On the Social Efficiency of Conflict*

by

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Abstract

We present a model where agents can obtain exclusive control rights over a common resource through an exclusion contest. The alternative is shared control entailing inefficient exploitation. If the agents engage in confrontation, they invest resources in order to win the conflict at the cost of the foregone production possibilities and the risk of exclusion. We show that if the over-exploitation associated with open access is severe enough and conflict is not too fierce, agents have incentives to engage in conflict and that the resulting allocation Pareto dominates free access.

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1 Introduction

Traditionally, economists have embraced the idea that the creation of new property rights responds "to the desires of the interacting persons for adjusting to new benefit-cost possibilities"[1]. This is to say that the emergence of property is the outcome of some sort of group consensus since the new rights can make everybody better off. However, this view ignores what history tells us, namely that property rights were often the fruit of a (sometimes brutal) exercise of force; and that losers were not compensated.

Indeed, the creation through coercion of property rights over resources previously of open access has been an endemic cause of conflict. An early example is the development in England of private rights to land, traditionally of common property: A rise in the price of wool increased the value of land for sheep farming uses. This triggered the political initiative of upper classes aimed at establishing private ownership by excluding serfs[2]. In the 18th century, the Acts of Enclosure finally achieved the full emergence of the new legal system.

A more recent example of this phenomenon are the events in Mauritania in 1989 where the Moor elite of the country, anticipating the increase in land values due to the construction of a dam in the Senegal River, modified the legislation governing land ownership. This effectively abrogated the rights of the black Africans to continue

[1] Demsetz (1967), p. 350.

[2] "Where enclosure involved significant redistribution of wealth it led to widespread rioting and even open rebellion" (North and Thomas, 1973.)

their economic activities on that area. After the subsequent explosion of violence in response, the black Mauritanians who lived alongside the river were expelled from the country and their properties seized[3].

This historical evidence points to an obvious but neglected fact: Property rights given by law or custom are not always the fruit of a societal endeavor gently adjusted through "legal and moral experiments".[4] Instead, ownership systems were many times created and altered by means of the conscious coercive effort of agents, who spent their time and resources in appropriation. The achievement of sufficiently strong control rights by these means was the main step to the recognition of the "legal" forms we observe today. This process did not -by definition- benefit all participants.

The aim of this paper is to analyze the creation of property rights by coercive means. It explores a very simple general-equilibrium model where agents depend on the output they can generate from a resource. Examples include minerals, a fishery, or a pasture. Agents are able to foresee that free access will yield over-exploitation, i.e. the "tragedy of the commons", and low individual payoffs. So they have the possibility to engage in an *exclusion contest* whose winner is granted total control over the resource by excluding the losers. Hence, effective property rights are created and obtained through confrontation[5].

[3]For many other examples of "resource capture" type conflicts worlwide (in the Jordan and Nile River basins, China, Philippines or Indonesia) see Homer-Dixon (1994).

[4]Demsetz (1967), p. 350.

[5]Conflict or confrontation do not necessarily imply violent behavior. "Lobbying" or "influencing" are also resource-consuming means to attain control rights: For instance, Britain and Norway

As any type of conflict, the exclusion contest is probabilistic. Agents can affect its outcome by investing part of their initial endowments into effort. The cost of these coercive activities are both the foregone production possibilities and the risk of being excluded.

So if agents choose to contest open access, they have to decide the share of their endowments they will invest in the contest and the amount they will devote to production if control of the resource were to be attained. It turns out that this game has a unique interior Nash Equilibrium (Proposition 2).

The alternative to confrontation is the open and peaceful access to the resource. By settling, the agents agree on not fighting each other, so they get secure but shared control.

We show that, if the over-exploitation associated with the free access regime is severe and the returns to scale of conflict effort small enough, agents will contest open access in order to get exclusive property rights. Moreover, and in sharp contrast with the existing literature, this conflict has a welfare enhancing effect making *coercive exclusion Pareto dominate open access* (Proposition 3).[6]

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obtained preferential exploitation rights over the oil and gas found in the North Sea because they were able to diplomatically impose the 'smallest distance to the coast' criterion to other contending nations.

[6] Recently, several papers have dealt with the allocation of resources between productive and coercive activities in the absence of well-defined property rights. Relevant contributions include Skaperdas (1992), Hirshleifer (1995) and Grossman and Kim (1995). The first paper assumes that production is carried under common ownership and contested afterwards; whereas in ours, common

2 On Commons and Conflicts

2.1 The Model

Two agents (individuals, social groups or countries[7]) labeled as 1 and 2 possess E units of endowment each that can be transformed into *effort* in an *exclusion contest* (effort henceforth) or in *labor* in the exploitation of a *resource*. We denote these investments by r_i and l_i respectively, where $r_i + l_i \leq E$.

Agents only derive utility from the output they are able to get from that resource. They can obtain monopolistic access to it through the exclusion contest: The winning agent obtains full control and is enabled to exploit the resource by using her labor; the loser is excluded and gets nothing. This contest is probabilistic. Given r_1 and r_2, the *conflict technology* determines each's player probability of winning the contest. We adopt a simple functional form (axiomatized by Skaperdas (1996)) with agent i attaining control with probability

$$p_i = \frac{r_i^m}{r_1^m + r_2^m}, \qquad i = 1, 2,$$

where $m \geq 0$ denotes the returns to scale or *decisiveness* of effort[8].

The alternative to the exclusion contest is a peaceful agreement granting access

ownership arises only when all agents prefer to settle rather than to initiate conflict. The other two papers assume, as we do, that agents fight for the right to produce output *individually;* but they do not consider any alternative to conflict, so peace is never a possibility. But more importantly, all these models render conflict activities as socially wasteful.

[7] In the case of groups one can assume that they behave as unitary agents.

[8] Hirshleifer (1995).

rights to both agents. In that case, control is shared, there is open access and *agents exploit the resource non-cooperatively.* Under this property regime, agents do not internalize the associated negative externalities and the possibility of over-exploitation arises.

Our formalization of the free access problem will follow a simplified version of the canonical model by Cornes and Sandler (1983): The amount of output produced is given by a twice-differentiable production function $f(\cdot)$, and depends only on the total labor input. This function is concave and satisfies $f(0) = 0$ and $f'(0) > 0$. Moreover, it is assumed that $f(\cdot)$ attains a maximum at $L^* < 2E$.[9] Output is distributed in proportion to individual labor contributions.

If agents agree on sharing the control of the resource there is no contest and their initial endowments can be transformed into labor only. Payoffs under free access are thus

$$u_i^F = \frac{l_i}{l_i + l_j} f(l_i + l_j), \qquad i = 1, 2.$$

At the symmetric Nash equilibrium of this non-cooperative game the following result holds true:

Proposition 1 (Cornes and Sandler, 1983) *If two agents have free access to a common resource, labor is oversupplied with respect to the efficient level such that the*

[9] The maximum assumption keeps our model as simple as possible but still equivalent to the one by Cornes and Sandler (1983). These authors use an increasing production function and a unit cost of labor in order to generate a payoff function attaining a maximum; but including such cost in our model would call also for introducing a cost of effort.

Nash Equilibrium total level of labor L^F satisfies

$$f'(L^F) + \frac{f(L^F)}{L^F} = 0, \tag{1}$$

provided that $L^F \leq 2E$.

Efficiency would be attained if $l_1 + l_2 = L^*$, so the marginal productivity and marginal cost of labor are equal, i.e. $f'(l_1 + l_2) = 0$. However, agents under free access do not take into account that they decrease the marginal productivity of the resource when increasing their labor input. This implies that $L^F > L^*$.

For the rest of the paper we will assume that the solution to (1) exists, i.e. $L^F \leq 2E$.

2.2 The Exclusion Game

The alternative to the peaceful (and inefficient) free access is coercive exclusion: Agents engage in confrontation in order to obtain monopolistic access at the risk of getting themselves excluded.

Let us introduce the exclusion contest in our simple version of the commons problem: If either of the agents refuses to settle and share control the two players engage in open conflict and play the *Exclusion Game.* In this non-cooperative game each agent decides the share of her endowments she devotes to effort and labor. Payoffs are

$$u_i^C = p_i f(l_i) = \frac{r_i^m}{r_1^m + r_2^m} f(E - r_i) \qquad i = 1, 2. \tag{2}$$

Players therefore maximize (2) subject to $0 \leq r_i \leq E$.[10] Note that the cost of effort are simply the foregone production possibilities.

Proposition 2 *The Exclusion Game admits a unique Nash Equilibrium characterized by the interior first order conditions*

$$f'(l_i) = (1 - p_i)\frac{m}{E - l_i}f(l_i) \qquad i = 1, 2. \tag{3}$$

Proofs are contained in the Appendix. In contrast with the free access regime, the resource is always underexploited under conflict; both because only one agent finally exploits it and because part of her endowment has been devoted to effort in the contest.[11]

Note that the Exclusion Game induces a 'rat race': An increment in effort by the opponent makes the exclusion of an agent more likely and decreases the opportunity cost of effort. Agents thus oversupply effort instead of labor.

In the next Section we explore the efficiency of incorporating coercion into the creation of property rights over open access resources.

3 The Efficiency of Exclusion

In this section we present the main result of the paper: When conflict is used to create property rights over an open access resource it may have a welfare enhancing effect and Pareto dominate shared ownership.

[10] Since agents do not derive utility from the endowments they do not use it is clear that $l_i = E - r_i$.

[11] Although the former is a sufficient condition.

The intuition for this result is fairly simple. It is clear that, from a social point of view, exclusion is potentially welfare enhancing because it prevents over-exploitation. But, more importantly, there are substantial incentives at the individual level to engage in confrontation since victory in the contest exclusive property rights.

Agents will compare the payoff under free access, derived from expression (1), and the equilibrium payoff in the Exclusion Game, characterized by the symmetric solution to (3). So if one agent prefers to initiate conflict rather than settle both agents will do so since the equilibria of the two games are both symmetric.

But conflict is not always welfare enhancing. If agents' productive capabilities are too low (because their endowments are small) there is no advantage from confrontation: They would be clearly better off by settling and sharing the property of the resource since it will not be heavily over-exploited.

Let us denote by l^F the optimal labor input in the open access case when there is only one agent. It satisfies

$$l^F = \begin{cases} E & \text{if } E < L^* \\ L^* & \text{otherwise.} \end{cases}$$

It is plain to see that if $f(L^F) \geq f(l^F)$ agents are always worse off under conflict. Hence, a necessary condition on the endowments and the production technology for conflict to prevail (and therefore to be welfare enhancing) is that the resource should be heavily over-exploited under free access; or, in short, agents should be "big" enough.

Proposition 3 *Suppose that $f(l^F) > f(L^F)$. Then there exists a threshold M such that conflict Pareto dominates free access if and only if $m \leq M$.*

Even when players are sufficiently "big", the scope for a welfare enhancing conflict is also limited by the intensity of confrontation: If the conflict technology is very decisive (for instance, if the quality of weapons or the tolerance of society towards influence activities is high), agents invest a big share of their endowments in the exclusion contest. Confrontation becomes then so fierce that the resource is left virtually unexploited, agents prefer to settle and free access prevails[12].

In short, when coercion is used to obtain exclusive property rights, only one agent exploits the resource and there is no over-exploitation. Then if the inefficiencies associated with shared ownership are strong enough and conflict is not too resource consuming (the decisiveness parameter is low enough) both agents will want to engage in conflict and therefore the resulting allocation will Pareto dominate free access.

4 Conclusion

Although simple, the model presented in this paper is robust to straightforward modifications. It is true that, with more than two agents, confrontation would be more fierce and the set of conflict technologies giving rise to the exclusion contest would shrink. But at the same time, free access would become less attractive since over-

[12] Our condition on m resembles the condition on this parameter ($m < 1$) obtained by Hirshleifer (1995) in order to ensure the stability of *anarchy,* a situation where agents fight but retain viable shares of output.

exploitation would worsen and the condition needed on the production technology would relax. Similarly, the introduction of a substitute for the open-access good (e.g. leisure) would reduce the amount of conflict expenditures but this would in turn generate more incentives to initiate conflict.

Two final remarks. First, we have obtained conflict in a model with identical agents. On the contrary, historical examples seem to support a strong vs. weak pattern: In England, the upper classes excluded the serfs and in Mauritania the Moor elite did the same with the black Africans. However, prior differences in (ill-defined) "power" are self-explanatory of conflict (and thus meaningless). Our result goes exactly in the opposite direction: It is conflict what establishes differences in power by creating differences in the access to resources.[13]

Finally, our contribution should be interpreted with caution; it must be regarded from a purely positive perspective. We do not advocate that property rights over open access resources should be allocated through confrontation: Though maybe superior to free access, coercive exclusion is still a second best. However, it is necessary to admit that such scenario is likely to arise whenever agents are not able or willing to contract for amicable welfare enhancing arrangements; and that it indeed arose in many historical instances of the "emergence" of new property rights.

[13] In contrast with "purely" economic activities, conflict cannot benefit all participants: The Pareto domination result holds *ex-ante*; *ex-post*, the distribution of output ends up being very unequal since one of the agents is excluded (although the total output produced may still be higher than under free access).

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A Appendix

Proof of Proposition 2. Recall that the first order condition for agent i is

$$m\frac{(1-p_i)p_i}{r_i}f(E-r_i)=p_i f'(E-r_i), \qquad i=1,2.$$

This condition yields a unique best response for any level of effort by the opponent. After some manipulation it is clear that in any equilibrium the choice made by both agents must be identical, i.e. $r_1=r_2$.

Take the function

$$\phi(r)=m\frac{1}{4r}f(E-r)-\frac{1}{2}f'(E-r). \tag{4}$$

It is defined over $[0,E]$. It is clear than the values of r that make $\phi(r)$ equal to zero are the Nash Equilibria of our Exclusion Game. Now we will show that an equilibrium exists indeed and it is unique.

First, one can show that if $\phi(r)\leq 0$ then $\phi(r)$ is strictly decreasing in r: The derivative of $\phi(r)$ with respect to r is:

$$\frac{\partial\phi(r)}{\partial r}=-m^2\frac{1}{4r^2}f(E-r)-m\frac{1}{4r}f'(E-r)+\frac{1}{2}f''(E-r)\leq 0,$$

where the last inequality holds from the fact that when $\phi(r)\leq 0$ it is clear from (4) that $f'(E-r)\geq 0$.

Finally, note that when $r\to 0$, $\phi(r)\to\infty$. On the other hand $\phi(r)\to-\frac{1}{2}f'(0)<0$ when $r\to E$. Since $\phi(r)$ is continuous, the previous result ensures that there exists a unique value for r^* that makes $\phi(r^*)=0$. Such r^* is the unique (and symmetric) Nash Equilibrium of the Exclusion Game. ■

Proof of Proposition 3. First we show the equilibrium level of effort is increasing in m. Take the function

$$\phi_i(r_i, r_j) = m\frac{(1-p_i)p_i}{r_i}f(E-r_i) - p_i f'(E-r_i) = 0, \qquad i = 1, 2. \tag{5}$$

By the Implicit Function Theorem, the best response effort $r_i^*(r_j)$ is increasing in m if and only if $\frac{\partial r_i^*(r_j)}{\partial m} = \frac{-\frac{\partial \phi_i(r_i,r_j)}{\partial m}}{\frac{\partial \phi_i(r_i,r_j)}{\partial r_i}} < 0$, where

$$\begin{aligned}\frac{\partial \phi_i(r_i, r_j)}{\partial r_i} &= m\frac{p_i(1-p_i)[m-1-2mp_1]}{r_i^2}f(E-r_i) \\ &\quad -2m\frac{p_i(1-p_i)}{r_i}f'(E-r_i) + p_i f''(E-r_i),\end{aligned}$$

and it has negative sign because one can use expression (5) to show that

$$-2m^2\frac{(1-p_i)^2 p_i}{r_i^2}f(E-r_i) = -2m\frac{p_i(1-p_i)}{r_i}f'(E-r_i).$$

Finally,

$$-\frac{\partial \phi_i(r_i, r_j)}{\partial m} = -\frac{r_i^{m-1}r_j^m}{R^2}f(E_i - r_i)(1 + mr_i^m[\ln r_j - \ln r_i]).$$

Hence, the equilibrium level of effort must increase with m since there $r_1 = r_2$.

When $m = 0$, the exclusion contest becomes a fair lottery and payoffs are simply $\frac{1}{2}f(l^F)$, that is greater than u_i^F by assumption. As m increases the total labor input of the agent decreases but the winning probabilities are still $p_1 = p_2 = \frac{1}{2}$ by symmetry. Since the production function is continuous and $f(0) = 0$, there must exist a threshold $M > 0$ such that $u_i^F = \frac{1}{2}f(L^F) = \frac{1}{2}f(l_i) = u_i^E$. Below that threshold, the output under conflict is still greater than the output under free access. Since this holds for both agents, the resulting allocation Pareto dominates free access. ■