Corruption in the Ivory Trade:
Optimal Ranger Compensation Policies

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Abstract: Despite the 1989 CITES ban on international ivory trade, the poaching industry has continued to thrive, to the extent that African elephant populations are threatened of extinction. The opportunities to significantly increase wealth by harvesting high-value elephant ivory tusks are tempting to both poachers and conservation rangers. In this paper, we use the Nash bargaining model to study the poacher-ranger relationship, explore the economic incentives driving the parties' decisions and resulting corruption, and investigate optimal compensation policies for rangers that could minimize bribery. We find that a ranger's salary and reward rate have opposite correlations with bribery, and hence opposite correlations with the amount of ivory poached. Based on this theory, we suggest that in order to induce a decrease in poaching incentives, compensation policies should focus on reward rates instead of salaries.

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I. Introduction

Burgeoning global demand for African elephant ivory has fueled the poaching industry to the extent that the African elephant population has been classified as nearly extinct. The Humane Society International estimates that in 2012, "more than 35,000 of them – or close to 100 per day – were killed for their tusks…[and] if things continue at this rate, African elephants may be extinct in as few as 15 years." In 1990, following a decade of elephant poaching resulting in nearly a 50% decrease in elephant populations, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) declared an international trade ban on African elephant ivory (U.S. Fish & Wildlife Service, 2013; Humane Society International, n.d.; Milner-Gulland & Leader-Williams, 1992; Heltberg, 2000).

This ban caused poaching to decrease for a time, allowing the elephant populations to revive; however, after several legal one-off sales of stockpiled ivory, the poaching industry rekindled (U.S. Fish & Wildlife Service, 2013; Humane Society International, n.d). Ivory dealers discovered that demand for the product was incredibly high and, because of the ban, supply was limited; the black market price for a single elephant tusk was exorbitant, enough to serve as an African countryman's annual earnings (Bennett, 2014). This fact is critical to our analysis, as African countries have extremely low individual annual earnings. African wildlife rangers, in particular, are not paid well; in fact, it is not uncommon for rangers to not receive paychecks for months at a time (Bennett, 2014; Nshuli, 2013, Peh & Drori, 2012). For both poachers and rangers, high-value elephant tusks offer a quick, easy opportunity to increase wealth.

Corruption is more common for higher value items, and with increasing demand for ivory, corruption incidence is further heightened in all portions of the trade chain. And, in fact, the Last Great Ape Organization (LAGA) discovered corruption, namely bribery, in 85% of its conservation enforcement cases (LAGA, 2013). It is this corruption we seek to investigate. The purpose of this paper is to model the relationship between poachers and rangers and to offer an economic rationale for the corruption between the two parties. We seek to understand the optimal ranger compensation policy for the purpose of minimizing corruption.

Related Research

The literature surrounding the analysis of the impact of the CITES ban on the African elephant population is vast. Heltberg (2001) used simple supply and demand to model the ban's impact on a poacher's incentives. He argues that the trade ban has ambiguous effects, because it causes a lower international demand, yet a higher black market price. Van Kooten (2005) uses a partial equilibrium model with multiple exporting regions and a single demand region to show that the trade ban can be effective if it results in a stigma effect and significantly increased marginal costs. Bulte and van Kooten (1999) use illegal poaching, enforcement effort, and legal culling as hypothetical variables for theoretically modelling the ivory trade and determining a positive or negative relationship between the ban and elephant population. They use Zambian data to create an empirical application of the model, and show that the ban is more effective than permitting open trade. These studies show that the CITES ban can be effective, but Lemieux and Clarke (2009) use empirical population data from 1979 to 2007 to show that in some African countries, it was not, because elephant populations continued to decline. We suggest that the reason for this is the bribery in the poacher-ranger relationship; the illegal ivory trade continues to thrive, just in a more discreet manner.

Few models explore this interaction between poachers and law enforcement and the intertwined economic incentives. While the impact of the CITES ban is important in determining the course of action for conserving elephant populations, understanding the incentives for all parties involved is paramount to formulating a successful conservation policy. Milner-Gulland & Leader-Williams (1992) use empirical data from Zambia and optimization methods to explore poaching incentives and model the relationships between financial gains, detection, and penalties. They show that the probability of capture, namely the monitoring intensity/effort of the ranger, to be a significant factor in the poacher's decision on level of poaching. Milner-Gulland & Leader-Williams focus on poaching incentives in different organizational structures such as local versus gang poaching, and the correlating enforcement policies. We will be focusing on the interaction between the local poacher and ranger and the level of corruption between the two.

Corruption in organizations has been a topic of concern for economists for many years. The controversy on how to manage and compensate a worker in order to have maximum productivity has been explored both theoretically and empirically. The workers and managers in their principle-agent relationship do not always have similar interests. Lazear (1981) explores the different compensation schemes managers may employ to maximize their workers' marginal productivity. Becker & Stigler (1974) argue that the incentive structure for law enforcement in particular is heavily influenced by compensation schemes. They find that the enforcers' effectiveness is reduced when bribes are offered by violators, resulting in less criminal punishment and deterrence. We will apply this theory to corruption among rangers charged with protecting wildlife in Africa.

Our investigation is close in spirit to the research of Pashigian (1975) and Mookherjee & Png (1995). Pashigian (1975) theorizes that the markets for both a crime and a bribe are interrelated in that the bribe offered depends on the expected lesser crime fine which consequently depends upon the severity of the crime itself. We combine these elements with the model presented by Mookherjee & Png (1995), showing a complex relationship between compensation strategies and corruption.

II. Model

To model this strategic interaction between poachers and wildlife conservation rangers, we will be using the Nash bargaining solution. A model for cooperative actions, the Nash bargaining game will allow us to examine the relationship between poachers and rangers and identify key variables in ivory trade corruption. We will examine the incentive schemes of the poacher and ranger separately, then explore the parties' interactions.

Poachers

A poacher elects to poach an amount G of elephant ivory to harvest (i.e. the severity of his crime). The price per unit of elephant ivory on the black market will be denoted p; thus, the poacher gains pG in revenue. The poacher incurs for himself fixed production and effort costs which we will denote as a fixed amount Z. The penalties for poaching depend on the severity of the crime; a poacher might be subject to penalties ranging from high fines to life sentences in jail. Therefore, we will denote the penalty assessed to a crime equivalent to the amount of a fine as a function FG, where FG is dependent on both the severity of the crime, pG, and the amount of the bribe, B:

$$FG = f(pG, B); \text{where} \frac{\partial FG}{\partial G} > 0, \frac{\partial FG}{\partial B} < 0, \text{and } f(0,0) = 0$$

These assumptions are justified as follows:

(1) $\frac{\partial FG}{\partial G} > 0$; The penalty assessed to the poacher increases with the severity of the crime.

(2) $\frac{\partial FG}{\partial B} < 0$; The penalty assessed to the poacher decreases as the size of the bribe increases.

(3) $f(0,0) = 0$; The penalty assessed to the poacher will be zero if both the severity of the crime and bribe are zero.

The poacher seeks to maximize his profit and thus faces the classic optimization problem: $Max(\pi) = r(G) - c(G)$. This is given by:

$$E\Pi = pG - Z - \mu B - \mu FG$$

Because the poacher chooses G to maximize $E\pi$, the optimal value of G must satisfy the first order conditions:

$$\frac{dE\Pi}{dG} = p - \mu \frac{\partial FG}{\partial G} = 0$$

When he decides on G, the poacher assumes that the ranger's monitoring intensity level μ is fixed, and thus the probability of being caught is also fixed. We will assume that an individual poacher's selection of G does not affect the future level of protection provided by the ranger and, in turn, the future probability of being caught[1].

Rangers

African countries use rangers to protect the wildlife by enforcing anti-poaching laws and arresting poachers. The rangers enforce with some intensity level μ; to do this, they must expend unobservable energy and effort $e(\mu)$. $\mu \in [0,1]$, representing the probability that the ranger will catch the poacher[2]. We assume that if the ranger catches the poacher, the ranger will have sufficient evidence of poaching for conviction. With probability $1 - \mu$, the ranger will not catch the poacher. The ranger receives a salary of S regardless of $e(\mu)$. The ranger has full discretion of $e(\mu)$ and, should he catch a poacher, also decides (jointly with poacher) whether to report G or $\hat{G} < G$. To incentivize the ranger to catch more poachers, government regulators pay a reward of r dollars per fine dollar imposed on the poacher, i.e. rFG.

Because the ranger will be required to provide proof of either the capture of illegally harvested ivory tusks or the arrest of a poacher, the opportunity for over-reporting is extremely small. Thus, we will not consider here the potential corrupt activity of a ranger's over-reporting for a greater reward $r\widehat{FG}$.

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[1] We use the same assumption as Pashigian (1975) that the marginal impact of a successful crime has little to no impact on public and private protection measures.

[2] As a ranger more intensely pursues the poacher, he is more likely to catch him. The intensity level here acts as a proxy for the probability a poacher will be caught.

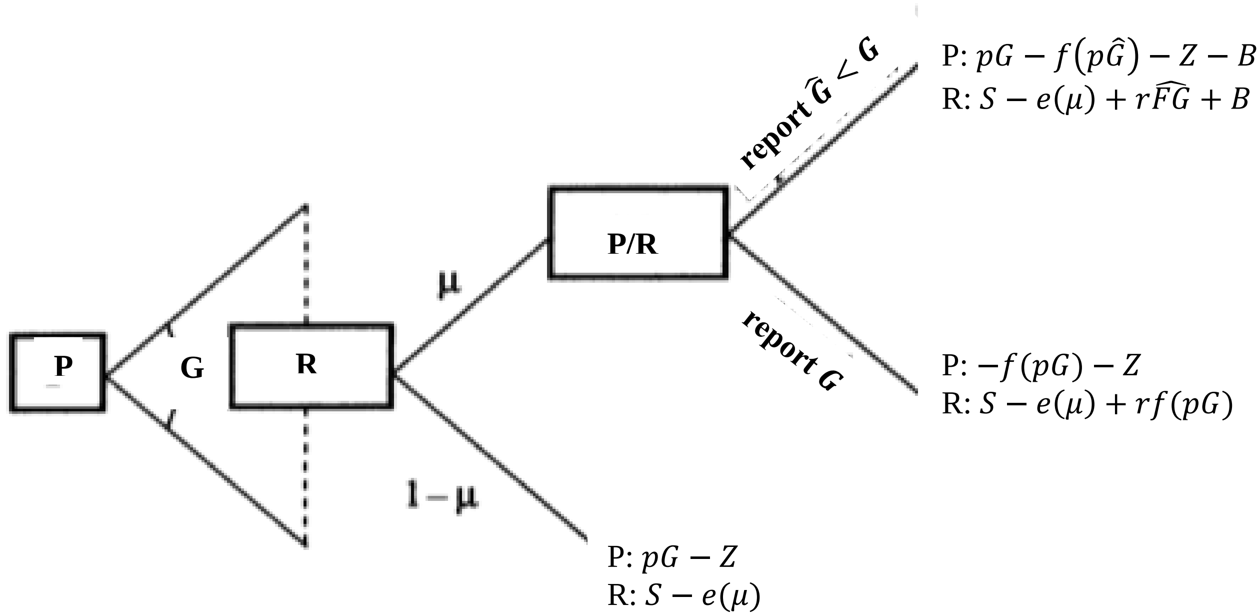

Figure 1: Sequence of events. Note: first entry at end of tree branches is return of poacher (P), second entry is return of ranger (R). Based on game tree in Mookherjee & Png (1995).

<u>Corrupt Interaction</u>

Let us suppose that the poacher has chosen his level of poaching at level G, and the ranger has discovered this criminal action. This situation allows us to examine both the conditions under which the poacher and ranger will engage in corruption and the size of the bribe, B.

If the poacher does not bribe the ranger, he must pay the penalty equivalent to the fine of FG for poaching. If he does pay B and causes the ranger to decide to report some level $\hat{G} < G$, he will pay a reduced fine level $\widehat{FG}$. Thus, the poacher expects to gain $pG - \left(B + Z + \widehat{FG}\right)$ from the bribe. If the ranger decides to not engage in corruption, he will receive a reward rFG from the government. If the ranger decides to take a bribe B and reduce her report of G to $\hat{G}$, his reward will be smaller, i.e. $r\widehat{FG}$. Therefore, his expected gain from accepting a bribe is $S + B - [\mu r f(\hat{G})]$.

In the event that the ranger has discovered the poacher's crime, a bribe will only be exchanged if both the poacher and ranger can benefit. Therefore, there exists a necessary and sufficient condition for bribery:

$$pG - \left[Z + (1 - \mu r)\widehat{FG} - S\right] > 0$$

The ranger and poacher are both corruptible, but whether bribery takes place depends on if this condition is met. When it is, meaning that bribery is profitable, we will assume that poacher and ranger maximize their joint gains and split the amount equally[3]. This means that the ranger and poacher's respective benefits from bribery are equivalent:

$$\left[pG - \left(B + Z + \widehat{FG}\right)\right] = S + B - \left(\mu r\widehat{FG}\right)$$

From this, we may find the optimal size of the bribe:

$$B = \frac{1}{2}\left[pG - S - Z + (\mu r - 1)\widehat{FG}\right]$$

The above equation shows that when the poacher and ranger act optimally, they decide on a level of $\hat{G}$ to report so that they maximize and balance their joint profits: $\left[pG - \left(B + Z + \widehat{FG}\right)\right] = S + B - \left(\mu r\widehat{FG}\right)$.

The game decision tree shown in Figure 1 illustrates that the poacher and ranger act independently and simultaneously; no cooperation in decision-making is available, until the opportunity for bribery arises. The poacher decides on her own how much ivory he would prefer to poach, and the ranger determines her level of monitoring effort.

III. Results

Now that we have derived this equation for the optimal size of the bribe, we can examine the effects of the government's ranger compensation policy on the decisions made by the poacher and ranger. First, let us consider the effect of an increase in the ranger's salary on the size of the bribe. We propose the following:

Proposition 1: An increase in the ranger's salary decreases the size of the bribe.

Let us examine the equation:

$$B = \frac{1}{2}\left[pG - S - Z + (\mu r - 1)\widehat{FG}\right]$$

We can see that a small increase in the salary of the ranger, S, will cause the size of the bribe to decrease, a negative correlation. *Ceterus paribus*, the poacher does not have any increased income, and the two parties share the joint profits from corruption equally; therefore, to compensate for the ranger's increased income, the bribe size received by the ranger must decrease. From the poacher's perspective, this decrease in bribe size lowers the 'price' of poaching, creating a greater incentive to continue or even increase poaching. Therefore, if the government desires to save the elephant population by decreasing poaching, policies with increases in ranger salaries are counterproductive. Let us consider the other aspect of the ranger's compensation policy, the reward rate, r.

Proposition 2: An increase in the ranger's reward rate increases the amount of bribe.

Again, let us examine the bribe's optimal size equation:

$$B = \frac{1}{2}\left[pG - S - Z + (\mu r - 1)\widehat{FG}\right]$$

We can see a positive correlation between bribe size and reward rate in that a small increase in the reward rate for the ranger will cause the size of the bribe to increase. Again, holding all else constant (including the poacher's income and costs), the bribe size must increase to compensate for the ranger's increased income. In effect, this increase in bribe price increases the 'price' of poaching by lowering the poacher's net gain. So, the poacher is incentivized to decrease his hunting. This is the desired result.

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[3] This assumption is made to simplify mathematics. Balancing gains is also fairly reasonable, as we have yet to determine the bargaining power each party possesses. A more complicated model would accommodate the potential of differing bargaining powers.

Therefore, we find that the two aspects of a ranger's compensation have opposite correlations with amounts of bribery, and hence opposite correlations with the amount of ivory poached. Increasing a ranger's salary only serves to decrease the bribe and incentivize the poacher to increase activity. On the other hand, increasing the reward rate for a ranger increases the bribe, making poaching more expensive for the poacher. Based on this theory, we suggest that in order to induce a decrease in poaching incentives, compensation policies should focus on reward rates instead of salaries. These policies, in effect, focus on rewarding rangers for their performance and effort, not their participation[4].

IV. Conclusions

Many efforts have been made to slow the poaching industry for African elephant ivory. However, no policy has made much impact, resulting in a near extinction of the African elephant population. The extremely high value of an elephant tusk on the black market provides great incentives for poachers to harvest ivory. For relatively poor citizens (including the rangers charged with conservation of the species), high-value elephant tusks offer a quick, easy opportunities for wealth. The interaction between poachers and rangers offers an opportunity for corruption where both parties could cooperate and share wealth. As mentioned before, LAGA (2013) has found that corruption does exist, and in at least 85% of conservation enforcement cases.

By using the Nash bargaining solution, we were able to examine this relationship between poachers and rangers and identify key variables in ivory trade corruption. By doing this, we discovered an economic rationale for the incentives in corruption, and we are able to suggest optimal ranger compensation policies that could lower the corruption rate and minimize elephant poaching. We find that the two aspects of rangers' compensation, namely their salaries and reward rates, have opposite correlations with bribe size and resulting corruption. Increasing a ranger's salary only serves to lower the bribe price for the poacher and incentivize more corruption and higher rates of poaching. However, an increase in the reward rate causes the bribe price to increase, incentivizing the rangers to report more poaching and poachers to hunt less. An optimal ranger compensation policy would include greater reward rates for ranger reporting and effort and less focus on a standard salary. This policy would result in less corruption between rangers and poachers and would minimize the poaching taking place.

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[4] This analysis results in conclusions similar to those found in literature regarding effects of salaried vs hourly paid employees on performance. Future models might focus on this aspect.

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