Digital Piracy and Corruption: A Tale of Two Crimes*

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Abstract

The efficacy of government enforcement policies to prevent piracy is studied in the existing literature in a corruption-free context. However, empirical evidence shows a positive correlation between corruption and piracy. In this paper, we theoretically analyse this twin issue, which is yet to be addressed in the literature. In the presence of corruption, we show that a higher penalty on piracy does not decrease piracy and reinforces corruption. We further show that appropriate choice of penalties for corruption and compensation for law enforcement officers can eliminate corruption and effectively reduce piracy.

Keywords: corruption; piracy; bribery; anti-corruption policy.

JEL classification: H8, K4.

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1 Introduction

The advent of digital technology and its regular exponential growth has unwittingly resulted in increased violation of Intellectual Property Rights (IPR) through digital piracy. This is a relatively new phenomenon, which can broadly take the form of end-user or commercial piracy. The former refers to the situation where copying of copyrighted products is done for personal consumption, and the latter is defined as the illegal copying and selling of copyrighted products.

The existing literature on piracy focuses on the effectiveness and efficacy of enforcement policies in eliminating piracy in a *corruption-free* context. For example, Png and Chen (1999), Cheng et al. (1997) and Noyelle (1990) show that lower price rather than enforcement is a better strategy to combat end-user piracy. Harbaugh and Khemka (2010) show that at best enforcement targeted towards big organizations regarding violation of IPR can reduce piracy, though broad based enforcement is better but difficult to implement. Duchêne and Waelbroeck (2006) show that stronger copyright protection increases the profits of firms practicing the conventional sales and marketing of physical products (dubbed as information-push technology). On the contrary, stronger copyright protection lowers the profits of firms who adopt the information-pull technology by which consumers search and sample music through the p2p network and decides whether to purchase a quality-enhanced original product. In the context of commercial piracy, Lu and Poddar (2012) show that only strong IPR protection results in the copyright holder choosing an entry-deterring strategy, which is an investment that raises the cost of copying. Vázquez and Watt (2011) show that public anti-piracy policies can in fact increase piracy while private strategies like digital rights management always decrease piracy. Contrary to Lu and Poddar (2012) and Vázquez and Watt (2011), Banerjee (2011) shows that government anti-piracy enforcement policy can in fact effectively prevent piracy and improve social welfare. He also shows that stronger government enforcement policies reduce the copyright holder's investment in anti-copying technology.

However, to assume, as is often done in the literature, that corruption and piracy are not related is unrealistic. Empirical evidence shows that countries with high levels of corruption find difficulty in monitoring and penalising piracy (Robertson et al., 2008). This suggests that piracy and corruption are a twin problem and need to be analysed simultaneously. Such an analysis will allow us to have a better understanding of addressing the issue of piracy by investigating the interconnections between anti-corruption and anti-piracy policies. To the best of our knowledge such a study is yet to be done and is thus the focus of this paper.[1]

Specifically, we consider a situation in which a law enforcement officer (hereafter referred to as the officer) responsible for enforcing copyright law can behave in a dishonest manner and engage in bribery with a copyright violating firm (hereafter referred to as the pirate). Our model follows the delegated enforcement framework as in Mookherjee and Png (1995) and Hindriks et al. (1999), and uses four policy variables to emulate anti-piracy and anti-corruption policies.[2] The policy variables considered are the penalty for piracy, the reward to the officer for reporting piracy, and the penalties on the pirate and the officer for engaging in bribery.

We show that increasing the penalty on piracy reinforces corruption, which allows the pirate to operate unchecked rendering the anti-piracy policy ineffective. Intuitively, an increase in the penalty on piracy increases the bribeable surplus, which provides the incentive to the officer to monitor at a higher rate but also behave dishonestly. Stronger anti-corruption penalties eliminate corruption but their effect on piracy is ambiguous as such policies reduce the officer's incentive to monitor. However, increasing the corruption penalty and the reward to the officer can eliminate corruption while keeping the monitoring incentive unchanged. We also show that if the increase in

[1]The empirical literature on piracy does use corruption as an explanatory variable for piracy, however, there have been no empirical papers focusing specifically on the joint problem of corruption and piracy and there are no theoretical papers that address this twin problem.

[2]The corruption literature concentrates on three types of relationships defined by the power and duties of the agent. The relationship we look at in this paper is the one where the agent has an information-collecting role and his power arises from the ability to choose to report or misreport the information. The other two relationships are classified as: when the agent has broad objectives but the power to choose how to perform these duties, and when the principal transfers all power to the agent to complete a certain responsibility or objective. See Mishra (2005) for further details.

the reward exceeds the increase in the corruption penalty then corruption is eliminated and there is a decrease in piracy.

In recent years there has been an increased focus in addressing commercial piracy, which motivates us to analyse this issue. The creation and establishment of numerous institutions (like international treaties, agreements, organisations), and laws aimed at the elimination of commercial piracy, bears testimony to the above fact. These can range from US trade sanctions tailored for intellectual property concerns to global agreements such as the World Trade Organisation's Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement aimed at establishing minimum standards for intellectual property rights protection. Organisations such as the Business Software Alliance, the International Federation of the Phonographic Industry lobby governments, facilitate research and promote awareness in order to mitigate the economic damage that piracy is causing. These concerns about piracy are not limited to the private sector, in 2004 the Bush Administration established Strategy Targeting Organised Piracy (STOP), an enforcement agency specifically set up to counter commercial software piracy.

This paper is arranged as follows. Section 2 contain the empirical facts. In sections 3 and 4, we present the theoretical model and perform the equilibrium analysis. Section 4 contains the policy analysis and in Section 5 we provide the concluding remarks.

2 Empirical Evidence

In this section we provide empirical facts to motivate the theoretical model and the findings discussed in the later sections of the paper. The piracy data used here is sourced from the Business Software Alliance's annual Global Piracy Study[3] and defines the piracy rate as follows.

[3]Taken from the Business Software Alliance Annual Global Piracy Studies from 2006 to 2011.

$$\text{Piracy Rate} = \frac{\text{Unlicensed Software Units}}{\text{Total Software Units Installed}}$$

The corruption data used is sourced from Transparency International's Corruption Perceptions Index (CPI) from 2006 to 2011. This index assigns countries numbers from 0 to 10 indicating how corrupt they are where 0 and 10 represent the most and least corrupt countries respectively. We transform this by subtracting the CPI value from 10 so that 10 now represents the most corrupt and 0 the least corrupt. The scatter plot shown in Figure 1 indicates that there is a positive correlation between piracy and corruption especially so for more corrupt countries.

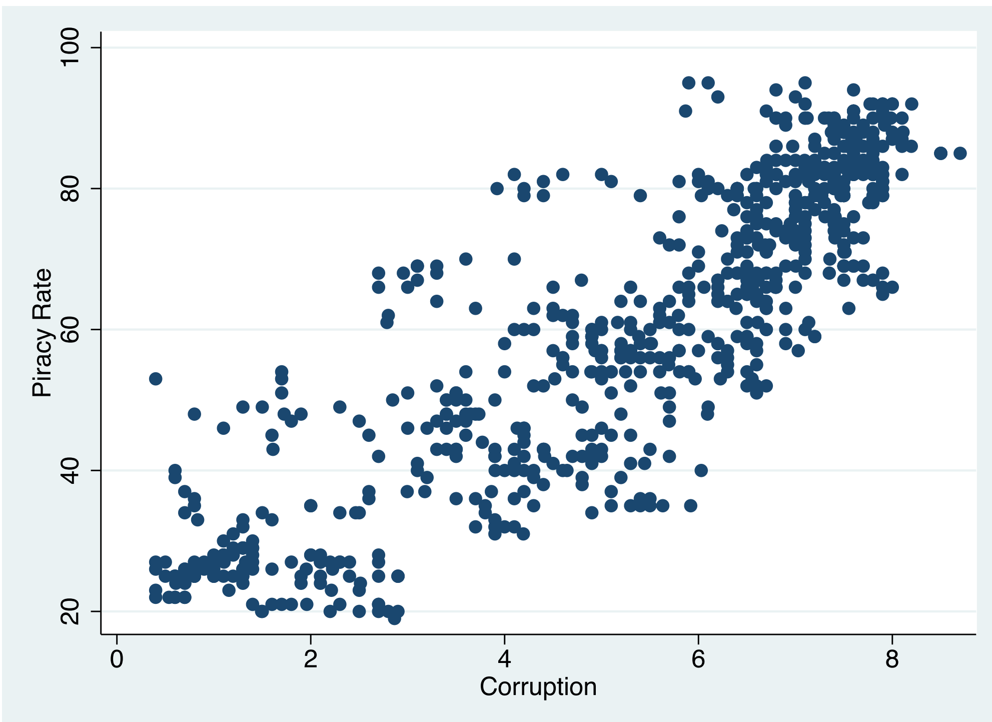

Figure 1: Piracy and Corruption

The strong positive correlation in Figure 1 is a good indication that we should consider piracy and corruption as a twin problem. To draw further inference about the interrelation between corruption and piracy, using country fixed effects, we consider the following model specification.

$$Piracy_{it} = \beta_0 + \beta_1 WCT_{it} + \beta_2 WTO_{it} + \beta_3 Corruption_{it} + \alpha_j X_{it} + h_i + u_{it} \quad (1)$$

The variables considered in the regression model are defined as follows.

$Piracy_{it}$	is the piracy rate for country i, in year t.
WCT_{it}	is the WCT status of country i, in year t.
WTO_{it}	is the WTO status of country i, in year t.
X_{it}	is a vector of j control variables for country i, in year t.
h_i	is the time invariant error of country i.
u_{it}	is the idiosyncratic error of country i, in year t.

The main explanatory variables used in the model are explained in further detail below.

1. WCT_{it}: This is a dummy variable which takes the value of 1 if a country is party to the World Intellectual Property Organisation's Copyright Treat (WCT) and 0 otherwise. The WCT is a wide reaching copyright and intellectual property protection treaty which requires members to adhere to strict copyright and intellectual property regulations.[4] This variable is used to proxy for strictness of anti-piracy regulation.

2. WTO_{it}: This is a dummy variable which takes the value of 1 if a country is a member of the World Trade Organisation (WTO) and 0 otherwise. Members of the WTO are required to adhere to all WTO agreements one of which, the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS), is a minimum standards intellectual property protection agreement. This variable is also used to proxy for strictness of anti-piracy regulation.[5]

[4] See The World Intellectual Property Organisation's website: www.wipo.int

[5] Andres (2006) also includes three international copyright treaty dummy variables to capture government stance

3. $Corruption_{it}$: This variable is constructed from Transparency International's Corruptions Perception Index (CPI) calculated using the following formula: $Corruption = 10 - CPI$. This variable measures the degree of corruption that is perceived to be present in a country. It takes a value of 0 for the lowest level of corruption and a value of 10 for the highest level of corruption pereceived to be present in a country.

We divide the data by grouping countries into high and low corruption categories. A country with a corruption value of at least 5 is considered as a high corruption country. A corruption value of less than 5 represents a low corruption country. This division facilitates a comparison between piracy in a low corruption country and that in a high corruption country.

Looking at a summary of the data on treaty dummy variables (Table 1) we can gain insight into the effect that a copyright treaty may have on a country's piracy rate. Table 1 shows that member countries of the WCT or WTO agreements on average have a lower piracy rate than non member countries. Countries that have both WCT and WTO agreements have on average a 5.7% lower piracy rate than countries that are not members of both agreements. Table 1 also shows that the biggest difference between member and non-member country's average piracy rates is with respect to the WTO agreement.

Table 1: Summary of Treaty Dummy Variables

	Proportion of Countries		Average Piracy Rate	
Treaty Dummy	Members	Non-Members	Members	Non-Members
WCT	55%	45%	59.4%	60.5%
WTO	86%	14%	57.0%	77.9%
WTO and WCT	48%	52%	57.0%	62.7%

toward piracy and using a country fixed effects analysis over three periods (1994,1997 and 2000) finds that copyright software protection and income are the most important factors in explaining software piracy.

We now run a country-fixed effects regression on both the low and high corruption country groups. The results are shown below in Table 2.[6] From the high-corruption countries regression, we observe that the WCT and WTO variables are both insignificant. This suggests that anti-piracy regulation has no effect on the piracy rate in high corruption countries. On the contrary, in the low-corruption countries regression, WCT is highly significant and WTO drops out of the regression. Due to the fixed effects specification of the regression model, we unfortunately run into the problem of not being able to use time invariant regressors so we cannot analyse WTO in the context of low corruption countries. We can say though, as WCT is highly significant and negative, that in low corruption countries strict anti-piracy regulation does seem to have a negative effect on piracy.

This empirical evidence motivates us to find a theoretical justification for the contrast of anti-piracy regulation being ineffective in high corruption countries and effective in low corruption countries. We further use the theoretical analysis to discuss relevant policies to address piracy in the presence of corruption.

[6] See Table A1 in the Appendix for the full regression output.

Table 2: Comparison of Anti-Piracy Policy in High Corruption and Low Corruption Countries

	(1) Piracy-High Corruption Countries	(2) Piracy-Low Corruption Countries
WCT	-0.0236	-0.0143^{***}
	(-1.79)	(-3.67)
WTO	-0.0128	.
	(-0.48)	.
Corruption	-0.00546	-0.00858
	(-1.24)	(-1.43)
GDPpc	-0.0000189^{***}	-0.00000620^{***}
	(-3.43)	(-3.70)
Observations	442	268

High Corruption Countries refer to countries with a corruption value greater than or equal to 5

Low Corruption Countries refer to countries with a corruption value less than 5

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3 The Model

Following Mookherjee and Png (1995), we consider a sequential game between a copyright holder (monopolist), a pirating firm (pirate) who illegally sells illegal copies of the copyrighted product, and an officer responsible for monitoring piracy. The officer does so by choosing a monitoring rate μ, which is the probability of detection.[7] The monitoring cost is assumed to take the form $c(\mu) = \frac{\mu^2}{2}$. The marginal cost of production for the monopolist and the pirate is assumed to be zero.

If the pirate is detected, then the officer can choose to act honestly or dishonestly. If the officer acts honestly which implies reporting piracy, then the pirate incurs a fine proportional to the quantity of pirated goods sold. So the fine revenue is fD_c, where f is the fine rate, and D_c is the demand for the copied or the pirated good. The reward to the officer's honest act is rfD_c, where r is the reward rate.[8]

The dishonest act of the officer implies that he and the pirate engage in an act of bribery, where the bribe is b. For simplicity, we assume that the officer and the pirate have equal bargaining power and hence the bribeable surplus (defined later) is shared equally. This act of bribery does however entail a risk of being discovered, with probability λ. In this case the pirate is penalised for piracy and corruption and the officer is penalised for corruption.[9] The penalty rates for corruption are denoted as f_c for the pirate and f_o for the officer. Note that we will use the terms fine and penalty interchangeably.

The game played between the monopolist, pirate and the officer can be represented in an extensive form as follows.

Stage 1: The monopolist chooses a price, P_m. At this stage of the game, the pirate also chooses whether to *enter* (E) or *not enter* (NE). If the pirate chooses E, the game proceeds to stage 2. If the pirate chooses NE, then the monopolist earns the monopoly profit, π_m and the game ends.

Stage 2: If the pirate chooses E, then he also chooses a price P_c. The officer can observe the

[7]We assume that the probability of detecting the pirate is a good representation of the effort put in by the officer.

[8]This could be thought of as a promotion or some sort of commission scheme. Mookherjee and Png (1995) and Hindriks et al. (1999) also use reward schemes in their models of corruption.

[9]This probability is arbitrarily assigned and it could be thought of as the officer being audited, or the act of bribery itself being chanced upon. Similar assumptions are also made in (Mookherjee and Png, 1995).

presence of piracy and chooses a monitoring rate μ.[10] If the officer detects the pirate then the game proceeds to stage 3, otherwise, the game ends and the monopolist's and pirate's payoffs are denoted as π_L and π_F, which are the same as that of a leader and a follower in a sequential pricing game with vertical product differentiation. In this case the officer's payoff is the monitoring cost $c(\mu) = \frac{\mu^2}{2}$.

Stage 3: The pirate is detected, and the officer and the pirate choose either to engage or not to engage in bribery. If they jointly choose to exchange a bribe the game continues to stage 4, otherwise, the game ends.[11] If the game ends the monopolist's payoff is π_L, the pirate's payoff is π_F less the fine for piracy fD_c, and the officer receives $rfD_c - c(\mu)$.

Stage 4: In the final stage of the game the pirate and the officer's act of bribery is discovered with probability λ . In this case the monopolist's payoff is π_L. The pirate's payoff is π_F less the fine for piracy and corruption ($f(1 + f_c)D_c$), and the bribe (b). The officer's payoff is b less the penalty for corruption f_oD_c.

This extensive form game is diagrammatically represented in Figure 2. In this figure, the rectangles represent the decision stages and the ellipses represent the outcomes. The diamond shape at the fourth stage of the game represents a random event and is not a function of any choice that the agents make.

[10]As (Banerjee, 2006) mentions "it is possible that the government monitors but cannot detect the seller of the pirated software. This means that the government observes or knows that illegal software is sold in the market but cannot find the seller".

[11]Both parties need to benefit from bribery otherwise the bribe will not be exchanged. We assume that neither party can force the bribe upon the other.

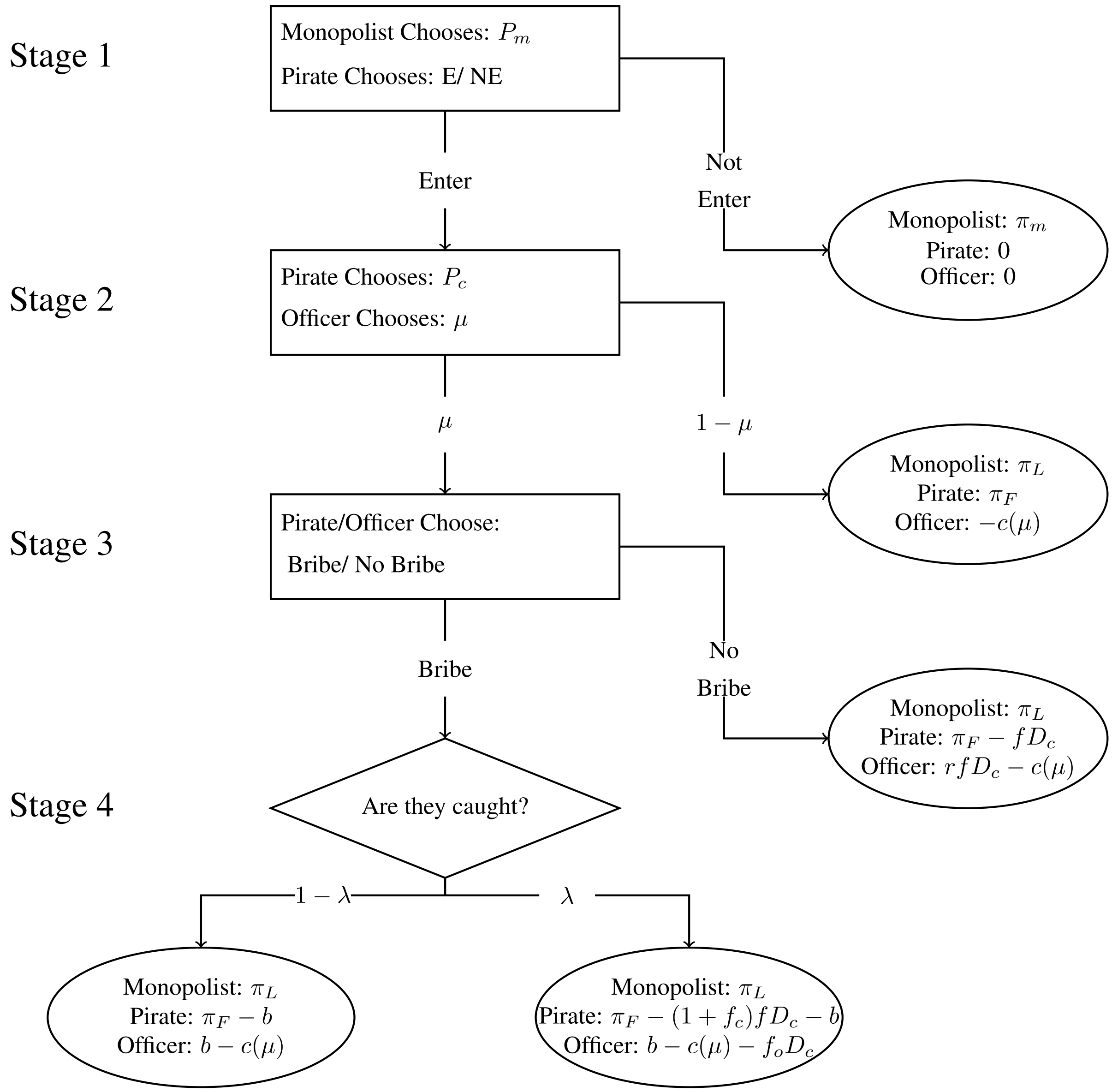

Figure 2: Game Tree

3.1 Market Demand

There is a continuum of consumers whose valuations of the good are represented by θ, which is uniformly distributed in the interval $\theta \in [0, 1]$. Let $q \in (0, 1)$ be quality of the pirated software, and the quality of the original software is normalised to 1.[12] The above assumptions imply that the pirated software is an inferior substitute of the original software. Consumers derive utility depending on their valuation of the good, the quality of the product they purchase, and the price they pay for it. This gives the following utility structure:

$$u(\theta) = \begin{cases} \theta - P_m & \text{if consumer buys the original software} \\ q\theta - P_c & \text{if consumer buys the pirated software} \\ 0 & \text{if consumer does not buy the software} \end{cases} \tag{2}$$

There are two marginal consumers whose valuations are represented by θ_c and θ_x, where θ_c represents the consumer who is indifferent between purchasing the original software and the pirated software and θ_x represents the consumer who is indifferent between purchasing the pirated software and not buying the software. θ_c satisifies, $\theta_c - P_m = q\theta_c - P_c \implies \theta_c = \frac{P_m - P_c}{1-q}$, and θ_x satisfies $q\theta_x - P_c = 0 \implies \theta_x = \frac{P_c}{q}$.

As in Banerjee (2006) we assume that $1 > \theta_c$, $\theta_c > \theta_x$, and $\theta_x > 0$. These assumptions imply that each firm faces a positive demand and that the market is not fully covered meaning that some consumers do not purchase any product. Using the expressions for the marginal consumers we can derive the demands for the original software, D_m, and that for the pirated software, D_c.

$$D_m(P_m, P_c) = \int_{\theta_c}^{1} \frac{1}{\theta_1 - \theta_0} \, \mathrm{d}\theta = 1 - \theta_c = \frac{\theta_1 - \frac{P_m - P_c}{1-q}}{\theta_1 - \theta_0} = 1 - \frac{P_m - P_c}{1-q} \tag{3}$$

$$D_c(P_c, P_m) = \int_{\theta_x}^{\theta_c} \frac{1}{\theta_1 - \theta_0} \, \mathrm{d}\theta = \theta_c - \theta_x = \frac{qP_m - P_c}{(\theta_1 - \theta_0)(1-q)q} = \frac{qP_m - P_c}{q(1-q)} \tag{4}$$

[12] See Banerjee (2003),Banerjee (2006),Takeyama (1994) for a detailed discussion on the assumption $q \in (0, 1)$.

4 Equilibrium Analysis

In this section we solve the game using the method of backward induction. Since Stage 4 of the game is about the possibility that bribery is discovered which is a random event, we begin our analysis from Stage 3 of the game assuming that the pirate has chosen E. We derive the bribery condition in subsection 4.1 and then determine the optimal choices of all agents under bribery in subsection 4.2. Using these optimal choices we then perform the comparative static analysis under bribery in subsection 4.3. Subsection 4.4 considers the optimal choices under no bribery.

4.1 Bribery Condition

The conditions for bribery are as follows. For bribery to be profitable to the officer, the gain from bribery must exceed the forgone reward from reporting piracy. That is, $b > D_c(rf + \lambda f_o)$. For bribery to be profitable to the pirate, the bribe has to be smaller than the amount of the fine, that is, $fD_c - \lambda(1 + f_c)fD_c > b$. Combining these two conditions we get, $fD_c - \lambda(1 + f_c)fD_c > b > D_c(rf + \lambda f_o)$. This condition (the Bribery Condition) can be rewritten as,

$$f - \lambda(1 + f_c)f > (rf + \lambda f_o). \tag{C1}$$

Equal sharing of the bribable surplus, which is $D_c[f(1 + r) - \lambda(f(1 + f_c) - f_o)]$, yields the bribe as given in equation (5).[13]

$$b = \frac{D_c}{2}[f(1 + r) - \lambda(f(1 + f_c) - f_o)] \tag{5}$$

If the officer chooses to engage in bribery we must also determine whether or not the officer

[13] This is the Nash Bargaining solution where each party has equal bargaining power.

will report all of the piracy or some proportion of it. Let $f\hat{D}_c$ be the penalty that the pirate pays where $\hat{D}_c$ is the quantity of pirated goods reported by the officer and $\hat{D}_c \leq D_c$, D_c being the actual quantity produced by the pirate. If it is discovered (with probability λ) that the officer has behaved dishonestly and engaged in bribery then the pirate must pay an additional fine $(1 + f_c)f(D_c - \hat{D}_c)$. Hence the expected gain to the pirate from bribery is $b - (1 - \lambda(1 + f_c))f(D_c - \hat{D}_c)$. If the officer detects the pirate and does not take a bribe, he receives rfD_c. Alternatively, if he engages in bribery and does not report the full scale of the piracy then he takes a bribe b and a reward, $rf(\hat{D}_c)$, for the reported quantity of piracy. If, however, the officer is discovered in the act of bribery then he will be fined $f_o(D_c - \hat{D}_c)$. Hence his expected gain from bribery is $b - (rf + \lambda f_o)(D_c - \hat{D}_c)$. For bribery to take place both the pirate and the officer must benefit, so corruption will occur only if the following condition holds.

$$(1 - \lambda(1 + f_c))f > rf + \lambda f_o$$

Observe that this condition is the same as C.1. Suppose this condition is satisfied and that the bribery does take place. The joint gain to the pirate and the officer is as follows.

$$(1 - \lambda(1 + f_c))f(D_c - \hat{D}_c) - b + b - (rf + \lambda f_o)(D_c - \hat{D}_c)$$

$$= [(1 - \lambda(1 + f_c))f + rf + \lambda f_o](D_c - \hat{D}_c)$$

We know the term within square brackets in the above equation is positive because of the bribery condition so we can say that the joint gain is decreasing in $\hat{D}_c$. Therefore the joint gain maximising quantity to report is $\hat{D}_c = 0$. That, is the officer will not report piracy at all.

This leads us to our first result. On inspection of the bribery condition (C1) we can see that increasing the piracy fine f may in fact induce bribery to occur or it may reinforce this condition. Hence, if corruption is ignored and an anti-piracy policy is implemented, it may not be effective as the officer will not report any piracy and take a bribe. This occurs because the bribe is also increasing in the piracy fine, f, so the officer has an increased return from engaging in bribery. This result is summarised in Proposition 1 and the proof is given in the Appendix.

Proposition 1. *Increasing the piracy fine (f) will not decrease piracy but will either induce bribery to occur or reinforce bribery.*

4.2 Optimal Choices Under Bribery

Assuming that bribery is chosen in Stage 3 of the game we now proceed to Stage 2 where the officer chooses a monitoring rate. The officer's expected profit under bribery is,

$$E\pi_o(B) = \mu(b - \lambda f_o D_c) - c(\mu). \tag{6}$$

Substituting b from equation (5) into equation (6), the first order profit maximisation condition gives us the optimal monitoring rate, as shown in Lemma 1.

Lemma 1. *Officer's optimal monitoring rate, given bribery, is* $\mu^*(B) = \frac{D_c}{2}[X - Y]$ *where* $X = f(1+r)$ *and* $Y = \lambda(f(1+f_c) + f_o)$.

Now we move to Stages 2 and 1 of the game where the pirate and the monopolist choose their prices, assuming that the pirate has entered the market. The pirate's expected profit under bribery is given in equation (7).

$$\begin{aligned} E\pi_c(B) &= (1-\mu^*(B))P_cD_c + \mu^*(B)[(1-\lambda)(P_cD_c - b) + \lambda(P_cD_c - b - (1+f_c)fD_c)] \\ &= P_cD_c - \mu^*D_c[\frac{f(1+r))}{2} + \frac{\lambda f(1+f_c)}{2} + \frac{\lambda f_o}{2}] \end{aligned} \tag{7}$$

From Lemma 1 we know that $\mu^*(B) = \frac{D_c}{2}[X - Y] = \frac{D_c}{2}[f(1+r) - \lambda(f(1+f_c) - f_o)]$. Using this and the expression for D_c as given in equation (4), we can rewrite equation (7) as,

$$E\pi_c(B) = \frac{qP_mP_c - P_c^2}{q(1-q)} - \frac{1}{4}(\frac{qP_m - P_c}{q(1-q)})^2[X^2 - Y^2]. \tag{8}$$

From the first order condition, $\frac{\mathrm{d}E\pi_c(B)}{\mathrm{d}P_c} = \frac{qP_m - 2P_c}{q(1-q)} + \frac{1}{2}(\frac{qP_mP_c}{q(1-q)}(X^2 - Y^2) = 0$ we get the pirate's reaction function as given in equation (9).

$$P_c(B) = qP_mZ \tag{9}$$

$$\text{where } Z = \frac{2q(1-q) + X^2 - Y^2}{4q(1-q) + X^2 - Y^2}$$

The monopolist's profit, using the expression for D_m as given in equation (3), is given in equation (10).

$$\pi_m = P_mD_m = P_m\big(1 - \frac{P_m - P_c}{1-q}\big) \tag{10}$$

Substituting $P_c(B)$ from equation (9) into equation (10) and from the first order condition $\frac{\mathrm{d}\pi_m(B)}{\mathrm{d}P_m} = 1 - \frac{2P_m - 2qP_mZ}{1-q} = 0$, we get the monopolist's equilibrium price, $P_m^*(B)$. Substituting this back into equation (9), we get the pirate's equilibrium price, $P_c^*(B)$. These are shown below in equations (11) and (12).

$$P_m^*(B) = \frac{1-q}{2(1-qZ)} \tag{11}$$

$$P_c^*(B) = \frac{q(1-q)}{2(1-qZ)}Z \tag{12}$$

These expressions can be used in conjunction with Lemma 1 to derive the equilibrium payoffs of the agents. We now proceed to perform the comparative static analysis of the choice variables, given bribery, with respect to the policy parameters. This is analysed in the next subsection.

Table 3 below provides a summary of the equilibrium prices, demands, monitoring rate and expected payoffs of the three players.

Table 3: Summary of Model Variables

Summary of Model Variables				
	Price	Demand	Monitoring Rate	Expected Payoff
Pirate	$P_c^* = \frac{q(1-q)}{2(1-qZ)}Z$	$D_c^* = \frac{1-Z}{2(1-qZ)}$	NA	$E\pi_c = P_c{}^* D_c^* - \frac{1}{4} D_c^{*2}[X^2 - Y^2]$
Monopolist	$P_m^* = \frac{1-q}{2(1-qZ)}$	$D_m^* = \frac{1}{2}$	NA	$E\pi_m = \frac{1-q}{4(1-qZ)}$
Officer	NA	NA	$\mu^* = \frac{1}{2} D_c^* [X-Y]$	$E\pi_o = b^* - c(\mu^*)$

4.3 Comparative Static Analysis Under Bribery

In this subsection we examine the agents' responses to changes in the four policy parameters (f, r, f_c, f_o). We do this by looking at the comparative static analysis of the choice variables: the optimal monitoring rate, $\mu^*(B)$ and the equilibrium prices $P_c^*(B)$, $P_m^*(B)$. These results are summarised in Proposition 2, and will be used to infer their effects on the demands, the bribe and the firms' profits. The proof of Proposition 2 is given in the Appendix.

Proposition 2. *The results for the comparative static analysis, given bribery, are summarised in Table 4.*

Table 4: Comparative Statics

	Effect on equilibrium		
Small increase in	Monitoring Rate	Pirate's Price/Demand	Monopolist's Price/Demand
	$\mu^*(B)$	$P_c^*(B)/D_c^*$	$P_m^*(B)/D_m^*$
Piracy fine, f	*Increasing*	*Increasing/Decreasing*	*Increasing/Constant*
Officer's Reward, r	*Increasing*	*Increasing /Decreasing*	*Increasing/Constant*
Pirate's Corruption Fine, f_c	*Decreasing*	*Decreasing/Increasing*	*Decreasing/Constant*
Officer's Corruption Fine, f_o	*Decreasing*	*Decreasing/Increasing*	*Decreasing/Constant*

From Table 4 we observe that in the bribery situation the monitoring rate reacts positively to both an increase in the piracy fine (f) and the reward (r). Intuitively, this can be explained as follows. The expected return from detecting the pirate is increasing in f (and r) so the officer will increase the monitoring rate. The pirate increases his price in reaction to an increase in f (and r). This occurs because an increase in the monitoring rate due to an increase in f (or r) results in a higher marginal cost to the pirate as evident from equation (7). Consequently, the pirate reduces his equilibrium quantity in order to reduce his exposure to detection.[14] The monopolist will then react to the pirate's higher price by increasing P_m, as $D_m^* = \frac{1}{2}$ is constant. Being the leader he always commits to the monopoly output level.

We see interesting results with the agent's strategic responses to changes in the corruption fine parameters, which are f_c and f_o. Increasing either the pirate's corruption fine (f_c) or the officer's corruption fine (f_o) will result in the officer decreasing the monitoring rate. This happens as the corruption fine, which is a penalty on the officer's alternative source of income (b), reduces the officer's monitoring incentive. As the monitoring rate decreases, the pirate will react by lowering

[14] The pirate's total fine is increasing in the demand for the pirate's good, hence a lower demand will result in a lower total fine.

their price which results in a larger demand for the pirate's good and higher profits. An increase in f_o (or f_c), thus has opposing effects on P_c. The direct effect of an increase in f_o is an increase in P_c because of a higher marginal cost. The indirect effect of a lower μ due to a higher f_o is a decrease in P_c because of a lower marginal cost. The indirect effect dominates the direct effect which explains the decrease in P_c due to a higher f_o. This also applies for an increase in f_c. Consequently, the monopolist's reaction to a lower P_c is a lower P_m.

These results differ from that of Mookherjee and Png (1995) in the following way. In Mookherjee and Png (1995) increases in the penalty to the officer, reward to the officer, and penalty to the bribe giver had lower, ambiguous, and lower effects on the monitoring rate, respectively. The same changes had ambiguous, lower and ambiguous effects on the amount of pollution. Proposition 2 shows that the direction of the effects are specific.

4.4 Optimal Choices Under No Bribery

In this section we consider the case where the policy parameters are such that bribery does not occur. This implies that the bribery condition C.1 is violated. The officer's expected profit, given no bribery, is shown below in equation (13).

$$E\pi_o(NB) = \mu(rfD_c) - c(\mu) \tag{13}$$

The optimal monitoring rate, given no bribery, is shown in Lemma 2 below.

Lemma 2. *The officer's optimal monitoring rate, given no bribery, is* $\mu^*(NB) = rfD_c$.

Now we move to Stages 2 and 1 of the game where the pirate and the monopolist choose their prices, assuming that the pirate has entered the market. The pirate's expected profits under no bribery is given in equation (14).

$$E\pi_c(NB) = (1 - \mu^*(NB))P_cD_c + \mu^*(NB)[P_cD_c - fD_c] \tag{14}$$

Substituting $\mu^*(NB)$ from Lemma 2 into equation (14) and from the first order condition we get the pirate's optimal price under no bribery as follows.

$$P_c(NB) = \frac{qP_m[2q(1-q) + 2rf^2]}{2q(1-q) + 2rf^2]}$$

$$P_c(NB) = qP_m\Omega \tag{15}$$

$$\text{where } \Omega = \frac{q(1-q) + 2rf^2}{2q(1-q) + 2rf^2}$$

The monopolist's profit, using the expression for D_m as given in equation (3), is given in equation (16).

$$\pi_m = P_mD_m = P_m\big(1 - \frac{P_m - P_c}{1-q}\big) \tag{16}$$

Substituting $P_c(NB)$ from equation (13) into equation (8) and from the first order condition $\frac{\mathrm{d}\pi_m(NB)}{\mathrm{d}P_m} = 1 - \frac{2P_m - 2qP_m\Omega}{1-q} = 0$ we get the monopolist's equilibrium price, $P^*_m(NB)$. Substituting this back into equation (13), we get the pirate's equilibrium price, $P^*_c(NB)$. These are shown below in equations (15) and (16).

$$P^*_m(NB) = \frac{1-q}{2(1-\Omega)} \tag{17}$$

$$P^*_c(NB) = \frac{q(1-q)}{2(1-q\Omega)}\Omega \tag{18}$$

We now compare the results under the bribery case to that under the no bribery case to examine the policy implications. Specifically we will analyse the interrelation between the anti-piracy and anti-corruption policies which is given in the next section.

5 Policy Analysis

As shown in the existing literature on the effectiveness of enforcement policies, when there is no corruption not monitoring is the socially optimal policy. This result holds in our paper as well, because allowing piracy under bribery only reduces the monopolist's profit but increases consumer surplus and the pirate's profit.

However, corruption within law enforcement agencies has far reaching consequences in the sense that it undermines the law and order structure of an economy. This weakening of the governance structure can have high economic costs which are not immediately obvious. For example Marjit et al. (2000) show that in the context of tax policies, corruption worsens the welfare of people at lower income levels while benefiting those at higher income levels. Tolerating a select few types of corruption may in fact weaken institutions such that it is difficult to prevent other types of corruption. In general, people are sensitive towards corruption as evident from the recent popular support for the anti-graft Lokpal Bill in India designed to create an independent watch dog to monitor bureaucratic corruption. Therefore, the cost of corruption can be perceived to be prohibitively high and thus elimination of corruption may be a desired government objective.

In light of the above discussion, we assume that the government's aim is to prevent illegal activities. So the question we propose to analyse is how can we simultaneously remove corruption and effectively monitor piracy. The challenge of tackling these two issues arises from the findings in propositions 1 and 2. Proposition 1 shows that increasing the piracy fine only serve to induce bribery or reinforce the bribery condition. In Proposition 2 we see that increasing the corruption fine to either the officer or the pirate decreases the officer's incentive to monitor piracy.

To tackle the above mentioned challenging issues, consider a situation where we have a policy setting (f, r, f_c, f_o) such that the bribery condition is satisfied. Now, introduce a new policy (f, r', f_c, f_o') by increasing f_o to f_o' and r to r' such that the bribery condition (C1) is violated, that is, $\lambda f'_o > f - \lambda(1+f_c)f$. Since an increase in f_o decreases the optimal monitoring rate we therefore consider the higher reward r' such that the monitoring rate is unaffected, that is $\mu^*(B) = \mu^*(NB)$. Using the expressions for $\mu^*(B)$ and $\mu^*(NB)$ from lemmas 1 and 2 we get the following.

$$\frac{D_c(B)}{2}(X - Y) = r' f D_c(NB)$$
$$D_c(B) = \frac{2r'f}{X - Y} D_c(NB)$$

So we can say that if:

$$2r'f > X - Y, \qquad \text{then } D_c(B) > D_c(NB),$$
$$2r'f < X - Y, \qquad \text{then } D_c(B) < D_c(NB), \text{ and}$$
$$2r'f = X - Y, \qquad \text{then } D_c(B) = D_c(NB).$$

The bribery condition (C1) can be rewritten as $X - Y > 2rf$.

Under the new set of policy variables the bribery condition is violated, which means $X' - Y' < 2r'f$, where $X' = f(1 + r')$ and $Y' = \lambda[f(1 + f_c) + f'_o]$. If $X' - Y' > X - Y$, then we can definitely say that $X - Y < 2r'f$. This will be the case if the condition $r' - r > f'_o - f_o$ is satisfied. This condition implies that the increase in the reward to the officer must exceed the increase in the corruption fine to the officer for a reduction in piracy to occur. This result is summarised in Proposition 3.

Proposition 3. *Corruption can be eliminated and piracy reduced by simultaneously adjusting the officer's corruption fine, f_o, such that bribery is no longer viable and compensating the officer by increasing r such that there is no decrease in the monitoring level between the bribery and no-bribery situation. Furthermore, if the increase in the officer's reward, $r' - r$, exceeds the increase in the corruption fine for the officer, $f'_o - f_o$, then there is a decrease in the demand for the pirated* *product.*

A similar result will also hold by increasing the pirate's corruption fine (f_c) to overturn the bribery condition (C1) and then increasing the reward (r) to compensate the officer. In this case the demand for piracy will decrease if the increase in the officer's reward exceeds the increase in the corruption fine for the pirate.

The implication of Proposition 3 is as follows. Let us define the level of piracy (s) as the pirate's market share in the total demand, that is, $s = \frac{D_c}{D_m+D_c}$. Since $D_m^* = \frac{1}{2}$, then $s^* = \frac{D_c^*}{\frac{1}{2}+D_c^*}$ is increasing in D_c^*. Thus, if D_c^* decreases, as discussed above, it implies a decrease in the pirate's equilibrium market share (s^*). That is the level of piracy decreases.

6 Conclusion

The existing literature has analysed the issue of piracy in a corruption-free context. However, our empirical evidence shows a significant positive correlation between piracy and corruption and a country-fixed effects regression analysis suggests that these two problems are in fact interrelated. Motivated by these empirical findings, we developed a model of corruption and piracy to address the twin problem. We considered a sequential game played between a monopolist, a pirate and an officer, where the officer can receive a bribe from the pirate in exchange for not reporting piracy. We considered four policy variables for our analysis of anti-piracy and anti-corruption policies.

We showed that increasing the penalty for piracy may not be effective in the context that there is a bribeable officer and may in turn either induce bribery to occur or increase the size of the bribe if bribery is already taking place. Comparative static analysis showed that increases in piracy fine and the officer's reward increased the equilibrium monitoring rate and prices. However, an increase in the pirate's corruption fine and the officer's corruption fine had an inverse effect on the above equilibrium variables.

The policy analysis showed that by using an appropriate choice of penalties for corruption and compensation for the officer, we can eliminate corruption and effectively reduce piracy. Specifically, a simulatenous increase in the reward and the corruption fine, either to the officer or to the pirate, eliminates corruption. Further, if the increase in the reward exceeds the increase in the corruption fine the demand for pirated goods and the level of piracy are reduced.

References

Andres, A.R., 2006. The relationship between copyright software protection and piracy: Evidence from europe. European Journal of Law and Economics 21, 29 – 51.

Banerjee, D.S., 2003. Software piracy: A strategic analysis and policy instruments. International Journal of Industrial Organization 21, 97 – 127.

Banerjee, D.S., 2006. Lobbying and commercial software piracy. European Journal of Political Economy 22, 139–155.

Banerjee, D.S., 2011. On the sufficiency of regulatory enforcement in combating piracy. Journal of Regulatory Economics 40, 160 – 176.

Cheng, H., Sims, R., Teegen, H., 1997. To purchase or to pirate software: an empirical study. Journal of Management Information Systems , 49–60.

Duchêne, A., Waelbroeck, P., 2006. The legal and technological battle in the music industry: Information-push versus information-pull technologies. International Review of Law and Economics 26, 565–580.

Harbaugh, R., Khemka, R., 2010. Does copyright enforcement encourage piracy?*. The Journal of Industrial Economics 58, 306–323.

Hindriks, J., Keen, M., Muthoo, A., 1999. Corruption, extortion and evasion. Journal of Public Economics 74, 395–430.

Lu, Y., Poddar, S., 2012. Accommodation or deterrence in the face of commercial piracy: the impact of intellectual property rights protection. Oxford Economic Papers 64, 518–538.

Marjit, S., Mukherjee, V., Mukherjee, A., 2000. Harassment, corruption and tax policy. European Journal of Political Economy 16, 75–94.

Mishra, A., 2005. The Economics of Corruption. Oxford University Press.

Mookherjee, D., Png, I.P.L., 1995. Corruptible law enforcers: How should they be compensated?. Economic Journal 105, 145 – 159.

Noyelle, T., 1990. Computer software and computer services in five asian countries, in: United Nations Conference on Trade and Development/United Nations Development Programme (UNCTAD/UNDP), Services in Asia and the Pacific: Selected Papers.

Png, I., Chen, Y., 1999. Software pricing and copyright: enforcement against end-users. SSRN working paper series .

Robertson, C., Gilley, K., Crittenden, W., 2008. Trade liberalization, corruption, and software piracy. Journal of Business Ethics 78, 623 – 634.

Takeyama, L., 1994. The welfare implications of unauthorized reproduction of intellectual property in the presence of demand network externalities. The journal of industrial economics , 155–166.

Vázquez, F., Watt, R., 2011. Copyright piracy as prey–predator behavior. Journal of Bioeconomics 13, 31–43.

Appendix

Proof of Proposition 1. The bribery condition is $f - \lambda(1+f_c)f > (rf + \lambda f_o)$. Assuming that $\lambda f_o > 0$, this implies $f\left[(1-r) - \lambda(1+f_c)\right] > 0$. Since $b = \frac{D_c}{2}\Big[f\left[(1+r) - \lambda(1+f_c)\right] + \lambda f_o\Big]$, $\frac{\mathrm{d}b}{\mathrm{d}f} > 0$ since $(1-r) - \lambda(1+f_c) > 0 \implies (1+r) - \lambda(1+f_c) > 0$. □

Proof of Lemma 1. $\frac{\mathrm{d}E\pi_o(B)}{\mathrm{d}\mu} = b - \lambda f_o D_c - c'(\mu) = 0$. Using the functional form $c(\mu) = \frac{\mu^2}{2}$, we get $\mu^*(B) = \frac{D_c}{2}[f(1+r) - \lambda(f(1+f_c) + f_o)]$ □

Proof of Proposition 2. Before going through the comparative statics for the choice variables we first take derivatives of Z, X and Y with respect to the four policy parameters f, r, f_c, f_o.

$$X = f(1+r),\ Y = \lambda(f(1+f_c)+f_o),\ Z = \frac{q(1-q) + X^2 - Y^2}{2q(1-q) + X^2 - Y^2} = 1 - \frac{q(1-q)}{2q(1-q) + X^2 - Y^2}$$

$$\frac{\mathrm{d}X}{\mathrm{d}f} = 1 + r > 0,\ \frac{\mathrm{d}X}{\mathrm{d}r} = f > 0,\ \frac{\mathrm{d}X}{\mathrm{d}f_c} = 0,\ \frac{\mathrm{d}X}{\mathrm{d}f_c} = 0\ .$$

$$\frac{\mathrm{d}Y}{\mathrm{d}f} = \lambda(1+f_c) > 0,\ \frac{\mathrm{d}Y}{\mathrm{d}r} = 0,\ \frac{\mathrm{d}Y}{\mathrm{d}f_c} = \lambda f > 0,\ \frac{\mathrm{d}Y}{\mathrm{d}f_o} = \lambda > 0\ .$$

$$\frac{\mathrm{d}Z}{\mathrm{d}f} = \frac{-q(1-q)}{(2q(1-q) + X^2 - Y^2)^2}\Big[-(2X\frac{\mathrm{d}X}{\mathrm{d}f} - 2Y\frac{\mathrm{d}Y}{\mathrm{d}f})\Big]$$

The bribery condition:$f - \lambda(1+f_c)f > (rf + \lambda f_o)$ can be rearranged as $f(1-r) > \lambda(f(1+f_c) + f_o)$.

This implies $f(1-r) > \lambda f(1+f_c)$. Hence, $f(1+r) > \lambda f(1+f_c) \implies 1 + r > \lambda(1+f_c)$.

So $X > Y,$ and $\frac{\mathrm{d}X}{\mathrm{d}f} > \frac{\mathrm{d}Y}{\mathrm{d}f}$ which implies $\frac{\mathrm{d}Z}{\mathrm{d}f} < 0.$

$\frac{\mathrm{d}Z}{\mathrm{d}r} = \frac{-q(1-q)}{2q(1-q)+X^2-Y^2}\left[2X\frac{\mathrm{d}X}{\mathrm{d}r}\right] < 0$ as $X^2 - Y^2 > 0$ and $2X\frac{\mathrm{d}X}{\mathrm{d}r} < 0.$

$\frac{\mathrm{d}Z}{\mathrm{d}f_c} = \frac{-q(1-q)}{2q(1-q)+X^2-Y^2}\left[-2Y\frac{\mathrm{d}Y}{\mathrm{d}f_c}\right] > 0$ as $X^2 - Y^2 > 0$ and $2Y\frac{\mathrm{d}Y}{\mathrm{d}f_c} > 0.$

$\frac{\mathrm{d}Z}{\mathrm{d}f_o} = \frac{-q(1-q)}{2q(1-q)+X^2-Y^2}\left[-2Y\frac{\mathrm{d}Y}{\mathrm{d}f_o}\right] > 0$ as $X^2 - Y^2 > 0$ and $2Y\frac{\mathrm{d}Y}{\mathrm{d}f_o} > 0.$

Comparative statics for $P_m^*(B) = \frac{1-q}{2(1-qZ)}$:

By inspection $\frac{\mathrm{d}P_m^*(B)}{dZ} > 0$. Therefore,

$\frac{\mathrm{d}P_m^*}{\mathrm{d}f} > 0$ as $\frac{\mathrm{d}Z}{\mathrm{d}f} > 0,$

$\frac{\mathrm{d}P_m^*}{\mathrm{d}r} > 0$ as $\frac{\mathrm{d}Z}{\mathrm{d}r} > 0,$

$\frac{\mathrm{d}P_m^*}{\mathrm{d}f_c} < 0$ as $\frac{\mathrm{d}Z}{\mathrm{d}f_c} < 0,$

$\frac{\mathrm{d}P_m^*}{\mathrm{d}f_o} < 0$ as $\frac{\mathrm{d}Z}{\mathrm{d}f_o} < 0.$

Comparative statics for $P_c^*(B) = \frac{q(1-q)}{2(1-qZ)}Z$:

By inspection, $\frac{\mathrm{d}Pc^*}{\mathrm{d}Z} > 0$. Therefore,

$\frac{\mathrm{d}P_c^*}{\mathrm{d}f} > 0$ as $\frac{\mathrm{d}Z}{\mathrm{d}f} > 0,$

$\frac{\mathrm{d}P_c^*}{\mathrm{d}r} > 0$ as $\frac{\mathrm{d}Z}{\mathrm{d}r} > 0,$

$\frac{\mathrm{d}P_c^*}{\mathrm{d}f_c} < 0$ as $\frac{\mathrm{d}Z}{\mathrm{d}f_c} < 0,$

$\frac{\mathrm{d}P_c^*}{\mathrm{d}f_o} < 0$ as $\frac{\mathrm{d}Z}{\mathrm{d}f_o} < 0.$

Comparative Statics for $\mu^*(B)$:

$$\mu^*(B) = \frac{D_c}{2}\Big[f(1+r) - \lambda(f(1+f_c)+f_o)\Big] = \frac{1-Z}{2(1-qZ)}\Big[f(1+r) - \lambda(f(1+f_c)+f_o)\Big]$$

$$\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}f} = \frac{-(1-q)}{2(1-qD)^2}\frac{\mathrm{d}Z}{\mathrm{d}f}[X-Y] + \frac{1-Z}{2(1-qZ)}(1+r-\lambda(1+f_c)$$

Which can be rewritten as:

$$\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}f} = \frac{(1+r-\lambda(1+f_c)(2q(1-q)^2)}{2(1-qZ)(4q(1-q)+X^2-Y^2)^2}\Big[-2[X-Y]^2+2q(2-q)+X^2-Y^2\Big] = A\Big[-2[X-Y]^2+2q(2-q)+$$

As A is positive, the sign of $\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}f}$ depends on the sign of $-2[X-Y]^2+2q(2-q)+X^2-Y^2$. We know that the pirate will not attempt to bribe the regulator unless they can make a positive profit. The pirate's expected profit given detection is as follows.

$$E\pi_c(B)|_{detected} = (1-\lambda)(P_c^*(B)D_c^*(B)-b)+\lambda(P_c^*(B)D_c^*(B)-b-(1+f_c)fD_c^*(B)) = D_c^*(B)(P_c^*(B)-\frac{X+Y}{2})$$

This is positive when $P_c = \frac{q}{2}\left(\frac{Z-qZ}{1-qZ}\right) > \frac{X+Y}{2}$. As $Z<1$, we can say:

$$P_c < \frac{q}{2} \implies \frac{X+Y}{2} < \frac{q}{2} \implies X+Y<q \text{ and as } X>Y \implies X-Y<q$$

Hence, $2[X-Y]^2 < 2q^2 \implies 2[X-Y]^2 < 2q(2-q)$ as $q<1$.

And $-2[X-Y]^2+2q(2-q)+X^2-Y^2$ So $\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}f} > 0$.

$$\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}r} = \frac{-(1-q)}{2(1-qD)^2}\frac{\mathrm{d}Z}{\mathrm{d}r}fX[X-Y] + \frac{f(1-Z)}{2(1-qZ)}$$

Which can be rewritten as:

$$\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}r} = \frac{f(1-q)(2q(1-q))}{2(1-qZ)(4q(1-q)+X^2-Y^2)^2}\Big[-2[X-Y]X+2q(2-q)+X^2-Y^2\Big]$$

We said above that $X+Y<q \implies 2[X+Y]^2<2q^2<2q(2-q)$ We can further say then that $2[X-Y]X<2q(2-q)$.

Hence, $\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}r}>0$.

$$\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}f_c} = \frac{-(1-q)}{2(1-qD)^2}\frac{\mathrm{d}Z}{\mathrm{d}f_c}[-Y\lambda][X-Y]+\frac{f(1-Z)}{2(1-qZ)}$$

Which can be rewritten as:

$$\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}f_c} = \frac{-\lambda f(1-q)(2q(1-q))}{2(1-qZ)(4q(1-q)+X^2-Y^2)^2}\Big[-2[X-Y]Y+2q(2-q)+X^2-Y^2\Big]$$

We said above that $X+Y<q \implies 2[X+Y]^2<2q^2<2q(2-q)$ We can further say then that $2[X-Y]Y<2q(2-q)$.

Hence, $\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}f_c}>0$.

$$\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}f_o} = \frac{-(1-q)}{2(1-qD)^2}\frac{\mathrm{d}Z}{\mathrm{d}f_o}[-Y\lambda][X-Y]+\frac{f(1-Z)}{2(1-qZ)}$$

Which can be rewritten as:

$$\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}f_c} = \frac{-\lambda(1-q)(2q(1-q))}{2(1-qZ)(4q(1-q)+X^2-Y^2)^2}\Big[-2[X-Y]Y+2q(2-q)+X^2-Y^2\Big]$$

We said above that $X+Y<q \implies 2[X+Y]^2<2q^2<2q(2-q)$ We can further say then that $2[X-Y]Y<2q(2-q)$. Hence, $\frac{\mathrm{d}\mu^*(B)}{\mathrm{d}f_o}>0$. □

Table A1: Comparison of Anti-Piracy Policy in High Corruption and Low Corruption Countries

	(1)	(2)
	Piracy-High Corruption Countries	Piracy-Low Corruption Countries
Berne	0.0616^{*}	.
	(2.17)	.
WCT	-0.0236	-0.0143^{***}
	(-1.79)	(-3.67)
WTO	-0.0128	.
	(-0.48)	.
Corruption	-0.00546	-0.00858
	(-1.24)	(-1.43)
Regulatory Quality	-0.0212	0.0118
	(-1.09)	(0.61)
Rule of Law	-0.0197	-0.0265
	(-1.03)	(-1.09)
Control of Corruption	0.0262	-0.0170
	(1.50)	(-0.99)
Log(Population)	-0.189^{***}	-0.138^{***}
	(-3.72)	(-6.29)
GDPpc	-0.0000189^{***}	-0.00000620^{***}
	(-3.43)	(-3.70)
Constant	3.954^{***}	2.791^{***}
	(4.63)	(7.81)
Observations	442	268

High Corruption Countries refer to countries with a corruption value greater than or equal to 5

Low Corruption Countries refer to countries with a corruption value less than 5

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Control Variables X_{it} is a vector of control variables that consist of the following variables:

- $Berne_{it}$: A dummy variable that takes the value of 1 if a country is a member of the Berne Convention, and 0 if they are not.
- $GDPpc_{it}$: Gross Domestic Product per capita data from the World Bank.
- $RegulatoryQuality_{it}$: A variable measuring perceptions of regulatory quality. Taken from the World Banks' World Governance Indicators dataset.
- $RuleofLaw_{it}$: A variable measuring perceptions of confidence that agents have in the laws of society. Taken from the World Banks' World Governance Indicators dataset.
- $ControlofCorruption_{it}$: A variable measuring perceptions of the extent that official power is used for private gain. Taken from the World Banks' World Governance Indicators dataset.
- $Log(Population)_{it}$: The natural log of the population. Data taken from the World Bank.