could aim to attract investors with social preferences who might be discouraged from investing in a firm that promotes corporate crime (Schmitz and Schrader, 2015). Finally, deterring corporate crime could be a mean to protect the firm's reputation (Crifo and Forget, 2015).

3.4 Conclusion

We have presented a review of the economic, law and economics and managerial literature that considered the question of corporate crime and particularly the incentives and the deterrents that affect the firm's decision to undertake a corporate crime.

We can derive some general conclusions regarding the determinants of the corporate crime. The agency problem between the firm and the manager can undermine the effectiveness of some enforcement measures. This could be interpreted either by the link between the managerial incentives and the level of corporate crime or by the manager's risk preference. Moreover, the role of the top managers in controlling the corporate crime is crucial. They design the main tools affecting the enforcement within the firm, which in turn affects the incentives of the middle managers to commit the crime. Therefore, ensuring that their incentives are aligned with those of the shareholders is important.

As for the deterrents determined outside the firm, we can conclude that a joint liability between the corporation and the manager is optimal. The compound liability regime is the liability regime that allows the firm to internalize the social harm of the corporate crime and to undertake optimal self-enforcement measures, which ensures optimal deterrence of crime and optimal levels of production. Furthermore, relying on individual and corporate leniency programs could enhance the level of deterrence of corporate crime.

Bibliography

Abrantes-Metz, R. M. and Sokol, D. D. (2013). Antitrust Corporate Governance and Compliance.

Acconcia, A., Immordino, G., Piccolo, S., and Rey, P. (2014). Accomplice Witnesses and Organized Crime: Theory and Evidence from Italy. *Scandinavian Journal of Economics*, 116(4):1116–1159.

Alexander, C. R. (1999). On the Nature of the Reputational Penalty for Corporate Crime: Evidence. *Journal of Law and Economics*, 42(S1):489–526.

Andergassen, R. (2008). High-Powered Incentives and Fraudulent Behavior: Stock-Based versus Stock Option-Based Compensation. *Economics Letters*, 101(2008):122–125.

Angelucci, C. and Han, M. A. (2010). Monitoring Managers Through Corporate Compliance Programs.

Arlen, J. (1994). Potentially Preverse Effect of Corporate Criminal Liability. *Journal of Legal Studies1*, XXIII:833–867.

Arlen, J. (2012). Corporate Criminal Liability: Theory and Evidence. In Harel, A. and Hylton, K. N., editors, *Research Handbook on the Economics of Criminal Law*, chapter 7, pages 144–203. Edward Elgar, Northampton.

Arlen, J. and Kahan, M. (2017). Corporate Governance Regulation through Non-Prosecution. *University of Chicago Law Review*, 1(1):323–387.

Arlen, J. and Kraakman, R. (1997). Controlling Corporate Misconduct: An Analysis of Corporate Liability Regimes. *New York University Law Review*, 72(4):687–779.

Aubert, C. (2009). Managerial Effort Incentives and Market Collusion.

Aubert, C., Rey, P., and Kovacic, W. E. (2006). The Impact of Leniency and Whistle-Blowing Programs on Cartels. *International Journal of Industrial Organization*, 24(6):1241–1266.

Basu, K., Basu, K., and Cordella, T. (2016). Asymmetric Punishment as an Instrument of Corruption Control. *Journal of Public Economic Theory*, 18(6):831–856.

Biswas, R., Marchese, C., and Privileggi, F. (2013). Firm's Tax Evasion in a Principal-Agent Model with Self-protection. *Journal of Economics*, 110:125–140.

Boubakri, N. (2011). Corporate Governance and Issues From the Insurance Industry. *The Journal of Risk and Insurance*, 78(3).

Buccirossi, P. and Spagnolo, G. (2006). Leniency Policies and Illegal Transactions. *Journal of Public Economics*, 90(6-7):1281–1297.

Buccirossi, P. and Spagnolo, G. (2008). Corporate Governance and Collusive Behavior. In *Issues in Competition Law and Policy*, chapter 51, pages 1219–1240. American Bar Association.

Chen, K.-P. and Chu, C. Y. C. (2005). Internal Control versus External Manipulation: A Model of Corporate Income Tax Evasion. *The RAND Journal of Economics*, 36(1):151–164.

Chen, Z. and Rey, P. (2013). On the Design of Leniency Programs. *Journal of Law and Economics*, 56(4):917–957.

Chêne, M. (2008). Organised Crime and Corruption. Technical Report 18, Anti-Corruption Resource Centre.

Crifo, P. and Forget, V. D. (2015). The Economics of Corporate Social Responsibility: A Firm-Level Perspective Survey. *Journal of Economic Surveys*, 29(1):112–130.

Crocker, K. J. and Slemrod, J. (2004). Corporate Tax Evasion with Agency Costs. *Journal of Public Economics*, 89(2005):1593–1610.

David Robison, H. and Santore, R. (2011). Managerial Incentives, Fraud and Monitoring. *The Financial Review*, 46(2):281–311.

Desai, M. A. and Dharmapala, D. (2006). Corporate Tax Avoidance and High-powered Incentives. *Journal of Financial Economics*, 79:145–179.

Desai, M. A. and Dharmapala, D. (2009). Corporate Tax Avoidance and Firm Value. *The Review of Economics and Statistics*, 91(3):537–546.

Dijk, J. V. and Buscaglia, E. (2003). Controlling Crganized Crime and Corruption in the Public Sector. *Forum on Crime and Society*, 3(1-2):3–34.

Dufwenberg, M. and Spagnolo, G. (2015). Legalizing Bribe Giving. *Economic Inquiry*, 53(2):836–853.

Dugan, L. and Gibbs, C. (2009). The Role of Organizational Structure in the Control of Corporate Crime and Terrorism. In Simpson, S. S. and Weisburd, D., editors, *The Criminology of White-Collar Crime*, chapter 6, pages 79–110. Springer.

Garoupa, N. (2000). Corporate Criminal Law and Organization Incentives: A Managerial Perspective. *Managerial and Decision Economics*, 21(6):243–252.

Goldman, E. and Slezak, S. L. (2006). An Equilibrium Model of Incentive Contracts in the Presence of Information Manipulation. *Journal of Financial Economics*, 80:603–626.

Gounev, P. and Bezlov, T. (2010). *Examining the Links Between Organised Crime and Corruption*, volume 13. Center for the Study of Democracy.

Harrington, J. E. (2013). Corporate Leniency Programs when Firms have Private Information: The Push of Prosecution and the Pull of Pre-emption. *Journal of Industrial Economics*, 61(1):1–27.

Hiriart, Y. and Martimort, D. (2006). The Benefits of Extended Liability. *The RAND Journal of Economics*, 37(3):562–582.

Inderst, R. and Ottaviani, M. (2009). Misselling through Agents. *American Economic Review*, 99(3):883–908.

Karpoff, J. M., Lott, J. R. J., and Wherly, E. W. (2005). The Reputational Penalties for Environmental Violations: Empirical Evidence. *Journal of Law and Economics*, 48(2):653–673.

Krawiec, K. D. (2003). Cosmetic Compliance and the Failure of Negotiated Governance. *Washington University Law Review*, 81(2):487–544.

Kugler, M., Verdier, T., and Zenou, Y. (2005). Organized Crime, Corruption and Punishment. *Journal of Public Economics*, 89(9-10):1639–1663.

Lambsdorff, J. and Mathias, N. (2007). Fighting Corruption with Asymmetric Penalties and Leniency.

Lefouili, Y. and Roux, C. (2012). Leniency Programs for Multimarket Firms: The Effect of Amnesty Plus on Cartel Formation. *International Journal of Industrial Organization*, 30(6):624–640.

Lin-Hi, N. and Müller, K. (2013). The CSR Bottom Line: Preventing Corporate Social Irresponsibility. *Journal of Business Research*, 66:1928–1936.

Maignan, I. and Ferrell, O. (2001). Antecedents and Benefits of Corporate Citizenship: An Investigation of French Businesses. *Journal of Business Research*, 51(1):37–51.

Motta, M. and Polo, M. (2003). Leniency Programs and Cartel Prosecution. *International Journal of Industrial Organization*, 21(3):347–379.

Mullin, W. P. and Snyder, C. M. (2009). Corporate Crime. In Garoupa, N., editor, *Encyclopedia of Law and Economics - Criminal Law and Economics*, volume 3, chapter 9, pages 220–256. Edward Elgar, 2nd edition.

Oak, M. (2015). *Legalization of Bribe Giving when Bribe Type Is Endogenous*, volume 17.

Oded, S. (2011). Inducing Corporate Compliance: A Compound Corporate Liability Regime. *International Review of Law and Economics*, 31(4):272–283.

OECD (2009). Typologies on the Role of Intermediaries in International Business Transactions. Technical Report October, OECD, Paris.

OECD (2016). TheLiability of Legal Persons for Foreign Bribery: A Stocktaking Report. Technical report.

Reuters (2018). VW tells court it did not break rules over 'dieselgate' disclosure.

Rose-Ackerman, S. (2010). The Law and Economics of Bribery and Extortion. *Annual Review of law and Social Science*, 6(408):217–236.

Rotondi, V. and Stanca, L. (2015). The Effect of Particularism on Corruption: Theory and Empirical Evidence. *Journal of Economic Psychology*, 51:219–235.

Schmitz, J. and Schrader, J. (2015). Corporate Social Responsibility: A Microeconomic Review of the Literature. *Journal of Economic Surveys*, 29(1):27–45.

Schnatterly, K. (2003). Increasing Firm Value through Detection and Prevention of White-Collar Crime. *Strategic Management Journal*, 24(7):587–614.

Siano, A., Vollero, A., Conte, F., and Amabile, S. (2017). "More than words": Expanding the Taxonomy of Greenwashing After the Volkswagen Scandal. *Journal of Business Research*, 71:27–37.

Spagnolo, G. (2000). Stock-Related Compensation and Product-Market Competition. *The RAND Journal of Economics Journal of Economics*, 31(1):22–42.

Spagnolo, G. (2004). Divide et Impera: Optimal Leniency Programs.

Spagnolo, G. (2005). Managerial Incentives and Collusive Behavior. *European Economic Review*, 49:1501–1523.

Spagnolo, G. (2008). Leniency and Whistleblowers in Antitrust. In Buccirossi, P., editor, *Handbook of Antitrust Economics*, volume 46, chapter 07, pages 259–303. MIT Press, Cambridge.

Tabuchi, H., Ewing, J., and Apuzzo, M. (2017). 6 Volkswagen Executives Charged as Company Pleads Guilty in Emissions Case. *The New York Times*, pages 11–14.

UNODC (2011). Estimating Illicit Financial Flows Resulting from Drug Trafficking and other Transnational Organized Crimes. Technical report, United Nations Office on Drugs and Crime, Vienna.

Van Dijk, J. (2007). Mafia Markers: Assessing Organized Crime and its Impact upon Societies. *Trends in Organized Crime*, 10(4):39–56.

Wils, W. P. J. (2013). Antitrust Compliance Programmes and Optimal Antitrust Enforcement. *Journal of Antitrust Enforcement*, 1(1):52–81.