

# When to Open Infrastructure Access

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*This Essay comments on and develops Professor Brett Frischmann's concept of infrastructure commons, a theory which suggests that a variety of public and social resources (including information, transportation, environmental, and intellectual property resources) should be managed through open access regimes. Infrastructure theory remains underdeveloped, as it does not identify under which circumstances public and social infrastructure should be managed as commons or how the commons should operate for such resources. Differentiating the developmental stage of an infrastructure resource—whether it is yet to be conceived, yet to be produced, or needs to be managed—can help to fill this gap. Infrastructure at different stages of development poses different challenges for optimizing social value, and the nature and strength of rationales supporting open access vary significantly across the different infrastructure stages. This Essay is based on a presentation at a panel on infrastructure commons at the Law & Society Annual Conference in Berlin, Germany.*

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## INTRODUCTION

Frischmann's theory of infrastructure commons provides a useful lens through which to view a wide variety of societal resources, including information, transportation, environmental, and intellectual property resources. His focus is on public and social infrastructure, which he defines as nonrivalrous generic input resources that are used to produce a wide variety of

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public or nonmarket output goods.<sup>1</sup> Frischmann concludes that “there are strong economic arguments” that public and social infrastructure “should be managed in an openly accessible manner.”<sup>2</sup> The arguments are based on his reasoning that open access to such infrastructure would generate significant positive externalities that will benefit society.<sup>3</sup>

Infrastructure theory is attractive from egalitarian and liberal political perspectives, but remains underdeveloped. While presenting an original and useful descriptive framework, Frischmann’s infrastructure theory does not provide significant guidance for determining under which circumstances particular public and social infrastructure resources should be managed through open access regimes or how open access should operate for such infrastructure resources.

This Essay extends Frischmann’s infrastructure theory by beginning to develop guidelines for how and when to select open access regimes for infrastructure resources. The principal recommendation is that the developmental stage of a given infrastructure resource is critical to determining whether the resource should be managed through open access, and, if so, what type of open access regime is appropriate. For these purposes, infrastructure resources can be divided into three categories based on their stage of development: (1) resources that are not yet conceived (such as potential intellectual resources); (2) resources that are conceived but not yet developed; and (3) resources that are developed and need to be managed. Infrastructure at different stages of development poses different challenges for optimizing social value, and the nature and strength of rationales supporting open access vary significantly across the different infrastructure stages.

#### I. EFFECTS OF OPEN ACCESS FOR NOT-YET-CONCEIVED INFRASTRUCTURE

One of the central types of public and social infrastructure that Frischmann discusses is intellectual infrastructure, such as inventions, discoveries, and artistic creations. Incentives to create new intellectual infrastructure provide a paradigmatic example of not-yet-conceived infrastructure, and Frischmann’s primary illustration of intellectual infrastructure is basic scientific research.<sup>4</sup> Basic research fits Frischmann’s definition of infrastructure well as it is a generic input to a wide variety of downstream uses, and it is public and social infrastructure because of the public and nonmarket goods it produces (for example, information, knowledge, and learning).<sup>5</sup> Frischmann concludes that for basic research “the balance [of social benefits] tilts heavily toward access . . . [because] the social costs of restricting

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1. Brett Frischmann, *An Economic Theory of Infrastructure and Commons Management*, 89 MINN. L. REV. 917, 956 (2005).

2. *Id.* at 923.

3. *Id.* at 975–78.

4. *Id.* at 990–1003.

5. *Id.* at 993.

access to the resource can be significant and yet evade observation or consideration within conventional economic transactions.”<sup>6</sup>

Open access for public and social infrastructure that is not yet conceived, however, raises complex questions. Intellectual property law generally exists to provide incentives for the creation of intellectual advances, such as new inventions and artistic works. Consider, for example, patent law. Absent patent protection, there would be a market failure in innovation—individuals and firms would invest less in inventive activities than is socially optimal, and therefore there would be less invention than is socially optimal.<sup>7</sup> This would occur because new inventions generally are nonexcludable and nonrivalrous. Without patent law, if I build a better mousetrap and commercialize it or make it known (often a necessary antecedent to commercialization), I cannot prevent others from copying the invention without paying royalties. As a result, I cannot profit very much from the invention, or cannot profit to the full extent of the invention’s social value. Realizing this *ex ante*, I will not put socially appropriate research and development resources into inventive activity.

Patent law solves this free-rider problem by creating legal rules that, when satisfied, make inventions excludable, bringing the private benefits of invention more closely in line with their social value. Once I have a patent on my mousetrap, the world has to beat a path to my door. Consequently, I can reap more appropriate rewards, primarily through price discrimination. Price discrimination allows me to charge a price for my mousetrap that more closely approaches the value consumers place on the mousetrap than a competitive price would. Allowing the inventor to charge prices that approach the social value of an invention creates incentives for inventors that more accurately reflect the societal benefits produced by the invention.

For these reasons, if an open access regime is instituted for basic research (or any other intellectual infrastructure yet to be conceived), the incentives to perform basic research (or other infrastructure) will be reduced.<sup>8</sup> Frischmann is careful to point out that open access does not necessarily require free access, but only no discrimination among users and uses.<sup>9</sup> But, limiting a potential inventor in his or her ability to price discriminate (such as open access via

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6. *Id.* at 995.

7. The following discussion is drawn from Gregory N. Mandel, *Promoting Environmental Innovation with Intellectual Property Innovation: A New Basis for Patent Rewards*, 24 *TEMP. J. SCI. TECH. & ENVTL. L.* 51 (2005).

8. That incentives will be reduced does not mean that there will be no incentives at all. Individuals may still create intellectual infrastructure for other reasons, such as prestige. But, the inability to generate certain profits due to an open access regime will reduce incentives from what they otherwise would be.

9. Frischmann, *supra* note 1, at 925–26. There appears to be some inconsistency in contending that open access does not need to be free, just nondiscriminatory among uses and users. A fee, by definition, causes price discrimination. Certain uses will be excluded. The higher the fee, the greater the types of uses (and users) that are effectively precluded. Perhaps the point is that access can still be considered open so long as the fee or other restrictions remain sufficiently low.

compulsory licensing) reduces the potential value of the invention to the inventor, and therefore reduces the inventor's incentives. Providing open access for basic research and other yet-to-be-conceived infrastructure will lead to the creation of less infrastructure in the first instance. This concern is mirrored in the ongoing debate over how much protection to grant a patent owner. Greater protection, in general, provides greater incentive to invent, but also may limit the downstream ability of others to use the invention or improve upon it, each of which could increase social benefit. How to best balance patent protection in order to maximize social welfare is a topic of much analysis.<sup>10</sup>

The particular challenge for not-yet-conceived public and social infrastructure is that it faces two market failures, each of which prevents it from being conceived at a socially optimal rate. The first market failure is due to the nonrivalrous and nonexcludable nature of information discussed above; the second market failure is due to the positive externalities that potentially could be produced by the new infrastructure. Intellectual property law systems, such as patent and copyright law, help solve the former failure, but not the latter. Open access helps solve the latter market failure, but at the cost of reducing incentives to produce the infrastructure initially. Frischmann's focus on the demand side of producing infrastructure is welcome, but it is important not to ignore the supply-side effects of open access. What is needed is a method of optimizing both demand-side and supply-side efficiency.

One solution to the dual market failure problem for not-yet-conceived infrastructure is a system of patent rewards, a topic I discuss in earlier work, from which the following discussion draws.<sup>11</sup> Under a patent rewards system, the government acquires the right to patentable subject matter that meets the standard patent validity requirements,<sup>12</sup> and in exchange financially compensates the inventor directly, rather than granting the inventor a patent.<sup>13</sup> The invention is then made available to the public openly, either freely or for a fee.

Under most patent rewards proposals, compensation is based on the inventor's expected market profit.<sup>14</sup> Such compensation, however, would not

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10. See generally Robert Merges & Richard Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839 (1990); Brett Frischmann & Mark Lemley, *Spillovers*, 107 COLUM. L. REV. 257 (2007).

11. Mandel, *supra* note 7, at 64–69.

12. In order to receive a patent, an invention must be useful, new, nonobvious, adequately disclosed, and be patent-eligible subject matter. 35 U.S.C. § 101–103, 112 (2006); *Bonito Boats, Inc. v. Thunder Craft Boats, Inc.*, 489 U.S. 141, 149–50 (1989).

13. See Steve P. Calandrillo, *An Economic Analysis of Intellectual Property Rights: Justifications and Problems of Exclusive Rights, Incentives to Generate Information, and the Alternative of a Government-Run Reward System*, 9 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 301, 306–07 (1998) (discussing the elements of a patent rewards system). A rewards system was favored by George Washington and Alexander Hamilton at the time the Constitution was being drafted.

14. See, e.g., Robert C. Guell & Marvin Fischbaum, *Toward an Allocative Efficiency Prescription Drug Industry*, 73 MILBANK Q. 213, 221 (1995) (discussing a patent rewards system for prescription

provide proper incentives for public and social infrastructure for the very reason that Frischmann defines them as such—the infrastructure has significant nonmarket value. In the case of a rewards system for infrastructure innovation, compensation instead could be based on the social benefit of the invention.<sup>15</sup> The patent rewards system thus would shift an inventor's expected invention profits from compensation based on market profits to compensation based on the social benefit provided by the invention. This shift could internalize the positive externalities of public and social infrastructure innovation by bringing private incentives more in line with the social value of the infrastructure, providing a more efficient incentive for infrastructure innovation. Such a system could both solve the market failure caused by the nonexcludability of intellectual infrastructure and provide open access to such valuable infrastructure.

A patent rewards system could be implemented in parallel to the existing patent law system, rather than requiring an overhaul. Most inventors could still use the extant patent system to acquire exclusionary patent rights and reap market profits. But, where the inventor of an infrastructure advance believed that the invention had significant public or social value in excess of expected market profits, he or she could opt into the patent rewards system. The rewards system thus could be implemented in tandem with the existing patent system and still preserve the autonomy of private inventors, who would maintain the right to choose how to handle their inventions.

Patent rewards systems offer many benefits,<sup>16</sup> but are difficult to implement, and as yet generally untried in the United States.<sup>17</sup> The difficulty of setting and paying public and social infrastructure rewards would be hard to understate.<sup>18</sup> As Frischmann describes, public and social infrastructure benefits are difficult both to observe and to value.<sup>19</sup> Valuing most public and social infrastructure would appear to be a nearly impossible task, precisely because of the category at issue: generic inputs to a wide variety of public and nonmarket

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drugs with the reward to the inventor based on the net present value of what the patent would have generated on the market).

15. See Mandel, *supra* note 7, at 64–69 (proposing a patent rewards system for environmental innovation due to the market failure in demand for pollution reduction and other environmental goods); Steven Shavell & Tanguy Van Ypersele, *Rewards Versus Intellectual Property Rights*, 44 J.L. & ECON. 525, 534–35 (2001) (proposing a patent rewards system with the reward based on the lowest possible “social surplus” provided by the invention, although still based on the quantity of invented product demanded).

16. In addition to confronting the positive externality problem identified above, patent rewards systems can reduce the deadweight loss created by traditional patent monopoly rights, reduce the inefficiency of firms expending resources to invent around competitors' patents, and reduce the transactions costs of licensing patents and, relatedly, patent thickets. Michael Abramowicz, *Perfecting Patent Prizes*, 56 VAND. L. REV. 115, 131–33, 192–93 (2003); Mandel, *supra* note 7, at 65.

17. The United States does have a patent reward system for atomic energy inventions. Mandel, *supra* note 7, at 66. For national security reasons, individuals may not obtain patents on atomic energy inventions, but may receive a patent reward set by the Patent Compensation Board. *Id.*

18. For a discussion of issues pertaining to funding and paying patent rewards, see *id.* at 66–69.

19. Frischmann, *supra* note 1, at 988–89.

outputs. However, in order to be beneficial, a patent reward system would not have to reward infrastructure perfectly, but only better than the current system. This goal appears substantially more attainable, considering the great disparity between the social value created by, and users' willingness to pay for, much public and social infrastructure. Patent rewards offer a potential open access solution to the yet-to-be-conceived infrastructure commons problem, and it is an open access system that does not rely on the government to allocate funding or manage research, capabilities in which the government may not excel.<sup>20</sup>

## II. EFFECTS OF OPEN ACCESS FOR NOT-YET-DEVELOPED INFRASTRUCTURE

The second category of public and social infrastructure is that which has been conceived, but not yet produced. Most traditional infrastructure, such as transportation and communication systems prior to their maturity, falls into this category. Consider the status of the national interstate highway system prior to the mid-1950s. The infrastructure had already been conceived (it had been studied for a couple of decades),<sup>21</sup> but the infrastructure had not yet been developed. The conceived-but-not-produced infrastructure challenge is the infrastructure problem that developing, and particularly least-developed, countries face.

Conceived-but-not-produced public and social infrastructure presents a classic infrastructure question—whether the government should produce the infrastructure (as occurred with the interstate highway system), or, if not, how private entities can be incentivized to produce the infrastructure (as is occurring with the Internet). For private production there can be a similar dual market failure as that discussed above when the infrastructure is nonrivalrous and nonexcludable.

The market failures here, however, will be less severe under many circumstances than those produced by not-yet-conceived infrastructure. First, much public and social infrastructure is excludable. Consider tolls for road use or fees for phone service or Internet access. For such infrastructure, excludability can create sufficient incentives for private production. In addition, for conceived-but-unproduced infrastructure, positive externalities may not pose as great a hurdle as first appears. In order for such infrastructure to be privately produced at a socially appropriate level, it is not necessary that positive externalities be very low or internalized, but only that users' willingness to pay exceed the cost of production. The social value (due to positive externalities) may be far greater than willingness to pay, but so long as willingness to pay is high enough, the infrastructure will be produced. Once produced, the infrastructure owner's profit motive will often (though not

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20. See *id.* at 999 (noting criticism of the government's ability to allocate public funds and efficiently manage research).

21. Ricco Villanueva Siasoco, *Red, White, and Blue Highways: The Story of the U.S. Interstate*, INFOPLEASE, <http://www.infoplease.com/spot/interstate1.html>.

always) lead to some system of open access, as Frischmann defines it.<sup>22</sup> Because the infrastructure is nonrivalrous, owners often will try to make their infrastructure widely available. Most communications providers present an example.

To the extent a system of open access does not evolve, government intervention may be appropriate. But, as with not-yet-conceived infrastructure, the effect of regulation on incentives must be considered. If potential infrastructure producers are concerned about the effect of regulation on their ability to control access in a manner so as to maximize profits, then the infrastructure producers' incentives to produce the infrastructure will be reduced. Again, it is necessary to optimize both demand-side and supply-side efficiency. As one example of the importance of supply-side characteristics, the high psychic value many individuals receive from developing and providing content (for free) has been critical to the development of the Internet.

The above analysis has unique application to trade secret protection. Trade secret law provides certain legal protection against misappropriation of business information that derives value from not being commonly known.<sup>23</sup> The relevant public or social infrastructure in the trade secret information context is information (infrastructure) that has been conceived but not yet developed or not yet developed to a socially optimal extent. In some circumstances, a trade secret owner may have conceived of or partially developed public and social infrastructure that would have high social value, but the owner retains it as a secret because the owner does not receive accurate demand signals or could not derive sufficient value from the information if disclosed. Providing means to create more accurate demand signals for public and social infrastructure would be expected to lead to the disclosure of some trade secret information infrastructure, in particular where the potential infrastructure supplier will be able to appropriate greater value than previously perceived. Improving demand-side efficiency for trade secret information could result in the production of more public and social infrastructure, and consequently increase social welfare.

### III. EFFECTS OF OPEN ACCESS FOR MANAGING ALREADY DEVELOPED INFRASTRUCTURE

The final type of public and social infrastructure is that which already exists and must be managed. Environmental and natural resources are prime examples—water, clean air, parks, and ecosystem services, for example. No incentives are necessary to conceive or produce such infrastructure; the question is how best to manage it.

A system of open access is problematic for many resources of this type. The tragedy of the commons is the classic story and a serious threat to open

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22. See *supra* note 8.

23. *Reeves v. Hanlon*, 95 P.3d 513, 522 (Cal. 2004); MELVIN F. JAGER, 1 TRADE SECRETS LAW § 3:3 (2004).

access systems. Open access has led to the inefficient use and destruction of disparate natural resources including fisheries,<sup>24</sup> timber,<sup>25</sup> water resources,<sup>26</sup> oil and gas,<sup>27</sup> and ranch land.<sup>28</sup> Carol Rose argues eloquently that a comedy of the commons can exist for certain resources, but her thesis concerns only resources that produce increasing returns to scale as participation increases.<sup>29</sup> A comedy of the commons for existing resources is rare—for most resources there will be decreasing returns to scale, at least after a point. The comedy of the commons would be expected only for resources that are highly nonrivalrous and whose use produces very high positive externalities. Beach access appears to be one example;<sup>30</sup> Internet access may be another. The existence of the comedy of the commons phenomena, however, should not be used to understate that a potential tragedy exists for open access to many resources, particularly environmental ones.

One of the important lessons learned from tragedy and comedy of the commons analysis is that there is no silver bullet to commons problems. Rather, commons problems are highly contextual, depending significantly on various characteristics of the resource in question. Superior methods of solving tragedy of the commons problems for fisheries (such as individual quota systems)<sup>31</sup> are substantially different from superior methods for solving tragedy of the commons problems for oil and gas production (such as managing an entire oil field as a single unit).<sup>32</sup> Optimal commons management solutions vary both in form and in implementing institution. In some cases a private market solution is best, in others government regulation is most efficient, in still others some form of community agreement is optimal, and sometimes a hybrid of these various options is best. Open access is a very important option to consider for managing infrastructure and commons, but it will not always be the best solution, even for public and social infrastructure. Frischmann's admonition to focus on the potential positive externalities of access to natural resources as

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24. Carl Safina, *The World's Imperiled Fish*, SCI. AM., Nov. 1995.

25. CHARLES F. WILKINSON, *CROSSING THE NEXT MERIDIAN: LAND, WATER, AND THE FUTURE OF THE WEST* 114–74 (1992).

26. Barton H. Thompson, Jr., *Water Allocation and Protection: A United States Case Study*, in *EARTH SYSTEMS: PROCESSES AND ISSUES* 476 (W.G. Ernst ed., 2000); Barton H. Thompson, Jr., *Tragically Difficult: The Obstacles to Governing the Commons*, 30 ENVTL. L. 241 (2000).

27. Rance L. Craft, *Of Reservoir Hogs & Pelt Fiction: Defending the Ferae Naturae Analogy Between Petroleum & Wildlife*, 44 EMORY L.J. 697, 700–13 (1995); David Edward Pierce, *Coordinated Reservoir Development—An Alternative to the Rule of Capture for the Ownership and Development of Oil & Gas*, 4 J. ENERGY L. & POL'Y 1, 49–79 (1983).

28. WILKINSON, *supra* note 25, at 75–113.

29. Carol Rose, *The Comedy of the Commons: Custom, Commerce, and Inherently Public Property*, 53 U. CHI. L. REV. 711, 769–70 (1986).

30. *Id.* at 755–58.

31. See MICHAEL J. BEAN & MELANIE J. ROWLAND, *THE EVOLUTION OF NATIONAL WILDLIFE LAW* 148–92 (1997).

32. GARY D. LIBECAP, *CONTRACTING FOR PROPERTY RIGHTS* 93–114 (1989); Pierce, *supra* note 27, at 49–79.

well as the negative externalities is a good recommendation,<sup>33</sup> but in many cases maximizing the social value of a natural resource will require management based on sustainable use rather than open access.

The direction and magnitude of the returns to scale of use of an infrastructure resource will play a critical role in determining the optimal level of access. For those (few) public and social infrastructure resources that truly exhibit increasing returns to scale, open access will often be viable and optimal; for resources with strongly decreasing returns to scale, open access would be problematic. Many infrastructure resources fall somewhere in between. Roads, and many other transportation resources, for instance, often will have increasing returns to scale up to a point, but then decreasing returns to scale once the roadway or transportation system becomes too crowded. The point of inflection on returns to scale for these resources is critical—generally we will want to encourage open access up to this point of use, but begin to discourage access beyond it.

Differentiating infrastructure resources according to their stage of development also highlights the need to optimize infrastructure management and access dynamically, across time and different stages of infrastructure development. Most infrastructure resources will evolve through the different stages identified in this article: from not-yet-conceived to not-yet-developed to in-need-of-management. How to optimally handle early stage (not-yet-conceived or not-yet-developed) public and social infrastructure will depend to some extent on how the infrastructure will be affected by open access at later stages. For instance, if certain not-yet-developed infrastructure is expected to suffer significant tragedy of the commons problems once developed, it may be preferable not to promote full open access at the development stage, if such restriction could reduce the tragedy of the commons at the management stage.

#### CONCLUSION

This Essay builds on Frischmann's theory of infrastructure commons to further explore when and how public and social infrastructure should be managed under open access regimes. The developmental stage of a particular infrastructure resource is critical to determining how it should be managed. For infrastructure that is not yet conceived or produced, both supply-side and demand-side characteristics are critical. Infrastructure will not be adequately developed or produced unless both supply-side and demand-side inefficiencies are resolved. There appear to be greater challenges for access to not-yet-conceived infrastructure than for not-yet-produced infrastructure. For infrastructure that already exists, but which needs to be managed, supply-side concerns are less pressing, and the primary questions involve rivalrousness of use. For such resources, the tragedy of the commons warns of the need to

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33. Frischmann, *supra* note 1, at 984.

restrict access to avoid negative externalities, while the comedy of the commons counsels the value of open access to reap positive externalities. The challenge is how to best balance internalizing any externalities or otherwise resolve both types of inefficiency.

Though infrastructure theory is highly useful in highlighting the potential positive externalities of infrastructure and in clarifying the need to take them into account in selecting infrastructure management, we still are left with a great challenge of trying to balance the supply and demand of unobservable and often incommensurate options and values. Dividing infrastructure according to its stage of development sheds useful light on how to answer these questions, but there is no doubt that there is more work to be done on developing the intellectual infrastructure of infrastructure commons management.