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# Perverse Innovation

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# PERVERSE INNOVATION[†]

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ABSTRACT

*An inescapable feature of regulation is the existence of loopholes: activities that formally comply with the text of regulation, but which in practice avoid the desired outcome of the regulation. Considerable ingenuity may be devoted to exploiting regulatory loopholes. Where technological regulation is at issue, such ingenuity may often be devoted to developing new technology that avoids the regulation; such innovation may be termed "perverse" because it is directed to avoiding the regulation that prompted it. Nonetheless, in this Article I argue that such regulatory circumvention may result in socially beneficial innovation. Drawing on insights from innovation policy in the law of intellectual property, I suggest several principles that should be adopted to channel such perverse innovation toward constructive activity.*



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## INTRODUCTION

Recombinant crops are unpopular in Europe.[1] Known as "GMO," an acronym for genetically modified organisms,[2] crops that have been altered by recombinant DNA technologies have sparked public concern over potential safety and health risks.[3] While there is little scientific evidence to support such concerns,[4] the possibility of unknown risks from such plants prompts European consumers to avoid foods derived from GMO crops, and both GMO plants and their products are subject to strict and costly regulatory controls.[5] Prominent labeling is required for GMO-derived products, and regulatory oversight for GMO planting is stringent.[6] Only a handful of European Union applications for planting GMO crops have ever been approved, and these have generally not found a market.[7]

As a consequence, seed producers have moved away from recombinant DNA technology for producing new seed varieties in Europe.[8] Instead, they have adopted a different approach, producing new crops with desired characteristics—such as herbicide tolerance—through mutagenic chemical or radiation treatments.[9] Mutagenic plant varieties may be produced by exposing seeds to

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1. *See* Charles W. Schmidt, *Genetically Modified Foods: Breeding Uncertainty*, 113 ENVTL. HEALTH PERSP. 526, 528 (2005) ("As far as opinions in Europe go, the public is heavily against GM." (quoting Geoffrey Lean, Env't Editor, INDEP. ON SUNDAY)).

2. *See GMO*, MERRIAM-WEBSTER, http://www.merriam-webster.com/dictionary/GMO [https://perma.cc/W5WK-KZ3N].

3. *See* Mark A. Pollack & Gregory C. Shaffer, *Biotechnology Policy: Between National Fears and Global Disciplines*, *in* POLICY-MAKING IN THE EUROPEAN UNION 329, 330 (Helen Wallace et al. eds., 5th ed. 2005).

4. *See* Alessandro Nicolia et al., *An Overview of the Last 10 Years of Genetically Engineered Crop Safety Research*, 34 CRITICAL REVS. BIOTECHNOLOGY 77, 77 (2014).

5. *See* John Davison, *GM Plants: Science, Politics and EC Regulations*, 178 PLANT SCI. 94, 98 (2010).

6. *See id.* at 95; Yves Tiberghien, *Competitive Governance and the Quest for Legitimacy in the EU: The Battle over the Regulation of GMOs Since the Mid-1990s*, 31 J. EUR. INTEGRATION 389, 390 (2009).

7. *See* Tiberghien, *supra* note 6, at 390.

8. *See* Jack Kaskey, *Mutant Crops Drive BASF Sales Where Monsanto Denied: Commodities*, BLOOMBERG (Nov. 13, 2013, 11:04 AM), http://www.bloomberg.com/news/ articles/ 2013-11-13/mutant-crops-drive-basf-sales-where-monsanto-denied-commodities [https://perma.cc/57JJ-BHD7].

9. *See id.*

nuclear radiation, which causes random changes in the plant genome.[10] Alternatively, seeds may be exposed to mutagenic chemicals, again causing random changes in their genes, some of which may be commercially beneficial.[11] Mutated plants with desirable traits are then selected from the altered seeds and propagated for sale.[12]

These mutagenic crops are subjected to essentially no regulation and, unlike recombinantly modified crops, can be readily grown and distributed in the European Union.[13] For example, the German chemical firm BASF has successfully produced and marketed herbicide resistant crop varieties through chemical mutagenesis, while the "Roundup Ready" herbicide resistant crops produced by Monsanto via recombinant DNA technology have been restricted.[14] There is no indication that mutagenic crops are any safer or healthier than GMO crops—indeed, unlike GMO crops, some mutagenic crops have had to be withdrawn from the market because of inadvertently increased levels of naturally occurring toxins, such as cyanide.[15]

There is little question that mutagenic crops have been "genetically modified" in any common or ordinary sense of that term. To the degree that uncertainty about possible harms is an issue, one might actually expect mutagenic crops to be a greater concern, as mutagenesis introduces multiple random and unpredictable changes into a plant's genetic structure, rather than the targeted, controlled changes introduced by recombinant DNA techniques.[16] However, because they were not modified via recombinant DNA technology, mutagenic crops do not meet the formal requirements for strict oversight under the European Union regulatory scheme and so escape the restrictions imposed on GMO plants.[17]

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10. *See id.*
11. *See id.*
12. *See id.*
13. *See* Shane H. Morris, *EU Biotech Crop Regulations and Environmental Risk: A Case of the Emperor's New Clothes?*, 25 TRENDS BIOTECHNOLOGY 2, 2 (2007).
14. *See* Kaskey, *supra* note 8.
15. *See id.*
16. *See id.*
17. *See* Jack Kaskey, *The Scariest Veggies of Them All*, BLOOMBERG (Nov. 22, 2013, 5:52 PM), http://www.bloomberg.com/news/articles/2013-11-21/monsanto-vs-dot-mutant-crop-developers-in-global-seed-market [https://perma.cc/S7Y6-KM2T].

The European shift toward mutagenic crops offers an example of what I dub "perverse innovation": perverse not (necessarily) in the prurient sense, but rather in the sense of being contrary to what might otherwise be expected or desired. The innovation that has gone into exploiting a formal loophole in GMO regulation is in at least two senses perverse. First, it seems perverse in outcome; seed companies avoid GMO regulation by producing seeds that ironically may be a greater risk to public health than the products they replace. But second, from a purely legal standpoint, mutagenic crops provide a technical work-around to ingeniously dodge the intended outcome of regulation, while still formally adhering to the text of the regulation.

The deployment of mutagenic crops in the European Union thus provides a striking example of activity that produces unexpected and unintended technical innovation in response to state regulation. In a highly regulated and technologically complex world, examples of this effect occur with increasing frequency. Actors that are subject to regulation often look for loopholes or work-arounds to avoid complying with the regulation without formally violating the regulation.[18] Where the regulation is technically oriented, such loopholes or work-arounds may take the form of technical redesign of the regulated item. Often such technical innovation is orthogonal, and sometimes even directly contrary, to the intent that was manifest in the precipitating regulation.

To the extent that such perverse innovation frustrates the purpose of regulation—perhaps negating the expected benefit of the animating regulation, perhaps even creating new risks that were unanticipated by the regulation—the exploitation of such loopholes may seem socially counterproductive.[19] But, at the same time, technical innovation is frequently considered to be a social benefit, and entire bodies of law and policy are devoted to promoting innovation.[20] Some perverse innovation is likely socially wasteful, but some may prove to be unexpectedly beneficial. Rather than try to

18. *See infra* Part I.

19. *See infra* Part II.C.

20. *See, e.g.*, Daniel J. Hemel & Lisa Larrimore Ouellette, *Beyond the Patents-Prizes Debate*, 92 TEX. L. REV. 303, 310-17 (2013) (identifying multiple regulatory regimes that promote innovation).

close the formalist loopholes that prompt perverse innovation, which would likely become an ongoing exercise in futility, regulators might intentionally design loopholes so as to purposefully, rather than haphazardly, promote innovative responses.

Recent scholarship has identified a range of underutilized policy options that might promote innovation.[21] In this Article I will similarly argue that one adjunct to intellectual property and other legal innovation incentives may be explicit recognition of, and purposeful reaction to, the perverse innovative outcomes that occur in response to imposition of state regulation. I begin by offering several examples of perverse innovation arising from different regulatory loopholes.[22] I then explore whether such responses to state regulation may not only be anticipated, but potentially harnessed as a source of innovation.[23] I ask in particular whether the design of the patent system, which not only anticipates but encourages similar responses to patents, can point the way toward regulatory design that might winnow instances of socially beneficial innovation from instances of socially wasteful innovation.[24]

## I. EXPLORING LOOPHOLES

Perverse innovation is to some degree a subspecies of a broader phenomenon, which is the exploitation of "loopholes" in regulatory imperatives. The exploitation of legal loopholes is a familiar occurrence and by no means limited to the provision of seed varieties in Europe.[25] It happens routinely, in all areas of social activity, producing unexpected and often undesired outcomes as regulation

21. *See id.*; Amy Kapczynski, *The Cost of Price: Why and How to Get Beyond Intellectual Property Internalism*, 59 UCLA L. REV. 970, 976 (2012).

22. *See infra* Part I.

23. *See infra* Part II.

24. *See infra* Part III.

25. *See, e.g.*, *Small Business Contracts: How Oversight Failures and Regulatory Loopholes Allow Large Businesses to Get and Keep Small Business Contracts: Hearing Before the Ad Hoc Subcomm. on Contracting Oversight of the S. Comm. on Homeland Sec. & Governmental Affairs*, 112th Cong. 1-5 (2011) (addressing exploitation of loopholes in government contracting); Elizabeth A. Weeks, *The Ethical Health Lawyer: Loopholes: Opportunity, Responsibility, or Liability?*, 35 J.L. MED. & ETHICS 320, 321 (2007) (discussing the ethics of exploiting loopholes in the context of health care law); Daniel W. Butrymowicz, Note, *Loophole.com: How the FEC's Failure to Fully Regulate the Internet Undermines Campaign Finance Law*, 109 COLUM. L. REV. 1708 (2009) (examining loopholes in Internet regulation).

changes behavior in unanticipated ways. Considerable energy and ingenuity may go into identifying and exploiting loopholes or alternatives. The outcome is often counterproductive and may or may not be innovative.

For example, in the United States, Chrysler Corporation's popular "PT Cruiser" automobile was lauded for its innovative, retro styling, reminiscent of 1930s automotive silhouettes.[26] But in a different sense, perhaps the most significant aspect of the PT Cruiser design was instead its "footprint," a regulatory metric derived from a calculation incorporating the vehicle's wheelbase—the distance between the centers of its front and rear wheels—and its track width—the distance between the wheels on each side of the vehicle.[27] This measurement is used by the U.S. Environmental Protection Agency in classifying vehicles for regulation.[28] The PT Cruiser's footprint places it in the EPA's Corporate Average Fuel Efficiency (CAFE) classification for "light trucks" rather than "passenger cars."[29] This definitional loophole allowed Chrysler to follow a less stringent fuel efficiency requirement than would have been required for a passenger car, allowing the manufacturer to avoid some of the costs associated with building a more fuel efficient vehicle.[30]

Such loopholes in the law are as a general matter unavoidable—the inevitable result of various combinations of incompleteness, formalism, and textual ambiguity. When textual terms are subjected to formal interpretation, the limits articulated in the text will always include certain activities and exclude other activities. Those who are subjected to the regulation are thus in a position to search for excluded, unregulated activities that are formally

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26. *See, e.g.*, Tony Swan, *2001 Chrysler PT Cruiser: Road Test*, CAR & DRIVER (June 2000), http://www.caranddriver.com/reviews/2001-chrysler-pt-cruiser-road-test [https://perma.cc/VJ9A-URB6].

27. *See* Vehicle Classification Definitions, 49 C.F.R. § 523.2 (2015).

28. U.S. ENVTL. PROT. AGENCY, EPA-420-F-12-051, EPA AND NHTSA SET STANDARDS TO REDUCE GREENHOUSE GASES AND IMPROVE FUEL ECONOMY FOR MODEL YEARS 2017-2025 CARS AND LIGHT TRUCKS 3 (2012) (noting that "standards are based on CO2 emissions-footprint curves").

29. *See* Derek Kreindler, *How CAFE Killed Compact Trucks and Station Wagons*, TRUTH ABOUT CARS (Oct. 1, 2012), http://www.thetruthaboutcars.com/2012/10/how-cafe-killed-compact-trucks-and-station-wagons/ [https://perma.cc/EYR8-H4DQ]; Swan, *supra* note 26.

30. *See* Kreindler, *supra* note 29.

permissible. Some of these will inevitably have been unforeseen when the text was drafted, as legal texts are well understood to be incomplete.[31] No drafter can foresee all possible contingencies, especially where innovation is concerned, and it is not only futile, but expensive to try to incorporate every possible factual scenario into the ambit of a regulatory text.[32] Consequently, some situations will certainly arise that lie outside the contemplation of any given regulation: some could have been foreseen but mistakenly were not, some were entirely unforeseeable given the finite information available to the drafter, and some were simply not foreseen because the costs of developing information and contingencies for them were prohibitive.[33]

This means that doctrinal "loopholes" are to some extent the converse of what I have explored in previous work as "policy levers."[34] In some instances, regulatory texts can be written sufficiently openly or flexibly so as to facilitate their application to unexpected new factual situations, particularly unexpected new technologies.[35] Because some future situations cannot be predicted with any certainty, the legislature can empower courts or other legal authorities to apply a flexible text as needed to achieve the desired outcome. In work with Mark Lemley, I have argued that such policy levers are critical to the innovation incentives of the patent system; because technology is dynamic, the proper scope and frequency of patent rewards cannot be predicted.[36] Open texts allow the patent incentive to be calibrated on an ongoing basis.

In the case of loopholes, the opposite occurs: the regulated entity takes advantage of ambiguities or open language in the text in order to modulate its activity into formal compliance with the textual requirements. Indeed, in some situations, much as a legislature will use open text to empower future application of policy levers, regula-

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31. *See, e.g.*, Oliver Hart & John Moore, *Incomplete Contracts and Renegotiation*, 56 ECONOMETRICA 755, 755 (1988) (discussing the textual limitations of contracts).

32. *See id.* at 756.

33. *See id.* at 775-76.

34. *See, e.g.*, DAN L. BURK & MARK A. LEMLEY, THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT 109 (2009); Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1579 (2003).

35. *See* BURK & LEMLEY, *supra* note 34, at 109.

36. *See id.* at 104-05.

tors may purposely calibrate regulatory texts so as to prompt innovative private work-arounds.[37] This tactic might be used to prompt any number of socially desired behaviors, but here I am concerned with situations in which the state purposefully imposes restrictive regulation specifically in order to prompt product innovation.[38]

For example, a combination of penalties and disincentives in U.S. federal law served to effectively curtail manufacture and sale of incandescent light bulbs, forcing development of compact fluorescent, LED, and halogen alternatives.[39] Similarly, the CAFE standards, mentioned above in conjunction with the PT Cruiser, were expected to produce some fuel efficiencies through innovation by forcing manufacturers to develop better fuel consumption technologies.[40] Technical redesign in response to such regulation may be a form of regulatory compliance, anticipated by the regulatory structure. However, perverse innovation stems largely from the unanticipated use of loopholes, as in the case of the PT Cruiser, or from the use of unanticipated loopholes, as in the case of mutagenic European Union crops. Loopholes in the regulation of European GMOs and American fuel efficiency produced behavior that is formally compliant with the text of the regulation, but which may defeat, or at least avoid, the regulatory purpose. Regulators can of course

37. *See id.* at 109.

38. I note that, in a similar vein, a number of scholars have begun to recognize that open or flexible contract language often allows the parties to better perform under conditions of uncertainty. *See* Wendy Netter Epstein, *Facilitating Incomplete Contracts*, 65 CASE W. RES. L. REV. 297, 297 (2014); Michal Shur-Ofry & Ofer Tur-Sinai, *Constructive Ambiguity: IP Licenses as a Case Study*, 48 U. MICH. J.L. REFORM 391, 391 (2015).

39. *See* Energy Independence and Security Act of 2007, Pub. L. No. 110-140, § 321, 121 Stat. 1492, 1573 (2007). Other nations have adopted similar regulations. *See* Manuel Frondel & Steffen Lohmann, *The European Commission's Light Bulb Decree: Another Costly Regulation?*, 39 ENERGY POL'Y 3177, 3177 (2011).

40. This could happen through two interrelated effects: the standards could change the direction of fuel efficiency technology or could change the rate of adoption of fuel efficiency technology. While there is consistent evidence of the former effect, evidence of the latter effect is mixed. *Compare* Don MacKenzie, Mass. Inst. of Tech., Do Automotive Fuel Economy Standards Increase Rates of Technology Change?, Presented at 31st USAEE/IAEE North American Conference 1 (Oct. 2012), http://faculty.washington.edu/dwhm/files/MacKenzie%20CAFE%20Standards%20and%20Technology%20Change.pdf [https://perma.cc/D9VC-NCTE] (finding no evidence that CAFE standards changed the rate of technology adoption), *with* Thomas Klier & Joshua Linn, *The Effect of Vehicle Fuel Economy Standards on Technology Adoption* 2 (Res. for the Future, Discussion Paper No. 13-40-REV2, 2015), http://www.rff.org/ files/ document/file/RFF-DP-13-40-REV2.pdf [https://perma.cc/386U-K2X5] (finding that CAFE standards affected both the direction and adoption rate of fuel efficiency technologies).

amend the text to cover these after-arising situations, but the amendment process will typically be costly and will only be undertaken periodically.[41] Alternatively, the policy lever approach can be used to combat contrary loopholes; a court or administrative agency can be given interpretive authority to try to close loopholes ex post. Of course, either amending or interpreting the text to cover previously uncontemplated behaviors may lead to a sort of extended cat-and-mouse game in which the regulator is continually trying to catch up with the latest evasion devised to get around the text. As a practical matter, the game of loophole exploitation and loophole mending for any given regulation may be unending.

### *A. Loophole Incentives*

Since loopholes are unavoidable and often unforeseeable, the question I pursue here is whether otherwise perverse loophole exploitation can be channeled into activity that will tend to be productive rather than detrimental.[42] This requires some thinking about the incentives that prompt behaviors that take advantage of loopholes, and how such incentives might be modified. Timothy Wu has pointed out in a different context that responses to regulation can be thought of as an exercise in least cost avoidance.[43] Regulated entities will assess the costs of different responses to regulation.[44] An entity subjected to regulation might comply with the expected requirements of the regulation as formally stated in the text of the regulation. In the majority of regulatory situations, this type of compliance is the expected behavioral change envisioned by the regulator. But it will occur only if it is the least costly option.[45]

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41. *See* Daniel Carpenter, *Changing the Conversation About Regulation*, WASH. MONTHLY (Mar./Apr./May 2016), http://washingtonmonthly.com/magazine/maraprmay-2016/changing-the-conversation-about-regulation/ [https://perma.cc/L7V2-ZFQZ] (noting that regulations are seen as a necessary evil and outdated but that few changes are made).

42. *See infra* Part III.

43. *See* Timothy Wu, *When Code Isn't Law*, 89 VA. L. REV. 679, 682 (2003). Wu's analysis is a variant on the classic economic "least cost avoider" argument for placing legal liability on the actor able to avoid social costs at the overall lowest social cost. *See* Guido Calabresi & John T. Hirschoff, *Toward a Test for Strict Liability in Tort*, 81 YALE L.J. 1055, 1060 (1972); Harold Demsetz, *When Does the Rule of Liability Matter?*, 1 J.L. STUD. 13, 28 (1972).

44. *See* Wu, *supra* note 43, at 684.

45. *See id.* at 688.

As an alternative, the regulated entity may instead choose to disobey the regulation and accept whatever penalty accompanies noncompliance. Typically, regulations will entail penalties thought to be sufficient to prompt compliance, but in individual circumstances accepting the penalty may be cheaper than compliance, particularly if the penalty cost is discounted by the probability of discovery and enforcement.[46] There is also a third possibility, which is that the regulated entity could attempt to avoid both compliance and penalty by changing the regulation—perhaps by means of a court challenge, or perhaps by means of lobbying the relevant agency or the legislature. Public choice theory teaches us that entities subject to regulation will choose to comply, to disobey, or to invest in lobbying depending on which option is the cheapest.[47]

In addition to the latter two strategies—either to evade the regulation via noncompliance or to avoid the regulation via legislative lobbying—Professor Leo Katz points out that regulated entities may pursue a fourth option, which he dubs "avoision," a portmanteau word combining evasion and avoidance.[48] Avoision constitutes a type of formal compliance, or at least an ostensible change in behavior, but is not necessarily the type of compliance the regulator might have anticipated. In other words, avoision constitutes exploiting a loophole.[49] In this instance, the subject of regulation looks for cheaper *compliant* alternatives to the anticipated requirements of the regulation. As Wu points out, when the regulatory text allows such cheaper alternatives, and they are cheaper than the first three responses, then avoision rather than the expected regulatory behavior will result.[50]

This least cost avoidance model is helpful in understanding the occurrence of perverse innovation. To understand the implications of the model, a good starting place is the type of deliberately restrictive regulation mentioned above, which employs penalties to create incentives to innovate.[51] In such instances, innovation to

46. *See* RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 277-78 (8th ed. 2011).

47. MANCUR OLSON, THE LOGIC OF COLLECTIVE ACTION 9-11 (2d ed. 1971).

48. *See* LEO KATZ, ILL-GOTTEN GAINS: EVASION, BLACKMAIL, FRAUD, AND KINDRED PUZZLES OF THE LAW 4 (1996).

49. *See id.* at 16-17.

50. *See* Wu, *supra* note 43, at 692.

51. *See supra* notes 39-40 and accompanying text.

avoid the legal penalties for employing the disfavored technology is exactly what is anticipated by the regulator. But the desired innovation only occurs when innovation is cheaper than the penalty for maintaining the prohibited status quo—in the case of CAFE standards, for example, a few automobile manufacturers have opted to pay fines for violating the standards rather than alter the design of their products.[52]

Ian Ayres and Amy Kapczynski have considered the incentives related to some of these examples—specifically, the CAFE fuel efficiency standards and the incandescent light bulb phaseouts—in the context of penalties that are imposed for failure to innovate.[53] They contrast such regulatory penalties with regulatory reward systems, such as grants or intellectual property rights, most often associated with incentives to innovate.[54] Ayres and Kapczynski argue that regulatory "sticks" or penalties may sometimes be as effective to promote innovation as the more customary regulatory "carrots" or rewards.[55] Admittedly, as they acknowledge, it is often difficult to tell carrots from sticks; withholding a government benefit such as a tax credit might be as much a penalty as imposing a regulatory fine.[56]

Wu's framework of least cost avoidance, drawn as it is from criminal jurisprudence, applies fairly directly to avoidance of such sticks or penalties. Its application is similarly straightforward in cases where rewards and penalties are hard to distinguish. Gaining a tax credit for research and development can also be seen as avoiding a tax penalty for failing to invest in the specified type of research and development; under either formulation regulated actors will engage in much the same calculus of compliance, avoidance, evasion, or avoision no matter how the tax incentive is viewed.[57] Additionally, the least cost avoidance framework extends beyond explicit legal

52. *See* U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-07-921, VEHICLE FUEL ECONOMY: REFORMING FUEL ECONOMY STANDARDS COULD HELP REDUCE OIL CONSUMPTION BY CARS AND LIGHT TRUCKS, AND OTHER OPTIONS COULD COMPLEMENT THESE STANDARDS 24 (2007).

53. *See* Ian Ayres & Amy Kapczynski, *Innovation Sticks: The Limited Case for Penalizing Failures to Innovate*, 82 U. CHI. L. REV. 1781, 1781 (2015).

54. *See id.* at 1794, 1798.

55. *See id.* at 1799-803.

56. *See id.* at 1800-01.

57. *See id.* at 1799, 1801.

rewards or penalties to assess behavior vis-à-vis any legal constraint—to regulatory scenarios in which no defined reward or penalty was contemplated. Thus, restrictive regulation of GMO crops might be viewed as a "penalty" for investing in such technology, or as creating a "reward" for switching to mutagenic crops, but seems best viewed as creating a formal constraint that invites technical avoision.[58]

Perhaps surprisingly, a least cost avoidance framework also functions in the context of regulatory rewards, at least where the regulatory rewards constitute exclusive rights.[59] Limited periods of market exclusivity in the form of systems of intellectual property rights are certainly the most readily recognized rewards for innovation.[60] But these carrots come bundled with sticks.[61] Unlike other innovation carrots such as a grant or tax benefit, which can be simultaneously enjoyed by any innovator who meets the regulatory criteria, intellectual property rights differentiate among innovators.[62] Intellectual property law offers a reward to only one innovator who holds the exclusive rights.[63] In the case of patents, for example, the reward generally goes to the first qualifying patent applicant.[64] Other, subsequent competitors, even if they are innovating, are excluded and so are effectively penalized for applying later in time.[65]

### *B. Cost Complexities*

Determining which of these alternatives will be the cheapest, preferred choice can be complex. The choice of response to a given regulation will be determined by the total cost of a particular alternative,[66] and multiple overlapping regulations may impose conflicting costs. For example, the avoision of EPA CAFE emissions

58. *See infra* Part II.

59. *See infra* Part III.

60. *See generally* Dan L. Burk, *Law and Economics of Intellectual Property: In Search of First Principles*, 8 ANN. REV. L. & SOC. SCI. 397 (2012) (reviewing incentive theories of intellectual property).

61. *See* Ayres & Kapczynski, *supra* note 53, at 1811.

62. *See id.* at 1782-83.

63. *See* Burk, *supra* note 60, at 399.

64. *See* 35 U.S.C. § 102(a)(2) (2012).

65. *See id.*

66. *See* Wu, *supra* note 43, at 688-89.

standards for passenger vehicles, mentioned above,[67] is complicated by a set of tax incentives—and disincentives—relating to the production and import of light trucks.[68]

As a class, light trucks and sport-utility vehicles (SUVs) are exempt from a U.S. federal manufacturing excise tax for "gas guzzlers," entirely apart from their position in the EPA's fleet emission standards requirements.[69] Accordingly, a design that places a vehicle into this class not only accrues a less burdensome emission standard, but it also incurs a tax benefit. At the same time, light trucks are also subject to the so-called "chicken tax," an import tariff imposed on imported trucks during the 1960s by the Johnson Administration in retaliation for French and German import duties on American chickens.[70] Since the Johnson Administration, car companies have increasingly manufactured many "American" brand automobiles outside the United States to take advantage of lower manufacturing and labor costs.[71] To enjoy the savings of manufacturing abroad while avoiding the onerous "chicken tax" import duties on light trucks, Ford Motor Company imports one light truck model as a passenger vehicle, then, after its arrival in the United States, strips out the rear seats and seatbelts to convert the vehicle into a light truck.[72]

Such a scheme only becomes attractive if the private savings from offshore manufacturing, minus the cost of reconfiguring the vehicles, plus the savings from avoiding the import tariff, generate a more attractive profit than would domestic manufacture. But, from a social welfare perspective, this seems to be a highly perverse

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67. *See supra* notes 26-30 and accompanying text.

68. *See infra* notes 73-74 and accompanying text.

69. *See* David L. Greene et al., *Feebates, Rebates and Gas-Guzzler Taxes: A Study of Incentives for Increased Fuel Economy*, 33 ENERGY POL'Y 757, 758 (2005).

70. Dan Ikenson, *Ending the "Chicken War": The Case for Abolishing the 25 Percent Truck Tariff* 1, 2 (CATO Inst., Trade Briefing Paper No. 17, 2003), http://object.cato.org/sites/cato.org/files/pubs/pdf/tbp-017.pdf [https://perma.cc/VM6A-U69T].

71. *See* Jenny Strieter, *Buying "American" Could Mean Buying Foreign*, U.S. NEWS & WORLD REP. (Mar. 13, 2013, 12:46 PM), http://usnews.rankingsandreviews.com/cars-trucks/best-cars-blog/2013/03/Buying_American_Could_Mean_Buying_Foreign/ [https://perma.cc/8MCC-GB4Q].

72. *See* Matthew Dolan, *To Outfox the Chicken Tax, Ford Strips Its Own Vans*, WALL ST. J. (Sept. 23, 2009, 12:01 AM), http://www.wsj.com/articles/SB125357990638429655 [https://perma.cc/H7KY-TL2V].

design work-around, wasting a good deal of time, material, and effort to convert imports from one classification to another.

## II. TECHNOLOGICAL AVOISION

If we are to determine when a regulated entity is likely to choose avoision rather than noncompliance or lobbying as the least cost choice, and also determine how to avoid rewarding socially detrimental avoision such as Ford's response to the chicken tax, then we must also give some consideration to the relative costs of different types of avoision. For example, we are somewhat accustomed to exploitation of loopholes in areas such as tax or finance, where deals may be restructured or ownership reallocated so as to reduce tax liability or to circumvent other types of regulatory oversight.[73] Much of the activity typical of such avoision might be considered "ontological," in the sense of reclassifying the activity being regulated. Such reclassification is likely to be relatively low cost, involving relabeling an activity rather than the higher costs associated with redesigning or physically altering a product.[74]

Of course, to some extent, all avoision involves moving activity from one classification to another—if only from the category of regulated to that of unregulated. But purely ontological avoision simply switches labels and does not prompt the kind of innovative activity we are concerned with here. Paying a certain debt on January 1 rather than December 31, so as to advantageously move the debit into a different tax year, constitutes a pure category shift, requires minimal implementation costs, and generates no new physical artifacts. Such exploitation of tax and accounting loopholes might in some sense be considered quite creative and perhaps even ingenious. But whatever the merits of such nontechnical innovation, it will seldom if ever produce technological development.[75]

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73. *See* Sarah Stodola, *10 Giant Loopholes that Businesses Use to Dodge Taxes*, BUS. INSIDER (Feb. 10, 2011, 1:17 PM), http://www.businessinsider.com/corporate-tax-breaks-2011-2 [https://perma.cc/2XAB-2N44].

74. *See id.*

75. There is a related, long-standing debate in patent policy regarding whether incentives are really needed to prompt new forms of business practices. *See, e.g.*, Rochelle Cooper Dreyfuss, *Are Business Method Patents Bad for Business?*, 16 SANTA CLARA COMP. & HIGH TECH. L.J. 263, 263-65 (2000).

Nonetheless, awareness of purely ontological avoision allows us to recognize that, even within the subset of technological avoision, there exists a range of costs and complexity for tangible implementation. This is clear from the avoision examples discussed above. Changing the dimensions of the PT Cruiser to shift categories from "passenger vehicle" to "light truck" seems largely ontological rather than technical ingenuity.[76] If the design change requires additional or different materials than would be needed for a passenger vehicle, there may be some cost difference in producing the vehicle with the footprint of a light truck, but the numerical alteration seems very close to an accounting stratagem. On the other hand, developing mutagenic seed varieties to avoid the GMO regulatory category likely involves more than juggling numbers or shifting labels.[77] Changing methods of seed development requires the implementation of new procedures, new expertise, and perhaps even new apparatus.[78] This seems a more likely candidate to foster technical creativity, or at least the possibility of technical creativity.

### *A. Copyright Avoision*

Thus, in some circumstances, avoision may involve creative engineering rather than creative accounting. In particular, where a regulation specifies certain technological parameters—such as a certain definition of "genetically modified organism"—loopholes or unregulated spaces in the statute may be exploited by technical redesign.[79] In his discussion of least cost avoidance, Timothy Wu explores the motivation for legal loopholes to produce technological avoision.[80] Following the framework set out by Lawrence Lessig's analysis of law and technology,[81] Wu observes that both formal law and technological design can be constraints on behavior, and are to some degree interchangeable for achieving behavioral outcomes. This equivalence implies that avoision may occur by restructuring technology rather than by restructuring behavior where technologi-

76. *See supra* notes 26-30 and accompanying text.
77. *See supra* notes 1-14 and accompanying text.
78. *See supra* note 14 and accompanying text.
79. *See* Wu, *supra* note 43, at 708.
80. *See id.* at 682.
81. *See generally* LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE (1999).

cal restructuring is less costly than compliance.[82] In other words, technical innovation may occur in response to regulation when compliance, disobedience, and lobbying are more expensive.

Wu's case study for technological avoision is the development of peer-to-peer file-sharing systems in the wake of the Ninth Circuit Court of Appeals' *Napster* decision, which held that the purveyors of the Napster peer-to-peer file-sharing system were contributorily and vicariously liable for copyright infringement.[83] The conclusion of secondary copyright liability was a direct consequence of the particular technological design of the Napster system. The individual computing devices connected in a peer-to-peer system, rather than communicating through a central hub, communicate directly with one another. But the Napster system featured a centralized database listing the files resident on the system; users accessed the database to determine which files they wished to share or acquire, then exchanged files directly between their individual machines. The presence of this centralized indexing feature led the Ninth Circuit to conclude that Napster had the ability to monitor both who was using its system and which files were accessible by means of the system.[84] Such knowledge of infringing activity is a key component of secondary copyright liability, and led inevitably to the finding of infringement.[85]

Given that secondary liability was premised on the centralized features of the Napster system, it is no surprise that such features were notably absent from the next generation of peer-to-peer file-sharing software.[86] Napster's successors, such as Grokster and KaZaa avoided any centralized monitoring or control point in their peer-to-peer architectures, adopting more fully distributed designs that dispersed not only content but also indexing among multiple network nodes.[87] Consequently, when the developers of these systems were sued on the same theory as the Napster lawsuit, they

82. *See* Wu, *supra* note 43, at 681-83.

83. A&M Records, Inc. v. Napster, Inc., 239 F.3d 1004, 1020-24 (9th Cir. 2001).

84. *Id.* at 1021-24.

85. Stacey L. Dogan, *Is Napster a VCR? The Implications of* Sony *for Napster and Other Internet Technologies*, 52 HASTINGS L.J. 939, 949 (2001).

86. REBECCA GIBLIN, CODE WARS: 10 YEARS OF P2P SOFTWARE LITIGATION 29-33 (2011).

87. *Id.* at 73-74; Lior Strahilevitz, *Charismatic Code, Social Norms, and the Emergence of Cooperation on the File-Swapping Networks*, 89 VA. L. REV. 505, 517 (2003).

were able to assert quite truthfully that they had no means of knowing who or what was on their system at any given time. Because they had no ability to monitor or control the use of their systems, they could not be secondarily liable for infringing activity as Napster had been. This defense was perversely successful; the United States Supreme Court acknowledged that Grokster lacked the necessary knowledge and control needed for contributory infringement, and instead invented and imposed a new form of secondary liability, dubbed inducement, which required no centralized features to trigger liability.[88]

*B. Avoiding Public Transmissions*

More recently, I have noted that a similar pattern of technical redesign is seen in the Supreme Court's recent *American Broadcasting Companies v. Aereo, Inc.* decision.[89] My analysis of Aereo's technical work-around provides a foundation for considering technological avoision as a general matter: much as Grokster and similar peer-to-peer services developed new architectures to avoid the legal definition for secondary liability, the Aereo service developed a new technical architecture in order to avoid copyright law's definition of public performance.[90] Among other exclusive rights, the U.S. copyright statute grants copyright holders an exclusive right of public performance for their protected works. Judicial interpretation of that provision had previously held that the public performance right does not encompass an individually stored recording of a broadcast television show, accessed by a particular user at that user's discretion.[91] Rather, such an individually controlled transmission was held to constitute a private performance outside the ambit of the copyright holder's exclusive right.

The Aereo service provided its subscribers with retransmission of over-the-air broadcast television programming, by means of Internet streaming.[92] Taking advantage of the judicial characterization of

88. MGM Studios, Inc. v. Grokster, Ltd., 545 U.S. 913, 934-37 (2005).
89. 134 S. Ct. 2498 (2014).
90. Dan L. Burk, *Inventing Around Copyright*, 109 NW. U. L. REV. 547, 550-51 (2015).
91. Cartoon Network, LP v. CSC Holdings, Inc., 536 F.3d 121, 139 (2d Cir. 2008).
92. *Aereo*, 134 S. Ct. at 2503.

noninfringing private transmission, Aereo designed a technical system that incorporated thousands of tiny antennae that received broadcast programming, and each of which was assigned to an individual subscriber.[93] The antenna signals were either transmitted directly to its assigned subscriber via Internet streaming media or stored in an individual recording accessible only to the particular subscriber.[94] Thus, every step of the Aereo transmission service was designed to permit only private performances, by individualizing the reception and transmission technology, avoiding—or complying with—judicial definitions of the rights of the copyright holder as articulated in previous copyright decisions.

The copyright owners of broadcast programs challenged the legitimacy of the Aereo service in an infringement suit that was rejected by a majority of a Second Circuit Court of Appeals reviewing panel. The majority agreed that Aereo's system complied with its previous decisions on public performance, providing only a private transmission.[95] The third panel judge, Judge Chin, remained unconvinced, asserting in an outraged dissent that the Aereo system design was an "over-engineered," "Rube Goldberg" contraption, created solely to avoid the letter of the copyright statute.[96] This conclusion rested in part on the observation it might well have been more efficient to design a service for streaming and recording broadcast with a single receiving antenna, rather than Aereo's multiple antennae. Absent the previous judicial definition of public performance, Judge Chin believed that there was no particular reason to design the system with tiny individual receiving antennae except to avoid copyright holders' exclusive rights. Ultimately, the Supreme Court largely agreed, rejecting the Aereo system's "technological differences" as

93. Cecilia Kang & Robert Barnes, *Supreme Court to Decide on Aereo, an Obscure Start-Up that Could Reshape the TV Industry*, WASH. POST (Apr. 21, 2014), https://www.washingtonpost.com/business/technology/2014/04/21/50bbd1e8-c59d-11e3-9f37-7ce307c56815_story.html [https://perma.cc/W42V-3JCK].

94. *Aereo*, 134 S. Ct. at 2503.

95. WNET, Thirteen v. Aereo, Inc., 712 F.3d 676, 693 (2d Cir. 2013).

96. *Id.* at 697 (Chin, J., dissenting). Judge Chin's reference to a "Rube Goldberg" design invokes the cartoonist famous for illustrating ridiculously complicated and improbable mechanisms for producing simple results. *See* MAYNARD FRANK WOLFE, RUBE GOLDBERG INVENTIONS 8-9 (2000).

immaterial to the question of public performance, and holding Aereo liable for infringement.[97]

### *C. Private and Social Costs*

As with the other examples of avoision described above, the technical innovation that occurred in the cases of *Grokster* or *Aereo* was certainly not contemplated within the original purposes of the statute that animated their creation. The copyright statute is intended to promote creative works, not to promote advances in the structure of the technology that transmits such works.[98] Copyright law is for the most part not associated with technological innovation—most copyrightable subject matter, such as painting, dance, drama, or poetry, lies within the areas of artistic or aesthetic creation.[99] Computer software is an exception to this rule, but even in the case of computer software, copyright is expected to cover only the expressive portions of the code (if any)—not the functional or technical portions.[100]

Perverse incentives to technically innovate around the loopholes in the American copyright statute therefore demonstrate an extreme variety of avoision, in which the statute promotes a kind of innovation that lies entirely outside its subject matter. Perverse innovation is by definition never what was contemplated by the law, but, where copyright is concerned, technical innovation of any sort is not a statutory goal. The oddly dimensioned PT Cruiser may not have been the outcome envisaged by the CAFE regulations, but the PT Cruiser is still a vehicle within the statute's purview.[101] Mutated crop varieties may not have been an outcome anticipated under GMO crop regulations, but they are still crops.[102] By contrast, the Aereo system is not a copyrighted work at all.[103]

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97. *Aereo*, 134 S. Ct. at 2507.

98. *See, e.g.*, Julie E. Cohen, *Creativity and Culture in Copyright Theory*, 40 U.C. DAVIS L. REV. 1151 (2007) (discussing the statutory goal of promoting creativity through copyright law).

99. *See* 17 U.S.C. § 102(a) (2012) (listing categories of copyright subject matter).

100. *See* Pamela Samuelson et al., *A Manifesto Concerning the Legal Protection of Computer Programs*, 94 COLUM. L. REV. 2308, 2323 (1994).

101. *See supra* notes 26-30 and accompanying text.

102. *See supra* notes 8-17 and accompanying text.

103. *See supra* notes 98-100 and accompanying text.

At the same time, the Aereo system has an impact on the goals of the statute that prompted its creation. Technical designs that circumvent the copyright definition of public performance are not only unanticipated, but may perversely diminish the scope of exclusivity conferred by the law on the copyright holder. This suggests two dimensions or components to the social cost of avoision in the *Aereo* case: the social cost of an outcome that is not the law's expected outcome, and the social cost of the method by which such avoision is achieved. Technological avoision in copyright has the potential to undermine aspects of the system's existing incentive structure. In other words, the total cost of perverse innovation in copyright may depend on whether a given innovation nibbles away at the existing regulatory carrot.

For purposes of this Article, I dispense with consideration of the second kind of cost. It is not a generalized problem for perverse innovation, as it will occur only in those instances in which there is an existing regulatory carrot. In the case of copyright, such nibbling costs are historically endogenous to the balance of interests in copyright.[104] As Jessica Litman has pointed out, as a historical matter, new communications technologies routinely grow up outside the purview of the copyright statute.[105] Phonographs, photography, movies, radio, and other technical media were initially held to fall outside the ambit of copyright even though they incorporated creative work that might otherwise be subject to copyright.[106] None of them appear to have been developed in response to copyright loopholes, but they flourished within such loopholes.[107] Only later were these media brought within statutory copyright.[108] Historically, the copyright system has, via statutory reform, been well able to deal with the question of exclusivity in innovative media.[109]

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104. These types of costs have been the subject of a number of other copyright-oriented examinations based on the *Aereo* decision. *See, e.g.*, Rebecca Giblin & Jane C. Ginsburg, *We (Still) Need to Talk About* Aereo*: New Controversies and Unresolved Questions After the Supreme Court's Decision*, 38 COLUM. J.L. & ARTS 109, 109-11 (2015); Glynn S. Lunney, Jr., Aereo *and Copyright's Private-Public Performance Line*, 162 U. PA. L. REV. ONLINE 205, 205-06 (2014); Ira Steven Nathenson, Aereo*'s Errors*, 2 J. INT'L & COMP. L. 171, 197-98 (2014).

105. *See* JESSICA LITMAN, DIGITAL COPYRIGHT 106-07 (2001).

106. *See id.*

107. *See id.*

108. *See id.* at 106.

109. *See supra* notes 90-91 and accompanying text.

The Aereo and Grokster situations are unusual because the statute prompted the new media through avoision. When we set aside questions of interference with existing carrots, the general question then becomes that articulated by Judge Chin in his *Aereo* dissent: whether the perverse innovation, directed toward avoiding its animating regulation, rather than toward expected compliance, is socially useful or socially detrimental.[110] Often it may be the latter. I have already suggested that it is probably not in the general social interest to have Ford tear out the seats of what are nominally imported passenger cars to produce light trucks, or to fill the shelves of European grocers with mutagenic produce having unknown qualities, even if these are the least costly options for the actors engaged in such avoision.[111] These activities seem not merely to perversely circumvent statutory intent, but to do so in a perversely costly manner.

But it is not at all clear that the statutory circumvention leading to the peer-to-peer Grokster architecture or to the Aereo multiantenna reception system imposes the same type of costs. These outcomes seem to lie elsewhere on a continuum of avoision. Redesign of the PT Cruiser footprint seems very close to ontological avoision along the lines of tax or accounting loopholes: a superficial, probably low-cost change in numbers, merely to achieve reclassification.[112] The teardown of Ford vehicles seems a rather expensive alteration merely to achieve reclassification, and involves no new technical development at all. But the engineering of the Grokster and Aereo systems, along with perhaps the example of the mutagenic seeds, generates a more innovative, or at least novel, product with the potential for whatever benefits we value from technical innovation.[113]

Of course, Judge Chin may be correct that the latter products are unnecessary or are inefficient over designs that might have been produced without the avoision motive. But even if orthogonal to the purposes of the statute that prompted them, such products appear to be technically innovative, rather than merely ontologically clever.

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110. *See* WNET, Thirteen v. Aereo, Inc., 712 F.3d 676, 697 (2d Cir. 2013) (Chin, J., dissenting).

111. *See supra* notes 11-17, 75-76 and accompanying text.

112. *See supra* Parts II.A-B.

113. *See supra* Parts II.A-B.

Thus, whatever the comparative merits of such specific examples, they suggest that in some cases redesign results not merely in ontological avoision, but also in production of a new technology outside the ambit of the existing legal scheme. Indeed, the CAFE limits discussed above appear to produce both types of avoision: changes in the PT Cruiser footprint to achieve reclassification, but perhaps also some technological efficiencies in fuel combustion, as was intended by the passage of the statute.[114]

Returning to Wu's least cost avoidance framework, we can recognize from these examples that there may at times be a disjunction between the public and private cost of avoision—the lowest cost option for a particular actor may not be the lowest cost option for society generally. Indeed, the choice that minimizes the cost to a given regulated actor might well be socially wasteful. For perverse avoision to be guided toward social benefit, public and private valuations should align. If socially beneficial innovative avoision sometimes occurs, the question is whether it is possible to identify and optimize such avoision so as to minimize the socially wasteful variety. One potential method for separating wasteful and beneficial avoision may come from the treatment of parallel types of innovation in the area of patent law.

## III. LESSONS FROM PATENT LAW

Technologically innovative avoision appears largely independent of the innovation purposes of the technological regulation that prompts it. We have seen that such avoision appears in the examples of European GMO policy, which was not intended to foster technical innovation, and American copyright law, which is primarily intended to foster expressive creativity. It also appears in the example of U.S. EPA fuel efficiency policy, which *was* intended to foster technical innovation by means of regulatory *penalties*. But perhaps surprisingly, directed technological perversity is a familiar feature of the law most often associated with innovation *incentives*, which is the law relating to patents.

114. *See* David L. Greene, *Why CAFE Worked*, 26 ENERGY POL'Y 595, 610 (1998).

Patent law has long entailed an expectation that competitors to a patent holder will "invent around" the claims of the patent. The scope of a patent holder's rights are defined in the patent document by textual claims that recite the features of technology intended to be covered by the patent. The exclusive rights conferred by the patent include any unauthorized making, using, selling, offering for sale, or importing technology that falls within the claims.[115] Competitors engaging in these activities may be liable as infringers. One way to avoid infringement liability is to invest in developing substitute technologies that do not have the precise features recited in the claims. Development of such substitutes in effect "invents around" the obstacle posed by the text of the patent claims.[116]

This activity is of course a form of technological avoision, intended to deliberately circumvent the patent claims, just as the other examples we have seen are intended to deliberately circumvent statutory texts. Such inventing around in patent law is, like technological avoision generally, and indeed like any textual loophole that takes advantage of the incompleteness of the text, driven by textual formalism. Because patent rights are defined by written claims, determining the scope of the claims requires interpretation.[117] Current interpretive practice almost invites avoision. In an earlier era, patent disclosures were interpreted purposively, according to what the inventor accomplished and intended, and what courts deemed a fair scope of protection for the inventor's efforts.[118] But as patent claims have come to represent the outermost definitive limits of patent holder's rights, this approach of "central claiming" has been replaced by "peripheral claiming" which purports to give a strict meaning to the text.[119]

Thus, under current interpretive rubrics, the first step in patent claim construction is deciding the literal meaning of the claims—

115. 35 U.S.C. § 271 (2012).

116. *See* Paul N. Katz & Robert R. Riddle, *Designing Around a United States Patent*, 45 S. TEX. L. REV. 647, 649 (2004).

117. *See* Dan L. Burk, *Dynamic Claim Interpretation*, *in* INTELLECTUAL PROPERTY AND THE COMMON LAW 107 (Shyamkrishna Balganesh ed., 2013) (discussing formalism in claim interpretation).

118. *See* Dan L. Burk & Mark A. Lemley, *Fence Posts or Sign Posts? Rethinking Patent Claim Construction*, 157 U. PA. L. REV. 1743 (2009).

119. *See generally id.*

that is, to assign discrete denotations to words or phrases within the text.[120] Such peripheral claim construction is intended to be both technologically inclusive and exclusive. Literal claim construction purports to define a conceptual boundary that designates not only what technology is covered by the patent, but also what technology is not covered by the patent. Technologies that lack each and every element found in the text of the claims, or that arrange the elements of the claims in some substantially different way, fall outside the formal denotation of the text. Technologies outside the textual periphery are not considered infringing.

Competitors to the patent holder are considered perfectly justified in developing or adopting noninfringing alternatives that lie outside the interpretive boundaries of the claims. A technological design that intentionally skirts the patent holder's rights may be viewed as a proper or desirable response to the competitive obstacle posed by patent exclusivity. Patents are considered something of a necessary evil, providing an exclusive reward for innovative activity, but at the same time potentially burdening access to the patented technology. Consequently, patent owners are considered to be entitled to the full scope of their exclusive rights, but no more than that.

Indeed, far from frustrating or eluding the intent of the patent, inventing around may be viewed as furthering important goals of the patent system. Such activity has been particularly touted by the United States Court of Appeals for the Federal Circuit as a spur to innovation. The court has repeatedly suggested that rights which may be viewed as impediments to competitors actually force competitors to become more innovative in the course of avoiding infringement.[121] This inventing around rationale suggests that patents not only constitute a direct reward for innovation, but also somewhat perversely spur innovation by an alternative, adjunct effect, as others seek permissible alternatives to the legally encumbered technology. On this view, patents promote innovation not only via

120. *See* Autogiro Co. of Am. v. United States, 384 F.2d 391, 395-96 (Ct. Cl. 1967) (explaining claim interpretation).

121. *See, e.g.*, Yarway Corp. v. Eur-Control USA, Inc., 775 F.2d 268, 277 (Fed. Cir. 1985); State Indus., Inc. v. A.O. Smith Corp., 751 F.2d 1226, 1236 (Fed. Cir. 1985); Kimberly-Clark Corp. v. Johnson & Johnson, 745 F.2d 1437, 1457-58 (Fed. Cir. 1984).

the carrot of exclusive rights in a meritorious invention but also via the stick of infringement liability for those who stray into the protected area of the claims.

### *A. The Cost of Inventing Around*

If this view of inventing around is correct, then assessing the benefits of such secondary innovation effects is complex, but helpful to understanding technological avoision generally. In particular, several key economic features of patent law's inventing around doctrine have been explored in the context of literature on patent racing and rent dissipation.[122] The phenomenon known as patent racing occurs in situations where two (or more) competitors invest resources into developing an invention, each seeking to be first to secure a patent. Patent racing may be wasteful if the competition to secure the patent leads to "rent dissipation," that is, to over-investment in invention development that offsets the future income from the exclusive rights attending the patent.[123] However, Mark Lemley has recently argued to the contrary that racing may be socially beneficial because patent races may develop alternatives to the patented technology. The availability of alternatives encourages competition, avoiding the potential monopoly stagnation of placing a broad swath of exclusive rights into the hands of a single patent owner.[124]

Nonetheless, the orthodox view of such races has been that both the private and social value of the patent might be overshadowed by expenditures to capture legal exclusivity.[125] This analysis gives some insight into the social value of inventing around. Inventing around may be regarded as a sort of patent race in which one of the parties has already won. In patent races, two innovators seek to be

122. *See* Michael B. Abramowicz, *Perfecting Patent Prizes*, 56 VAND. L. REV. 115, 119 (2003).

123. *See id.* at 185-86.

124. *See* Mark A. Lemley, *The Myth of the Sole Inventor*, 110 MICH. L. REV. 709, 753 (2012); *see also* Robert P. Merges, Commentary, *Rent Control in the Patent District: Observations on the Grady-Alexander Thesis*, 78 VA. L. REV. 359 (1992) (cautioning that preventing rent dissipation could curb beneficial competition).

125. *See* Mark F. Grady & Jay I. Alexander, *Patent Law and Rent Dissipation*, 78 VA. L. REV. 305, 309-10 (1992); Louis Kaplow, *The Patent-Antitrust Intersection: A Reappraisal*, 97 HARV. L. REV. 1813, 1869 (1984).

the first to claim a patent; in inventing around, the late coming competitor is left to develop a technological alternative to the patent that has already been granted.[126] In terms used by Ayres and Kapczynski, the follow-on innovator is no longer seeking to claim the carrot, which has already been claimed, but rather to avoid the costs of the licensing (or infringement) stick.[127]

Thus, as in patent racing, wasteful inventing around might occur when a competitor over-invests in avoiding the patent claims covering the existing technology. The follow-on competitor may perhaps not be re-inventing the wheel, but is at least re-inventing an unclaimed variation on the wheel. If the unpatented variation essentially duplicates the functions of the patented version without providing a significant advance in the art, then avoiding the license may not advance social welfare. In such cases there may be private value in avoiding a license to the claimed invention, but little public value from the investment necessary to do so.

However, as highlighted by Lemley's characterization of patent racing, simply having an alternative may itself be valuable, as substitutes help to deter detrimental monopolies.[128] Substitutes, of course, accomplish this by undercutting the market power of the patent holder, and so diminish the returns the patent holder can expect from her investment in innovation. The degree to which this will be true will depend on the degree to which the follow-on alternative is a true substitute, and the calculus of social welfare will be the usual guesstimate balancing innovation incentives and impediments to competition. However, if the Federal Circuit is to be believed, there are at least some instances in which the technological alternative will be an advance on the prior technology, so that the benefits of innovation and of competition both weigh in favor of inventing around. In such cases private loss to the patent holder fuels overall social welfare.

Some additional insight into the relative costs and benefits of inventing around can also be drawn from previous analyses of the related area of trade secrecy. Patent law is not unique in encouraging inventing around; the law of trade secrets, which penalizes

126. *See* Abramowicz, *supra* note 122, at 190.
127. Ayres & Kapczynski, *supra* note 53, at 1788 & n.29.
128. *See supra* note 124 and accompanying text.

misappropriation of confidential business information, is structured in such a way as to encourage similar productive circumvention of the proprietary right. Either reverse engineering or independent re-creation of proprietary information are considered permissible methods to obtain a trade secret.[129] The availability of these permissible options channels effort into inventive activity rather than into socially wasteful activity, such as industrial espionage.[130] So long as reverse engineering or independent re-creation of a trade secret is a lower cost alternative to the likely penalty for misappropriation, they will be the preferred option. Although such are duplicative of the knowledge held by the trade secret owner, they tend to be socially preferable to industrial espionage, as they encourage investment in human and firm expertise.

This least cost avoidance view of trade secrecy extends to the additional option of licensing the secret. The existence of permissible modes of obtaining otherwise confidential information places a natural cap on the cost of licensing a trade secret.[131] A trade secret holder cannot promise a licensee exclusivity, as the proprietary right offers no claims against reverse engineering or independent development. Trade secret licenses are therefore always bargains for disclosure, since the licensee could without a license opt to reverse engineer or independently create the secret himself. And, since these approaches are available as alternatives to disclosure, the cost of disclosure will rationally be set at something a bit less than the cost of the alternatives.[132] If the trade secret holder sets the price higher, the potential licensee will opt for the cheaper permissible alternatives.

This view of trade secrecy suggests a similar approach to understanding patent inventing around. Much as in trade secrecy, patent inventing around is unlikely to occur unless the patent holder and the competitor have very different estimations of the cost of devel-

129. *See* RESTATEMENT (THIRD) OF UNFAIR COMPETITION § 43 (AM. LAW INST. 1995).

130. *See* David Friedman et al., *Some Economics of Trade Secret Law*, 5 J. ECON. PERSP. 61, 70 (1991).

131. *See* Martin J. Adelman, *Property Rights Theory and Patent-Antitrust: The Role of Compulsory Licensing*, 52 N.Y.U. L. REV. 977, 984 (1977).

132. *See* Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 279 (1977).

oping an alternative technology.[133] If the valuations of inventing around are similar, the parties are likely to be able to negotiate a royalty for use of the patented technology that will be lower than the cost of inventing around. Both parties have incentives to reach such an agreement; the competitor will not wish to incur the inventing around cost if the royalty is cheaper, and the patent holder will be inclined to set the royalty low enough to avoid inducing the competitor to invent around. If the patent holder gets greedy, raising the price of a license or otherwise holding out, he may then have to deal with an invented around substitute that will undercut his exclusivity. Consequently, inventing around, when it occurs, in some sense represents a bargaining breakdown.

As both the economics of patent racing and those of trade secrecy suggest, the positive view of inventing around that I have outlined above entails a tricky allocation of economic surplus between the patent holder and the competitor.[134] The initial innovator who obtains the patent must be awarded sufficient surplus from the social value to motivate optimal investment in the patented item; this may include some of the value of follow-on innovation. At the same time, the follow-on competitor must be allocated enough surplus to ensure the necessary investment in beneficial inventing around, and private licensing may not accomplish this allocation properly. This suggests some risk that incentives for patent inventing around will be deficient. Just as inventing around may be socially wasteful if the private value to the competitor exceeds the social benefit of having a new alternative technology, so too *failure* to invent around may be socially wasteful where the private value of the license to the patent owner exceeds the social benefit of having the new technology.

### *B. Controlling Avoision Incentives*

This analysis of patent inventing around provides a useful perspective on technically innovative avoision. Some distinctions must be taken into account. Perverse innovation should not be expected

133. *See* Martin J. Adelman, *The Supreme Court, Market Structure, and Innovation*: Chakrabarty, Rohm and Haas, 27 ANTITRUST BULL. 457, 464 (1982).

134. *See* Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and Patent Law*, 5 J. ECON. PERSP. 29, 34-35 (1991).

to produce racing, at least not in the same sense that this occurs in patent inventing around. Avoision is not a race between competing private parties. The provisions of a public statute, rather than the claims of a private right, are the text around which perverse innovation will occur. If patent inventing around constitutes a race in which one of the parties has already reached the finish line, perverse innovation is perhaps a race in which the regulator has already won. The benchmark against which technical redesign may occur is not the scope of rights held by a competitor, but the default set by the regulation—perhaps the regulatory default is no incandescent light bulb production, or heavily impeded deployment of GMO crops. Thus, avoision does not occur from bargaining breakdown—the regulator is not in the market to license compliance, at least not ostensibly—but the threshold incentive structure is the same.

A sort of avoision "racing" may of course also occur between competing regulated entities; there will be multiple private parties constrained by the copyright statute, or by the CAFE requirements, or by GMO regulations. Each of them may independently seek to avoid the legal constraint via technical redesign. But in general such redesign is neither rivalrous nor exclusive. One party's design-around does not prevent another party's design-around; indeed, they may be duplicative or similar. The outcome of successful technical avoision is not the allocation of exclusive rights, and so the investment in avoision is not driven by the promise of exclusivity. Rather, the private reward for such innovation is the difference in cost between the innovative design and the cost of compliance, and this can accrue to multiple competitors.

### *C. Avoision Equivalents*

In the patent context, the allocation of surplus, and the problem of social waste, is in part addressed by ensuring that a competitor's circumvention of patent claims is not a trivial variation on the claimed invention, but must be significantly different from what is delineated in the claims. This is required by patent law's Doctrine of Equivalents (DOE), which prevents such trivial or obvious inventing around patent claims. Courts long ago realized that an overly

formalist reading of patent claims would render them essentially worthless, as potential infringers would find loopholes in the claims and make trivial changes that would fall outside a strict reading of the text, but which would effectively provide a market substitute for the claimed invention.[135] The DOE therefore developed to provide an additional zone of protection where the strict language of the claims might not.[136] The DOE therefore harks back to the era of central claiming, allowing a more purposive reading of the claims than strict peripheral claiming would provide.[137]

Under the DOE, a substitution that performs the same function in the same way with the same result as a patented item, even if not formally within the text of the claims, still infringes by equivalents, if not literally.[138] Thus, in order to avoid infringement, a competitor who is inventing around a patent will need to avoid known substitutions in order to avoid infringing the patent by equivalents.[139] The competitor must not merely invent around, but invent around by a substantial margin. Consequently, successful inventing around requires venturing at least somewhat into the unknown. Indeed, while a noninfringing substitution need not necessarily qualify for its own patent, the ambit of equivalents is demarcated by the patent inventiveness criterion of obviousness.[140] Successful circumvention of patent claims will therefore tend to require a substantial degree of innovation, and the investment that goes along with this requirement. Inventing around will occur only in the cost range where it is less expensive than taking a license, and also less expensive than developing a substantially different substitute.

Equivalence thus helps to separate desirable inventing around from wasteful inventing around. I have suggested in earlier work

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135. *See* Winans v. Denmead, 56 U.S. (15 How.) 330, 342-43 (1853).

136. *See* London v. Carson Pirie Scott & Co., 946 F.2d 1534, 1538 (Fed. Cir. 1991).

137. *See* Burk & Lemley, *supra* note 118, at 1772.

138. *See* Graver Tank & Mfg. Co. v. Linde Air Prods. Co., 339 U.S. 605, 608 (1950).

139. *See* Paul N. Katz, *The Doctrine of Equivalents and Its Impact on "Designing Around,"* 4 FED. CIR. B.J. 315, 323 (1994).

140. *See* Wilson Sporting Goods Co. v. David Geoffrey & Assocs., 904 F.2d 677, 684-85 (Fed. Cir. 1990) (holding that the permissible scope of equivalents cannot include embodiments that would have been obvious at the time of patenting); *see also* Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 741 (2002) (holding, in language similar to that defining nonobviousness, that prosecution history estoppel is based on the foreseeability of an equivalent to those of skill in the art).

that an equivalence standard might benefit technical innovation associated with copyright.[141] Certainly the Supreme Court in *Aereo* engaged in a type of purposive statutory reading, deeming Aereo's system to fall within the Congressional intent for cable systems, whatever the actual characteristics of the technology. This constitutes a type of equivalents standard, declaring the system to be essentially a substitute for a conventional cable transmission system as contemplated by the copyright statute.[142] The Court unfortunately did so without the benefit of the DOE's multipart functional analysis, or for that matter any cost-benefit balancing. The analysis focused only on the result of the Aereo service, not on its actual function or method of operation.[143] The outcome was therefore consistent with a theory of rewarding copyrightable creation, but without any serious consideration of the impact on non-copyright innovation or the impact on overall social welfare that might occur.

Evaluation on a patent DOE model might more comprehensively ask whether the Aereo antenna design accomplished the same result as a cable system, in the same manner as a cable system, by means of the same function as a cable system.[144] It seems fairly clear that the answer to at least two of these questions would be no: Aereo produced a result equivalent to that of a cable rebroadcast system, but clearly did so in a different way, employing different technological functions. This suggests that the Aereo redesign was substantial enough to constitute productive inventing around. An alternative version of the patent equivalents test would ask whether the antenna array was a known substitute for previous antenna apparatus.[145] Answering this inquiry might require some investigation into the engineering literature, but again I suspect the answer would be no, meaning that the change was substantial.

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141. *See* Burk, *supra* note 90, at 558-59.

142. Am. Broad. Cos. v. Aereo, Inc., 134 S. Ct. 2498, 2507 (2014). Ironically, having been declared a cable equivalent, Aereo was unable to secure treatment as a cable system for other purposes such as statutory licensing. *See* Annemarie Bridy, Aereo*: From Working Around Copyright to Thinking Inside the (Cable) Box*, 2015 MICH. ST. L. REV. 465, 473.

143. *See Aereo*, 134 S. Ct. at 2507.

144. *See* Katz, *supra* note 139, at 324.

145. *See* London v. Carson Pirie Scott & Co., 946 F.2d 1534, 1538 (Fed. Cir. 1991).

Adoption of a similar approach in other regulation would similarly help ensure that technological avoision in other regulatory arenas is socially productive. Language is imprecise and no regulator can anticipate all the loopholes. But unanticipated circumventions can be channeled in productive directions by adopting the rule that technical exploitation of a textual loophole should only be considered compliant with the underlying law if it is a nontrivial advance over what was contemplated. Returning to our previous examples, unless shifting the "footprint" measurement of an automobile involves real engineering challenges, the PT Cruiser seems a known or obvious substitution. On the other hand, mutagenesis methods may not necessarily be a known substitute for GMOs; the function and method of producing mutagenic plants appear different from the target of the GMO regulation, even if the result is similar to a GMO.

Applying an equivalents standard would raise the private cost of avoision, directing investment in statutory circumvention toward socially significant work-arounds. Avoision is always formally compliant with regulation, just as substituting an equivalent is always literally outside the language of a patent claim. The question in each case is whether the text should be read more broadly than its plain meaning, to encompass formally compliant activity that might nonetheless evade the regulatory purpose. In patent law, the DOE demarcates the limits of such broader readings, rewarding substantial inventing around by exempting it from the patent.[146] A parallel rule for avoision would draw a line encouraging productive avoision, sanctioning its formal compliance, and rewarding technical ingenuity by exempting it from the animating regulation.

## CONCLUSION

Perverse innovation is serendipitous, arising from technical ingenuity that is directed toward circumventing the formal terms of regulation. Although many regulations seek to prompt innovation, perverse innovation may flower where innovation was not the goal. Innovation in such instances constitutes something of a byproduct, a possibly useful result of regulation; just as water management

146. *See supra* notes 135-40 and accompanying text.

may also facilitate the yield of hydroelectric power, regulatory avoision may yield technical innovation. We know technical redesign will occur in some instances, and it may be better to channel such innovation in a useful direction than to have it run wild.

As I have shown here, harnessing the tendency to perverse innovation would require some forethought to balance the incentives toward the desired alternative. Innovating must be the least costly alternative, with literal compliance, lobbying, and noncompliance following in increasing cost order. A primary consideration in making innovation the least costly alternative requires the regulator to produce a relatively "clean" innovation loophole—that is, unlike the CAFE fuel efficiency classifications, one that is not complicated by an extended calculus of extraneous tax and regulatory duties. This requirement may not be simple, but it is of course not at all unique to scenarios of innovative avoision: more familiar legal schemes that are clearly intended to offer innovation incentives—for example, the patent system—are routinely complicated by tax credits, orphan drug incentives, and a host of other interlocking factors.[147] And, even when innovating is the least costly private alternative, there remains the concern that the innovation may be the wrong type of innovation, that is, an avoision that is socially wasteful. A key consideration toward ensuring that the avoision is in fact innovative is adopting some enforcement rule similar to the patent Doctrine of Equivalents. Trivial or obvious substitutions for literal compliance must be considered noncompliant, so that permissible avoision is substantially different than the core regulated activity. Only when avoision rises to the level of innovation does perverse innovation lose its perversity and become socially constructive.

147. *See* Alexander Korniakov et al., *The Orphan Drug and Research Tax Credits: The "Substantially All" Rule*, TAX ADVISER (Oct. 1, 2014), http://www.thetaxadviser.com/issues/2014/oct/korniakov-oct14.html [https://perma.cc/8S24-8FDD].