Commons, anti-commons, corruption and "maffia" behavior.

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During the last ten years corruption has drawn increasing attention from academicians and politicians. They studied the origins and consequences of corruption and tried to devise methods to discourage it. A vast literature developed and recent contributions were made by Susan Rose-Ackermann (1978, 1997, 1999), Arvind Jain (1998), Andrei Shleifer and Robert W. Vishny (1993), Vito Tanzi (1994,1998), Vito Tanzi and Hamid Davoodi (1997), Simon Johnson, Daniel Kaufmann and Pablo Zoido-Lobatón (1998a, 1998b), Daniel Kaufmann and Jeffrey Sachs (1998).

Corruption is a special kind of crime. This paper applies standard microeconomic tools to examine the effects of corruption on the allocation of resources.

First, corruption as a crime will be defined and then the framework used to analyze the symmetric "tragedies" of the commons and the anti-commons [1] will be recalled in order to apply it to the study of corruption. At the end of the paper some non-intuitive conclusions will de drawn.

I

Corruption is a crime characterized by the use by an agent of a third party's resources for his own advantage. [2]

Economists have devoted their attention to corruption since they persuaded themselves that bribes paid to corrupt agents were not mere redistributions of wealth without further effects on the allocation of resources. [3] But the canonical model used to study criminal behavior does not focus the analysis on the effect of crime on resources allocation but on the way to discourage crime. As Gary Becker [4] pointed out in his Nobel Lecture: "I was late and had to decide quickly whether to put the car in a parking lot or risk getting a ticket for parking illegally on the street. I calculated the likelihood of getting a ticket, the size of the penalty, and the cost of putting the car in a lot. I decided it paid to take the risk and park the car on the street… As I walked…it occurred to me that the city authorities had probably gone through a similar analysis. The frequency of their inspection of parked vehicles and the size of the penalty imposed on violators should depend on their estimates of the type of calculations potential violators like me would make." The point is quite clear: criminal behavior involves economic considerations in the evaluation of the trade-off between expected benefits and costs. So, the way society chooses to improve the working of institutions to discourage crime should recognize such a rational reasoning and when solving the problem directed to minimize the damage caused by criminal activity plus the level of resources devoted to deterrence detailed attention is paid to the choice of optimum levels of punishment and enforcement to produce deterrence by reducing expected benefits and increasing expected costs of criminal activity. The analysis usually assumes that the utility derived from criminal activity is given and does not depend on institutions devised to discourage crime. [5]

Corruption is a criminal activity and can be analyzed within the general model outlined above but the particular point that will be stressed in this paper is that utility (or benefits) derived from corrupt behavior depends on institutions devised to discourage it. So, the study of the symmetric "tragedies" of the commons and the anti-commons which stresses the link between the allocation of property rights and the efficient utilization of resources

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[1] See James M. Buchanam and Yong J. Yoon (2000)

[2] Andrei Schleifer and Robert Vischny (1993) define corruption as the use of public property to get private benefits. This definition excludes corruption among private agents as is presented for example in Federico Weinschelbaum (1998).

[3] See Alberto Ades and Rafael Di Tella (1997) for a survey.

[4] Becker (1993), pp. 389-390.

[5] Expected utility depends on institutions but utility derived from criminal activity does not since the former does depend on the probability of crime success which is a function of the level of deterrence while the latter does not. See Javier Estrada (1994).

appears as a useful scheme to analyze the effects of corruption on the efficiency of resources allocation and to suggest institutional policies to discourage it.

Perfect property rights concede one and only one agent the right to use and the right to exclude other agents from the use of a valuable resource. Imperfect property rights that concede multiple agents the right to use a resource result in a "tragedy of the commons" while imperfect property rights that concede multiple agents the right to exclude others from the use of a resource result in a "tragedy of the anti-commons". Both "tragedies" imply an inefficient utilization of a valuable resource: the "tragedy of the commons" results in an over-utilization of the resource while the "tragedy of the anti-commons" results in an under-utilization of the valuable resource.

The framework to analyze the "tragedy of the commons" was suggested by Garret Hardin (1968) and it will be used here to study first the case of perfect property rights endowed upon one agent and then the cases of no agent endowed with exclusion rights and multiple agents endowed with exclusion rights.

Let us think about a field used to feed cows. Cows produce milk and cows` average productivity, measured as a flow of liters per unit of time, declines as the number of cows fed in the field increases. One agent is the sole owner of the field (he is endowed with perfect property rights) and must decide how many cows to feed there. His target is to maximize benefits measured in total liters of milk per unit of time (or in money for a constant price of milk). To get maximum benefits marginal revenues and marginal costs must be equated and, if it is assumed that there are no costs associated with the feeding of cows, the optimum number of cows to be fed in the field is the one that makes marginal revenue equal to zero. It is the monopoly solution with no production costs. The function linking cows` average productivity with the number of cows fed in the field plays the rôle of a demand curve. For the simple case of a linear average productivity function $p = a - bx$ with *p* measuring average productivity, *x* the number of cows and *a* and *b* positive constants, the optimum solution is $x^* = \frac{1}{2}\frac{a}{b}$ and $x^c = \frac{a}{b}$ is the competitive solution which is equal to the saturation number of cows. These solutions are shown in Figure 1. It must be pointed out that x^* is the efficient solution: the number of cows that maximizes social revenue.

To illustrate "the tragedy of the commons", let us assume that there are two agents and no one has exclusion rights. It implies that both of them may use the feeding field. The field is now a common property (a "common"). Each agent must decide how many cows to feed there in order to maximize his own benefit. Nothing has changed but the way property rights are defined. The analogy is now with Cournot`s duopoly (again, without production costs or strictly Cournot). Each agent gets maximum benefits carrying $\frac{1}{3}\frac{a}{b}$ cows (the Cournot-Nash solution). There will be $\hat{x} = \frac{2}{3}\frac{a}{b}$ cows fed in the field as is also shown in Figure 1. An immediate generalization suggests that when the field is used as a true "common" (as in the Middle Ages) and there are *n* agents the number of cows fed will be $\frac{n}{n+1}\frac{a}{b}$ that tends to $x^c = \frac{a}{b}$ as *n* tends to infinity. In this case the wealth society draws from the use of the field is dissipated. The "tragedy of the commons" is the overuse of the valuable resource.

A symmetric case appears under the label "tragedy of the anti-commons".[6]

The same technological conditions assumed to present the "tragedy of the commons" apply in this case but multiple agents are endowed with the right too exclude others from the use of the valuable resource. Each agent must set the price each cow should paid to him to

[6] The name is due to Michael Heller (1998) who also applied it to patent analysis in Michael Heller and Rebecca Eisenberg (1998).

enter the feeding field. In order to enter the field, a cow must pay the sum of the prices set by each agent. Let us assume there are two excluding agents. One of them sells a red ticket and the other a blue one. To enter the field a cow (the owner of a cow) must buy both tickets so the price to introduce a cow into the field is p: the sum of the price of a red ticket p_1 plus the price of a blue ticket p_2. The reserve price the owner of a cow is willing to pay to enter the field is its average productivity and so $p = a - bx$ in Figure 1 is now a demand curve showing the reserve price as a function of the total number of cows being fed in the field. Each excluding agent sets his price p_1 or p_2 to maximize his own revenue (remember that costs are assumed to be zero). Again, the analogy is with Cournot`s duopoly but, in a symmetric way to the "commons" analysis, the control variable is not quantity but price: one agent chooses p_1, the other p_2 and so $p = p_1 + p_2$ is set. Once p is known $x = \frac{a}{b} - \frac{1}{b}p$ determines the number of cows fed in the field. The price $p^0 = a$ is the symmetric value of quantity $x^c = \frac{a}{b}$. The Cournot-Nash solution is $p_1 = p_2 = \frac{1}{3}a$ and so $p = \frac{2}{3}a$ which implies that $\bar{x} = \frac{1}{3}\frac{a}{b}$ is the number of cows fed in the field. When there are n excluding agents the price to be paid is $\frac{n}{n+1}a$ and the number of cows fed in the field is $\frac{1}{n+1}\frac{a}{b}$. When n tends to infinity then the price tends to a and the number of cows tends to zero. No wealth is drawn by society from the use of the field (in fact the field is not used at all). The "tragedy of the anti-commons" is the under-utilization of the valuable resource.

II

A corrupt agent uses a third party's resource for his own advantage or benefit. To do so the corrupt agent supplies a good which is not his although he has exclusion rights on such a good. Those exclusion rights were given to him by delegation by the owner of the good. Examples of goods supplied by potentially corrupt agents are passports, driving licenses, important export licenses, licenses to exploit oil fields, access to industrial promotion regimes, rights to sell inputs to a firm, manufacturing franchises for a good and so on.

There is a demand curve for the good supplied by the potentially corrupt agent. The simplest case is that in which the demand curve is linear as in Figure 1. The demand curve $p = a - bx$ shows the reserve prices consumers are willing to pay to the corrupt agent who supplies each unit of the good. The analysis of the symmetric "tragedies" of the commons and the anti-commons can be applied to this case. Since marginal cost is zero, the social efficient quantity to be supplied is $x^c = \frac{a}{b}$. Price and marginal cost are equal for this quantity: x^c is the efficient Pareto solution and this is also the "tragedy of the commons" solution with a number of agents that tends to infinity. Quantity x^c is the supply society will choose and the good will be a free good as it should be the case for the examples of passports, driving licenses, import and export licenses, licenses to exploit oil fields, access to industrial promotion regimes, rights to sell inputs to a firm, manufacturing franchises for a good and so on. But, if there is just one corrupt agent with exclusion rights, he will only supply $x^* = \frac{1}{2}\frac{a}{b}$ to get a bribe equal to $\frac{1}{2}a$ as is shown in Figure 1. Corruption implies that the good is under-supplied or the valuable resource under-utilized. The result is even worst if there are n corrupt agents endowed with exclusion rights. The case is easy to understand thinking about the different conditions required to get a driving license: a physical exam must be passed, then a psychological exam must be passed, then a theoretical exam must be passed, then a driving exam must be passed, then … Each requirement is administered by a different agent. Each one of them has exclusion rights: all requisites must be fulfilled to get the good. Each corrupt agent is able to charge a bribe: a red ticket and a blue ticket and … must be paid to get the good. It is the "tragedy of the anti-commons" case. If there are *n* corrupt agents and each of them charges an independent bribe, the price for each requisite will be $\frac{1}{n+1}a$ and the price for each unit of the good supplied is $\frac{n}{n+1}a$ with $\frac{1}{n+1}\frac{a}{b}$ units supplied. Price goes up as the number of requisites grows. In the limit, when *n* (the number of requisites administered by different corrupt agents) tends to infinity the good is not supplied.

The structure of the analyses presented follows Cournot`s oligopoly study. Equilibrium solutions for both "tragedies" –commons and anti-commons- are Cournot-Nash solutions and both problems can be worked out as *n* persons games as it is done in the Appendix. Although it is important to point-out that the Pareto efficiency characteristics of solutions is totally different when the analysis is applied to study oligopoly behavior and when it is used to examine the symmetric "tragedies" of the commons and the anti-commons. In the case of an oligopolistic market the efficient solution is reached with a large number of suppliers (*n* should tend to infinity) so that competition maximizes consumers` surplus and monopoly rents are reduced to zero. In the "tragedies" analysis the efficient use of a valuable resource implies that rents derived from it should be maximized and competition among agents endowed only with rights to use in the "commons" case and exclusion rights in the "anti-commons" case dissipates rents with no redistribution to consumers. When the "tragedies" analysis is applied to the study of corruption the efficiency characteristics of solutions come back to the oligopoly case with a Pareto efficient solution for a large number of users (*n* tends to infinity) and no exclusion rights (the "commons" solution) and dissipation of rents with no production (the "anti-commons" solution) for a large number of excluders (*n* tends to infinity) and no user. In the "commons" case consumers` surplus is maximized and no corruption bribes are charged; in the "anti-commons" case, corrupt agents capture a part of consumers` surplus through bribes and, in the limit, make surplus zero.

III

Three main conclusions about the effects of corruption on the allocation of resources can be drawn from the analysis performed. The first conclusion is about corruption punishment. The second conclusion is about organized crime or "maffia" behavior. The third conclusion is about institutions devised to avoid corruption.

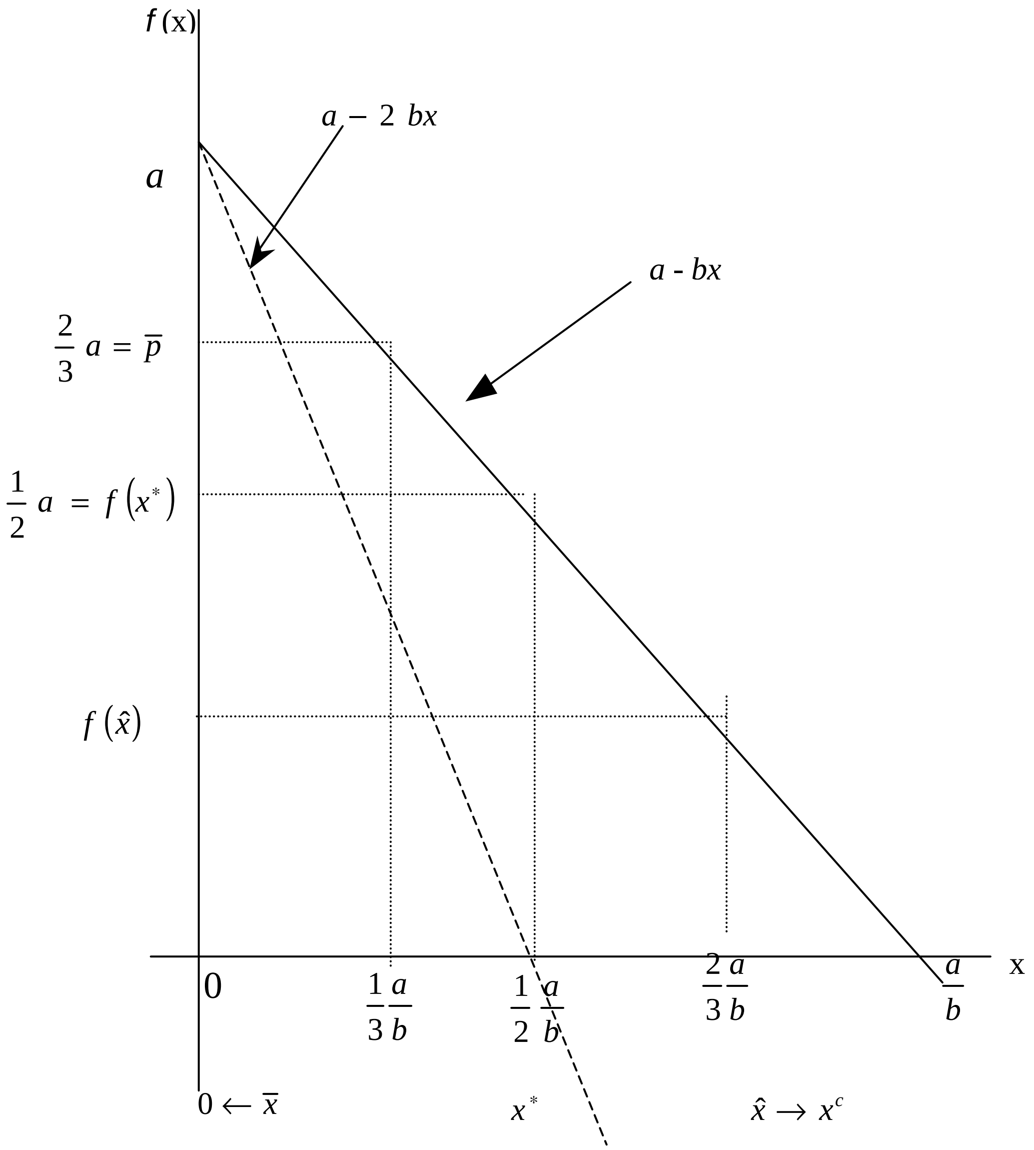
The traditional economic analysis of crime points out that expected punishment is the price (or cost) of criminal activity. So, increased punishment should reduce criminal activity through increasing costs. But the analysis presented in section II shows that to increase punishment implies to increase the marginal cost for each corrupt agent so that this is no longer zero but positive. Efficient allocation of resources still requires to equate demand to zero because marginal production costs are null. Each corrupt agent trying to maximize benefits will set a higher bribe than the one he set when expected punishment implied a zero marginal cost and quantity supplied (the use of the valuable resource for society) will depart even more than before from the Pareto efficient solution. The only exception to this result follows when expected cost is higher than the maximum reserve price society is willing to pay. In this improbable case corruption is discouraged. This is an improbable case because expected cost of punishment is the product of a probability with a very low value for this kind of crime, multiplied by a fine which cannot be extremely high in order to be credible.

The analysis of the "tragedy of the anti-commons" presented in section II showed that as the number of corrupt agents increases the use of the valuable resource decreases departing more and more from the Pareto-efficient solution. This implies that when the number of corrupt agents is one the departure from the efficient solution is minimum. Many different corrupt agents behaving under a collusion agreement (a “maffia” agreement) will produce a better use of the valuable resource for society than the one resulting from each one acting as an isolate decision-making unit.

The analysis presented in section II shows that when there are multiple exclusion rights the effects of corruption on the allocation of a valuable resource may be avoided turning a “tragedy of the anti-commons” solution into a “tragedy of the commons” solution. Society should build institutions to achieve this objective. Institutions that favor competition among potentially corrupt agents work in the right direction: it is clear that many agents endowed with the power of supplying the same good will end up using the valuable resource up to the point in which marginal cost is equal to demand. It should be stressed that this is a case in which many agents can supply the same good and each one of them “sells” the whole set of requirements needed to get each unit of the good as opposed to the case of multiple agents with exclusion rights on the same unit of the good.

To sum-up: first, punishment of corruption may result in a worst allocation of a valuable resource than no punishment at all; second, organized crime produces a better allocation than disorganized crime and third, competition among potentially corrupt agents avoids the effect of corruption on the allocation of resources.

Figure 1



$f(x)$
$a - 2bx$
a
a - bx
$\frac{2}{3}a = \overline{p}$
$\frac{1}{2}a = f(x^*)$
$f(\hat{x})$
x
0
$\frac{1}{3}\frac{a}{b}$
$\frac{1}{2}\frac{a}{b}$
$\frac{2}{3}\frac{a}{b}$
$\frac{a}{b}$
$0 \leftarrow \overline{x}$
x^*
$\hat{x} \rightarrow x^c$

Appendix

In this appendix a proof is provided to show that with no exclusion rights and agents responding only to private incentives a valuable resource is over-utilized while multiple exclusion rights results in under-utilization of the same resource.

Consider *n* agents, each of them supplies units of a good so that the total number of units offered is

$$x = x_1 + ... + x_n \tag{1}$$

where x_i is the quantity supplied by agent *i.* Production costs are zero. The benefit of supplying a unit when *x* units are supplied is

$$p = p(x) \tag{2}$$

Function (2) is such that

$$p_{\max} = p(x) \rangle 0 \text{ for } x \langle x_{\max} \text{ but } p(x) = 0 \text{ for } x \geq x_{\max} \tag{3}$$

and

$$\text{for } x \langle x_{\max}, \quad p'(x) \langle 0 \text{ and } p''(x) \langle 0 \tag{4}$$

When there are no exclusion rights agents simultaneously choose how many units to supply. Assume the good is continuously divisible. A strategy for agent *i* is the choice of x_i. Assuming that the strategy space is $[0, \infty)$ which covers all the choices that could possibly be of interest to the agent, the pay off (benefit) to agent *i* from supplying *x* units when the quantities supplied by the other agents are $(x_1, ..., x_{i-1}, x_{i+1}, ..., x_n)$ is

$$R_i = p(x_1, ..., x_{i-1}, x_{i+1}, ..., x_n)\, x_i \tag{5}$$

Thus, if $(x_1^c, ..., x_n^c)$ is to be a Nash equilibrium then x_i^c must maximize (5) given that the other agents choose $(x_1^c, ..., x_{i-1}^c, x_{i+1}^c, ..., x_n^c)$. The first-order condition for this optimization problem is

$$p(x_i + x_1^c + ... + x_{i-1}^c + x_{i+1}^c + ... + x_n^c) + x_i\, p'(x_i + x_1^c + ... + x_{i-1}^c + x_{i+1}^c + ... + x_n^c) = 0 \tag{6}$$

Substituting x_i^c into (6), summing over all *n* agents' first-order conditions and then dividing by *n* yields

$$p(x^c) + \frac{1}{n} x^c\, p'(x^c) = 0 \tag{7}$$

where $x^c = x_1^c + ... + x_n^c$ which implies $x^c = \frac{n}{n+1} \frac{a}{b}$ for the linear case presented in the main text.

The "maffia" solution x^* solves

$$\max_{0 \leq x \leq \infty} R = p(x)x \tag{8}$$

and the first-order condition is

$$p(x^*) + x^*\, p'(x^*) = 0 \tag{9}$$

which implies $x^* = \frac{1}{2} \frac{a}{b}$ for the linear case presented in the main text.

When there are multiple exclusion rights and *n* agents they simultaneously choose p_i to maximize

$$R_i' = p_i\; x(p_1, .., p_{i-1}, p_{i+1}, .., p_n) \tag{10}$$

Thus, if $(p_1^e, .., p_n^e)$ is to be a Nash equilibrium then p_i^e must maximize (10) given that the other agents choose $(p_1^e, .., p_{i-1}^e, p_{i+1}^e, ..., p_n^e)$. Getting the first-order condition for this problem, summing over all *n* agents` first-order conditions and then dividing by *n* yields

$$x\left(p^e\right)+\frac{1}{n}\ p^e\ x`\left(p^e\right)=0 \tag{11}$$

where $p^e = p_1^e + ... + p_n^e$ which implies $p^e = \dfrac{n}{n+1}a$ for the linear case presented in the main text.

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