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Finance Working Paper N° 750/2021
July 2021

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ECGI Working Paper Series in Finance

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Keywords: Property rights, commons, non-exclusivity, externalities, environment, fisheries

JEL Classifications: B31, D62, K11, L51, Q50

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Current version: July 5, 2021

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1. Introduction

Garrett Hardin's "The Tragedy of the Commons" (Hardin, 1968) is a blockbuster article and one of the most influential essays ever published by *Science* magazine. Cited more than 46,000 times (per Google Scholar), it is widely anthologized and taught to students in ecology, political science, environmental studies, and other fields. It forms the basis of many scientists' understanding of the commons problem and has profound impact on governmental policies affecting natural resource management, environmental harms, and climate change.

The problem, however, is that Hardin's narrative of the commons problem contains an important error. Hardin's classic depiction of animal herders overgrazing a communal piece of land accurately *describes* a commons problem. But he mischaracterizes the *cause* of the commons problem as arising from the exercise of free will in a world with limited carrying capacity. In this view, resources are overexploited not because property rights are non-exclusive, but because uncontrolled demand eventually overloads the ecological system. Hardin applies this view to his central concern about human population growth to argue for coercive population control measures. Hardin's screed on population control is now largely ignored. But his Malthusian characterization of the commons problem remains hugely influential. It is not a stretch to connect the long history of command-and-control environmental regulation in the United States, and of current proposals to ameliorate climate change by restructuring economies, to Hardin's argument for coercive policies to constrain demand pressure in a world with fixed carrying capacity.[1]

[1] Command-and-control regulations delineate specific practices to achieve environmental goals. In the fisheries examples noted below, such policies dictate fishing vessel length, the days of the week or times of the day that a vessel can engage in fishing, net length and mesh size, and other details. This is in contrast to regulations that define property rights (e.g., via transferable catch quotas) or impose taxes and subsidies, and that allow individual firms to adjust their production inputs. See Field and Field (2017) or https://en.wikipedia.org/wiki/Command_and_control_regulation.

Hardin's narrative stands in sharp contrast to that of early natural resource and property rights theorists – including H. Scott Gordon (1954), Anthony Scott (1955), Ronald Coase (1960), Armen Alchian (1965), and Harold Demsetz (1964, 1966, 1967) – who more accurately described and analyzed the commons problem in the years *before* Hardin's article was published. This paper reviews the theory of the commons problem by contrasting Hardin's narrative with the development of the property rights literature in the 1950s through the 1970s. I argue that the differences are important and still relevant for both science and public policy.

Whereas Hardin's illustration involves herders grazing a common pastureland, Gordon (1954) and Scott (1955) were concerned with the fishery. Gordon (1954) identifies the root source of the commons problem as open access to the fishery, or non-exclusive use rights. Scott (1955) shows that clear assignment of fishing rights is one solution to the problem. Coase (1960) establishes that inefficient resource allocations, including those that characterize the commons problem, arise from poorly defined private property rights and costly contracting. Alchian (1965) and Demsetz (1964, 1966, 1967) expand these insights into a broad theory of property rights in which non-exclusivity is but one type of restriction on private ownership that increases the cost of externalities and encourages dissipative rent-seeking. Demsetz (1967) also shows that property rights adjust endogenously to ameliorate the costs of non-exclusive use-rights in the commons. For example, private property rights develop when the costs of non-exclusivity exceed the costs of defining, assigning, and enforcing exclusive rights. Demsetz (1967) provides historical examples of such adjustments from Indigenous groups in the Americas the 17th and 18th Centuries. Later researchers apply Demsetz' insights to describe various solutions to commons-type problems in communities around the world.[2]

Sections 2 and 3 below describe Hardin's characterization of the commons problem and the analysis of the problem by early property rights theorists. There is only limited overlap between

[2] See, for examples, Cheung (1970, 1974), Ostrom (1990), Anderson and Hill (2002), Haddock and Kiesling (2002), and Libecap and Smith (2002), or for an overview, Merrill (2002).

these two narratives, and Section 4 shows that the differences are important conceptually and for policy. Hardin's analysis, for example, considers the tragedy of the commons to be the physical exhaustion of the underlying resource, whereas the property rights analysis highlights the loss in value from rent-seeking activity, which can occur even when the underlying resource is not physically depleted and includes the costs of all other affected resources as well. Policies based on Hardin's analysis tend to favor regulatory coercion because he characterizes the problem as the exercise of free will in a world with fixed carrying capacity. Policies based on the property rights approach, in contrast, tend to favor the assignment of rights and market trading because it characterizes the problem as arising from poorly defined ownership rights. The two traditions tend toward different policies because their analyses of the problem are so different.

This paper is not the first to criticize Hardin's (1968) analysis. Section 5 contrasts my argument with previous criticisms, which generally miss the central point that the commons problem is one of non-exclusive use rights. In Section 6, I draw from the property rights literature to show that non-exclusivity – the root cause of the commons problem – is itself a special case of a class of restrictions on private ownership that promote dissipative behavior. Section 7 concludes by discussing reasons for the enduring influence of Hardin's narrative of the commons problem, especially among non-economists, despite its shortcomings and lack of generality compared to the property rights literature.

2. Hardin's analysis of the commons problem

The most striking aspect of Hardin's analysis of the commons problem is that it is first and foremost a Malthusian polemic on the dangers of human population growth and a clarion call for coercive measures of population control.

> "The only way we can preserve and nurture other and more precious freedoms is by relinquishing the freedom to breed, and that very soon… Only so, can we put an end to this aspect of the tragedy of the commons" (Hardin 1968, concluding paragraph, p. 1248).

Hardin's concern about population growth is rooted in a paradigm of the earth's fixed carrying capacity. Carrying capacity refers to "… the average population density or population size of a species below which its numbers tend to increase and above which its numbers tend to decrease because of shortages of resources."[3] Applying this concept to humans, Hardin sees a trade-off between the number of humans the planet can support and the resources available per person.

It is in this context of Malthusian population pressure on a system with limited carrying capacity that Hardin introduces the concept of the commons. The commons that matters to Hardin is the earth itself, and Hardin's main concern is that human beings' unchecked freedom to reproduce will lead to overpopulation and penury. Hardin's illustration of animals overgrazing a common pastureland is but an analogy to his main argument, that the earth is a commons that people will overgraze:

> "The tragedy of the commons develops in this way. Picture a pasture open to all. It is to be expected that each herdsman will try to keep as many cattle as possible on the commons … [T]he rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another … But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit – in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all" (p. 1244).

Hardin's herdsmen problem illustrates his concern about overpopulation because, to him, they are the same problem. He minces no words that the tragedy is borne of unchecked individual freedom and population pressure on a system with fixed carrying capacity. The passage above is in a section titled, "Tragedy of Freedom in a Commons," and the theme that dominates the rest of Hardin's paper is reflected in a subsequent section title: "Freedom to breed is intolerable."

In other words, the world's most influential description of the commons problem is an analogy for a Malthusian nightmare of unchecked human population growth, based on an assertion

[3] https://www.britannica.com/science/carrying-capacity, accessed May 10, 2021.

that the problem is one of individual freedom and fixed carrying capacity. Students of science, for whom Hardin's analysis has been their primarily pathway to the concept of the commons problem, have been laboring with this narrative for more than fifty years.

In this paper I argue that the commons problem is not primarily one of individual freedom, population growth, demand pressure, or carrying capacity. Rather, the commons problem arises when property rights are not exclusive, as demonstrated by Scott (1954), Demsetz (1967), and others. This basic insight yields insight into the nature and cost of the "tragedy" of the commons, and policies to address it.

To be sure, Hardin's concern about demand pressure is one aspect of the commons problem. But in Section 4, I argue that demand pressure that taxes the ecological system is neither necessary nor sufficient to create a commons problem. It also is important to recognize that Hardin gives a nod to private property rights – i.e., rights that are exclusive – as one potential solution to the commons problem, and at one point states, "The tragedy of the commons … [can be] averted by private property, or something formally like it" (p. 1245). In a section on pollution, Hardin also begins promisingly by observing that pollution frequently is an example of the commons problem. But the context of these statements makes clear that Hardin does not have in mind the analysis of the commons problem as developed by in the property rights literature and discussed below in Section 3 of this paper. He quickly circles back to the claim that, "The pollution problem is a consequence of population" (p. 1245) and "… we are locked into a system of 'fouling our own nest' so long as we behave only as independent, rational, free-enterprisers" (p. 1245).[4]

[4] In this essay I focus on Hardin's characterization of the commons problem and, except for Section 4.5, do not engage with his arguments about overpopulation. For an opposing view about population growth, see Simon (1996).

3. The property rights analysis of the commons problem

The commons problem probably has been understood at some level for centuries.[5] In 1954, however, H. Scott Gordon provided a detailed theoretical analysis of open access fisheries that precisely identifies the nature of the problem: "… [T]he natural resource is not private property; hence the rent it may yield is not capable of being appropriated by anyone … The result is a pattern of competition among fishermen which culminates in the dissipation of the rent of the inframarginal grounds" (p. 131). Gordon's model demonstrates the social surplus created by the fishery when property rights to the fishery are exclusive, and contrasts it to the zero surplus generated when rights to the fishery are non-exclusive.

Scott (1955) extends Gordon's model, emphasizing that with open access, "… the tendency will be for exploitation to continue beyond the point where the marginal product of fishing effort equals its marginal cost, to the point where the average product of effort just covers the marginal cost of effort … and average cost is equal to price." As a result, "the dollar value of the catch exactly equals the dollar cost of landing the catch." In Gordon's words, "This is why fishermen are not wealthy, despite the fact that the fishery resources of the sea are the richest … available to man" (p. 132).

This analysis of the commons problem contrasts sharply with Hardin's characterization. In the property rights analysis, a commons problem arises in fishing because nobody has exclusive

[5] De Young (1999) traces recognition of the commons problem to Aristotle. Hardin (1968) cites Lloyd (1833) as an early commenter on the commons problem, although Lloyd and Hardin both view the problem as one of Malthusian population growth. The earliest clear statement of the commons problem that I have found is from a 1919 report by two U.S. government fisheries biologists on overfishing in Alaska: "So long as the public throws this field open to unrestricted competition, and so long as there results keen rivalry for every fish that swims, no individual canner can accomplish anything toward the protection of the streams. Whatever he spares for spawning purposes, his competitors will thankfully accept and place in cans. He is powerless to conserve either the public interest, or even – should he be sufficiently enlightened to see it – his own private interests, by listening to any counsels of moderation. If fishing grounds or fishing rights could be leased or assigned, and property rights acquired which would become valueless should the fishing greatly decline, cooperation with the authorities to preserve the fisheries could confidently be counted on. But so long as the present policy is maintained, and the canners have only what they can seize and can hold with every man's hand against them, there can be but one final outcome. Total exhaustion of the fisheries will occur; if not to-morrow then the day after" (Gilbert and O'Malley, 1919, p. 146).

rights to the fishery or to any individual fish. Ownership is established by the rule of capture, and fishers will expend resources to establish ownership of the fish, which they can do only by getting the fish in their net, on their lines, or in their boats before anyone else does. Put differently, each person has an incentive to expend resources as long as the average return from doing so exceeds the average cost, even though the socially optimal amount of effort is where the marginal cost of fishing effort equals the marginal cost. The result is that the commons – a fishery in this case – yields little net value to society, even though the fish that are caught can be extremely valuable.[6]

An important aspect of Gordon's and Scott's analyses is that non-exclusive use rights undermine any attempt by far-seeing and well-meaning individuals to limit fishery overexploitation. A single fisher can constrain her own effort in an attempt to preserve the resource, but she cannot keep others from entering the fishery. Such self-sacrifice may be noble, but will prove futile. Scott (1955) points out that one solution is to have a single individual or entity own the rights to the fishery, including the right to exclude others from entering the fishery. This solves the commons problem because the right to fish is defined, assigned, and enforceable.

These early characterizations of the commons problem are based on open-access fisheries. Coase (1960), Alchian (1965), Demsetz (1964, 1966, 1967), and Cheung (1970, 1974) generalize the fisheries analyses in a broader theory of property rights. In Section 6, I draw from this work to show that the commons problem is but one manifestation of dissipative rent-seeking that arises when rights to a resource are not exclusive or when the owner is not able to lend or sell these rights, i.e., when private property rights are restricted.

[6] In Gordon's (1954) model, the full value of the fishery is dissipated, as fishers enter the fishery until average revenue equals average cost for all (homogeneous) fishers. Cheung (1974), Anderson and Hill (2002), and others show that, with heterogeneous producers, the amount of dissipation will be less than the full value of the non-exclusively owned resource. It also may be useful to distinguish non-exclusive ownership with the notion of a public good. Non-exclusive means that no person has the explicit or implicit legal right to exclude another person from accessing or using the resource. In contrast, the characteristic of a public good, such as a radio signal or national defense, is that its use is non-excludable and its consumption is non-rivalrous.

4. How the two views differ

The property rights characterization of the commons problem has elements that overlap with Hardin's narrative, as both note that the commons problem requires some demand pressure on the resource. But the similarities are relatively superficial and the distinctions are important. Here are five important ways the two views diverge:

4.1. Population pressure

Hardin's commons problem is driven by population pressure, or what we can view more generally as an increase in demand. This insight overlaps with Demsetz' (1964, 1967) argument that the cost of non-exclusivity depends on demand for the resource, and that with little demand, the cost of non-exclusivity is low. In the property rights formulation, however, increasing population pressure is neither necessary nor sufficient for a commons problem to arise. This can be illustrated with the fishery example. Pressure from many agents is not necessary for the commons problem to arise because competition from as few as two agents can lead to overinvestment in fishing effort and at least partial dissipation of the fishery's value. For example, the two fishers may expend resources to secure the best fishing spot or get their catch to market first. Demand pressure from many agents is also not sufficient to cause the commons problem because, even with large demand, the commons problem is alleviated if exclusive use rights are assigned, i.e., if the fishery is solely owned or catch quota rights are assigned.

4.2. Resource depletion vs. value lost

In Hardin's description of animal herders' pastureland, herders will add animals beyond the pastureland's carrying capacity until the pastureland is overgrazed and ruined. Therein lies the "tragedy" of the commons: "Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons…" (p. 162). In Hardin's view, the commons problem describes how the resource (e.g., the earth) will be denuded and ruined.

Hardin's characterization ignores Gordon's (1954) point that each herder will not add animals ad infinitum, but rather, up to the point that average product equals average cost. This implies a much broader view of the nature of the "tragedy" of the commons, because society suffers a loss even if the resource is not denuded or ruined. The tragedy is the value loss to society of the surplus that the resource otherwise could yield, and it includes the opportunity cost of the resources used to compete for effective ownership. Denudation and physical ruin are possible but, unlike Hardin's narrative, are not necessary for a "tragedy" – i.e., a loss to society – to occur.

The property rights view of the commons problem is therefore more general because it describes a larger class of activities and outcomes related to the commons. To illustrate, note that the commons problem – as more generally understood through the property rights paradigm – could persist even if we were to implement one of Hardin's preferred solutions by restricting the number of animals on the pastureland. The pastureland itself might be saved, but if the rights to use it are non-exclusive, herders will still expend resources to capture its value, thus dissipating some of its value and lowering its net surplus to society. For example, herders could expend resources to get their animals to the choicest parts of the pastureland first. Or they might have their animals linger longer than necessary because there is no private cost from doing so. Put another way, Hardin's solution could prevent his narrow view of the tragedy. But it would still promote dissipative activities and the loss of value – which is the focus of Gordon (1954), Demsetz (1967), and others.

This difference between Hardin (1968) and the property rights view has had large policy consequences. As a notable example, advocates of a 200-mile exclusive economic zone, established by the United States in 1976, argued that U.S. fish stocks would be preserved because the 200-mile limit would decrease fishing pressure from foreign fishing fleets in U.S. waters (see United States Office of Technology Assessment, 1977). This prediction reflects Hardin's narrative that the commons problem arises from harvesting pressure on the resource. The prediction, however, turned out to be wrong because most fisheries still had open-access with non-exclusive use rights among U.S. fishers. When overfishing continued to be a problem, policymakers who knew Hardin (1968),

but not Gordon (1954) and Demsetz (1967), expressed puzzlement that the 200-mile limit had not solved the overfishing problem (e.g., see McHugh, 1990; Pontecorvo and Schrank, 2006).

4.3. Maximum sustainable yield vs. maximum value

Hardin's focus on only the production side of the commons problem is consistent with, and most likely has contributed to, an inefficient approach to the management of many publicly owned resources, including many fisheries. It is common for fishery managers to impose rules that keep fish stocks healthy and perhaps even achieve a "maximum sustainable yield" (MSY). As Gordon (1954) points out, however, such a focus ignores the cost of fishing effort. If fishers expend more incremental resources than the additional fish are worth, a management regime that focuses only on the size of the fish stock dissipates some of the fishery's value compared to a regime that seeks to create value. Field and Field (2017) point out that the value-maximizing fish harvest typically is less than the maximum sustainable yield.

This distinction has widespread implications for public policy. For example, entry limitations in fisheries are widely viewed as a *biological* success because they make it easier for fishery managers to implement gear and season closure regulations to preserve the fish stock (Morehouse and Rogers, 1980). Property rights theorists, however, point out that entry limitations do not prevent dissipative competition for rights to individual fish among the licensed fishers, and that some of the *value* of the fishery is preserved only if the effort per entrant is not a perfect substitute for the number of entrants (see Cheung 1970; Karpoff 1987). Fortunately, the evidence shows that such substitution is not perfect, at least in some fisheries; while entry limitations have dissipated some value compared to individual fishing quota rights, they preserve some of the fishery's value (Karpoff 1985).

4.4. Restricting action

For Hardin, the key to resolving the commons problem is to restrict free action. Indeed, much of his article is a plea to recast the notion of "coercion" in a way that makes his policy proposals seem less odious. "Freedom to breed is intolerable," reads one of Hardin's section headings, followed by, "To couple the concept of freedom to breed with the belief that everyone born has an equal right to the commons is to lock the world into a tragic course of action" (p. 1246). Such freedom is what allows humans to keep adding pressure on the earth's carrying capacity, just as it allows herders to add additional animals to the pastureland. Only by constraining such freedom, says Hardin, can we avoid the tragedy.

Hardin acknowledges that there are many ways to restrict action, including taxes and regulations (and briefly, as noted above, the private assignment of use rights). But his central focus is on controlling specific behaviors using the levers of government. Scott (1955) and Demsetz (1967), in contrast, emphasize that the key to resolving the commons problem is to eliminate, where it is cost effective to do so, the non-exclusivity of use-rights. This frequently also requires collective or government action, but once the rights to the resource are made exclusive, there is little need for continued regulation of specific activities. Indeed, with exclusive use rights, Adam Smith's insight about the Invisible Hand again applies, such that freedom of action is not a problem, but rather, facilitates the efficient allocation of resources.

Once again, these different views about how to ameliorate the commons problem have large effects on public policy. Traditional command-and-control fishery regulations, for example, follow Hardin's lead by imposing specific restrictions on the type of gear that fishers can use and the times they can fish (e.g., see Johnson and Libecap, 1982; Karpoff 1987). Regulations based on the property rights literature, in contrast, emphasize the allocation of fishing rights rather than specific controls over gear type and fishing activity (see, e.g., Environmental Defense Fund, 2019). These differences also are central to the debate over competing policies to limit carbon emissions (e.g., Roberts 2019).

4.5. The endogeneity of property rights

By focusing on freedom of action and demand pressure as the source of the commons problem, Hardin's analysis completely misses Demsetz' (1967) key insight, which is that property rights are themselves endogenous. Communities therefore tend to assign and enforce private rights when the cost of doing so is less than the cost of the commons problem. This insight, which is a direct implication of Coase's (1960) analysis, has prompted research into the many and varied solutions to commons problems around the world (e.g., Cheung 1974; Ostrom 1990; Anderson and Hill 2002). In short, Hardin's analysis falls short because the nature of property rights changes in response to changes in demand pressures, new discoveries, and transaction costs.

Demsetz' insight even provides a new perspective on Hardin's main concern about human population growth.[7] Suppose that population growth increases the demand for the world's resources, increasing their values and increasing the cost of communal ownership of these resources. This increases the incentive to define and enforce private rights, thereby increasing the incentives to use the resources efficiently. Changing prices of privately owned resources reflect marginal valuations across all users and affect all decisions, including the decision to have children. That is, both property rights and human reproduction are endogenous to the benefits and opportunity costs of resource use. Even Hardin's global commons turns out to be not so static as he assumes.

5. Previous criticisms of "The Tragedy of the Commons"

As a prominent paper, Hardin (1968) has attracted much criticism. Tierney (2009), for example, points out that Hardin (1968) misapplied the analogy of a common pastureland to human population growth because, essentially, grazing animals are property and people are not: "Parents

[7] I thank Terry Anderson for this insight.

are not like the cattle owners who profit individually by adding cows to the pasture … Parents, unlike the cattle owners, have to pay to feed and house and educate their children…" As far as I know, however, this is the first paper to criticize Hardin's fundamental characterization of the commons problem. Even many of Hardin's critics seem to accept his Malthusian narrative that the problem arises from free will in a world with fixed carrying capacity.

Perhaps the most frequent criticism is that Hardin presents the "tragedy of the commons" as inexorable and inescapable. Critics claim that, to the contrary, many solutions implemented all over the world ameliorate or eliminate the problem of the commons.[8]

The argument that the commons problem is not inevitable is important and well taken. This is, however, only a mild criticism of Hardin's thesis. To be sure, Hardin uses language that at times suggests the process is inevitable.[9] But this is primarily to emphasize his view that unchecked population growth is a serious problem. Hardin's paper is a call for a "fundamental extension in morality" (albeit, to justify coercive population control policies) by which Hardin hopes his tragedy will be averted. By arguing for policies to avoid the problem, it is clear that Hardin himself did not view the tragedy as inevitable.

A second popular criticism of Hardin's paper is that it has been used to justify private ownership and free market contracting as a solution to the commons problem, and that this is a bad thing (e.g., de Villiers 2012). There are at least two problems with this argument. First, and as noted above, Hardin does mention private ownership as one solution to a subset of commons problems. But it is difficult to extract an inference that Hardin makes a case for private property rights. To the

[8] For examples, see Feeny et al. (1990), Ostrom (1999), and Feeny et al. (1996). It is worth noting again that Demsetz (1964, 1966, 1967) first proposed that property rights are themselves endogenous and that communities assign and enforce private rights when the cost of doing so is less than the cost of the commons problem. Along these lines, Berkes (1985) documents the sometimes complex assignments of use-rights in many fisheries managed by indigenous peoples, and Cox (1985) shows that medieval pasturelands were managed through community-sanctioned use-rights. Johnsen (2009) shows that Pacific Northwest tribes enforced exclusive use rights to fisheries through reciprocity arrangements.

[9] Hardin quotes Whitehead (1948) to explain his use of the word "tragedy" – it reflects "… the solemnity of the remorseless working of things" and the "inevitableness of destiny…" – language that implies inevitability.

contrary, Hardin takes a strong stance against freedom of action and is strongly critical of market solutions to the commons problem. Hardin even blames the commons problem on widespread acceptance of Adam Smith's notion of an Invisible Hand (see Hardin 1968, p. 1244), and MacLellan (2016) correctly points out that Hardin's thesis is that markets are incompatible with environmental protection. Also, Hardin's main policy proposal is the antithesis of market-based solutions to the commons problem, as he advocates coercion to avoid commons-type problems, especially regarding his main concern about human population.

The second problem with this criticism of Hardin is that private ownership and free market contracting frequently do offer superior solutions to the commons problem. As examples, Gordon's (1954) and Scott's (1955) papers laid the intellectual groundwork for the adoption of transferable fish quotas in the Pacific halibut fishery and tradeable sulphur dioxide emissions rights as part of the 1990 Clean Air Act Amendments, both policies that have generated substantial gains relative to open access or traditional command-and-control policies (e.g., see Stavins et al., 2012). As Ostrom (1990) and Anderson and Leal (1991) describe, many other types of solutions also are common. Demsetz (1967) argues that the specific set of rights that arise to ameliorate the commons problem will tend to minimize the total net costs of developing and enforcing those rights, as well as the cost of external effects that persist when rights are poorly defined.

6. A generalization of the commons problem

This paper argues that non-exclusivity of use rights is the essential feature of the commons problem, in contrast to Hardin's focus on freedom of action amidst capacity constraints. Non-exclusivity, however, is but one of several potential restrictions on private property rights that create incentives for dissipative activity. This section argues that the commons problem is a special case of the broader theory of property rights articulated by Alchian (1965), Demsetz (1964, 1966, 1967), Cheung (1970, 1974), and others.

To begin, it is useful to establish what we mean by "ownership." I own a hammer, but only in the sense that I have community permission to do certain things with it. I can use it to pound in nails, pull out nails, prop open my door, or hang on my wall as a conversation piece. But I do not have the right to throw it through my neighbor's window or toss it on the highway. I own some trees, and can trim, climb, or hang tire swings from them. I can also keep my neighbors out of them, but community covenants prohibit me from razing them. Similarly, I own parts of two short roads. I can walk, ride a bike, ski, or drive my car on them. I must share the roads, however, because others own easements that keep me from restricting access.

"Ownership" means different things in the case of my hammer, trees, and roads. When I purchase a hammer I am really purchasing a set of rights, not just a blob of metal and wood. These rights include some things not included in my ownership of the trees. I can throw the hammer away, for example, or melt it into a real blob of metal. I can also keep everyone else from using my hammer, unlike (alas) my roads. "Ownership" is not a tangible or physical item. It is instead a bundle of use-rights defined by contracts, customs, laws, and social mores.

All communities have systems of ownership rights, in the sense that laws, customs, contracts, and social mores dictate the acceptable use-rights to all known resources. Communities cannot avoid defining the set of resource uses that are deemed acceptable. Utopians may decry the idea of ownership, but this is like bemoaning gravity. Ownership is not unique to western cultures or market economies. It is neither good nor bad. It just is.

Whereas all communities explicitly or implicitly define ownership rights to their resources, not all ownership rights are private. *Private ownership* conveys three rights in addition to the community-sanctioned ways in which the good can be used:

(i) the right to exclude others from using the good or accessing these rights;

(ii) the right to receive compensation from the use of the good; and

(iii) the right to transfer, in whole or in part, the bundle of ownership rights.

The property rights literature emphasizes how private ownership is valuable because it conveys the enforceable right to capture any surplus generated by using the good. As such, individuals will compete to obtain the rights of private ownership if these rights are not already privately owned. Similarly, when private ownership is attenuated through a restriction on any of these three rights, opportunities arise to gain from placing claim on the use-rights to the good. The competition to establish ownership is redistributive and not productive, so resources engaged in such competition are dissipated compared to the alternative in which ownership is pre-assigned and clear.

This implies the following generalization of the commons problem:

> When the rights of private ownership to a good are attenuated by restricting any of the three rights associated with private ownership, the net value of the good is decreased as individuals compete to establish effective ownership. This competition can have the effect of decreasing the value of the good, increasing the cost associated with the production or use of the good, or both.

In short, removing any of the three rights associated with private ownership encourages opportunistic behavior that is redistributive rather than productive, thereby dissipating wealth compared to the counterfactual of low-cost assignment and enforcement of private rights.[10]

(i) Non-exclusivity

Non-exclusivity – a restriction on item (i) above – creates the commons problem. As discussed in Section 3, the classic example of a non-exclusive use right is the open access fishery, in which each fish is owned in common until a fisher establishes private ownership by catching it. Fishers therefore compete merely to establish rights in the fish. In fisheries around the world, non-exclusive ownership encourages many fishers with more and increasingly sophisticated equipment to compete for fewer and fewer fish. Many fisheries, including the North Atlantic cod, Alaska king

[10] It is important to note that the costs of defining, assigning, and enforcing private rights can exceed the costs of non-private rights. So restrictions on private rights are truly dissipative only when the costs of assigning and enforcing private rights are lower than the costs of non-private rights.

crab, and Peruvian anchovy fisheries, have crashed under the burden of overharvests. Some fish and mammal populations have faced near or actual extinction because of overharvest pressures wrought by non-exclusive ownership, including some whale species and the black rhinoceros.

Although the fishery is the archetypal example of the commons problem, there are many other examples, including Hardin's overgrazing of commonly owned pastureland, overharvests on public forestlands, ozone depletion, air and water pollution, and freeway congestion. Climate change resulting from carbon emissions is at its core a problem of non-exclusive rights to the atmosphere. In each case, a resource is overused because no one has exclusive rights to it, and/or other costs are incurred to capture the right to use the resource. Rights to the resource are not captured until the resource is used, so individuals compete for the rights by exploiting, capturing, or using the resource.

(ii) Restrictions on the right to receive compensation from use of the good

Like non-exclusivity, eliminating or attenuating the owner's right to receive compensation also fosters dissipative activity. Consider price or rent controls, which restrict the right to receive income from the resource, e.g., an apartment. In the absence of such a restriction a private owner has incentive to allocate the apartment to its highest valued use. Restricting an owner's right to receive the highest real income from the apartment will decrease this incentive and decrease the apartment's net value.[11]

As an example, suppose rent control reduces the monthly rental from a market price of $2000 to a controlled price of $1500. This attenuates the apartment owner's right to receive full value from the apartment's use. In Cheung's (1970) language, it creates a non-exclusive surplus of $500. The apartment owner and renter will engage in actions that seek to appropriate the $500

[11] It is important to distinguish between restrictions on the right to receive income and voluntary suppression of the price mechanism. As Alchian and Allen (2018) discuss, many goods voluntarily are allocated by non-price means, including window seats at restaurants and dessert portions at family dinners.

monthly non-exclusive surplus, thereby dissipating wealth compared to the alternative of no rent control. If the value of the apartment in an alternate use (e.g., conversion to a condominium) is more than $1500, the owner can capture part of the non-exclusive income by converting the apartment's use or selling to someone who will. The conversion of apartments to condominiums in rent-controlled areas is evidence of such competition for non-exclusive income (e.g., Cranch 1980, Steimle 2019). Alternatively, the owner can save on maintenance expenses and allow the apartment to deteriorate in quality until the marginal value of the apartment is the controlled price. The apartment owner can capture some of the non-exclusive income by requiring key money payments or tying in furniture sales to renters at marked-up prices. Or the apartment owner can capture some of the surplus in non-pecuniary forms by discriminating among potential renters based on race, gender, or political views.

Such actions to capture all or some of the surplus created by the rent control are conceptually similar to fishers' competition to establish ownership rights to fish in an open access fishery. As with the fishery, we could prevent the dissipation of wealth by assigning an exclusive right – in this case, to the $500 monthly surplus. For example, the rent control could be lifted and the tenant assigned a right to $500 of the apartment owner's monthly income. This would accomplish a transfer of wealth to the renter without prompting dissipative activity to capture the $500 surplus, because the right to the $500 surplus would be pre-assigned. When the right to a valuable resource – such as the fishery or the $500 surplus – is not privately assigned, competition to acquire the resource results in dissipative activity and a reduction in the resource's net value.

Queuing is another alternative allocation mechanism when the right to receive income is constrained via price controls (e.g., see Barzel 1974). The cost of queuing analytically is similar to the cost of competition for a non-exclusive use-right, as both direct competitive behaviors toward dissipative rather than productive activities. In both cases, the restriction on private ownership places some resource value up for grabs, and other resources are expended merely to capture this value (before someone else does). In the case of queuing due to price controls, the dissipation of

value comes through the waiting costs incurred by buyers. As illustrated by problems with non-price allocations of COVID-19 vaccinations, such costs can be substantial (e.g., Cochrane 2021).

(iii) Restrictions on the right to transfer ownership

Restrictions on the third right associated with private ownership – the right to sell the bundle of rights associated with ownership – create similar losses. A stark example is provided by the 12 remaining regional corporations established under the Alaska Native Claims Settlement Act of 1971 (ANCSA). These corporations are much like other profit-seeking corporations except that shareholders in these corporations are forbidden from selling their stock. Primarily as a result of this restriction on private ownership, some of the value of shareholders' claims in these corporations has been dissipated. In the case of the fishery, dissipation takes the form of overcapitalized fishing fleets and an overharvested fish stock. In the case of the ANCSA corporations, the dissipation occurred primarily through poor financial performance and shareholder in-fighting (Karpoff and Rice, 1989). Because of the restrictions on the right of sale, there is no market for shares and shareholders have severely restricted ways to protect their wealth from incompetent or self-serving managerial decisions.

Demsetz (1967) cites the military draft as another example of a restriction on the right to transfer ownership rights. Typically when an army is raised by a draft, draftees are prohibited from negotiating to buy their way out of service. "With either voluntary recruitment, the 'buy-him-in' system, or with a 'let-him-buy-his-way-out' system, the full cost of recruitment would be brought to bear on taxpayers" (Demsetz 1967, p. 348). As another example, Edwards, Fiszbein, and Libecap (2020) describe how property rights developed in the Argentine Pampas region with binding cultural constraints on large landowners' abilities to sell or partition their properties. The result was a slowdown of production and long-term economic decline compared to physically comparable farming areas without such restrictions.

7. What accounts for Hardin's (1968) enduring influence?[12]

Hardin's characterization and the property rights approach imply different policies to ameliorate the commons problem. The conventional view based on Hardin's (1968) analysis focuses on the dangers of unconstrained private action and leans toward command-and-control regulations. Examples include restrictions on fishing vessels' size, firm and plant-level emissions limits, and bureaucratic allocation of COVID-19 vaccines. The property rights approach, in contrast, leans toward policies that establish clear use-rights that are exclusive and exchangeable. Examples include individual catch quotas in fisheries, tradeable emission rights for pollutants, and tradable COVID-19 vaccine rights.

Many economists argue that rights-based policies yield relatively efficient outcomes to commons-type problems (e.g., see Anderson and Leal, 1991), and herein lies a puzzle. Demsetz (1967, p. 350) argues that institutional rules tend toward efficient outcomes and that "… property rights develop to internalize externalities when the gains of internalization become larger than the cost of internalization." Indigenous groups in the Americas, for example, developed private property rights around beaver hunting when trade opportunities increased the cost of non-exclusive hunting rights. Yet, command-and-control regulations dominate most natural resource and environmental public policies, even when rights-based policies would appear to create greater social benefits. What accounts for this discrepancy? That is, what explains the enduring appeal of Hardin's analysis and the command-and-control policies it supports?

Economists have wrestled with some version of this question since at least the 1960s, when the term "irrational" was used to describe the seemingly baffling mix of command-and-control rules that guide most regulated fisheries (e.g., Crutchfield and Pontecorvo, 1969). I propose there are several potential, non-mutually exclusive answers to this question. One is simply that command-and-control policies combined with non-price allocations are efficient in some settings.

[12] I thank the reviewer for insights reflected in this section.

Even when overuse is a risk, voters can prefer open access, say to beaches and parks, because transaction costs or wealth disparities would lead to suboptimal or politically unattractive allocations if rights were privately assigned.

A second answer is that, as Weitzman (1974) observes, Hayek's (1945) information problem is not obvious to most non-economists, nor is the role of prices in communicating information efficiently and coordinating value-increasing adjustments by many people across many dimensions. Policies that seek direct control over observable quantities – such as the number of fish caught or the amount of sulfur dioxide a power plant can spew into the air – have the appeal of a seemingly predictable outcome. Policies that convey clear use-rights and rely on market transactions, in contrast, affect quantities in ways that can be difficult to predict.

A third explanation for the popularity of some command-and-control policies is that they reflect a misapplication of Demsetz' (1967) insight that private use-rights are not the only solution to the commons problem. As noted above (see footnote 2), researchers have documented ways in which some commons problems are ameliorated via informal rules, social mores, and implicit or explicit agreements that partly duplicate and partly substitute for private ownership. Swiss villagers, for example, manage communal grazing meadows using restrictions on the number of cows a farmer is allowed to graze (Landholt and Haller, 2015). These examples of collective action, however, typically involve small communities in which the costs of informal and interpersonal enforcement are relatively small. Attempts to use "collective action" to address large scale problems, e.g., the oceans commons or climate change, encounter an explosion in the cost of large-group collective action and quickly morph into governmental command-and-control policies (e.g., see Ostrom 1999; Wilson 2016).

Finally, any answer to the puzzle of Hardin's enduring appeal must consider the political economy of regulation. Stigler (1971) and Peltzman (1976) show how regulatory control can favor politically connected groups compared to market-oriented policies such as those implied by the property rights approach. The costs of transfers to politically favored groups can be diffuse and

opaque under command-and-control policies, making these policies attractive to both the regulated parties and the regulators who benefit from the transfers. Even regulations that allow open access can generate rents for some, typically low-cost, producers (e.g., see Anderson and Hill, 2002; Boyce, 2004).

It is also costly to develop and enforce private rights. Anderson and Hill (1990) and Granger and Parker (2013) point out that no one will agitate for regulations that emphasize private use-rights unless they can capture a sufficient share of the surplus. As an illustration, Joskow and Schmalensee (1998) describe the complex political tradeoffs required to muster support for the system of tradeable sulfur dioxide allowances as part of the 1990 Clean Air Act. With command-and-control rules generating benefits for politically influential incumbents, plus the cost of adopting rights-based rules, regulatory capture can explain the stability of a command-and-control equilibrium.

This latter observation raises a related question, namely, under what circumstances will rights-based solutions to the commons problem emerge and replace command-and-control regulations? Johnson and Libecap (1982) and Karpoff (1987) argue that incumbent fishers support traditional command-and-control regulations that protect their quasi-rents from competition. But Karpoff (1989) argues that this support crumbles when the fishery becomes severely depleted and incumbents' incomes are low; in addition, incumbents are more likely to support rights-based solutions when their opportunity costs of changing the regulatory regime is low, when their prospects of being given the rights in the new regime is high, and when the option value of fishing rights is high. These predictions are consistent with observations that rights-based policies have been adopted at fisheries that were on the verge of ecological collapse (Edwards, 2001; Liu and Qin, 2018), as well as observations that rights must be distributed in ways that garner sufficient political support (e.g., Joskow and Schmalensee, 1998; Boyce, 2004).

These fisheries examples suggest a broader hypothesis. The gains from internalizing the dissipative costs associated with traditional command-and-control policies are positively related to

the size of such costs. These costs, in turn, are large when the resource generates negligible surpluses for incumbent producers. The rights-based policies advocated by property rights theorists are therefore most likely to emerge when a pre-existing command-and-control regime fails to generate large surpluses for the incumbents. This hypothesis differs starkly from some models in which a shift toward a property rights regime occurs when resource rents are high (e.g., Copeland and Taylor, 2009).

In sum, Garrett Hardin's (1968) "A Tragedy of the Commons" provides a popular characterization of the commons problem. In this paper, I argue that Hardin's analysis is incorrect because it characterizes the commons problem as arising from the exercise of free will in an ecological system with fixed carrying capacity. Before Hardin's article was published, several scholars at the forefront of the property rights literature – including Gordon (1954), Scott (1955), Coase (1960), Alchian (1965), and Demsetz (1967) – had already established the essential nature of the commons problem as arising from non-exclusive use rights. One of the most useful insights from this literature is that, without specific and well-defined private use-rights, individuals will expend resources merely to establish ownership rights, thus decreasing the net value of the resource compared to the counterfactual in which rights are privately owned. This loss in value – a loss in contribution to the larger society – provides a broader perspective on the actual tragedy of the commons.

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