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Price, W. Nicholson, II. "The Cost of Novelty." *Colum. L. Rev.* 119, no. 8 (2020): 769-833.

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ESSAY

THE COST OF NOVELTY

*W. Nicholson Price II**

Patent law tries to spur the development of new and better innovative technology. But it focuses much more on “new” than “better”—and it turns out that “new” carries real social costs. I argue that patent law promotes innovation that diverges from existing technology, either a little (what I call “differentiating innovation”) or a lot (“exploring innovation”), at the expense of innovation that tells us more about existing technology (“deepening innovation”). Patent law’s focus on newness is unsurprising, and fits within a well-told narrative of innovative diversity accompanied by market selection of the best technologies. Unfortunately, innovative diversity brings not only the potential benefits of technological advances but also the costs: incompatibility between different technologies; a spread-out, shallow pool of knowledge; and the underlying costs of developing parallel technologies that aren’t actually better. These costs matter.

Biomedical innovation illustrates the high costs of divergence. Although pharmaceuticals are touted as a poster child for patents, the world is rife with me-too drugs that drive up costs with little to show for it. Biomedical innovation often suffers from a particular trap: Patent incentives push innovators toward “new,” but incentives from Food and Drug Administration approval and insurer reimbursement push innovators toward “not too new.” In this space, artificially constricted markets do a poor job of selecting better technologies. The result is a proliferation of

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technologies that are “new for the sake of new,” giving us the costs of divergence without much in the way of benefits.

This Essay presents an original spectrum of innovative divergence, illuminates how various patent doctrines drive divergence, and lays out the substantial costs of divergence through biomedical examples. It analyzes the complex interactions between three different incentives for biomedical innovation and presents policy prescriptions to help avoid the trap of “new for the sake of new.” In the process, it lays out how innovation scholars and policymakers alike should take into account the cost of novelty.

INTRODUCTION.....	771
I. DEGREES OF DIVERGENT INNOVATION	774
II. HOW PATENT LAW PROMOTES DIVERGENT INNOVATION.....	779
A. Patentability.....	782
1. Novelty.....	782
2. Nonobviousness.....	785
3. Utility.....	787
B. Infringement	790
1. Literal Infringement and Inventing Around.....	792
2. The Doctrine of Equivalents.....	793
III. THE DARK SIDE OF DIVERGENT INNOVATION.....	794
A. Benefits of Divergent Innovation	794
B. Costs of Inventing Around	796
1. Me-Too Drugs: Statins	797
2. Evergreening Practices.....	801
C. Interoperability: Insulin Pumps	803
D. Shallow Learning and Spread Expertise.....	806
1. Dispersed User Knowledge: Epinephrine Auto-Injectors	806
2. Spread Knowledge: Me-Too Statins.....	810
IV. PATENT DIVERGENCE IN CONTEXT	812
A. FDA Approval	812
1. Getting Medical Devices on the Market.....	814
2. The Biosimilar Approval Pathway.....	816
B. Reimbursement.....	818
C. Interactions.....	821
V. INTERVENTIONS.....	823
A. Inside the Patent System.....	824
1. Nonobviousness.....	824
2. Utility.....	825
B. Outside the Patent System.....	827

1. FDA Approval	827
2. Payer Reimbursement	828
CONCLUSION	830

INTRODUCTION

Patent law promotes innovations that are different from what the world already knows. This may seem a truism: What is innovation other than the search for new things?¹ But mere novelty is not the aim of innovation policy—improvement is. Put more plainly, what we want is “better”; what we get is “new.” Often, in fact, we get innovations that are new purely for the sake of being new, and not better at all. Sometimes they are worse. This Essay explores how patent law promotes what I call divergent innovation—innovation that develops significant or minor changes to existing technology rather than learning more about that technology—drawing from examples in the field of biomedical innovation.

Patent law can drive divergent innovation even when other incentives suggest focusing on developing an older technology. Known drugs provide a useful case. If a known chemical would make an effective drug, companies typically still won’t develop it, because it isn’t new, and therefore, isn’t patentable.² Instead, they may make minor changes (or seek out a totally different chemical), even if those changes might make the drug worse, because the patent incentive is so important to the innovative process.³ Patent doctrines focus incentives on the search for new and different innovation without emphasizing improving technology or increasing welfare. Novelty, nonobviousness, and utility doctrines all drive innovations’ newness when innovators seek patent protection.⁴ And in a mirror image of patent incentives to create new innovations, innovators “invent around”

1. Innovation policy scholars often distinguish invention—the process of creating a new technology—from innovation—the process of commercializing a new invention. See, e.g., Yale Brozen, *Invention, Innovation, and Imitation*, 41 *Am. Econ. Rev.* 239, 239 (1951). I use innovation here to describe the entire process, assuming a unified innovator whose inventive and commercialization efforts are driven by a desire to profit from the innovation.

2. See Benjamin N. Roin, *Unpatentable Drugs and the Standard of Patentability*, 87 *Tex. L. Rev.* 503, 513 (2009) [hereinafter Roin, *Unpatentable Drugs*] (“[I]t is well known that pharmaceutical companies generally refuse to develop new drugs unless they have strong patent protections over them.”); *infra* section II.A.1. New use patents may be available but provide relatively weak incentives. See *infra* section II.A.1; see also Rebecca S. Eisenberg, *The Problem of New Uses*, 5 *Yale J. Health Pol’y L. & Ethics* 717, 724–25 (2005) [hereinafter Eisenberg, *New Uses*] (describing the limited incentives provided by new use patents); Erika Lietzan, *Paper Promises for Drug Innovation*, 26 *Geo. Mason L. Rev.* 168, 182–95 (2018) (arguing that protections for new uses are inadequate).

3. See *infra* section III.A.

4. While the title of this Essay refers to “novelty,” it addresses newness in general, not just the novelty doctrine of patent law.

patents on existing technology not because inventing around will improve a product but to avoid the cost imposed by existing patents.⁵

Divergent innovation may bring benefits, but it also brings costs that differ from the cost of patent exclusivity itself. I identify three here. First, the process of inventing around existing patents is itself costly. To develop a new drug similar to an existing drug, the developer needs to undergo the entire process of preclinical work, clinical trials, and Food and Drug Administration (FDA) approval, at a cost of many millions of dollars. Second, divergent innovation can lead to incompatible technologies, the absence of standards, and the loss of network effects and economies of scale. Third, when the path of innovation is deliberately forked, we lose the ability to draw from existing stocks of knowledge about a particular technology because the new technology is different for the sake of being different. Those new clinical trials mean that we know less about both the new drug *and* the old drug than we would have known if we had simply developed more knowledge about the old drug. Even when divergent innovation effectively moves technology forward, the costs of divergent innovation should be weighed against its benefits.⁶

The costs of divergent innovation have gone understudied partly because divergence fits so neatly within a patent-driven market theory of innovation. Patent law relies on the market to sort out the value of inventions. Patents are only worthwhile if the protected goods are valuable in the marketplace, so the market will work to sort out the valuable innovations from a *mélange* of patented inventions.⁷ As John Duffy puts it, “[P]atent law has no aversion to awarding commercially worthless property rights.”⁸ But firms, with their private knowledge about markets and consumers, can predict market value (to some extent), and use that information to drive their innovation investment decisions. Under this account, while patent law does not require superiority for individual inventions,⁹ patent law and markets together should lead to overall improvements over time.

Unfortunately, markets aren’t always great at identifying innovating improvements. Consumers select goods for many reasons besides quality.¹⁰

5. See *infra* section III.B.

6. Patent law creates these costs by prioritizing divergent innovation, as I argue here, but these costs are not dependent on patent law; if a grant system or prize system similarly promoted technological divergence, the same sorts of divergence costs would arise.

7. Note that while patent law permits the patenting of useless new things, see *infra* section II.A.3, it does not permit the patenting of useful old things, see *infra* section II.A.1.

8. John F. Duffy, *Rethinking the Prospect Theory of Patents*, 71 *U. Chi. L. Rev.* 439, 453 (2004).

9. See *infra* section II.A.3.

10. See, e.g., Jake Linford, *Placebo Marks*, 47 *Pepp. L. Rev.* 45, 53–62 (2019) (explaining how trademarks can drive economically irrational consumer behavior but can also alter consumer experience of the branded product); Irina D. Manta, *Hedonic Trademarks*, 74 *Ohio St. L.J.* 241, 264–66 (2013) (describing how brand names can contribute to consumers’ hedonic experiences of goods). For additional information, see generally Deborah

We might therefore expect the costs of divergence—the source of the variety from which markets pick the winners—to be more problematic where market mechanisms do a poor job of incentivizing, selecting, and adopting superior innovations.

Markets are especially bad at selecting superior biomedical technologies. Efficient markets require informed consumers who can choose goods. But biomedical technologies, which make up a trillion-dollar annual industry with tremendous health implications, are often “credence goods,” meaning that their users cannot evaluate the innovations’ quality independently.¹¹ Even with FDA regulation, information about biomedical technologies’ quality is frequently poor or unavailable.¹² Finally, patients, doctors, and insurers split the consumer functions of selecting, paying for, and benefiting from goods, each with their own incentives. Since market mechanisms for selecting superior technologies underperform for biomedical innovations, the costs of divergent innovation matter more. These costs are particularly significant because biomedical technology encompasses drugs, which are presented as the exemplar of an industry where patents are truly important and work as designed.¹³

Patents create incentives within a broader innovation ecosystem, where some policy tools, like patents, promote divergence, but others discourage innovators from diverging. For biomedical technology, consider two among many:¹⁴ Market approval by FDA and health insurer reimbursement decisions each create substantial innovation incentives. Each can penalize divergence. At FDA, specialized processes ease market access for new medical devices that resemble existing devices; if the technology is substantially different, getting premarket approval can be much harder.¹⁵ Similarly, winning insurer reimbursement for a new technology is easier if the insurer is familiar with the technology, such that the innovator need not make their case from scratch.¹⁶ The interaction between these incentive

J. MacInnis, C. Whan Park & Joseph R. Priester, *Handbook of Brand Relationships* (2019) (describing relationships between consumers and brands).

11. Ariel Dora Stern, *Innovation Under Regulatory Uncertainty: Evidence from Medical Technology*, 145 *J. Pub. Econ.* 181, 182 (2017). The nature of health technology as a credence good, among other factors, drives the need for FDA regulation. See *id.* at 183–84; see also Stephen Breyer, *Regulation and Its Reform* 26–29 (1982) (using drugs as an example to argue that information failures can justify regulation).

12. See *infra* section III.D.2.

13. Roin, *Unpatentable Drugs*, *supra* note 2, at 504.

14. Other levers could and should be considered in future work. Prestigious journals, for instance, prioritize novel, surprising results over confirmations or refinements of existing work; government grants may go either to new research pathways or to existing areas with which grant reviewers are comfortable. See generally John P.A. Ioannidis, *Why Most Published Research Findings Are False*, 2 *PLoS Med.* 696 (2005) (discussing publication incentives); W. Nicholson Price II, *Grants*, 34 *Berkeley Tech. L.J.* 1 (2019) [hereinafter *Price, Grants*] (discussing grant incentives).

15. See *infra* section IV.A.

16. See *infra* section IV.B.

systems can lead to bad outcomes: Patent incentives pushing for newness can be partially counterbalanced by reimbursement and regulatory incentives pushing against too much newness, resulting in a spate of technologies that are different enough to bring the costs of divergence, without being sufficiently different to bring substantial benefits.

Good innovation policy depends on understanding innovation, and the costs of divergence are a part of that. This Essay makes a general claim: Patent law drives divergent innovation, and that divergence carries costs. As to this picture of innovation in general, the only prescription I offer is that scholars and policymakers take divergence costs into account when analyzing innovation incentives, benefits, and costs.

This Essay also makes a specific claim: Divergence is especially costly for biomedical innovations, which patents and other incentives can drive toward an unhappy medium of differentiating, proliferating, nonsuperior technologies. This specific problem may be amenable to solutions. Within patent law, strengthening the nonobviousness requirement could reduce close imitators of existing technology. Outside patent law, FDA or insurer requirements for superiority could do the same.

This Essay proceeds in five Parts. Part I describes the ways in which innovation paths can diverge or not. Part II lays out how several patent doctrines can drive divergent innovation. Part III provides three cases to illustrate divergent innovation and the costs it can bring: me-too drugs, including statins; insulin pumps for diabetics; and epinephrine auto-injectors like the EpiPen. Part IV places patent law into a broader context in the case of biomedical innovation, addressing how the incentives provided by FDA approval and insurer reimbursement can drive innovation to follow the path of existing technology. It also considers how these combined incentives can perversely lead to innovation landing in an unhappy middle: close enough to existing technology that we derive little social benefit from diversity but far enough from that technology that we see the costs of divergence. Part V describes potential solutions to the problems specific to biomedical innovation, located either within or outside patent doctrine.

I. DEGREES OF DIVERGENT INNOVATION

Consider the cases of three potential innovators.

Jenn heads a firm focused on allergy medications.¹⁷ She wants to improve the field of epinephrine (a.k.a. adrenaline) auto-injectors that are used in emergencies by patients with severe allergies, a field currently

17. Firm size and composition affect innovation efforts. See generally Dan L. Burk, *Intellectual Property and the Firm*, 71 *U. Chi. L. Rev.* 3 (2004) (discussing the interactions between intellectual property and theories of the firm). I set aside these fascinating issues here, assuming innovators face similar firm structures. Adding firm complexities would, of course, further complicate the picture.

dominated by the EpiPen.¹⁸ The EpiPen saves lives, but user error causes problems: Sometimes people get the ends mixed up and inject the epinephrine into their thumbs when they're trying to use the device.¹⁹ It's also currently mired in scandal because its price has quadrupled over seven years.²⁰ Jenn considers three possible options. She can try to develop a more efficient manufacturing process for the EpiPen with the goal of lowering its price. She can try to make a new auto-injector that's essentially the same as the EpiPen but just a little different—perhaps it has two safety caps where the EpiPen has one. Or she can try to make something that's quite different—a different overall design to reduce the risk of thumb-sticking, and perhaps other substantial changes.

Michelle runs a drug company with expertise in statins, drugs used to reduce high cholesterol. She can choose to develop new information about an existing blockbuster statin, Lipitor, identifying new dosing regimens or new data about effects in different populations. She can try to develop another statin that reduces high cholesterol. Or she can pursue some new anticholesterol drug target.

Finally, Martin runs a medical device company. He is developing a new line of insulin pumps and is considering what connector to use to link the pumps to insulin reservoirs. He can use the existing, industry-standard technology, incorporating it into the new line. He can tweak the existing technology to work slightly better for the new line. Or he can develop a new connector designed specifically for the new line of pumps.

We can think of the three options faced by innovators as, roughly, learning more about the existing technology (“deepening”), pursuing minor variations on the existing technology (“differentiating”), or moving further afield from the existing technology toward something markedly different (“exploring”).²¹ The latter two are forms of divergent innovation. In differentiating innovation, an invention can be trivially different from what came before, perhaps just “new for the sake of new.” In exploring innovation, inventions take a larger step away from what came before. Either change may be good or bad; the size of the change says nothing about whether it is an improvement, a worsening, or neither.

18. See *infra* section III.D.1.

19. Ceara McNeil & Julie Copeland, *Accidental Digital Epinephrine Injection: To Treat or Not to Treat?*, 60 *Canadian Fam. Physician* 726, 726 (2014).

20. See Michael A. Carrier & Carl J. Minniti III, *The Untold EpiPen Story: How Mylan Hiked Prices by Blocking Rivals*, 102 *Cornell L. Rev. Online* 53, 53 (2017).

21. See *infra* Table 1.

TABLE 1: DIFFERENT POTENTIAL INNOVATIONS

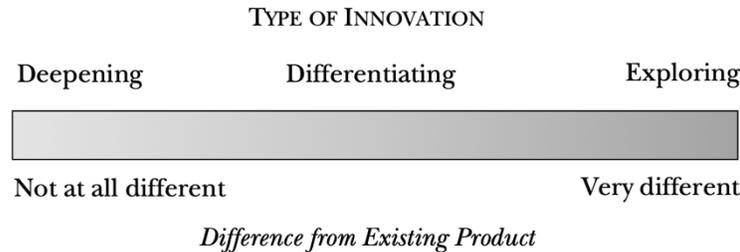
	Nondivergent	Divergent	
	Deepening	Differentiating	Exploring
Allergies	Improve EpiPen manufacturing	Slightly modify EpiPen	Develop a new form-factor auto-injector
Statins	Identify new Lipitor dosing regimen	Develop a new statin	Pursue a different anti-cholesterol drug
Insulin	Adopt the existing connector	Tweak the connector	Develop a new connector

This typology of innovation divergence sits to some degree at the intersection of broad literatures on cumulative innovation and product differentiation. Cumulative innovation is the process by which innovation builds on earlier innovation; Suzanne Scotchmer and others have explored patent law's impact on cumulative innovation in some depth.²² Product differentiation, on the other hand, focuses on the various ways that firms differentiate their products for consumers, whether based on quality, branding, price, or otherwise.²³ Although I borrow insights from each field throughout this Essay, I ultimately do not adopt either's framework. Instead, I focus on the ways that a new technology can differ from older technology, the degrees of those differences, and how patent law and other incentives interact with the process of divergent innovation.

22. See, e.g., Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 *J. Econ. Persp.* 29, 30–40 (1991) (modeling cumulative innovation and patent law's impact on it); see also, e.g., Christopher Buccafusco, Stefan Bechtold & Christopher Jon Sprigman, *The Nature of Sequential Innovation*, 59 *Wm. & Mary L. Rev.* 1, 57–58 (2017) (describing the incentives of creators to “build on” versus “build around” prior intellectual property and discussing the difference between “tweaking” and “pioneering” innovation); Arti K. Rai, *Fostering Cumulative Innovation in the Biopharmaceutical Industry: The Role of Patents and Antitrust*, 16 *Berkeley Tech. L.J.* 813, 838–44 (2001) (describing how patents and antitrust can help or hinder cumulative innovation).

23. See, e.g., Erin Parrish, *Retailers' Use of Niche Marketing in Product Development*, 14 *J. Fashion Marketing & Mgmt.* 546, 546–47 (2010) (describing methods of product differentiation and their benefits to industry).

FIGURE 1: DEEPENING, DIFFERENTIATING, AND EXPLORING INNOVATION



Deepening, differentiating, and exploring innovation are not sharply delineated, nor will any particular innovation fit neatly into only one category.²⁴ The boundary between differentiating and exploring innovation is often particularly fuzzy; these are labels along a spectrum of divergence rather than distinct classes. Exploring or differentiating innovation can also lead to increased knowledge about the existing technology: When you try to change a product substantially, you may learn more about how it works now, and when you make minor variations, you might learn more about how to manufacture it. Nevertheless, these three general classes can help us think about the types of innovation that innovators might pursue.

In each of the three cases described above, any of the options could be best for social welfare.²⁵ Society might be better off with more cheaply manufactured EpiPens, better information about how Lipitor works, or increased adoption of the insulin pump interface (deepening). But it might just as well be better off getting a really different epinephrine auto-injector, a new drug in a new class, or a connector that is more secure (exploring). In the middle (differentiating), society might benefit from small variations in existing technology through, for instance, increased competition or small improvements. To the extent that differentiating and exploring innovation both bring the costs discussed in Part III, one *might* expect that deepening innovation (which doesn't have those costs) and exploring innovation (which has the potential for bigger performance breakthroughs) will often be more desirable than differentiating innovation, but that conclusion is certainly not a given in any instance. Specific answers will involve tradeoffs between knowledge breadth and depth, interoperability and improvements, competition and differentiation, and other values. Finding the right answer won't always be straightforward.

But patent law has a favorite answer. Patent law creates incentives for innovators to pursue pathways that are different from what has come before, whether differentiating or exploring. Its various doctrines make

24. See *supra* Figure 1.

25. It would be nice to have all these innovations, of course, but I assume limited innovator resources.

patents available only for new inventions and substantially limit patents' ability to promote developing new information about old inventions.²⁶ In addition, the exclusivity created by earlier patents limits the ability of later inventors to practice the earlier invention without paying a license or facing the risk of infringement liability.²⁷ Thus, innovators choosing between different possible forms of innovation will be driven, at least by patent law, to pursue paths diverging from existing knowledge.

Patent law's preference for novelty exists even when we *do* know what's socially best, and even when it's not a divergent path. Jenn may be certain (and right) that auto-injectors will be best advanced by improving EpiPen manufacturing. Or Martin may be certain (and right) that new proprietary connectors would create negative effects by locking consumers into existing platforms, and that these negative effects would swamp the benefits from most technological advances.²⁸ And the all-too-common failure of scientific results to hold up over time suggests that simply replicating existing studies—perhaps the most straightforward form of deepening innovation—would substantially benefit society.²⁹ Patent law will nevertheless create incentives to pursue the divergent path.³⁰ The next section explores the purpose of patent law and the doctrines by which it creates incentives for divergent innovation.

26. See *infra* section II.A.

27. See *infra* section II.B.

28. Cf. Melissa A. Schilling, Technological Lockout: An Integrative Model of the Economic and Strategic Factors Driving Technology Success and Failure, 23 *Acad. Mgmt. Rev.* 267, 267–69 (1998) (explaining how “technological lockout” occurs (1) when firms “produce[] products representing or conforming to a technological standard that is subsequently rejected by the market” and (2) when “there is an existing dominant design and the firm is unable to . . . produc[e] or sell[] products conforming to this standard”).

29. See Jacob S. Sherkow, Patent Law's Reproducibility Paradox, 66 *Duke L.J.* 845, 882–902 (2017) [hereinafter Sherkow, Reproducibility Paradox] (describing the failure of many patented drugs to actually work in practice).

30. Many other incentives also apply. For FDA approval and reimbursement, especially relevant in biomedical innovation, see *infra* Part IV. Patent law itself may not be the dominant form of incentive for technology, especially in an academic context. See generally, e.g., Rebecca S. Eisenberg, Public Research and Private Development: Patents and Technology Transfer in Government-Sponsored Research, 82 *Va. L. Rev.* 1663 (1996) (describing innovation incentives in government-sponsored research); Arti K. Rai & Rebecca S. Eisenberg, Bayh-Dole Reform and the Progress of Biomedicine, 66 *Law & Contemp. Probs.* 289, 289–91 (2003) (describing the erosion of open science norms after the Bayh–Dole Act); Arti Kaur Rai, Regulating Scientific Research: Intellectual Property Rights and the Norms of Science, 94 *Nw. U. L. Rev.* 77 (1999) (describing the tension between scientific norms and intellectual property's exclusivity mechanism). Patent law's incentives are also substantially different in the software space. See generally, Julie E. Cohen & Mark A. Lemley, Patent Scope and Innovation in the Software Industry, 89 *Calif. L. Rev.* 1 (2001) (providing an overview of this space); Lisa Larrimore Ouellette, Patentable Subject Matter and Nonpatent Innovation Incentives, 5 *U.C. Irvine L. Rev.* 1115, 1137–41 (2015) (describing limits on software patents and the availability of other incentives).

II. HOW PATENT LAW PROMOTES DIVERGENT INNOVATION

Patent law aims to promote innovation. The Constitution authorizes Congress “[t]o promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.”³¹ But what does this mean? What are patents really supposed to do?

Four major theories justify patent law.³² Incentive theory—by far the dominant theory—responds to the status of new, costly ideas as public goods³³ on which competitors can free-ride.³⁴ Firms want to make money; why invest in innovation if competitors can swoop in and compete without making that costly initial investment? Incentive theory argues that patents can provide exclusivity, allowing innovators to reap supracompetitive market returns and creating *ex ante* incentives to innovate.³⁵ Disclosure theory takes as a given that innovation will happen but offers patents as a reward to innovators to share their inventions with the world rather than keeping them secret.³⁶ Commercialization theory argues that patents induce companies to expend the effort to take inventions from early stages to commercial products.³⁷ Finally, prospect theory argues that patents, especially early patents, enable initial innovators to orchestrate the many efforts to develop later innovative products from that initial innovation.³⁸ Each theory has received substantial criticism³⁹ and different theories appear to predominate

31. U.S. Const. art. I, § 8, cl. 8.

32. See, e.g., Roberto Mazzoleni & Richard R. Nelson, *Economic Theories About the Benefits and Costs of Patents*, 32 *J. Econ. Issues* 1031, 1033 (1998).

33. Public goods are nonrivalrous (I can possess your idea without diminishing your possession of the idea) and nonexcludable (once an idea is available, it’s hard to keep others from knowing/using it). See, e.g., Molly McLure Wasko, Robin Teigland & Samer Faraj, *The Provision of Online Public Goods: Examining Social Structure in an Electronic Network of Practice*, 47 *Decision Support Sys.* 254, 255 (2009) (defining public goods).

34. See, e.g., Rebecca S. Eisenberg, *Patents and the Progress of Science: Exclusive Rights and Experimental Use*, 56 *U. Chi. L. Rev.* 1017, 1024–25 (1989) [hereinafter Eisenberg, *Progress of Science*] (describing free-riding by competitors).

35. *Id.* at 1024–26 (describing the incentive theory of patents).

36. See Jeanne C. Fromer, *Patent Disclosure*, 94 *Iowa L. Rev.* 539, 551 (2009); Lisa Larrimore Ouellette, *Do Patents Disclose Useful Information?*, 25 *Harv. J.L. & Tech.* 545, 556–57 (2012) [hereinafter Ouellette, *Useful Information*].

37. See generally F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 *Minn. L. Rev.* 697 (2000) (describing commercialization theory); Ted Sichelman, *Commercializing Patents*, 62 *Stan. L. Rev.* 341 (2010) (proposing a new type of patent focused on commercialization).

38. See generally Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 *J.L. Econ.* 265 (1977) (proposing prospect theory).

39. See, e.g., Mark A. Lemley, *Ex Ante Versus Ex Post Justifications for Intellectual Property*, 71 *U. Chi. L. Rev.* 129, 135–41 (2004) (critiquing the commercialization and prospect theories); Mazzoleni & Nelson, *supra* note 32, at 1037 (noting the dearth of empirical evidence for any theory except the incentive theory); Heidi L. Williams, *How Do Patents Affect Research Investments?*, 9 *Ann. Rev. Econ.* 441, 448–56 (2017) (noting that empirical evidence on the incentive theory remains unclear).

in different contexts.⁴⁰ All the theories, however, share the aim of promoting the “progress of science and useful arts” by helping innovators develop new, better technologies. Nevertheless, because it is hard to identify “better” technologies in advance, the identification of better technologies typically comes about ex post, through market selection of technologies, and ex ante, through firms selecting which innovations to pursue based on private knowledge about market preferences.⁴¹

Patent law, like all forms of IP law, aims to promote innovation but does not create incentives for all forms of innovative knowledge that we value, nor for all forms of innovation that suffer from public goods problems.⁴² Market value, on which IP law relies, systematically values some goods differently than a social planner or a committee of scientists might,⁴³ and some types of market-valued innovation are difficult to protect and therefore incentivize. Amy Kapczynski and Talha Syed cut across patent-justification theories to point out that patent law promotes only innovation that can be protected through patent law’s excludability mechanism;

40. For instance, the Bayh–Dole Act, which allows universities to patent federally funded inventions, was expressly motivated by commercialization and development theory. See Mazzoleni & Nelson, *supra* note 32, at 1040–41 (noting the incompatibility of the Bayh–Dole Act with an incentive theory of patents).

41. See Nancy Gallini & Suzanne Scotchmer, *Intellectual Property: When Is It the Best Innovation System?*, 2 *Innovation Pol’y & Econ.* 51, 54–56 (2002) (noting the preferability of patents when private firms have information about market preferences); Daniel J. Hemel & Lisa Larrimore Ouellette, *Beyond the Patents–Prizes Debate*, 92 *Tex. L. Rev.* 303, 327 (2013) [hereinafter Hemel & Ouellette, *Beyond the Debate*] (noting patents’ function of aggregating private information about demand for innovations).

42. See, e.g., Jane C. Ginsburg, *Creation and Commercial Value: Copyright Protection of Works of Information*, 90 *Colum. L. Rev.* 1865, 1895–1900 (1990) (describing copyright’s rejection of “sweat of the brow” as sufficient justification for authorship); Jane C. Ginsburg, *No “Sweat”? Copyright and Other Protection of Works of Information After *Feist v. Rural Telephone**, 92 *Colum. L. Rev.* 338, 338–41 (1992) (same); Price, Grants, *supra* note 14, at 41–63 (discussing gaps in IP incentives that can be addressed through the grant system); Jerome H. Reichman & Pamela Samuelson, *Intellectual Property Rights in Data?*, 50 *Vand. L. Rev.* 51, 61–63 (1997) (describing how IP law does provide useful protections for data); cf. Jessica Silbey, *The Eureka Myth: Creators, Innovators, and Everyday Intellectual Property* 10–11 (2014) (describing how intellectual property does not account for things that creators actually need). For applications to biomedical innovation, see, e.g., Eisenberg, *New Uses*, *supra* note 2, at 717–20 (describing inadequate incentives to find new uses for drugs); W. Nicholson Price II, *Big Data, Patents, and the Future of Medicine*, 37 *Cardozo L. Rev.* 1401, 1406–07 (2016) (discussing the absence of intellectual property protection for health data—aside from trade secrecy—and the problems that absence creates); Jacob S. Sherkow, *Cancer’s IP*, 96 *N.C. L. Rev.* 297, 302–04 (2018) (discussing the inadequate incentives provided by IP to invest in modern cancer research).

43. See, e.g., Amy Kapczynski, *The Cost of Price: Why and How to Get Beyond Intellectual Property Internalism*, 59 *UCLA L. Rev.* 970, 999–1000 (2012) (explaining how IP’s focus on price prevents it from encouraging distributive justice); see also, e.g., Camilla A. Hrdy, *State Patents as a Solution to Underinvestment in Innovation*, 62 *U. Kan. L. Rev.* 487, 509–10 (2013) (arguing for state agency valuation of innovation); Price, Grants, *supra* note 14, at 63–64 (“[T]he aggregation of scientific knowledge and priorities—with input from the government as to social benefit—is not inferior to determinations that arise from private market aggregation of private knowledge; it’s just different.”).

nonexcludable innovation, like negative information or efficiency checklists, receives few patent incentives.⁴⁴ This Essay takes a similar cross-cutting tack: Much as patent law's excludability mechanism promotes the production of excludable knowledge, its focus on difference promotes the development of divergent innovation rather than deepening innovation that increases knowledge about existing products.

Patent law and policy are explicit about promoting divergent innovation. The former Chairman of the Department of Commerce's Patent Survey Committee elaborated this goal of divergence in testimony before Congress:

The effect of the patent system . . . is to force diversity. A is a manufacturer of can openers; B is a competitor. B comes along with a new type of can opener. He gets a patent on it. A can't copy it, but he still has to stay in the can-opener business, so he gets busy and gets himself up some new type of can opener, and it is usually a little better than B's.⁴⁵

Of course, this example assumes that a consumer can tell that the new can opener is better, so that markets can help drive progress—an assumption that often does not hold true, especially for biomedical products.⁴⁶

Patent law creates incentives for divergent innovation in two principal ways. First, patentability doctrines demand difference; an inventor can patent their invention only if it is novel and nonobvious.⁴⁷ To the extent that patents increase the amount of an invention's value appropriable by the inventor,⁴⁸ this will increase the realizable value of inventions that diverge from what has come before. Utility doctrine also plays a role, not by driving divergence but by failing to require improvements. Second, difference can shield later inventors from needing to pay earlier inventors for infringement.⁴⁹ Patents grant exclusionary rights; if later inventions fall within the scope of existing patents covering earlier inventions, the later inventor must either license the earlier patent or run the risk of infringement liability.⁵⁰ Innovators who diverge from earlier inventors may be able to avoid these costs.⁵¹

44. Amy Kapczynski & Talha Syed, *The Continuum of Excludability and the Limits of Patents*, 122 *Yale L.J.* 1900, 1903–06 (2013).

45. Atomic Energy Act of 1946: Hearings on S. 1717 Before the Spec. Comm. on Atomic Energy, 79th Cong. 61 (1946) (statement of William H. Davis, Former Director, Office of Economic Stabilization, and Former Chairman, War Labor Board).

46. See *supra* notes 10–12 and accompanying text.

47. See 35 U.S.C. §§ 102–103 (2012).

48. See, e.g., Eisenberg, *Progress of Science*, *supra* note 34, at 1024–26 (describing how patents increase the appropriability of inventions' value).

49. See Scotchmer, *supra* note 22, at 29–30.

50. See *id.* at 30–32. The later inventor may still be able to obtain a patent on the later invention, in which case each patentee could prevent the other from using the later technology until the first patent expired.

51. See *id.*

A. Patentability

Three patentability doctrines promote divergent innovation.⁵² The most straightforward are the novelty and nonobviousness requirements, which enshrine patent law's push toward what is new and different. However, the utility requirement also plays a substantial role based on what it does not do: require that a new invention be better.

1. *Novelty*. — The novelty requirement explicitly requires divergence. To be patentable, an invention must be new.⁵³ More precisely, an invention cannot be patented if every element of the invention can be found within a single prior art reference.⁵⁴ Patent law creates a broad set of references known as the “prior art”—essentially, all printed publications, patents, patent applications, and things that were publicly used or on sale prior to the date the patent was filed.⁵⁵ If any single reference within that set contains every element of the invention claimed in the new patent, the patent is “anticipated” and cannot be granted (or, if already granted, is invalid).⁵⁶ If an innovator wants to patent an invention, they must create something new. Of course this is unsurprising; a principal purpose of patent

52. Not all patent doctrines promote divergent innovation and not all doctrines cut clearly in one direction or another. The various disclosure doctrines (enablement, written description, and definiteness) arguably play minor roles in shaping innovation divergence as well but do not cut definitively either for or against divergence. For instance, disclosure requirements may promote divergence during the term of the patent, especially when fuzzy claim drafting or voluminous specifications lay out broad and unclear barriers for future inventors to avoid. See Janet Freilich, *Patent Clutter*, 103 *Iowa L. Rev.* 925, 936–39 (2018) (describing fuzzy claims, the difficulties of running patent searches, and the costs of drafting around); Janet Freilich, *Prophetic Patents*, 53 *U.C. Davis L. Rev.* 663, 727–28 (2019) (providing summary statistics of voluminous specifications in chemical and biological patents). To the extent that satisfying enablement is easier when new inventions are closer to existing inventions, it should promote differentiating over exploring innovation. However, once patents have expired, the enablement doctrine should make it easier to replicate a patented invention or engage in deepening innovation; this should also be true during the patent term but is counterbalanced by the exclusionary force of the patent itself. Finally, the very fact that the patent term is limited promotes novelty; an innovative monopolist who wishes to remain a monopolist needs to develop new products as patents expire. See *infra* section III.B.2 (discussing pharmaceutical evergreening). This Essay focuses on those doctrines principally involved in pushing innovation in divergent directions during the patent term.

53. See 35 U.S.C. § 102 (2012). To be sure, patents are explicitly available on improvements of existing processes or products. But as described in more detail below, those improvements, if made to a process or product covered by an existing patent, will face costs in the form of licensing requirements or the likelihood of liability for infringement. See *infra* section II.B.

54. See 35 U.S.C. § 102(a).

55. *Id.* The exact timing and contours of the prior art are complex but need not concern us here.

56. *Id.*; see also *W.L. & Assocs., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1554 (Fed. Cir. 1983) (“Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration.”). For a useful analysis of novelty doctrine with respect to pharmaceuticals, see generally Sean B. Seymore, *Rethinking Novelty in Patent Law*, 60 *Duke L.J.* 919 (2011) (describing the doctrine, arguing that disclosure of chemicals without more should not suffice to be an anticipatory disclosure, and arguing for a new framework).

law is to drive the creation and sharing of new ideas.⁵⁷ Under disclosure theory, the public should suffer the deadweight loss of monopoly only in exchange for information it did not have before;⁵⁸ under incentive theory, innovators need incentives only to develop new technologies, not technologies that already exist.⁵⁹

Novelty also reduces incentives for deepening innovation. Information about new uses of a known product, or new results of existing processes, will not make that known product or existing process patentable, although the new use may itself be patentable.⁶⁰ Understanding more about an existing process or product—for example, how mixing water with a drug may avoid toxic explosions⁶¹ or the usefulness of a subset of known alloys in resisting corrosion⁶²—may be tremendously socially valuable. But later innovators have limited incentives to discover that information. There are two caveats to this story: incentives for the initial innovator and the possibility of patents on new uses or improvements.

a. *Incentives for the Initial Innovator.* — The mechanics of novelty create different incentives for initial inventors than for later inventors. Patents create a largely “winner-take-all” system, in which the first inventor to patent an invention reaps most of the reward.⁶³ This system is embodied in the novelty requirement: Once one inventor has won the race to the patent office, other inventors lose the incentive of market exclusivity.⁶⁴ This creates incentives for other inventors to pursue different paths and decreases incentives for those inventors to develop socially valuable information about the invention.⁶⁵

However, a winner-take-all system also gives the initial inventor assurance that they can capture at least some gains from additional investment

57. See, e.g., Eisenberg, *Progress of Science*, supra note 34, at 1024.

58. See, e.g., id. at 1028–30.

59. See, e.g., id. at 1024–26.

60. Patent law permits inventors to patent the use of an old process to a new end—that is, to accomplish a new goal—but not the use of a known process toward the same end, even if the results were previously unrecognized. See *Bristol-Myers Squibb Co. v. Ben Venue Labs., Inc.*, 246 F.3d 1368, 1376 (Fed. Cir. 2001) (“Newly discovered results of known processes directed to the same purpose are not patentable because such results are inherent.”).

61. *Abbott Labs. v. Baxter Pharm. Prods., Inc.*, 471 F.3d 1363, 1367 (Fed. Cir. 2006).

62. *Titanium Metals Corp. of Am. v. Banner*, 778 F.2d 775, 780–82 (Fed. Cir. 1985).

63. Vincenzo Denicolò & Luigi A. Franzoni, *On the Winner-Take-All Principle in Innovation Races*, 8 J. Eur. Econ. Ass’n 1133, 1133 (2010).

64. For a sampling of the extensive literature on patent racing, see generally, e.g., Duffy, supra note 8, at 443–45 (arguing that racing may dissipate private rents but may increase social value because patents filed earlier expire earlier and thus leave the invention to the public); Mark F. Grady & Jay I. Alexander, *Patent Law and Rent Dissipation*, 78 Va. L. Rev. 305, 307–09 (1992) (noting the risk of dissipating the social returns of innovation through wasteful patent racing).

65. Cf. Eisenberg, *New Uses*, supra note 2, at 720–25 (describing how patent law disincentivizes investing in research to discover new uses for products); Sherkow, *Reproducibility Paradox*, supra note 29, at 847–50 (“[T]he availability of patents . . . appears to hamper or even actively dissuade reproducibility.”).

in the patented innovation. If they discover a more efficient way to manufacture a patented drug, or a new use for that drug, they can reap the rewards from that deepening innovation, at least during the term of the patent.⁶⁶ For instance, sildenafil (Viagra) was originally patented and tested to treat hypertension.⁶⁷ When the drug caused erections in male clinical trial participants, Pfizer switched to testing it to treat erectile dysfunction,⁶⁸ won approval,⁶⁹ and sold billions of dollars of pills for that purpose—all within the patent term. Sildenafil was subsequently also approved for its original purpose.⁷⁰ Both commercialization theory and prospect theory recognize that creating this protected space can aid commercialization efforts by the initial inventor.⁷¹ Thus, patentees of pioneer inventions may in fact have incentives, derived partly from the novelty requirement, to engage in deepening innovation.

b. *New Use Patents.* — Patents on new uses of existing products also create some incentives for forms of deepening innovation but are limited in their effectiveness. Patents are available when innovators discover a new use for an existing product.⁷² For instance, if a doctor discovers that an old drug used to treat high blood pressure also treats male pattern baldness, they can obtain a patent on the use of the drug to treat male pattern baldness—this is how we got Rogaine.⁷³ Thus, patents can in some circumstances provide incentives for some types of deepening innovation.

However, while patent doctrine tries to support this type of deepening innovation in theory, in practice it doesn't do so particularly well, for two reasons. First, patents for new uses are typically not especially valuable, and therefore provide relatively weak incentives, because they are difficult to enforce.⁷⁴ For new uses of existing drugs, once the patent covering the drug itself has expired, generic manufacturers can make inexpensive generic

66. This limitation is significant. As Rebecca Eisenberg has pointed out, initial innovators' incentives to develop new information drop as the patent approaches the end of its life, especially for slow innovations like validating new uses for drugs. See Eisenberg, *New Uses*, supra note 2, at 720.

67. See U.S. Patent No. 5,250,534 col. 1 l. 18 (filed May 14, 1992).

68. Mitradev Boolell, Michael J. Allen, Stephen A. Ballard, Sam Gepi-Attee, Gary J. Muirhead, Alasdair M. Naylor, Ian H. Osterloh & Clive Gingell, *Sildenafil: An Orally Active Type 5 Cyclic GMP-Specific Phosphodiesterase Inhibitor for the Treatment of Penile Erectile Dysfunction*, 8 *Int'l J. Impotence Res.* 47 (1996).

69. Letter from Robert Temple, Dir., Ctr. for Drug Evaluation & Research, FDA, to Sandra J. Croak-Brossman, Pfizer Cent. Research (Mar. 27, 1998), https://www.accessdata.fda.gov/drugsatfda_docs/appletter/1998/20895ltr.pdf [<https://perma.cc/QTP4-FV28>].

70. Letter from Norman Stockbridge, Acting Dir., Ctr. for Drug Evaluation & Research, FDA, to Martha C. Brumfield, Pfizer, Inc. (June 3, 2005), https://www.accessdata.fda.gov/drugsatfda_docs/appletter/2005/021845ltr.pdf [<https://perma.cc/E4XY-PJJQ>].

71. See supra notes 37–38 and accompanying text.

72. See Eisenberg, *New Uses*, supra note 2, at 724–25.

73. Compare U.S. Patent No. 3,461,461 col. 1 l. 18 (filed Nov. 1, 1965) (claiming the compound minoxidil and its use to treat high blood pressure), with U.S. Patent No. 4,139,619 col. 1 l. 30 (filed Aug. 19, 1977) (claiming the use of minoxidil to stimulate hair growth).

74. See Eisenberg, *New Uses*, supra note 2, at 724–25.

versions of the drug. Patients can then use the cheaper, generic version for any use, including the newly patented use (for example, by taking cheap generic minoxidil, labeled only for use for hypertension, for baldness).⁷⁵ Theoretically, the holder of the new use patent can sue doctors or patients for violating its patent but realistically this is an unlikely strategy.⁷⁶ Thus, new use patents provide lower incentives than patents on entirely new compounds.⁷⁷

Second, as discussed below, the exclusive rights created by patents on earlier inventions create costs for later innovators.⁷⁸ Practicing a new use of a patented product, even if the subject of an independent patent, can still be blocked by an earlier patent on the product itself. This phenomenon reduces the net incentives to develop that new use through deepening innovation.⁷⁹

Taken as a whole, the doctrine of novelty creates substantial incentives for innovation to follow either differentiating or exploring pathways, rather than deepening pathways.

2. *Nonobviousness*. — Nonobviousness also pushes inventors away from existing technologies. Under 35 U.S.C. § 103, an invention cannot be patented if it would have been obvious to the person having ordinary skill in the art,⁸⁰ taking into account the universe of relevant prior art, the difference between the prior art and the new invention, and the skill of the “person having ordinary skill in the art,” or PHOSITA.⁸¹ The purpose of the obviousness requirement is to ensure that patents are not available for trivial advances in technology by requiring more substantial differences; it is a stronger screen than novelty but harder to administer.⁸² Under an incentive theory of patenting, small differences from the prior art—often, merely differentiating innovation—are too easy to need the incentive of an additional patent.⁸³ The nonobviousness requirement thus aims

75. *Id.* at 720. There are complex strategies to try to avoid this pattern, but they do not always work, and an exploration of them is outside the scope of this Essay. See, e.g., Robin Feldman & Evan Frondorf, *Drug Wars: A New Generation of Generic Pharmaceutical Delay*, 53 *Harv. J. on Legis.* 499, 549–54 (2016) (discussing the strategy of “skinny label[ing],” wherein brand companies attempt to restrict generic behavior by limiting the approved uses listed on the drug’s label).

76. Rebecca S. Eisenberg, *The Role of the FDA in Innovation Policy*, 13 *Mich. Telecomm. & Tech. L. Rev.* 345, 351 (2007) [hereinafter Eisenberg, *Role of the FDA*]; see also Amy Kapczynski & Talha Syed, *supra* note 44, at 1917 (explaining how social norms make it problematic for patentees to sue doctors).

77. See Eisenberg, *New Uses*, *supra* note 2, at 724–25.

78. See *infra* section II.B.

79. See Scotchmer, *supra* note 22, at 32–33.

80. 35 U.S.C. § 103 (2012).

81. *Graham v. John Deere Co.*, 383 U.S. 1, 3, 17 (1966).

82. See *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 417–18 (2007) (describing the potential challenges a court may face in evaluating the obviousness of a new invention).

83. See Robert P. Merges, *Uncertainty and the Standard of Patentability*, 7 *High Tech. L.J.* 1, 2 (1992) (arguing that uncertain innovation should more likely be held nonobvious).

specifically at driving divergent innovation, and exploring innovation in particular. It doesn't always work.

Nonobviousness provides a weaker filter for exploring innovation in the biotechnology and pharmaceutical industries than elsewhere.⁸⁴ Predictability is the touchstone of obviousness, and these fields are considered to be inherently unpredictable.⁸⁵ If a medicinal chemist would be expected to know that an existing drug could be improved by changing its structure in a particular way, the nonobviousness doctrine should theoretically bar receiving a patent on that improved drug.⁸⁶ But as Rebecca Eisenberg notes, nonobviousness analysis in pharmaceuticals suffers from something of an opposite hindsight bias—rather than innovations looking *more* obvious in hindsight, they look *less* obvious.⁸⁷ The Federal Circuit (the appellate court with exclusive jurisdiction over patent law) has accordingly made obviousness very hard to show.

To determine whether new chemicals—including pharmaceuticals—are obvious, the Federal Circuit has adopted a doctrine known as “lead compound analysis.”⁸⁸ Essentially, if you want to show that a new chemical is obvious, you do two things: First, you find a close relative that is already known and second, you argue that the inventive step from that prior art compound to the new compound would be an obvious step for a PHOSITA to take.⁸⁹ This is hard. Under the lead compound analysis framework, the prior art must essentially contain each step rather plainly to demonstrate *prima facie* obviousness.⁹⁰ To show that a chemist of ordinary skill would select that chemical as a “lead compound”—“a compound in the prior art that would be most promising to modify”⁹¹—structural similarity is necessary but insufficient; the field must know something about the putative lead compound, such as activity, solubility, or toxicity, that makes it a

84. Dan L. Burk & Mark A. Lemley, Policy Levers in Patent Law, 89 Va. L. Rev. 1575, 1593 (2003) [hereinafter Burk & Lemley, Policy Levers] (“In biotechnology cases, the Federal Circuit has gone to inordinate lengths to find biotechnological inventions nonobvious, even if the prior art demonstrates a clear plan for producing the invention.”).

85. See *KSR*, 550 U.S. at 417–18 (emphasizing predictability); Sean B. Seymore, Heightened Enablement in the Unpredictable Arts, 56 UCLA L. Rev. 127, 137–39 (2008) (“[E]ven though the judiciary recognizes the unique challenges that inventions in the unpredictable arts bring to the patent system, it has struggled to adapt the old doctrinal framework of the patent laws to meet these challenges.”).

86. Roin, Unpatentable Drugs, *supra* note 2, at 532–34.

87. Rebecca S. Eisenberg, Pharma's Nonobvious Problem, 12 Lewis & Clark L. Rev. 375, 378 (2008) [hereinafter Eisenberg, Pharma's Nonobvious Problem].

88. See generally Briana Barron, Structural Uncertainty: Understanding the Federal Circuit's Lead Compound Analysis, 16 Marq. Intell. Prop. L. Rev. 401 (2012). The Federal Circuit reaffirmed this relatively rigid test even after the Supreme Court counseled flexibility in the obviousness analysis in *KSR*. *Eisai Co. v. Dr. Reddy's Labs., Ltd.*, 533 F.3d 1353, 1359 (Fed. Cir. 2008).

89. *Otsuka Pharm. Co. v. Sandoz, Inc.*, 678 F.3d 1280, 1291–92 (Fed. Cir. 2012).

90. *Id.* at 1291.

91. *Takeda Chem. Indus., Ltd. v. Alphapharm Pty., Ltd.*, 492 F.3d 1350, 1357 (Fed. Cir. 2007).

promising lead.⁹² Once a lead compound (or a small set of lead compounds) is identified, you must show that “prior art would have supplied one of ordinary skill in the art with a reason or motivation to modify a lead compound to make the claimed compound with a reasonable expectation of success.”⁹³ This is a lot to ask of the prior art.⁹⁴

Once a *prima facie* obviousness showing has been made, the patentee can rebut it by showing unexpected properties compared to prior art compounds⁹⁵—a factor that Chris Cotropia has noted adds an *ex post* windfall element to nonobviousness rather than actually driving innovators to pursue nonobvious paths.⁹⁶ Overall, “lead compound analysis greatly favors the patentee in most situations,”⁹⁷ and “[i]n some biotechnology cases, [the Federal Circuit’s approach] has functioned as a virtual *per se* rule of nonobviousness for molecules that are not structurally similar to molecules disclosed in the prior art.”⁹⁸

In sum, although nonobviousness doctrine pushes innovators to pursue exploring innovation rather than differentiating innovation, the doctrine has little bite in biotechnology and pharmaceuticals. It still pushes for divergent innovation over deepening innovation—the new technology must still be *different* from what has come before—but pushes less strongly for exploring innovation. This weaker requirement allows relatively small variations on known biopharmaceutical products to pass the nonobviousness requirement.⁹⁹

3. *Utility*. — Finally, an invention must be useful to be patentable.¹⁰⁰ The utility doctrine does not directly promote divergent innovation, but it *does* permit innovation to be new-for-the-sake-of-new, rather than better, and that was not always a foregone conclusion. The first Patent Act, passed in 1790, required that three cabinet members “deem the invention or

92. *Otsuka*, 678 F.3d at 1292.

93. *Id.*

94. See Eisenberg, *Pharma’s Nonobvious Problem*, *supra* note 87, at 377 (noting that the Federal Circuit has “articulated an approach to evaluating the (non)obviousness of chemical inventions, including pharmaceuticals, that sometimes seems as ‘rigid and mandatory’ as the [teaching, suggestion, or motivation] approach at issue in *KSR*”).

95. *Sanofi-Synthelabo v. Apotex*, 550 F.3d 1075, 1089–90 (Fed. Cir. 2008).

96. Christopher A. Cotropia, *Predictability and Nonobviousness in Patent Law After KSR*, 20 *Mich. Telecomm. & Tech. L. Rev.* 391, 394–95 (2014).

97. Barron, *supra* note 88, at 423; see also Douglas L. Rogers, *Federal Circuit’s Obviousness Test for New Pharmaceutical Compounds: Gobbledygook?*, 14 *Chi.-Kent J. Intell. Prop.* 49, 54 (2014) (“[T]he Federal Circuit . . . applies . . . a test for new pharmaceutical compounds that generally makes it more difficult than under *KSR* to prove obviousness.”).

98. Eisenberg, *Pharma’s Nonobvious Problem*, *supra* note 87, at 377.

99. See *id.*; Amir A. Naini, *Convergent Technologies and Divergent Patent Validity Doctrines: Obviousness and Disclosure Analyses in Software and Biotechnology*, 86 *J. Pat. & Trademark Off. Soc’y* 541, 544–60 (2004) (describing the effects of “a relatively low nonobviousness barrier”); see also *infra* section III.B.1 (discussing *me-too* drugs).

100. 35 U.S.C. §§ 101, 112 (2012); *Juicy Whip, Inc. v. Orange Bang, Inc.*, 185 F.3d 1364, 1366–67 (Fed. Cir. 1999).

discovery sufficiently useful and important,” requiring some meaningful advance.¹⁰¹ But this language was eliminated in 1793.¹⁰² In the 1817 case *Lowell v. Lewis*, the renowned patent litigator Daniel Webster argued that inventions should only be patentable if they were not only new but also *better* than existing technology.¹⁰³ Justice Story, riding circuit, roundly rejected this argument:

All that the law requires is, that the invention should not be frivolous or injurious to the well-being, good policy, or sound morals of society. But if the invention steers wide of these objections, whether it be more or less useful is a circumstance very material to the interests of the patentee, but of no importance to the public. If it be not extensively useful, it will silently sink into contempt and disregard.¹⁰⁴

Congress reintroduced an “importance” requirement in the 1836 Act.¹⁰⁵ Michael Risch argues that the 1836 Act aimed to require some commercial utility,¹⁰⁶ but courts and the United States Patent and Trademark Office (PTO) largely failed to implement that requirement and the utility requirement has become “toothless” over time.¹⁰⁷ The Supreme Court did hold in *Brenner v. Manson* that patentability requires “benefit derived by the public from an invention with substantial utility,”¹⁰⁸ which could theoretically justify some commercial relevance requirement.¹⁰⁹ However, the Federal Circuit weakened that holding in *In re Brana*, which held that utility can be found even in very oblique assertions by the patent applicant, that the patent examiner bears the burden of rebutting asserted utility, and even that treating tumors in lab mice provides enough utility to satisfy the requirement.¹¹⁰

The utility requirement does not require superiority to existing technology. Demonstrating superiority (or market demand, which is a weak proxy) is hard at the time of patenting, which is typically early in the

101. Patent Act of 1790, ch. 7, § 1, 1 Stat. 109–112 (1790) (repealed 1793).

102. Patent Act of 1793, ch. 11, § 1, 1 Stat. 318–323 (1793) (repealed 1836).

103. 15 F. Cas. 1018, 1019 (C.C.D. Mass. 1817).

104. *Id.*

105. Patent Act of 1836, ch. 357, § 7, 5 Stat. 117 (1836) (repealed 1870).

106. Michael Risch, *Reinventing Usefulness*, 2010 *BYU L. Rev.* 1195, 1236–40.

107. *Id.* at 1195. But see Sean B. Seymore, *Making Patents Useful*, 98 *Minn. L. Rev.* 1046, 1060–66 (2014) [hereinafter Seymore, *Making Patents Useful*] (arguing that the utility requirement is minimal for certain types of inventions but stringent for others).

108. 383 U.S. 519, 534 (1966).

109. See Risch, *supra* note 106, at 1232. Interestingly enough, nonobviousness doctrine does sometimes take commercial relevance into account because commercial success is a secondary indicator of nonobviousness—though as Robert Merges has noted, the link between commercial success and nonobviousness requires quite a few steps. Robert P. Merges, *Commercial Success and Patent Standards: Economic Perspectives on Innovation*, 76 *Calif. L. Rev.* 803, 838–52 (1988) [hereinafter Merges, *Commercial Success*] (presenting and critiquing this inferential leap).

110. 51 F.3d 1560, 1565–69 (Fed. Cir. 1995).

development process; firms may not know themselves how well their innovations perform.¹¹¹ But that difficulty is not insurmountable. Jake Sherkow, for instance, argues that post-application evidence should be admissible to prove lack of enablement (and consequently, lack of utility) for drugs that looked like they would work but actually did not.¹¹²

The Indian patent system goes even further. Section 3(d) of the Indian Patents Act prohibits patenting derivatives of an existing substance—including new forms of drugs—unless they result “in the enhancement of the known efficacy of that substance.”¹¹³ Section 3(d) deals with the timing difficulty through its limited applicability—it is not relevant to all innovations, just those that involve new forms of a known compound.¹¹⁴ These inventions are especially likely to be differentiating innovation without new benefits.¹¹⁵ A patent on such an innovation requires a demonstration that the differentiation actually constitutes an improvement. The Indian Supreme Court used this provision to deny a patent on Gleevec, a blockbuster cancer drug sold by Novartis for which the patent covered only a new form of a known chemical with no improved efficacy.¹¹⁶ Amy Kapczynski has argued that this provision should help innovation by driving companies to develop drugs that are better, not just new.¹¹⁷

Demonstrating superiority can be challenging even setting aside the timing challenges. When a later innovation changes an earlier product so that it works better for some but worse for others, is that an improvement? If it works a bit worse, but at a much lower price?¹¹⁸ The now-defunct Canadian promise doctrine held patentees to their own promises of utility, sidestepping the problem by letting patentees define the goal.¹¹⁹ Indian law leaves it largely undefined, at least for now. For biomedical innovation, the issue may be somewhat easier due to the presence of regulators qualified

111. See Risch, *supra* note 106, at 1211–16 (noting the challenges of demonstrating commercial utility at the time of patenting).

112. Sherkow, *Reproducibility Paradox*, *supra* note 29, at 907–11.

113. Patents Act, No. 39 of 1970, India Code, ch. 2 § 3(d), <https://indiacode.nic.in/bitstream/123456789/1392/3/a1970-39.pdf#search=Patent%20acts> [<https://perma.cc/M4NV-3D2U>]. The section, overall focused on novelty, also prohibits patenting “the mere discovery of any new property or new use for a known substance or of the mere use of a known process, machine or apparatus unless such known process results in a new product or employs at least one new reactant.” *Id.*

114. *Id.*

115. See *infra* section III.A.

116. *Novartis AG v. Union of India*, (2013) 13 SCR 148, 274–76 (India).

117. Amy Kapczynski, *Engineered in India—Patent Law 2.0*, 369 *New Eng. J. Med.* 497, 498 (2013).

118. See generally Aaron L. Nelson, Joshua T. Cohen, Dan Greenberg & David M. Kent, *Much Cheaper, Almost as Good: Decrementally Cost-Effective Medical Innovation*, 151 *Annals Internal Med.* 662 (2009) [hereinafter Nelson et al., *Almost as Good*].

119. See Norman Siebrasse, *The False Doctrine of False Promise*, 29 *Canadian Intell. Prop. Rev.* 3, 4–5 (2013) (describing the doctrine); *id.* at 47–55 (criticizing the doctrine); see also *AstraZeneca Canada Inc. v. Apotex Inc.*, [2017] 1 S.C.R. 943, para. 36 (Can.) (eliminating the doctrine).

to evaluate at least some claims of superiority, particularly for close variants of the same product.¹²⁰ But in any event, U.S. utility doctrines do not require improvement.

B. *Infringement*

Incentives from infringement mirror those from patentability. A person infringes a patent when they make, use, sell, or import the patented invention.¹²¹ The patentee may seek injunctive relief or damages for patent infringement.¹²² Therefore, a later innovator working in a particular area has an incentive to avoid infringing an earlier patent on an invention in that area (assuming they are aware of the patent¹²³). If Jenn is working in the field of epinephrine auto-injectors, she has an incentive to avoid the subject matter covered in patents on the EpiPen; if she cannot, she'll have to share some of her profits with the holders of those patents.¹²⁴

A rich literature discusses patent policy in the context of cumulative innovation.¹²⁵ If the later innovation is worthwhile (that is, if Jenn's ideas for innovation based on the EpiPen are valuable), the innovation should theoretically still take place because the patentee should be willing to license the patent to the later innovator.¹²⁶ But licensing is hard. Suzanne Scotchmer and colleagues have theorized about how best to divide R&D efforts and social surplus between earlier and later inventors, concluding that *ex ante* licenses are generally the best way to allocate surplus.¹²⁷ *Ex post* licenses are harder to reach and can result in hold-up problems.¹²⁸ However, empirical evidence gathered by Heidi Williams and others suggests that *ex ante* licenses occur relatively rarely;¹²⁹ James Bessen argues

120. See *infra* section IV.A.

121. 35 U.S.C. § 271 (2012).

122. *Id.* §§ 283–284.

123. See Ouellette, *Useful Information*, *supra* note 36, at 557–59, 566–71 (discussing why scientists might not read patents but finding evidence that at least some do).

124. See, e.g., *Acorda Therapeutics, Inc. v. Roxane Labs., Inc.*, 903 F.3d 1310, 1339 (Fed. Cir. 2018) (“[A] blocking patent diminishes possible rewards from a non-owner’s or non-licensee’s investment activity aimed at an invention whose commercial exploitation would be infringing, therefore reducing incentives for innovations in the blocked space by non-owners and non-licensees of the blocking patent.”).

125. See generally, e.g., Jerry R. Green & Suzanne Scotchmer, *On the Division of Profit in Sequential Innovation*, 26 *RAND J. Econ.* 265 (1995) (discussing patents and cumulative innovation); Scotchmer, *supra* note 22 (same).

126. See, e.g., James Bessen & Eric Maskin, *Sequential Innovation, Patents, and Imitation*, 40 *RAND J. Econ.* 611, 613 (2009) (“[I]f the follow-on R&D is worthwhile, [the patent holder] could share in its value by a suitably chosen licensing fee/royalty, thereby increasing her own profit . . .”). Edmund Kitch’s prospect theory of patents is a strong articulation of this idea. Kitch, *supra* note 38, at 276–80.

127. Green & Scotchmer, *supra* note 125, at 21.

128. See *id.*

129. Heidi L. Williams, *Intellectual Property Rights and Innovation: Evidence from the Human Genome*, 121 *J. Pol. Econ.* 1, 23 (2013) [hereinafter Williams, *Intellectual Property Rights*]; see also Bharat N. Anand & Tarun Khanna, *The Structure of Licensing Contracts*,

that information asymmetries between the two parties can limit licensing.¹³⁰ Williams identifies other limits, including Arrow's information paradox (you can't dicker over the price of an idea unless the idea is shared, but once it's been shared, why would the prospective buyer pay for it?).¹³¹ Whatever the exact causes, some empirical evidence suggests that IP on earlier biomedical innovations limits later innovation in that area.¹³²

Given a range of more and less divergent innovation possibilities, a later innovator faces patent incentives to choose more divergent options to avoid compensating the initial licensee through either licensing or patent infringement.¹³³ Negotiating a successful license is challenging, whether ex ante or ex post, and in either case the later innovator must share profits with the earlier patentee.¹³⁴ Infringement liability is probabilistic but can be catastrophic.¹³⁵ The innovator could also simply ignore the patent, but that is a risky strategy, especially in biopharmaceutical contexts where FDA approval and patents are tightly linked.¹³⁶ In any case, it may be easier—all else being equal—to avoid the problem altogether by avoiding infringement of the patent.

Direct infringement liability can be found in either of two ways, each of which has features promoting divergent innovation. First, literal infringement requires that the accused product be exactly covered by a patent; this encourages inventing around, a form of divergent innovation in which later innovators make changes to avoid infringement liability or the need

48 J. Indus. Econ. 103, 115 (2000) (finding low rates of ex ante licensing in many technological areas, with the highest ex ante licensing rates (twenty-three percent) in chemicals and pharmaceuticals).

130. James Bessen, Holdup and Licensing of Cumulative Innovations with Private Information, 82 Econ. Letters 321, 323 (2004).

131. Williams, Intellectual Property Rights, *supra* note 129, at 23.

132. See Michael A. Heller & Rebecca S. Eisenberg, Can Patents Deter Innovation? The Anticommons in Biomedical Research, 280 Science 698, 698–99 (1998) (making a theoretical argument about blocking gene patents); Fiona Murray, Philippe Aghion, Mathias Dewatripoint, Julian Kolev & Scott Stern, Of Mice and Academics: Examining the Effect of Openness on Innovation, 8 Am. Econ. J. 212, 235–36 (2016) (finding that removing IP on genetically engineered mice led to about a twenty to forty percent increase in citations to scientific papers on those mice); see also Williams, Intellectual Property Rights, *supra* note 129, at 4 (“Celera’s IP appears to have generated economically and statistically significant reductions in subsequent scientific research and product development, on the order of 20–30 percent.”). But see Bhaven Sampat & Heidi L. Williams, How Do Patents Affect Follow-On Innovation? Evidence from the Human Genome, 109 Am. Econ. Rev. 203, 229 (2019) (finding that gene patenting did not decrease later innovation among genes of similar potential value).

133. Payment through patent infringement is probabilistic; it depends on a successful suit (or willingness to pay in response to a demand letter). Nevertheless, the expected liability for infringing a patent is greater than zero. See Mark A. Lemley & Carl Shapiro, Probabilistic Patents, J. Econ. Persp., Spring 2005, at 75, 88–89.

134. See Williams, Intellectual Property Rights, *supra* note 129, at 22–24.

135. See generally Lemley & Shapiro, *supra* note 133, at 79–80 (discussing the economics of probabilistic patents).

136. See Mark A. Lemley, Ignoring Patents, 2008 Mich. St. L. Rev. 19, 21–22, 29–31.

to license the patent.¹³⁷ Literal infringement promotes differentiating infringement. Second, the doctrine of equivalents creates liability beyond the clear limits of a patent's claim.¹³⁸ It promotes exploratory innovation.

1. *Literal Infringement and Inventing Around.* — Literal infringement requires that the accused product contain every element in the claimed invention.¹³⁹ To avoid infringement liability, innovators (those aware of an existing patent) may engage in the process of “inventing around”: altering an invention enough that it falls outside the boundaries of the patent claims.¹⁴⁰ For instance, if a claim described two pieces of a hinge with recesses directly across from one another, a later entrant might make a very similar product with the recesses offset from one another, thus attempting to avoid literal infringement.¹⁴¹ Inventing around has at times been heralded as a spur to creativity on the part of later innovators,¹⁴² in this case, perhaps offset recesses prolong hinge life or are easier to manufacture. But perhaps not.

At base, inventing around requires that later innovators change an invention, not because they may improve it, or because they may increase the invention's social welfare value or market share, but rather because that change is necessary to avoid patent infringement. The second invention differs purely for the sake of difference. Sometimes inventing around may require trivial effort, such as substituting a different type of fastening; other times, it may require substantial effort, such as developing a slight

137. See, e.g., Rochelle C. Dreyfuss & James P. Evans, From *Bilski* Back to *Benson*: Preemption, Inventing Around, and the Case of Genetic Diagnostics, 63 Stan. L. Rev. 1349, 1360–61 (2011) (describing the practice of inventing around in the context of genetic patents).

138. See *Graver Tank & Mfg. Co. v. Linde Air Prods. Co.*, 339 U.S. 605, 608 (1950) (describing the doctrine of equivalents as protecting against infringements of a product that “performs substantially the same function in substantially the same way to obtain the same result”).

139. Literal infringement is the mirror to anticipation, discussed *supra* section II.A.1. A well-known maxim states, “That which infringes, if later, would anticipate, if earlier.” *Peters v. Active Mfg. Co.*, 129 U.S. 530, 537 (1889) (internal quotation marks omitted) (quoting *Peters v. Active Mfg. Co.*, 21 F. 319, 321 (C.C.S.D. Ohio 1884)).

140. See Dreyfuss & Evans, *supra* note 137, at 1360–61. To be sure, innovators may wish to go further than just outside the boundaries of the patent claim, since the doctrine of equivalents occasionally allows patentees to reach beyond those literal boundaries. See *infra* section II.B.2.

141. *Roton Barrier, Inc. v. Stanley Works*, 79 F.3d 1112, 1126–27 (Fed. Cir. 1996) (affirming a finding of no literal infringement and reversing a finding of infringement under the doctrine of equivalents).

142. See, e.g., Rebecca Tushnet, Free to Be You and Me? Copyright and Constraint, 128 Harv. L. Rev. Forum 125, 125–26 (2015) (noting the creativity-enhancing effects of inventing around); see also, e.g., *State Indus., Inc. v. A.O. Smith Corp.*, 751 F.2d 1226, 1235–36 (Fed. Cir. 1985) (finding that the defendant's conduct “involving keeping track of a competitor's products and designing new and possibly better or cheaper functional equivalents is the stuff of which competition is made and is supposed to benefit the consumer”).

chemical variation on a drug and then taking that variant through hundreds of millions of dollars of clinical trials.¹⁴³

Birth control pills provide an excellent example of pointless inventing around. Bio-Technology Group makes Mircette, an oral contraceptive protected by a patent that claims administering one week of an estrogenic compound (during the user's period) followed by three weeks of progestin.¹⁴⁴ Duramed filed an application to market a generic version of the drug—but to avoid infringing the patent, it changed the order of the drug to three weeks of progestin followed by one week of an estrogenic compound.¹⁴⁵ Duramed hoped this unnecessary and unhelpful inventing around would help it avoid infringing the relevant patent. (It didn't work.¹⁴⁶)

2. *The Doctrine of Equivalents.* — The doctrine of equivalents allows courts to find infringement beyond the bounds of literal infringement. Under the doctrine of equivalents, a product can infringe a patent, even if it does not literally infringe, so long as it is not substantially different from the patented invention.¹⁴⁷ The doctrine of equivalents pushes innovation from differentiating innovation toward exploring innovation; to the extent that the doctrine brings slightly different inventions to the fuzzy ambit of a patent claim, later inventors face incentives to diverge further from the existing product. Patents on especially groundbreaking inventions can theoretically be treated as “pioneer patents,” which receive even broader protection, creating additional incentives for exploring innovation.¹⁴⁸ Nevertheless, the doctrine of equivalents has become substantially weaker over the years, including decreasing emphasis on pioneer patents,¹⁴⁹ which has the impact of decreasing the incentives for exploring innovation relative to merely differentiating innovation.¹⁵⁰

143. See *infra* section III.B.

144. U.S. Patent No. Re. 35,724 col. 7 ll. 36–50.

145. *Bio-Tech. Gen. Corp. v. Duramed Pharm., Inc.*, 174 F. Supp. 2d 229, 232–33 (D.N.J. 2001), *rev'd*, 325 F.3d 1356 (Fed. Cir. 2003).

146. See *id.* at 234–41 (finding no infringement). But see *Bio-Tech. Gen.*, 325 F.3d at 1361, 1364 (reversing the district court).

147. See, e.g., *Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co.*, 535 U.S. 722, 726–27 (2002); *Graver Tank & Mfg. Co. v. Linde Air Prod. Co.*, 339 U.S. 605, 608 (1950).

148. See generally Esther Steinhauer, Note, Using the Doctrine of Equivalents to Provide Broad Protection for Pioneer Patents: Limited Protection for Improvement Patents, 12 *Pace L. Rev.* 491 (1992) (attempting to “reconcile[] the application of the doctrine of equivalents with the protection of innovative and useful research”).

149. See John R. Allison & Mark A. Lemley, The (Unnoticed) Demise of the Doctrine of Equivalents, 59 *Stan. L. Rev.* 955, 958–60 & n.18 (2007) (“The [pioneer patent] doctrine today may or may not be moribund, though it is clearly applied only infrequently by the Federal Circuit.”).

150. Notably, the doctrine of reverse equivalents also promotes divergent innovation. This doctrine—mostly moribund—holds that an accused product that literally infringes may not infringe if it is in fact very different from the subject matter of the original patent. Robert Merces, Intellectual Property Rights and Bargaining Breakdown: The Case of Blocking Patents, 62 *Tenn. L. Rev.* 75, 75 (1994) (describing the reverse equivalents doctrine as “basically a rule of excused infringement; when it applies, it declares that even though a patentee

* * * *

Taken together, multiple doctrines of patentability and infringement promote divergent innovation but do not require improvement. Novelty and nonobviousness directly make it easier to obtain patents for differentiating or exploring innovation, and infringement liability, whether literal or by equivalents, creates incentives to stray from existing, patented technology. Coupled with these, the utility requirement allows differentiating innovation and exploring innovation without any accompanying social welfare gain from improving the innovation. Thus, the costs of divergence, described below, are less likely to be offset by the benefits of improved technology.

III. THE DARK SIDE OF DIVERGENT INNOVATION

Patent law drives divergent innovation, and divergence can create real problems along with its benefits. This Part considers in detail three forms of costs arising from divergent innovation: the costs of inventing around, the lack of interoperability or standards, and the dispersion of knowledge about particular technologies. It illustrates these problems through three in-depth case studies and shorter examples. But novelty is not all bad; this Part thus begins with a brief account of its benefits.

A. *Benefits of Divergent Innovation*

To be sure, pushing innovators to constantly explore new paths of innovation has benefits—I am not suggesting that innovation is bad, or that creating incentives such that innovators broadly explore many possible paths is inherently problematic. The benefits of innovation are widely recognized,¹⁵¹ and to the extent that our default conception of innovation is to focus on new products or technologies, these benefits are largely associated with divergent innovation. Most importantly, while patent doctrine does not require that inventions be better, only new,¹⁵² the inventions certainly *can* be better, and these improvements drive progress.

Scholars have long argued that inventing around can be beneficial. As Joseph Fishman summarizes, “The basic insight is that the patentee’s

has proven infringement, the infringer is free from liability”). But see *Tate Access Floors, Inc. v. Interface Architectural Res., Inc.*, 279 F.3d 1357, 1368 (Fed. Cir. 2002) (noting that the reverse doctrine of equivalents had never been applied by the Federal Circuit). To the extent that this takes truly divergent innovations out of the scope of literal infringement, the doctrine of reverse equivalents promotes divergent innovation by exempting inventions from the licensing fees or infringement liability resulting from earlier patents. But, as noted, this doctrine is largely gone from practice.

151. See, e.g., Roin, *Unpatentable Drugs*, supra note 2, at 507–15 (“Pharmaceutical innovation is often seen as the golden child of the patent system, with patents taking credit for the discovery and development of valuable new drugs that provide tremendous health benefits to the public.”).

152. See supra section II.A.3.

right to exclude triggers a virtuous cycle in which one invention begets a competing and sometimes even better invention.”¹⁵³ We often don’t know the best solution to a problem beforehand, and inventing around results in diverse potential solutions.¹⁵⁴ Scholars of innovation law and judges on the Federal Circuit alike have argued that inventing around can generate useful solutions and aid innovation.¹⁵⁵

If consumers can identify better innovations, the market should reward improvements. Nonmonetary considerations can also drive improvement over mere differentiation—many innovators are driven not just by profit motives but by the desire to improve the world.¹⁵⁶ Finally, even if the innovator is not trying to improve existing technology, but just to change it, some fraction of changes will be improvements purely by chance. Such improvements are a desirable result of divergent innovation and fit well with the goals of the patent system.

Some benefits arise from divergent innovation even when the innovation is *not* better—when it is just different, or perhaps even when it is somewhat worse. Mere difference can itself be beneficial. In a world of varying needs, different solutions can be helpful, even if none is strictly better: Users may have different tradeoffs between risks and benefits, drugs may have different side effects, or users may have different preferences along any number of dimensions.¹⁵⁷ We may also learn new facts from the mere existence of variation.¹⁵⁸

Divergent innovation that yields no technical improvement can also lower costs. Most straightforwardly, competition between substitutes should lower costs to consumers.¹⁵⁹ The only producer in a class can charge

153. Joseph P. Fishman, *Creating Around Copyright*, 128 *Harv. L. Rev.* 1333, 1339 (2015).

154. *Id.* at 1353.

155. See, e.g., *id.* at 1353–55; see also, e.g., *State Indus., Inc. v. A.O. Smith Corp.*, 751 F.2d 1226, 1236 (Fed. Cir. 1985) (“One of the benefits of a patent system is its so-called ‘negative incentive’ to ‘design around’ a competitor’s products, even when they are patented, thus bringing a steady flow of innovations to the marketplace.”).

156. See generally, e.g., Maurice Cassier & Christiane Sinding, ‘Patenting in the Public Interest:’ Administration of Insulin Patents by the University of Toronto, 24 *Hist. & Tech.* 153 (2008) (describing the patenting of insulin and licensing to the University of Toronto for management in the public interest); Margit Osterloh & Sandra Rota, *Open Source Software Development—Just Another Case of Collective Invention?*, 36 *Res. Pol’y* 157 (2007) (describing the open software movement and intrinsic motivation for invention).

157. This variation may, of course, be captured in broader definitions of “better” products. See *supra* section II.A.3.

158. But see *infra* section III.D (describing the costs associated with broader, shallower knowledge from divergent innovation).

159. See Fiona Scott Morton & Lysle T. Boller, *Enabling Competition in Pharmaceutical Markets 1* (Hutchins Ctr., Working Paper No. 30, 2017), https://www.brookings.edu/wp-content/uploads/2017/05/wp30_scottmorton_competitioninpharma1.pdf [<https://perma.cc/455P-T932>] (discussing the benefits of competition between substitutes). In the drug industry in particular, competition between substitutes is complicated because it is mediated by FDA; substitutes may be similar drugs that are also branded or generic drugs that are determined to be bioequivalent by FDA. See *id.* at 8–10.

monopoly prices, but once multiple substitutes exist in a product class—different, even if not better—prices should drop closer to the cost of production. Competition between substitutes doesn't always work especially well in biomedical innovation, where patient and doctor preferences for particular products can be sticky and can reduce competition, but it still has some effect even there and is tremendously important in markets in general.¹⁶⁰ Costs can also be lowered through a different type of divergent innovation, in which the new technology actually performs worse but does so at a lower cost, which may be a preferable combination to some purchasers.¹⁶¹

The benefits from divergent innovation are substantial, whether the innovation is an improvement or not. Nevertheless, balanced against those benefits are costs that are less often recognized.

B. *Costs of Inventing Around*

Inventing around an existing patented invention is costly. When downstream inventors are forced to vary an invention simply for the purpose of avoiding an existing patent, they spend R&D resources on something that may turn out to have little or no benefit.¹⁶² Even if the result is beneficial, other innovation might have been a better allocation of those resources.¹⁶³

In a prominent early study of the R&D costs of imitating competitors, Richard Levin and colleagues found substantial costs of inventing around.¹⁶⁴ Many industry leaders stated that duplicating competitors' patented major new processes or products would cost nearly as much as the competitor spent to develop it in the first place.¹⁶⁵ Without patents, the estimated costs dropped significantly, suggesting that inventing around patents is a costly

160. See generally, e.g., Panos Kanavos, Joan Costa Font & Alistair McGuire, Product Differentiation, Competition, and Regulation of New Drugs: The Case of Statins in Four European Countries, 28 *Managerial & Decision Econ.* 455 (2007) (discussing competition among statins in Europe).

161. See Nelson et al., *Almost as Good*, supra note 118, at 662.

162. See, e.g., Michael Abramowicz, Perfecting Patent Prizes, 56 *Vand. L. Rev.* 115, 190–91 (2003); Louis Kaplow, The Patent-Antitrust Intersection: A Reappraisal, 97 *Harv. L. Rev.* 1813, 1869–70 (1984).

163. See, e.g., Subcomm. on Patents, Trademarks & Copyrights of the S. Comm. on the Judiciary, 85th Cong., *An Economic Review of the Patent System* 50–52 (Comm. Print 1958) (authored by Fritz Machlup) (lamenting how inventing around wastes “inventive talent”).

164. Richard C. Levin, Alvin K. Klevorick, Richard R. Nelson & Sidney G. Winter, Appropriating the Returns from Industrial Research and Development, 3 *Brookings Papers on Econ. Activity* 783, 802–11 (1987), https://www.brookings.edu/wp-content/uploads/1987/12/1987c_bpea_levin_klevorick_nelson_winter_gilbert_griliches.pdf [<https://perma.cc/PKU7-BWNR>].

165. *Id.* at 809 (reporting that, in 66 of 127 industries, respondents estimated the costs of duplicating a major patented new process to be 76 to 100% of the innovator's R&D costs; in 63 of 127 industries, respondents estimated the same for products).

endeavor;¹⁶⁶ similarly, duplication costs for patented inventions increased more in industries with stronger patent protection in general.¹⁶⁷ Overall, Levin and colleagues found that patents raise imitation costs by forty percent for new drugs, thirty percent for major new chemical products, and twenty-five percent for typical new chemical products¹⁶⁸—presumably all differentiating inventions to copy the product with enough differences to avoid the patents. For electronics, patents increased imitation costs by seven to fifteen percent for major products and seven to ten percent for typical products.¹⁶⁹ These numbers are old—the survey was conducted in 1987—but the general pattern accords with the idea that patents substantially increase the costs of developing existing technologies by requiring inventing around.

The drug industry provides many examples of divergent innovation with high costs of inventing around. Two areas stand out: “me-too” drugs and evergreening practices.

1. *Me-Too Drugs*. — Me-too drugs, also known as “follow-on” drugs, have similar chemical structures and mechanisms of action as already-marketed drugs.¹⁷⁰ They evoke both sides of divergent innovation: Critics argue that they require redundant R&D with little benefit,¹⁷¹ while supporters argue they can better serve different subpopulations and can reduce prices through competition.¹⁷²

Statins show how patents drive me-too drug development and how development’s costs can outweigh its benefits.¹⁷³ Researchers began synthesizing

166. *Id.* (reporting that, in 49 of 127 industries, respondents estimated the costs of duplicating a major unpatented new process to be 76 to 100% of innovator R&D; in 40 of 127 industries, respondents estimated the same for products).

167. *Id.* at 810. Although the costs of duplication increased with a patent, the time to duplication decreased in some industries, suggesting that the disclosure found in patents at least helps focus duplicative R&D efforts. *Id.* at 810–11.

168. *Id.* at 811.

169. *Id.*

170. Joseph A. DiMasi & Laura B. Faden, *Competitiveness in Follow-On Drug R&D: A Race or Imitation?*, 10 *Nature Revs. Drug Discovery* 23, 23 (2011).

171. *Id.*; see also Nicole M. Gastala, Peter Wingrove, Anne Gaglioti, Stephen Petterson & Andrew Bazemore, *Medicare Part D: Patients Bear the Cost of ‘Me Too’ Brand-Name Drugs*, 35 *Health Aff.* 1237, 1237 (2016).

172. See DiMasi & Faden, *supra* note 170, at 23. The price-competition point is especially complex for drugs; while competition between different on-patent branded drugs can reduce prices, the entry of generic versions of a branded drug results in far lower prices. See *Generic Competition and Drug Prices*, FDA, <https://www.fda.gov/about-fda/center-drug-evaluation-and-research-cder/generic-competition-and-drug-prices> [<https://perma.cc/66B9-BLHU>] (last updated Dec. 19, 2019). To the extent that me-too drugs result in higher use of branded drugs relative to generic drugs, the overall market price for the group of drugs is thus likely to remain higher.

173. See Gastala et al., *supra* note 171, at 1237 exhibit 1 (using statins to illustrate how “me-too” drugs raise costs for consumers); see also Joshua J. Gagne & Niteesh K. Choudhry, *How Many “Me-Too” Drugs Is Too Many?*, 305 *J. Am. Med. Ass’n* 711, 711 (2011) (illustrating

statins in the late 1970s to lower cholesterol and reduce the risk of coronary heart disease.¹⁷⁴ Merck received FDA approval for the first, Mevacor (lovastatin), in 1987.¹⁷⁵ Since Mevacor's release, researchers have discovered eight more statins; FDA has approved six of them.¹⁷⁶ Pfizer's Lipitor (atorvastatin) was approved in 1997 and became one of the best-selling drugs of all time, with over \$100 billion in revenue by 2011.¹⁷⁷ AstraZeneca's Crestor (rosuvastatin), approved in 2003, had over \$62 billion in sales by 2017.¹⁷⁸

The development of Crestor shows the power of patent law's incentives for divergent innovation. After Pfizer brought Lipitor to market in 1987, researchers in Japan sought to develop a new statin.¹⁷⁹ The researchers initially experimented with variations on the same chemical core contained in atorvastatin.¹⁸⁰ Results from those early experiments, however, proved toxic in animals, stymieing the researchers' progress.¹⁸¹ So they switched gears, moving to a different chemical core.¹⁸² Working with this new core, the researchers discovered rosuvastatin, a new statin that appeared to have promising levels of potency with limited side effects in animal studies.¹⁸³ In 1993, the researchers received a patent for their discovery,¹⁸⁴ which was eventually sold as the blockbuster drug Crestor.¹⁸⁵

In the process, patent law pushed the research in a direction that researchers *expected* would be only moderately successful—but which,

how “me-too” drugs like statins “may make treatment decisions more difficult and may undermine clinical outcomes”).

174. See Akira Endo, A Historical Perspective on the Discovery of Statins, 86 Proc. Japan Acad. Series B Physical & Biological Sci. 484, 487, 489 (2010).

175. See *id.* at 490; Jeremy A. Greene, The Abnormal and the Pathological: Cholesterol, Statins, and the Threshold of Disease, *in* Medicating Modern America: Prescription Drugs in History 183, 183–84 (Andrea Tone & Elizabeth Siegel Watkins eds., 2007).

176. See Emma Hennessy, Claire Adams, F. Jerry Reen & Fergal O’Gara, Is There Potential for Repurposing Statins as Novel Antimicrobials?, 60 Antimicrobial Agents & Chemotherapy 5111, 5111 (2016).

177. See Veronique Dupont, Pfizer’s Blockbuster Drug Lipitor Goes Generic, Med. Xpress (Nov. 30, 2011), <https://medicalxpress.com/news/2011-11-pfizer-blockbuster-drug-lipitor.html> [<https://perma.cc/39V2-CHXU>].

178. Tracy Staton, I. Crestor, FiercePharma (Aug. 28, 2017), <https://www.fiercepharma.com/special-report/1-crestor> [<https://perma.cc/4J4N-Y7VW>]; see also *In re Rosuvastatin Calcium Patent Litig.*, 703 F.3d 511, 515 (Fed. Cir. 2012).

179. See *In re Rosuvastatin*, 703 F.3d at 515.

180. See Plaintiffs’ Responsive Post-Trial Brief at 5–6, *In re Rosuvastatin Calcium Patent Litig.*, 719 F. Supp. 2d 388 (D. Del. 2010), 1:07-cv-00811-JJF, 2010 WL 9432313.

181. See *id.* at 6–7.

182. *Id.* at 7.

183. *Id.* at 7–8.

184. U.S. Patent No. 5,260,440.

185. *In re Rosuvastatin Calcium Patent Litig.*, 703 F.3d 511, 514–15 (Fed. Cir. 2012). Arguably, the development process includes elements of all three types of innovation; researchers started out trying to differentiate and ended up moving more toward exploring innovation once they found toxicity—perhaps best characterized as a form of deepening innovation.

coincidentally, would be easier to patent. Counsel for AstraZeneca described the invention during a 2010 patent dispute.¹⁸⁶ Counsel noted that a PHOSITA, “if provided with the structure of rosuvastatin on [the date of invention], at best might expect that rosuvastatin would function as a statin and therefore could inhibit cholesterol in humans.”¹⁸⁷ Thus, researchers would think rosuvastatin was—at best!—nothing more than a me-too statin.¹⁸⁸ And in fact, this “at best” result was probably not reality. At the time, researchers “would have . . . expected” that a structure like rosuvastatin would have “poor activity, and thus be considered a failure” based on the prevailing research.¹⁸⁹ As the Federal Circuit noted, “[A]t least five pharmaceutical companies had abandoned their research on statins with [similar chemical] cores, on the prevailing belief that [such] statins were not promising leads to improved products.”¹⁹⁰

While this likelihood of failure makes research less promising to pursue, it makes getting a patent easier. One of the secondary indicia of nonobviousness is “teaching away”; if the prevailing knowledge in a field suggests that a new solution will not be successful and “teaches away” from that solution, that solution becomes more likely to be nonobvious and therefore patentable.¹⁹¹ Similarly, surprising and unexpected results make inventions more likely to be patented and bolstered the validity of the patent covering Crestor.¹⁹²

To reiterate: I am not arguing that patent law’s penchant for divergence is all bad, in this example or elsewhere. Pursuing modifications to the same chemical scaffold can have benefits, lowering the risk of off-target effects and leading cheaper development.¹⁹³ Small tweaks to a molecule could also make it much better, and it is often difficult to know in advance whether they will. In the case of Crestor, patent law created incentives for

186. *In re Rosuvastatin*, 719 F. Supp. 2d at 388.

187. Plaintiffs’ Responsive Post-Trial Brief at 72, *In re Rosuvastatin*, 719 F. Supp. 2d 388, 1:07-cv-00811-JJF, 2010 WL 9432313.

188. In fact, AstraZeneca did not even license the drug rights (a proxy for measuring its commercial potential) from the original patent assignee until 1998, five years after the first U.S. rosuvastatin patent issued. Benjamin Yang, Drug Profile: Crestor, *Discovery Med.* (May 23, 2009), <http://www.discoverymedicine.com/Benjamin-Yang/2009/05/23/drug-profile-crestor/> [<https://perma.cc/V4TD-9MND>].

189. See Plaintiffs’ Responsive Post-Trial Brief at 56, *In re Rosuvastatin*, 719 F. Supp. 2d 388, 1:07-cv-00811-JJF, 2010 WL 9432313.

190. *In re Rosuvastatin*, 703 F.3d at 517.

191. See *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994) (“A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant.”).

192. See *In re Rosuvastatin*, 703 F.3d at 516–18 (explaining how unexpectedness supported the plaintiff’s patent).

193. See Camille G. Wermuth, Similarity in Drugs: Reflections on Analogue Design, 11 *Drug Discovery Today* 348, 348–49 (2006) (“The process of using marketed drug structures as a basis for investigation . . . results in increased efficacy and safety of therapeutic agents, thanks to iterative improvements.”).

Japanese researchers to pursue a new line of research (even though, and in fact because, it seemed unlikely to work). That type of counterintuitive knowledge creation—that the new line did actually work—is innovation that we wouldn't get without patents.

But statins and other divergent me-too drugs come with substantial costs, and it is not at all clear that those costs are worth the benefits. One meta-analysis comparing four leading statins found that “it is barely possible to differentiate between the different statins in relation to any outcome.”¹⁹⁴ The authors found that statins were equally effective across subpopulations including women, patients with diabetes, and older patients, and are all generally well tolerated.¹⁹⁵ There is little difference between the drugs, but drug companies have developed eight statins and gotten them approved, and each one costs substantial resources in terms of making the drug, running clinical trials, and undergoing FDA evaluation.¹⁹⁶

Me-too drugs are also costly in terms of, well, cost. More drugs in a class may decrease the average cost of *branded* drugs by some amount—a common argument for me-too drugs and differentiating innovation in general.¹⁹⁷ However, branded me-too drugs are typically much more expensive than generic versions of the earlier drugs and sometimes are developed even after the pioneer drug has already lost patent protection and generics have entered the market (multiple statins follow this pattern).¹⁹⁸ Nevertheless, many doctors and patients stick with the more expensive me-too drugs rather than shifting to the far cheaper generics, raising social costs and firm profits alike.¹⁹⁹ Why? It's typically not because

194. S. Ward, M. Lloyd Jones, A. Pandor, M. Holmes, R. Ara, A. Ryan, W. Yeo & N. Payne, A Systematic Review and Economic Evaluation of Statins for the Prevention of Coronary Events, Health Tech. Assessment, Apr. 2007, at 1, 63; see also Murray Aitken, Ernst R. Berndt & David M. Cutler, Prescription Drug Spending Trends in the United States: Looking Beyond the Turning Point, 28 Health Aff. w151, w157 (2009) (“Although some controversy still exists, general consensus among the medical community is that for most patients, the various statins are equally effective and safe, and thus are therapeutically substitutable. An exception is at very high dosages, where Lipitor is believed to be more effective.”). But see Peter H. Jones, Michael H. Davidson, Evan A. Stein, Harold E. Bays, James M. McKenney, Elinor Miller, Valerie A. Cain & James W. Blasetto, Comparison of the Efficacy and Safety of Rosuvastatin Versus Atorvastatin, Simvastatin, and Pravastatin Across Doses (STELLAR TRIAL), 92 Am. J. Cardiology 152, 157–59 (2003) (finding some differences among statins).

195. See Ward et al., *supra* note 194, at 48–52, 62–63; see also Cesar S. Recto II, Stella Acosta & Adrian Dobs, Comparison of the Efficacy and Tolerability of Simvastatin and Atorvastatin in the Treatment of Hypercholesterolemia, 23 Clinical Cardiology 682, 688 (2000) (finding that simvastatin and atorvastatin are similarly tolerable).

196. See Gagne & Choudry, *supra* note 173, at 711–12.

197. See Stephane Régnier, What Is the Value of ‘Me-Too’ Drugs?, 16 Health Care Mgmt. Sci. 300, 301 (2013).

198. See Gagne & Choudry, *supra* note 173, at 711. This is not always the case; many instances that look like me-too imitations are really drug companies racing to pursue the same target. See Joseph A. DiMasi & Cherie Paquette, The Economics of Follow-On Drug Research and Development, Pharmacoeconomics Supplement 2, Oct. 2004, at 1, 9–10.

199. Régnier, *supra* note 197, at 301 (describing how me-too drugs can lead to slower adoption of generics after the pioneer loses patent protection). See generally Anupam B.

the me-too drugs are better.²⁰⁰ Instead, the market share from me-too drugs comes largely from marketing efforts²⁰¹—efforts that are unsurprisingly focused on me-too drugs.²⁰²

2. *Evergreening Practices.* — “Evergreening,” a special subset of me-too drug development practices, shows especially clearly the extent of new-for-the-sake-of-new differentiating innovation. In evergreening practices (also called “lifecycle management”), pharmaceutical companies engage in various practices to extend the effective term of patent protection on their drugs.²⁰³ Evergreening typically involves the initial innovator taking later actions to extend the effective patent life by making small changes to a drug.²⁰⁴ The initial patent on a drug inevitably expires, on average about twelve years after a drug is approved.²⁰⁵ Patent term limits drive divergent innovation: If the drug maker wants to maintain a monopoly, it needs to win new patents.

Firms use differentiating innovations to extend the effective patent term on a drug by making minor changes to the drug’s formulation, method of delivery, or, in the most extreme cases, active ingredient (changing the drug but keeping market share).²⁰⁶ There are many, many examples.²⁰⁷ In a particularly prominent case, AstraZeneca was about to lose patent protection on Prilosec (omeprazole), a racemic mixture of both left- and right-handed molecules used to treat acid reflux and related conditions.²⁰⁸ AstraZeneca isolated one enantiomer (a left- or right-handed molecule)

Jena, John E. Calfee, Edward C. Mansley & Tomas J. Philipson, ‘Me-Too’ Innovation in Pharmaceutical Markets, 12 *F. for Health Econ. & Pol’y*, Jan. 2009, at 1 (noting the lack of substitution from follow-on branded drugs to generics of the pioneer drug and using this to argue that there must be some superiority visible to doctors and patients).

200. See *supra* note 194 and accompanying text.

201. Régnier, *supra* note 197, at 312 (finding that me-too drugs spend twenty percent more on marketing than pioneer drugs and that market share is related to marketing but not to price).

202. See Charles Ornstein & Ryann Grochowski Jones, *Vying for Market Share, Companies Heavily Promote ‘Me Too’ Drugs*, ProPublica (Jan. 7, 2015), <https://www.propublica.org/article/vying-for-market-share-companies-heavily-promote-me-too-drugs> [<https://perma.cc/UBK9-4PY6>].

203. See C. Scott Hemphill & Bhaven N. Sampat, *Evergreening, Patent Challenges, and Effective Market Life in Pharmaceuticals*, 31 *J. Health Econ.* 327, 327–28 (2012).

204. *Id.* at 330 & n.10 (describing action taken by drug manufacturers to extend the patent lifecycle).

205. *Id.* at 337. For an exploration of how the ticking patent clock shapes pharmaceutical target selection, see Eric Budish, Benjamin N. Roin & Heidi Williams, *Do Firms Underinvest in Long-Term Research? Evidence from Cancer Clinical Trials*, 105 *Am. Econ. Rev.* 2044, 2044–49 (2015) (finding greater investment in drugs with shorter clinical trials).

206. See Hemphill & Sampat, *supra* note 203, at 328–29.

207. See *id.* at 330 (reporting that, on average, each of the 119 drugs studied has two patents covering ancillary components).

208. See Michael A. Carrier & Steve D. Shadowen, *Product Hopping: A New Framework*, 92 *Notre Dame L. Rev.* 167, 172, 224–25 (2016).

from the mixture, patented it, and got it approved as Nexium (esomeprazole).²⁰⁹ This move has been tremendously profitable, and Nexium is a blockbuster drug, but it seems to have minimal therapeutic benefit over Prilosec, even though it cost a lot to develop in terms of FDA approval and clinical trials, and costs a lot to buy today.²¹⁰ Other strategies include changing the dosage form from twice-a-day to once-a-day (Actavis' Namenda IR (memantine) to Namenda XR)²¹¹ or replacing a drug with the metabolite the body makes from the drug (Pfizer's Efexor-XR (venlafaxine) to Pristiq (desvenlafaxine)).²¹²

These evergreening changes have little evidence that they help patients more than the original drugs—but they result in new patents and extended market protection.²¹³ As Hazel Moir puts it:

Was the invention of desvenlafaxine induced by the patent system? Almost certainly—without a further effective market exclusivity period, it seems unlikely that Pfizer would have developed this alternative medicine. Was there any benefit to society from the development of this 'new' medicine? . . . [A] net benefit in exchange for this monopoly grant is hard to perceive.²¹⁴

These changes are all examples of innovation that make a new product just different enough from the old product to get patent protection. The only real difference to patients is that they pay higher prices longer.

* * * *

The exact empirics of the balance between the costs and benefits of inventing around are uncertain and perhaps unascertainable. But at the least, we should recognize the costs—indeed, some already have²¹⁵—and tally those against the baseline assumption that novelty is inherently a good goal for the patent system.

209. *Id.* at 172.

210. See *id.* at 224–25; Aaron S. Kesselheim, Michael A. Fischer & Jerry Avorn, Extensions of Intellectual Property Rights and Delayed Adoption of Generic Drugs: Effects on Medicaid Spending, 25 *Health Aff.* 1637, 1642–43 (2006).

211. See *New York ex rel. Schneiderman v. Actavis PLC*, 787 F.3d 638, 646–48 (2d Cir. 2015); *Carrier & Shadowen*, *supra* note 208, at 198–200 (discussing the case as an example of the “product hopping” evergreen strategy).

212. See Hazel V. J. Moir, Exploring Evergreening: Insights from Two Medicines, 49 *Australian Econ. Rev.* 413, 419–21 (2016). This particular technique no longer works; the doctrine of inherent anticipation now prevents patenting a known drug's metabolite. See *Schering Corp. v. Geneva Pharm., Inc.*, 339 F.3d 1373, 1381 (Fed. Cir. 2003). For an examination of the doctrine, see generally Dan L. Burk & Mark A. Lemley, *Inherency*, 47 *Wm. & Mary L. Rev.* 371 (2005).

213. See David F. Lehmann & Sarabeth Wojnowicz, The Evergreening of Biopharmaceuticals: Time to Defoliate, 56 *J. Clinical Pharmacology* 383, 387 (2015) (arguing that evergreening techniques are common but offer little benefit). But see Israel Agranat & Silyya R. Wainschtein, The Strategy of Enantiomer Patents of Drugs, 15 *Drug Discovery Today* 163, 167–69 (2010) (arguing that the obviousness doctrine will render many such patents invalid).

214. Moir, *supra* note 212, at 420.

215. See, e.g., Abramowicz, *supra* note 162, at 190–91; Dan L. Burk, *Perverse Innovation* 1, 26–29 (2016); Dreyfuss & Evans, *supra* note 137, at 1371–72.

Finally, the costs of inventing around are not incurred only by the innovator, but also by other social institutions.²¹⁶ When new drugs are developed just to avoid an existing patent, the second innovator must conduct clinical trials. In addition to the economic costs felt by the innovator, the subjects in those trials face risks of injury or foregoing better treatment options.²¹⁷ FDA will expend resources evaluating the new drug, and those costs will be higher because the new drug needs to be evaluated from scratch rather than as a new set of information about an existing product.²¹⁸ And, as described below, generating and sharing information about a slightly different product spreads out the process of learning and the development of expertise.²¹⁹ In sum, the process of inventing around to create something new—just to avoid an existing patent—creates its own costs; those costs *may* be offset by some benefits, but they may also be wasted effort.

C. *Barriers to Interoperability*

Divergent innovation can reduce the ability of products to interact with each other. When products interact readily, sharing standards, many things are easier: Consumers can switch from one vendor to another, replacement parts can be produced in a competitive market, and network effects can develop when many people use the same system.²²⁰ Systems that don't work well together can raise the costs of switching from one system to another and thus promote lock-in.²²¹ For biomedical technology, interoperability can lead to modularized system parts that can be improved separately.²²² The ability to pass information between different systems is also key to many health technologies and requires interoperability.²²³

216. To the extent that these social costs are internalized by innovators or consumers, of course, this all comes out in the wash. But it is still useful to group together the initial source of the costs.

217. See generally, e.g., Kenneth J. Rothman & Karin B. Michels, *The Continuing Unethical Use of Placebo Controls*, 331 *New Eng. J. Med.* 394 (1994) (describing ethical concerns with placebo trials). Certainly, there is also a chance that the participants may encounter a better treatment.

218. Cf. Francis S. Collins, *Mining for Therapeutic Gold*, 10 *Nature Revs. Drug Discovery* 397, 397 (2011) (noting that existing information about a drug can speed up clinical testing).

219. See *infra* section III.D.

220. Mark A. Lemley, *Intellectual Property Rights and Standard-Setting Organizations*, 90 *Calif. L. Rev.* 1889, 1896–97 (2002) [hereinafter Lemley, *Intellectual Property Rights*] (arguing that the ability of products to interact produces many positive benefits, both in the marketplace and for consumers).

221. See, e.g., William Barnes, Myles Gartland & Martin Stack, *Old Habits Die Hard: Path Dependency and Behavioral Lock-In*, 38 *J. Econ. Issues* 371, 371–73 (2004) (explaining the concept of lock-in).

222. Hassan Masum, Rebecca Lackman & Karen Bartleson, *Developing Global Health Technology Standards: What Can Other Industries Teach Us?*, *Globalization & Health*, Oct. 2013, at 1, 2 (discussing how interoperability can lead to modularized system parts).

223. See, e.g., W. Nicholson Price II, *Risk and Resilience in Health Data Infrastructure*, 16 *Colo. Tech. L.J.* 65, 66–67 (2017).

A rich literature addresses standards, interoperability, and intellectual property. One prominent strand discusses the problem of overlapping patent rights and the role that standard-setting organizations can play in reducing that problem.²²⁴ Another strand considers what happens when patents cover technologies essential to adhere to an industry standard.²²⁵ This section considers a problem in some sense antecedent to both: When patents create incentives for innovators to pursue divergent innovation, they can drive a proliferation of different technologies that may be incompatible.²²⁶ That is to say, patent-promoted divergent innovation can lead to the problem that standards try to *solve*.²²⁷

Wearable insulin pumps show how patent-related divergent innovation can lead to interoperability problems. Insulin pumps help individuals with diabetes deliver insulin more easily than traditional manual injections.²²⁸ First developed in 1963,²²⁹ they are now typically small devices (about the size of a deck of cards) that deliver insulin through a thin tube to a cannula implanted in a patient.²³⁰

Before 2001, the industry used a standard system to connect durable insulin pumps (which last for years) with disposable insulin sets (which last for a few days, contain insulin, and connect to the pumps) via “luer locks.”²³¹ Medtronic, the dominant maker of insulin pumps at the time, made several types of pumps under the name MiniMed that used standard luer locks.²³² Kits connecting to these pumps could be and were made by

224. See Lemley, Intellectual Property Rights, *supra* note 220, at 1948–54 (discussing how standard-setting organizations can reduce the problem of overlapping patent rights).

225. See generally, e.g., Janice M. Mueller, Patent Misuse Through the Capture of Industry Standards, 17 Berkeley Tech. L.J. 623 (2002) (describing how conflicts arise when patent holders are involved in setting industry standards); Pamela Samuelson, Are Patents on Interfaces Impeding Interoperability?, 93 Minn. L. Rev. 1943, 2004–05 (2009) (arguing that market forces typically overcome problems of interface patents and result in interoperability).

226. The problems are not totally distinct; when a standard is covered by patents, innovators face an incentive not to use the standard to avoid licensing those patents. That incentive may be overcome if the benefits of standardization are sufficient, but it nevertheless pushes toward divergence.

227. Bernard Chao has written about the challenge that arises when patents on interfaces that are no better than existing technology—what he calls “horizontal innovation”—are used to limit interoperability, with a focus on information technology. See Bernard Chao, Horizontal Innovation and Interface Patents, 2016 Wis. L. Rev. 287, 295–307.

228. Grazia Aleppo, Insulin Pump Overview: How Insulin Pumps Work, Who Benefits from Them, and Different Types of Pumps, EndocrineWeb (Mar. 5, 2019), <https://www.endocrineweb.com/guides/insulin/insulin-pump-overview> [<https://perma.cc/X94D-K95F>].

229. Noel E. Schaeffer, Linda J. Parks, Erik T. Verhoef, Timothy S. Bailey, Alan B. Schorr, Trent Davis, Jean Halford & Becky Sulik, Usability and Training Differences Between Two Personal Insulin Pumps, 9 J. Diabetes Sci. & Tech. 221, 221 (2015).

230. Aleppo, *supra* note 228.

231. Medtronic Minimed Inc. v. Smiths Med. MD Inc., 371 F. Supp. 2d 578, 581 (D. Del. 2005).

232. *Id.* at 581–82.

multiple vendors, including Medtronic.²³³ In 1999, a new market entrant began aggressively marketing its own luer lock-compatible insulin kits.²³⁴ Two years later, Medtronic introduced the Paradigm line of insulin pumps, which use a proprietary connection system that Medtronic patented.²³⁵ Unsurprisingly, the number of manufacturers making insulin sets compatible with Medtronic pumps dropped substantially.²³⁶ Since 2001, Medtronic has developed multiple different insertion and connection systems with proprietary connections.²³⁷ For some systems, it remains the only manufacturer, and other diabetes manufacturers have developed their own, incompatible, proprietary systems.²³⁸ This divergence did not respond to some flaw with prior systems—even though divergent and incompatible standards have spread, many insulin pumps still use mutually compatible luer-lock systems today,²³⁹ even as insulin sets themselves have developed new features.²⁴⁰

Patents created an incentive to develop a system different from the prior art just for the sake of obtaining a patent. Medtronic was encouraged to engage in differentiating innovation. But the story didn't stop there; once Medtronic moved away from the existing industry luer-lock standard, other innovators then pursued their own proprietary interface standards, diverging not only to pursue patent benefits but also presumably to avoid paying Medtronic for technologies that might infringe its new patents. The result was a proliferation of different incompatible systems. This incompatibility comes with economic and personal costs; aside from potential damage to competition,²⁴¹ switching between insulin pumps with different

233. *Id.*

234. *Id.* at 582.

235. See U.S. Patent No. 6,585,695 B1; see also *Medtronic*, 371 F. Supp. 2d at 581.

236. See *Medtronic*, 371 F. Supp. 2d at 582 (describing design changes that made non-Medtronic insulin sets incompatible with Medtronic insulin pumps).

237. Infusion Sets, Medtronic, <http://www.medtronicdiabetes.com/products/infusion-sets> [<https://perma.cc/S3MH-AY2V>] (last visited Oct. 16, 2019).

238. See, e.g., Dep't of Veterans Affairs, Justification for Single Source Awards IAW FAR 13.106-1 (May 6, 2016), <https://www.vendorportal.ecms.va.gov/FBODocumentServer/DocumentServer.aspx?DocumentId=2996620&FileName=VA770-16-Q-0506-003.pdf> (on file with the *Columbia Law Review*) (justifying purchasing only MiniMed infusion sets for users of MiniMed insulin pumps and only Animas infusion sets for users of Animas insulin pumps).

239. Infusion Set Comparison, Diabetesnet.com (Dec. 2, 2010), <https://www.diabetesnet.com/diabetes-technology/infusion-sets> [<https://perma.cc/K9UP-RSMA>].

240. See, e.g., Up Close with BD's New Infusion Set: A Much Needed Improvement to Insulin Pumps, diaTribe Learn (May 18, 2015), <https://diatribe.org/close-bd-new-infusion-set-much-needed-innovation-improve-insulin-pumps> [<https://perma.cc/W6LV-SNX3>].

241. Competitive harms suggest that such patent-prompted interoperability can sometimes raise antitrust concerns. Indeed, Smiths made exactly such an argument but failed. *Medtronic*, 371 F. Supp. 2d at 584–85. This argument was made with greater success in *C.R. Bard, Inc. v. M3 Sys., Inc.*, in which a company changed the design of a biopsy gun to accept a new and different needle design, patented the new needle and the needle-gun interface,

connectors can require patient retraining and increase the risk of medical error.²⁴²

D. *Problems of Shallow Learning and Spread Expertise*

Finally, divergent innovation decreases the depth of knowledge acquired and available about particular innovative products. Zachary Liskow and Quentin Karpilow describe a broader pattern of innovation: Innovation is easier when knowledge stocks are concentrated, allowing future innovators to exploit a basis of existing expertise.²⁴³ When innovations diverge—driven by patent law doctrine or by other factors—we should expect to see shallower knowledge stocks relevant to those innovations. There are certainly benefits from broader knowledge; as elsewhere in this story, tradeoffs exist. But decreased depth of knowledge comes with substantial costs. This section illustrates the problem of dispersed knowledge with two examples: the EpiPen and the market for epinephrine auto-injectors, and me-too statins.

1. *Dispersed User Knowledge.* — Consider the EpiPen, which illustrates the problem of divergent innovation leading to diffused patient knowledge and increased switching costs. The EpiPen, owned by Mylan and manufactured by Pfizer, is an epinephrine auto-injector used to treat allergic reactions, including anaphylaxis, which can lead to shock, suffocation, and death.²⁴⁴ It is a relatively simple device, including a fixed dose of epinephrine, a needle, a spring, and a plastic housing including a retractable cap for the needle.²⁴⁵ And epinephrine itself has been a generic drug for decades.²⁴⁶ Nevertheless, the EpiPen itself has seen little improvement.²⁴⁷

and reduced competition in the market through its patents. 157 F.3d 1340, 1367–72 (Fed. Cir. 1998).

242. See Lutz Heinemann & Lars Krinelke, *Insulin Infusion Sets: The Achilles Heel of Continuous Subcutaneous Insulin Infusion*, 6 J. Diabetes Sci. & Tech. 954, 960–61 (2012).

243. Zachary Liskow & Quentin Karpilow, *Innovation Snowballing and Climate Law*, 95 Wash. U. L. Rev. 387, 404–14 (2017) (discussing knowledge stocks and innovation path dependency in the context of clean energy technology). As noted above, the depth of existing knowledge stocks and expertise can also have implications for the nonobviousness and enablement doctrines; when more knowledge and understanding are available in a particular technological area, the PHOSITA is likely enabled to do more without undue experimentation, which also raises the bar for nonobvious innovations. Thus, these doctrines are cyclically related to the social problem of shallow knowledge; nonobviousness pushes toward divergent innovation, which then results in decreasing knowledge stocks and broadens the set of potential innovations which are considered nonobvious. See *supra* sections II.A.2–.3; see also Burk & Lemley, *Policy Levers*, *supra* note 84, at 1648–51 (noting the relationship between knowledge in the art, enablement, and nonobviousness).

244. See Meghana Keshavan, *5 Reasons Why No One Has Built a Better EpiPen*, STAT (Sept. 9, 2016), <https://www.statnews.com/2016/09/09/epipen-lack-of-innovation/> [<https://perma.cc/G28Q-SFRQ>].

245. See *id.*; see also EpiPen, Drugs.com, <https://www.drugs.com/epipen-auto-injector.html> [<https://perma.cc/7TE8-E3AZ>] (last updated Jan. 4, 2019).

246. See Keshavan, *supra* note 244.

247. See *id.*

Competitor innovation has mostly been divergent innovation, which has been largely unsuccessful in reaching patients and has imposed costs when it has because patients don't know how to safely use the different auto-injectors available.²⁴⁸

Competitors with the EpiPen have pursued divergent innovation to avoid infringing the patents protecting it.²⁴⁹ Five related patents protect the EpiPen, all expiring in 2025.²⁵⁰ The key element in the EpiPen auto-injector is a safety cap that surrounds the needle when the device is not in use, automatically retracts when the device is jabbed against the thigh, and then automatically returns to guard the needle and protect the user against needle-sticks after use.²⁵¹ The patents around this key design feature drive divergent innovation: As an auto-injector innovation consultant put it, "It would not be very difficult to create an EpiPen product, in terms of engineering . . . It's not rocket science. It's purely the patent that stops us."²⁵²

The Adrenaclick, the closest competitor, is just a little bit different than the EpiPen: a path of differentiating innovation. It has two safety caps instead of one, and does not have an automatic shield that guards the needle after use.²⁵³ The differences are minor, and certainly not improvements; it is hard to see a reason for them besides avoiding the EpiPen patents, especially since the Adrenaclick was developed well after the EpiPen.²⁵⁴ Another competitor has tried to tread this path even closer:

248. See *id.*; see also Carolyn Y. Johnson & Catherine Ho, *How Mylan, the Maker of EpiPen, Became a Virtual Monopoly*, *Wash. Post* (Aug. 25, 2016), https://www.washingtonpost.com/business/economy/2016/08/25/7f83728a-6aee-11e6-ba32-5a4bf5aad4fa_story.html (on file with the *Columbia Law Review*).

249. I do not claim that patents create the only incentives for product differentiation, just that they create at least some incentives for such differentiation.

250. See U.S. Patent No. 7,449,012; U.S. Patent No. 7,794,432; U.S. Patent No. 8,048,035; U.S. Patent No. 8,870,827; U.S. Patent No. 9,586,010; see also *Orange Book: Approved Drug Products with Therapeutic Equivalence Evaluations: Patent and Exclusivity for: N019430*, FDA, https://www.accessdata.fda.gov/scripts/cder/ob/patent_info.cfm?Product_No=001&Appl_No=019430&Appl_type=N [<https://perma.cc/Z525-5KRN>] (last visited Oct. 22, 2019) (listing the patents granted for the EpiPen).

251. See *How to Use an EpiPen*, Mylan, <https://www.epipen.com/-/media/files/epipen/howtouseepipenautoinjector.pdf> [<https://perma.cc/4H5U-UMG2>] (last visited Jan. 7, 2020).

252. See Keshavan, *supra* note 244 (internal quotation marks omitted) (quoting Matthew Allen, head of drug delivery for Cambridge Consultants).

253. *How to Use Adrenaclick (Epinephrine Injection, USP Auto-Injector)*, Adrenaclick, http://adrenaclick.com/how_to_use_adrenaclick_epinephrine_injection_USP_auto_injector.php [<https://perma.cc/55Y2-VEW9>] (last visited Oct. 16, 2019).

254. The Adrenaclick was introduced in 2010. *Adrenaclick Auto-Injector Launched for Anaphylaxis*, MPR (Jan. 7, 2010), <https://www.empr.com/home/news/adrenaclick-auto-injector-launched-for-anaphylaxis/> [<https://perma.cc/69TE-59HG>]. It is covered by one patent, U.S. Patent No. 7,905,352, which expires in 2027. See *Orange Book: Approved Drug Products with Therapeutic Equivalence Evaluations: Patent and Exclusivity for: N020800*, FDA, https://www.accessdata.fda.gov/scripts/cder/ob/patent_info.cfm?Product_No=003&Appl_No=020800&Appl_type=N [<https://perma.cc/Q8UV-5P33>] (last visited Oct. 16, 2019) (listing the patents for Adrenaclick).

Teva sought approval to market a generic version of the EpiPen—but Teva's version had both a safety clip at one end and a removable cap covering the needle end, in another effort to design around Mylan's patents but still make a device that could substitute for the EpiPen.²⁵⁵

The Auvi-Q, the third and final epinephrine auto-injector available in the United States, pursued a path of exploring innovation, and is quite different. In addition to a different form factor (the Adrenaclick and EpiPen are both cylinders, while the Auvi-Q is shaped like a pack of playing cards), the Auvi-Q uses a needle that automatically extends and retracts and uses an electronic voice instruction system to guide patients.²⁵⁶ It also has a single safety cap.²⁵⁷ The Auvi-Q's substantial differences are reflected in its larger patent portfolio; the Orange Book lists twenty-six patents covering the Auvi-Q, the last of which expires in 2029.²⁵⁸

Slightly different technologies can create high switching costs through decreased knowledge and the need for retraining. Although the differences between the EpiPen, Adrenaclick, and Auvi-Q are not especially large, they matter a great deal to patients—especially children—who use them in high-stress emergency situations. For example, the EpiPen requires users to remove one cap and the Adrenaclick requires users to remove two caps; inadequate training can result in confusion, possibly leading to mistakes that could result in injury or death.²⁵⁹ Unsurprisingly, users—especially parents of children with allergies—do not wish to make even small changes in using the devices. This desire to avoid the risk and uncertainty associated with differentiating technological change can manifest in policy. Summer camps, for instance, may require that parents provide the EpiPen—and not a different epinephrine auto-injector—because they only train camp counselors on one type of auto-injector to avoid confusion.²⁶⁰

255. Michael Gibney, *Could EpiPen's Plastic Cap Be Mylan's Secret Weapon?*, FiercePharma (Sept. 1, 2016), <https://www.fiercepharma.com/drug-delivery/could-a-plastic-cap-epipen-have-given-mylan-its-market-dominance> [<https://perma.cc/688X-UM6A>]; see also Adam Rubenfire, *Mylan's Fight Against Teva Highlights Logjam Created by FDA Petitions*, Modern Healthcare (Sept. 2, 2016), <https://www.modernhealthcare.com/article/20160902/NEWS/160909983/mylan-s-fight-against-teva-highlights-logjam-created-by-fda-petitions> [<https://perma.cc/Q248-ZR2J>].

256. See *About Auvi-Q*, Auvi-Q, <https://www.auvi-q.com/about-auvi-q> [<https://perma.cc/D6PK-32BN>] (last visited Oct. 16, 2019).

257. *Id.*

258. See *Orange Book: Approved Drug Products with Therapeutic Equivalence Evaluations: Patent and Exclusivity for: N201739*, FDA, https://www.accessdata.fda.gov/scripts/cder/ob/patent_info.cfm?Product_No=003&Appl_No=201739&Appl_type=N [<https://perma.cc/J53T-82VM>] (last visited Oct. 22, 2019) (listing patents for Auvi-Q).

259. Emily Willingham, *Why Did Mylan Hike EpiPen Prices 400%? Because They Could*, Forbes (Aug. 21, 2016), <https://www.forbes.com/sites/emilywillingham/2016/08/21/why-did-mylan-hike-epipen-prices-400-because-they-could/> [<https://perma.cc/TW8F-4PX6>].

260. Anna Edney, *The U.S. Is Facing an EpiPen Shortage*, Bloomberg (May 8, 2018), <https://www.bloomberg.com/news/articles/2018-05-08/patients-can-t-find-epipen-at-the-pharmacy-as-supply-runs-short> (on file with the *Columbia Law Review*).

FDA seems to have recognized the switching costs and the danger of variety. When Teva filed its application to market a generic EpiPen, Mylan filed a citizen petition requesting FDA to deny the application on the grounds that the design difference (one cap versus two) would be unsafe for device users.²⁶¹ FDA denied Mylan's citizen petition²⁶²—but then rejected Teva's generic application all the same, citing “certain [unspecified] major deficiencies.”²⁶³ Eventually, after public outcry over EpiPen costs and efforts by FDA Commissioner Scott Gottlieb, FDA approved Teva's two-cap version.²⁶⁴

Shallow knowledge for divergent innovations—patients not knowing much about the Adrenaclick or Auvi-Q—can also limit competition among different products. The EpiPen has long been the hugely dominant market leader.²⁶⁵ Its market leadership has resulted from several factors, including allegedly anticompetitive conduct,²⁶⁶ but bolstering them has been the fact that once you start using the EpiPen, the costs of switching are high. And Mylan—smartly—has created an extensive program of providing free or discount EpiPens to schools (in contracts that limit schools' purchases of competitive devices) so that consumers develop knowledge about the EpiPen and not its competitors.²⁶⁷

Information-based limits on competition limit the benefits from divergent innovation. Costs stay high; the EpiPen's price went up over

261. Citizen Petition from Frank Casty, Head Glob. Med. Affairs, Mylan, to Div. of Dockets Mgmt., FDA 3 (Jan. 16, 2015), <https://s3.amazonaws.com/assets.fiercemarkets.net/public/005-LifeSciences/mylancitizenpetition1.16.15.pdf> [<https://perma.cc/A4BF-MRSX>]. Mylan filed a supplemental report claiming that users trained on the EpiPen could not use the proposed device safely. Citizen Petition Supplement from Frank Casty, Head Glob. Med. Affairs, Mylan, to Div. of Dockets Mgmt., FDA (Apr. 28, 2015), <https://www.modernhealthcare.com/assets/pdf/CH10683591.PDF> [<https://perma.cc/YL49-SGD3>]. Others questioned the quality of the report. Ed Silverman, How Mylan Tried to Keep Teva from Selling a Generic EpiPen, STAT (Aug. 31, 2016), <https://www.statnews.com/pharmalot/2016/08/31/mylan-teva-generic-epipen/> [<https://perma.cc/Z7MJ-26NL>].

262. Kieran Meagher, Note, Abuse of the Hatch-Waxman Act: Mylan's Ability to Monopolize Reflects Major Weaknesses, 11 *Brook. J. Corp. Fin. & Com. L.* 589, 603 (2016).

263. See Carly Helfand, FDA Swats Down Teva's EpiPen Copy, Putting Mylan in Cruise Control, *FiercePharma* (Mar. 1, 2016), <https://www.fiercepharma.com/sales-and-marketing/fda-swats-down-teva-s-epipen-copy-putting-mylan-cruise-control> [<https://perma.cc/LHU6-NGYW>].

264. Press Release, FDA, FDA Approves First Generic Version of EpiPen (Aug. 16, 2018), <https://www.fda.gov/news-events/press-announcements/fda-approves-first-generic-version-epipen> [<https://perma.cc/UG5V-UPPV>] [hereinafter FDA, Generic Version of EpiPen].

265. See generally Carrier & Minniti, *supra* note 20 (describing EpiPen's dominance and the tactics underlying that dominance).

266. See generally *id.*

267. See Pauline Bartolone, EpiPen's Dominance Driven by Competitor's Stumbles and Tragic Deaths, *NPR* (Sept. 7, 2016), <https://www.npr.org/sections/health-shots/2016/09/07/492964464/epipen-s-dominance-driven-by-competitors-stumbles-and-tragic-deaths> [<https://perma.cc/Q9E3-NG8J>].

400% in seven years, resulting in outcry and Congressional hearings²⁶⁸ (which didn't impact its price).²⁶⁹ A second problem arises when the sole source runs into manufacturing problems; EpiPen manufacturing problems led to shortages in Canada, the United Kingdom, and the United States in 2018.²⁷⁰

Of course, one version of this story goes that this is exactly what patents are supposed to do. EpiPen has a patent on its technology; it gets something like a monopoly; it makes a lot of money; and that ex post reward is what motivates the ex ante research that goes into developing a lifesaving technology. We wait for the patent to expire, and everyone is better off. Of course, this story poses problems for the EpiPen.²⁷¹ But that's not the point I'm making here. The story of the EpiPen demonstrates how the classical narrative of market selection for superior devices can provide an inadequate description of real innovation and market dynamics.²⁷² In particular, divergent innovation, whether differentiating or exploring, can create substantial costs for consumers because of shallow information, incompatibility, and switching costs among otherwise substitutable products. These costs, moreover, can lead to an absence of market competition and the absence of even the putative benefits of innovative divergence.

More generally, product variety means that users are less likely to know how to use any particular product and more likely to encounter costs when switching from more familiar to less familiar. This may be the case for patients, as with the EpiPen and its competitors, or for providers, who may know less about each individual drug available for prescription, and who may face decision costs when choosing between options.

2. *Spread Knowledge*. — Shallow knowledge doesn't only afflict consumers; providers and drug-makers alike can face problems from shallow knowledge, as the case of me-too drugs demonstrates.²⁷³ When different

268. Katie Thomas, *Mylan's Chief Is Chastised by Lawmakers Questioning EpiPen Pricing*, N.Y. Times (Sept. 21, 2016), <https://www.nytimes.com/2016/09/22/business/mylan-chief-to-insist-epipen-is-priced-fairly-at-house-hearing.html> (on file with the *Columbia Law Review*); Willingham, *supra* note 259 (cataloging financial and human costs).

269. Charles Duhigg, *Outcry Over EpiPen Prices Hasn't Made Them Lower*, N.Y. Times (June 4, 2017), <https://www.nytimes.com/2017/06/04/business/angry-about-epipen-prices-executive-dont-care-much.html> (on file with the *Columbia Law Review*).

270. Edney, *supra* note 260.

271. See Carrier & Minniti, *supra* note 20, at 55–56 (recounting the manufacturing and distribution history of the EpiPen and noting Mylan's near monopoly on the market); *id.* at 59–71 (describing Mylan's anticompetitive actions in the fields of patent litigation settlements, FDA citizen petitions, and exclusive contracts with schools); Keshavan, *supra* note 244 (summarizing the technological, financial, and regulatory incentives against improving the EpiPen); Katie Thomas, *Mylan to Settle EpiPen Overpricing Case for \$465 Million*, N.Y. Times (Oct. 7, 2016), <https://www.nytimes.com/2016/10/08/business/epipen-mylan-justice-department-settlement.html> (on file with the *Columbia Law Review*) (describing the federal government's concerns about Mylan allegedly misclassifying the EpiPen as a generic and overcharging Medicaid).

272. See *supra* notes 7–11 and accompanying text.

273. See *supra* section III.B.1.

me-too drugs are developed, each drug requires clinical trials for approval,²⁷⁴ broadening the set of class-related clinical trials but resulting in less information gathered about each individual drug. To the extent that real-world data are collected based on ongoing drug use in the context of a learning health system, dispersed use of different statins also ensures that we learn relatively less about any one drug.²⁷⁵ And when providers are choosing whether to prescribe a new statin, they must rely on the limited set of information generated in clinical trials, rather than whatever information has been gathered through years of clinical practice and adverse event reporting.²⁷⁶

Having multiple drugs available does have benefits. Competition can reduce prices (though as discussed above, this price reduction is limited).²⁷⁷ Learning how different patients respond to different drugs can lead to more precise medical practice.²⁷⁸ And there may be benefits to having a broader armamentarium of drugs available for treatment—though this argument is weakened by evidence that providers rarely use the breadth of that armamentarium, perhaps because of information and familiarity concerns.²⁷⁹

Overall, whether related to knowledge, interoperability, or inventing-around costs, divergent innovation creates costs that counterbalance at least some of its benefits. These costs are especially worrisome when divergent benefits are limited; the next Part discusses how different incentives for biomedical innovation can limit the potential upside of divergent innovation.

274. 21 U.S.C. § 355(b) (2012).

275. See W. Nicholson Price II, *Drug Approval in a Learning Health System*, 102 *Minn. L. Rev.* 2413, 2414, 2437–45 (2018) [hereinafter *Price, Drug Approval*] (describing the process of collecting data about drugs in learning health systems to allow for deeper learning about drugs in clinical care).

276. Gagne & Choudry, *supra* note 173, at 712.

277. See *supra* notes 197–202 and accompanying text.

278. See, *Price, Drug Approval*, *supra* note 275, at 2433–34 (“[C]linical trials, with their inherent limits, simply don’t provide all the information the health system needs to provide the best care.”).

279. See Peter C. Austin, Muhammad M. Mamdani & David N. Juurlink, *How Many “Me-Too” Drugs Are Enough? The Case of Physician Preferences for Specific Statins*, 40 *Ann. Pharmacotherapy* 1047, 1048 (2006) (finding that in a large sample of Ontario doctors, the average doctor wrote 94.9% of prescriptions for just one or two statins; thus half of all doctors only ever prescribed one or two). For some diseases, like psychiatric conditions or HIV/AIDS, this argument holds more force. See, e.g., *HIV Drug Resistance, Avert* (Oct. 10, 2019), <https://www.avert.org/professionals/hiv-programming/treatment/drug-resistance> [<https://perma.cc/HDR9-64PV>] (describing the threat of HIV drug resistance partially caused by providers continuing to prescribe a less effective treatment regimen); *Mental Health Medications*, Nat’l Inst. Mental Health, <https://www.nimh.nih.gov/health/topics/mental-health-medications/index.shtml> [<https://perma.cc/VN6G-6Z7Y>] (last updated Oct. 2016) (describing different kinds of psychiatric medication and the need to try multiple variations to find a drug with manageable side effects for effective treatment).

IV. PATENT DIVERGENCE IN CONTEXT

Patents act in context. Innovation incentives do not exist in a vacuum. For biomedical technologies, in particular, a wide set of additional incentive mechanisms shape the direction of innovation. Grants create funding for research,²⁸⁰ FDA-administered data or market exclusivity give additional protection for drugs or biologics,²⁸¹ prizes create ex post rewards set by prize administrators rather than the market,²⁸² and reimbursement policies shape how the market pays—or doesn't—for biomedical technologies.²⁸³ These different incentives can also push innovation to diverge, or not. Biomedical innovation is not unique in this regard; other innovation fields have their own incentive landscapes. A full canvassing of the influences of different innovation incentives awaits future work, but the next sections discuss two key mechanisms to illustrate how other incentives can interact with patent law's incentives for divergent innovation: FDA approval and insurer reimbursement.

A. *FDA Approval*

Most biomedical technologies require FDA approval to be marketed and sold,²⁸⁴ and the approval process can be extremely expensive. Estimates of the cost of winning FDA approval for a new drug range widely and are contested but are typically thought to be at least several hundred

280. See generally Price, Grants, *supra* note 14 (describing the role of grants in funding research).

281. See, e.g., Eisenberg, Role of the FDA, *supra* note 76, at 359–64 (explaining FDA “pseudo-patents”); Yaniv Heled, Regulatory Competitive Shelters, 76 Ohio St. L.J. 299, 336–53 (2015) (surveying FDA’s competition-limiting practices). Because these FDA-administered exclusivity periods are greatest for new chemical entities and new biologics—that is, for new products, not new uses for old products—these periods, too, create incentives for pursuing divergent innovation over deepening innovation. See Heled, *supra*, at 341, 351. But see Erika Lietzan, The Myths of Data Exclusivity, 20 Lewis & Clark L. Rev. 91, 103–20 (2016) (arguing that data exclusivity is the wrong framing).

282. See, e.g., Benjamin N. Roin, Intellectual Property Versus Prizes: Reframing the Debate, 81 U. Chi. L. Rev. 999, 1001–07 (2014) [hereinafter Roin, Intellectual Property] (reviewing the literature on prize systems). Prizes, while of substantial theoretical interest to innovation law scholars, are relatively small in terms of dollars at stake. See Price, Grants, *supra* note 14, at 3 (describing how governments spend far more on grants than on prizes).

283. See Roin, Intellectual Property, *supra* note 282, at 1040–41; Rachel E. Sachs, Prizing Insurance: Prescription Drug Insurance as Innovation Incentive, 30 Harv. J.L. & Tech. 153, 178–93 (2016) [hereinafter Sachs, Prizing Insurance].

284. A notable exception is the category of laboratory-developed tests, which are diagnostics developed and administered in a single laboratory. Laboratory Developed Tests, FDA, <https://www.fda.gov/medical-devices/vitro-diagnostics/laboratory-developed-tests> [<https://perma.cc/R92X-WPXY>] (last updated Sept. 29, 2018).

million dollars.²⁸⁵ Approval for a new biologic is similarly expensive.²⁸⁶ Approval for new medical devices (those that require premarket approval) is less expensive but still costs millions of dollars.²⁸⁷ Unsurprisingly, approval costs are a substantial hurdle in developing a new technology.²⁸⁸ In a way, these costs reflect an FDA requirement for deepening innovation by requiring substantial data about the functioning, safety, and efficacy of a chemical that was patented for a particular use long before. Nevertheless, the process is exceedingly costly. The possibility of avoiding these substantial approval costs can thus create substantial incentives for innovation.²⁸⁹

Some FDA approval or clearance pathways drive divergent innovation like patent law does. FDA has programs that reduce the regulatory burden of approval for drugs that fill unmet medical needs: Fast Track and Accelerated Approval.²⁹⁰ These programs create incentives for drug developers to pursue exploring innovation. Easier review can also come with the demonstration of significant improvement over existing technology through the Breakthrough Therapy or Priority Review pathways.²⁹¹ A Breakthrough Device category similarly eases the regulatory burden for devices when either there is no existing approved or cleared treatment, or the new device offers “significant advantages.”²⁹² On the other hand, FDA might also prioritize improvement and review purely me-too drugs more

285. See, e.g., Joseph A. DiMasi, Henry G. Grabowski & Ronald W. Hansen, *Innovation in the Pharmaceutical Industry: New Estimates of R&D Costs*, 47 *J. Health Econ.* 20, 31 (2016) (estimating costs of over \$2 billion); Sachs, *Prizing Insurance*, *supra* note 283, at 163 n.45 (describing varying estimates and controversy). These estimates include the costs of clinical trials, FDA approval itself, and the cost of capital. However, the entire process is shaped by FDA requirements; faster pathways can reduce not only administrative burdens but also the costs of clinical trials. See Sachs, *Prizing Insurance*, *supra* note 283, at 163–64.

286. See *infra* section IV.A.2.

287. See *infra* notes 300–302 and accompanying text.

288. See Eisenberg, *Role of the FDA*, *supra* note 76, at 356–57 (“Like other costly regulatory regimes, FDA regulation serves as a barrier to entry . . .”); Roin, *Unpatentable Drugs*, *supra* note 2, at 505 (describing the “immense investment” needed to secure FDA approval).

289. For instance, Priority Review Vouchers, which promise access to a faster approval process by FDA, have sold on the open market for well over \$100 million. See Alexander Gaffney, Michael Mezher & Zachary Brennan, *Regulatory Explainer: Everything You Need to Know About FDA’s Priority Review Vouchers, RAPS: Regulatory Focus*, <https://www.raps.org/regulatory-focus/news-articles/2017/12/regulatory-explainer-everything-you-need-to-know-about-fdas-priority-review-vouchers> [<https://perma.cc/7Y8P-9GSP>] (last updated Dec. 20, 2019) (arguing that efforts to avoid substantial approval costs can create substantial incentives for innovation).

290. *Fast Track, Breakthrough Therapy, Accelerated Approval, Priority Review, FDA*, <https://www.fda.gov/ForPatients/Approvals/Fast/default.htm> [<https://perma.cc/X4F2-77WG>] (last updated Feb. 23, 2018).

291. See *id.*

292. See 21st Century Cures Act, Pub. L. No. 114-255, § 3051(a), 130 Stat. 1033, 1121–22 (2016).

closely for safety problems if they offer no clinical improvement, though its general standard is safety and efficacy, not comparative improvement.²⁹³

FDA also has pathways that create powerful incentives for firms to avoid divergent innovation. This section considers two: (1) the premarket clearance and approval pathways for medical devices and (2) the biosimilar approval process.

1. *Getting Medical Devices on the Market.* — FDA allows some medical devices onto the market through abbreviated processes that discourage divergent innovation. FDA classifies all medical devices into one of three regulatory control categories (I, II, or III) based on their level of risk and complexity.²⁹⁴ Class I devices are subject to general controls that are applicable to all devices; Class II devices require more assurance of safety and effectiveness because general controls, by themselves, are insufficient; Class III devices present potential unreasonable risk of illness or injury and are subject to premarket approval to assure safety and effectiveness.²⁹⁵

The 510(k) premarket clearance process aims to streamline FDA's regulatory scheme. When devices are neither so high-risk as to require premarket approval nor so low-risk as to be exempted from premarket clearance or approval requirements, they can undergo the 510(k) clearance process.²⁹⁶ Under this process, FDA evaluates whether a device is "substantially equivalent" to a legally marketed Class II predicate device.²⁹⁷

In contrast to the premarket approval process, which directly requires a reasonable assurance of safety and effectiveness, "substantial equivalence" is a comparative standard. It requires that "the device has the same intended use as the predicate device" and either (a) the device "has the same technological characteristics as the predicate device," or (b) if the new device has different technological characteristics, information²⁹⁸ submitted by the device sponsor "demonstrates that the device is as safe and effective as a legally marketed device, and . . . does not raise different

293. See The FDA's Drug Review Process: Ensuring Drugs Are Safe and Effective, FDA, <https://www.fda.gov/drugs/drug-information-consumers/fdas-drug-review-process-ensuring-drugs-are-safe-and-effective> [<https://perma.cc/6DZG-8P82>] (last updated Nov. 24, 2017).

294. See FDA, The 510(k) Program: Evaluating Substantial Equivalence in Premarket Notifications [510(k)]: Guidance for Industry and Food and Drug Administration Staff 2 (2014), <https://www.fda.gov/media/82395/download> (on file with the *Columbia Law Review*) [hereinafter FDA, Substantial Equivalence Guidance].

295. 21 U.S.C. § 360c(a)(1) (2012).

296. FDA, Substantial Equivalence Guidance, *supra* note 294, at 2–4.

297. 21 U.S.C. § 360c(i). There is also a *de novo* classification process, which allows sponsors to seek lower-risk classifications even when there is no substantially equivalent predicate device that would permit using the 510(k) pathway. *De Novo Classification Request*, FDA, <https://www.fda.gov/medical-devices/premarket-submissions/de-novo-classification-request> [<https://perma.cc/W8E2-4RZS>] (last updated Sept. 6, 2019).

298. This information may include "appropriate clinical or scientific data if deemed necessary." 21 U.S.C. § 360c(i)(1)(A)(ii)(I).

questions of safety and effectiveness than the predicate device.”²⁹⁹ FDA may clear devices under the 510(k) pathway even if they are different enough that they may be independently patented, but they must still be close enough for FDA to find them substantially equivalent.

The 510(k) pathway is substantially cheaper than the premarket approval pathway. On average, firms spend \$94 million taking a device through the premarket approval pathway (\$75 million on the FDA process itself), and \$31 million to take a device through the 510(k) pathway (\$24 million at FDA).³⁰⁰ The premarket approval pathway is also longer than the 510(k) pathway; it typically takes over 400 days,³⁰¹ compared with around 200 days for a 510(k) preclearance.³⁰²

Thus, as Lisa Suter and colleagues argue, “Since [510(k)] regulatory approval hinges on claims of similarity to previously approved devices, the process may encourage the development of devices that provide only small improvements at higher cost than their predecessors.”³⁰³ Because the 510(k) preclearance process is so much cheaper, and requires that devices be substantially equivalent to existing devices, the overall FDA approval process creates substantial incentives for firms to diverge less from existing medical device technologies.³⁰⁴

299. *Id.* at § 360c(i)(1)(A)(i)–(ii). The 510(k) clearance pathway has defied advocate arguments that it should be eliminated. See, e.g., Gregory D. Curfman & Rita F. Redberg, *Medical Devices—Balancing Innovation and Regulation*, 365 *New Eng. J. Med.* 975, 976–77 (2011); IOM Says Get Rid of 510k Approval FDA Responds Not So Fast, *U.S. Med.* (Jan. 10, 2012), <http://www.usmedicine.com/hhs-and-usphs/fda/iom-says-get-rid-of-510k-approval-fda-responds-not-so-fast> [https://perma.cc/N74T-UNH2]. Instead, FDA is looking to implement more thorough post-market surveillance. Scott Gottlieb, *Advancing Policies to Promote Safe, Effective MedTech Innovation*, FDA (Dec. 11, 2018), <https://www.fda.gov/news-events/fda-voices-perspectives-fda-leadership-and-experts/advancing-policies-promote-safe-effective-medtech-innovation> [https://perma.cc/LJ9E-SRLE] (describing new reforms that involve monitoring and follow-up studies).

300. Josh Makower, Aabed Meer & Lyn Denend, *FDA Impact on U.S. Medical Technology Innovation: A Survey of Over 200 Medical Technology Companies* 7 (2010), https://www.advamed.org/sites/default/files/resource/30_10_11_10_2010_Study_CAgenda_makowerreportfinal.pdf [https://perma.cc/BQY7-WUE2].

301. Elaine Silvestrini, *Premarket Approval (PMA)*, Drugwatch, <https://www.drugwatch.com/fda/premarket-approval> [https://perma.cc/G4SA-5LAU] (last visited Oct. 16, 2019).

302. Emergo, *How Long It Takes the US FDA to Clear Medical Devices Via the 510(k) Process* 5 (2017), <https://www.emergogroup.com/sites/default/files/emergo-fda-510k-data-analysis-2017.pdf> [https://perma.cc/58TE-YKSP].

303. Lisa G. Suter, A. David Paltiel, Benjamin N. Rome, Daniel H. Solomon, Ilya Golovaty, Hanna Gerlovin, Jeffrey N. Katz & Elena Losina, *Medical Device Innovation—Is “Better” Good Enough?*, 365 *New Eng. J. Med.* 1464, 1464 (2011).

304. See Richard Williams, Robert Graboyes & Adam Thierer, *US Medical Devices: Choices and Consequences* 13 (2015), <https://www.mercatus.org/system/files/Williams-Medical-Devices.pdf> [https://perma.cc/G5H2-S77V] (explaining why a manufacturer would make products similar to existing ones to use the 510(k) process); Kyle M. Fargen, Donald Frei, David Fiorella, Cameron G. McDougall, Philip M. Meyers, Joshua A. Hirsch & J. Mocco, *The FDA Approval Process for Medical Devices: An Inherently Flawed System or a Valuable Pathway for Innovation?*, 5 *J. NeuroInterventional Surgery* 269, 271 (2013) (“A Premarketing

Not all medical devices are approved through standard device procedures; combination devices that contain both a drug and a device may be approved instead through a drug approval process, such as a New Drug Application or an Abbreviated New Drug Application (ANDA).³⁰⁵ Epinephrine auto-injectors, described above, are such combination devices.³⁰⁶ FDA has noted the need for similarity for those devices should they seek approval through the shorter, cheaper ANDA: If the product is used by patients independently, especially in emergency situations (like auto-injectors), FDA will ask whether patients can safely switch to the generic “without retraining by a physician or health care professional.”³⁰⁷ This pathway therefore offers cheaper, more expeditious device approval to devices that hew very closely to existing technology. Teva tried, and failed, to bring a generic version of the EpiPen, slightly modified to avoid patent infringement, to market through exactly this process.³⁰⁸

2. *The Biosimilar Approval Pathway.* — FDA’s pathway for biosimilar approval also creates incentives for firms to stray less from existing technology, partially undermining patent incentives for divergent innovation.³⁰⁹ Biologics are a class of therapeutics, often proteins, produced by living cells and then purified.³¹⁰ The biosimilar pathway aims to encourage firms to develop products that are nearly copies of existing biologics to increase competition and decrease prices.³¹¹

The Biologics Price Competition and Innovation Act (BPCIA), passed as part of the Affordable Care Act, creates a pathway whereby firms can

Notification (510(k)) is a fast-track process wherein applicants must demonstrate that the device to be marketed (moderate risk or Class II) is ‘substantially equivalent’ to a pre-existing legally-marketed device (predicate) in terms of safety and effectiveness.”); see also Keshavan, *supra* note 244 (citing Matthew Allen, head of drug delivery for Cambridge Consultants, for his claim that FDA “rules keep consumers safe [b]ut . . . also make it difficult to come up with design that can meet the standards—without infringing on Mylan’s patent”).

305. See, e.g., Ctr. for Drug Evaluation & Research, FDA, Comparative Analyses and Related Comparative Use Human Factors Studies for a Drug-Device Combination Product Submitted in an ANDA: Draft Guidance for Industry 1 n.2, 4–5 (2017), <https://www.fda.gov/media/102349/download> [<https://perma.cc/Z3SB-Y4WQ>] (describing supporting data needed to file for an ANDA for a combination device).

306. FDA, Generic Version of EpiPen, *supra* note 264.

307. Letter from Janet Woodcock, Dir., FDA Ctr. for Drug Evaluation and Research, to Thomas K. Rogers, III, Exec. Vice President, Regulatory Affairs, King Pharmaceuticals 6 (July 29, 2009), <https://www.regulations.gov/document?D=FDA-2007-P-0128-0006> (on file with the *Columbia Law Review*).

308. See Rubenfire, *supra* note 255; *supra* section III.D.1.

309. One may quibble with whether there is actually “innovation” going on here—are the follow-on companies actually innovating or just copying something that already exists? Nevertheless, to the extent that the biosimilar pathway explicitly and deliberately pushes some companies to pursue development pathways that diverge not at all from prior products, it counteracts some of the incentives created by patent law’s premium on divergence.

310. See W. Nicholson Price II & Arti K. Rai, Manufacturing Barriers to Biologics Competition and Innovation, 101 *Iowa L. Rev.* 1023, 1032–33 (2016).

311. See *id.* at 1028–29.

develop approximate copies of biologics and pursue a more streamlined approval pathway.³¹² Current technology does not allow exact copies of biologics; they are too complicated for the tools we have available.³¹³ The BPCIA therefore creates an easier path for companies to win approval for biologics that are very similar to existing biologics (thus, “biosimilars”).³¹⁴ The biosimilar approval pathway offers substantial savings: Biosimilar approval costs around \$100–250 million, while approval for an innovator biologic costs around \$1 billion or more.³¹⁵ The pathway is also shorter and less risky because FDA and the biosimilar company both know that the innovator biologic actually works.³¹⁶ Although the biosimilar pathway does not permit marketing while patents protect the original biologic, firms develop biosimilars while those patents are still in force, waiting to market them either until the patents expire, are invalidated through litigation, or are licensed.³¹⁷

This pathway for biosimilar approval creates incentives for firms to avoid divergent innovation. If firms pursue versions of biologics that already exist, they face lower development costs, lower risk, and an easier pathway to approval. These incentives may counterbalance the patent incentives to pursue differentiating or exploring innovations—though in some cases, both incentives can be relevant, as when firms develop biosimilars that are close enough to follow the FDA biosimilar approval pathway

312. See *id.* at 1040–42.

313. See *id.* at 1034–37 (noting the lack of available tools for precisely identifying and copying the characteristics of biologics); *id.* at 1039 (noting the regulatory incentives for innovator firms to avoid developing the fundamental knowledge to be able to characterize biologics fully).

314. *Id.* at 1040.

315. *Id.* at 1049; see also Thomas Sullivan, *A Tough Road: Cost to Develop One New Drug Is \$2.6 Billion; Approval Rate for Drugs Entering Clinical Development Is Less Than 12%*, *Pol’y & Med.* (Mar. 21, 2019), <https://www.policymed.com/2014/12/a-tough-road-cost-to-develop-one-new-drug-is-26-billion-approval-rate-for-drugs-entering-clinical-de.html> [<https://perma.cc/YUJ5-YEL4>].

316. Note that the pathway still has substantial problems, including the possibility that trade secrets about manufacturing processes will substantially limit innovation. See Price & Rai, *supra* note 310, at 1046–48 (describing this dynamic generally); W. Nicholson Price II, *Regulating Secrecy*, 91 *Wash. L. Rev.* 1769, 1791–92 (2016) (describing the interactions between trade secrecy and tight regulatory definitions that make the former especially powerful in this context).

317. The BPCIA includes elaborate patent-related provisions. See Erika Hanson, *Biosimilars, Shall We Do the Patent Dance?*, *U. Utah S.J. Quinney C.L.* (Jan. 24, 2019), <https://law.utah.edu/biosimilars-shall-we-do-the-patent-dance> [<https://perma.cc/F3TN-YY8E>] (“The patent dance will begin when the manufacturer of a biosimilar submits an application with [FDA] The two parties then go back and forth on which patents are infringed upon . . . [allowing them] to litigate the patent infringement issues before the biosimilar is on the market.”); see also *Sandoz Inc. v. Amgen*, 137 S. Ct. 1664, 1670–72, 1674–76 (2017) (describing the so-called “patent dance” and holding it not enforceable by injunction under the terms of the BPCIA itself). Companies developing biosimilars are immunized from patent infringement liability for activities related to seeking eventual FDA approval under the safe harbor of 35 U.S.C. § 271(e)(1) (2012).

but, for instance, use a slightly different manufacturing process to avoid patents held by the original biologic developer.³¹⁸ Overall, these procedures reduce incentives for divergent biomedical innovation.

B. *Reimbursement*

Insurance reimbursement procedures can similarly create incentives against divergent innovation in biomedical technologies. This section focuses on the basics of reimbursement for medical devices.³¹⁹ In essence, it is often easier to obtain coverage for products that are similar to devices already covered by insurers. This may be because payers are already familiar with the technology, so that knowledge acquisition is easier, or it may simply be because administrative barriers to payment have already been surmounted by an earlier product.³²⁰

The process of obtaining reimbursement for a new medical product is not trivial. New products need to be assigned a “code,” which is used by providers to indicate which product is being used and how it should be reimbursed.³²¹ The Centers for Medicare and Medicaid Services (CMS)³²²

318. See Ctr. for Drug Evaluation & Research & Ctr. for Drug Biologics Evaluation & Research, FDA, Development of Therapeutic Protein Biosimilars: Comparative Analytical Assessment and Other Quality-Related Considerations 11–12 (2019), <https://www.fda.gov/media/125484/download> [<https://perma.cc/C5UJ-BDWM>] (describing application requirements for differing manufacturing processes for biosimilar biologics). Duplicating manufacturing methods is challenging, and many aspects are held as trade secrets instead of patents, compounding that difficulty. See Price & Rai, *supra* note 310, at 1046–48. However, in those instances when manufacturing methods patents do exist, those patents are sometimes easier to enforce against biosimilar applicants under the “patent dance” provisions of the BPCIA, which allow the original biologic sponsor to examine the biosimilar applicant’s application, including manufacturing methods, to evaluate potential patent infringement. See *id.* at 1053–54. But see *Sandoz*, 137 S. Ct. at 1664, 1676 (finding that the disclosure of a biosimilar application in the “patent dance” is optional under the BPCIA).

319. Drug reimbursement has its own complications, including the existence of true generic products, automatic substitution, tiered formularies, pharmacy benefit managers, and mandates to cover certain types of drugs. For an introduction to some of the mechanics of drug reimbursement, see Rachel E. Sachs, *Delinking Reimbursement*, 102 Minn. L. Rev. 2307, 2311–21 (2018) [hereinafter Sachs, *Delinking Reimbursement*] (describing linkages between FDA approval and insurance reimbursement); Sachs, *Prizing Insurance*, *supra* note 283, 178–93 (describing reimbursement and arguing it should be used as an innovation policy lever).

320. See Marcia Nusgart, *HCPCS Coding: An Integral Part of Your Reimbursement Strategy*, 2 *Advances in Wound Care* 576, 578 (2013) (explaining how substantially equivalent devices may be placed on the same HCPCS code).

321. See Tiffini Diage, *NAMSA, Planning for Successful Medical Device Reimbursement: So Your Device Is Cleared, Now What?* 3–4 (2015), <https://www.namsa.com/wp-content/uploads/2015/10/NAMSA-Planning-for-Successful-Medical-Device-Reimbursement.pdf> [<https://perma.cc/4XPG-TKPE>] (“Coding is the language of CMS, private payers, facilities, and physicians. Coding translates into payment. Without a proper code, procedures and products are not paid for.”); Fee for Service, *HealthCare.gov*, <https://www.healthcare.gov/glossary/fee-for-service/> [<https://perma.cc/SJ6N-JL5G>] (last visited Oct. 14, 2019).

322. I focus on CMS in this section, but private insurers typically follow CMS’s lead. See *Ctrs. for Medicare & Medicaid Servs., Innovators’ Guide to Navigating Medicare* 7 (2015),

relies on codes to process reimbursement and to set rates; for instance, the Level II Healthcare Common Procedure Coding System identifies durable medical equipment used outside physician's offices, among other things.³²³ If a technology is relatively similar to an existing product, then it can sometimes just use the existing code, which requires relatively little effort or risk.³²⁴ If the new technology is further afield, though, getting reimbursement can require requesting that CMS modify the code, or create an entirely new code for the new technology.³²⁵ But this process often fails—in 2017, CMS approved only three of ten requests for code modifications for medical devices and only ten of seventy-two requests for new codes for medical devices.³²⁶ Even when the process is successful, it typically takes at least a year.³²⁷ Industry actors have formally complained to the Secretary of Health and Human Services about the difficulty of getting new codes created.³²⁸

Obtaining a code does not guarantee reimbursement; the developer of a new technology must also obtain a favorable coverage determination.³²⁹ Coverage determinations, whether “local” or national, request that Medicare provide “the formal instruction to the Medicare claims processing contractors regarding how to process claims (e.g., when to pay, when not to pay, pay only when certain clinical conditions are met).”³³⁰ For an item to be eligible for coverage, it must be within the categories of established benefits, not specifically excluded from coverage, and “reasonable and necessary.”³³¹ Coverage determinations also consider whether the device is a breakthrough technology or medically beneficial and available when other medically beneficial alternatives are not available or covered by Medicare.³³² Coverage determinations can thus promote divergence, if no other product is available or if the new product uses a different clinical

<https://www.cms.gov/Medicare/Coverage/CouncilonTechInnov/Downloads/Innovators-Guide-Master-7-23-15.pdf> [<https://perma.cc/J4T9-FSU4>] [hereinafter *Innovators' Guide*].

323. See Ctrs. for Medicare & Medicaid Servs., *Healthcare Common Procedure Coding System (HCPCS) Level II Coding Procedures 1* (2015), <https://www.cms.gov/Medicare/Coding/MedHCPCSGenInfo/Downloads/2018-11-30-HCPCS-Level2-Coding-Procedure.pdf> [<https://perma.cc/EZD3-ZZBA>] [hereinafter *Coding Procedures*].

324. See *Innovators' Guide*, supra note 322, at 4.

325. See *id.* at 16–18 (describing the creation of new codes).

326. Ctrs. for Medicare & Medicaid Servs., *CMS Level II Coding Decisions for the 2017–2018 Coding Cycle* (2018), <https://www.cms.gov/Medicare/Coding/MedHCPCSGenInfo/Downloads/2017-2018-HCPCS-Coding-Decisions.zip> (on file with the *Columbia Law Review*).

327. *Innovators' Guide*, supra note 322, at 5.

328. E-mail from All. for HCPCS II Coding Reform to Tom Price, Sec'y, U.S. Dep't of Health & Human Servs. & Seema Verma, Adm'r, Ctrs. for Medicare & Medicaid Servs. (Aug. 15, 2017), <https://www.aahd.us/wp-content/uploads/2017/08/HCPCSCodingReformMedicare082017letterHHS.pdf> [<https://perma.cc/N3CB-YB8B>].

329. *Innovators' Guide*, supra note 322, at 3–4, 16.

330. *Id.* at 13.

331. *Id.* at 11.

332. Medicare Program; Criteria for Making Coverage Decisions, 65 Fed. Reg. 31,124, 31,125 (proposed May 16, 2000) (to be codified at 42 C.F.R. § 405).

modality. But convincing the Medicare Administrative Contractors that make local coverage determinations means demonstrating that the new technology works and is “reasonable and necessary”—and that process is easiest when the new technology is not too far from what the clinicians already know.³³³

Sometimes, the incentives against substantial difference are even more obvious. According to a 1984 report by the Office of Technology Assessment, when the Veterans Administration set standards for wheelchairs that it would buy, it historically wrote them “with a specific wheelchair in mind, usually an Everest & Jennings, Inc. (E&J) model.”³³⁴ Other manufacturers that wanted “to obtain VA contracts may have [needed] to make products similar to the E&J wheelchair” because “products were often evaluated on the basis of how closely they conformed to E&J’s model.”³³⁵

Thus, getting reimbursement—like winning FDA approval—can create incentives for innovators to avoid more divergent technological approaches.³³⁶ This pattern does not always hold—truly breakthrough technologies are specifically recognized as appropriate for coverage determinations, and when an innovator does get a new code, the innovator may be able to negotiate higher reimbursement rates for the new technology, with no pricing anchor of rates set for an older technology.³³⁷ But the most straightforward path to obtaining a code and coverage, minimizing

333. See Medicare Program; Revised Process for Making National Coverage Determinations, 78 Fed. Reg. 48,164, 48,164–65 (Aug. 7, 2013) (“NCDs serve as generally applicable rules to ensure that similar claims for items or services are covered in the same manner.”).

334. Donald S. Shepard & Sarita L. Karen, *The Market for Wheelchairs: Innovations and Federal Policy* 27 (1984), <https://ota.fas.org/reports/8418.pdf> [<https://perma.cc/EY4G-5DEX>].

335. *Id.*

336. Manufacturers may also deprioritize significant differences as a way to avoid liability in the presence of third-party payers who are less performance sensitive. Christopher Buccafusco, *Disability and Design*, N.Y.U. L. Rev. (forthcoming) (manuscript at 19–22), https://papers.ssrn.com/abstract_id=3497902 (on file with the *Columbia Law Review*) (making this point in the context of motorized wheelchairs).

337. One trade magazine explains the issue this way:

If your product is placed in a HCPCS code that does not include similar products with similar manufacturer’s suggested retail price (MSRPs), then the reimbursement established for it by the payer could be inappropriate and thus, not be prescribed or used. For instance, if the retail price for your surgical dressing is \$25.00 and the HCPCS code that was assigned to your product had a Medicare reimbursement amount of \$17.00, it may be likely that a supplier may choose a different company’s product to purchase that is closer to or less than \$17.00. Thus, this HCPCS code may not be appropriate for the product, since the reimbursement rate is not adequate and including it in this code would not allow patient access to your product.

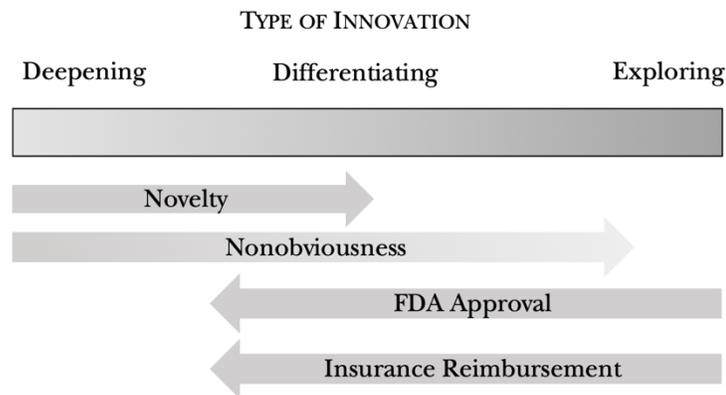
Nusgart, *supra* note 320, at 577–78.

at least procedural costs, is to follow fairly closely the technologies that have gone before and avoid divergent innovation.

C. *Interactions*

Incentives for and against divergent innovation can interact in problematic ways, and biomedical innovation is rich with examples. Patent law pushes toward divergent innovation—either differentiating innovation or, if the nonobviousness requirement works well, exploring innovation. On the other hand, FDA and reimbursement incentives can push against divergent innovation, driving innovators to hew closely to existing technology. Figure 2 shows these counteracting incentives. The result can be an unhappy middle in which firms spend resources on minor variations,³³⁸ building parallel but shallow knowledge bases, and creating interoperability problems—bringing all the costs of divergence but only limited benefits from technological advances.

FIGURE 2: IMPACTS OF PATENT, FDA, AND INSURANCE INCENTIVES ON INNOVATION³³⁹



Slightly different medical devices follow this pattern. Patent law pushes inventors to make medical devices different from each other so

338. See Janet Freilich, *The Paradox of Legal Equivalents and Scientific Equivalence: Reconciling Patent Law's Doctrine of Equivalents with the FDA's Bioequivalence Requirement*, 66 SMU L. Rev. 59, 78–82 (2013); Janet Freilich, *Patent Infringement in the Context of Follow-On Biologics*, 16 Stan. Tech. L. Rev. 9, 26–30 (2012) (discussing this type of dynamic in the drug and biologic contexts).

339. Novelty promotes differentiating or exploring innovation, and nonobviousness furthers exploring innovation when it works well—but the arrow for nonobviousness fades to mirror its relative weakness in biomedical innovation. FDA approval and insurance reimbursement both create incentives for less-divergent innovation—that is, for differentiating rather than exploring innovation.

that they can receive patent protection.³⁴⁰ But receiving FDA approval is far less costly through the 510(k) pathway if the inventor can demonstrate that the resulting product is substantially equivalent to an already-approved product—that is, if the innovation is closer to differentiating innovation than exploring innovation.³⁴¹ Similarly, receiving reimbursement approval from insurance companies is substantially easier if the new device can be reimbursed under an existing code rather than requiring the development and approval of a new code.³⁴² The result can easily be differentiating innovation that doesn't advance the field but creates substantial costs.

The point isn't that drugs or other biomedical technologies pursued through divergent innovation are never going to work, or are never going to be better than earlier products—of course some are. Divergent innovation can and does lead to great advances. But patent law can create incentives to pursue divergent innovation even if it doesn't lead to great advances—even if it's not expected to lead to any advance at all.

Sometimes, with biomedical technologies, it doesn't even matter whether a new technology works better or not. Vinay Prasad and colleagues make this point generally.³⁴³ They argue that the way cancer drugs are regulated and reimbursed in the United States, with relatively low standards for approval and high reimbursement rates, means that “[e]mbarking on unpromising trials agendas that involve testing marginally effective or even ineffective drugs, is now potentially profitable . . . because the reward for even one rare successful trial generates enough revenue to support the costs of all the failures.”³⁴⁴ Essentially, “new for the sake of new” is enough to make money; better doesn't matter very much.

In many circumstances, we know that it doesn't matter whether a new biomedical technology is better than earlier technologies for a rather simple, if depressing, reason: No one bothers to find out. If innovators were especially concerned with how a new technology surpassed an old technology, we would expect to see extensive studies demonstrating that superiority. Wouldn't drug companies want to show their new drugs are superior? But for many biomedical technologies, we have no such evidence.³⁴⁵ FDA requires only evidence of safety and efficacy, although some

340. See *supra* Part II.

341. See *supra* section IV.A.1; see also Fargen et al., *supra* note 304, at 272 (noting “the financial incentive for manufacturers to develop new devices via the 510(k) clearance process with only minor improvements”).

342. See *supra* section IV.B.

343. See generally Vinay Prasad, Christopher McCabe & Sham Mailankody, Low-Value Approvals and High Prices Might Incentivize Ineffective Drug Development, 15 *Nature Revs. Clinical Oncology* 399, 399 (2018) (describing how ineffective drugs can prove profitable).

344. *Id.*

345. See, e.g., Harvey V. Fineberg, Foreword to Comm. on Comparative Effectiveness Research Prioritization, Inst. of Medicine, Initial National Priorities for Comparative Effectiveness Research, at xiii (2009), <https://www.multiplechronicconditions.org/assets/pdf/>

have argued that approving me-too drugs should require a demonstration of superiority.³⁴⁶ Comparative effectiveness research, which explicitly determines which of multiple interventions works better, is still relatively rare; when it does happen, especially in the United States, it is largely pursued by government or nonprofit actors.³⁴⁷ Drug developers, it seems, are more worried about the possibility that their product might be inferior than they are driven by the possibility of showing that their products are superior—a showing they demonstrably do not need for market success.³⁴⁸

V. INTERVENTIONS

This Essay has argued both a broader and a narrower point. On the broad side, divergent innovation, driven in part by the patent system, comes with a set of costs, including shallower knowledge, compatibility problems, and the costs of inventing around. These costs should be part of the calculus that policymakers undertake or academics explore when considering how to use policy levers to shape ongoing innovation. It is hard to know *ex ante* the right combination of deepening, differentiating, and exploring innovation. But getting the right balance from a policy standpoint is exceptionally hard if policymakers and academics leave out a key piece of the picture.

On the narrow side, biomedical innovation faces a special set of challenges: Combining patent law's incentives for divergent innovation with FDA and insurance reimbursement incentives against divergence can lead to differentiating innovation that involves many of the costs of divergence with few of its benefits (in particular, those that might arise from exploring innovation). The broader issue demands less a solution than an acknowledgement and ongoing attention. But the narrower issue—costly differentiating innovations in biomedical innovation—could be addressed by more targeted policy interventions. This section does not try to explore these interventions exhaustively; any one could be the subject of its own

Comparative%20Effectiveness%20Research/iom-cer-1.pdf [https://perma.cc/ZG9B-A94W] (“[F]or want of appropriate studies, innumerable practical decisions facing patients and doctors every day do not rest on a solid foundation . . . about what constitutes the best choice of care.”).

346. See, e.g., Gagne & Choudry, *supra* note 173, at 712 (calling for FDA to require superiority for approval once a generic exists in a drug class).

347. See, e.g., Institute for Clinical & Economic Review, <http://www.icer-review.org> [https://perma.cc/7QVE-5KEB] (last visited Oct. 17, 2019); see also Rebecca S. Eisenberg & W. Nicholson Price II, Promoting Healthcare Innovation on the Demand Side, 4 *J.L. & Biosciences* 3, 16–18 (2017) [hereinafter Eisenberg & Price, Demand Side] (describing the possibility and desirability of comparative effectiveness research by insurers and other health payers and noting the relative scarcity of such efforts); *id.* at 44–45 (describing the establishment of the Patient Centered Outcomes Research Institute to conduct comparative effectiveness research).

348. See Eisenberg & Price, Demand Side, *supra* note 347, at 18.

Essay. Instead, this section briefly canvasses four possibilities: two within the patent system and two outside it.

A. *Inside the Patent System*

Within the patent system, two potential areas of doctrine suggest possibilities for change: nonobviousness, in which biomedical technologies encounter lower bars to patentability than other areas, and utility, which across the board has no requirement for market superiority or desirability—but which could.

1. *Nonobviousness*. — Nonobviousness doctrine provides a lever to promote exploring innovation over differentiating innovation. Theoretically, it should reduce incentives for much differentiating innovation by denying patents to the resulting inventions. Nevertheless, as described above, the nonobviousness requirement applies less strongly to biopharmaceutical innovation than elsewhere.³⁴⁹

Tightening nonobviousness doctrine in the fields of biotechnology and pharmaceuticals could encourage more exploring innovation in those fields. A first step would be abandoning rigid “lead compound analysis”³⁵⁰ to accept the more flexible approach to nonobviousness reiterated by the Supreme Court in *KSR v. Teleflex*.³⁵¹ Being more willing to follow an “obvious-to-try” analysis—that is, asking whether compounds were within the realm of what medicinal chemists would be likely to try—would also raise the threshold of nonobviousness.³⁵² To be sure, contemporary nonobviousness doctrine has its own challenges, including difficulty in administration.³⁵³ And increasing the nonobviousness threshold wouldn’t directly create incentives for exploring innovation. But it would reduce the patent-provided incentives for differentiating innovation while leaving them intact for exploring innovation, making the latter a more attractive approach.

Raising the nonobviousness bar isn’t an uncontroversial solution for biopharmaceutical innovation.³⁵⁴ An obvious response,³⁵⁵ drawing on the

349. See *supra* section II.A.2.

350. See *supra* notes 88–96 and accompanying text.

351. 550 U.S. 398, 415 (2007).

352. See Eisenberg, *Pharma’s Nonobvious Problem*, *supra* note 87, at 402, 407 (criticizing the Federal Circuit’s unwillingness to apply “obvious-to-try” logic).

353. See, e.g., Rochelle Cooper Dreyfuss, *Nonobviousness: A Comment on Three Learned Papers*, 12 *Lewis & Clark L. Rev.* 431, 433–37 (2008) (summarizing and extending scholars’ takes on the indeterminacy of the obviousness requirement); Daralyn J. Durie & Mark A. Lemley, *A Realistic Approach to the Obviousness of Inventions*, 50 *Wm. & Mary L. Rev.* 989, 990 (2008) (“It is also perhaps the most vexing doctrine to apply, in significant part because the ultimate question of obviousness has an ‘I know it when I see it’ quality that is hard to break down into objective elements.”).

354. Notably, since the difference in nonobviousness is less stark when applied to medical devices, the doctrine provides less of an opportunity for positive change there.

355. Ha!

work of Benjamin Roin, is that novelty and nonobviousness both *already* do too much to limit the field of available drugs for pharmaceutical development.³⁵⁶ Roin would prefer more deepening innovation of the type that patent law does not reward now: research on known compounds to demonstrate that they really work as drugs.³⁵⁷ Raising the nonobviousness threshold would cut in the opposite direction, improving one problem (relatively high incentives for unhelpful differentiating innovation) but not another (absent incentives for deepening invention). The absence of incentives for deepening innovation cuts at the heart of the newness driving the patent system and would require either substantial revamping of patent law³⁵⁸ or turning to other incentives to address.³⁵⁹

Better enforcing the on-the-books doctrinal requirement of nonobviousness would help to ensure that the new drugs we get are really different, which helps address at least some of the problems described above.³⁶⁰ Nonobviousness can only be a partial lever because, among other things, it largely focuses on technical difficulty rather than social benefits or outcomes, which are the results of greater concern in this Essay.³⁶¹

2. *Utility*. — Utility doctrine provides another potential avenue for reform within the patent system. If part of the problem is that we want better but we get new, maybe patentability should require superiority.³⁶²

356. Roin, *Upatentable Drugs*, *supra* note 2, at 505.

357. See *id.* at 541–42.

358. See generally, e.g., Benjamin N. Roin, *The Case for Tailoring Patent Awards Based on Time-to-Market*, 61 *UCLA L. Rev.* 672 (2014); Sichelman, *supra* note 37 (proposing commercialization patents).

359. See, e.g., Hemel & Ouellette, *Beyond the Debate*, *supra* note 41, at 375–81 (arguing for combining innovation policy levers); Price, *Grants*, *supra* note 14, at 41–63 (describing ways grants can be deployed as a useful innovation incentive).

360. One might worry that me-too drugs have some use in reducing prices, or that drugs with minor technical differences might have substantially different results, and that a strengthened obviousness requirement might limit their development too much. In response, one could imagine an obviousness-type double-patenting bar that applies within a class of drugs. Under such an approach, me-too drugs could still be patented—but their patent term would expire (with a terminal disclaimer) at the same time as the first-in-class drug. The contours of such an approach would need some thought to work out in detail and are beyond the scope of this Essay. See generally Douglas L. Rogers, *Double Patenting: Follow-On Pharmaceutical Patents that Suppress Competition*, 14 *Nw. J. Tech. & Intell. Prop.* 317 (2017) (analyzing pharmaceutical double patents). Thanks to Mark Lemley for this suggestion.

361. See Merges, *Commercial Success*, *supra* note 109, at 812 (describing nonobviousness as measuring technical achievement). Commercial success is a secondary indicium of nonobviousness. See *id.* at 823–28 (describing the commercial success factor); *id.* at 842–52 (criticizing the use of commercial success). But as described above, commercial success is only a weak indication that a biomedical technology is worthwhile. See *supra* notes 11–12 and accompanying text.

362. For a contrary view, see Seymore, *Making Patents Useful*, *supra* note 107, at 1071–80 (arguing that the utility requirement should be abolished wholesale).

Perhaps utility could get us there—should we just overrule Justice Story in *Lowell v. Lewis*?³⁶³

Probably not. There is a reason that patent law doesn't require more than that an invention have some use (and even the practical utility requirement as it exists now is controversial).³⁶⁴ The basic idea that the market should determine which inventions are worthwhile and which are not is mostly right—as long as there is a market that actually performs that role. The problem with biomedical inventions and the utility requirement is that the market doesn't work very well, for many reasons we've seen, to perform that function. FDA review helps; it evaluates whether a biomedical invention works *at all*, a task that the market is especially bad at accomplishing, and that the Federal Circuit's predecessor court recognized should lie with FDA and not the utility doctrine.³⁶⁵ But neither FDA nor the market does a good job letting purchasers decide which biomedical innovations are *better*.

Nevertheless, that dynamic doesn't hold as well in other markets, where Justice Story's logic is more powerful and we can rely more heavily on consumers and other purchasers to ensure that better technology wins out.³⁶⁶ And patent law is (mostly) technology-neutral, so that raising the utility bar would also impact other industries and create problems.³⁶⁷ As discussed above, it's also quite difficult to know and to evaluate utility at the time of patent filing.³⁶⁸ Changing utility, while a *prima facie* attractive solution to the problem of innovations that are not actually better, is unlikely to work in practice.

363. See *supra* notes 103–104 and accompanying text.

364. Timing issues are also problematic, though potential solutions exist. See *supra* section II.A.3.

365. See *In re Hartop*, 311 F.2d 249, 257–58 (C.C.P.A. 1962) (rejecting the Patent Office's requirements for evidence of safety in human trials as a condition of patentability because such a requirement is committed to FDA); Seymore, *Making Patents Useful*, *supra* note 107, at 1058 (discussing the case's place in the evolution of the utility requirement).

366. Naturally, this doesn't always work, and history is littered with discarded Betamax tapes describing technologically superior innovations that nonetheless lost in the market. And, as Risch describes, the costs of worthless patents merely existing (and thus their value) can be large. Risch, *supra* note 106, at 1224–28; see also Robin Feldman & W. Nicholson Price II, *Patent Trolling: Why Bio and Pharmaceuticals Are at Risk*, 17 *Stan. Tech. L. Rev.* 773, 776 (2014) (arguing that patent assertion entities are likely to become more active in the biopharmaceutical space).

367. See Burk & Lemley, *Policy Levers*, *supra* note 84, at 1576–77 (“In theory, then, we have a uniform patent system that provides technology-neutral protection to all kinds of innovation.”). But see *id.* at 1577 (“In practice the rules actually applied to different industries increasingly diverge.”). The utility doctrine in particular has more bite in biomedical innovations than in other technological areas. *Id.* at 1645–46. But the difference is that it already applies more strongly in those areas because of the nature of biomedical research and the desire to patent inventions especially early. Requiring even greater utility just for biomedical innovations would be a substantial step further.

368. See *supra* section II.A.3.

B. *Outside the Patent System*

A separate set of interventions could involve law outside the patent system. FDA regulation and insurer reimbursement cause problematic interactions with patent incentives, but each of those areas also provides possible points of intervention.³⁶⁹ In general, interventions to improve the market for health technology could bring us closer to Story's story of marketplaces solving the problem of worthless (or at least not better) technologies.³⁷⁰ There are many ways this could work; two illustrative avenues for change involve altering how FDA regulation and insurer reimbursement work for biomedical innovation.

1. *FDA Approval.* — FDA exerts pressure toward differentiating intervention, and it does so in a way that makes sense: It is easier to evaluate a technology if the technology is familiar. There is a reason the 510(k) pathway exists; FDA's regulatory knowledge is cumulative just like innovation can be. Trying to increase regulatory burdens when easier paths are available would be counterproductive, especially in an area already known for high regulatory overhead.

But we could imagine an approach in which FDA required that new technologies demonstrate improvement over old technologies in the same class in order to be approved. For instance, before approving a new statin, FDA might require its sponsor to demonstrate its superiority to existing approved statins. This would likely push innovators toward exploring innovation, or at least away from difference solely for the sake of difference.

Such an intervention would face substantial challenges. First, FDA probably lacks the statutory authority to institute superiority requirements for approval.³⁷¹ Second, implementing a requirement for superiority would be quite complex and would create additional uncertainty in the drug development process, since improvement is often unknown until later in

369. This is not a complete list of possible interventions, which could span many areas of law and policy. Grants, for example, could be used to provide resources for the development of deepening innovation about drug manufacturing or new uses for old drugs, or to develop infrastructural resources to make that sort of research easier. See, e.g., Price, Grants, *supra* note 14, at 42–49, 59–63; cf. Price & Rai, *supra* note 310, at 1056–59 (describing government-led efforts to increase innovation in biologics manufacturing technology).

370. See *supra* notes 103–104 and accompanying text.

371. I say “probably” because the agency has historically been creative about finding statutory authority for its initiatives, and even before gaining the authority in 1962 to evaluate drugs for efficacy, FDA routinely folded efficacy into the requirement that new drugs be safe. See Daniel Carpenter, Reputation and Power: Organizational Image and Pharmaceutical Regulation at the FDA 115–16, 120–21 & n.3 (Ira Katznelson, Martin Shefter & Theda Skocpol eds., 2014). Similarly, one could imagine FDA folding “improvement” into the concept of “efficacy” or “safety,” perhaps because existing drugs have known safety profiles and some improvement would be needed to justify the uncertainty of a new therapy. That imagining is beyond the scope of this Essay.

that process and can be difficult to define operationally.³⁷² Third and finally, this type of approach goes rather strongly against the current (controversial) zeitgeist of getting FDA *out* of the business of telling patients which technologies they can and can't access once they've been demonstrated to be safe.³⁷³

An intermediate and more feasible approach could borrow from the interaction between patent law and FDA and help resolve the timing problem in utility mentioned above. For instance, *enforcing* patents on drugs could require a certification from FDA that the drug be clinically superior to earlier approved products in the class. Dmitry Karshedt has suggested an approach along these lines in the limited context of product-hopping, arguing that comparative effectiveness research data either be added to a drug's labeling (or replaced by the fact that the company couldn't be bothered to generate such data),³⁷⁴ or that listing of a patent in the Orange Book—which confers quite a bit of power on the patent—be dependent on such a showing.³⁷⁵ This approach would create incentives to demonstrate superiority, ensuring that divergent innovation brings the benefit of progress. This regime would have the benefit that nonsuperior drugs could still be approved and available on the market—they just would not receive the additional *ex post* exclusivity (and hence, *ex ante* incentives) provided by the patent system. In fact, FDA already plays a parallel role for biologics, which cannot receive FDA-mediated market exclusivity if they are variants of another approved biologic unless the sponsor demonstrates that the variation is an improvement.³⁷⁶ Extending this treatment to the patent system by tying enforcement to FDA review for improvement provides an intriguing possibility for reducing some of the costs of divergent innovation.

2. *Payer Reimbursement.* — Finally, although fixing the market for health technologies generally would be a heavy lift,³⁷⁷ we could inspire health

372. See Dmitry Karshedt, *The More Things Change: Improvement Patents, Drug Modifications, and the FDA*, 104 *Iowa L. Rev.* 1129, 1192–94 (2019) (describing the difficulty of measuring improvements in drug safety and effectiveness).

373. See Trickett Wendler, Frank Mongiello, Jordan McLinn, and Matthew Bellina *Right to Try Act of 2017*, *Pub. L. No. 115-176*, 132 *Stat.* 1372 (2018) (allowing the use of experimental drugs by certain patients); Holly Fernandez Lynch, Patricia J. Zettler & Ameet Sarpatwari, *Promoting Patient Interests in Implementing the Federal Right to Try Act*, 320 *JAMA* 869, 869–70 (2018) (offering suggestions for implementing the Act); Patricia J. Zettler, *Pharmaceutical Federalism*, 92 *Ind. L.J.* 845, 881–85 (2017) (describing right-to-try laws generally).

374. Karshedt, *supra* note 372, at 1194–98.

375. *Id.* at 1202–05.

376. 42 U.S.C. § 262(k)(7)(C)(ii) (2012) (stating that FDA-enforced data and marketing exclusivity are not available for any later application by the biologic sponsor that covers certain nonstructural modifications or structural modifications “that do[] not result in a change in safety, purity, or potency”).

377. See Michelle M. Mello, *What Makes Ensuring Access to Affordable Prescription Drugs the Hardest Problem in Health Policy?*, 102 *Minn. L. Rev.* 2273, 2288–98 (2018)

insurers and other payers to encourage innovation to be better, rather than new.³⁷⁸ Again, it makes sense that administrative hurdles are higher to win approval for exploring innovations than differentiating innovation; insurers, too, become familiar with existing technology. To make those hurdles worth overcoming—that is, to move away from the unhappy medium of differentiating innovation—payers would need to tie reimbursement more closely to performance. Payers could refuse to pay (or to pay more) for technologies unless the new technology presents a demonstrable improvement over existing technologies.

That payers in general don't already do this more is something of a mystery, and reflects some of the market perversities in health care: patients demand specific drugs; the “consumer” is split between payers, patients, and doctors; and costs can be passed around between different actors.³⁷⁹ That Medicare specifically doesn't take comparative effectiveness into account when making coverage decisions is much less surprising; CMS faces strict legal limits on how it can use such research.³⁸⁰ Similarly, CMS is limited in how it can price drugs. Medicare Part D plans (the plans that cover outpatient prescription drugs) are administered by contractors, and the government is prohibited from centrally negotiating drug prices, leaving the task to those individual Medicare Part D plan administrators.³⁸¹

But not everywhere follows this path. Payers in many other countries do demand comparative-effectiveness and cost-effectiveness data before agreeing to pay for new biomedical technologies, sometimes limiting new therapies to the prices of existing therapies (or refusing to pay for them) if no additional clinical benefit is shown.³⁸² U.S. payers could follow suit.

(describing the market factors contributing to the problems with fixing prescription drug prices in the United States).

378. To the extent that payers defray the individual impact of costs that are artificially high because of the novelty-promoting incentives of patent law, they may already help to reduce allocative inefficiencies created by those incentives, even if other novelty costs continue. See Daniel J. Hemel & Lisa Larrimore Ouellette, *Innovation Policy Pluralism*, 128 *Yale L.J.* 544, 559–63, 593–601 (2019) (describing the potential disconnect between innovation incentives and allocative inefficiencies and offering policy mechanisms, including subsidies, to address the latter).

379. Eisenberg & Price, *Demand Side*, *supra* note 347, at 26–39 (describing legal and economic hurdles that prevent payers from playing a “a larger role in healthcare innovation”); see also Mello, *supra* note 377, at 2288–98 (describing market factors and perverse incentives in the pharmaceutical market); Sachs, *Delinking Reimbursement*, *supra* note 319, at 2311–21 (explaining the link between FDA approval and CMS reimbursement and that private insurers often follow the lead of public payers).

380. 42 U.S.C. § 1320e-1 (2012) (prohibiting CMS from establishing a dollar-per-quality-adjusted-life-year threshold for coverage and creating other limitations).

381. 42 U.S.C. § 1395w-111(i); see also Mello, *supra* note 377, at 2299–300 (describing these dynamics).

382. See, e.g., Ariel D. Stern, Felicitas Pietrulla, Annika Herr, Aaron S. Kesselheim & Ameet Sarpatwari, *The Impact of Price Regulation on the Availability of New Drugs in Germany*, 38 *Health Aff.* 1182, 1182–83 (2019) (summarizing a German law that limits new drug prices based on an assessment of their clinical benefit); What We Do, *Nat'l Inst. for*

Growing efforts at value-based pricing for pharmaceuticals are in this vein.³⁸³ Even Medicare leaves some room for this. Medicare Part D plans must cover all drugs within six protected classes—but outside those classes they must cover only two drugs per class, leaving room for choice based on real effectiveness.³⁸⁴ Nevertheless, Medicare drug pricing rules complicate efforts to move forward, though the specifics are outside the scope of this Essay.³⁸⁵ In Germany, where prices for new drugs are limited if the drugs fail to show clinical improvement over existing therapies, drugs without such improvement were much more likely to leave the market than drugs that really made a difference, and in any case, they weren't reimbursed at a premium relative to older therapies.³⁸⁶ And it turns out that many new drugs did not, in fact, show improvement.³⁸⁷ If U.S. payers—Medicare or not—more widely refused to pay or pay more for new therapies that were just new-for-the-sake-of-new and not actually better, incentives to develop such therapies would decrease.

CONCLUSION

Patent law promotes new, different technology, and that is generally seen as a good thing. But it is not only good. There is a dark side to novelty. When patent law pushes inventors across the board to diverge from what has come before, society faces costs from that divergence, ranging from the effort of inventing around to the problem of systems that are not interoperable to the decrease of expertise. These costs may at times exceed the benefits created by novel technologies—but patent law does not take this point into consideration. Perhaps it shouldn't—but we should. When setting innovation policy, policymakers should recognize that patent law will drive unbridled novelty.

Health & Care Excellence, <https://www.nice.org.uk/about/what-we-do> [<https://perma.cc/6P9L-RZ2G>] (last visited Oct. 17, 2019) (describing a U.K. organization that determines pricing and access to new health technologies).

383. See Leemore S. Dafny, Christopher J. Ody & Matthew A. Schmitt, *Undermining Value-Based Purchasing—Lessons from the Pharmaceutical Industry*, 375 *New Eng. J. Med.* 2013, 2013–15 (2016) (describing industry strategies for resisting value-based purchasing); Anna Kaltenboeck & Peter B. Bach, *Value-Based Pricing for Drugs: Theme and Variations*, 319 *JAMA* 2165, 2165–66 (2018) (describing different forms of value-based pricing); Elizabeth Seeley, Susan Chimonas & Aaron S. Kesselheim, *Can Outcomes-Based Pharmaceutical Contracts Reduce Drug Prices in the US? A Mixed Methods Assessment*, 46 *J.L. Med. & Ethics* 952, 958–59 (2018) (finding mixed evidence of success in value-based pricing and noting CMS's apparent willingness to pursue value-based pricing strategies).

384. 42 C.F.R. § 423.120(b)(2)(vi) (2018).

385. See generally Rachel Sachs, Nicholas Bagley & Darius N. Lakdawalla, *Innovative Contracting for Pharmaceuticals and Medicaid's Best-Price Rule*, 43 *J. Health Pol. Pol'y & L.* 5 (2018) (describing this interaction).

386. Stern et al., *supra* note 382, at 1185.

387. Beate Wieseler, Natalie McGauran & Thomas Kaiser, *New Drugs: Where Did We Go Wrong and What Can We Do Better?*, 366 *BMJ* 1, 2 (2019).

Policymakers should also recognize that, for biomedical innovation in particular, patent law's incentives for divergence fit within a complex ecosystem of other incentives that may push innovation not to diverge—with sometimes problematic results. Two of those other incentives, FDA approval and insurer reimbursement, are particularly salient in the context of biomedical technology. Considering how these different incentives work together to shape the development of new technology is a complex but crucial task that demands continuing scholarly attention.

One potential avenue for future work within the biomedical sphere would question the temporal effect of different incentives for and against divergent innovation. Some incentives are clustered around the beginning of the research process; grants and publications are typically more relevant to basic research and early-stage work. Other incentives tend to occur later—reimbursement questions and FDA approval arise once a technology has already been developed (though, of course, savvy developers should be thinking of these issues very early in the development process, and at least some are). Patents come into play somewhere in the middle, though their influence stretches across the development process. Notably, all three of the earlier incentives are at least partially oriented toward divergent innovation, and both later incentives promote divergent innovation. Does this timeline make sense for innovation, or does it stunt the growth and adoption of new biomedical technologies?

An orthogonal set of inquiries would look more deeply into divergent innovation in industries outside biomedicine. This piece has laid out a framework for patent law's promotion of divergent innovation and has explored in depth the costs of such divergence in the biomedical context—as well as some complicating factors from other incentives. Other fields are different.

While a full exploration of differences between fields with respect to divergent innovation must await future work, a few points come to mind. First, the relative strength of patents in providing incentives for divergent innovation will be different in other industries. Information technology, for instance, tends to move much faster than biomedicine, and much faster than patent life cycles; divergent innovation may be driven more by product differentiation theories than patent law.³⁸⁸ For many types of software, patents are likely unavailable under recent § 101 subject-matter jurisprudence.³⁸⁹ In nonbiomedical fields in which patents are important, the nonobviousness requirement's comparatively greater strength (relative

388. See *supra* note 23 and accompanying text. See generally Colleen V. Chien, *Of Trolls, Davids, Goliaths, and Kings: Narratives and Evidence in the Litigation of High-Tech Patents*, 87 N.C. L. Rev. 1571 (2009) (discussing litigation behavior in high-tech patents); Cohen & Lemley, *supra* note 30 (discussing software patents).

389. See Laura R. Ford, *Patenting the Social: Alice, Abstraction, & Functionalism in Software Patent Claims*, 14 *Cardozo Pub. L. Pol'y & Ethics J.* 259, 304–16 (2016) (discussing recent patentable subject matter cases with respect to computers and software).

to pharmaceuticals) should push for more exploring over differentiating innovation.³⁹⁰

Second and relatedly, markets hopefully work better outside the health technology sector. Most goods are not credence goods, and in most markets the consumer is a single entity rather than a doctor/patient/insurer hybrid. Where markets function better, they should be able to discipline unhelpful and nonimproving divergent innovation, giving more truth to Justice Story's admonition in *Lowell v. Lewis*.³⁹¹ If consumers can easily identify inferior products (or nonsuperior but higher-priced products) and avoid them, patents on those products will not provide much incentive for innovation.

Third, however, to reiterate this Essay's broader argument, the existence and types of divergent innovation costs are generalizable across technologies, even if the examples given here are biomedical. Inventing around, lack of interoperability, and shallow knowledge/spread expertise are technology-agnostic. The cost of working around others' patents is the entire rationale behind the (contested but voluminous) literature on patent hold-up, which occurs more frequently in nonbiomedical industries.³⁹² Patented, incompatible electronic connections limit interoperability between different systems.³⁹³ And anyone who has had to shift from one software platform to another, and found everything irritatingly different, knows firsthand the issue of nontransferable expertise.

Fourth and finally, different industries will face different intersecting nonpatent regimes. FDA does not regulate (most) software, and insurance reimbursement is typically not an issue for consumer goods. Thus, the intersection highlighted here, and its unhappy medium of new-for-the-sake-of-new differentiating innovation, may be a less frequent outcome in different fields. But other regimes may play parallel roles, whether they be regulators, such as the Environmental Protection Agency or the Federal Aviation Agency in pesticides and airplanes, or procurement systems with their own limits, such as the Department of Defense for military technology. Again, the specifics must await future work.

More generally, questions of deepening, differentiating, and exploring innovation could apply across creative fields beyond technological innovation. Intellectual property privileges what is new and different—even in instances in which consumers may or may not benefit from that

390. See *supra* section II.A.2 (discussing nonobviousness, including in the pharmaceutical context).

391. See *supra* note 366 and accompanying text.

392. See, e.g., Colleen V. Chien, *Holding Up and Holding Out*, 21 *Mich. Telecomm. & Tech. L. Rev.* 1, 9–20 (2014) (laying out the hold-up theory). But see *id.* at 20–26 (describing an alternate perspective); *id.* at 30–34 (critiquing the hold-up theory).

393. See, e.g., Samuelson, *supra* note 225, at 1965–69 (discussing patented and incompatible interfaces in videogames, voice over IP, and early modem technologies).

newness.³⁹⁴ Like the intellectual property system's reliance on price to set rewards, and on exclusivity to implicitly determine what can be protected, its prioritization of difference shapes the kind of knowledge and creative effort that creators put forth. Across various contexts, we should take into account the costs of divergence and consider how we can drive the creation that is not just new—but also deeper and better.

394. See, e.g., Buccafusco et al., *supra* note 22, at 41–46 (describing different consumer tastes for novelty in different creative fields). Compare Jeanne C. Fromer, *A Psychology of Intellectual Property*, 104 *Nw. U. L. Rev.* 1441, 1472–74 (2010) (describing relatively easy acceptance of substantially new technologies in science), with *id.* at 1479–83 (describing that in creative arts, successful works are typically not too different from what has come before).

