Retrospectives: Tragedy of the Commons After 50 Years

Brett Frischmann, Alain Marciano, Giovanni Ramello

Retrospectives: Tragedy of the Commons After 50 Years

Brett M. Frischmann, Alain Marciano, and Giovanni Battista Ramello

Brett M. Frischmann is the Charles Widger Endowed University Professor in Law, Business and Economics, Villanova University, Villanova, Pennsylvania. Alain Marciano is University Professor in Economics, University of Montpellier, Montpellier, France. Giovanni Battista Ramello is University Professor in Economics, Università del Piemonte Orientale, Alessandria & Chair of the IEL International Program, Torino, Italy. Their email addresses are brett.frischmann@law.villanova.edu, alain.marciano@umontpellier.fr and giovanni.ramello@uniupo.it

Abstract

Garrett Hardin's "The Tragedy of the Commons" (1968) has been incredibly influential generally and within economics, and it remains important despite some historical and conceptual flaws. Hardin focused on the stress population growth inevitably placed on environmental resources. Unconstrained consumption of a shared resource—a pasture, a highway, a server—by individuals acting in rational pursuit of their self-interest can lead to congestion and worse, rapid depreciation, depletion, and even destruction of the resources. Our societies face similar problems, not only with respect to environmental resources but also with infrastructures, knowledge, and many other shared resources. In this Retrospective, we examine how the tragedy of the commons has fared within the economics literature and its relevance for economic and public policies today. We revisit the original piece to explain Hardin's purpose and conceptual approach. We expose two conceptual mistakes he made, that of conflating resource with governance and conflating open access with commons. This critical discussion leads us to the work of Elinor Ostrom, the recent Nobel Prize in Economics Laureate, who spent her life working on *commons*. Finally, we discuss a few modern examples of commons governance of shared resources.

Introduction

Garrett Hardin's "The Tragedy of the Commons" (1968) has been incredibly influential in biology, ecology, and various social sciences, including economics. It has become a totemic reference to which tributes are regularly paid (for examples, see Feeny, Berkes, McCay and

Acheson 1990; Bajema 1991; Burger and Gochfiled 1998; and the symposium in *Science* magazine, December 14, 2018, at https://science.sciencemag.org/content/362/6420/1236.summary). But "tragedy of the commons" has been transmuted into little more than a useful catchphrase, as if it was synonymous with free-rider problems endemic to public or collective goods. This obfuscates the usefulness of the concept of how a commons can function for the governance of shared resources. In this essay, we revisit Hardin's article 50 years after it was written to clarify, set the record straight, and explore its relevance in the 21st century.

We first remind readers that Hardin drew on both biological and economic theories of how competition worked and that he stressed the pressure that population growth would place on environmental resources. His narrative was very much in the public eye. After all, Paul Ehrlich's book, *The Population Bomb*, was a best seller in 1968. We describe Hardin's famous allegory of how sheepherders are likely to overexploit a commons, which had a significant impact on how subsequent generations understood the phenomena. Yet perhaps surprisingly, few economists engaged with Hardin's paper in the decade following its publication. To our knowledge, no economists paid much attention to the biological or economic arguments behind Hardin's essay, nor to his argument that tragedy of the commons required government-imposed limits on births. It took some time before the "tragedy of the commons" spread among economists, and then it was typically as a quick mention in the background of a discussion of providing public goods.

However, Elinor and Vincent Ostrom, were more insightful. In particular, Elinor Ostrom dedicated much of her career to demonstrating how commons in the real world had not and do not inevitably lead to tragic ruin, as Hardin had insisted. In 2009, she received the Nobel Prize in Economics because she "challenged the conventional wisdom by demonstrating how local property can be successfully managed by local commons without any regulation by central authorities or privatization."[1] In retrospect, and in the context of the work by Elinor and Vincent Ostrom, we can see that Hardin's famous sheepherder allegory failed to make two key conceptual distinctions: the allegory conflated the idea of a scarce

[1] For background material on Elinor Ostrom's Nobel prize, see https://www.nobelprize.org/prizes/economic-sciences/2009/ostrom/facts.

resource with the governance of that resource, and it further conflated open access with commons, despite significant differences in those forms of governance. We will clarify these distinctions and thus explore the limitations of Hardin's view. Unfortunately, Hardin's distorted perspective on the commons often persists to this day in economic discussions. Thus, we discuss some applications and extensions of research on the commons, including infrastructure, knowledge, and other issues. Interdisciplinary scholars have identified an expanding set of shared resources for which commons governance may effectively address social dilemmas.

Hardin's *Tragedy of the Commons*

Garrett Hardin (1915–2003) is well-known in biology for his work on evolution and natural selection. He spent most of his career at the University of California at Santa Barbara, where he arrived in 1946 and stayed until his retirement in 1978. Hardin was also prominent as a public intellectual. He contributed to magazines, gave popular lectures, appeared on TV and radio, and testified before many congressional committees. In both his academic and non-academic work, Hardin emphasized the need to control population growth. The "Tragedy of the Commons" essay is his most famous attempt to make his case, but it was neither the first nor the last attempt (as emphasized by Oakes 2016). A prominent early effort along these lines, "The Competitive Exclusion Principle," appeared in *Science* magazine in 1960. In this article, Hardin stated that "*complete competition cannot coexist*" (p. 1292; italics in original), explaining:

> … (i) if two non-interbreeding populations "do the same thing"--that is occupy precisely the same niche in Elton's sense-and (ii) if they are "sympatric" that is, if they occupy the same geographic territory-and (iii) if population A multiplies even the least bit faster than population B, then ultimately A will completely displace B, which will become extinct.

Anticipating Michael Ghiselin's bioeconomics (1974) and Edward O. Wilson's sociobiology (1975), Hardin combined, extrapolated, and generalized a result that he had found in biology and economics. In 1960, Hardin first anchored his competitive exclusion principle, also known as "Gause's principle." Specifically, Russian evolutionist Georgii Gause (1932) had shown in a series of experiments involving yeast and paramecia that when different species live in a shared environment and use similar resources, one species will tend to drive out the others. Hardin (1960, 1293) acknowledged the principle was hard to "prove or disprove" empirically, but further argued that "[t]he "truth' of the principle is and can be established only by theory."

Second, Hardin (1960, 1295) thought it was "possible" that principle "originated in economic thought." Thus, as another source of inspiration for the claim that competition would destroy itself, he cited "the French mathematician" Joseph Bertrand. Commenting on Cournot's duopoly model, Bertrand (as quoted in Hardin, pp. 1295-6) noted that if

> … one of the competitors will lower his price in order to attract the buyers to himself and that the other, trying to regain them, will set his price still lower … there is no limit to the lowering of the price. Whatever common price might be initially adopted, if one of the competitors were to lower the price unilaterally he would thereby attract the totality of the business to himself ...

Hardin (1296) thus stated baldly: "Any competitor knows that unrestrained competition will ultimately result in but one victor," in part because unrestricted companies will form cartels or use intellectual property to block competitors. In international trade, Hardin argued, his proposed competition exclusion principles meant that the world would need to reconsider tariffs and trade barriers, to prevent one country from being the victor that drives all others from the market.

Of course, just as many biologists of the time were engaged in controversy over the actual reach of the competitive exclusion principle, many economists then and now would take issue with the claim that all competition tends to monopoly. Even at the time, Gordon Tullock (1960, p. 95) stressed that Hardin's article "contains an error in economics. From the principle that complete competitors cannot coexist he deduces the development of

monopolies." Tullock argued: "If the principle has any application to economics at all, it would indicate that one type of economic enterprise might, by multiplication of its members, replace another, but this would not lead to monopoly."

In Hardin's (1968) "tragedy of the commons" essay, instead of focusing on biological competitors with a fixed set of resources and similar needs, Hardin added another dimension: the stress that population growth inevitably placed on environmental resources – "the world available to the terrestrial population is finite" (1243). That was also the case with other natural resources, such as oceans – that people tend to think as "inexhaustible" (1245), National parks – "there is only one Yosemite Valley" (1245), air and rivers, and even "airwaves of radio and television" (1249). Scarcity was the origin of the economic, ecological, and social problem.

In what is probably the most-quoted portion of the essay (at least in classes in economics!), Hardin (1968, 1244) proposed a sheepherder allegory to understand the basic motivation at work.

> 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. As a rational being, each herdsman seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks, 'What is the utility to me of adding one more animal to my herd?' This utility has one negative and one positive component.
>
> (1) The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly 1.
>
> (2) The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular decision-making herdsman is only a fraction of −1.
>
> Adding together the component partial utilities, the 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.

In Hardin's (1968) view, individuals acted vis-à-vis the world and its resources as if they were "independent, rational, free-enterprisers" (1245), as if their action had no impact on them, as if Adam Smith's invisible hand had actually worked and that "decisions reached individually will, in fact, be the best decisions for an entire society" (1244). Rationally, such behavior was perfectly understandable: "Each man," explained Hardin (1244-45), "is locked into a system that compels him to increase his herd without limit [or] of 'fouling our own nest.'" The consequence was unavoidable. Because of the ongoing increase in population and humanity's shared use of the global commons, "the per capita share of the world's goods must steadily decrease" (1243) which would generate "misery" (1243) and "ruin" (1244).

At its core, Hardin's (1968) tragedy, captured in his sheepherder analogy, illustrates a rather standard economics problem of interdependence, which involves issues of collective goods or external effects. After early analyses by Pigou (1920) and Knight (1924), these problems had received more attention and had been more frequently discussed in the second half of the 1950s with the works of Samuelson (1954), Bator (1958) and Coase (1960) (for an overview, see Marciano and Medema 2015). Hardin offered quick and casual references to Adam Smith and Thomas Malthus, but he did not refer to any of the modern economists who had contributed to study how to deal with situations involving interdependence. Hardin also neglected prior work in economics that dealt with commons (for example, Gordon 1954 on fisheries).

Indeed, Hardin's (1968) sheepherder allegory strikingly echoed the view Samuelson advanced in 1954: namely, that the economic problem of inefficient resource allocation does not come from the interdependence of resources but rather from the tendency of self-interested individuals to engage in free-riding – the "hope to snatch some selfish benefit" in Samuelson's words (389). For Hardin, the problem resided more in the *freedom* to use a

resource rather than in the characteristics of the resource itself; significantly, he titled one of the sections of his article "Tragedy of Freedom in a Commons" (1244).

To avoid the tragedy, Hardin (1968) argued for governance to constrain consumption and ensure sustainability. His advice was simple: stop making resources open to all. He pointed out that this step already had been taken with "food gathering; when farms were enclosed, pastures, hunting and fishing areas were restricted." It should also be done, in Hardin's (1249) view with "commons as a place for waste disposal" and with "pollution by automobiles, factories, insecticide sprayers, fertilizing operations, and atomic energy installations" and as well with the "commons in matters or pleasure," restricting, for instance, "the propagation of sound waves […] mindless music … in the public medium." All this would imply coercion, "the infringements on somebody's personal liberty." But in Hardin's view, it was the illusion and appearance of freedom associated with the philosophy of open access to resources that was actually coercive: "Individuals locked into the logic of the commons are free only to bring on universal ruin."

Hardin's (1968) primary focus and attack in the "tragedy of the commons" essay was on rising human populations: indeed, the subtitle of the article is "The population problem has no technical solution; it requires a fundamental extension in morality." Hardin argued that the "freedom to breed" is "intolerable." He rejected appeals to conscience: "[A]n appeal to independently acting consciences selects for the disappearance of all conscience in the long run, and an increase in anxiety in the short." He insisted upon mutual coercion as the approach: "Coercion is a dirty word to most liberals now, but it need not forever be so." He referred to the UN Universal Declaration on Human Rights, which held that all choices about the size of families should be made by families. Hardin responded: "It is painful to have to deny categorically the validity of this right; denying it, one feels as uncomfortable as a resident of Salem, Massachusetts, who denied the reality of witches in the 17th century" (1246)."[2]

---

[2] As Bajema (1991), notes, Hardin was often willing to "break social taboos." Along with calling for government-mandated population control, he signed with 51 others a *Wall Street Journal* op-ed called "Mainstream Science on Intelligence,", written by Linda Gottfredson (1997 [1994]), that discussed average racial-ethnic differences in intelligence measured in terms of IQ. Another striking example is his 1974 essay, "Living in a Lifeboat," in which he again insisted on the need to control population growth and asserted that the

Hardin (1968) recognized two solutions to the tragedy of the commons: government regulation and privatization. Both solutions rely on collective action through government to introduce constraints on resource consumption. The approaches differ substantially in terms of the manner in which ongoing (month-to-month, day-to-day, minute-to-minute) resource allocation decisions are made. Government can constrain consumption by directly managing or regulating resource use. Alternatively, government can establish a system of private property rights delineating ownership of the resources. The former presumes government will consider the aggregate effects and manage resource use efficiently over time, and the latter presumes well-defined private property rights will facilitate market exchanges and thereby lead to an efficient allocation of access and use rights, and consequently, efficient resource management over time. In the case of population growth, Hardin's essay does not explicitly contemplate a privatization approach (like a transferable right for any adult to be the biological parent to one child). Government regulation of population is necessary, Hardin (1248) claimed: "Freedom to breed will bring ruin to all."

Early Interpretation and Incorporation within Economics

Hardin's (1968) article attracted a reasonable degree of public attention, but most economists did not much refer to Hardin. The few who did argued that Hardin was cited for having coined an interesting expression for what economists already knew. For example, in one of the first references made by an economist to Hardin, Dales (1975, 495) explained that because of the difficulties in assigning property rights, "the expected outcome followed – overuse, congestion, premature depletion, or extinction, depending on the particular characteristics of the case – and the value of the resource dropped toward zero. 'The tragedy of the commons,' to use Hardin's apt phrase, unfolded inexorably." Along the same lines, a few years later, one reads that "[w]ithout private property, society will experience the 'tragedy of the commons' – ownership by all actually means ownership by none" (Carroll,

---

problem of "Christian-Marxist" idealism is "the sharing ethics is that it leads to the tragedy of the commons" (1974, 581).

Ciscil, and Chisholm, 1979, 607). At the beginning of the 1980s, a few economists discussed again the problem of fisheries and with a similar tone. For instance, Johnson and Libecap (1982) referred to a series of articles on fisheries as common property resources, and they mentioned Hardin's 1968 article only in passing, as if it were a necessary reference.[3]

But over time, the "tragedy of the commons" article became one among many articles that formed "the large literature" devoted to "common-property management" (Thiesenhusen 1991, 18). In the economics literature, it was no longer distinguished from the articles written by economists themselves, and Hardin was put on the same footing as the economists who had worked on property rights. He was thus cited as a scholar defending a neoclassical "perspective" (Carroll, Ciscil, and Chisholm, 1979) or "paradigm" (Swaney 1981) and lumped together with Coase (1960) and Demsetz (1967), despite their very different perspectives and approaches. The context of Hardin's (1968) work, with its focus on overpopulation and advocacy of mandatory government control over population growth, largely faded away.

The Ostroms

Elinor and Vincent Ostrom noted as early as 1971 (p. 207) that "Garret Hardin had indicated that these strategies [such as free riding] give rise to 'the tragedy of the commons' where increased individual effort leaves everyone worse off." Again in 1973 (pp. 210-211), Vincent Ostrom referred to Hardin and described the tragedy as follows:

> Individualistic decision making applied to common-property resources will inexorably result in tragedy unless the structure of decision-making arrangements can be modified to enable persons to act jointly in relation to those resources as a common property.

[3] One set of writers even supposed that Hardin had "documented more fully" the problem of overexploitation (Balachandran, Fisher, and Stanley, 1989, p. 261), which is obviously an exaggeration: Hardin had given no more than a few examples. Furthermore, despite Hardin's depiction, commons existed and where successfully managed in various ways in medieval England and many other parts of the world for a very long time (Dahlman, 1980; Buck Cox 1985, Bannon, 2017).

> Potential recourse to coercive measures will also be necessary to preclude a hold-out strategy and regulate patterns of use among all users. Unrestricted individualistic decision making in relation to common-property resources or public goods will lead to the competitive dynamic of a negative-sum game: the greater the individual effort, the worse off people become.

These references were not different from those of most economists at that time. But the Ostroms, and especially Elinor, disagreed with Hardin. In an interview with Levi (2010), she recounted that the first time she heard Hardin she "was somewhat taken aback" because her and Vincent's work proved Hardin was wrong.4

Elinor Ostrom and other social scientists challenged the frame set by Hardin by asking two foundational sets of questions: First, how well does the tragedy of the commons allegory describe reality? Is it a useful theory for making predictions about real-world behavior of individuals sharing common pool resources? Does it describe a normal or exceptional situation? Does it provide a useful basis for choosing or designing regulatory solutions? Second, does the binary choice between government command-and-control regulation and private property-enabled markets reflect the full range of options? Are there alternative (bottom-up) institutions and/or means for collective action (Frischmann 2013)?

To answer the first set of questions, it may be *convenient* to work within the confines of Hardin's sheepherder allegory, because doing so makes analysis tractable. As Elinor Ostrom explained (2007, 15183):

> Situations characterized by [Hardin's] assumptions, in which individuals independently make anonymous decisions and primarily focus on their own immediate payoffs, do tend to overharvest open-access resources. Researchers have repeatedly generated a 'tragedy of the commons' in experimental laboratories when subjects make independent and anonymous decisions in a common-pool resource setting.

4 For more details on Elinor Ostrom's framework, useful starting points are Aligica and Boettke (2009) and Tarko (2017).

The allegory, however, is reductionist and distorting. It includes a series of assumptions with respect to both resource and resource management that severely limited its generalizability. Simply put, Hardin's description of the "tragedy of the commons" ruled out—by assumption—the possibility that people might communicate and find ways to cooperate. Again, as Ostrom explained (2007, 15183):

> Making one small change ... in the structure of laboratory experiments, a change that is predicted by game theory to make no difference in the predicted outcome, has repeatedly had major impacts on interactions and outcomes. Simply enabling subjects to engage in face-to-face communication between decision rounds enables them to approach socially optimal harvesting levels rather than severely overharvesting the commons. In the face-to-face discussions, participants tend to discuss what they all should do and build norms to encourage conformance.

Elinor Ostrom (2000) also criticized reliance on the rational actor model at the heart of Hardin's allegory when analyzing collective action and social dilemmas. After establishing a series of 'well-substantiated facts' about human behavior based on extensive fieldwork, she concluded: "I believe that one is forced by these well-substantiated facts to adopt a more eclectic (and classical) view of human behavior" (141). She then developed a "second-generation model of rationality" in which humans are "complex, fallible learners who seek to do as well as they can given the constraints that they face and who are able to learn heuristics, norms, rules, and how to craft rules to improve achieved outcomes" (E. Ostrom 1998, p. 9). The second-generation model of rationality predicts that reciprocity, reputation, and trust as "core relationships" can lead to increased net benefits (13). This theoretical model identifies "individual attributes" that are particularly important in explaining behavior in social dilemmas. These attributes include "[1] the expectations individuals have about others' behavior (trust), [2] the norms individuals learn from socialization and life's experiences (reciprocity), and [3] the identities individuals create that project their intentions and norms (reputation)" (14).

Elinor Ostrom (1990) rebelled against the distorting reductionism that Hardin's essay represented –and Hardin was hardly the only culprit. Donning the analytical straitjacket

would "lead the analyst to miss what is most important and focus on what is least relevant" (Frischmann 2013, p. 5). This was especially true when approaching the second set of questions and the feasibility of institutional solutions besides private property-enabled markets and government command-and-control regulation. Commons governance was ignored as a solution because it was presumed to be *the* problem that inevitably leads to ruin.

To explore alternative institutional arrangements, Elinor and Vincent Ostrom, and their colleagues both at the Workshop in Political Theory and Policy Analysis at Indiana University and also around the world, advocated "to combine formal approaches, fieldwork and experiments in order to 'penetrate' social reality rather than to use formal techniques to 'distance' ourselves from it" (V. Ostrom 2009, p. 5). Thus, in the three decades that followed publication of Hardin's "tragedy," they engaged in rigorous, interdisciplinary social science to diagnose social dilemmas and to understand the commons as a mode of governing access to and use of shared resources. This approach stressed context and was grounded in empirical study. Systematic studies of real communities demonstrated that commons governance works in some contexts and fails in others (E. Ostrom 1990; E. Ostrom 2005). Communities may develop their own governance institutions, but communities still are embedded in government and market systems. Recognizing that governance institutions vary across communities and contexts, Elinor Ostrom and colleagues developed a framework illustrated in Figure 1 – the Institutional Analysis and Development (IAD) framework (Kiser and Ostrom 1982; E. Ostrom 1986, 1994, and many other references) – that could be used to analyze institutional arrangements and capture its diversity.[5] To quote Elinor Ostrom (2010, p. 646), "[t]he IAD framework is designed to enable scholars to analyze systems that are composed of a cluster of variables, each of which can then be unpacked multiple times depending on the question of immediate interest."

[5] The Social Ecological Systems (SES) and Governing Knowledge Commons (GKC) Frameworks build upon the IAD framework (Ostrom 2007; Frischmann, Madison, and Strandburg 2014). All three frameworks enable systematic institutional analysis.

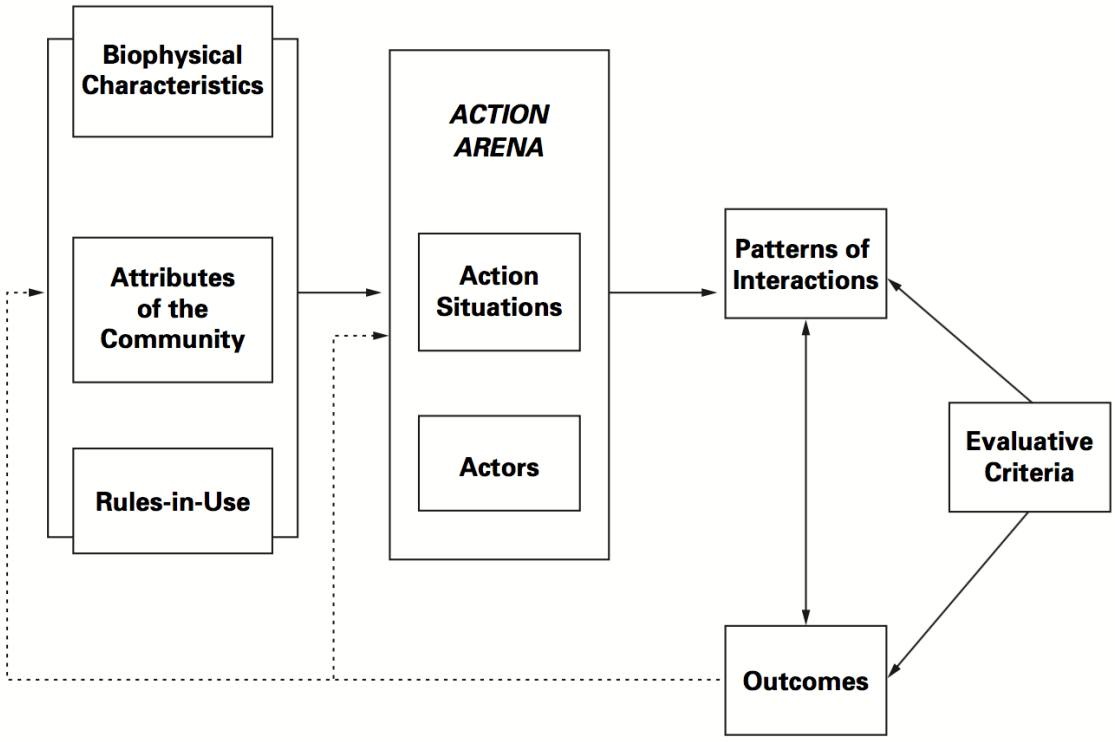

Figure 1: Institutional Analysis and Development (IAD) Framework

Source: From Ostrom and Hess (2007, p. 44).

Because these clusters of variables are interrelated, researchers can start at the left with the external variables, at the center with the action arena, or at the right with the outcomes. The external variables affect actors and action situations, which "generate patterns of interactions and outcomes that are evaluated by participants in the action situation (and potentially by scholars) and feed back on both the external variables and the action situations" and the actors (Ostrom, 2010, 647). There are many detailed examples using the IAD framework is beyond the scope of this paper. As one brief example, consider a lobster fishery. The tragedy of the commons allegory makes assumptions about the biophysical characteristics (depletable), community (independent, self-interested rational actors), and rules-in-use (every fisherman for himself); also, it assumes the only actors are the fishermen and the only relevant collective action problem is the prediction of ruinous competition. Viewed through the IAD lens, the empirical shortcomings of Hardin's allegory become clear: lobsters are not purely depletable; as a biological matter, they can reproduce and replenish

stocks. The relevant community involves more than just the fishermen. Communication and cooperation are feasible. The rules-in-use are more nuanced than everyone for himself (for detailed examination, see Acheson 2003).

Recognizing that people often can cooperate effectively and build institutions to enable sustainable use of shared resources focused scholarly attention on complexity, context, communities, and institutions. This broader field of vision brought informal institutions into view and encouraged their systematic study, and it also improved our understanding of formal institutions by revealing the many ways that government, market, and community institutions depend on each other to be successful. Figuring out how best to successfully cooperate in governing ourselves and our shared environments remains one of the core questions studied in law, economics, political science, sociology, and many other related fields today.

Two Key Conceptual Mistakes that Further Muddle Hardin's Special Case

As the work of Elinor Ostrom and many others makes clear, the assumptions made in Hardin's (1968) "tragedy of the commons" article, highlighted by the sheepherder allegory, limit his analysis to a special case. In this section, we go one step further, explaining why Hardin made two basic conceptual mistakes that further distort the usefulness of his case.

First, Hardin confused resources with governance. In his sheepherding allegory, for example, the relevant resource is a pasture, and the relevant governance is open access sharing: as the allegory begins, "Picture a pasture open to all." To describe commons as the resource subject to tragedy is a category error. Commons are *not*, and should not be conflated with, resources. They are not common pool resources nor public goods; these types of sharable goods may, however, be governed as or within commons. Instead, commons are a form of resource governance where members of a community share resources on terms set by the community. Thus, commons "applies to resources, and involves a group or community of people, but commons does not denote the resources, the community, a place, or a thing. Commons [are] the institutional arrangement of these elements" (Frischmann, Madison, Strandburg 2014, p. 2). Unfortunately, many people describe commons as the shared resource

subject to tragedy. This perpetuates Hardin's conceptual mistake.

Second, Hardin conflated two different governance systems. He used the term "commons," but he limited his analysis to the consequences of *only one* mode of governance, open access sharing. Yet these are quite different, and the differences matter (Frischmann 2012, 8). *Open access* implies no ownership or property rights. No individual or institution has the right to exclude others from the resource. Hence, all who want access can get access, typically for free. By comparison, *commons* involve some form of communal ownership (community property rights, public property rights, joint ownership rights). As a consequence, access to the resource is restricted to the members of the relevant community, under more or less restrictive conditions, and nonmembers can be excluded. In other words, *open access* differs from *commons* in several ways: in terms of *ownership* (none vs. communal/group), its *definition of community* (public at large vs. a more narrowly defined and circumscribed group with some boundary between members and nonmembers), and its *degree of exclusion* (none vs. exclusion of nonmembers).

These distinctions are important for understanding different institutions and how social arrangements operate at different scales. By making the assumptions that he did, Hardin (1968) locked himself into the analysis of a special case and significantly underestimated the power of commons as an efficient form of governance.

Extensions: Infrastructure and Knowledge

The tragic dilemma at the core of Hardin's allegory has been identified and discussed for a wide range of different resources. Much of the early work focused on natural resources like fisheries and other typically common pool resources. It has also received renewed attention in immigration debates (for example, Normadin and Valles 2015). But not surprisingly, the dilemma arises with many human-made resources too. Some are common pool resources subject to congestion and potential deterioration like roads and other infrastructure, while others are public goods subject to free rider concerns like ideas and other knowledge resources. In these settings, there can also be an inclination toward a Hardin-style bias to believe that the relevant collective action problems (i) can be diagnosed in terms of

ruinous competition and (ii) can only be addressed by direct government mandates and or government-enforced property rights. Such bias leads analysts to undervalue the usefulness and workability of commons governance over these resources by the relevant community. Here, we offer a brief and selective discussion of these topics, with an emphasis on how interdisciplinary research in these areas is moving past the basic "tragedy of the commons" model.

Infrastructure Commons

Infrastructure resources often are managed in an openly accessible manner that gives rise to possibilities that economists have likened to Hardin's tragedy of the commons.[6] For example, individual users rationally use toll-free highways at a rate and in a manner that maximizes private gains, but disregards the effects on other users or more generally, the sustainability of the resource. If each individual acts in such a fashion, aggregate consumption may lead to congestion costs from crowding, increased waiting time in queues, slower service, pollution, noise, reduced quality of service due to increased interruptions of service, and accelerated depreciation and depletion of the shared infrastructure (Frischmann 2012).

The basic economic model of congestion, like Hardin's (1968) tragedy of the commons, assumes homogenous uses (Vickrey 1969; Arnott 1993). The shared meadow is used for grazing sheep (not for grazing other animals or for other activities); the shared highway is used to complete trips (in more-or-less identical vehicles). When considering homogenous use, economists utilize a congestion cost function that relates the marginal social cost of resource use (like feeding sheep or completing a trip) to utilization rates (traffic) and resource capacity (like acreage or number of lanes). Such congestion is called "anonymous crowding," because the determinants of crowding are utilization and facility size, and attributes of individual users play no part in the equation (Cornes and Sandler 1996, p. 355). However, complications arise as heterogeneous users and uses are incorporated into economic models (Cornes and Sandler 1996): for example, variance in capacity consumption rates and cross-crowding between uses. To illustrate cross-crowding, Frischmann (2012)

---

[6] Unlike Hardin's pasture, most infrastructure resources are human-made, and that gives rise to a host of supply-side issues, which we leave aside for the sake of brevity.

extends Hardin's sheepherder allegory to include different livestock, assuming sheep, donkeys, and buffalo graze differently and also positing that "sheep and buffalo … fight each other." For roadways, a similar extension might involve cars, mass-transit buses, and trucks.

Heterogeneity affects the analysis of costs and benefits and is relevant to diagnosing congestion problems and comparing solutions. When crowding is no longer anonymous, discriminating among uses becomes a regulatory option to consider. In addition, a standard response of modern economists to congestion would be to use some form of congestion pricing to encourage users with heterogenous values of traveling by car at certain times to sort themselves—a policy choice which goes unconsidered in Hardin (1968).

There is also a case that certain infrastructural resources ought to be managed openly, because doing so may generate public goods and positive externalities or positive scale returns—greater social value with greater use of the resource (Frischmann 2012; Frischmann and Hogendorn 2015). Rose (1986) called this the "comedy of the commons." She used road systems (pp. pp. 775-81) to illustrate and explained how commerce enabled by roads is an

> … interactive practice whose exponential returns to increasing participation run on without limit… Through ever-expanding commerce, the nation becomes ever wealthier, and hence trade and commerce routes must be held open to the public, even if contrary to private interest. Instead of worrying that too many people will engage in commerce, we worry that too few will undertake the effort.

Commerce generates private value that is captured by participants in economic transactions, as buyers and sellers exchange goods and services, but it also generates social value that is not easily observed and captured by participants: for example, value associated with traveling to visit friends and relatives or traveling for recreation, as well as the value of widespread attendance at civic events, knowledge exchange, socialization, and acculturation. If open travel creates positive externalities, society may find diverse ways to take this into account as it considers how to manage access to roads. Frischmann (2012) extends the point to a variety of other infrastructural resources, ranging from basic research to the Internet.

The Public Domain and Knowledge Commons

The connection from intellectual property to the tragedy of the commons has been made explicit by a number of writers. Carrol, Ciscel and Chisholm (1979, p. 611) appear the first to refer to copyright law as a means for dealing with the tragedy that seems to also plague intellectual commons. Yet, ideas are public goods, not common pool resources. Thus, using and overusing ideas (or works of art) may, in special cases, reduce their value (Landes and Posner 2002, p. 15), but does not congest or deplete them. Unconstrained consumption seems good – *the more, the merrier* (Rose 1986; see also Merton 1988) – and even just (as discussed by Gosseries, Marciano, and Strowel 2008) rather than bad or wrong. If an intellectual resource, such as an idea, is openly accessible to all, then everyone who can profitably make use of it will do. But there's a catch. Ideas are products of human intellect; they require investment of time, effort, and capital. Unconstrained consumption by free riders presents a risk for potential investors, who may struggle to recover a sufficient return on their investment and may underinvest as a result. Thus, tragic underproduction of intellectual resources appears to be a social dilemma that mirrors Hardin's tragedy of the commons. Avoiding cultural, technological and scientific stagnation seems to require collective action.

Many approaching this problem assume Hardin's (1968) two options: direct government intervention (via public funding) or privatization (via intellectual property-enabled markets). To be clear, government funding and intellectual property are incredibly important drivers of socially valuable knowledge production. However, one can make a case that much or even most of humanity's intellectual resources have been generated and shared within open-access and community-based commons, often without government subsidy and outside of intellectual-property-mediated markets. The free rider allegory myopically presumes tragedy, leading people to believe that free-riding is necessarily harmful and needs to be eliminated (Lemley 2005). In fact, the opposite is often true. Free riding is pervasive and is often a beneficial feature, rather than a bug, of our economic, cultural, and social systems (Ramello 2011; Frischmann 2012). Since at least Schumpeter (1934), the creative process has been likened to a recombinant process in which (open) access to previously created knowledge plays a crucial role, fueling progress, and driving the combinatorial process of knowledge accumulation that fosters economic growth. This perspective

emphasizes the positive externalities characterizing knowledge production and the role of commons governance (Weitzman 1998; Marchese et al. 2019), including the role of the knowledge commons and rules governing the public domain.

Knowledge commons refers to the institutionalized community governance of the sharing and, in many cases, creation and curation, of a wide range of intellectual and cultural resources (Frischmann, Madison, and Strandburg 2014). Examples include scientific research commons, including data, literature, and research materials (Reichman, Dedeurwaerdere and Uhlir 2016), intellectual property pools (Madison, Frischmann and Strandburg 2010), open source computer software projects (Schweik and English 2012), Wikipedia (Hoffman and Mehra 2009; Safner 2016), "jamband" fan communities (Schultz 2006), and highly specialized technical knowledge like the Cornish steam engine (Nuvolari, 2004). Using the Ostrom-inspired Governing Knowledge Commons framework, case studies examine many governance issues, including interactions with intellectual property, government subsidies, and regulation. (Frischmann, Madison, and Strandburg 2014; Strandburg, Frischmann and Madison 2017; Sanfilippo, Frischmann and Strandburg 2020). For example, rare disease research consortia must address numerous governance challenges, including allocating research funding, authorship credit, and other rivalrous resources; overcoming potential "anti-commons"[7] dilemmas arising from researchers' incentives to hoard access to patients and their data; maintaining privacy, security, and the trust of patients and their families; reducing transaction costs of cooperation between widely dispersed researchers; and managing interactions with outsiders, such as pharmaceutical companies.

Other researchers have focused on the governance of the public domain, which is the incredibly capacious set for ideas, facts, and many other intellectual resources that are openly accessible by default to everyone (Litman 1990; see also Posner 2005). As an example of work in this area, a rich legal literature explores categories related to public domain like the

---

[7] Michael Heller (1998) coined the term "anticommons." He argued that too much private property could lead to underuse and waste of resources, with effects as tragic as the lack of property rights described by Hardin (1968). Heller and Rebecca Eisenberg explored the potential tragedy of the anticommons in biomedical research (Heller and Eisenberg 1998). Buchanan and Yoon (2000) develop a formal economic model of anticommons. The anticommons concept may offer a justification for fair-use and other copyright exceptions (Parisi, Schultz, and Depoorter 2000; Depoorter and Parisi 2002).

semi-commons constructed within intellectual property systems and the creative commons constructed with intellectual property licenses (for a detailed survey, see Benkler 2014).

Social demand for trusted governance of shared knowledge resources, ranging from medical data to algorithmically generated intelligence, is growing (Frischmann and Selinger 2018), even as public trust in governments and markets as sources of governance seems tenuous. Now, more than ever, we need to explore if, when, and how commons governance can scale.

Conclusion

Hardin's (1968) ultimate legacy is not really about his analysis of the tragedy of the commons, which was relatively trivial given already available economic tools, nor is it about his analysis of commons, which focused only on a narrow special case. Hardin contributed a catchphrase that caught the prevailing winds of public discourse and drew attention to the governance of shared resources. In the end, Ostrom's interdisciplinary, international and systematic analysis of commons governance is and should be the abiding legacy of the tragedy of the commons.

References

Acheson, James M. 2003. *Capturing the Commons: Devising Institutions to Manage the Maine Lobster Industry*. University Press of New England.

Aligica, Paul D. 2009. "Rethinking Institutional Analysis: Interviews with Vincent and Elinor Ostrom", Research Paper, Mercatus Center, https://www.mercatus.org/publication/rethinking-institutional-analysis-interviews-vincent-and-elinor-ostrom

Aligica, Paul Dragos, and Peter J. Boettke. 2009. Challenging institutional analysis and development: The Bloomington school. Routledge.

Arnott, Richard, Andrew de Palma, and Robin Lindsey. 1993. "A Structural Model of Peak-Period Congestion: A Traffic Bottleneck with Elastic Demand." *American Economic Revi*ew 83:161-179.

Bajema, Carl J. 1991. "Garrett James Hardin: Ecologist, Educator, Ethicist and Environmentalist." *Population and Environment: A Journal of Interdisciplinary Studies* 12 (3):193-212.

Balachandran, Chandra S., Peter F. Fisher and Michael A. Stanley. 1989. "An Expert System Approach to Rural Development: A Prototype (TIHSO)", The Journal of Developing Areas, 23 (2): 259-70.

Bannon, Cynthia. 2017. "Fresh Water in Roman Law: Rights and Policy." *Journal of Roman Law* 107: 60-89.

Bator, Francis. 1958. "The Anatomy of Market Failure." *Quarterly Journal of Economics* 72 (3):351-379.

Benkler, Yochai. 2014. Between Spanish Huertas and the Open Road: A Tale of Two Commons?, in Governing the Knowledge Commons (Brett Frischmann, Michael Madison & Katherine Strandburg).

Frischmann, Brett and Christiaan Hogendorn. 2015. "Retrospectives: The Marginal Cost Controversy", Journal of Economic Perspectives, 29(1), Winter 2015: 193-206.

Buchanan, James M. and Yong J. Yoon. 2000. "Symmetric Tragedies: Commons and Anticommons." *Journal of Law and Economics* 43(1): 1-13.

Buck Cox, Susan Jane. 1985. "No Tragedy on the Commons." *Environmental Ethics* 7(1):

49-61.

Burger, Joanna and Michael Gochfield. 1998. “The tragedy of the commons: 30 years later.” *Environment* 40(10): 4-27.

Carroll, Thomas M., David H. Ciscil and Roger K. Chisholm. 1979. “The Market as a Commons: An Unconventional View of Property Rights.”, *Journal of Economic Issues* 13 (2): 605-27.

Coase, Ronald. 1960. “The Problem of Social Cost.” *Journal of Law and Economics* 3:1-44.

Cornes and Sandler 1996: Cornes, Richard and Todd Sandler. 1996. The Theory of Externalities, Public Goods and Club Goods. Cambridge University Press, New York.

Dahlman, Carl J. 1980. *The Open Field System and Beyond: A Property Rights Analysis of an Economic Institution*. Cambridge, Cambridge University Press.

Dales, J. H. 1975. “Beyond the Marketplace.” *The Canadian Journal of Economics / Revue canadienne d'Economique*, 8 (4): 483-503.

Hoffman, David A. & Salil K. Mehra. 2009. “Wikitruth Through Wikiorder”, 59 Emory Law Journal, 59, 151-210.

Demsetz, Harold M. 1967. “Toward a Theory of Property Rights.”, *American Economic Review*, Papers and Proceedings, 57 (2): 347-59.

Depoorter, Ben and Francesco Parisi. 2002. “Fair use and copyright protection: a price theory explanation.” International Review of Law and Economic, 21 (4): 453-73.

Feeny, David, Fikret Berkes, Bonnie J. McCay, and James M. Acheson. 1990. “The Tragedy of the Commons. Twenty-Two Years Later”, Human Ecology, 18 (1), 1-19.

Frischmann, Brett M. 2012. *Infrastructure: The Social Value of Shared Resources*. Oxford, Oxford University Press.

Frischmann, Brett M. 2013. “Two Enduring Lessons from Elinor Ostrom.” Journal of Institutional Economics 9(4): 387-406.

Frischmann, Brett M. and Evan Selinger. 2018. *Re-Engineering* Humanity. Cambridge, Cambridge University Press.

Frischmann, Brett M., Michael J. Madison, and Katherine J. Strandburg (eds.). 2014. *Governing Knowledge Commons.* Oxford, Oxford University Press.

Gause, Georgi F,. (1932. “Experimental Studies on the Struggle for Existence.” Journal of

Experimental Biology 9: 389-402.

Ghiselin, Michael T. 1974. *The Economy of Nature and the Evolution oJ Sex*, Berkeley, University of California Press.

Gordon, H. Scott. 1954. “The Economic Theory of a Common Property Resource: The Fishery.” *Journal of Political Economy* 62(2):124-142.

Gosseries, Axel, Marciano Alain and Alain Strowel. 2008. *Intellectual Property Rights and Theories of Justice*, Palgrave McMillan.

Gottfredson, Linda S. 1997 (1994). “Mainstream Science on Intelligence: An Editorial With 52 Signatories, History, and Bibliography”, *Intelligence*, 24 (1): 13-23.

Hardin, Garrett. 1960. “The Competitive Exclusion Principle”, *Science* 131(3409): 1292-97

Hardin, Garrett. 1968. “The Tragedy of the Commons.” *Science* 162(3859): 1243-48.

Hardin, Garrett. 1974. “Living on a Lifeboat.” *BioScience* 24 (10), 561-68.

Heller, Michael A. 1998. “The Tragedy of the Anticommons: Property in the Transition from Marx to Markets.” *Harvard Law Review* 111 (3): 621-688.

Heller, Michael A. and Rebecca S. Eisenberg. 1998. “Can Patents Deter Innovation? The Anticommons in Biomedical Research”, *Science* 280 (5364): 698-701.

Hess, Charlotte and Elinor Ostrom (eds.). 2007. *Understanding Knowledge as a Commons: From Theory to Practice*. Cambridge: MIT Press.

Hess, Charlotte and Elinor Ostrom. 2005 [2007]. “A Framework for Analyzing the Knowledge Commons.” in Hess and Ostrom, 2007, 41-81.

Hess, Charlotte. 2012. “The Unfolding of the Knowledge Commons.” *St Antony's International Review*, 8 (1): 13-24.

http://www.garretthardinsociety.org/info/links.html

Johnson, John P. and Gary D. Libecap. 1982. "Contracting Problems and Regulation: The Case of Fishery”, American Economic Review, 72: 1005-22.

Kiser, Larry L., and Elinor Ostrom. 1982. “The Three Worlds of Action: A Metatheoretical Synthesis of Institutional Approaches.” In Strategies of Political Inquiry, ed. Elinor Ostrom. Beverly Hills, CA: Sage, 179–222.

Knight, Frank H. 1924. “Some Fallacies in the Interpretation of Social Cost.” *Quarterly Journal of Economics* 38 (4): 582-606.

Lemley, Mark A. 2005. “Property, Intellectual Property, and Free Riding.” *Texas Law Review* 83: 1031-2185.

Levi, Margaret. 2010. “An Interview with Elinor Ostrom.” Annual Reviews Conversations, https://www.annualreviews.org/userimages/ContentEditor/1326999553977/ElinorOstromTranscript.pdf.

Litman, Jessica D. 1990. "The Public Domain." Emory Law Journal, 39: 965-1023.

Madison, Michael J., Brett M. Frischmann, and Katherine J. Strandburg. 2010. “Constructing Commons in the Cultural Environment”, *Cornell Law Review* 95 (4), 657-710

Marchese, Carla, Simone Marsiglio, Fabio Privileggi and Giovanni B. Ramello. 2017. “Endongenous Recombinant Growth and Intellectual Property Rights”, *Macroeconomic Dynamics* 23(5), 2035-2067.

Marciano, Alain and Steven G. Medema. 2015. “Market Failure in Context: Introduction.” *History of Political Economy* 47 (annual suppl.): 1-19.

Merton, Robert K. 1988. The Matthew Effect in Science, II: Cumulative Advantage and the Symbolism of Intellectual Property.”, Isis, Vol. 79, No. 4 (Dec., 1988), pp. 606-623.

Normandin, Sebastian and Sean A.Valles. 2015. “How a network of conservationists and population control activists created the contemporary US anti-immigration movement.” *Endeavour*, 39(2), 95-105.

Nuvolari, Alessandro. 2004. “Collective invention during the British Industrial Revolution: the case of the Cornish pumping engine.” *Cambridge Journal of Economics*, 28(3): 347-63.

Oakes, Jason. 2016. “Garrett Hardin's Tragic Sense of Life.” *Endeavour* 40 (4): 238-47.

Ostrom, Elinor. 1986. “An Agenda for the Study of Institutions.” Public Choice 48(1): 3–25.

Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, Cambridge University Press.

Ostrom, Elinor. 1998. “A Behavioral Approach to the Rational Choice Theory of Collective Action: Presidential Address, American Political Science Association, 1997”, The American Political Science Review, 92(1): 1–22.

Ostrom, Elinor. 2000. “Collective Action and the Evolution of Social Norms.” Journal of Economic Perspectives (13/4): 137–58.

Ostrom, Elinor. 2005. *Understanding Institutional Diversity*. Princeton University Press.

Ostrom, Elinor. 2007. "A diagnostic approach for going beyond panaceas", *Proceedings of the National Academy of Science*, 104(39): 15181–15187.

Ostrom, Elinor. 2010. "Beyond Markets and States: Polycentric Governance of Complex Economic Systems." American Economic Review 100(3): 641–72.

Ostrom, Vincent and Elinor Ostrom. 1971. "Public Choice: A Different Approach to the Study of Public Administration." Public Administration Review 31 (2): 203-16.

Ostrom, Vincent. 1973. "Can Federalism Make a Difference?" Publius 3(2): 197-237

Parisi, Francesco, Norbert Schulz and Ben Depoorter. 2005. "Duality in property: Commons and anticommons." International Review of Law and Economics, 25 (4): 578-91

Pigou, Arthur C. 1920. *The Economics of Welfare*. London, Macmillan.

Posner, Richard, A. 2005."Intellectual Property: The Law and Economics Approach." *Journal of Economic Perspectives*,19 (2): 57-73.

Ramello, Giovanni B. 2011, "Property Rights and Externalities. The Uneasy case of Knowledge." *European Journal of Law and Economics*, 31(1): 123-141

Reichman, Jerome H., Paul F. Uhlir andTom Dedeurwaerdere. 2016. *Governing Digitally Integrated Genetic Resources, Data, and Literature: Globally Intellectual Property Strategies for a Redesigned Microbial Research Commons*, Cambridge, Cambridge University Press.

Rose, Carol M. 1986, "The Comedy of the Commons: Commerce, Custom, and Inherently Public Property." *University of Chicago Law Review*, 53 (3): 711-781.

Safner, Ryan. 2016. "Institutional entrepreneurship, wikipedia, and the opportunity of the commons." *Journal of Institutional Economics* 12 (4): 743-771.

Samuelson, Paul A. 1954. "The Pure Theory of Public Expenditure." Review of Economics and Statistics, 36(4): 387-89.

Sanfilippo, Madelyn R, Brett M. Frischmann, and Katherine J. Strandburg. 2020 (forthcoming). *Governing Privacy in Knowledge Commons*, Cambridge, Cambridge University Press.

Schumpeter, Joseph A. 1934. *The Theory of Economics Development*. Cambridge, MA: Harvard University Press.

Schweik, Charles M. and Robert C. English. 2012. *Internet Success: A Study of Open-Source Software Commons*. MIT Press.

Strandburg, Katherine J., Brett M. Frischmann, and Michael J. Madison (eds.). 2017. *Governing Medical Knowledge Commons*. Cambridge University Press.

Swaney, James A. 1981. "Externality and Community." *Journal of Economic Issues*, 15 (3): 615-27.

Tarko, Vlad. 2017. *Elinor Ostrom. An Intellectual Biography*, Rowman and Littlefield.

Thiesenhusen, William C. 1991. "Implications of the Rural Land Tenure System for the Environmental Debate: Three Scenarios", *The Journal of Developing Areas* 26 (1): 1-24.

Tullock, Gordon. 1960. "Competitive Exclusion. Letter to Hardin." *Science* 132 (3419): 95.

Vickrey, William. 1969. "Congestion Theory and Transport Investment." *American Economic Review* 59: 251-260.

Weitzman, Martin L. 1998. "Recombinant Growth." *Quarterly Journal of Economics* 113 (2): 331-60.

Wilson, Edmund O. 1975. *Sociobiology: The New Synthesis*, Harvard University Press.