SYMMETRIC TRAGEDIES: COMMONS AND ANTICOMMONS*

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Abstract

An anticommons problem arises when there exist multiple rights to exclude. In a lengthy law review paper, Michael A. Heller has examined ''The Tragedy of the Anticommons,'' especially in regard to disappointing experiences with efforts to shift from socialist to market institutions in Russia. In an early footnote, Heller suggests that a formal economic model of the anticommons has not been developed. This paper responds to Heller's challenge. We analyze the anticommons problem in which resources are inefficiently underutilized rather than overutilized, as in the familiar commons setting. The two problems are shown to be symmetrical in several respects. We present an algebraic and geometric illustration and extend the discussion to several applications. Of greater importance, we suggest that the construction is helpful in understanding the sources of major value wastage in modern regulatory bureaucracy.

> The navigation of the Danube is of very little use to the different states of Bavaria, Austria, and Hungary, in comparison of what it would be if any of them possessed the whole of its course till it falls into the Black Sea. (Adam Smith, *The Wealth of Nations* (1776), bk. 1, ch. 3)

I. Introduction

In a lengthy law review paper, Michael A. Heller has examined ''The Tragedy of the Anticommons,'' especially in regard to disappointing experiences with efforts to shift from socialist to market institutions in Russia.[1] In an early footnote, Heller suggests that a formal economic model of the anticommons has not been developed.

This paper responds to Heller's challenge. More extensively, we propose to analyze the anticommons problem in comparison with that of the familiar

* Helpful comments were offered by participants in a seminar at the Center for Study of Public Choice, George Mason University, and particularly by our colleague Tyler Cowen.

[1] Michael A. Heller, The Tragedy of the Anticommons: Property in the Transition from Marx to Markets, 111 Harv. L. Rev. 621 (1998).

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commons setting, with, we think, interesting results. The anticommons problem arises when there exist multiple rights to exclude.

We suggest that perhaps Heller has opened up inquiry into a much more important subject area than his relatively limited applications may seem to imply. ''Anticommons'' is a useful metaphor for understanding how and why potential economic value may disappear into the ''black hole'' of resource underutilization, a wastage that may be quantitatively comparable to the overutilization wastage employed in the conventional commons logic.

To begin, we summarize briefly the familiar model of the commons in juxtaposition with the symmetrical logic of the anticommons. We present the analysis through a stylized example along with an algebraic and geometric illustration. We then extend the discussion to several applications, including those introduced by Heller. Of greater importance, perhaps, we suggest that only minor variations from our construction are required to infer sources of major value wastage in modern regulatory bureaucracy.

II. The Tragedy of the Commons: Familiar Territory Reviewed

A resource exists that may be used by the simultaneous application of complementary inputs. The resource becomes productive of value only if these complementary inputs are limited to some level below that which would be emergent under open access to all potential users.

The net value of the commonly used resource is related to the level of complementary inputs applied. If these inputs are separately controlled by choosing-acting agents, persons, or firms, the value potential of the resource in question may, for example, be wasted or dissipated in part or in total, by excessive usage. Examples are familiar: medieval common pasture, fishing grounds, oil pools, aquifers, hunting territories, and locational amenities.[2]

For a century, economists have been ready to offer solutions to the tragedy. The value shortfall emerges because of the absence of effective management of the resource; usage must be limited. One means of management that will insure efficiency is the assignment of ownership rights. Such as-

[2] Since A. C. Pigou's analysis of decreasing returns industry (A. C. Pigou, Wealth and Welfare (1912); and A. C. Pigou, The Economics of Welfare (1920)) and Frank H. Knight's accompanying criticisms (Frank H. Knight, Some Fallacies in the Interpretation of Social Cost, 38 Q. J. Econ. 582 (1924)), these issues have been central to the development of welfare economics. The term ''tragedy of the commons'' was introduced by Garrett Hardin, The Tragedy of the Commons, 162 Science 124 (1968). The specific theory of common property resource management received seminal treatment in H. Scott Gordon, The Economic Theory of a Common Property Resource: The Fishery, 62 J. Pol. Econ. 124 (1954), and in Anthony Scott, The Fishery: The Objectives of Sole Ownership, 63 J. Pol. Econ. 116 (1955). Elinor Ostrom, Governing the Commons: The Evolution of Institutions for Collective Action (1990), examines alternative institutional means through which common property resources have been, in fact, managed.

signment will change the incentive structure. Owners will maximize returns (rents) by restricting usage (through internal or external pricing) to levels that will approximately maximize the value potential.

In a recent paper, we have generalized analysis of the familiar model to allow for differing assignments of usage rights, from single to multiple ownership, and, particularly, to examine collective management under majoritarian decision-making institutions.[3] We did not, however, extend our treatment to include the anticommons setting, the subject matter to be considered below.

Before proceeding, it will be useful to summarize briefly the internal logic of the commons problem. Why does open usage, in total or in part, generate inefficiency? Because the commons or immobile resource is nonpartitionable, in the sense that simultaneous application of separate complementary inputs is possible, every action taken generates an external diseconomy on the value productivity of other input units. With decentralized usage decisions, such external effects will not be fully internalized within the choice calculus of the decision maker. In the limit, if the resource is fully open for usage, all the net value of the resource will be dissipated. Only with full centralization of decision authority within the ''mind'' that is coincident in range with that of potential resource use can full internalization of the potential externalities be guaranteed.

III. The Tragedy of the Anticommons: New Territory to Be Explored

It is necessary to recognize that the familiar tragedy of commons usage, summarized above, emerges because separate persons are assigned rights of usage, the exercise of which creates interdependencies that remain outside the explicit calculus of the choice makers. The whole analysis embodies the presumption that such rights of usage do not extend to rights of exclusion. The peasant may use the open commons as pasture for his sheep; he may not prevent others from doing the same thing.

With an explicit assignment of ownership in the resource, however, under privatization, a person, or agent, is given both usage and exclusion rights. She may exclude others from usage and, at the same time, may directly use the facility or allow others usage upon permission. The conventional commons problem emerges as more than a single person or agent is assigned usage rights. It is interesting that little attention has been given to the setting where more than one person is assigned exclusion rights that

[3] James M. Buchanan & Yong J. Yoon, Majoritarian Management of the Commons (unpublished manuscript, George Mason Univ., Ctr. Study Pub. Choice 1999).

may be simultaneously exercised analogously to the similar exercise of usage rights in the familiar model. As our more detailed analysis will demonstrate, the two sides of the problem are basically symmetrical in several respects.

The anticommons tragedy, as measured in nonrealized economic value, takes the form of underusage rather than overusage of the resource; the size of the opportunity loss will, as in the commons model, depend on the number of persons (or firms) assigned simultaneous rights.

The basic logic is equivalent in the two cases. The inefficiency arises because the separate decision makers, each of whom acts in exercise of assigned rights, impose external diseconomies on others who hold similar rights. In the commons or usage side of the model, persons (or firms) may, by adding a unit of input to the common resource, reduce the productivity of all other inputs and the rents of each person. In the anticommons or exclusion side of the model, persons (or firms) may, by reducing inputs to the common facility (via price), reduce the rents available to others who also exercise potential exclusion rights.[4]

In the limiting case, in which all persons in a large group are assigned rights of exclusion such that each proposed user must secure the permission of all persons, the resource may not be used at all, despite its potential value. This potential will be wasted in idleness in a way comparable with full dissipation wastage under open-access commons usage at the other limit.

IV. A Stylized Example

The analysis is facilitated by the introduction of a simple stylized model that illustrates explicitly the symmetry between the two ''sides'' of the account. Consider a large vacant lot adjacent to a country village. This lot may be used for parking, but its maximal capacity is well below open-access demand. The value of parking in this lot is monotonically and inversely related to the numbers of users. Ample parking is available 1 mile distant.

If access to the closer lot is free, congestion will reduce the value of parking there to equality with the value of parking in the mile-distant location. This solution, of course, describes the classic commons tragedy. The

[4] In either under- or overutilization solutions, there will, of course, exist mutual gain from Coase-like contracts among users and excluders that, if implemented, could generate efficient results. We assume that such contracts between the parties are, for some reason, impracticable. A generalized ''transactions costs'' explanation may be adduced here, but its specific relevance becomes relatively more important in the anticommons setting. Rights of exclusion are associated with ''ownership,'' whereas rights of usage need not be. And the number of excluders tends to be small as opposed to the potential for large numbers of common-resource users.

value of the adjacent lot can be realized only by restricting access, through pricing or other means, which may be institutionally accomplished through assignment of ownership rights or collective management.

Consider, then, the standard reform. The adjacent lot is privatized, and a single owner is assigned usage and exclusion rights. The lot is efficiently used, and the owner maximizes the rental return. Suppose now, however, that, instead of one person (or firm) being assigned usage and exclusion rights, two persons (or firms) are assigned exclusion rights to be exercised simultaneously. Note that exclusion rights must be total in order to have positive value. The assignment of a right to exclude all persons other than a single other designated user will be valueless because the latter could extend usage without restriction. Suppose, then, that two persons (or firms) are assigned total exclusion rights. That is, each ''excluder'' may prevent any potential user from gaining access. To make the example concrete, suppose that A, one of the two, is allowed to issue green permits and that the other person, B, is allowed to issue red permits. Anyone who then wants to park in the adjacent lot must, somehow, secure both a green and a red permit.

Here we clearly are in an anticommons setting, and any solution will involve less than efficient utilization of the commonly shared facility. The wastage of value will be a function of the number of decision-making units that are assigned rights to exclude users—rights that may be simultaneously exercised. As this number increases, the wastage of underutilization increases, and, in the limit, the resource will be completely unused.[5]

V. Geometric-Algebraic Illustration

We can make the example more specific by constructing a geometric-algebraic-numeric example. In Figure 1, the marginal value of parking in the adjacent lot, as a function of the number of cars, is shown by the linear relationship HQ_m, with the corresponding average value as HQ_c. We assume that all potential users are identical. At a zero price, usage is extended to Q_c, with all the value of the resource dissipated. Under single ownership, usage is restricted to Q_m, with rents maximized through pricing usage at P_m. All of the rental value accrues to the owner of the facility (or to the collectivity under efficient management).

If simultaneous usage rights are assigned to more than a single decision maker, usage is extended beyond Q_m, and the location of the Nash equilibrium through independent adjustment by separate users will fall between

[5] The price-theory analogue is the model in which there exist independently acting monopolists who market fully complementary goods (for example, left and right shoes).

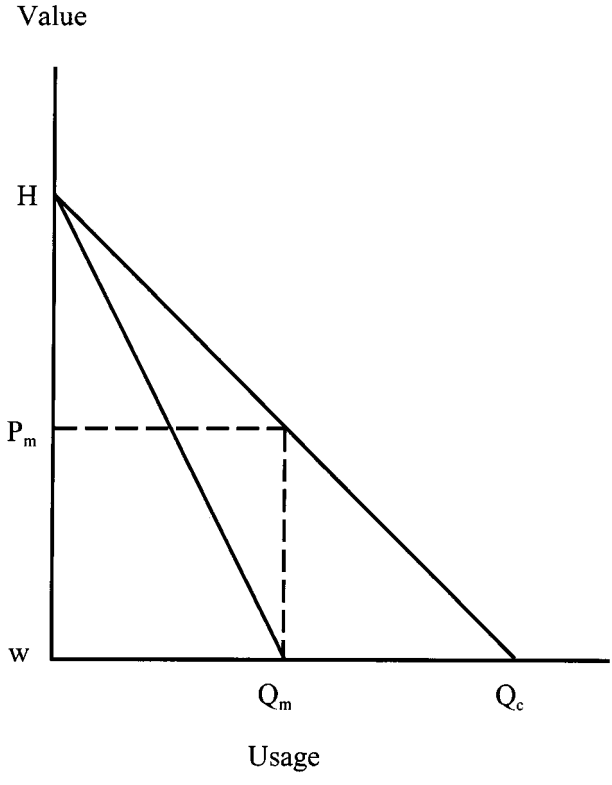

FIGURE 1.—Commons

Q_m and Q_c, depending on the number of users (from one to n). Economists have been almost exclusively interested in these values, which depict varying degrees of resource wastage under the commons rubric.

Our primary emphasis here is on the anticommons side of the construction, that is, on quantities below Q_m and prices above P_m in Figure 1. This range for equilibria emerges when we examine prospects for the assignment of exclusion rights, as contrasted with usage rights.

Consider, now, the independent adjustment process when each one of two decision makers is assigned the right to exclude potential users (cars from the parking lot). What price will A charge for a green ticket when she knows that B is allowed simultaneously to charge users for a red ticket and that users must hold both tickets for entry into the facility?

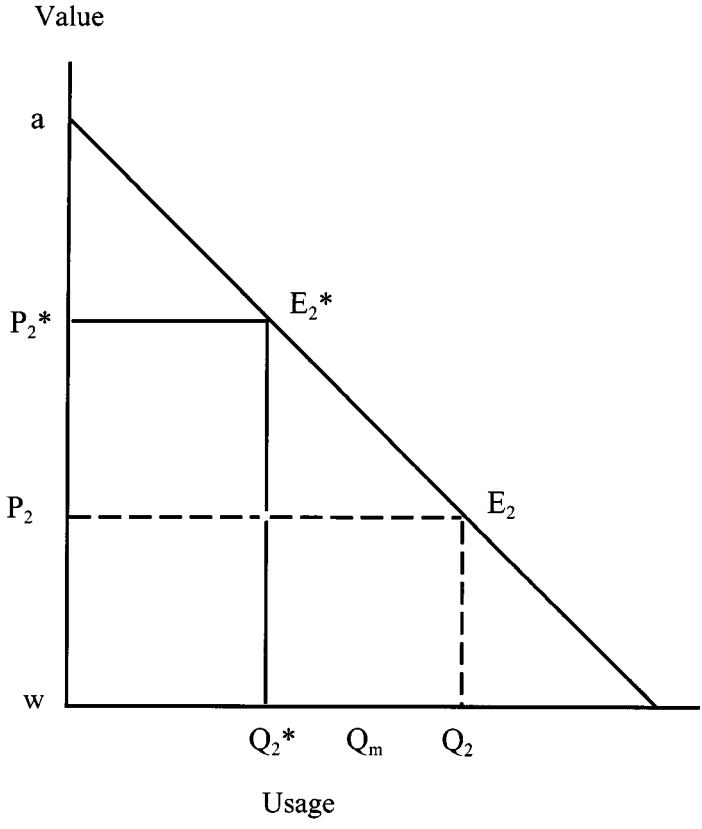

FIGURE 2.—Commons and anticommons

A Nash-type equilibrium will be reached at E_2^* in Figure 2, with each of the two excluders sharing symmetrically in the total rental value, measured by $P_2^* E_2^* Q_2^* w$. The facility will be underutilized, and the total rental value will be less than that which will be realized under single ownership (with concentrated exclusion and usage rights).

What is of special interest here is the precise symmetry between the underutilization equilibrium at E_2^* and the overutilization equilibrium at E_2, the latter attained when two persons (firms) are assigned usage rights but no exclusion rights. The value shortfall from the maximum potential under fully efficient usage is identical in the two cases, and, of course, the symmetry holds for any set of equal (number of) users and excluders over the two whole ranges of adjustment.

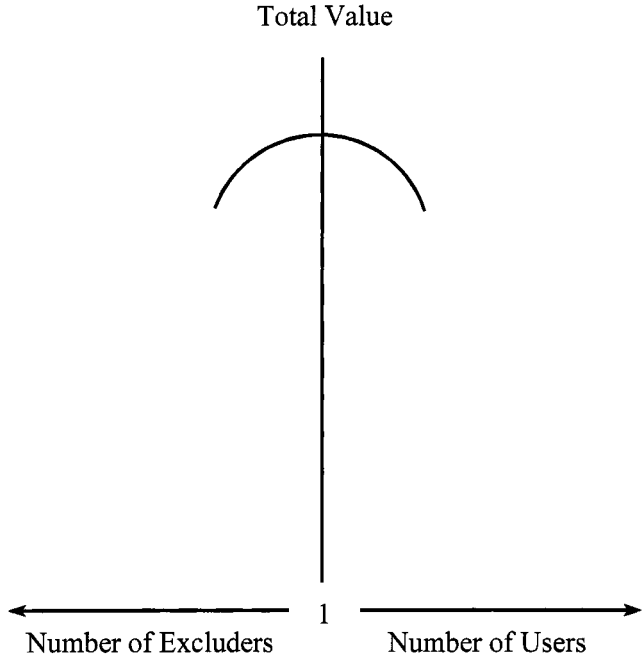

FIGURE 3.—Value symmetry: commons and anticommons

This symmetry is illustrated geometrically in Figure 3, which measures the total value on the ordinate and the number of agents on the abscissa. The two parts of the total value on either side of the peak are symmetrical in shape, as determined for the linear relationship depicted in Figure 1.[6]

We may further specify the example algebraically. When Q measures usage and P measures the average value product, we get the linear relationship

$$P = a - bQ, \tag{1}$$

where a and b are constants.

Consider, first, the two-person case, where A and B are to be assigned either (i) usage rights or (ii) exclusion rights. In either case, explicit collusion will allow for attainment of the efficient solution. We assume, however, that the required mutual trust is absent; hence, joint action is not possible.

[6] The exact symmetry holds only with a linear relationship. When productivity curves are concave upward or downward, the exact symmetrical relationship does not hold.

First consider usage rights. If each person is assigned a right to use the facility but cannot exclude the other from usage, the interaction will converge on an equilibrium that is analogous to Cournot-Nash duopoly. Person A chooses the level of usage (number of cars), Q_1, that will maximize her rent, given person B's choice of usage, Q_2. Potential users are willing to pay the average product determined by equation (1), where $Q = Q_1 + Q_2$. The rent to person A will be

$$\max_{Q_1} PQ_1 = (a - bQ_1 - bQ_2)Q_1, \tag{2}$$

where the first-order condition for the rent maximization gives

$$0 = a - bQ_1 - bQ_2 - bQ_1, \tag{3}$$

and we obtain a stable symmetric solution $Q_1 = Q_2 = (a/b)/3$. The usage by one person, Q_1 (or Q_2), will be one-third of the quantity, Q_0, that defines total dissipation of value. The rent obtained by each person is $R_1 = PQ_1 = (a/3)(a/b)/3 = (a^2/b)/9 = R_2$, and the total rent is $R(2) = (2/9)(a^2/b)$.

For multiple (n) usage, the quantity for each person is $Q_n = Q_0/(n + 1)$, and the total rent is $R(n) = (na^2/b)/(n + 1)^2$, which approaches zero as n increases.

Now consider exclusion rights. If each person is assigned a right to exclude, she can exercise this right by setting the price of her tickets independently from the practice of the other owner. Let P_1 denote the price of a green ticket and P_2 denote the price of a red ticket. Users are required to secure both a green ticket and a red ticket, but a user can get a refund on any ticket if the total price, $P_1 + P_2$, exceeds her reservation price. A user is willing to pay up to the average differential value of the convenient parking lot. Therefore, equation (1) can be interpreted as the demand schedule, where price of usage is $P = P_1 + P_2$. The quantity demanded, Q, will be determined by

$$P_1 + P_2 = a - bQ. \tag{4}$$

A Nash equilibrium can be obtained by formulating a game in which each owner tries to maximize her rent by setting the ticket price. Person A chooses P_1 so as to

$$\max P_1 Q = P_1(a - P_1 - P_2)/b. \tag{5}$$

The first-order condition for maximization is

$$(a - P_1 - P_2)/b - P_1/b = 0,$$

from which we can express P_1 as a function of P_2:

$$P_1(P_2) = a/2 - P_2/2, \tag{6a}$$

and likewise

$$P_2(P_1) = a/2 - P_1/2. \tag{6b}$$

Solving the system of simultaneous equations gives a stable solution,

$$P_1^* = P_2^* = a/3.$$

The price a customer pays is $P^* = P_1^* + P_2^* = 2a/3$, and the total rent is $(P_1^* + P_2^*)Q = (2a/3)(a/b)/3 = (2/9)(a^2/b)$.

For a setting with multiple excluders (n), the price of each separately designated colored ticket, P_n, quantity $Q(n)$, and the total rent, TR(n), are

$$P_n^* = a/(n + 1),$$
$$Q(n) = Q_0/(n + 1) = (a/b)/(n + 1),$$

and

$$\mathrm{TR}(n) = n(a^2/b)/(n + 1)^2.$$

The values of $Q(n)$ and TR(n) approach zero as n becomes larger. The common facility or resource tends toward total abandonment, its potential value being wasted in idleness.

The analysis demonstrates that the equilibrium in either the multiple-users model or the multiple-excluders model is structurally analogous to that familiar in Cournot-Nash duopoly-oligopoly settings of interfirm competition. Note particularly, however, that the efficiency implications are diametrically different as between the commons setting and that of interfirm rivalry. In the latter, optimality is attained when net rents are zero, when firms are forced by competition to allow consumer-buyers to secure all potential surplus. In the commons setting, by contrast, optimality is attained when net rents are maximized. Competition among users, on the one hand, or among excluders, on the other, tends to reduce rents as in the interfirm model, but, instead of reflecting transfers of value to consumer-buyers, such rent reduction represents destruction of value. Fully ''competitive'' equilibrium is in either of the commons models the pessimal rather than the optimal result.[7]

[7] The results here are analogous to those that emerge in the related but different setting that involves the generation of public bads. See James M. Buchanan, A Defense of Organized Crime? in The Economics of Crime and Punishment (Simon Rottenberg ed. 1973).

VI. Applications

Michael Heller introduced the concept of the anticommons to explain his observation of post-1990 developments in Moscow, where many buildings remain empty while numerous kiosks occupy the streets. The buildings remain idle because any potential user must secure the agreement or permission of several agents, each of whom may exercise a right of exclusion.

Heller and Rebecca Eisenberg have also applied the anticommons metaphor to explain possible lags in applying research developments subsequent to the institutional changes in the 1980s that extended patent protection to basic research findings often emerging from academic university laboratories.[8] To the extent that, through exclusive licensing rights, the holders of a patent on a basic research finding seek to exploit the rental value, the follow-on potential developer is inhibited from securing the value that might otherwise have been available. As a result, development is stifled, especially when patent protection is itself designed to offer the basic motivation for investment in research.

James Buchanan recently encountered another clear application of the anticommons tragedy. On a visit to Sardinia, Italy, in early 1999, we were informed that a potential entrepreneur seeks to invest in a combined seaside/hunting-preserve resort. Action is inhibited, however, by the necessity of getting permits from several regional agencies (for example, the tourist board, a hotel-restaurant agency, and the wildlife protection agency), each one of which holds effective exclusion rights to the project that might, if implemented, be productive of value.

Another example that is widely familiar involves the bureaucratic barriers to residential construction. Housing permits require the approval of several separate overlapping agencies, each of which can prevent construction. Neither the motivation of the bureaucratic authorities nor the constraints on their exclusion rights is captured in the simple unidimensional models introduced in the formal analysis. Those who are empowered to issue permits may not seek to maximize rents and, perhaps of greater importance, may be authorized to refuse permits only with cause. In sum, only some elements of the behavior of permit-granting bureaucrats may be described in models that embody ''as if'' ownership. Nonetheless, the partial insight offered by such models can scarcely be questioned.

The inefficiencies introduced by overlapping and intrusive regulatory bureaucracies are, of course, widely recognized. Our claim is only that, used

[8] Michael A. Heller & Rebecca S. Eisenberg, Can Patents Deter Innovation? The Anticommons in Biomedical Research, 280 Science 698 (1998).

as simile, the anticommons construction offers an analytical means of isolating a central feature of sometimes disparate institutional structures.

These examples suggest the pervasiveness of the anticommons setting in many areas of modern economic interaction. The environmental movement, emergent since the 1960s in particular, has had the effect of interposing additional authorities with the right to exclude development of facilities. While these authorities have, without question, prevented some value-reducing development, they have also prevented value-enhancing development. Economists as well as environmentalists have perhaps concentrated too much attention on the commons side of the ledger to the relative neglect of the anticommons side.

The primary thrust of the analysis in this paper is the demonstration of the formal symmetry between the overusage of a resource because of common (multiple) access and the underusage because of multiple exclusion rights. It has seemed useful, for this purpose, to assume that either users or excluders can capture pecuniary gains from their own actions. The applications suggest, however, that either usage or exclusion rights may be assigned to agents who cannot, or may not desire to, capture directly pecuniary gains (for example, the environmental agents whose permission must be secured for a resource development). Allowance for such noneconomic motivation on the part of excluders also suggests that the potential conflict need not be primarily distributional but may also reflect different objectives for facility development. In addition, allowance for noneconomic motivation suggests that the ''natural'' pressures toward efficiency represented by the implementation of agreements, mergers, or contractual arrangements generally among affected parties may be much less effective than the formal analysis seems to imply. The genuine zealot, as either user of or excluder from a potentially valuable resource, may be insensitive to proffered compensations.

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