Modelling Domestic Corruption Deterrence Through Self-Reporting and Collaborations

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February 6, 2020

Abstract

****WRITE NEW ABSTRACT*****

1 Introduction

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Indicate strands of literature.
Whats new?
Specifically looking to domestic corruption, allowing self-reporting before and after.
Crime is particularly different than antitrust offences.
Crime inducing X crime deterrent effects.
Comparative law analysis.

Crime and Corruption Deterrence Models

Given that the recent anti-corruption enforcements observed in Brazil deal with corporate leniency agreements (Law No. 12.846/13) and individual self-reporting (Law No. 12.850/13[1]), this review is focused on relevant literature in these specific issues.

Since Becker's (1968) seminal paper analysing efficiency of anti-crime law-enforcements from a welfare maximization perspective, much has been improved in the literature. More recently Polinsky and Shavell (2007) devised a general static model based on contributions of a vast literature [2]. The model accommodates a series of effects such as different liability rules, different risk preferences, non-monetary sanctions, expected fines, judicial errors, deterrence effect, incapacitation effect, Principal-Agent relation, settlements, repeated offenders, corruption on judgements, social norms and self-reporting.

This study focuses on the deterrent effects of self-reporting. This feature was first introduced in a static approach by Kaplow and Shavell (1994) considering the decision of a single agent facing only self-affecting implications given specific law-enforcement incentives. Later on, Motta and Polo (2003) started a new approach of the same enforcing mechanisms by setting a dynamic game between parties accounting for self-reporting. Advances

[1] The 'awarded collaborations' have similar features with plea bargains for multiple defendants and whistle-blowing (when self-reported before the authority's knowledge). The discussion regarding the possibility of Law No. 12.850/13 allowing the defenders to self-report before the start of an investigation, or if it would be needed some specific norm about whistle-blowing is more detailed on the previous section of this literature review.

[2] See also Garoupa (1997) for a resume of the relevant literature.

on the same approach were observed in the studies of Aubert et al. (2006) and Harrington (2008). Importantly, the dynamic models were not devised for general criminal activities, but specifically for cartel activity.

Spagnolo (2005) merges the cartel collusion model with general criminal organization (and corruption) deterrence model . In his working paper, the author evolved his initial approach, in line with Motta and Polo (2003) contemplating a welfare maximizing solution. The model seems to be the one that resembles best the problem of corruption in Brazil, even though the game set by Buccirossi and Spagnolo (2006) is better framed for the Brazilian case as it sets government bureaucrats receiving bribes from private entrepreneurs. The model of Spagnolo (2005) can be extended to accommodate the same type of criminal activity, as argues the author:

> The issue is not only relevant to Antitrust policy. As an illegal activity involving many agents, cartels can be considered a form of organized crime, certainly not the most harmful. Long term corruption (where at least two parties are repeatedly involved, a briber and a bribee), collusion between agents and supervisors (e.g. auditors and management, or regulators and regulated firms), large scale frauds (including financial ones), mafia, terrorism, and most kinds of illegal trade (drugs, arms and people trafficking, where at least a buyer and a seller repeatedly interact) share with cartels a fundamental "governance problem": to curb internal moral hazard, prevent 'hold up' and ensure compliance with illegal agreements collaborating wrongdoers cannot rely on explicit contracts enforced by the legal system. This is why, as cartels, most other forms of organized crime take the form of long-term dynamic criminal relationships, where reputational considerations and implicit contracts can substitute for explicit contracting.[...]
>
> [...] For the sake of crispness, in the remainder of the paper we will phrase our discussion mainly in terms of a collusive agreement between oligopolistic firms. However, the reader should keep in mind that all reasoning and results directly apply to the other forms of organized crime discussed in the introduction. (Spagnolo, 2005, p. 1,2 and 9)

One important difference between the static and dynamic approaches so far is that the first were set on individual level, or else, the decisions were taken by natural persons. The later dynamic models were set on the corporate level, with the exception of Spagnolo (2005) extents on criminal organizations. In this sense, the dynamic models assume that the corporation is the relevant agent making decisions.

Note that, for corporate crime deterrence model, there is an intrinsic assumption that there is no principal-agent conflict which sometimes is not always explicit in models (Søreide and Rose-Ackerman, 2018)[3], e.g. no conflict between the bureaucrats performing the corruption activity and the politicians or political parties that back them up. Also, there is no conflict between the firms shareholders or owners and their employees that pay the bribe.

Since operating bribes require individuals (often employees and bureaucrat officials) to perform the activity, this assumption is important to address the issue of desired liability regimes. For individuals, Polinsky and Shavell (2007) conclude that, for risk-averse defendants, fault-based liability is preferable than strict-liability, however strict-liability is more easy to implement. Arlen and Kraakman (1997) discuss corporate liability. The authors

[3]Aubert et al. (2006) discuss the principal-agent and the extents of individual and corporate decisions when addressing the whistle-blowing issues. Also Garoupa (2007) deals with agency problems when agents can rely on plea bargains. In his model, it is a superior equilibrium to pay low wages for agents and give little information that can lead to the principal arrest.

identify that, based on optimum activities of monitoring and compliance from firms along with preventive measures to avoid criminal activity, duty-based liability together with residual strict liability can be optimum. In fact, distinct liability can induce different incentives on self-enforcements, in this case, there can be a compound corporate liability that maximizes social welfare, as Oded (2012) would suggest.

There are also game-theoretical models dealing with crime deterrence on the individual level with dynamic frameworks. Notably, they are focused on the deterrence effect of multiple defendants with the possibility of plea bargains (self-reporting after authority detection of the offence). For long, the benefits of plea bargaining were mainly due to better conditions on the trade-off between certainty of the conviction of the defendant and reduction of costs of investigations and trials (Landes, 1971)[4]. Nonetheless, society may have some desutility from letting defendants go unpunished. However, since the introduction of dynamic analysis with Grossman and Katz (1983), the studies of Kobayashi (1992) and Berg and Kim (2018) found that, due to the expected behaviour of other defendants, plea bargains can lead to a deterrence effect. This shows that, dynamic models are suited to the study objectives since corruption is necessarily performed by two distinct defendants at least, one corruptor and one corruptee.

Since self-reporting under corruption conditions will always lead to some type of report on other agent's activity, the theory of leniency agreements is applicable. In fact, in Brazilian recent experience, self-reporting is being used widely along with collaboration in exchange for sanction benefits. Here, with corruption related crimes, plea bargains with multiple defendants and leniency agreements are both provoking similar incentives on agents. In this sense, a possible deterrence effect that could be observed in the Brazilian case may be better captured on dynamic models.

In general, there are similarities and differences between the two approaches (static and dynamic). Notably, ones that followed Becker's view of optimal public enforcement aimed to maximize social welfare by choosing enforcements constrained to their costs, as resumed by Rose-Ackerman (2006):

> How then should anti-corruption policies be designed? Recall that the goal is not to minimize bribes but to limit the overall social costs of corruption, taking into account the costs of anti-corruption programs themselves. (Rose-Ackerman, 2006, p. XXXIII)

Some were focused on maximizing criminal deterrence, setting probabilities of detection and enforcement costs as given, as Harrington (2008) suggests:

> The antitrust authority (AA) wants to choose a leniency policy, which is a value for $Y_A[0, 1]$, that minimizes the frequency of collusion. [. . .]
>
> [. . .] One could augment this objective function by having the AA care about how much fines are collected. Greater leniency may reduce fines paid conditional on guilt though, by making conviction easier, it could raise expected fines. My preference is to keep the analysis focused on deterring collusion for that is the real objective of antitrust law and policy. Along the lines of Motta and Polo (2003), one could also introduce antitrust expenditure which impacts o and G(.). By making prosecution easier, a leniency policy can allow expenditure to move from prosecution to detection. At this point, I'm keeping the analysis focused on how leniency influences the incentive to collude. (Harrington, 2008, p. 226)

[4]It should be noted that Kaplow and Shavell (1994) admit deterrence effects on self-reporting schemes, however, this is mostly due to the marginal effects of certainty of convictions on risk averse defendants.

Lastly, it is notable that models can account for a variety of distinct features when trying to achieve different goals on criminal analysis. Table 1 resumes the features present in some models discussed here[5]. On the next subsection, a summary of some common characteristics of optimal policy measures are exposed. Thereafter, the reader can compare literature findings with the ones extracted from the study's model.

[5]Models of plea-bargain are not included in the table because of a slightly different, yet less comparable, approach.

Features	Becker (1968)	Polinsky and Shavell (2007)	Kaplow and Shavell (1994)	Motta and Polo (2003)	Spagnolo (2005)	Aubert et al. (2006)	Buccirossi and Spagnolo (2006)	Harrington (2008)
Self-reporting	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Dynamic Model	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Corruption Frame	*No*	*No*	*No*	*No*	*Yes*	*No*	*Yes*	*No*
Split Probabilities	*No*	*No*	*No*	*Yes*[a]	*No*[b]	*No*	*No*	*Yes*[c]
Non-Monetary Sanctions	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*No*	*No*
Risk-Aversion	*Yes*	*Yes*	*Yes*	*No*	*No*[d]	*No*	*No*	*No*
Individual Wealth	*Yes*	*Yes*	*No*	*No*	*No*	*No*	*No*	*No*
Liability Rules	*Yes*	*Yes*	*No*	*No*	*No*	*No*	*No*	*No*
Recidivism	*No*	*Yes*	*No*	*No*	*Yes*	*No*	*No*	*No*
Agent-Principal	*No*	*Yes*	*No*	*No*	*No*	*Yes*	*No*	*No*

Table 1: Enforcement Models and Different Features

[a] α Detection β Conviction
[b] β =Conviction under detection and γ =Conviction for Defectors
[c] ω =Auditing ρ =Detection and Conviction
[d] Riskiness Analysis

1.1 Best Practices on Theoretical Design of Enforcements

The models cited before are able to state some predictions about legal rules that may lead to optimal corruption deterrence under some specific conditions. The general findings are that:

1. Optimal fines are greater than the social harm. The expected fine, or the value of the fine associated with the probability of conviction, must be equal to the harm[6] and they should be exhausted before applying any imprisonment sanction[7], the fines can go as high as the total wealth of the offender (Becker, 1968; Polinsky and Shavell, 2007).

2. Policy makers can exchange fines for lowering the probability of detection (hence lowering enforcement costs) without changing social welfare (Becker, 1968; Polinsky and Shavell, 2007);

3. There should be some underterrence when the wealth of the offender is lower than the harm of the crime (Polinsky and Shavell, 2007; Harrington, 2008)[8];

4. Recidivism or repeated offenders should be more severely punished[9](Polinsky and Shavell, 2007; Spagnolo, 2005);

5. The existence of self-reporting mechanism before the start of an investigation in exchange for judicial benefits (leniency) increases criminal deterrence[10](Spagnolo, 2005; Harrington, 2008);

6. The existence of plea bargains or leniency after the start of an investigation can have a deterrence effect for multiple defendants[11](for corporate leniency (Motta and Polo, 2003) for plea bargains (Kobayashi, 1992; Berg and Kim, 2018));

7. Other more controversial findings are related to the size of the leniency, i.e. the size of the benefit. In general full leniency (full amnesty) is optimal when given before accusations (Buccirossi and Spagnolo, 2000; Spagnolo, 2005)[12];

8. Along with full leniency, the benefit should be given only to the first firm to report (Spagnolo, 2005) even if it is after the investigation have started (Motta and Polo, 2003). The same applies for plea agreements (Berg and Kim, 2018);

9. There must be some benefit given to whistle-blowers (Aubert et al., 2006);

[6] If defendants are sufficiently risk averse on wealth, there can be fines lower than the harm.

[7] Under the assumption of costless (social and economically) imposition of fines and neutral risk aversion on fines and imprisonment the policy maker, for the same level of deterrence, can always trade fines for probability of imprisonment. Since the last one is costly, it is better to set fines as high as possible.

[8] Under some situations of uncertainty, maximum sanctions could lead to unnecessary overdeterrance (Garoupa, 1997).

[9] There are some findings on the literature defending less severe punishment to repeated offenders to certain types of crimes (Burnovski and Safra, 1994).

[10] Although Landes (1971) and Kaplow and Shavell (1994) are more focused on the trade-off between reduction of judicial and investigation costs and crime incentive given by the reduction of real and expected fines, it is assumed that there is sufficient evidence from dynamic models to state that there is at least some deterrence effect.

[11] For Garoupa (2007) the net effect of self-report is dubious. It can either increase criminal activity by increasing expected criminal profits but it also enhances probability of capturing the principal of a criminal organization.

[12] The author admits that under riskness analysis moderate leniency can work efficiently.

10. Regarding individual liabilities, fault based liability generate more deterrence, however strictly liability should be easier, therefore less costly, to implement (Polinsky and Shavell, 2007); and

11. Similarly for corporations, based on optimum activity levels derived from tort law theory, duty based liability and residual strict liability are the best for assuring both compliance for firms and best practices of prevention measures (Arlen and Kraakman, 1997).

There are many other rules leading to different levels of deterrence using distinct assumptions and some of them not necessarily increasing social welfare. Other contradictions, desirable features and specific characteristics of Brazilian corruption can be explored in different ways through different types of models.

Lastly it is important to point out that there is no such thing as a holistic theory about optimal law enforcement strategies against corruption. Economic theories of corruption deterrence are developed under specific assumptions in order to work, this characteristic leads to clashes between the camps of law and economics since the narrow solutions given by economic models are inconsistent both one policy with another and sometimes with local criminal justice system (Søreide, 2016). In this sense, the innovation of the recently introduced self-reporting mechanisms in Brazil need to account for local characteristics both economic and judicial.

In the next section, given the specificity of the Brazilian anti-corruption law-enforcements cited in the last section, the basic model of corruption deterrence is presented. Additionally, there are comparative analysis between ideal policies extracted from the model and the ones observed in Brazil.

2 The Theoretical Model

This section analyses theoretically if the possibility of self-reporting impact the current level of corruption. Importantly, this study considers only one dimension of the corruption activities, the bribery related crimes. Moreover, this model is focused on the domestic bribery. Consequently, the prosecution and judiciary authorities have jurisdiction over both the bribe payer and the receiver.

The study's overall methodological approach to achieve this goal is to devise an economic model of public enforcement against corruption that accounts the possibility of defendants or potential criminals to report their acts to the authorities in exchange of some judicial benefit. If the model is consistent with reality, the theoretical predictions extracted here should be confirmed by an eventual empirical test.

The model allows agents to self-report either before being detected (investigated or accused by the prosecutorial authority) or after. The judicial frameworks that allows criminals to self-report are numerous,such as leniency agreements, whistle-blowing and plea bargaining. They differ between each other in their intentions and, consequently, in their procedure. In the next section the peculiarities of each type of self-reporting is better investigated.

In the next subsection, the basic model of corruption deterrence is presented and its outcomes are discussed.

2.1 The Basic Model

The main goal in this section is to devise a simple model of individual decisions to engage in corruption. The model must account for the possibility of agents to self-report both before

and after investigations (detection) and there must be sanction reductions in each possible different agreement.

Here, corruption consists of bribes paid in a *quid pro quo* exchange for some advantage. This deal is illegal and if detected an investigation/accusation is brought against involved parties. If the parties are convicted they pay a monetary sanction[13]. The bribery can be performed in one-shot (one time only) or in repeated interactions. For the sake of simplicity, the assumptions bellow are proposed in order to decrease the model complexity. Furthermore, there are assumptions which are specific to the conditions in which games are played. Nonetheless, most of the assumptions are relaxed in the expanded model in the next section.

Assumptions:

1. The model is agent based and there are no principal-agent problems[14];
2. Agents are risk neutral;
3. There must be at least one agent as corruptor and one as corruptee;
4. Agents are not liable for damages by third parties or for crimes in other jurisdictions regarding the reported offence;
5. The Judicial authorities have jurisdiction over all defendants;
6. There is no Type I judicial error (innocents will be never found guilty);
7. Prosecutors decide the sanction reduction based on fixed rules;
8. Corruption generates hard evidence for the parties which can be used to convict the other party with certainty;
9. Agents are Rational; and
10. Agents are under a fault-based liability.

The model begins with the agent's choice. For the moment, the enforcement expenditures are considered as exogenous. In this sense, the welfare maximization is given by restricting the set of possible enforcement combinations in which corruption can occur. In the next section a welfare maximization with endogenous expenditures is provided.

In the following subsections the formalized model is proposed on each specific condition. Nonetheless, all the assumptions above hold in every different scenario proposed on this section.

At this point, the model resemble Buccirossi and Spagnolo (2006) formulation and notations. The game arises when two agents, the government bureaucrat and private entrepreneur[15], decide whether to play or not a strategy of corruption (cooperation), constrained on probabilities of being detected and later convicted.

Given the above conditions, let:

[13]Non monetary sanctions are discussed in the extension of the model.

[14]Agents can either be a firm or an individual. The implications for each type of agent is better developed on the next chapter.

[15]Following Assumption (3) the model can account for more agents, such as politicians, government agents and private companies. Also, briberies could happen between private parties, although the case of bribery between public and private parties is more emblematic and easier to picture.

B = Bureaucrat,
E = Entrepreneur,
π = Advantage from corruption,
b = Bribe,
c = Cost of the bureaucrat for generating π,

where $\pi > 0$ is the gain of the entrepreneur from corruption and b is the gain of the bureaucrat, such that $0 < b < \pi$. Note that, the existence of $\pi > 0$ rules out crimes of extortion from the bureaucrat, since in that case the entrepreneur would not face any positive benefit from corruption. In this sense, the best way to tackle extortions would be by following the hypothesis of Basu (2011) better explored on Basu and Cordella (2016).

Following assumption 8, the act of deciding for collusion (corruption) generates hard evidence for both parties. Furthermore, they can store the evidence or hide it but never manipulate it[16].

Let the enforcement variables be:

α = probability of detection; and
ρ = probability of conviction.

In the traditional Beckerian approaches of crime deterrence, the probability of detection and conviction are merged. Here, in line with the study of Motta and Polo (2003) the probabilities are split. This feature allows for the specific propose of analysing self-reporting after detection.

Finally, for $i = B, E$, let:

S_i = Sanction; and
F = Fine.

For the moment, it is considered that S_i is given by the gains of each player with addition of F which is the same for the corruptor and the corruptee. Consequently, $S_E = -\pi - F$ and $S_B = -b - F$. It is important to notice that there are only monetary sanctions, or they can be represented in a monetary fashion at least[17].

For convenience, the representative game in which the entrepreneur plays first is the standard approach. However, the same results can be mirrored if the bureaucrat plays first. In the next subsections different specifications of the games are discussed.

2.2 Without Self-Reporting

If there is no self-reporting policy, the timing of the game for the entrepreneur is given by:

1. Government set the rules for F;
2. Nature sets the distribution of π and the Entrepreneur decides whether to offer b;
3. The bureaucrat decides to accept or not;

[16]This assumption is similar to the one on Aubert et al. (2006). Moreover, the role of information on self-reporting is more elaborated in Garoupa (2007). However his concept of criminal organization may not apply on this situation of corruption between public and private sectors. It could successfully account for criminal organization of either public or private separately. That is because if both agents are analysed distinctively, it is easier to differentiate the principal from the agents.

[17]This simplification may be more real for corporate agents than it is for natural persons. In this sense, imprisonment would be expected for individuals but not for firms. Nonetheless, there are also other types of non-monetary sanctions that can be applied to firms. In expanded model, this specific issue is revisited.

4. If the bribe is accepted, the bureaucrat decides to perform or not the corruption act;

5. Prosecution authority investigate with probability α; and

6. If investigated, Judicial authority convicts with probability ρ.

One-Shot, Perfect and Complete Information

In this one-shot (one time) game agents have perfect information, meaning that they know where they are in the sequential game, because they can observe what the other player did. This is a natural real assumption of paying a bribe, agents know whether they paid or received a bribe.

Agents have complete information, meaning that, they know their and other's benefits from corruption ($\pi - b$ for the entrepreneur and $b - c$ for the bureaucrat). Moreover, agents know their fines F and probability of being caught α and if so convicted ρ. Along with the assumption of rationality, these agents can be seen as more sophisticated ones.

The game consists in the first mover making a 'take it or leave it' offer of a bribe to the second agent who decides whether to reject, accept and perform or accept and not perform the corruption act. Figure 1 shows the extensive form of the game, in which E and B are the entrepreneur and the bureaucrat. The, strategies nb, b, r, p and np represent respectively, 'no bribe', 'bribe', 'reject the bribe', 'perform the act' and 'not perform the act'. Finally, the upper pay-offs are from the entrepreneur and the lower from the bureaucrat.

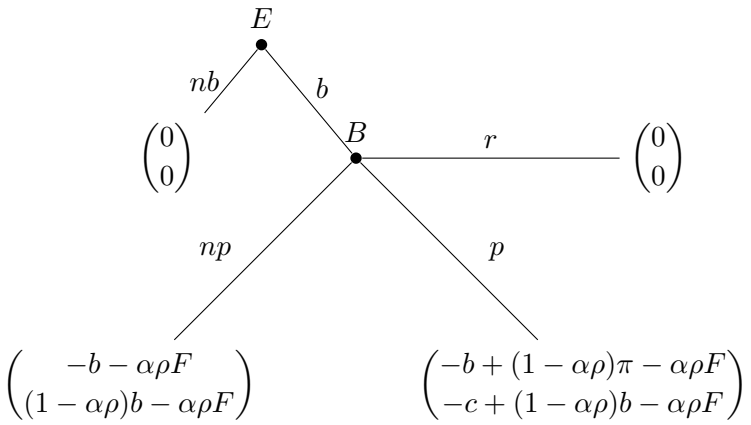


Figure 1: One-Shot Sequential Game Tree

Note that, by following the timing structure, after the bureaucrat chooses either to perform or not the act, the prosecutors play and after them the judges play. These moves are exogenous to this model and the expected values of each node is condensed in the pay-off following B's decision. Therefore, in this reduced form only the nodes in which the relevant players E and B play are displayed.

It is also important to point out that the expected fine $\alpha\rho F$ is the same in cases of the bureaucrat performing or not the corruption, both for the public official and for the entrepreneur. This assumption is in line with many national laws[18], since the mere attempt or promise to corrupt is considered a crime. For simplicity it is here considered as being the same crime as performing the corruption act. Moreover, following assumption 8, and

[18]For example, Brazilian Law No. 2.848/40 Art. 317 and 333.

considering that hard evidence is only generated when the payee accepts the bribe, than rejection generates zero pay-offs to both parties.

The game can be expressed for the entrepreneur by the following matrix form, where the upper pay-offs are from the entrepreneur and the lower from the bureaucrats:

E/B	Perform	Not Perform	Reject
Bribe	$-b + (1 - \alpha\rho)\pi - \alpha\rho F$	$-b - \alpha\rho F$	0
	$-c + (1 - \alpha\rho)b - \alpha\rho F$	$(1 - \alpha\rho)b - \alpha\rho F$	0
NB	0	0	0
	0	0	0

Solving the game backwards. It can be noted that, for any positive expected return from corruption for the bureaucrat, rejection is strictly dominated. Additionally, for any costly corruption $c > 0$, the bureaucrat would chose to 'not perform' then no corruption benefit π for the entrepreneur is generated. Consequently, the entrepreneur is not going to offer the bribe. Furthermore, by symmetry, since the bribe will always be costly to the entrepreneur, there is no corruption if the bureaucrat plays first. In both cases, the agent would prefer to take the benefit and not perform the activity.

Proposition 1. *If agents have perfect and complete information. If they play rationally, then there is no corruption in a one-shot game without enforcible agreements.*

In this case, corruption can only happen if parties can find a way to privately enforce their agreements. This outcome is in line with Buccirossi and Spagnolo (2006)[19], in their work with a similar game structure the authors found that corruption would not be implemented because parties dominant strategy would lead to mutual defection. Nonetheless, Lambsdorff and Nell (2007) found that, for different punishments F_i to distinct agents, there can be a punishment structure that allow players to collude.

One-Shot, Perfect and Incomplete Information

With incomplete information, agents cannot know for sure what type of player one is playing against. If the entrepreneur supposes that there are three type of bureaucrats: honest who never accepts the bribes; dishonest and trustworthy who accepts the bribe and perform the act; dishonest and not trustworthy who accepts the bribe and do not perform the act[20]. Assuming that the probability of being of each type is λ_h, λ_t and λ_{nt} respectively, such that $\lambda_h + \lambda_{nt} + \lambda_t = 1$.

If the game is played under the conditions of Figure 1, the pay-off matrix with the type specific probability is the following:

[19]There is a subtle difference between the assumption 8 here, and hard evidence in Buccirossi and Spagnolo (2006). In their model hard evidence is only generated if both bureaucrat and entrepreneur agree on the bribery. Since evidence can only be used as a threat with some leniency for the reporter. Therefore, agents take the bribe, do not perform occasional bribes and cannot be prosecuted for it. Here, considering that the mere attempt (promise) to corrupt, if one keeps the bribe, is enough to perform the corruption crime and be liable for it under fault-based liability. Therefore it is one-sided decision to accept that generates the hard evidence. Consequently agents are only not prosecuted for corruption if they defect and do not earn anything from bribes.

[20]One can argue that these types of bureaucrat are not rational. However, this could be fixed by imposing a moral cost for each type of bureaucrat, such that pay-offs would be negative to honest bureaucrats that receive bribes, or trustworthy bureaucrats that do not perform the act.

E/B	Perform (λ_t)	Not Perform (λ_{nt})	Reject (λ_h)
Bribe	$-b+(1-\alpha\rho)\pi-\alpha\rho F$ $-c+(1-\alpha\rho)b-\alpha\rho F$	$-b-\alpha\rho F$ $(1-\alpha\rho)b-\alpha\rho F$	0 0
NB	0 0	0 0	0 0

The entrepreneur decides what to do based on the bureaucrats best option. In this game, for positive expected pay-offs of corruption[21], collusion will be a dominant strategy strategies for the entrepreneur if:

$$\lambda_t(-c+(1-\alpha\rho)b-\alpha\rho F) > \lambda_{nt}((1-\alpha\rho)b-\alpha\rho F),$$

rearranging,

$$\frac{\lambda_t-\lambda_{nt}}{\lambda_t} > \frac{c}{(1-\alpha\rho)b-\alpha\rho F}. \tag{1}$$

In conclusion, following the inequality (1), corruption occurs if the share of not trustworthy bureaucrats (left side) is bigger than the cost-benefit of corruption for bureaucrats (right side). The same results can be mirrored if the bureaucrat plays first and expects different types of entrepreneurs in the market[22].

Proposition 2. *With incomplete information, an one-shot corruption can occur if there is enough dishonest trustworthy agents in the bribery market.*

Repeated Game

A one-shot bribe game can be seen as a small bribery act. This is the type of interaction that occurs occasionally, such as paying an officer to avoid a speed limit ticket. However, if the game is repeated, this can represent a more serious offence. Generally it is the indication of other associated crimes and is a common characteristic of big corruption cases. Of course, it does not mean strictly that one time corruption is a small bribe and repeated ones are big. Nonetheless, from this point on, conclusions about repeated corruption are going to be addressed to big corruption and conclusions about one-shot to smaller bribery offences.

An indefinitely repeated game can be represented in a matrix form just as the previous ones. However, benefits of iterated collusion are represented as the present value of infinite collusions given a certain time discount δ_i for $i=[E,B]$ and $\delta_i \in [0,1]$. Lastly, defection is a one time gain[23]. Given these characteristics, the matrix form of repeated collusion can be given as:

E/B	Perform (λ_t)	Not Perform (λ_{nt})	Reject (λ_h)
Bribe	$\frac{-b+(1-\alpha\rho)\pi-\alpha\rho F}{1-\delta_E}$ $\frac{-c+(1-\alpha\rho)b-\alpha\rho F}{1-\delta_B}$	$-b-\alpha\rho F$ $(1-\alpha\rho)b-\alpha\rho F$	0 0
NB	0 0	0 0	0 0

[21]Rejection will be always strictly dominated for positive expected returns from corruption.

[22]This result may support the hypothesis that there is no such thing as a 'cultural corruption'. However, some environments are more prone to corruption than others. Moreover screening effects may play a bigger role for agents to bribe

[23]The underlining assumption is that, if agents see a defection they punish the other player by never colluding again (grim trigger).

The possibility of repetition induces corruption when the entrepreneur plays first if:

$$\frac{-c + (1-\alpha\rho)b - \alpha\rho F}{1-\delta_B} > (1-\alpha\rho)b - \alpha\rho F,$$

or,

$$-c > -\delta_B[(1-\alpha\rho)b - \alpha\rho F],$$

or even,

$$\delta_B > \frac{c}{(1-\alpha\rho)b - \alpha\rho F}. \tag{2}$$

This result shows that the entrepreneur is going to propose the bribe if bureaucrat's time discount is sufficiently bigger than the bureaucrat's cost benefit from corruption (right side of (2)). Symmetrically, it is straightforward to see that, corruption is going to happen when the bureaucrat plays first, if:

$$\delta_E > \frac{b}{(1-\alpha\rho)\pi - \alpha\rho F}. \tag{3}$$

Note that, corruption always happens if, for a given set of pay-offs, the time discount is big enough (Folk Theorem) and expected returns from corruption are positive. Therefore, when (2) and (3) are true, the agents accept the bribe whenever $-b + (1-\alpha\rho)\pi - \alpha\rho F > 0$ and $-c + (1-\alpha\rho)b - \alpha\rho F > 0$.

In order to derive the agent's decision rule, and for the sake of simplicity let,
p_i = probability that i happens for $i = \pi, F, b$,
$p_F = \alpha\rho$ and,
$p_b = p_\pi = (1-\alpha\rho)$.

In this way, the entrepreneur (bureaucrat) proposes (accepts) a bribe if:

$$-b + p_\pi\pi + p_F F > 0,$$

or,

$$\pi - b > \frac{p_F F}{p_\pi} = F\frac{\alpha\rho}{(1-\alpha\rho)}. \tag{4}$$

For the Bureaucrat:

$$-c + p_b b + p_F F > 0,$$

or else,

$$b - c > \frac{p_b F}{p_b} = F\frac{\alpha\rho}{(1-\alpha\rho)}. \tag{5}$$

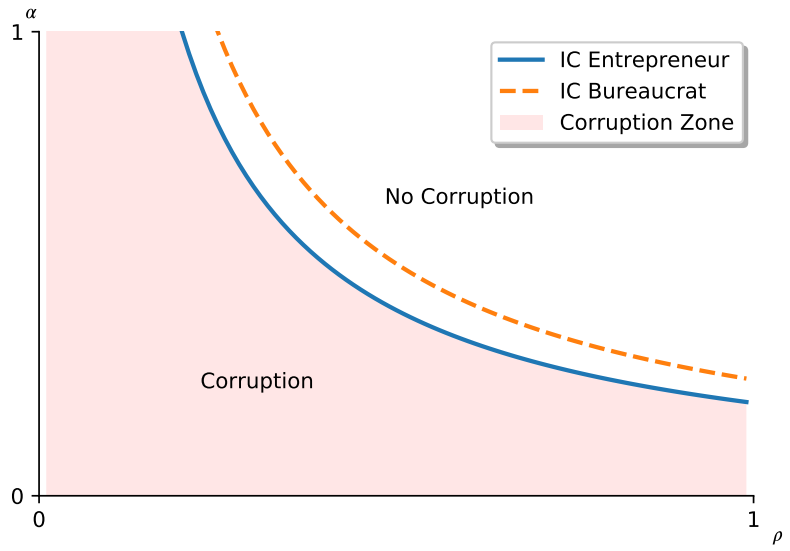
Proposition 3. *With no self-reporting policies, when agents have high enough time discounts, corruption happens if* $\pi - b = F\frac{\alpha\rho}{(1-\alpha\rho)}$ *for the entrepreneur and* $b - c > F\frac{\alpha\rho}{(1-\alpha\rho)}$ *for the bureaucrat.*

From (2) and (4) we can see that, given fixed levels of $\alpha\rho$, higher fines will always lead to higher constraints for bribe acceptance in both cases. Thus, if F is costless to implement,

it should be the maximum feasible (generally up to the agents total wealth) lowering the enforcement costs. This conclusion is in line with traditional beckerian approaches [24].

Analogously, for fixed conditions of c, b, π and F there will be some combination of α and ρ which makes bureaucrats and entrepreneur equally likely to engage or not in corruption. The Figure 2 shows the Indifference Curves between prosecutorial or judicial efficiency against the agents .

Figure 2: Indifference Curves Without Self-Reporting and Plea Bargaining



Given the above conditions, agents will engage in corruption if $\alpha < \frac{\pi-b}{\rho(\pi+F)}$ or $\rho < \frac{\pi-b}{\alpha(\pi+F)}$for the entrepreneur and $\alpha < \frac{b}{\rho(b+F)}$ and $\rho < \frac{b}{\alpha(b+F)}$ for the bureaucrat. Therefore, an increase in F moves both curves to the left, increasing the deterrent effect. Meanwhile, a decrease in $(b-c)$ moves the bureaucrat indifference curve towards a more deterrent set, whereas for the entrepreneur's indifference curve, it moves left if $(\pi - b)$ decreases[25].

2.3 Self-Reporting Before Detection

In this setting, the agents are allowed to self-report only before an eventual detection from the prosecutorial authority. This king of setting is approaches the ones used on 'leniency policy' studies, most of them aiming to analyse anti-trust policies(Marvão and Spagnolo, 2018). However, extensions of these approaches acknowledge the possibility of analysing other crimes such as corruption(Buccirossi and Spagnolo, 2006) and other criminal organizations(Spagnolo, 2005). The timing of the game can be given by the following events:

1. Government set the rules for F;

2. Nature sets the distribution of π and the Entrepreneur decides whether to offer b;

[24] Assuming that enforcement variables α and ρ are functions of some exogenous government expenditure $f(e)$, such that, for both cases, $f'(e) > 0$ and $f''(e) < 0$. It is possible to note from (4) and (5) that it is always possible to exchange (F) for lower levels of $\alpha\rho$ and maintain the decision rule unchanged (deterrence level). The model with endogenous expenditures is explored on the next chapter.

[25] The set of values for the model variables that generated the above Indifference Curves is available at: `https://nbviewer.jupyter.org/github/caxaxa/Chacha_PhD_Projects/blob/master/corruption_deterrence_model.ipynb`

3. The bureaucrat decides to accept or not. If the bribe is accepted, the bureaucrat decides to perform or not the corruption act;

4. Agents decide whether or not to self-report in exchange for a reduced fine RF;

5. Prosecution authority investigate with probability α;and

6. If investigated, Judicial authority convicts with probability ρ.

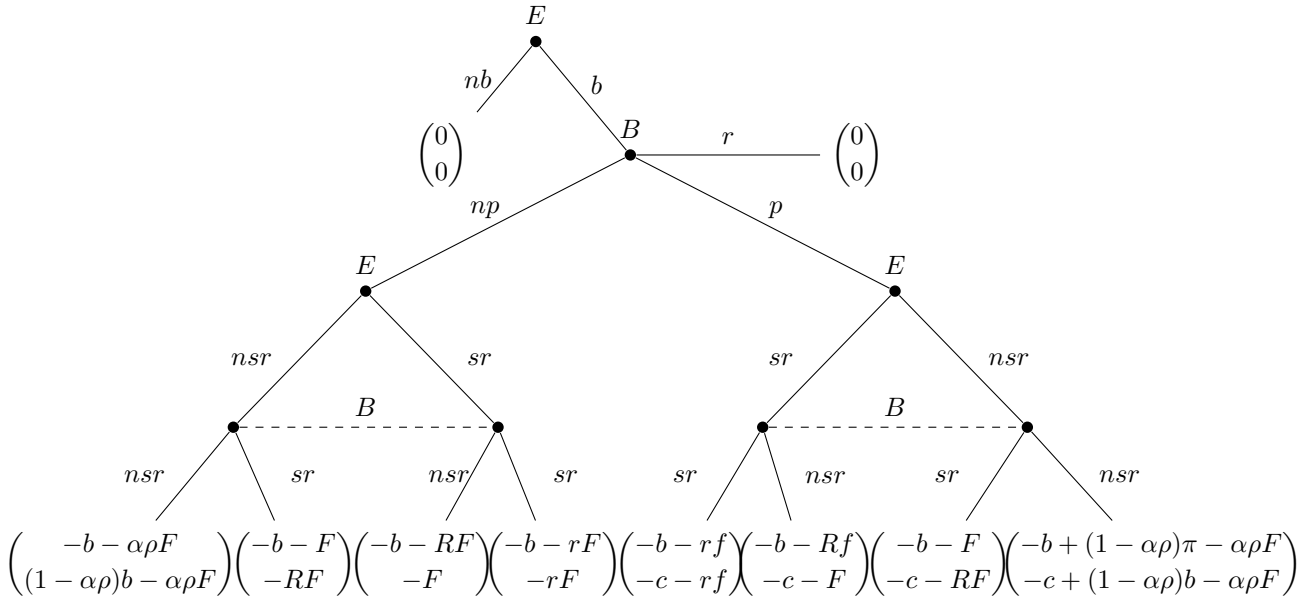
This feature implies that from now on the information of the game is imperfect. In other words, the agents cannot know what the other player did, or else, they do not know with certainty which node they are in the game. For an example, if the entrepreneur decides to self-report, he or she will only knows if the bureaucrat did the same after taking the decision to the authority. On the other hand, if an agent does not self-report, he or she will only know if he or she was reported when the authority pronounces about it, or when the game (or round if repeated) ends[26].

One Shot, Imperfect and Complete Information

In this section, the model allows agents to self-report after committing a corruption crime but before any detection from competent authority. The self-reporter receive a reduced fine of RF, with $R \in [0, 1]$. Lastly, if both players self-report at the same time they pay a reduced fine rF[27].

The Figure 3 shows the extensive form of the game for the players, where 'nsr' and 'sr' stand for not self-report and self-report respectively:

Figure 3: Corruption Game With Self-Reporting Before Detection



[26] Although the absence of a clear game ending may be confusing. It is possible to assume that, for a one shot corruption, the game finishes at the prescription date.

[27] Under the usual rule that leniencies are only given to the first to self-report, than $E[r] = (1 - R/n)$, i.e. the real fine is still $r = R$ for the first to come up and $r = 1$ for all the others.

Before analysing the game, it is interesting to check when would agents self-report tf the crime is performed. In this case, an agent would only self-report if the premium for self-reporting is greater than the expected pay-off of corruption after committing the crime, or else $-RF > (1-\alpha\rho)\pi - \alpha\rho F$ for the entrepreneur and $-RF > (1-\alpha\rho)b - \alpha\rho F$ for the bureaucrat[28]. This condition is only true if $-RF > 0$[29], this implies that $R < 0$, which means that agents would need to earn some bonus from self-reporting, otherwise they would certainly prefer to stick with the expected returns from corruption.

Solving the game backwards, it is possible to see that if the bureaucrat does not perform the corruption, the entrepreneur would self-report if $-b - \alpha\rho F < -b - rF$. Under the rule that leniency is only given to the first to self-report, then the entrepreneur would not self-report if $r > \alpha\rho$. However, since $r > R$the policymaker would never want to set the reduced RF fine bigger than the expected value of being caught and convicted$\alpha\rho F$, otherwise self-reporting would never be preferred[30]. Therefore, self-reporting here acts like a credible threat to the bureaucrat[31].

Given the above conditions, if leniency is either moderated up to full amnesty ($R = [0, \alpha\rho]$), self-reporting can only happen in pure strategies after committing a crime but before detection if there is a shock in α or ρ that make the pay-off of collusion negative. If this is not the case, since in the super-game agents have colluded before, they have no incentive to change their strategy, leading to corruption being performed. On the other hand, if prosecutors allow bounties for collaborators $R < 0$ then, there can be situations in which collusion would be profitable, but enforcements deter the criminal act. This result is in line with Spagnolo (2005) and Aubert et al. (2006).

Proposition 4. *In an one-shot game with complete information, bounties for agents who self-report before authority's detection deter corruption.*

In summary, allowing agents to self-report before being detected by authority's can induce corruption. This output is in line with Buccirossi and Spagnolo (2006), in which the addition of a self-reporting mechanism provide a credible threat that can make collusion possible. Therefore, if agents are already colluding they have no incentives to defect if probabilities of detection and conviction do not change over time.

Proposition 5. *In an one-shot game with complete information, sanction reductions for agents who self-report before detection of authorities induce corruption for any effective leniency program ($0 \leq R < \alpha\rho$), because agents can use self-reporting as a credible threat.*

Lastly ,it is important to point out that, in an one-shot game with incomplete information, there are two types of agents, the ones that self-report and the ones that never do. Note that, there is no pay-off difference for the two types, besides the addition of an exogenous probability of self-report. In this sense, the game played resembles a repeated game with mixed strategies in which the probability of self-reporting is equal to the probability of the

[28]Note that b and c are not computed in the corruption pay-off after the crime, because they were already paid and can be understood as sunk costs from corruption.

[29]It is easy to extrapolate that $-RF > b$ for the entrepreneur and $-RF > c$ for the bureaucrat, players will only play this game if $b < (1-\alpha\rho)\pi - \alpha\rho F$ for the entrepreneur and $c < (1-\alpha\rho)b - \alpha\rho F$ for the bureaucrat.

[30]This assertion holds for risk-neutral agents under the whistle-blowing conditions: $R < \frac{\alpha\rho F - (1-\alpha\rho)\pi}{F}$ for the entrepreneur and $R < \frac{\alpha\rho F - (1-\alpha\rho)b}{F}$ for the bureaucrat. However, there can be a sufficiently risk averse agent that accepts to pay a reduced fine RF bigger than the expected value of the fine $\alpha\rho F$. This issue is revisited on the next chapter

[31]There may be an $r > \alpha\rho$ that make the self-reporting not a credible threat. However it would imply that $R > \alpha\rho$, which leads to no self-reporting.

agent being a self-reporter. In this sense, the same conclusions extracted from the repeated game apply to this situation.

Repeated Game

In this case, similar to the repeated game without self-reporting. There are two constraints for briberies; the agents' time discount and the expected value of the corruption act.

Regarding the time discount condition, like in the former example (2) or by applying the Folk Theorem, there must be a time discount δ_i big enough that disrupts the one time defection constraint. In this case, agents chose collusion (corruption) whenever expected pay-offs from briberies are positive.

In this setting, the probability of self-reporting is exogenous and given by a γ_i for $i = [E, B]$. Thereafter, using the same notations as in the previous case, now all probabilities are a function of $(\alpha, \rho, \gamma_B, \gamma_E)$. In this case, letting:

$p_{F_E} = \alpha\rho(1-\gamma_E)(1-\gamma_B) + (1-\gamma_B)\gamma_E R + (1-\gamma_E)\gamma_B + \gamma_E\gamma_B r$,
$p_\pi = (1-\alpha\rho)(1-\gamma_E)(1-\gamma_B)$,

aggregating for $(1-\gamma_E)(1-\gamma_B) = \Gamma$, then:

$p_{F_E} = \alpha\rho\Gamma + (1-\gamma_B)\gamma_E R + (1-\gamma_E)\gamma_B + \gamma_E\gamma_B/N$, and
$p_\pi = (1-\alpha\rho)\Gamma$.

Probabilities of being fined now depend on other player's movement. Therefore, the entrepreneur accepts the bribe if:

$$-b + p_\pi\pi + p_F F > 0$$

or,

$$-b + \pi\Gamma(1-\alpha\rho) - F(\alpha\rho\Gamma + (1-\gamma_B)\gamma_E R + (1-\gamma_E)\gamma_B + \gamma_E\gamma_B r) > 0.$$

By the same way, the decision rule for the bureaucrat for engaging corruption, if:
$p_{F_B} = \alpha\rho(1-\gamma_E)(1-\gamma_B) + (1-\gamma_B)\gamma_E + (1-\gamma_E)\gamma_B R + \gamma_E\gamma_B r$,
$p_b = p_\pi = (1-\alpha\rho)(1-\gamma_E)(1-\gamma_B)$,
or,
$p_{F_B} = \alpha\rho\Gamma + (1-\gamma_B)\gamma_E + (1-\gamma_E)\gamma_B R + \gamma_E\gamma_B r$,
$p_b = (1-\alpha\rho)\Gamma$ is

$$-c + p_b b + p_F F > 0,$$

or else,

$$-c + b(1-\alpha\rho) - F(\alpha\rho\Gamma + (1-\gamma_B)\gamma_E + (1-\gamma_E)\gamma_B R + \gamma_E\gamma_B r)\Gamma > 0.$$

Given the above conditions, probabilities of fining are now different for each players. And both probabilities of being fined or earn the corruption premium are now dependent on the other player's action. More specifically, for any positive probabilities of self-reporting $\gamma_i > 0$ the expected fine $p_F F$ is bigger and expected advantages from corruption ($p_b b$ and $p_\pi\pi$) are smaller in relation to the case without self-reporting. Consequently, extrapolating (2) and (3), then:

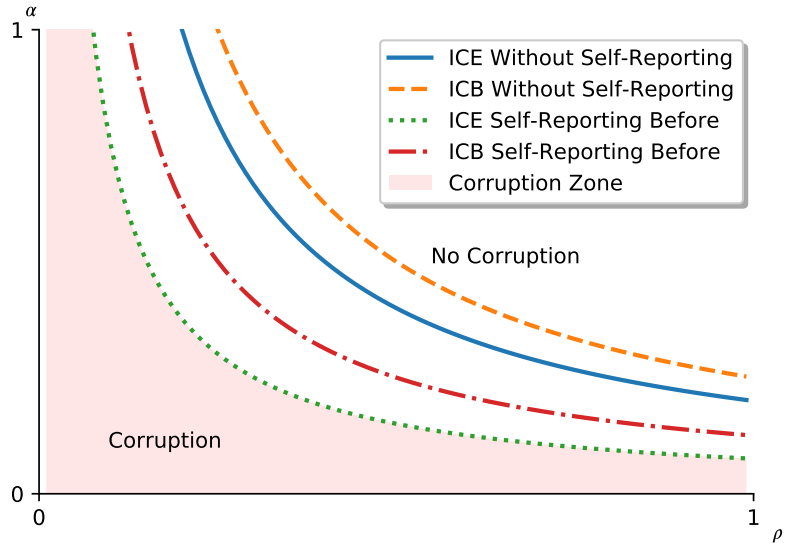
$$\delta_B > \frac{b}{p_\pi\pi - p_F F}; \tag{6}$$

$$\delta_E > \frac{c}{p_b b - p_F F}. \tag{7}$$

Note that δ_i need to be bigger under the possibility of self-reporting before authority's detection than it is with no self-reporting policies (if self-reporting possible $\gamma_i > 0$), since the denominator of both inequalities is smaller. Therefore, the agents must have a bigger time discount to engage in corruption, i.e. agents must be more patient to engage in corruption in a repeated game with whistle-blowing.

The time discount is not the only channel in which corruption is deterred. The self-reporting constraint decreases the combination set in which corruption would be feasible. Hence, the deterrence effect can be seen by the retraction of the indifference curves in relation to the ones with no self-reporting given the same bribery structure, as shown in Figure 4.

Figure 4: Indifference Curves With Self-Reporting Before Authorities' Detection



Proposition 6. *In a repeated game with the possibility self-reporting before authorities' detection, corruption will be deterred if there is any positive probability of the other player self-report.*

In summary, the deterrence effect happens both by the necessity of agents having bigger time discounts δ_i and a softer combination of α and ρ to start colluding.

2.4 Self-Reporting After Detection

Being able to self-report after detection means that defendants can report their actions (and others) in exchange for a reduced fine. This type of self-reporting has been investigated by a particular strand of literature that mostly investigates plea bargaining such as the works of Grossman and Katz (1983) and Kobayashi (1992). However, there are important law-related issues regarding plea-bargains that may misdirect the reader towards a different interpretation from what is being proposed by this model. Therefore, no conceptualization of the possibility self-reporting after detection is made by now. In the next section, the issue of judicial and prosecutorial frameworks in which agents can self-report their actions either before or after detection is better explored.

The timing for this type of game is the following:

1. Government set the rules for F;
2. Nature sets the distribution of π and the Entrepreneur decides whether to offer b;
3. The bureaucrat decides to accept or not. If the bribe is accepted, the bureaucrat decides to perform or not the corruption act;
4. Prosecution authority investigate with probability α;
5. If investigated, agents decide whether or not to self-report in exchange for a reduced fine PF; and
6. If they do not self-report, then judicial authority convicts with probability ρ.

Like the in the case of being able to self-reporting before detections, the game has incomplete information after deciding whether to perform or not the corruption act. Due to the fact that players cannot know the other's action until the end of the round.

One Shot, Imperfect and Complete Information

Just like in the past examples, here corruption happens if bureaucrat has any incentive to perform the bribery act. As seen before, this happens when the entrepreneur can credibly threat the bureaucrat with some punishment. Therefore, the relevant part of the game is after the node in which the bureaucrat decides whether to perform or not the corruption.

Before analysing the game, it is necessary to know the incentive for any agent to self-report after detected in the first place. Given a reduction rule where PF is the reduced fine, for $P \in [0, 1]$ in case of an unilateral self-reporting, and pF if both parties self-report simultaneously, where $PF < pF$ or $p > P$. Then, an agent would plead guilty after detected by the prosecutorial authority with probability α when $-PF > (1-\rho)\pi - \rho F$ for the entrepreneur and $-PF > (1-\rho)b - \rho F$ for the bureaucrat.

The extended game for this example has 32 pay-offs after the decision from the agent whether to perform or not corruption. Therefore, it is not feasible to draw. However, similar to the former example, if the second agent to move does not perform the activity, it is expected that, if detected, the first mover will always self-report. This strategy is dominant for every credible self-reporting program after detection.

Notably, it is necessary that the prosecutorial authority is able to detect the act. In other words, the probability of detection must be positive $\alpha > 0$. In summary, analogously to the self-reporting before detection policy, bureaucrat and entrepreneur know that they have a credible threat if $P < \rho$. Once again, no policy maker would set a self-reporting agreement with reduced fines lower than expected fines ρF, unless the defendant is risk averse. In this context, plea bargain also gives agents credible threats. Consequently, it disrupts the defection strategy (np) and induces corruption.

Proposition 7. *In an one-shot game with complete information, if detection is possible $\alpha > 0$, allowing agents to self-report after being detected induces corruption for any effective sanction reduction program $P < \rho$, because agents can use self-reporting as a credible threat.*

Likewise the former example, incomplete information leads to the same expected results as a repeated game with mixed strategies.

Repeated Game

In a repeated game with possibility of self-reporting after detection, agents need to have high enough time discount δ_i that disrupts the prisoners dilemma and make them collude (Folk Theorem, similar to (6) and (7)). If such condition is met, agents only need expected returns of corruption to be positive.

In this sense, let β_i be the probability of an agent to self-report for $i = [E, B]$ and $B = (1 - \beta_E)(1 - \beta_B)$ be the probability of not self-reporting, then p_{F_i} and $p_\pi = p_b$ are $f(\alpha, \rho, \beta_B, \beta_E)$ which is different for each i, such as,

$p_{F_E} = \alpha[\rho B + (1 - \beta_B)\beta_E P + (1 - \beta_E)\beta_B + \beta_B\beta_E p]$ and
$p_\pi = p_b = (1 - \alpha) + \alpha B(1 - \rho)$.

By symmetry, for the bureaucrat, if

$p_{F_B} = \alpha[\rho B + (1 - \beta_B)\beta_E + (1 - \beta_E)\beta_B P + \beta_B\beta_E p]$,

than the decision rules is also,

$$-c + p_b b + p_F F > 0,$$

or else, when substituting the terms ,

$$-c + b((1 - \alpha) + \alpha B(1 - \rho)) - F\alpha[\rho B + (1 - \beta_B)\beta_E + (1 - \beta_E)\beta_B P + \beta_B\beta_E p > 0.$$

Given p_{F_E}, p_{F_B}, and $p_\pi = p_b$, then through (6) and (7) it is straightforward to see that the time discount δ_i necessary for agents to start colluding with possibility of self-reporting after detection, likewise before detection, is greater than with no self-reporting policies. However, it is not possible to determine in what situation δ_i would be bigger without knowing the public enforcement variables (α, ρ, R, r, P and p). Therefore, agents need to be more patient to engage in corruption if other parties can rely on self-reporting.

Regarding the decision rule of the entrepreneur, he or she is going to propose a bribe if,

$$-b + p_\pi \pi + p_F F > 0,$$

or else,

$$-b + \pi((1 - \alpha) + \alpha B(1 - \rho)) - F\alpha[\rho B + (1 - \beta_B)\beta_E P + (1 - \beta_E)\beta_B + \beta_B\beta_E p] > 0.$$

Likewise, for the bureaucrat the decision rules is also,

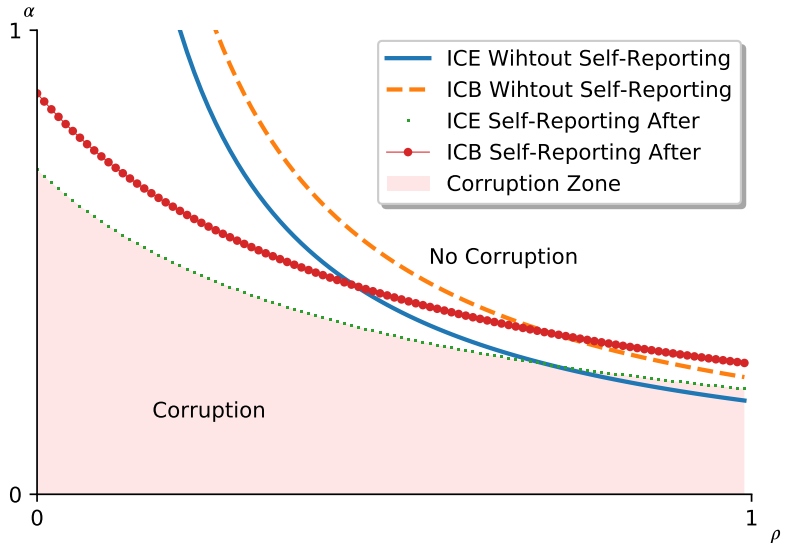
$$-c + p_b b + p_F F > 0,$$

or else, when substituting the terms ,

$$-c + b((1 - \alpha) + \alpha B(1 - \rho)) - F\alpha[\rho B + (1 - \beta_B)\beta_E + (1 - \beta_E)\beta_B P + \beta_B\beta_E p > 0.$$

The most notable difference between self-reporting before or after detection is given by the impact of α in the decision choice. In the current case, by definition, agents would fear self-reporting only if detected. In other words, if agents perceive that they are more likely to be found guilty, it does not influence their choice of engaging in corruption. Or else, they are more afraid of prosecutors than they are afraid of the judges. This peculiar effect can be shown in the Figure 5, in which indifference curves are more restrictive to increases in the probability of detection α than they are with probabilities of conviction ρ.

Figure 5: Indifference Curves With Plea Bargains



Note that, for crimes with a high probability of conviction (crimes that produces undeniable evidence),self-reporting after detection may be crime inducing. The reasoning behind this is that, if agents know they can self-report after being detected, they will do it, because there is almost certainty of conviction in any case.

Proposition 8. *In a repeated game when agents can self-report after being detected, corruption can be deterred if there is any positive probability of the other player to self-report. However, if players face a high probability of conviction, agents can be induced to criminal acts.*

2.5 Self-Reporting Before and After Detection

Considering all together the possibility of self-reporting before and after an eventual detection, the timing of the game can be given as follows:

1. Government set the rules for F;
2. Nature sets the distribution of π and the Entrepreneur decides whether to offer b;
3. The bureaucrat decides to accept or not. If the bribe is accepted, the bureaucrat decides to perform or not the corruption act;
4. Agents decide whether or not to self-report in exchange for a reduced fine RF;
5. Prosecution authority investigate with probability α;
6. If investigated, agents decide whether or not to self-report in exchange for a reduced fine PF; and
7. If they do not self-report, then judicial authority convicts with probability ρ.

One Shot, Perfect and Complete Information

As previous examples shows, the existence of profitable corruption schemes ($b < (1-\alpha\rho)\pi - \alpha\rho F$ and $c < (1-\alpha\rho)b - \alpha\rho F$) and effective self-reporting programs ($RF < (1-\alpha\rho)F$ and $PF < (1-\rho)F$) are necessary conditions (but not sufficient) for inducing corruption. Once again, it happens because bribe givers gain a credible threat under these conditions.

Notably, if applied together, the two policies do not seem to have any type of enhanced crime-inducing effect. Assuming absence of bounties $R, P > 0$ and that there are no enforcement shocks (α and ρ are constant over the game), the agents are only accepting the bribe if pay-offs of collusion are positive . As seen before, this condition is the same in all cases, either under self-reporting exclusively before or after or both before and after detections. Under this hypothesis, rational agents are always performing the corruption and never self-reporting.

Repeated Game

As stated before, repeated bribes with same agents are a signal of a more structured corruption scheme. This case is perhaps the one that better mimics conditions observed in the real world, since allowing agents to self-report both before and after investigations or detections is the most widely adopted type of self-reporting policies when it comes to corruption[32].

It is important to notice that, staged games tend to get very complex with only a few games. In this sense, a diagram showing all the game decision tree is already massive for this example. Since there are three decision nodes, namely: first the bribe taker decide to perform or not, then both agents choose to self-report or not before an eventual detection and finally, if detected, agents decide whether to self-report or not. Along with the actions of prosecutors and judges, this game has 2^5 distinct pay-offs from the 'bribery detection' node plus the pay-offs of not bribing, not accepting the bribe and not being detected, summing up to 36 different pay-offs. Thereafter, is not practical to analyse the decision tree.

Another similar aspect of the staged game, with mixed strategies is that there are a lot of different variables for each possible strategy. Therefore, it is preferable to follow the straightforward intuition of the game than it is to play with it algebraically. Nonetheless, with some aggregation, like the previous ones (Γ and B), it is possible to deal with the reduced form of the model with a little less complexity.

Differently from the one shot game with complete information, the addition of the two policies together may have some combined effects. This phenomenon seems to be expressed in the minimum time discount δ_i necessary to disrupt the equilibrium of not colluding. Note that, following the intuition behind (6) and (7), players will engage in corruption whenever they value the future period as important as the ratio between the cost of benefit of corruption. In this case, let:

$p_{F_E} = f(\alpha, \rho, \gamma_E, \gamma_B, \beta_B, \beta_E, P, R, p, r)$,
$p_{F_E} = \alpha\Gamma(B\rho + (1-\beta_B)\beta_E P + (1-\beta_E)\beta_B + \beta_E\beta_B p) + (1-\gamma_B)\gamma_E R + (1-\gamma_E)\gamma_B + \gamma_E\gamma_B r$,
$p_{F_B} = f(\alpha, \rho, \gamma_E, \gamma_B, \beta_B, \beta_E, P, R, p, r)$
$p_{F_B} = \alpha\Gamma(B\rho + (1-\beta_B)\beta_E + (1-\beta_E)\beta_B P + \beta_E\beta_B p) + (1-\gamma_B)\gamma_E + (1-\gamma_E)\gamma_B R + \gamma_E\gamma_B r$,
$p_\pi = p_b = f(\alpha, \rho, \gamma_E, \gamma_B, \beta_B, \beta_E, P, R, p, r)$, or
$p_\pi = p_b = \Gamma[(1-\alpha) + \alpha B(1-\rho)]$.

[32]This assertion is revisited in the next section when discussing the types of self-reporting policies around the world.

Note that, probabilities of being fined are now greater and probabilities of receiving the advantages of corruption are smaller. Consequently, through (6) and (7), $\delta_i^{nsr} \leq max[\delta_i^{srb}, \delta_i^{sra}] \leq \delta_i^c$ for 'nsr' 'srb', 'sra' and 'c' being respectively no self-report, self-reporting before, self-reporting after and combined policy. In other words, under combined sanctions, agents have to be more patient to engage corruption than they would need to be in previous cases. Or else, combined self-reporting policy is a more restrictive condition then previous ones.

Combined sanctions may also lead to lesser incentives to collude from the pay-off perspective. Given that agents still face the same problem of having a positive expected pay-off from collusion ($-b + p_\pi \pi - p_F F > 0$ and $-c + p_b b - p_F F > 0$). Then, the constraints given by the positive probability of being reported by other player may enhance expected fines through bigger probability of being fined and lesser probability of going unpunished and receiving the advantage of corruption. Therefore, the decision rule for the entrepreneur can be expressed as:

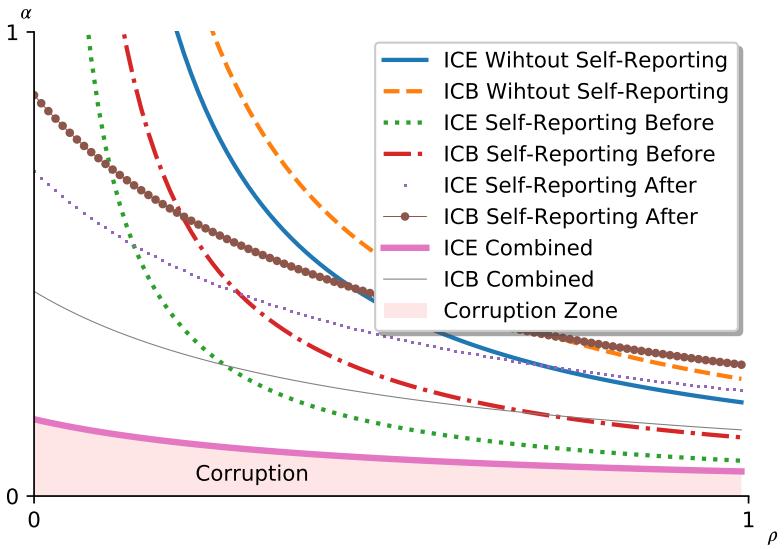
$$-b + \pi\Gamma[(1-\alpha) + \alpha B(1-\rho)] - F(\alpha\Gamma(B\rho + (1-\beta_B)\beta_E P + (1-\beta_E)\beta_B + \beta_E\beta_B p) + (1-\gamma_B)\gamma_E R + (1-\gamma_E)\gamma_B + \gamma_E\gamma_B r) > 0,$$

and for the bureaucrat,

$$-c + b\Gamma[(1-\alpha) + \alpha B(1-\rho) - F(\alpha\Gamma(B\rho + (1-\beta_B)\beta_E + (1-\beta_E)\beta_B P + \beta_E\beta_B p) + (1-\gamma_B)\gamma_E + (1-\gamma_E)\gamma_B R + \gamma_E\gamma_B r) > 0.$$

Computing the indifference curves from the above conditions and comparing with the previous calculated ones, from Figure 6 it is clear to see the deterrent effect of the combined policies. The deterrence effect is given by the reduced set of combinations of the public enforcements in which corruption would be feasible.

Figure 6: Indifference Curves With Combined Policies



Proposition 9. *In a repeated game when agents can self-report both before and after detections, corruption is deterred if there is any positive probability of the other player to self-report by any time in the game.*

It is important to remember that, for now, enforcements expenditures are exogenous, then the social welfare is given by the reduced corruption in the economy. As mentioned

in the previous section, less corruption is always more desirable regarding social welfare (no grease money assumption). However, in the next chapter, the need for such assumption is dropped in the model with a social welfare maximization model.

3 Conclusion

This study theoretically modelled the behaviour of agents regarding the decision of engaging bribery under different self-reporting rules. The main conclusions are resumed on the propositions bellow:

1. For sophisticated agents with complete information there is no corruption in a one-shot game without self-reporting;

2. With incomplete information and no self-reporting, an one-shot corruption can occur if there is enough dishonest trustworthy agents in the bribery market;

3. With no self-reporting policies, when agents have high enough time discounts, corruption happens if $\pi - b = F\frac{\alpha\rho}{(1-\alpha\rho)}$ for the entrepreneur and $b - c > F\frac{\alpha\rho}{(1-\alpha\rho)}$ for the bureaucrat;

4. In an one shot game with complete information, bounties for whistle-blowers can deter corruption;

5. In an one shot game with complete information, whistle-blowing induce corruption for any effective leniency program $0 < R < \alpha\rho$, because agents can use self-reporting as a credible threat;

6. In a repeated game with whistle-blowing, corruption will be deterred if there is any positive probability of the other player self-report;

7. In an one shot game with complete information, if detection is possible $\alpha > 0$, plea bargains induce corruption for any effective sanction reduction program $P < \rho$, because agents can plead guilty as a credible threat;

8. In a repeated game with plea bargains, corruption can be deterred if there is any positive probability of the other player to plead guilty. However, if players face a high probability of conviction, agents can be induced to criminal acts; and

9. In a repeated game with self-reporting and plea bargains, corruption is deterred if there is any positive probability of the other player to report by any time in the game.

Furthermore, some Brazilian anti-corruption rules are and some are not in line with the ideal ones modelled here, fore instance:

1. There are no bounties for agents who self-report. It was showed that bounties can deter corruption by setting stricter conditions for corruption to happen;

2. First comer rule is better for corruption deterrence than any less lenient rule $r > R$ or $p > P$;

3. In Brazil $P = R$. It does not seem to affect agents' decision rule for $R < \alpha\rho$ and $P < \rho$ in a one-shot game;

4. In Brazil, due to political prerogatives, there can be different probabilities of ρ and α for bureaucrats and entrepreneurs (This topic is revisited in the next chapter under 'asymmetric punishments');

5. There is great judicial discretion on Brazilian self-reporting policy. Since defendants still go to trials there is another component of uncertainty, meaning that reductions are not fully efficient. Moreover, without judicial trials for self-reporters, the same level of deterrence can be theoretically achieved with lesser expenditures and lesser Type II judicial errors. Meaning that the social welfare enhances without the need to trial self-reporters (This topic is revisited in the next chapter under 'welfare maximization'); and

6. There is no need for enforcement differences between corporative and individual anti-corruption rules. However, liability rules may affect agents differently (This topic is revisited in the next chapter under 'liability regimes').

Some features of the Brazilian anti-corruption enforcements cannot be fully analysed by the framework of this basic model. In this sense, the following extensions are proposed.

Further Studies

In the next chapter, the model can be extended to account for the following features:

- The welfare maximization problem;
- Corporate Vs Individual self-reporting;
- Non monetary sanctions;
- Different liability regimes (Agency Costs);
- Asymmetric punishments;
- Recidivism ;
- Endogenizing variables (repeated games complete information);
- Letting variables change over time;
- Allowing Type I errors;
- Risk-preferences; and
- Social norms and other behavioural biases.

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