

REVIEW

Commons and Growth: The Essential Role of Open Commons in Market Economies

Yochai Benkler†

Infrastructure: The Social Value of Shared Resources
Brett M. Frischmann. Oxford, 2012, Pp ix, 417.

INTRODUCTION

Complex modern market economies would cease to function were they not pervaded by commons. These are not commons on the model of the centuries-old irrigation districts or pastures that inspired and shaped three decades of the study of the commons, pioneered by Elinor Ostrom.¹ Rather, these are commons that all modern economies live and breathe on, commons over which no one exerts exclusionary proprietary claims and that are available for all to use on symmetric terms. These commons are the highways and roads that make arteries and capillaries, the sidewalks and squares that facilitate the flow of commerce and public life in the world's metropolitan engines. These are the utilities—electricity, water, and sewage to power, feed, and cleanse—and the major shipping lanes and container standards that make trade flow smoothly. These are also math and geometry, scientific data, ideas, knowledge, and truths ascertained. So too is the Internet, from its very core standards to the software that runs the overwhelming majority of servers, and the rule of law to govern them all.

None of these is built on a classic model of property rights and free market exchange between an owner—who centralizes in a single decision maker all rights to exclude, use, manage,

† Jack N. and Lillian R. Berkman Professor for Entrepreneurial Legal Studies, Harvard Law School, and Faculty Co-director of the Berkman Center for Internet and Society, Harvard University. © 2013, Yochai Benkler.

¹ See generally Elinor Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action* (Cambridge 1990).

and dispose of the object of the property—and all others, an owner whose exclusive control thereby centralizes the coordination among all comers and their diverse valuations of the resource. Sure, there are private property roads; there are proprietary power generators, pumps, and cesspools or septic tanks. But these are a sideshow. The main event for all these systems *is* open commons: systems that eschew the core of property—the allocation of asymmetric rights to exclude, use, and manage the resource set whose use they govern—and instead offer (a) symmetric access and use privileges to (b) an open class of potential users. The price system works when there is asymmetric allocation—it consists in the use of prices to determine comparative availability of the resource for competing uses. Symmetric-access privileges, even when priced, abandon the use of price for fine-grained allocation, and rely instead on any one of a range of alternative systems: queuing being the most common, social determination an oft-found alternative.

Brett Frischmann's new book, *Infrastructure: The Social Value of Shared Resources*, is the most recent and sustained contribution to the still-small but growing literature seeking to explore the central role of large-scale open commons in modern economies. It is an ambitious effort and invites us to think about four major questions: first, the question of the provision of classic public goods and a range of quasi-public goods; second, the question of property versus commons as institutional forms for managing the production and use of a wide range of resources and goods that play a critical role in any well-functioning capitalist economy; third, the respective roles of market production, public provisioning, and social production in providing these critical resources; and fourth, the costs and benefits of general institutional solutions and analyses as compared to analyses that are more context specific to spheres of action.

In this, the book is an important contribution to a process of trying to mesh the longstanding work on the commons in the Ostrom school with the increasing pervasiveness of commons at the foundation of the networked information economy: knowledge and innovation, communications and computation. Ostrom herself began to explore this convergence over the past decade,² in particular as applied to a wide range of new commons

² See Elinor Ostrom, *Understanding Institutional Diversity* 219–88 (Princeton 2005).

in sustained collaboration with Charlotte Hess.³ Carol Rose early pointed in this direction in *Comedy of the Commons*.⁴ But most of the work on understanding the role of the commons in contemporary society and economy developed over the course of the 1990s in a legal literature focused on the networked information economy, where “tragedy of the commons” is a fundamentally flawed metaphor: studies of the public domain in copyright and patent,⁵ and studies of communications networks and the then-emerging Internet.⁶ Frischmann here follows up on his original expansion of insights from the scholarship on the networked economy to “infrastructure” generally,⁷ with infrastructure taking on an extremely expansive definition.⁸

Frischmann’s core claim is that (a) there is a set of resources whose use creates large positive externalities, particularly through facilitating downstream production activities of public and social goods (pp 61–66); (b) these resources are either nonrival or nonscarce over a sufficient range of their uses and renewable over the range of nonscarcity that the costs associated with implementing a private-property system during the noncongested periods outweigh the benefits of improved management during congestion (pp 61–63);⁹ and (c) these resources are often, and should be from an economic perspective (the core purpose of the book is to make the economic argument), subject to commons management, rather than property, where “commons” is marked primarily by emphasis on availability to all, of some

³ See generally, for example, Charlotte Hess and Elinor Ostrom, *Ideas, Artifacts, and Facilities: Information as a Common-Pool Resource*, 66 L & Contemp Probs 111 (Winter-Spring 2003); Charlotte Hess and Elinor Ostrom, *A Framework for Analysing the Microbiological Commons*, 58 Intl Soc Sci J 335 (2006); Charlotte Hess and Elinor Ostrom, *Introduction: An Overview of the Knowledge Commons*, in Charlotte Hess and Elinor Ostrom, eds, *Understanding Knowledge as a Commons: From Theory to Practice* 3 (MIT 2007). See also generally Charlotte Hess, *Mapping the New Commons* (Syracuse University Working Paper, July 2008), online at <http://surface.syr.edu/cgi/viewcontent.cgi?article=1023&context=sul> (visited Sept 15, 2013).

⁴ See Carol Rose, *The Comedy of the Commons: Custom, Commerce, and Inherently Public Property*, 53 U Chi L Rev 711, 778–80 (1986).

⁵ See notes 51–65 and accompanying text.

⁶ See notes 66–77.

⁷ See generally Brett M. Frischmann, *An Economic Theory of Infrastructure and Commons Management*, 89 Minn L Rev 917 (2005).

⁸ “This book views infrastructure capaciously, emphasizing the functional role of infrastructure. . . . [I]nfrastructure resources are *shared means to many ends*” (p 4).

⁹ He calls these “partially (non)rival” (p 30), which may be more confusing than helpful, since they are not in fact nonrival at all, but rather, as the text says, nonscarce over substantial ranges of their use.

level of access to the resource, on nondiscriminatory terms (pp 91–114).

This Review is part review, part observations that reading the book elicited. Part I outlines the intellectual history of commons studies, and in particular, makes an effort to diagnose the relations between the more famous Ostrom school of commons studies—historically focused on the management of natural resources under limited common property regimes (CPRs)—and the open-commons school that Internet studies and intellectual property literature in particular developed over the past twenty years. Part II will outline Frischmann’s argument and its contribution to the open-commons school. The contribution is significant; in particular, Frischmann pushes us to think of the role of commons well beyond the public domain in intellectual property or common carriage, open standards, and free and open source software in communications and Internet systems. I will also suggest certain ways in which Frischmann’s ambition to create a theory of infrastructure generally, stated almost exclusively in terms of demand-side market failures, and his effort to yoke open commons and CPRs together create internal tensions in the work as a guide to infrastructure policy and as a theory of commons.

Part III is an effort to clarify and expand an important aspect of the argument for open commons that Frischmann suggests in the book. It offers an argument, based on uncertainty and action in error-prone systems characterized by uncertainty, for why modern complex economies and societies in particular depend so heavily on open commons and institutional forms that eschew exclusive proprietary control over critical resources in favor of symmetrically defined access and use privileges (p 93). * * *

~~In a world with persistent uncertainty and positive transaction costs, commons offer the benefits of *freedom to operate* that a classical perfect market is supposed to provide in the absence of transaction costs and with perfect information. The symmetric-use privileges that typify the most important commons—like highways or electricity, information or the Internet—avoid the need for transactions at the margin and allow for low-cost exploration in an uncertainty space through experimentation, reassessment, and adaptation to new information. Commons obtain this high flexibility at the cost of the *power to appropriate* the benefits of the new action through control of the resource set that enabled it, requiring enterprises to seek different leverage~~

access, use, management, and disposition of a given resource in a single entity by giving that entity asymmetric power to determine who will get to access or use the resource, at what time, and for what purposes.¹²² Institutionally, what does the work of centralizing information and incentives is the location, in a discrete entity, of a call on the state to impose its power to support that entity's decision. The defining feature of commons is that there is no such asymmetric power. Instead, the resource is subject to a set of symmetric rules concerning access, use, extraction, and management. The absence of asymmetry removes the focal point for transactions—the owner—as a coordinating mechanism for competing claims; but the symmetry allows diverse users the freedom to operate without transacting, at least the freedom to operate within the symmetric constraints and subject to whatever congestion is characteristic of the resource. Information, as in the case of property, is gathered and processed by diverse actors, but unlike the case of property, it is not then collated in a single decision point; rather, diverse actors act upon information they have or exchange without the need to translate it into a universally understood expression (currency, for example) that compares competing uses and clears them. Similarly, motivations for action are not directly tied to, or measured by, the information and decision mechanism. This allows the motivations, like the information, to be divergent and loosely defined. Open commons with this institutional pattern are ubiquitous in modern economy and society.

→ Consider a day in the life of a Wall Street trader. She wakes up in her private-property apartment (whatever complications co-ops and condos present are outweighed by the core private-property nature of the apartment). She gets out of her private-property bed, and goes into her proprietary bathroom. But then she turns on the light. The electricity is provided by either a private company or a publicly owned utility; whether the company is privately or publicly owned, public utility law prevents it from refusing service to our trader unless she pays a higher amount than do her less wealthy neighbors.¹²³ If she wants to make toast, the company has no right to prevent her from connecting any toaster she wishes or to advantage her over her neighbors, for a fee, as long as the equipment complies with symmetrically

¹²² Benkler, *The Commons as a Neglected Factor* at 12 (cited in note 67).

¹²³ See NY Pub Serv Law § 65 (prohibiting price discrimination in the provision of electricity).

imposed safety laws and technical standards. Even after electricity-market deregulation, distribution to homes continues to include a provider of first and last resort—the utility—whose terms of service are regulated and symmetrically available to all. The electric utility cannot offer tiered service to some who are willing to pay more while throttling back use and creating brownouts for those not willing to pay more.¹²⁴ While usage metering certainly introduces a market mechanism of sorts to regulate consumption, the critical tell is that even under conditions of extreme congestion we do not permit rolling brownouts based on willingness and ability to pay. The utility has the right to refuse service to nonpaying customers. But the rates and use privileges to connect are not within its property right. That right is constrained to require the company to offer to all comers symmetric privileges of access and use subject to set rates and public standards of connecting equipment to the grid.

Our trader turns on the tap in her sink, and the water that flows is also a commons. The same applies to the sewage system she uses as the water leaves the sink. She uses private property for her toothbrush and soap, her refrigerator, and breakfast. Then she walks out of her door; if she lives in Tribeca and walks, she will use the commons that is the sidewalk. If she hops in a taxi, that private business will use the commons called the street and be regulated as a common carrier.¹²⁵ The freedom to operate of the commons assures that she has not only a yellow cab, but can also call any one of a wide range of private carriers, all of whom use the commons to take her from point A to point B without needing to transact to receive permission from an owner of the streets. If she lived in Connecticut and drove in, she would be using I-95 or any of many highways and parkways, all of which are commons, despite the theoretically and occasionally attempted alternatives: private turnpikes, bridges, and ferries. She might take the subway or commuter rail. Again, each is a publicly provisioned, commons-managed system.

As she walks into her office building, she relies on its private property for a place to work. She then turns on her private-property computer. Like her refrigerator at home, this computer, or at least many of its components, was likely imported over an

¹²⁴ See NY Pub Serv Law § 65 (prohibiting electric companies from granting unreasonable preferences to particular individuals).

¹²⁵ See NY Gen Mun Law § 181 (authorizing municipal officers and boards to regulate the registration and licensing of taxicabs).

ocean whose shipping lanes are commons, shipped in a container whose standard size reduced its cost, and is an international commons managed by an international standards-setting organization,¹²⁶ and was brought through the Panama Canal, which is required by international treaty to allow all peaceful shipping without discrimination,¹²⁷ and denies to the Canal Authority the rights to exclude or manage passage, or to alienate its powers.¹²⁸ She might read a proprietary news service, but that news service likely relied in part on facts collected elsewhere or data generated by the government. For example, she might wait for the next monthly jobs reports; these facts are in the public domain and governed as commons, and the newsletter harvests from the commons and bundles into a private product.

If she uses the Internet, our trader may use a private connection or a connection subject to common-carriage requirements. Common carriage, in turn, is a set of legal arrangements that assures that a private owner that provisions goods subject to this regime will make them available without discrimination. In other words, while it is a property regime, it is limited precisely along the dimension of asymmetric exclusion. It functions as an open commons, not as a club good, and certainly not as a private good. This is true everywhere outside the United States.¹²⁹ In the United States it was certainly true for Digital Subscriber Line (DSL) services prior to 2005, and likely true of

¹²⁶ See generally International Organization for Standardization, *Standards*, online at <http://www.iso.org/iso/home/standards.htm> (visited Sept 15, 2013).

¹²⁷ Treaty Concerning the Permanent Neutrality and Operation of the Panama Canal, 33 UST 11, TIAS No 10029 (1977).

¹²⁸ See *Organic Law of the Panama Canal Authority* (Autoridad del Canal de Panamá 1997), online at <http://www.pancanal.com/eng/legal/law/index.html> (visited Sept 15, 2013), translating *Ley Orgánica de la Autoridad de Panamá*, online at <http://www.pancanal.com/esp/legal/law/contents.html> (visited Sept 15, 2013). Article 3 bars all rights of alienation (“The Canal constitutes an inalienable patrimony of the Panamanian nation; therefore, it may not be sold, assigned, mortgaged, or otherwise encumbered or transferred.”). Article 5 requires nondiscriminatory access:

The fundamental objective of the functions attributable to the Authority is that the Canal always remain open to the peaceful and uninterrupted transit of vessels from all nations of the world, without discrimination, in accordance with the conditions and requirements established in the National Constitution, international treaties, this Law, and the Regulations. Because of the nature of the highly essential international public service provided by the Canal, its operation shall not be interrupted for any reason whatsoever.

¹²⁹ See Benkler, et al, *Next Generation Connectivity* at *229–39 (cited in note 117) (describing foreign investments in publicly accessible communications networks).

cable broadband as well.¹³⁰ Since 2005, debates over net neutrality have muddied these waters somewhat on the regulatory front.¹³¹ But the nature of the service has not changed yet, and its primary locus now concerns “managed services” as proposed by primarily the wireless data providers for their particular form of Internet service.¹³² If our trader is using a laptop, chances are it is connected to a WiFi network, and WiFi is an open commons subject to minimal symmetric-use constraints and a family of standards shepherded by a professional association. The Internet itself, riding on top of the wires or wireless, is a commons, as is the Web. If she accesses any website online, the probability is roughly 3:1 that the Web server software is an open-access commons governed by a FOSS license.¹³³ Market prices she needs to know are in the commons, although her employer likely pays for privileged early access to the information, and so for an economically relevant instant they are a proprietary club good and available only to those who buy access. In this regard membership in the stock exchange historically provided instantaneous access to market data on a club-good model, using the legal right to exclude nonmembers from the privately owned premises of the exchange as a way of excluding them from the real target—the market prices—which are, as a matter of law, a commons. And so the day goes on. If she makes trades, these depend on the legal system, which defines contract and property rights and promises to enforce them. The legal system is available to all on nondiscriminatory terms and no person has

¹³⁰ The status of broadband providers was hotly contested between 2000 and 2005. The most authoritative court of appeals case suggested that broadband consisted of a telecommunications service, which was common carriage, and an information service, which was not. See *AT&T Corp v City of Portland*, 216 F3d 871, 879 (9th Cir 2000). Justice Antonin Scalia wrote that any other interpretation was not only wrong, but impermissible. *National Cable & Telecommunications Association v Brand X Internet Services*, 545 US 967, 1005 (2005) (Scalia dissenting). The Federal Communications Commission nonetheless decided to treat broadband provisioning to the home as an information service, not telecommunications service, and the majority of the Supreme Court held that decision to have been legally permissible, if not obviously correct. *Id.* at 1000–03 (majority).

¹³¹ See generally Barbara van Schewick, *Internet Architecture and Innovation* (MIT 2010).

¹³² *In the Matter of Preserving the Open Internet Broadband Industry Practices*, 25 FCCR 17905, 17951–58 (2010).

¹³³ Apache’s most recent market share is ~62 percent; nginx’s is ~16 percent; the license used by Google, at 1.5 percent, is unclear. W3Techs, *Usage of Web Servers for Websites* (World Wide Web Technology Surveys May 14, 2013), online at http://w3techs.com/technologies/overview/web_server/all (visited Sept 15, 2013) (updating the percentage of websites using various servers on a daily basis).

the right to exclude anyone else from using it. It is a publicly provisioned commons.

In personal and commercial life, property is ubiquitous and highly visible to us. What is less visible is that this property system is suspended in commons that undergird and are interpolated throughout the proprietary system elements. Perhaps there is a libertarian utopia in which all these functions are subject purely to a proprietary regime. But no country in the world, whether it professes to be capitalist or socialist, functions purely on property or purely on commons.

B. Why Are Commons So Common?

1. Microefficiency under uncertainty and change given imperfect systems of action.

a) Commons and property-based markets. Commons and property trade off freedom to operate for security in holdings and power to appropriate. Imagine that John wants to organize a picnic with his friends. He can rely on a commons or on property. Imagine that John has a small backyard in a private home he owns or rents; he can invite people to his backyard. In this case, we can say that he invested in buying (or renting) secure (for a period) access to the capacity to invite up to fifteen people to an outdoor event at his home. He could also invite them to meet in the park. In that case, he runs the risk of not finding exactly the right spot he wants, or of congestion if it is a beautiful sunny day in Sheep Meadow in Central Park. But he gets the benefit of being able to invite thirty or fifty friends, if that's what he wants. He does not have the security of property holdings, but he does have a greater freedom of action with regard to the size of the lawn he can use and therefore the size of the social network he can engage in this form. Because the park is large and open for all to use, he can be fairly certain that there will be enough room, although he may be uncertain as to its precise quality relative to his yard. If he wants to issue an open invitation for friends of friends to come as well, the probability that such space will be available in the park, compared to the certainty of an available, but potentially cramped space in his backyard, begins to make the freedom to operate (in this case to expand the amount of space used as needed) of the park more appealing.

If he were planning to charge admission, then the loss of power to appropriate by excluding nonpaying participants would outweigh the benefits of flexibility. There, he might choose to expand capacity by renting space from a private party that owns a larger garden. But here again, he runs the risk of either overinvesting or underinvesting relative to the actual number of attendees, which requires that he limit invitations, require clearer RSVPs, and so on to avoid overcrowding or unnecessarily expensive overprovisioning. He also runs into transaction costs that may well make contracting too expensive to justify the transaction to begin with. Once he invests and invites people to a private, precleared, secure proprietary location, expanding or contracting capacity through market exchanges, and moving people to the new space, is likely to be difficult. It is trivial in the park. Note that in an ideal market, where square feet of yard are perfectly fluid and transactions costless, the market would seamlessly replicate the freedom to operate that the commons offers, avoiding the risk of congestion. But the real world is no ideal market; and in the real world—with units of goods and services delivered in noncontinuous packages, with transaction and information costs—the property approach trades off some freedom to operate for certainty and the power to appropriate, while the commons offers the inverse values.

In a highly uncertain, changing environment, with needs and plans that call for continuously updating the required resources, the freedom to operate provided by commons has important, valuable attributes relative to the security of holdings and the power to appropriate of property. This tradeoff is far from hypothetical or limited to parties in the park. When presented with major spikes in its network after introduction of the iPhone, AT&T had major congestion problems with its mobile data network.¹³⁴ It could have gone to the secondary spectrum markets set up by the Federal Communications Commission (FCC) a few years earlier,¹³⁵ where it could have leased the additional capacity in a spot market.¹³⁶ It did not. Instead, it

¹³⁴ See Benkler, 26 Harv J L & Tech at 89 (cited in note 32).

¹³⁵ See id at 101.

¹³⁶ See Eli Noam, *Spectrum Auctions: Yesterday's Heresy, Today's Orthodoxy, Tomorrow's Anachronism. Taking the Next Step to Open Spectrum Access*, 41 J L & Econ 765, 779 (1998). Noam's vision of a spot market in spectrum, replacing auctions of stable long-term property rights, is most closely implemented by Spectrum Bridge. See Spectrum Bridge *The Secondary Spectrum Market: A Licensing & Leasing Primer* *2 (Sept

combined a long-term proprietary strategy—seeking to purchase licenses from Qualcomm¹³⁷—with a short-term, more dynamic solution that was based on the commons. AT&T invested in WiFi hotspots and encouraged users to off-load traffic to their home and public WiFi spots.¹³⁸ SFR in France, the second-largest mobile provider and third-largest home broadband provider,¹³⁹ went one further and harnessed all of its home broadband subscribers—about 22 percent of the French market¹⁴⁰—to become WiFi load-balancing points for all their mobile data subscribers.¹⁴¹ WiFi off-loading by carriers has become the norm, carrying anywhere from 35 percent to 65 percent of mobile data.¹⁴² The dramatic rate of increase in required data carrying capacity meant that carriers found the commons—WiFi—a more flexible and responsive resource-management strategy for spectrum than secondary markets, which are the closest thing to straight property in spectrum that the FCC has ever developed. Note that carriers do not directly appropriate data carried over WiFi. They charge mobile users based on usage, but usage over WiFi connections does not count toward monthly caps and overage charges. Despite the lack of the power to appropriate data transferred over WiFi connections, the benefits of flexible deployment and network growth outweighed a more slow-moving, expensive, property-based spectrum approach.

The more diverse and uncertain the needs and plans of users—consumers or producers—are, the more attractive the freedom of action associated with having a resource in the commons is to these users. We can conceptualize it as the commons having a private option value to private users (distinct from its welfare effects), whose price is (a) the reduced certainty of availability of a stated quantity of the resource as is available in markets, itself a function of how perfect or imperfect the relevant market is, and how susceptible to failure; (b) the lost appropriation opportunity from not having the resource controlled in a proprietary form; (c) the cost differential between the desired use in the

2008), online at http://spectrumbridge.com/Libraries/White_Papers/The_Secondary_Spectrum_Market_A_Licensing_Leasing_Primer.sflb.ashx (visited Sept 15, 2013).

¹³⁷ See Benkler, 26 Harv J L & Tech at 101 (cited in note 32).

¹³⁸ See id at 101–02.

¹³⁹ See id at 104.

¹⁴⁰ Benkler, et al, *Next Generation Connectivity* at *77 (cited in note 117).

¹⁴¹ Benkler, 26 Harv J L & Tech at 104 (cited in note 32).

¹⁴² See id at 103. The scale and scope of use, rather than the precise numbers, are what is important for purposes of this Review.

market, given its imperfections (for example, market power over essential facilities) and the cost of using the commons; and (d) the risk that the commons will be congested. The greater the background uncertainty as to the required quantity or quality of the resource and the market imperfections, the higher the option value—that is, the more of the benefits of property an agent would be willing to forgo in exchange for the greater flexibility offered by commons. The symmetric constraints coupled with a general privilege to use the resource under these constraints mean that the need for transactions at the margin is eliminated, and with it transaction-cost barriers: strategic behavior of platform or essential-facilities owners, imperfect information with its widespread risk of unmatched offer-ask differences, and so forth.

Where the level of uncertainty is such that freedom of action (to adapt to changed circumstances) is an important desideratum—in some cases more so than security in holdings (whose value and utility are part of the uncertainty) and power to appropriate outputs directly through exclusion (whose coming into being is part of the uncertainty)—we need, and find ubiquitously around us, both commons and property. On this argument, with perfectly frictionless markets under perfect information, we wouldn't need commons. But this is no more relevant than saying that with perfectly selfless individuals under perfect information and frictionless social exchange we wouldn't need property. Given imperfect markets, imperfect information, diversely motivated individuals, and imperfect systems of social cooperation and exchange, some mix of property and commons is necessary for reasonable planning and pursuit of goals. This is from the *private-returns* perspective, setting aside collective goals like efficiency and growth, much less democracy or a richly expressive culture. From an individual agent's perspective, having a mix of resources—some commons, some property—will increase his or her utility over time, given imperfect markets, persistent uncertainty, and change.

b) Imperfect systems all the way down. This basic trade-off between property and commons is then replicated in the trade-off between commons and state-administered resource systems, where the desired action must be translated into a call on the necessary resources through an administrative process. Similarly, it is replicated in the trade-off between an open commons and a “social-community-governed” resource that needs to

deal with making calls on a resource through the socially acceptable challenge (“Dad, can I borrow the car Friday . . .”). We act through systems that provide us certain affordances and constraints that allow us to predict what resources will be available to us, under what circumstances, and what consequences are likely to follow from various actions we take. None of these systems is perfect (including, certainly, social coordination of commons); we therefore find our societies using a mix of all of them.

Commons are a partial solution to a decision problem we face as individuals, all of whose available systems of action are imperfect. For any given state of the world, we as human beings have a problem of deciding what to do: which set of resources to apply to which set of processes, in order to obtain which set of outcomes, through which system of action. One way to abstract this decision problem is that we can rely on one or any combination of four families of systems: two hierarchical systems, government and firms; and two distributed systems, markets and social interactions. Our actual behaviors and outcomes will be a function of our actions within these four systems and the combined outcome of those behaviors. Each system incorporates its own imperfections, its own error term if you will, such that our behaviors and outcomes reflect a function of these four systems and their cumulative errors. The error term combines information, decision, and execution. Each system has *information* failures: in acquisition, formalization, and processing of information about the state of the world in which we are considering action in terms comprehensible within that system. Each has *decision* errors in the processes it uses to convert the information into a prescription for action within the system. And each exhibits *execution* errors in the transformation of the prescription into action, and the action into outcome.

At a broad level of abstraction, hierarchies, both governments and firms, are better at planning, control, and management of relatively known sets of resources, people, processes, and outcomes. The freedom to operate embodied in commons is better at exploration, experimentation, rapid deployment, and adaptation to new information and experimentally observed improvements, but weaker at providing security in holdings and direct appropriation of the benefits of the action through control over the resources necessary to effect it. Markets, in turn, because of transaction costs and because of information failures

associated with formalization of competing options into a price-cleared comparative framework, fill a middle niche between firms or governments and commons. They permit more security and planning for predictable conditions at the expense of some flexibility and adaptability for unpredictable conditions. This stylized comparison is, of course, too simple. Experimental governmental forms, small entrepreneurial firms, and internal experimental processes within larger firms seek to retain the advantages of these hierarchical forms while improving on experimentation and adaptation; self-governance mechanisms within commons-based practices, such as free-software development or Wikipedia, seek to improve on the management and appropriation limitations without losing flexibility and openness; and market mechanisms incorporate trust, long-term cooperation, and extensive communication to overcome some of the lossiness¹⁴³ associated with converting complex real-world values into discrete prices.

By comparison to open commons in complex modern economies, limited common property regimes explored by the traditional Ostrom school cannot offer the same flexibility that open commons do. Indeed, the first three decades of studies in the Ostrom school were heavily focused on long-standing, stable arrangements that developed over time to embody highly refined local knowledge of the conditions of the resource system they governed.¹⁴⁴ What makes open-access commons so flexible is that no one need agree on anything with anyone else about the disposition of the resource, as long as they comply with a limited number of symmetrically applied rules (for example, speed limit, lane shifts, seatbelts; maximum power limits in spectrum; voltage and wattage restrictions in power). CPRs provide governance structures that are not based on the state, but they often define extraction and use rights quite clearly and provide mechanisms for revising the allocations or use rights, sometimes unilaterally and sometimes by agreement.¹⁴⁵ But their relative benefit is in capturing local knowledge that is, by definition, partly tacit and hard to abstract for incorporation into a state-managerial or property-market model, embodying that body of local knowledge in a stable, sustainable resource utilization

¹⁴³ Richard Mayr, *Undecidable Problems in Unreliable Computations*, 297 *Theoretical Computer Sci* 337, 337 (2003).

¹⁴⁴ See Ostrom, *Governing the Commons* at 58–102 (cited in note 13).

¹⁴⁵ See *id.* at 79–81.

system, and embedding it in a motivational matrix rich in social motivations, as well as material self-interest. While these systems generally include conflict-resolution systems and mechanisms for reorienting the resource and revising the respective rights, these are not systematically more flexible than just straight property or administrative fiat.

Recognizing this difference between open commons on the one hand, and property, administrative management (whether state based or firm based), and CPRs on the other, focuses the value of commons in the characteristics of information and knowledge. The world is complex, messy, and uncertain. It resists abstraction. That is why tacit knowledge is so critical and so sticky. “We know more than we can tell”¹⁴⁶ because even our own mental processes require abstraction if we are to communicate them in terms others can understand. In order to reallocate a resource from one exclusive use to another, it is necessary to translate the comparative uses into some commensurable abstraction: a price, a value cognizable in the administrative system, or a claim on a common pool or social resource stated in terms cognizable by the social system. Open commons avoid that necessity to abstract and translate because uses are not exclusive. It is sufficient for an individual to decide to act, within the constraints of the symmetric access and use rules, without fully expressing the value expected from the contemplated action. The more these rules confine the uses, the less valuable the commons for this purpose. The more abstract, minimally constraining, and general these constraints are, the more valuable the freedom to operate can be. That is why commons with highly abstract and general rules—such as TCP/IP for the Internet, simple power limits for WiFi, compatibility standards for electricity, or speed limits and safety requirements for roads without substantial emphasis on particular uses—implementations, or dedicated channels have proved so productive.

2. Macroeffects of open commons.

From Rose’s *Comedy of the Commons* to Frischmann’s *Infrastructure*, and through the literature on the public domain, a central claim on behalf of commons is their contribution to positive spillovers in activities that have demand-side increasing returns to scale and scope. As Rose argued, roads and navigable-waters

¹⁴⁶ See Michael Polanyi, *The Tacit Dimension* 4 (Chicago 1966).

doctrines developed to support open commons as trade began to expand, and in turn the open access to these arteries of trade fed back into increasing levels of trade that used these arteries as transportation inputs.¹⁴⁷ Autarky does not need open roads; free trade does. So too with the very act of trading, or access to ports. The abandonment of exclusive monopolies on trade with certain colonies, or in certain commodities, was a shift in the institutional design of trade to an open commons (in the sense a shift from asymmetric power to control a resource, an exclusive monopoly conveyed as a royal favor or auctioned to the highest bidder, to an institutional system in which anyone could buy and sell traded commodities under symmetrically imposed port tariffs, for example). These physical commons share this characteristic with intangible commons, like open standards. If shipping container standards were proprietary, in the sense that there was an owner of the standard with whom one would have to negotiate in order to use a standard-size container to ship goods around the world, from ship to tractor trailer or train, we would have the transaction costs, strategic behavior, and drag on trade that we see today debated in the question of patents on standards.¹⁴⁸ Innovation obviously does not grind to a halt, but the drag is well studied.¹⁴⁹ The centrality of robust open commons to growth became clearer as we came to see data and information, innovation, and knowledge as ever more central to growth and development, and innovation and growth, in turn, as the core contributor to welfare over time.

Frischmann's *Infrastructure* locates these spillovers at the heart of his case for infrastructure in general and commons management approaches in particular (p 94). Moreover, an important contribution of his particular analysis is to identify that most infrastructures we care about involve mixed downstream uses: commercial, public, and social. As a result, the positive externalities and spillovers are larger and less tractable, in the sense that they cannot effectively be internalized in the classic economic sense without altering or ignoring the social- and public-goods aspects of the infrastructure (pp 108–14).

stop here

¹⁴⁷ See Rose, 53 U Chi L Rev at 767–70 (cited in note 4).

¹⁴⁸ See Pamela Samuelson, *Are Patents on Interfaces Impeding Interoperability?*, 93 Minn L Rev 1943, 1965–69 (2009).

¹⁴⁹ See id at 1969–2003.