PATENT LAW'S EXTERNALITY ASYMMETRY

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Technologies such as social media, autonomous vehicles, and "big data" analytics generate enormous benefits for society, but they also create substantial harms. Many of these effects take the form of externalities—external benefits and harms that a decisionmaker (such as an inventor) imposes on third parties without charge or compensation. Considering negative externalities, for example, social media networks spread misinformation throughout the electorate, autonomous vehicles threaten the jobs of millions of professional drivers, and predictive policing based on big data can lead to unreasonable searches and seizures. Externalities can cause inefficient resource allocation, and the classic remedy is to "internalize" externalities by ensuring that decisionmakers consider the external benefits and costs of their actions. Patents, which confer exclusive rights on new inventions, enable inventors to internalize a share of the positive externalities from technology, thus shoring up incentives to invent. However, inventions also produce harms, and how patents treat negative externalities from new technologies has been largely overlooked. This Article is the first to extensively examine this issue. It argues that while patents internalize positive externalities associated with innovation, they do surprisingly little to internalize negative externalities. This Article refers to this underappreciated dynamic as patent law's externality asymmetry.

Patent law's externality asymmetry is particularly striking when comparing patents to physical property rights. Foundational economic theory holds that property rights (including patents) emerge to internalize externalities. However, physical property rights internalize negative externalities in several ways that are

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inapplicable to patents. Patents do not internalize negative externalities associated with the tragedy of the commons, and they encourage patentees to exploit their technologies rapidly rather than judiciously consider their third-party harms. Due to high transaction costs, patents do not facilitate efficiency-maximizing negotiations between patentees and individuals harmed by their inventions. Finally, patents create no duties for inventors to mitigate harms from their patented technologies. Patents, in other words, allow inventors to capture a meaningful share of the upside of their inventions while largely insulating them from the downside. Turning to normative considerations, this Article argues that patent law's externality asymmetry is highly problematic because it undermines efficiency, distributive equity, and fairness. It proposes modest reforms to patent law and greater integration of patent and nonpatent regulatory mechanisms to internalize negative externalities from technological innovations.

TABLE OF CONTENTS

I am not a Luddite. I am suspicious of technology. I am perfectly aware of its benefits, but I also try to pay attention to some of the negative effects.

—Neil Postman

All problems of externalities are closely analogous to those which arise in the land ownership example. The relevant variables are identical.

—Harold Demsetz, *Toward a Theory of Property Rights*

INTRODUCTION: THE PROMISE AND PERILS OF INNOVATION

Humanity's relationship with technology will define the twenty-first century.[1] Technological innovations permeate the most important and intimate areas of life, shaping how we maintain our health, obtain critical information, and connect with loved ones. Technology has advanced to dizzying heights, from 5G wireless networks transmitting data at unprecedented speeds to novel mRNA vaccines developed to combat the coronavirus pandemic.[2] The value of technology is so great that the Constitution authorizes a patent system to confer exclusive rights on new inventions, thus promoting technological progress.[3] However, alongside significant promise, technologies—including patented technologies—present many perils. Facebook's patented content-filtering system provides "curated" information to users that reinforces their ideological views, thus exacerbating political polarization throughout the electorate.[4] Autonomous vehicles based on patented technology threaten the jobs of millions of professional drivers.[5] Patented predictive policing systems based on "big data" can lead to unconstitutional searches and seizures.[6]

Put differently, patented technologies can generate significant negative externalities. Externalities are benefits or costs imposed on third parties that are external to a decisionmaker. Externalities may be positive, as when an individual gets vaccinated and thereby reduces disease transmission for everyone else.[7] Conversely, they may be negative, as when a factory belches pollution that harms nearby residents. Economists warn that significant externalities are problematic because they can lead to inefficient resource allocation. For instance, if a factory does not bear the cost of polluting others, it will operate at a higher capacity than is socially optimal. The classic remedy

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1 Thomas Philbeck & Nicholas Davis, *The Fourth Industrial Revolution: Shaping a New Era*, 72 J. INT'L AFFS. 17, 17 (2018).

2 *See* Sascha Segan, *What Is 5G?*, PCMAG (Aug. 26, 2021), https://www.pcmag.com/news/what-is-5g [https://perma.cc/VQY5-HE36] (discussing 5G technology); Sharon LaFraniere et al., *Politics, Science and the Remarkable Race for a Coronavirus Vaccine*, N.Y. TIMES (Nov. 30, 2020), https://www.nytimes.com/2020/11/21/us/politics/coronavirus-vaccine.html [https://perma.cc/C7KD-DXSJ] (discussing the development of mRNA vaccines).

3 U.S. CONST. art. I, § 8, cl. 8.

4 *See infra* Section I.D.1.

5 *See infra* Section I.D.2.

6 *See infra* Section I.D.3.

7 Lisa Grow Sun & Brigham Daniels, *Mirrored Externalities*, 90 NOTRE DAME L. REV. 135, 138 (2014) ("A textbook example of an action conferring positive externalities on society is an individual's decision to be vaccinated.").

for externalities is to "internalize" them, which refers to all public or private measures for ensuring that decisionmakers consider external benefits or costs in making some decision. One way of doing so is to hold producers of positive and negative externalities accountable for the benefits and costs, respectively, that they impose on others.

Externalities play a central role in patent law. Commentators have long explored the positive[8] and negative[9] externalities of subjecting technologies to exclusive rights via the patent system. On a more foundational level, the economics and IP literature has long recognized that *technology itself* produces positive externalities, also known as spillovers,[10] and concern over excessive spillovers provides a foundational justification for the patent system. Consider a regime without patents in which everyone could freely copy the inventions of others. If most of the value of inventions "spilled over" to free riders in the form of positive externalities, inventors would have little incentive to invent new technologies. Patents, which confer twenty years of exclusive rights on technologies, allow inventors to internalize a meaningful share of positive externalities, thus shoring up incentives to invent.

Technology, however, creates substantial costs as well as benefits. The economics and IP literature has largely overlooked—with a few exceptions—the potential for patented technologies to produce significant negative externalities.[11] This Article fills this gap. It represents the first extended examination of negative externalities arising from technology and the role of patents in allowing such externalities to persist. Technologies—including patented

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8 *See, e.g.*, Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257, 291 (2007) (explaining how the patent system creates information and temporal spillovers).

9 *See* Peter S. Menell & Michael J. Meurer, *Notice Failure and Notice Externalities*, 5 J. LEGAL ANALYSIS 1, 5 (2013) (arguing that concealing or obfuscating the scope of patents creates notice externalities); Jonathan D. Putnam & Andrew B. Tepperman, *Revisiting the Cost of Bad Patents: For Whom Is "Rational Ignorance" Rational?*, INTELL. PROP. TODAY, Oct. 2004, at 17, 19 ("The issuance of poor quality patents causes an externality to transacting parties which largely cannot be otherwise internalized.").

10 *See infra* Section I.B.

11 *See, e.g.*, Sun & Daniels, *supra* note 7, at 146–47, 152 (noting that creators generate positive externalities by creating and negative externalities by preventing dissemination of their creations, but not addressing the possibility that creations themselves can generate negative externalities). Among the few exceptions are Camilla A. Hrdy, *Intellectual Property and the End of Work*, 71 FLA. L. REV. 303 (2019) (considering the negative externalities of automation technology), and Stephanie Plamondon Bair, *Innovation's Hidden Externalities*, BYU L. REV. (forthcoming), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3850316 (last visited Apr. 15, 2022) (exploring how innovations can create negative externalities that hamper subsequent innovation).

technologies—generate significant uncompensated harms for third parties. In light of these harms, a natural question arises: What role do patents play in internalizing these negative externalities?

This Article argues that patent law exhibits a striking and overlooked asymmetry: while patents do much to internalize positive innovation externalities, they do very little to internalize negative innovation externalities. This Article refers to this underappreciated dynamic as patent law's externality asymmetry. As noted, patents exist for the core purpose of internalizing positive externalities. However, patents do almost nothing to internalize negative externalities. On rare occasions, the patent system has denied patents on "immoral" inventions (which may generate significant negative externalities), and a proliferation of patents can in theory slow progress in potentially harmful fields.[12] In practice, however, patents allow inventors of social media, automation, and big data technologies to profit from their inventions while doing nothing to internalize these technologies' external costs. Notably, the patent system is massively subsidizing the invention of technologies that impose uncompensated harms on others.

Patent law's externality asymmetry is even more striking when situating patents within foundational property theory. This Article gains insights into patent law's governance of cutting-edge technologies by exploring conceptual parallels with a classic legal regime: property rights in land. Harold Demsetz's canonical economic analysis argues that property rights arise precisely to internalize positive and negative externalities (when the benefits of internalization outweigh the costs).[13] Property rights internalize externalities in at least three ways, although Demsetz focused on the first two. First, property rights mitigate overconsumption associated with the tragedy of the commons and encourage conservation and judicious use of resources. Second, property rights lower transaction costs between landowners and people affected by their activities. By doing so, they facilitate voluntary negotiations that can lead to more efficient resource allocation. Third, property rights establish not only rights to exclude, but also duties to not unreasonably interfere with the property of others. This duty is evident in the doctrine of nuisance, which forces polluters and other offenders to internalize the costs that their actions impose on others. By their structure and design, physical property rights play an important role in internalizing negative externalities. Notably, Demsetz

12 *See infra* Section II.B.

13 *See* Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347, 350 (1967) [hereinafter Demsetz, *Property Rights*].

generalized beyond land to argue that property rights serve this function in numerous contexts, including the realm of intellectual property.[14]

Contrary to this received wisdom, however, patents do little to internalize negative externalities. Many mechanisms by which physical property rights internalize negative externalities do not apply, or do not apply to nearly the same extent, to patents. First, patents do not internalize negative externalities associated with the tragedy of the commons because this tragedy does not apply to the nonrival technical information at the heart of inventions. Such technical information cannot be overconsumed, and so the tragedy of the commons is inapposite. More importantly, rather than encouraging patentees to conserve protected assets, the time-limited nature of patents encourages them to exploit technologies rapidly. Such rapid exploitation is not conducive to patentees engaging in unhurried consideration and mitigation of externalities. Second, patents do not realistically facilitate efficiency-maximizing transactions between technology owners and individuals harmed by their technologies. Although patents lower some transaction costs, private negotiations remain prohibitively costly due to the large number of parties involved and the availability of technological substitutes for any given patented invention. Third, unlike property rights, patents create no duties for resource owners to limit harms imposed on external parties. Nobody has a right to be free from the effects of a patented invention. In sum, patents are a one-way ratchet that allows patentees to internalize positive externalities from technological innovation but does very little to internalize associated negative externalities.

These theoretical insights have significant practical payoff. Turning to normative analysis, this Article argues that patent law's externality asymmetry contributes to a host of social ills. Most prominently, it undermines efficiency. Reflecting the enduring influence of law and economics, the objective of efficiently allocating resources for innovation has dominated normative discourse on the patent system. However, by not providing effective mechanisms for internalizing negative externalities, patents likely overincentivize innovation, incentivize the wrong mix of innovations, and provide suboptimal incentives for technological design. While scholars have critiqued the patent system on several grounds other than efficiency, even within the dominant idiom of efficiency, it falls short. Looking

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14 *Id.* at 359.

beyond efficiency, patent law's externality asymmetry causes other harms as well by undermining distributive equity and fairness.

Turning to policy implications, this Article argues that there is little reason to think that the patent system achieves a socially optimal allocation of resources for innovation. A natural question then arises: What role, if any, should the patent system play in internalizing the negative externalities of patented inventions? Perhaps surprisingly, this Article argues that the patent system as presently constituted can only play a limited role. The inability of patent law to regulate specific uses of technology, as well as difficulties of timing and institutional competence, suggests a narrow role for the patent system in internalizing negative innovation externalities. To ameliorate these deficits, this Article proposes a requirement that would compel patentees to disclose the potentially harmful effects of certain technologies as a condition of obtaining a patent. However, this is a deliberately modest proposal, and this Article's broader prescription is to call for greater integration of patent and nonpatent mechanisms—such as environmental law, food and drug regulation, tort liability, and tax law—within a holistic framework for internalizing negative externalities from technological innovation. This Article argues that these "restrictive" mechanisms—which seem at odds with patent law's interest in promoting technological progress—are actually essential to achieving the patent system's objective of innovative efficiency. Furthermore, this Article argues for expanding the role of the patent system in generating valuable private information to inform regulatory responses to novel technologies. Turning to broader implications, this Article urges greater technological realism in innovation law and policy, and it challenges the fundamental association of property rights and internalizing externalities within economic theory.

The stakes of addressing the negative externalities of innovation are enormous. Undergirding the seemingly abstract concept of externalities are real harms caused by patented inventions. Technologies that the patent system actively subsidizes are degrading political discourse, eliminating jobs, and likely contributing to constitutional violations. Patents and market-based systems of technological development enjoy a presumption of efficiency in the allocation of resources for innovation. However, markets are unlikely to allocate resources efficiently if they ignore wide swaths of external costs. This Article highlights the underappreciated reality that patented technologies generate uncompensated third-party harms; greater attention to externalities (both positive and negative) will lead to more enlightened innovation policy and more efficient resource allocation.

This Article proceeds in five Parts. Part I introduces the concept of externalities. It briefly reviews the widely recognized view that technologies generate significant positive externalities. It then examines the less appreciated ways that technologies—including patented technologies—also generate significant negative externalities. It illustrates this phenomenon through case studies of three patented technologies: social media content filters, autonomous vehicles, and predictive policing based on big data. Part II advances the novel argument that patent law asymmetrically internalizes positive but not negative externalities. Patents allow inventors to internalize external benefits from their inventions, thus shoring up incentives to invent. However, patents do very little to internalize the negative externalities of those inventions. Part III delves deeper into patent law's externality asymmetry by comparing patents to physical property rights. Drawing on foundational economic theory, it shows how physical property rights internalize externalities in numerous ways that do not apply to patents. Part IV analyzes the normative implications of patent law's externality asymmetry. It argues that by internalizing positive but not negative externalities, patent law undermines efficiency, distributive equity, and fairness. Part V suggests patent reforms to compel inventors to consider the social implications of their inventions and calls for greater integration of patent and nonpatent mechanisms to internalize negative externalities. Furthermore, it explores the broader implications of this Article for technology policy and economic theory.

I. INNOVATION EXTERNALITIES

A. *Externalities: An Introduction*

While the precise definition of an externality is contested,[15] in general it refers to a benefit or cost that an actor imposes on external parties for which there is no charge or compensation. As such, the actor typically does not account for externalities when taking some action.[16] Externalities may be positive, often referred to as spillovers. A familiar example is vaccination, which helps the person receiving the shot but also reduces disease transmission for the community at large.

15 Demsetz, *Property Rights*, *supra* note 13, at 348 ("Externality is an ambiguous concept.").

16 Frischmann & Lemley, *supra* note 8, at 262; *see* Demsetz, *Property Rights*, *supra* note 13, at 348 ("What converts a harmful or beneficial effect into an externality is that the cost of bringing the effect to bear on the decisions of one or more of the interacting persons is too high to make it worthwhile, and this is what the term shall mean here.").

Externalities can also be negative. A familiar example from every property casebook is the factory belching pollution that harms nearby residents. Externalities (both positive and negative) are ubiquitous and pervade everyday life.

This Article speaks of technologies as "creating" externalities, particularly negative externalities, and it is helpful to clarify a few matters of terminology. First, it is useful to address the thorny issue of causality. Economist Ronald Coase famously argued that harm is reciprocal and that in any case involving a negative externality between two parties, both parties are but-for causes of the externality.[17] Applying this insight to the classic example of pollution, both the factory and the residents harmed by pollution are but-for "causes" of the negative externality; remove either party (or both), and there would be no externality. Similarly, in the technological sphere, if Facebook's filter bubble degrades the political discourse of citizens, both Facebook and the citizens themselves are but-for causes of this negative externality. Following linguistic and social convention, this Article will speak of active parties (such as technology developers) as imposing externalities on passive parties (such as technology users and society at large), while acknowledging that both are, technically, but-for causes of the externality. Within this framework, Facebook creates an externality for users and society at large when it develops a technology that degrades political discourse.

Second, it is helpful to clarify this Article's use of "negative" and "positive" externalities. Some commentators note that any situation involving a negative externality could be described in terms of a positive externality (and vice versa).[18] Such characterizations depend on the selection of a baseline that is ultimately arbitrary.[19] For instance, the "problem" of Facebook's filter bubble could be understood as either the presence of a negative externality from using a harmful technology or the absence of a positive externality from not using it.[20]

However, for two reasons, this Article suggests that characterizing a technology's harms to others as a negative externality is appropriate

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17 R.H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1, 2 (1960).

18 Sun & Daniels, *supra* note 7, at 138 ("That is, if an act results in a negative externality, refraining from that act necessarily creates a positive externality, and vice versa.").

19 John F. Duffy, *Intellectual Property Isolationism and the Average Cost Thesis*, 83 TEX. L. REV. 1077, 1086 (2005) ("Negative externalities can be distinguished from positive externalities only by identifying a baseline, and the choice of a baseline is generally considered arbitrary as a matter of theory. Thus, a situation involving an apparent 'negative' externality can always be described with equal accuracy as involving a 'positive' externality if the arbitrary baseline is changed.").

20 *Id.* at 1086–87.

and does not detract from its overall analysis. First, as has been widely recognized, "normalcy" and reasonable expectations provide, in many instances, a solid guide for characterizing a situation as involving positive or negative externalities.[21] While formalistically possible, it strains credulity to characterize a technology developer's external harm as the absence of internalizing the positive externality of not inventing a technology.[22] This Article adopts a "normal" baseline in which the default condition is nonaction and noninteraction.[23] Thus, the baseline will be quiet, no pollution, and no innovation. Relative to this baseline, factory owners create negative externalities for neighbors, vaccine recipients create positive externalities for the population at large, and innovators create both positive and negative externalities for others relative to a world in which their innovations do not exist.

Additionally, and more importantly, even if the selection of a baseline is ultimately arbitrary (in other words, there is no a priori, external measure of the "proper" baseline), once a baseline is selected, the concepts of positive and negative externalities in any given situation have internal meaning relative to that baseline. Here, patent law's asymmetric treatment of externalities on opposite sides of the baseline remains meaningful regardless of what baseline is picked.[24] One could say (as this Article does) that patents allow inventors to internalize the positive externalities of their inventions but not the negative externalities of those inventions. Or one could say that patents allow inventors to internalize the negative externalities of not inventing but not the positive externalities of not inventing. Either way, the *relative*

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21 Robert C. Ellickson, *Alternatives to Zoning: Covenants, Nuisance Rules, and Fines as Land Use Controls*, 40 U. CHI. L. REV. 681, 731 (1973) ("The distinction in economic theory between harmful and beneficial spillovers reflects an underlying notion of normalcy.").

22 *Cf.* Mark A. Lemley, *What's Different About Intellectual Property?*, 83 TEX. L. REV. 1097, 1098 & n.4 (2005) [hereinafter Lemley, *What's Different*] (addressing a similarly strained way of characterizing the positive externalities of innovation).

23 Other commentators have also suggested baselines to distinguish positive and negative externalities. *See, e.g.*, Donald Wittman, *Liability for Harm or Restitution for Benefit?*, 13 J. LEGAL STUD. 57, 71–72 (1984) (defining the relevant "point of reference" as the long-run efficient outcome).

24 One clarifying note is important here. This Article argues that patents internalize positive externalities from inventions but not their negative externalities. As Professor John Duffy argues, however, patents do internalize negative externalities from *not* inventing. Put differently, if patents allow an inventor to profit from inventing (thereby internalizing some positive externalities), she stands to "lose" money by not inventing (thereby internalizing negative externalities from not inventing). Duffy, *supra* note 19, at 1088. These considerations, however, are wholly apart from the negative externalities that inventions themselves impose on other parties.

relationships remain intact, and patent law's asymmetric treatment of positive and negative externalities remains consistent.

Third, economists further distinguish between so-called technological and pecuniary externalities. "Technological" or "real" externalities refer to interparty effects transmitted outside of the market.[25] Technological externalities change the production function of a firm (or the utility function of a consumer) so that more or fewer inputs are required to produce an additional unit of output. For example, a factory creates a negative technological externality when it belches pollution next to a restaurant and consequently decreases the productivity of the restaurant workers and the ability of customers to enjoy their meals. Technological externalities are problematic because they drive a wedge between private and social value and can lead to inefficient resource allocation.[26] In our example, the private returns of the factory will not equal its social returns because the private returns do not account for the negative externalities imposed on the restaurant and its customers (as well as any other negative externalities). It may be socially efficient for the factory to reduce its operations or even shut down, but the factory is unlikely to do so if it is not accountable for these third-party costs. In general, in markets where actors ignore externalities, production of a good or service that generates negative technological externalities will be too high. Conversely, production of any good or service that generates positive technological externalities will be too low.

Unlike technological externalities, pecuniary externalities work directly through the market.[27] Consider a change to our restaurant example: imagine that rather than operating next to a factory, a competing restaurant moves in next door. This new restaurant imposes a negative externality on the original restaurant, which now faces greater competition. However, this is a pecuniary externality rather than a technological externality because it operates directly through the

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25 Lawrence D. Schall, *Technological Externalities and Resource Allocation*, 79 J. POL. ECON. 983, 983 (1971); *see* J.-J. Laffont, *Externalities*, *in* ALLOCATION, INFORMATION AND MARKETS 112 (John Eatwell, Murray Milgate & Peter Newman eds., 1989); DAVID K. WHITCOMB, EXTERNALITIES AND WELFARE 6 (1972).

26 Laffont, *supra* note 25, at 113 ("[I]n a private competitive economy, equilibria will not be in general Pareto optimal since the private decentralized optimizations of economic agents lead them to the equalization of *private and not social* marginal rates through the price system."); Schall, *supra* note 25, at 984.

27 Laffont, *supra* note 25, at 113; S.J. Liebowitz & Stephen E. Margolis, *Network Externality: An Uncommon Tragedy*, 8 J. ECON. PERSPS. 133, 137 (1994) (contrasting pecuniary externalities, which are "external effects that work through the price system" with technological externalities, which are "actual benefits or costs [that] are imposed outside of market mechanisms").

market; competition from the new restaurant decreases the prices the original restaurant can charge for meals and increases wages that it must pay to workers.[28] Compared to technological externalities, the welfare effects of pecuniary externalities are more contested. Most economists ignore pecuniary externalities on the theory that they simply result in wealth transfers rather than a wedge between private returns and social returns.[29] On this view, pecuniary externalities do not result in resource misallocation.[30] Other economists, however, point out that pecuniary externalities can depress overall welfare if markets are not competitive or transactions do not occur.[31] Additionally, pecuniary externalities exacerbate distributive inequities,[32] which are problematic in their own right and may also impair welfare.[33]

This Article focuses primarily on technological externalities that result from innovation, though it will at times refer to pecuniary externalities. To minimize confusion, this Article will use the term "innovation externalities" to refer generally to externalities arising from technological innovations in order to differentiate them from the more specific economic concept of "technological externalities." When appropriate, it will distinguish within innovation externalities between technological and pecuniary externalities.

The classic remedy for problematic externalities is to "internalize" them, which refers to any public or private measures undertaken to ensure that decisionmakers consider unpaid benefits or costs in making some decision. A principal way of doing so is to allow (or force) decisionmakers to bear a greater share of the benefits and costs they create for external parties. In so doing, internalization allows private

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28 *See* Michael Abramowicz, *An Industrial Organization Approach to Copyright Law*, 46 WM. & MARY L. REV. 33, 55 (2004) (providing analogous examples distinguishing technological and pecuniary externalities).

29 Randall G. Holcombe & Russell S. Sobel, *Public Policy Toward Pecuniary Externalities*, 29 PUB. FIN. REV. 304, 304–05 (2001) ("For efficiency, people must take account of the technological externalities that they create, but pecuniary externalities should be ignored."). Applying this view to our example, the original restaurant's losses are the new restaurant's gains, and there is no loss of overall social welfare. *See* RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 7 (6th ed. 2003).

30 Holcombe & Sobel, *supra* note 29, at 304; Laffont, *supra* note 25, at 113.

31 Laffont, *supra* note 25, at 113; Paul Krugman, *Increasing Returns and Economic Geography*, 99 J. POL. ECON. 483, 485 (1991); Lemley, *What's Different*, *supra* note 22, at 1097–98.

32 Anton Korinek & Joseph E. Stiglitz, *Artificial Intelligence and Its Implications for Income Distribution and Unemployment*, *in* THE ECONOMICS OF ARTIFICIAL INTELLIGENCE: AN AGENDA 349, 368 (Ajay Agrawal, Joshua Gans & Avi Goldfarb eds., 2019) ("Even if the equilibrium reached after an innovation is Pareto efficient, the pecuniary externalities lead to redistributions and imply that there are winners and losers.").

33 *See infra* notes 255–56 and accompanying text.

resource allocation to better reflect social costs and benefits.[34] Thus, for example, governments use lotteries and other incentives to subsidize individuals' decisions to get vaccinated (which has positive externalities) and impose taxes on pollution (which creates negative externalities).

It is important to note that for several reasons, it is neither desirable nor feasible to internalize *all* externalities.[35] For example, a beneficial activity may generate enough private gain for a decisionmaker that she is indifferent to the positive externalities that spill over to others. In these cases, internalizing externalities would lead to social losses that are not offset by private gains. Take, for instance, a gardener who cultivates a beautiful garden that his neighbors enjoy.[36] It would make little sense to force the neighbors to compensate him (thus internalizing these positive externalities) given that the gardener already derives sufficient benefit to motivate his gardening. From the perspective of optimizing resource allocation, these positive externalities may simply be "irrelevant."[37] Similarly, internalizing all negative externalities is also not warranted. In a bustling, modern society, people will sometimes bump into each other, talk too loudly at restaurants, and wear overly pungent perfume. The administrative (and other) costs of internalizing every negative externality outweigh the benefits.

More fundamentally, some externalities do not warrant internalization because they are necessarily incidental to activities that increase net social welfare. This point is best illustrated by considering negative externalities. At one end of the spectrum are significant negative externalities that distort resource allocation, such as the factory that creates so much pollution that it represents a net social negative. In such cases, internalizing the externality (leading to the factory closing or reducing output) would be efficient. However, some negative externalities do not warrant internalization because they are necessary byproducts of an activity that is a net social positive. For instance,

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34 Frischmann & Lemley, *supra* note 8, at 265 (describing this idea while also articulating its limits).

35 *See* Mark A. Lemley, *Property, Intellectual Property, and Free Riding*, 83 TEX. L. REV. 1031, 1032 (2005) [hereinafter Lemley, *Property*] ("Various uses of property create uncompensated positive externalities, and we don't see that as a problem or a reason people won't efficiently invest in their property."); Brett M. Frischmann, *Evaluating the Demsetzian Trend in Copyright Law*, 3 REV. L. & ECON. 649, 652 (2007) [hereinafter Frischmann, *Demsetzian*] ("[A]s most economists recognize, not all externalities should be internalized (even if they could be).").

36 *Cf.* Frischmann & Lemley, *supra* note 8, at 258–59 (exploring similar examples).

37 *See* James M. Buchanan & Wm. Craig Stubblebine, *Externality*, 29 ECONOMICA 371, 371 (1962).

considering a pecuniary externality, when a new firm enters a market to challenge an established incumbent, we generally tolerate (perhaps even welcome) the negative externality imposed on the incumbent as part and parcel of healthy competition and all its attendant benefits.[38] In such cases, internalizing the negative externality by prohibiting competition would be inefficient.

In some contexts, welfare analysis counsels against fully internalizing a negative externality (which would eliminate a related activity that is a net social positive), yet policymakers may seek to partially internalize that externality, perhaps based on considerations of distributive equity or fairness.[39] Patent law, which aims to promote technological progress, creates negative externalities by incentivizing novel technologies that render existing ones obsolete.[40] For instance, as discussed further below, autonomous vehicles create a negative externality for professional drivers who may lose their jobs.[41] Like healthy competition, we generally tolerate the negative externality imposed on legacy technologies by the onward march of technological progress. Assuming (as is likely the case) that the macroscopic benefits of autonomous vehicles outweigh their costs, internalizing this externality by suppressing this technology would decrease overall welfare. However, nonwelfarist values such as distributive equity may justify at least partial internalization of this negative externality.[42] For instance, although we would not want to stop the development of autonomous vehicles, distributive concerns may justify providing some compensation for dislocated drivers, a topic to which this Article will return.[43]

Ultimately, while not all externalities merit internalization, some do. From a traditional welfare perspective, externalities that lead to inefficient resource allocation warrant some form of internalization. In

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38 Under certain conditions, however, imperfect competition and business stealing can facilitate excessive entry that reduces social welfare. N. Gregory Mankiw & Michael D. Whinston, *Free Entry and Social Inefficiency*, 17 RAND J. ECON. 48, 57 (1986).

39 *Cf.* Boomer v. Atl. Cement Co., 257 N.E.2d 870, 875 (N.Y. 1970) (imposing nuisance liability on a factory but allowing the factory to pay permanent damages to avoid an injunction); RESTATEMENT (SECOND) OF TORTS § 826 (AM. L. INST. 1979).

40 *Cf.* Demsetz, *Property Rights*, *supra* note 13, at 359 (noting how new technical ideas can render existing ones obsolete).

41 *See infra* Section I.D.2.

42 *See* Brett Frischmann, *Spillovers Theory and Its Conceptual Boundaries*, 51 WM. & MARY. L. REV. 801, 811 (2009) [hereinafter Frischmann, *Spillovers Theory*] (describing situations where distributional considerations might warrant internalizing an externality where efficiency considerations do not).

43 *See infra* notes 258–66 and accompanying text.

some cases, other values, such as distributive equity, may also justify internalizing (or partially internalizing) externalities.

Externalities are ubiquitous. Prominent sources of externalities from yesteryear, such as gardens, factories, and pig pens, continue to create external benefits and costs for third parties. However, the next two Sections focus on specific kinds of externalities of increasing significance in contemporary times, namely positive and negative externalities from technological innovation.

B. *Positive Innovation Externalities*

Commentators have long recognized that innovation creates enormous positive externalities.[44] While innovators benefit substantially from their own creations, significant benefit slips, uncompensated, to others.[45] Innovation spillovers benefit consumers who receive unanticipated consumer surplus, competitors and potential competitors who obtain valuable information, and society at large.[46] Because spillovers from innovation are well recognized in the economics and IP literature, this Section's discussion of positive externalities from innovation will be relatively brief.

Examples of innovation spillovers are legion. Biopharmaceutical companies receive compensation for the drugs they produce, but such drugs generate enormous uncompensated benefits by reducing healthcare costs and increasing social welfare for all. Similarly, Microsoft Office enhances worker productivity and generates significant social value that Microsoft does not capture as private gains. Communication technologies produce enormous spillovers by facilitating conversations, connections, and transactions that the developers of such technologies could never imagine, let alone factor into their development efforts. Network technologies enable positive externalities wherein the value of such networks increases as more users

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44 *See* Frischmann & Lemley, *supra* note 8, at 257; R. Polk Wagner, *Information Wants to Be Free: Intellectual Property and the Mythologies of Control*, 103 COLUM. L. REV. 995, 1005 (2003).

45 *See* Gregory N. Mandel, *Proxy Signals: Capturing Private Information for Public Benefit*, 90 WASH. U. L. REV. 1, 17 (2012); Frischmann & Lemley, *supra* note 8, at 257.

46 Frischmann & Lemley, *supra* note 8, at 268. There is some debate over whether "ordinary" consumer surplus constitutes an externality or whether it does not because it is an anticipated effect of a transaction. *See* Duffy, *supra* note 19, at 1082–84. However, a more plausible case could be made that unanticipated consumer surplus represents a pecuniary externality. *See* Frischmann & Lemley, *supra* note 8, at 261.

join them.[47] Broadly, one of the most important positive externalities of technological innovation is increased economic growth.[48]

Technologies produce positive externalities not only in the static sense of enhancing present social welfare, but also in the dynamic sense of promoting subsequent innovation.[49] Innovators stand on the shoulders of giants, building upon previous innovations.[50] Information spillovers drive further innovation, for example when scientists and engineers share information in academic publications and conferences or move between various organizations. Technological investments in one field, such as space exploration, often lead to unexpected applications in other fields, such as solar panels and heart monitors.[51]

A wide empirical literature has attempted to quantify the positive externalities of investments in research and development.[52] One classic study found that the median private rate of return for various industrial innovations was 25%, but the median social rate of return for these innovations was 56%.[53] These findings accord with a more recent study reporting that the private rate of return to R&D was 21% while the social rate of return was 55%.[54] These empirical findings suggest that the social returns to R&D far outstrip the private returns, indicating the presence of significant positive externalities. Furthermore, they suggest that economic actors may underinvest in R&D relative to the socially optimal level.[55]

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47 *See* Michael L. Katz & Carl Shapiro, *Network Externalities, Competition, and Compatibility*, 75 AM. ECON. REV. 424, 424 (1985).

48 *See* RICHARD R. NELSON, THE SOURCES OF ECONOMIC GROWTH 31 (1996).

49 *See* Wagner, *supra* note 44, at 1005–07 (noting numerous examples where innovations facilitated new lines of inquiry and subsequent innovations).

50 *See* Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. ECON. PERSPS. 29, 29 (1991).

51 INT'L SPACE EXPL. COORDINATION GRP., BENEFITS STEMMING FROM SPACE EXPLORATION 8 (2013).

52 *See, e.g.*, Zvi Griliches, *The Search for R&D Spillovers*, 94 SCANDINAVIAN J. ECON. S29, S43 (1992) (summarizing several studies and concluding that "R&D spillovers are present, their magnitude may be quite large, and social rates of return remain significantly above private rates").

53 Edwin Mansfield, *Contributions of New Technology to the Economy*, *in* TECHNOLOGY, R&D, AND THE ECONOMY 114, 117 (Bruce L.R. Smith & Claude E. Barfield eds., 1996). For a comprehensive account of quantitative estimates of innovation spillovers, see Frischmann & Lemley, *supra* note 8, at 259 n.5.

54 Nicholas Bloom, Mark Schankerman & John Van Reenan, *Identifying Technology Spillovers and Product Market Rivalry*, 81 ECONOMETRICA 1347, 1349 (2013).

55 *Id.*

C. *Negative Innovation Externalities*

Technology, however, also has a dark side. While the economics and IP literature has extensively examined the positive externalities of technology, it has devoted less attention to technology's negative externalities.[56] Technology produces a wide range of negative externalities, including serious harms to physical health and the environment. For example, prescription opioids were once heralded as safe and effective painkillers. However, they have caused an epidemic of addiction and misery involving nearly 500,000 overdose deaths in the United States.[57] The opioid crisis cost the U.S. economy $631 billion from 2015 to 2018.[58] These costs have largely been external to opioid manufacturers and distributors, though recent litigation has aimed to at least partially internalize these negative externalities.[59] For generations, "dirty" technologies, from coal-burning power plants to automobiles, have contributed to arguably the greatest threat facing humanity: global climate change.[60] Chemical fertilizers ramped up food production, but they have also enormously increased reactive nitrogen levels throughout the environment.[61]

Technology also generates negative externalities by harming mental health, well-being, and social connectedness. Numerous studies indicate that adolescents and young adults who spend more time on

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56 As noted, prominent exceptions include Hrdy, *supra* note 11, at 345, and Bair, *supra* note 11, at 7–8.

57 *Opioids: Understanding the Epidemic*, CTRS. FOR DISEASE CONTROL & PREVENTION (Mar. 17, 2021), https://www.cdc.gov/opioids/basics/epidemic.html [https://perma.cc/EX4U-KTVG]. *See generally* Daniel J. Hemel & Lisa Larrimore Ouellette, *Innovation Institutions and the Opioid Crisis*, 7 J.L. & BIOSCIENCES 1 (2020).

58 STODDARD DAVENPORT, ALEXANDRA WEAVER & MATT CAVERLY, SOC'Y OF ACTUARIES, ECONOMIC IMPACT OF NON-MEDICAL OPIOID USE IN THE UNITED STATES 4 (2019), https://www.soa.org/globalassets/assets/files/resources/research-report/2019/econ-impact-non-medical-opioid-use.pdf [https://perma.cc/UB3R-J2QD].

59 *See, e.g.*, Jan Hoffman & Mary Williams Walsh, *Judge Clears Purdue Pharma's Restructuring Plan for Vote by Thousands of Claimants*, N.Y. TIMES (Sept. 1, 2021), https://www.nytimes.com/2021/05/26/health/opioids-purdue-bankruptcy-settlement.html [https://perma.cc/EEC4-EVM4].

60 *See* Zachary Liscow & Quentin Karpilow, *Innovation Snowballing and Climate Law*, 95 WASH. U. L. REV. 387, 405 (2017).

61 *Environmental Impacts of Agricultural Modifications*, NAT'L GEOGRAPHIC (May 11, 2020), https://www.nationalgeographic.org/article/environmental-impacts-agricultural-modifications [https://perma.cc/6WML-MMF7].

digital media report lower psychological well-being.[62] A 2019 poll by the American Psychiatric Association found that thirty-eight percent of adults view social media usage as harmful to mental health.[63] Academic performance is negatively correlated with instant messaging, social networking sites, engaging with smartphones, and use of electronic media more generally.[64] Heavy use of digital media is also correlated with a loss of empathic accuracy.[65] Developers of computers, Artificial Intelligence, and robots do not bear the psychological costs of users' loss of human connection and intimacy from interacting with machines instead of people.[66]

Technology also creates negative externalities by threatening physical safety, privacy, and economic security. One study estimated that social media accounts for about ninety percent of all organized terrorism carried out on the Internet.[67] Autonomous weapon systems with no human oversight or input can commit war crimes.[68] Drones raise serious privacy concerns, particularly when used by local law enforcement.[69] Considering innovation more broadly, financial innovations such as structured financial products and credit default swaps contributed significantly to the Great Recession.[70] As noted, a negative externality endemic to the concept of technological progress is that of rendering legacy technologies (and associated jobs) obsolete. For instance, the word-processing programs developed by Microsoft and

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62 *See* Jean M. Twenge, *More Time on Technology, Less Happiness? Associations Between Digital-Media Use and Psychological Well-Being*, 28 CURRENT DIRECTIONS PSYCH. SCI. 372, 372–73 (2019) (summarizing several large studies).

63 *Americans Are Concerned About Potential Negative Impacts of Social Media on Mental Health and Well-being*, AM. PSYCHIATRIC ASS'N (May 20, 2019), https://www.psychiatry.org/newsroom/news-releases/americans-are-concerned-about-potential-negative-impacts-of-social-media-on-mental-health-and-well-being [https://perma.cc/PNK2-R64X].

64 Bair, *supra* note 11, at 21–22 (describing studies).

65 *Technology and Human Vulnerability*, HARV. BUS. REV., Sept. 2003, at 43, 46.

66 *Id.* at 45 ("[I]n the computer we have created a very powerful object, an object that offers the illusion of companionship without the demands of intimacy, an object that allows you to be a loner and yet never be alone." (quoting MIT Professor Sherry Turkle)).

67 *Terrorist Groups Recruiting Through Social Media*, CBC NEWS (Jan. 10, 2012, 12:15 PM), https://www.cbc.ca/news/science/terrorist-groups-recruiting-through-social-media-1.1131053 [https://perma.cc/3HYL-BZCM] (quoting Gabriel Weimann of the University of Haifa).

68 *See* Rebecca Crootof, *War Torts: Accountability for Autonomous Weapons*, 164 U. PA. L. REV. 1347, 1349–51 (2016).

69 Timothy T. Takahashi, *Drones and Privacy*, 14 COLUM. SCI. & TECH. L. REV. 72, 76 (2013). Satellites raise similar privacy concerns. *See* Ray Purdy, *Attitudes of UK and Australian Farmers Towards Monitoring Activity with Satellite Technologies: Lessons to Be Learnt*, 27 SPACE POL'Y 202, 205 (2011) (reporting that fifty-eight percent of Australian respondents and seventy-five percent of U.K. respondents agreed that satellite monitoring was "an invasion of their privacy").

70 Korinek & Stiglitz, *supra* note 32, at 362.

others led to the demise of the typewriter and displaced those employed by that industry.[71] Technology developers profit substantially from their creations, but they are largely insulated from their external costs.

D. *Negative Externalities from Patented Technologies*

This Article highlights an underappreciated facet of technology's harmful effects: many technologies that generate negative externalities are patented. In an unsettling irony, the patent system significantly subsidizes the development of technologies that impose uncompensated harms on third parties. To better understand this phenomenon, this Section turns to case studies of three patented technologies that produce substantial negative externalities.

1. Facebook's "Filter Bubble" and Ideological Polarization

One prominent example of a patented technology generating negative externalities is Facebook's "filter bubble."[72] Over the past two decades, Facebook has developed innovations to personalize content for users based on their interests and connections. This so-called filter bubble technology has several benefits, including enhancing the relevance of content to users, increasing the stickiness of Facebook's website, and raising Facebook's value to advertisers. However, the filter bubble also generates significant harms, particularly in the political sphere. Curated content streams spread misinformation and establish incommensurable "media ecosystems" that expose liberal and conservative users to different universes of information.[73] Facebook's

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71 For additional examples of technology's harmful effects, see Brent Hecht et al., *It's Time to Do Something: Mitigating the Negative Impacts of Computing Through a Change to the Peer Review Process*, ACM FUTURE OF COMPUTING ACAD. (Mar. 29, 2018), https://acm-fca.org/2018/03/29/negativeimpacts [https://perma.cc/PVW2-UK8T].

72 *See generally* ELI PARISER, THE FILTER BUBBLE: WHAT THE INTERNET IS HIDING FROM YOU (2011).

73 *See* YOCHAI BENKLER, ROBERT FARIS & HAL ROBERTS, NETWORK PROPAGANDA: MANIPULATION, DISINFORMATION, AND RADICALIZATION IN AMERICAN POLITICS 39 (2018); Mark Harris, *How Patents Made Facebook's Filter Bubble: The Social Network's Public Filings Portray an Echo-Chamber Factory*, IEEE SPECTRUM (Jan. 28, 2021), https://spectrum.ieee.org/computing/networks/the-careful-engineering-of-facebooks-filter-bubble [https://perma.cc/4AFD-WDDD] (characterizing filter bubbles as "powerfully addictive to users, irresistible to advertisers, and a welcoming environment for rampant misinformation and disinformation"); Lam Thuy Vo, *How the Internet Created Multiple Publics*, 4 GEO. L. TECH. REV. 399, 400 (2020)

algorithms prioritize content linked to "extreme" reactions or numerous posts, which tend to come from a small but vocal fraction of users.[74] Filter bubbles exacerbate political polarization[75] and have even been blamed for contributing to the January 6, 2021, U.S. Capitol insurrection.[76] Over two dozen U.S. states have filed suit against Facebook for alleged antitrust violations, some of which relate to Facebook's information-filtering practices.[77]

While it is difficult to quantify the harms of Facebook's filter bubble, they are likely substantial. Facebook is the dominant source of news and information for many of its users.[78] Filter bubbles foster confirmation biases by providing users with information that supports their existing views and shielding them from opposing perspectives.[79] The resulting deterioration of a shared epistemic commons degrades democratic discourse and can lead to political polarization and even violence. Foreign agents have also exploited filter bubbles to spread misinformation; Russia created Facebook pages touting fraudulent information that received 340 million engagements before Facebook deleted them.[80] Notwithstanding these harms, Facebook benefits from filter bubbles and has incentives to expand this technology. In the wake of the 2020 U.S. presidential elections, Facebook temporarily altered its algorithms to promote more fact-based information sources, but it soon reversed that decision.[81]

Notably, Facebook's filter bubble is patented technology. Among Facebook's 9,000 patents are several claiming inventions that

("These universes are segregated in the kind of information they consume due to the ways in which the social web is engineered.").

74 Vo, *supra* note 73, at 405.

75 *Id.* at 400–01 ("[I]nformation on social media is delivered in highly personalized ways that favor polarizing content. Consuming content on social media may, thus, potentially exacerbate existing political divides."); Harris, *supra* note 73 (citing Professor Jennifer Stromer-Galley).

76 Harris, *supra* note 73.

77 Complaint at 70, New York v. Facebook, Inc., 549 F. Supp. 3d 6 (D.D.C. 2020) (No. 1:20-cv-03589) ("Due to Facebook's unlawful conduct and the lack of competitive constraints resulting from that conduct, there has been a proliferation of misinformation and violent or otherwise objectionable content on Facebook's properties.").

78 R. Kelly Garrett, *Social Media's Contribution to Political Misperceptions in U.S. Presidential Elections*, 14 PLOS ONE 1, 1 (2019) (reporting that more survey respondents cited Facebook as a source of political information than any other news-related site).

79 PARISER, *supra* note 72, at 88.

80 Craig Timberg, *Russian Propaganda May Have Been Shared Hundreds of Millions of Times, New Research Says*, WASH. POST (Oct. 5, 2017), https://www.washingtonpost.com/news/the-switch/wp/2017/10/05/russian-propaganda-may-have-been-shared-hundreds-of-millions-of-times-new-research-says [https://perma.cc/EZ9V-MGLD].

81 Harris, *supra* note 73.

personalize content based on a user's interests and connections.[82] Take, for example, U.S. Patent No. 9,110,953 B2. This patent covers methods and systems for "Filtering Content in a Social Networking Service," and it lists Mark Zuckerberg as one of its inventors.[83] The patent claims methods and systems by which an algorithm considers various user attributes to deliver highly relevant content.[84] The patent consists of sixteen pages of technical diagrams, disclosures, and claims that describe the system's operation and various preferred embodiments. It discloses several benefits of this invention, which personalizes content for users and enables more targeted advertising.[85] However, the patent does not disclose any mechanism for verifying the information provided to users via this algorithm. Furthermore, it contains no discussion of this technology's wider social ramifications, such as its potential contribution to ideological polarization.

2. Autonomous Vehicles and Job Losses

Autonomous vehicles also generate significant negative externalities. Of course, self-driving vehicles promise significant benefits, such as reducing accidents, enhancing energy efficiency, and increasing mobility for those unable to drive. Alongside these benefits, however, this technology creates external harms for which technology developers are largely unaccountable. For instance, several Tesla cars using its semi-autonomous "Autopilot" driving technology have killed people.[86] Lawsuits against Tesla allege design defects; while such lawsuits may force Tesla to internalize some of these costs, Tesla has vigorously denied liability, thus seeking to maintain these costs as externalities. Autonomous vehicles also raise privacy concerns by gathering enormous amounts of data and potentially sharing that data

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82 *Id.*

83 U.S. Patent No. 9,110,953 B2 (issued Aug. 18, 2015).

84 *Id.* at col. 14 ln. 53 to col. 18 ln. 23.

85 *Id.* at col. 2 ln. 46–62.

86 Neal E. Boudette, *Tesla Says Autopilot Makes Its Cars Safer. Crash Victims Say It Kills.*, N.Y. TIMES (Sept. 1, 2021), https://www.nytimes.com/2021/07/05/business/tesla-autopilot-lawsuits-safety.html [https://perma.cc/YAR7-EREZ]; Rebecca Heilweil, *Tesla Needs to Fix Its Deadly Autopilot Problem*, VOX (Feb. 26, 2020, 1:50 PM), https://www.vox.com/recode/2020/2/26/21154502/tesla-autopilot-fatal-crashes (last visited May 14, 2022); Bryan Pietsch, *2 Killed in Driverless Tesla Car Crash, Officials Say*, N.Y. TIMES (Nov. 10, 2021), https://www.nytimes.com/2021/04/18/business/tesla-fatal-crash-texas.html [https://perma.cc/K3WC-6E8D].

with government entities and third parties.[87] At the heart of autonomous vehicles is Artificial Intelligence (AI), which gives rise to a host of negative externalities. As Tesla chief Elon Musk has warned, AI could become "an immortal dictator from which we can never escape."[88]

One significant negative externality of AI-based automation in general, and autonomous vehicles in particular, is job losses.[89] The threat of automation to replace human workers has attracted significant public policy concern.[90] The landscape is complex, as automation can enhance worker productivity and increase demand for skills in some contexts. In other contexts, however, automation eliminates jobs.[91] Lower-paid, lower-skilled, and less-educated workers are most susceptible to job losses.[92] Focusing on autonomous vehicles, it is estimated that when self-driving cars and trucks reach saturation, job losses among U.S. drivers will amount to 25,000 per month or 300,000 per year.[93] The White House Council of Economic Advisors estimates that autonomous vehicles threaten 2.2 to 3.1 million driving-based jobs in the United States.[94]

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87 Emilio Longoria, *Invisible, but Not Transparent: An Analysis of the Data Privacy Issues that Could Be Implicated by the Widespread Use of Connected Vehicles*, 28 ALB. L.J. SCI. & TECH. 1, 3–5 (2017).

88 Ryan Browne, *Elon Musk Warns A.I. Could Create an "Immortal Dictator from Which We Can Never Escape*," CNBC (Apr. 6, 2018, 1:11 PM), https://www.cnbc.com/2018/04/06/elon-musk-warns-ai-could-create-immortal-dictator-in-documentary.html [https://perma.cc/2D2B-QWQC] (quoting Elon Musk).

89 Korinek & Stiglitz, *supra* note 32, at 349 ("[A]s artificial intelligence draws closer and closer to human general intelligence, much of human labor runs the risk of becoming obsolete and being replaced by AI in all domains."); *see* Hrdy, *supra* note 11, at 312–15; Cynthia Estlund, *What Should We Do After Work? Automation and Employment Law*, 128 YALE L.J. 254, 257 (2018); Daron Acemoglu & Pascual Restrepo, *The Race Between Man and Machine: Implications of Technology for Growth, Factor Shares, and Employment*, 108 AM. ECON. REV. 1488, 1488 (2018).

90 Andrew Yang, Opinion, *Yes, Robots Are Stealing Your Job*, N.Y. TIMES (Nov. 14, 2019), https://www.nytimes.com/2019/11/14/opinion/andrew-yang-jobs.html [https://perma.cc/PTG8-AQ2K].

91 EXEC. OFF. OF THE PRESIDENT, ARTIFICIAL INTELLIGENCE, AUTOMATION, AND THE ECONOMY 2 (2016); Hrdy, *supra* note 11, at 313–14.

92 EXEC. OFF. OF THE PRESIDENT, *supra* note 91, at 2.

93 Anita Balakrishnan, *Self-Driving Cars Could Cost America's Professional Drivers up to 25,000 Jobs a Month, Goldman Sachs Says*, CNBC (May 22, 2017, 7:57 PM), https://www.cnbc.com/2017/05/22/goldman-sachs-analysis-of-autonomous-vehicle-job-loss.html [https://perma.cc/H9X4-T2PV].

94 EXEC. OFF. OF THE PRESIDENT, *supra* note 91, at 15.

Many of the technologies underlying autonomous vehicles are patented.[95] An informal search revealed over 135,000 patents or patent applications in the United States mentioning the term "autonomous vehicles."[96] On a massive scale, patent law is encouraging the development of technologies that promise significant benefits but that also impose substantial harms. Take, for example, U.S. Patent No. 9,244,462 B2, which covers "vehicle trajectory planning for autonomous vehicles."[97] This patent, owned by Nissan, claims methods for determining an initial vehicle trajectory and then calculating and executing an optimized vehicle trajectory based on changed parameters. Among other benefits, this method can "smooth out" abrupt changes in direction, such as U-turns, lane changes, and turns at intersections. In doing so, it reduces "occupant discomfort, motion sickness, and decreased confidence in the autonomous system."[98] Not surprisingly, however, amid twelve pages of technical disclosures, there is no mention of the broader social impact of this technology and potential job losses that may arise from autonomous vehicles.

3. Big Data and Government Overreaching

A final example of negative externalities from patented technologies involves methods for analyzing enormous amounts of data, commonly known as big data.[99] This innovation has numerous applications, from allowing Target to anticipate consumers' purchasing needs[100] to enabling health officials to track transmissions of coronavirus from people's cell phones.[101] One of the most significant government uses of big data is to predict the occurrence of crime. As

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95 *See* Hrdy, *supra* note 11, at 307 (noting how Alphabet, Uber, Tesla, and General Motors rely on patents and other forms of IP to develop autonomous vehicles). More generally, companies routinely patent labor-saving technologies. *Id.* at 334–35.

96 GOOGLE PATS., https://patents.google.com (search for "(autonomous vehicles), country:US, type:PATENT") (last visited May 25, 2022).

97 U.S. Patent No. 9,244,462 B2 (issued Jan. 26, 2016).

98 *Id.* at col. 2 ln. 23–39.

99 Elizabeth E. Joh, *Policing by Numbers: Big Data and the Fourth Amendment*, 89 WASH. L. REV. 35, 38 (2014) (noting that while definitions vary, most agree that big data refers to the application of AI to vast amounts of digitized data).

100 Charles Duhigg, *How Companies Learn Your Secrets*, N.Y. TIMES MAG. (Feb. 16, 2012), https://www.nytimes.com/2012/02/19/magazine/shopping-habits.html [https://perma.cc/YY8L-SXFQ]; *see also* Venky Shankar, *Big Data and Analytics in Retailing*, 11 NIM MKTG. INTEL. REV., no. 1, 2019, at 37, 40.

101 Serina Chang et al., *Mobility Network Models of COVID-19 Explain Inequities and Inform Reopening*, 589 NATURE 82, 86 (2021).

Professor Elizabeth Joh has chronicled, law enforcement authorities are using big data and predictive analytics to forecast when and where crime will occur.[102] Such predictions allow officials to optimize the allocation of law enforcement resources to various geographic areas. Notably, however, such technology may enable government overreaching that imposes unaccounted-for harms on third parties.[103]

In particular, predictive policing based on big data may violate Fourth Amendment safeguards against unreasonable searches and seizures. While standard investigative detentions require at least reasonable suspicion based on a totality of the circumstances,[104] it is unclear if predictive analysis from big data can support such determinations.[105] Furthermore, as Professor Joh argues, predictive policing systems can perpetuate bias: "[R]eliance on arrest rates is surely problematic because arrests themselves are discretionary decisions that, if used as the basis to justify more attention, may simply reinforce unjustified police stereotypes that certain neighborhoods need heavier police attention."[106] Additionally, in borderline cases, police officers may over-rely on prediction models based on the perceived objectivity of the algorithms.[107] In short, predictive policing technology can generate negative externalities in the form of biased and excessive arrests.[108]

Predictive policing technology, which generates negative externalities, is patented. One of these patents is U.S. Patent No. 8,949,164 B1, which covers a "predictive policing system" that uses a crime prediction server, historical crime data, and crime forecasting algorithm to forecast crimes for at least one geographic region.[109] Notably, this patented system incorporates the "broken windows" theory of policing. This theory holds that "untended" behavior, such as broken windows and broken-down cars, can undermine community controls.[110] (The predictive policing system literally prompts police

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102 Joh, *supra* note 99, at 35.

103 *Id.* at 38.

104 *Id.* at 56.

105 *Id.*

106 *Id.* at 58.

107 *Id.* at 58–59.

108 While this analysis focuses on negative externalities from government use of big data, private entities can also impose negative externalities. PredPol is a private company that provides predictive policing software, and its interests may diverge from those of a public police department. *Id.* at 66.

109 U.S. Patent No. 8,949,164 B1 (issued Feb. 3, 2015).

110 *Id.* at col. 13 ln. 65 to col. 14 ln. 2. *See generally* George L. Kelling & James Q. Wilson, *Broken Windows: The Police and Neighborhood Safety*, ATLANTIC, Mar. 1982, at 29, 31.

officers to "scan for broken glass.")[111] This inclusion is troubling in light of recent research debunking the broken windows theory and linking it to increased incidences of stop and frisk, racial profiling, and police misconduct.[112] The patent discusses several benefits of the invention, which can help reduce crime and improve the allocation of law enforcement resources.[113] At no point, however, does the patent mention the potential harms of this technology, such as the possibility of biased predictions of criminal activity, or offer any correctives. As with the other patented technologies profiled here, inventors benefit from highly valuable exclusive rights, but they are not accountable (in the patent system) for the harms their inventions impose on third parties.

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In sum, technologies generate significant negative externalities. More importantly, patented inventions—which enjoy government-granted exclusive rights—also generate significant negative externalities.[114]

Of course, it is exceedingly difficult to identify and measure the full scope of externalities associated with any invention.[115] While some externalities are obvious, others are quite attenuated from a particular

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111 164 B1 Patent col. 10 ln. 9–16.

112 Daniel T. O'Brien, Chelsea Farrell & Brandon C. Welsh, *Looking Through Broken Windows: The Impact of Neighborhood Disorder on Aggression and Fear of Crime Is an Artifact of Research Design*, 2 ANN. REV. CRIMINOLOGY 53 (2019); Shankar Vedantam et al., *How a Theory of Crime and Policing Was Born, and Went Terribly Wrong*, NPR (Nov. 1, 2016, 12:00 AM), https://www.npr.org/2016/11/01/500104506/broken-windows-policing-and-the-origins-of-stop-and-frisk-and-how-it-went-wrong [https://perma.cc/BT7A-2D3A].

113 164 B1 Patent col. 1 ln. 29–35; *see also id.* at col. 15 ln. 20–22 ("It will be appreciated that the predpol system provides a real time, cloud-based, SaaS, crime prediction process with specific actionable intelligence.").

114 This Article makes no assertions regarding the degree to which patents are necessary to stimulate the invention of filter bubbles, autonomous vehicles, predictive policing systems, and other technologies that generate significant negative externalities. The importance of patents relative to other incentives for invention—such as first-mover advantage—is likely to vary considerably by technological field and context. However, regardless of the role of patents in stimulating the invention of these technologies, firms routinely patent them.

115 *See* Frischmann & Lemley, *supra* note 8, at 258–60 (noting that spillovers are ubiquitous and describing several examples); Lemley, *Property*, *supra* note 35, at 1049; *cf.* Laffont, *supra* note 25, at 112 (noting that abstract concepts such as malevolence and benevolence are externalities). Economists have had some success quantifying positive externalities. *See supra* notes 53–55 and accompanying text. As such, this brief discussion will focus on the challenges of quantifying negative externalities.

invention. At this level, characterizing an effect as a negative externality is a policy judgment akin to the notion of proximate causation in tort law. Depending on one's judgment, the negative externalities of Facebook may include work hours lost to procrastination, harms to political discourse, and widespread feelings of ennui from seeing one's Facebook friends lead seemingly glamorous lives. Additionally, characterizing negative externalities can be highly context specific and subjective. Video games and the consoles that play them are certainly economically significant technologies. But are billions of person-hours spent playing video games wasting time and desensitizing people to violence, or do they provide beneficial amusement, excitement, and education?[116] Finally, as should be clear, even if one can properly identify negative externalities, it is very difficult to quantify them in any practical way. It seems doubtful that one could translate the harm from ideological polarization into a dollar amount for purposes of imposing a Pigouvian tax on Facebook's patented filter bubble technology.[117]

Yet just because externalities are hard to identify and measure does not mean they do not exist. Nor does it mean that policymakers should simply ignore them. The patent system represents a governmental system for promoting the invention and development of new technologies. In so doing, it rests upon a deep recognition of the significant benefits of technology, particularly its positive externalities. However, the patent system does not seem to recognize, or be capable of effectively remediating, the negative externalities of technology, a phenomenon that the next Part explores.

II. PATENT LAW'S EXTERNALITY ASYMMETRY: PATENTS INTERNALIZE POSITIVE EXTERNALITIES BUT NOT NEGATIVE EXTERNALITIES

We have seen that technological innovations generate both positive and negative externalities. Externalities are problematic because they can lead to inefficient resource allocation, and the classic prescription is to internalize them by ensuring that decisionmakers account for external benefits and costs when taking some action. Many

116 *Compare* Bruce D. Bartholow, Brad J. Bushman & Marc A. Sestir, *Chronic Violent Video Game Exposure and Desensitization to Violence: Behavioral and Event-Related Brain Potential Data*, 42 J. EXPERIMENTAL SOC. PSYCH. 532, 537 (2006), *with* Isabela Granic, Adam Lobel & Rutger C.M.E. Engels, *The Benefits of Playing Video Games*, 69 AM. PSYCH. 66, 66–67 (2013) (proposing several benefits of children playing video games).

117 A.C. PIGOU, THE ECONOMICS OF WELFARE 11 (4th ed. 1932) ("[T]he range of our inquiry becomes restricted to that part of social welfare that can be brought directly or indirectly into relation with the measuring-rod of money.").

technologies are patented, which raises the question of what role, if any, patents play in internalizing externalities. This Article finds a surprising result.

This Article argues that patents are asymmetric in their treatment of positive and negative innovation externalities. On the one hand, patents do much to internalize positive innovation externalities; indeed, this is their core function. On the other hand, patents do very little to internalize negative externalities arising from patented technologies. Put differently, the patent system allows patentees to capture a meaningful share of the external benefits of their inventions, but it plays almost no role in holding them accountable for their external costs. This Article refers to this imbalance as patent law's externality asymmetry. As we will see, this important and overlooked asymmetry impairs the efficient allocation of resources for innovation and undermines social welfare.[118] For the time being, however, this and the next Part will flesh out the contours of patent law's asymmetric internalization of positive and negative innovation externalities.

A. *Patents Exist to Internalize Positive Innovation Externalities*

The function of internalizing externalities is not foreign to patents; in fact, internalizing positive externalities is their reason for being. The classic justification for patents posits that the technical information at the heart of technology is a public good. This means that the information is both nonrival (one's consumption of the information does not diminish its availability) and nonexcludable (in the absence of legal protections, it is difficult to prevent others from accessing it).[119] As a public good, technical information is subject to undersupply in a fully competitive economy; noninnovating firms could simply copy the inventions of others, thus undermining incentives to invent. Patents

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118 *See infra* Part IV.

119 *See generally* Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, *in* THE RATE AND DIRECTION OF INVENTIVE ACTIVITY: ECONOMIC AND SOCIAL FACTORS 609, 614–16 (Nat'l Bureau of Econ. Rsch. ed., 1962) (noting the difficulties of preventing outside parties from appropriating information). Other work has challenged the public-good nature of information, highlighting how tacit technical information is naturally excludable. *See* Peter Lee, *Transcending the Tacit Dimension: Patents, Relationships, and Organizational Integration in Technology Transfer*, 100 CALIF. L. REV. 1503 (2012); Peter Lee, *Innovation and the Firm: A New Synthesis*, 70 STAN. L. REV. 1431 (2018). Nonetheless, the concepts that technical information is a public good and that patents are necessary to maintain incentives to invent are core to foundational patent theory.

allow inventors to exclude free riders, thus mitigating the public goods problem and maintaining incentives to invent.

Put differently, patents internalize positive innovation externalities. Assume that it costs Merck $2.6 billion to develop a new FDA-approved drug and bring it to market.[120] In the absence of patents, competing drug companies could simply copy Merck's drug for free. In this scenario, Merck's significant R&D expenditures would generate tremendous positive externalities for its competitors (as well as patients and society at large).[121] While positive externalities seem like a good thing, they can depress incentives to invent if the inventor does not capture a meaningful share of the benefits produced. If nearly the entire value of Merck's invention "spills over" to others (including competitors) as positive externalities, Merck would have little incentive to invest in R&D. Patents provide Merck and other inventors with a right to exclude others from practicing an invention for twenty years. As such, they allow inventors to internalize a significant share of the positive externalities of their inventions, thus shoring up incentives to invent.

Of course, patents are not the only mechanism for internalizing positive innovation externalities. Direct public funding, tax breaks, and prizes are among many policy levers that governments employ to enable innovators to capture a greater share of the positive externalities they generate.[122] However, patents are the primary legal mechanisms for promoting innovation, and they exist to internalize innovation spillovers.

Intellectual property scholars widely recognize that patents internalize positive externalities from technological development.[123] As

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120 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, 21 (2016). *But see* Aaron E. Carroll, *$2.6 Billion to Develop a Drug? New Estimate Makes Questionable Assumptions*, N.Y. TIMES: THE UPSHOT (Nov. 18, 2014), https://www.nytimes.com/2014/11/19/upshot/calculating-the-real-costs-of-developing-a-new-drug.html [https://perma.cc/A765-78UA] (critiquing the DiMasi et al. analysis).

121 Frischmann & Lemley, *supra* note 8, at 283.

122 *See generally* Daniel J. Hemel & Lisa Larrimore Ouellette, *Innovation Policy Pluralism*, 128 YALE L.J. 544 (2019) [hereinafter Hemel & Ouellette, *Pluralism*] (comparing various policy options for promoting innovation).

123 *See* DOUGLASS C. NORTH & ROBERT PAUL THOMAS, THE RISE OF THE WESTERN WORLD: A NEW ECONOMIC HISTORY 154–55 (1973) (describing patents as a mechanism for aligning private and social rates of return); Wendy J. Gordon, *Intellectual Property*, *in* THE OXFORD HANDBOOK OF LEGAL STUDIES 617, 622 (Peter Cane & Mark Tushnet eds., 2003) ("[M]ost of IP law is concerned with internalizing positive externalities . . . ."); Peter Lee, *Contracting to Preserve Open Science: Consideration-Based Regulation in Patent Law*, 58 EMORY L.J. 889, 906–07 (2009); Arti

we will see, even traditional property rights theorists like Harold Demsetz argued that patents enable inventors to internalize some of the external benefits of their inventions, thus bolstering incentives to invent.[124] Citing Demsetz, legal scholars Oren Bar-Gill and Gideon Parchomovsky state: "Patents, like other property rights, internalize the positive externalities flowing from inventions and allow the inventor to license the invention to third parties."[125]

Of course, the patent system neither aims for nor achieves *full* internalization of positive externalities. Legal scholars Brett Frischmann and Mark Lemley influentially argue that internalizing all spillovers by giving a patentee complete control over all uses of an invention would decrease, rather than increase, welfare.[126] Indeed, the patent system is designed to both internalize some positive externalities and produce others.[127] Patents facilitate information spillovers by requiring patentees to disclose their inventions.[128] Economist Giovanni Ramello even argues that "the existence of information externalities is the statutory goal of intellectual property."[129] Furthermore, patents generate temporal spillovers through providing widespread access to an invention after a patent expires.[130] Returning to the example of Merck,

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Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 116–17 (1999) (noting that R&D expenditures, which generate significant positive externalities, may be substantially lessened without patents); Amy Kapczynski & Talha Syed, *The Continuum of Excludability and the Limits of Patents*, 122 YALE L.J. 1900, 1913 n.40 (2013); FED. TRADE COMM'N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY ch. 2, at 5 (2003); Hrdy, *supra* note 11, at 331 ("A primary reason government creates intellectual property rights is to help innovators internalize the uncompensated benefits their innovations generate for others (called positive externalities or spillovers), so that innovators will innovate more than they otherwise would and get society closer to the optimal level of innovation."); Sun & Daniels, *supra* note 7, at 152 ("Indeed, many patent scholars have observed that the notion of 'positive externalities' has dominated the discourse about intellectual property rights . . . .").

124 Demsetz, *Property Rights*, *supra* note 13, at 359 ("If a new idea is freely appropriable by all, if there exist communal rights to new ideas, incentives for developing such ideas will be lacking. The benefits derivable from these ideas will not be concentrated on their originators. If we extend some degree of private rights to the originators, these ideas will come forth at a more rapid pace.").

125 Oren Bar-Gill & Gideon Parchomovsky, *The Value of Giving Away Secrets*, 89 VA. L. REV. 1857, 1866–67 (2003).

126 Frischmann & Lemley, *supra* note 8, at 292–93.

127 In this regard, the patent system operates similarly to the copyright system. *See* Frischmann, *Demsetzian*, *supra* note 35, at 653, 659–60.

128 Frischmann & Lemley, *supra* note 8, at 291.

129 Giovanni B. Ramello, *Property Rights, Firm Boundaries, and the Republic of Science—a Note on Ashish Arora and Robert Merges*, 14 INDUS. & CORP. CHANGE 1195, 1197 (2005); *accord* Lemley, *Property*, *supra* note 35, at 1052.

130 Frischmann & Lemley, *supra* note 8, at 291.

after its patent expires, spillovers increase substantially as generic competition drives down the price of a formerly patented drug.[131]

That being said, internalizing positive externalities remains the core function of patents. While the patent system does not aim to internalize all positive innovation externalities, it must allow inventors to internalize a meaningful share of spillovers to maintain incentives to invent.

B. *Patents Do Little to Internalize Negative Innovation Externalities*

Given that patents exist to internalize positive externalities from innovation, it is important to consider their role in internalizing associated negative externalities as well. Here, this Article reveals a striking asymmetry. Patents do very little to internalize technology's harmful effects on third parties. Patents operate as a one-way ratchet wherein inventors capture some of the external benefits of their inventions but are insulated from their external costs. In minimal and indirect ways, patents can help to internalize or prevent negative innovation externalities. However, their treatment of such negative externalities is a far cry from how they directly internalize positive externalities.

Patented technologies such as Facebook's filter bubble, autonomous driving innovations, and predictive policing systems generate negative externalities, but patents do very little to internalize them. Patentees of these technologies can profit from practicing these inventions, licensing them to other parties, or suing unauthorized users for infringement. The sweep of patent rights is so broad that Facebook can sue someone for infringement even if Facebook does not practice its invention and even if the infringer did not copy Facebook's technology. However, if Facebook's filter bubble degrades political discourse for millions, patents play no role in internalizing this negative externality. The same is true for patented autonomous vehicle innovations, predictive policing systems, and millions of other proprietary technologies.

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131 Ernst R. Berndt & Murray L. Aitken, *Brand Loyalty, Generic Entry and Price Competition in Pharmaceuticals in the Quarter Century After the 1984 Waxman-Hatch Legislation*, 18 INT'L J. ECON. BUS. 177 (2011) (reporting that within six months after launching, a generic drug is typically available at a twenty percent discount relative to the branded drug); *Generic Drug Facts*, U.S. FOOD & DRUG ADMIN., http://www.fda.gov/Drugs/ResourcesForYou/Consumers/BuyingUsingMedicineSafely/UnderstandingGenericDrugs/ucm167991.htm [https://perma.cc/S24C-NXVP] (stating that in the long run, generics sell for about an 80–85% discount relative to the original patented drug).

At this point, it is helpful to address the potential objection that merely inventing and patenting an invention does not create negative externalities, so it would be inapposite for the patent system to do anything to internalize such externalities. According to this objection, negative externalities only arise from *using* a technology. Under this view, unlike the factory spewing pollution, simply inventing and patenting a new technology does not harm anyone. Notably, this is the flip side of the economic argument that mere invention itself does not produce social benefit; what matters for social benefit is innovation—the act of putting an invention into practice.[132] This line of reasoning would contend that any negative externalities from technology—such as political polarization, job losses, or unreasonable searches and seizures—only arise when an invention is *practiced* rather than simply invented. Put differently, the inventor who patents a predictive policing system does not harm others; the police department that *uses* that system to violate constitutional rights harms others. In this light, because merely inventing a technology does not create external costs, it would be inapposite to expect the patent system to internalize those costs.

However, this argument is misplaced for several reasons. To begin, many inventors patent their technologies and practice them, thus "directly" causing negative externalities. This is the case, for instance, with filter bubble technology, which Facebook developed, patented, and then deployed on its network.

More importantly, the patent system is entirely predicated on allowing inventors to internalize positive externalities from real-world *use* of their inventions based simply on what their patent disclosures potentially *enable*. Under the patent quid pro quo, patentees need only provide an enabling disclosure of their technology, yet they get exclusive rights over all physical *uses* of that technology.[133] A patentee does not need to practice an invention to assert exclusive rights against other parties. Furthermore, a patentee does not even have to *actually* enable another party's use of an invention to sue for infringement; independent inventors who did not copy (or even know about) a

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132 JOSEPH A. SCHUMPETER, BUSINESS CYCLES: A THEORETICAL, HISTORICAL AND STATISTICAL ANALYSIS OF THE CAPITALIST PROCESS 84 (1939). This formulation seems incorrect, however, in light of valuable information spillovers from the act of invention, regardless of innovation.

133 35 U.S.C. § 271(a) ("Except as otherwise provided in this title, whoever without authority makes, uses, offers to sell, or sells any patented invention, within the United States or imports into the United States any patented invention during the term of the patent therefor, infringes the patent.").

patented invention are still liable for infringement.[134] Furthermore, patentees have exclusive rights over uses of their technologies that they could not even foresee, as long as those uses fall within the scope of their claims.[135] In essence, the sweep of exclusive rights encompasses not only what patentees actually enable, but what they potentially enable. It may seem unfair to hold a patentee accountable when an unrelated entity utilizes a patented technology in a way that harms third parties. By this token, it may seem unfair to provide the patentee with a share of the upside when an independent inventor utilizes a patented technology in a way that benefits third parties. Indeed, some have argued for limiting patent infringement liability to instances of direct copying.[136] Within the current framework, however, merely obtaining a patent gives a patentee a claim on third-party benefits from real-world use of an invention. As such, it would appear consistent to also hold a patentee accountable for some third-party costs based on real-world use of that invention.

It is also helpful to briefly address the objection that the patent system aims to promote technological progress, so it *should not* internalize negative innovation externalities. After all, doing so would chill inventive activity. This Article addresses this objection more fully below,[137] but for now it is sufficient to say that this argument misunderstands the objectives of the patent system. While the patent system seeks to promote technological progress, it does not aim to do so at all costs. Rather, it aims to maximize efficiency in the allocation of resources for innovation. Maximizing efficiency, moreover, must entail considering costs as well as benefits, including positive and negative externalities.

In some minimal and indirect ways, patent law can internalize negative externalities (or prevent them from arising in the first place). First, the patent system has applied certain requirements of patentability to deny patents on "immoral" inventions, which presumably have significant potential to create negative externalities. For example, historically the patent office and courts applied the

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134 Christopher A. Cotropia & Mark A. Lemley, *Copying in Patent Law*, 87 N.C. L. REV. 1421, 1424 (2009) ("[A] surprisingly small percentage of patent cases involve even allegations of copying, much less proof of copying.").

135 *See* Henry E. Smith, *Intellectual Property as Property: Delineating Entitlements in Information*, 116 YALE L.J. 1742, 1796 (2007) [hereinafter Smith, *Intellectual Property*] ("Importantly, the patent holder controls even uses that she did not foresee or disclose at the time of the application, and this has been one of the most controversial aspects of patent law.").

136 *See, e.g.*, Samson Vermont, *Independent Invention as a Defense to Patent Infringement*, 105 MICH. L. REV. 475, 479–80 (2006).

137 *See infra* Section IV.A.

doctrine of moral utility to deny patents on inventions that contravened public morals.[138] Under this doctrine, "a new invention to poison people, or to promote debauchery, or to facilitate private assassination" would fail the moral utility doctrine and not receive a patent.[139] However, the moral utility doctrine has largely fallen into desuetude because of institutional competence limitations: the Patent and Trademark Office (PTO) and courts are not arbiters of public morality.[140] While it had some historical bite, the moral utility doctrine does little these days to deny patents on so-called "immoral" inventions and reduce associated negative externalities.

Another requirement of patentability—patentable subject matter—also does little to reduce negative externalities. An invention must satisfy the threshold requirement of patentable subject matter in order to be eligible for patenting.[141] On rare occasions, patent authorities have excluded certain classes of inventions from patentable subject matter, ostensibly on moral grounds. For instance, in the late 1990s, the PTO denied a patent application claiming human-animal chimeras.[142] While it stated that this invention did not constitute patentable subject matter, lurking in the background were moral concerns over this technology. Unease about cloning technology and patenting humans led to a statutory carveout in the 2011 America Invents Act establishing that claims directed to or encompassing a human organism are not patentable subject matter.[143] While restrictions on patent eligibility could, in theory, deny patents on immoral inventions likely to generate high negative externalities, such exclusions are quite limited. Moral concerns play a very small role in narrowing patent eligibility in U.S. patent law, particularly compared to other jurisdictions.[144]

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138 *See* Lowell v. Lewis, 15 F. Cas. 1018, 1019 (C.C.D. Mass. 1817) (No. 8568) ("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. The word 'useful,' therefore, is incorporated into the act in contradistinction to mischievous or immoral.").

139 *Id. See generally* Laura A. Keay, *Morality's Move Within U.S. Patent Law: From Moral Utility to Subject Matter*, 40 AIPLA Q.J. 409 (2012).

140 Juicy Whip, Inc. v. Orange Bang, Inc., 185 F.3d 1364, 1368 (Fed. Cir. 1999); *see* Keay, *supra* note 139, at 415–16. Indeed, evolving norms now suggest that the deceptive nature of some inventions actually helps establish their utility for purposes of obtaining a patent. *Juicy Whip*, 185 F.3d at 1367.

141 35 U.S.C. § 101.

142 *Patent Application Is Disallowed as "Embracing" Human Being*, 58 PAT. TRADEMARK & COPYRIGHT J. (BL) (1999).

143 Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 33(a), 125 Stat. 284, 340 (2011).

144 Margo A. Bagley, *Patent First, Ask Questions Later: Morality and Biotechnology in Patent Law*, 45 WM. & MARY L. REV. 469, 479–80 (2003).

Second, in an indirect way, the patent system can reduce negative externalities by constraining the dissemination of harmful or undesirable inventions. While patents aim to promote invention, observers have long recognized that too much patent protection can have the opposite effect.[145] Innovations are often subject to multiple, overlapping patents, and the need to clear all of these exclusive rights may be prohibitively expensive. Scholars have extensively explored the innovation-dampening effects of so-called "anticommons" and "patent thickets."[146] In a provocative article, Professors Chris Cotropia and Jim Gibson argue that the ability of patents to *inhibit* innovation can have some unexpected benefits.[147] In particular, patents can impede innovation and dissemination of technologies in harmful industries. As a descriptive matter, however, several of the industries that Cotropia and Gibson examine, such as biotechnology, seem to be thriving quite well with robust patent protection. Additionally, as a normative matter, it is far from clear that industries like biotechnology are ones that we would want to suppress, a point that the authors recognize.[148] Cotropia and Gibson offer a valuable insight that policymakers can use patents to restrain innovation in undesirable areas. However, as presently constituted, the patent system does not do much in this regard in any targeted fashion.

In sum, while patents exist to internalize positive externalities associated with technology, they do very little to internalize negative externalities. This is particularly surprising in light of influential economic theory contending that property rights play an important role in internalizing both kinds of externalities, a topic that the next Part examines.

III. EXPLORING PATENT LAW'S EXTERNALITY ASYMMETRY: COMPARING

145 *See* Lab'y Corp. of Am. Holdings v. Metabolite Laboratories, Inc., 548 U.S. 124, 126 (2006) (Breyer, J., dissenting from the denial of certiorari) ("[S]ometimes *too much* patent protection can impede rather than 'promote the Progress of Science and useful Arts' . . . ." (quoting U.S. CONST. art. 1, § 8, cl. 8)).

146 *See, e.g.*, Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, *in* 1 INNOVATION POLICY AND THE ECONOMY 119 (Adam B. Jaffe, Josh Lerner & Scott Stern eds., 2001); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCIENCE 698 (1998).

147 Christopher A. Cotropia & James Gibson, *The Upside of Intellectual Property's Downside*, 57 UCLA L. REV. 921, 923 (2010).

148 *Id.* at 924.

PHYSICAL PROPERTY RIGHTS AND PATENTS

To gain greater insight into how patents govern cutting-edge technologies, this Part turns to a classic legal regime: property rights in land. Comparing patents to physical property rights reveals that patent law is quite singular in internalizing positive externalities while doing relatively little to internalize negative externalities. Foundational economic theory suggests that property rights arise for the precise purpose of internalizing externalities. Like patents, physical property rights allow resource owners to internalize *positive* externalities from productive activity, thus encouraging such activity. Physical property rights are symmetrical in that they also internalize negative externalities in several ways: they mitigate tragedies of the commons, facilitate efficiency-maximizing negotiations between property owners and those affected by their actions, and impose duties on property owners to limit harms to others. As this Part will show, however, these mechanisms largely do not apply to patents. This juxtaposition casts into sharper relief the unique incapacity of patents to internalize negative externalities.

In comparing patents and physical property rights, this Article takes no position in the long-running debate over whether intellectual property is property.[149] Rather, it advances the uncontroversial view that these bodies of law are similar in some ways but different in others. On the one hand, both patents and property rights in land confer exclusive rights. On the other hand, the subject matter of patents is nonrival, which clearly differs from the rivalrous subject matter of physical property rights.[150] Furthermore, this Article reveals another overlooked difference: while physical property rights symmetrically internalize positive and negative externalities, patents asymmetrically internalize only positive externalities.

In response to those who would question the value of comparing patents and physical property rights, this Article offers three reasons.

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149 *See, e.g.*, James Bessen & Michael J. Meurer, *Of Patents and Property*, 31 REGULATION, Winter 2008–2009, at 18, 18 (2009) ("Scholars hotly debate whether intellectual property is truly property and which lessons learned about property rights in land should be applied to property rights in inventions and other intellectual property."); Smith, *Intellectual Property*, *supra* note 135, at 1744 ("At the core of controversies over the correct scope of intellectual property lie grave doubts about whether intellectual property *is* property."). One notable flashpoint in this long-running debate was a back-and-forth between Professors Mark Lemley and John Duffy. *See* Lemley, *Property*, *supra* note 35, at 1032; Duffy, *supra* note 19, at 1077–78; Lemley, *What's Different*, *supra* note 22, at 1098–99.

150 *See, e.g.*, Mark A. Lemley, *Ex Ante Versus Ex Post Justifications for Intellectual Property*, 71 U. CHI. L. REV. 129, 141–45 (2004).

First, foundational economic theory holds that property rights (which at least nominally include patents)[151] serve to internalize externalities.[152] Second, the most influential expositor of this economic theory specifically argued that patents internalize externalities just like property rights in land (though this Article argues to the contrary).[153] Third, even if one believes that patents and physical property rights are completely unrelated, comparing these two regulatory regimes reveals idiosyncratic features of patents (and physical property rights) that scholars and policymakers have largely overlooked.

Where excessive externalities are a problem, law is often the solution.[154] Many bodies of law can be understood as mechanisms to internalize externalities.[155] Environmental regulation forces polluters to at least partially internalize the harms they impose on third parties. Tort law imposes liability on negligent actors who injure others.[156] Tax law is a major mechanism for internalizing externalities. So-called Pigouvian

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151 *See, e.g.*, Densmore v. Scofield, 102 U.S. 375, 378 (1880) ("Patents rightfully issued are property, and are surrounded by the same rights and sanctions which attend all other property."); Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 730 (2002) ("[The patent] monopoly is a property right; and like any property right, its boundaries should be clear."); eBay Inc. v. MercExchange, L.L.C., 547 U.S. 388, 392 (2006) ("Like a patent owner, a copyright holder possesses 'the right to exclude others from using his property.'" (citation omitted)); JAMES BESSEN & MICHAEL J. MEURER, PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATORS AT RISK 30 (2008) ("[T]he economics of property has valuable lessons for the economics of patents . . . ."); Frank H. Easterbrook, *Intellectual Property Is Still Property*, 13 HARV. J.L. & PUB. POL'Y 108, 109 (1990) ("Patents give a right to exclude, just as the law of trespass does with real property."); F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. REV. 697, 703 (2001) (arguing in favor of a property rights conception of patents); ROBERT PATRICK MERGES & JOHN FITZGERALD DUFFY, PATENT LAW AND POLICY 56 (7th ed. 2017) ("Patents are considered property rights precisely because they confer this right [to exclude]."); Adam Mossoff, *Exclusion and Exclusive Use in Patent Law*, 22 HARV. J.L. & TECH. 321, 325 (2009) (arguing that the conception of patents as conferring a right to exclude reflects legal realists' tangible property theory); Smith, *Intellectual Property*, *supra* note 135, at 1745, 1756–57 (describing similarities between real and intellectual property); *see also* Lemley, *Property*, *supra* note 35, at 1035 n.8 (collecting sources).

152 Demsetz, *Property Rights*, *supra* note 13, at 359.

153 *Id.* Elsewhere, Demsetz also maintained that property rights are more efficient than government funding as mechanisms to produce inventions due to the advantages of property rights and market transactions in allocating resources for invention. *See* Harold Demsetz, *Information and Efficiency: Another Viewpoint*, 12 J.L. & ECON. 1, 12–14 (1969) [hereinafter Demsetz, *Information and Efficiency*]; *see also* Amy Kapczynski, *The Cost of Price: Why and How to Get Beyond Intellectual Property Internalism*, 59 UCLA L. REV. 970, 982–83 (2012) (describing Demsetz's arguments in favor of property rights in information).

154 *See* Sun & Daniels, *supra* note 7, at 136 n.1 (noting numerous examples); Lemley, *Property*, *supra* note 35, at 1038 (listing several examples from property law).

155 Frischmann & Lemley, *supra* note 8, at 300 ("Many laws, and perhaps even bodies of law, can be understood as attempts to internalize externalities.").

156 *See* Sun & Daniels, *supra* note 7, at 176–77.

taxes levy taxes on activities and substances that adversely affect others, from pollution to sugary drinks.[157]

Among all legal fields, property rights play a particularly prominent role in internalizing externalities.[158] Indeed, as influential economist Harold Demsetz famously stated, "[P]roperty rights develop to internalize externalities when the gains of internalization become larger than the cost of internalization."[159] For Demsetz, property rights emerge precisely when new or increased externalities emerge, thus rendering the benefits of internalizing some externalities worth the costs, including the costs of delineating and enforcing property rights.[160]

A. *How Physical Property Rights Internalize Positive Externalities*

Physical property rights play an important role in internalizing positive externalities. This comparison reveals deep parallels with patent law, which, as we have seen, performs this function as well.[161] Examples of property rights internalizing spillovers are numerous. In the absence of property rights in land, a farmer's cultivation of crops would generate enormous positive externalities for others. Given that the farmer lacked a right to exclude, strangers could simply walk onto "her" land and take those crops for free. Exploitation of such positive externalities, a classic case of free riding, would significantly decrease

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157 *See* Laffont, *supra* note 25, at 114; Miranda Perry Fleischer & Daniel Hemel, *Atlas Nods: The Libertarian Case for a Basic Income*, 2017 WIS. L. REV. 1189, 1232 (discussing Pigouvian taxes on pollution); Lisa Aliferis, *Berkeley Decides to Try Taxing Away Its Soda Habit*, NPR (Nov. 5, 2014, 10:40 AM), https://www.npr.org/blogs/health/2014/11/05/361730578/berkeley-decides-to-try-taxing-away-its-soda-habit [https://perma.cc/YLE3-JAET] (discussing Berkeley's tax on sugar-added drinks). As the inverse of corrective taxes, Pigou also suggested corrective bounties (or subsidies) when positive externalities create a gap between private and social value. Holcombe & Sobel, *supra* note 29, at 308.

158 Demsetz, *Property Rights*, *supra* note 13, at 347; Frischmann & Lemley, *supra* note 8, at 264–65 ("At least since Harold Demsetz's seminal article, *Toward a Theory of Property Rights*, law and economics scholars have thought about private property rights as a means of encouraging both efficient allocation of private investment into the creation of resources and efficient management of resources.").

159 Demsetz, *Property Rights*, *supra* note 13, at 350.

160 *Id.*; *see* Duffy, *supra* note 19, at 1077 ("Demsetz's theory views external harms and benefits as always providing a potential justification (subject to cost considerations) for the extension of property rights . . . ."); Smith, *Intellectual Property*, *supra* note 135, 1749–50 ("[A]s a resource becomes more valuable and externalities become worse, we expect property rights to emerge."); Frischmann, *Demsetzian*, *supra* note 35, at 650 (distinguishing Demsetz's descriptive claim—that property rights arise to internalize externalities as resource values increase and internalization costs decrease—from his normative claim that this is a desirable phenomenon).

161 *See supra* Section II.A.

the farmer's incentive to cultivate crops.[162] Property rights in land allow farmers to exclude such free riders, allowing them to literally reap what they sow.

Demsetz used a similar example to illustrate how property rights internalized externalities among Indigenous Canadians of the Labrador Peninsula.[163] Originally, Indigenous Canadians were unconstrained in where they could hunt game. With the emergence of the fur trade, the value of fur increased substantially, and some individuals began investing time and effort in raising game. Given the increased value of furs, such cultivation generated a significant positive externality for others, particularly for poachers who could take the game for free. As Demsetz argued, the rise in the value of fur led to the recognition of private property rights in land. It became worthwhile for Indigenous Canadians to assert a right to exclude poachers from their land, thus internalizing the spillovers from husbandry (and, relatedly, decreasing negative externalities from poaching).[164] Here again, private property rights allowed people to reap what they sowed, thus maintaining incentives to engage in productive activity. In this respect, physical property rights clearly parallel patents, which also confer exclusive rights to prevent free riding and maintain incentives to invent.

B. *How Physical Property Rights Internalize Negative Externalities*

In addition to internalizing positive externalities from land use, physical property rights internalize negative externalities in several ways. In so doing, they diverge from patents, which are largely ineffectual in internalizing the negative externalities of technological innovation. While physical property rights do not internalize all negative externalities, they mitigate externalities associated with the tragedy of the commons, facilitate transactions whereby parties can negotiate efficient resource allocations, and create duties for property owners to limit harms to others.

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162 *See* Lemley, *What's Different*, *supra* note 22, at 1098 ("[Real property rights] allow their owners to invest in improving or developing the property.").

163 Demsetz, *Property Rights*, *supra* note 13, at 351.

164 *Id.* at 351–53. As noted, depending on how a baseline is defined, a situation involving a perceived positive externality could be described as involving a perceived negative externality. *See supra* notes 18–20 and accompanying text. Demsetz's account of the emergence of property rights could be understood as internalizing positive externalities associated with cultivating game. However, it could also be understood as property rights emerging to internalize the negative externalities of poaching.

1. Mitigating Overuse in the Tragedy of the Commons

First, property rights reduce negative externalities associated with the tragedy of the commons.[165] Consider a fishing pond open to all members of a community. Each person's fishing imposes a negative externality on other community members, as it leaves fewer fish for everyone else. Furthermore, in the absence of property rights, everyone has an incentive to fish as much and as fast as possible. The result is overconsumption and depletion of resources, a phenomenon Garrett Hardin famously described as the tragedy of the commons.[166] Property rights are a means to internalize negative externalities and mitigate this tragedy. One option would be to grant one party property rights to the pond. That individual could rationalize the consumption of fish either directly or through licensing other parties. Another option, more suited to industrial fishing, would be to allocate private harvesting rights to commercial fishing operations as a fraction of some "total allowable catch."[167] In both approaches, property rights help parties conserve resources and reduce the negative effects of their behavior on others.

Notably, property rights reduce negative externalities not only across parties but also across time. In a communal fishery, each person's fishing creates a negative externality for others. Additionally, given the incentive to fish as rapidly as possible, such actions also impose a negative externality on future generations, whose fish supply will be depleted. Private property rights internalize this temporal negative externality as well. If an individual owns a productive resource like a fishery or farm, she has greater incentive to conserve it so that it does not deplete over time. As Demsetz observed, "[A]n owner of a private right to use land acts as a broker whose wealth depends on how well he takes into account the competing claims of the present and the future."[168]

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165 *See* Lemley, *Property*, *supra* note 35, at 1037 ("The tragedy of the commons is a specific example of the more general preoccupation of the economic literature on real property with the internalization of externalities and with the use of property law to achieve that end.").

166 Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968). However, not all communal ownership is tragic. As Elinor Ostrom and others have documented, numerous commons-based property schemes have managed resources effectively for generations. *See generally* ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION (2015).

167 R. Quentin Grafton, Dale Squires & Kevin J. Fox, *Private Property and Economic Efficiency: A Study of a Common-Pool Resource*, 43 J.L. & ECON. 679, 684 (2000).

168 Demsetz, *Property Rights*, *supra* note 13, at 355. Additionally, property doctrine also establishes duties that internalize negative externalities over time. For example, the doctrine of

2. Lowering Transaction Costs and Promoting Efficiency-Enhancing Negotiations

Second, property rights lower transaction costs between decisionmakers and affected parties, enabling voluntary negotiations to internalize externalities. While introducing private property rights internalizes some externalities, many others still persist. Granting an individual property rights over a parcel of land will encourage her to cultivate it judiciously to maximize its private value.[169] In doing so, however, she may still impose negative externalities on her neighbors. For instance, a private landowner may store water on her land by damming a river, thus creating a negative externality for a downstream party who now has less access to water.[170] Here, property rights help internalize externalities by facilitating voluntary transactions between landowners and parties affected by their decisions. If the social returns to free-flowing water outweigh the private returns of a dam, the downstream party could pay the upstream landowner to not erect the dam, thus mitigating this externality and achieving a socially efficient allocation of resources. Through voluntary transactions, a decisionmaker can take into account an effect that would otherwise be an unaccounted-for externality. By assigning ownership over a resource, property rights enable such transactions between a party who controls that resource and those affected by it. In this example, if the upstream land were held in a commons rather than subject to individual property rights, negotiations to prevent building an upstream dam would be much more complicated.[171]

As Demsetz recognized, the role of property rights in facilitating transactions and internalizing externalities represents an application of

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waste prohibits a present possessory interest holder from unreasonably interfering with the expectations of a future interest holder. JESSE DUKEMINIER, JAMES E. KRIER, GREGORY S. ALEXANDER, MICHAEL H. SCHILL & LIOR JACOB STRAHILEVITZ, PROPERTY 280–82 (9th ed. 2018). Sequential ownership of property allows a present possessory interest holder to impose negative externalities on a future interest holder. For example, a life tenant has an incentive to consume all the valuable resources on a parcel of land during his life, thus undermining the expectations of a remainderman. The doctrine of waste, however, imposes liability on the present possessory interest holder for such activity. In so doing, the property doctrine promotes conservation of resources and internalizes negative externalities over time.

169 Demsetz, *Property Rights*, *supra* note 13, at 356 ("This concentration of benefits and costs on owners creates incentives to utilize resources more efficiently.").

170 *Id.*

171 *Id.* at 354–57.

the Coase theorem.[172] As conventionally understood, the Coase theorem posits that in the absence of transaction costs, parties will negotiate to achieve efficient allocations of resources.[173] Imagine someone operated a pig pen that annoyed his neighbors. If the private returns of the pig pen were less than the social returns, the neighbors could raise enough money to "buy off" the pig pen owner and cease the offending activity. In such a situation, voluntary negotiations would lead to the socially efficient result that internalized the negative externality.[174] In other words, without transaction costs, parties will negotiate to achieve an efficient allocation of resources regardless of the initial assignment of entitlements.[175] In the real world, of course, transaction costs are not zero. However, as Demsetz describes, property rights reduce transaction costs by allocating control over particular resources to specific owners. In the absence of clearly defined rights of control, bargaining to internalize externalities would be much more difficult and, in some cases, impossible. Property rights lower transaction costs, and "allowing transactions increases the degree to which internalization takes place."[176]

3. Establishing Duties to Limit Harms to Others

Third, moving beyond the areas on which Demsetz focused, physical property rights also internalize externalities directly by establishing duties on landowners to limit harms to others. This function is best illustrated by the doctrine of nuisance.[177] The guiding

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172 *Id.* at 349 (situating the role of property rights in lowering transaction costs within Coase's framework).

173 Coase, *supra* note 17, at 6. I am here referring to the Coase theorem as it has been widely adopted in legal and economic scholarship. As commentators point out, however, "Coase had little faith in the toy model of a zero transaction cost world; he did not champion property rights or any particular social arrangement over any other." Brett M. Frischmann & Alain Marciano, *Understanding* The Problem of Social Cost, 11 J. INST'L ECON. 329, 348 (2014).

174 *See* Gideon Parchomovsky & Peter Siegelman, *Selling Mayberry: Communities and Individuals in Law and Economics*, 92 CALIF. L. REV. 75, 79–80 (2004) ("Since publication of Ronald Coase's classic article *The Problem of Social Cost*, economists have identified high transaction costs as the key barrier to the efficient internalization of externalities such as pollution."). It should be noted that a socially efficient allocation of resources may not necessarily be equitable from a distributive perspective.

175 Coase, *supra* note 17, at 6, 15.

176 Demsetz, *Property Rights*, *supra* note 13, at 348.

177 Traditional Blackstonian conceptions of property rights identify their "core" as the right to exclude. Smith, *Intellectual Property*, *supra* note 135, at 1746. It is this function of property

principle of nuisance law is "*sic utere tuo ut alienum non laedas*," or "one should use one's own property in such a way as not to injure the property of another."[178] Nuisance law reflects the principle that property rights confer not only the right to exclude but also the duty to refrain from unreasonably interfering with the property rights of others.[179] Nuisance law has significant implications for internalizing negative externalities, particularly in the environmental context. For example, it can enjoin the operation of an oil refinery that emits nauseating fumes and odors, thus internalizing this externality.[180]

The externality-internalizing function of nuisance law has particular traction given the ubiquity of property rights in land. As Coase noted, just as it takes two to tango, it also takes two to have a nuisance: one party to engage in behavior and another to be bothered by it.[181] Thus, both the factory belching smoke and the neighbor bothered by it are "but-for" causes of a nuisance. Due to the reciprocal nature of nuisance, one only has duties to another property owner if there is another property owner to be bothered. This insight foregrounds another aspect of property rights that is highly relevant to internalizing externalities: property rights are everywhere, and just about everyone has a neighbor. Almost all land is owned by someone, and all property owners (in jurisdictions recognizing nuisance) have a right to enjoy their property free from unreasonable interference. Indeed, real property is famously difficult to abandon, partly to prevent people from avoiding the duties of landownership.[182] The ubiquity of property rights supports a pervasive system of internalizing externalities. The world is literally covered with rights to not be unreasonably bothered by one's neighbors.

Physical property rights internalize negative externalities in other ways as well. Under the traditional English rule of absolute ownership of groundwater, anyone owning land above an aquifer could withdraw

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rights that figures prominently in Demsetz's account of how property rights internalize externalities. However, property rights are complex and can shade into tort-like functions in some contexts, as in the law of nuisance. *Id.* at 1753–54.

178 DUKEMINIER, KRIER, ALEXANDER, SCHILL & STRAHILEVITZ, *supra* note 168, at 731.

179 In general, nuisance law only imposes liability for behaviors that are in some way unreasonable. *See id.* at 734; Henry E. Smith, *Exclusion and Property Rules in the Law of Nuisance*, 90 VA. L. REV. 965, 967 (2004) [hereinafter Smith, *Nuisance*].

180 *See, e.g.*, Morgan v. High Penn Oil Co., 77 S.E.2d 682, 690 (N.C. 1953).

181 *See* Smith, *Nuisance*, *supra* note 179, at 966.

182 *See, e.g.*, Pocono Springs Civic Ass'n v. MacKenzie, 667 A.2d 233, 235–36 (Pa. Super. Ct. 1995) (determining that a property owner had not abandoned property and was thus liable to pay homeowner association fees).

as much water as desired.[183] Such a regime enabled significant negative externalities, and the American rule of reasonable use mitigates those externalities by establishing that wasteful uses of water that harm others are unreasonable and unlawful.[184] Turning to another example, the doctrine of lateral support prohibits landowners from manipulating their soil in a way that would cause their neighbor's land to subside.[185] In so doing, this doctrine internalizes the negative externalities arising from how an owner uses her land. Similarly, the doctrine of subjacent support imposes a duty on owners of surface and subsurface rights to not erode property owned by the other.[186] The doctrine would impose liability on the owner of mineral rights whose mining caused the surface land (owned by another party) to cave in. Here again, physical property rights create duties to internalize negative externalities.[187]

Internalizing externalities is a core function of physical property rights, and in some contexts, it is their reason for being. Like patents, physical property rights internalize positive externalities and provide incentives for owners to acquire and use resources productively. Additionally, as this Section has explored, physical property rights internalize negative externalities in several prominent ways. In so doing, physical property rights encourage and compel property owners to think about and mitigate the harmful effects of their actions on others.

C. *Patent Law's Limited Ability to Internalize Negative Externalities*

As we have seen, patent law is very limited in its ability to internalize negative externalities related to innovation.[188] This limitation is even starker when comparing patents to physical property rights. Both kinds of exclusive rights internalize positive externalities. But whether by design or nature of the subject matter protected, the traditional mechanisms by which physical property rights internalize negative externalities largely do not apply to patents.

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183 DUKEMINIER, KRIER, ALEXANDER, SCHILL & STRAHILEVITZ, *supra* note 168, at 45.

184 *Id.*

185 This doctrine imposes a "duty on neighboring land to provide the support that the subject parcel would need and receive under *natural* conditions." *Id.* at 738.

186 *Id.*

187 As noted, the doctrine of waste also internalizes negative externalities over time, thus promoting conservation of resources. *See supra* note 168.

188 *See supra* Section II.B.

1. Patents Do Not Avert Tragedies of the Commons, and They Encourage Rapidly Exploiting Innovations

First, patents are inapposite to curtailing consumption of technology to avert a tragedy of the commons. Recall that in the physical realm, property rights play a salutary role in internalizing negative externalities associated with communally owned property.[189] Individual property rights help prevent overexploitation and resource depletion associated with the tragedy of the commons. However, patents cover nonrival resources such as technical information; accordingly, the tragedy of the commons does not apply.[190] For instance, given that the chemical formula for a drug is nonrival, this informational asset is not subject to overconsumption.[191] Patents thus do not internalize negative externalities associated with the tragedy of the commons because that tragedy does not arise. In fact, patents actually *create* negative externalities because they introduce artificial scarcity in otherwise inexhaustible resources.[192]

At first glance, this seems like an odd example to illustrate that patents, unlike physical property rights, do not internalize negative externalities. Indeed, the fact that patents do not internalize negative externalities associated with the tragedy of the commons may seem inapposite because such tragedies do not apply to nonrival assets. At a deeper level, however, this comparison reveals important differences in the ways that physical property rights and patents affect consumption and exploitation of protected resources.

While physical property rights encourage owners to conserve their resources (thus internalizing externalities), patents provide the opposite incentive: to exploit technologies as rapidly as possible. Such rapid exploitation may exacerbate negative externalities associated with patented inventions.[193] Recall that physical property rights internalize

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189 *See supra* Section III.B.1.

190 Lemley, *Property*, *supra* note 35, at 1050–51.

191 *See id.* at 1051 ("The notion that information will be depleted by overuse simply ignores basic economics.").

192 Indeed, technology and other nonrival assets invert the tragedy of the commons. The potential tragedy for these assets is not overconsumption of scarce resources, but underproduction of resources that are easily appropriated by others. As noted, Demsetz himself framed technological production as a problem of positive externalities that patents seek to internalize. Kapczynski, *supra* note 153, at 992 ("[A] Demsetzian worry [is that] [c]ommons-based production generates substantial external benefits that are not internalized by producers.").

193 *Cf.* Eric Kades, *Preserving a Precious Resource: Rationalizing the Use of Antibiotics*, 99 NW. U. L. REV. 611, 655–56 (2005) (noting that the limited nature of the patent term encourages firms

negative externalities associated with time. In the absence of exclusive rights, individuals have an incentive to exploit a resource as fast as possible, thereby discounting the interests of future generations. Private property rights mitigate this negative externality, encouraging owners to conserve their resources for the benefit of both their later selves and future owners. Patent law provides the opposite incentive. Rather than promote conservation of technologies, the expiration of patents after twenty years encourages patentees to exploit their inventions as fast as possible before they fall into the public domain. Of course, for a variety of reasons, many patentees do not rush to exploit their inventions during the patent term.[194] However, given the time-limited nature of exclusive rights, patents create an incentive for patentees to exploit their inventions quickly.

In general, this incentive to exploit inventions quickly seems like a feature rather than a bug. Given that technical information cannot be overconsumed, and in light of the constitutional objective of promoting technological progress, we generally want patentees to move quickly to churn out patented medicines, software applications, and other technologies.

However, the incentive to exploit technology quickly can also exacerbate negative externalities from innovation. Physical property rights have a conservative character in that they encourage owners to consume their resources judiciously. After all, owners bear the costs of overconsuming their resources, and property rights encourage measured resource exploitation. Patents, if anything, provide the opposite incentive: to rush headlong into developing and commercializing technologies as fast as possible. Such rapid exploitation is not conducive to unhurried considerations of the potential harms a technology imposes on others. This accelerated mindset is exacerbated by patent rules encouraging inventors to file patent applications as soon as possible after conceiving of an invention.[195] Liberal disclosure requirements that do not require

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to market patented antibiotics rapidly, which exacerbates negative externalities associated with antibiotic resistance).

194 One example of this phenomenon is patent trolls, entities that amass large numbers of patents, do not manufacture any products, and rely on licensing and the threat of infringement suits for revenues. *See, e.g.*, John M. Golden, *"Patent Trolls" and Patent Remedies*, 85 TEX. L. REV. 2111, 2112 (2007). Another example involves the cultivation of large defensive patent portfolios, especially by large incumbents in software and IT industries, to forestall litigation rather than to practice technologies. *See, e.g.*, Colleen V. Chien, *From Arms Race to Marketplace: The Complex Patent Ecosystem and Its Implications for the Patent System*, 62 HASTINGS L.J. 297, 299 (2010).

195 Christopher A. Cotropia, *The Folly of Early Filing in Patent Law*, 61 HASTINGS L.J. 65, 69 (2009).

inventors to build physical prototypes of their technologies[196] and novelty rules that punish patentees who file too late[197] push patent applicants to file early,[198] while their technologies may be quite embryonic. Early filing contributes to a host of well-recognized problems in the patent system, including the underdevelopment of patented inventions.[199] Additionally, early filing coupled with rapid exploitation of technologies before the patent term expires discourages patentees from engaging in measured considerations of the third-party harms of their inventions and attempts to mitigate them.

In sum, patents do not internalize negative externalities associated with the tragedy of the commons because of the nonrival nature of technology. More importantly, they do not promote the conservative and judicious use of owned resources in the way that physical property rights do. Rather, they encourage faster and wider exploitation of technology in ways that are not conducive to internalizing negative innovation externalities.

2. High Transaction Costs Undermine Patents' Ability to Facilitate Efficiency-Enhancing Negotiations

Patents are also limited in their ability to internalize externalities by facilitating transactions between patentees and parties harmed by their inventions. As discussed, physical property rights can internalize externalities by lowering transaction costs and thus facilitating voluntary exchanges between property owners and those affected by their decisions.[200] Thus, if a landowner prevents a river on his property from flowing downstream, an affected downstream party could pay that landowner to release the water. In this sense, property rights facilitate voluntary transactions that lead to more efficient resource allocation. To be sure, a wide literature explores how patents also lower transaction costs and facilitate voluntary transactions involving protected

196 *See* 35 U.S.C. § 112 (requiring that a patent application enable a person of ordinary skill in the art to practice a claimed invention, but not requiring an applicant to actually build a physical prototype); MANUAL OF PATENT EXAMINING PROCEDURE § 2138.05 (9th ed. 2020).

197 35 U.S.C. § 102 (establishing novelty rules where, in general, prior art arising before a patentee's filing date can anticipate a patent application, thus denying patentability).

198 *See generally* Cotropia, *supra* note 195, at 72–82 (discussing several factors leading to early filing of patent applications, including the absence of barriers to filing early and strong incentives to do so).

199 *Id.* at 71.

200 *See supra* Section III.B.2.

technology.[201] The classic example is the patent licensing agreement, in which patents facilitate the packaging and transfer of technology from a rightsholder to another party for exploitation. However, this kind of transaction facilitates the affirmative use of technology (thus helping the patentee capture positive externalities) rather than compelling a patentee to cease using or to redesign a technology, which may internalize negative externalities.

Notably, Demsetz specifically argued that patents—like physical property rights—helped internalize externalities by promoting transactions. He observed that innovations generate both benefits and harms for third parties that are external to innovators. However, patents can help facilitate voluntary transactions to internalize those externalities: "A new idea makes an old one obsolete and another old one more valuable. These effects will not be directly taken into account, but they can be called to the attention of the originator of the new idea through market negotiations."[202] Thus, someone harmed by a new technology could, in theory, negotiate with the owner of that technology (the patentee) to suppress it. Consistent with his view of property rights in land, Demsetz argued that patents can internalize externalities by lowering transaction costs between owners of inventions and those affected by those inventions. In discussing patents, he stated, "All problems of externalities are closely analogous to those which arise in the land ownership example. The relevant variables are identical."[203]

However, the ability of patents to facilitate negotiations to internalize negative externalities faces significant complications. In principle, patents do reduce transaction costs by assigning control over a technology to a single party. People affected by that technology can negotiate with a single patentee, resulting in lower transaction costs relative to a world in which patents did not exist. In the absence of patents, anybody could practice a given technology, and the cost of negotiating with all practitioners of a technology (including new ones as they emerge) would be prohibitively high. However, the nature of patent rights complicates the ability of such negotiations to internalize negative externalities. In the physical realm, negotiations with a polluting factory owner could conceivably lead to the owner agreeing to reduce pollution in exchange for a fee. However, negotiations with the holder of a patent on pollution-generating technology would play out

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201 *See, e.g.*, DANIEL SPULBER, THE CASE FOR PATENTS 8–18 (2021); Robert P. Merges, *A Transactional View of Property Rights*, 20 BERKELEY TECH. L.J. 1477, 1479 n.3 (2005); Paul J. Heald, *A Transaction Costs Theory of Patent Law*, 66 OHIO ST. L.J. 473, 476 (2005).

202 Demsetz, *Property Rights*, *supra* note 13, at 359.

203 *Id.*

much differently. An affected party could negotiate so that the patentee would not practice or license the technology. But to truly internalize externalities, the patentee would also have to commit to suing infringers, including independent inventors, who also practiced that technology. An agreement to not only refrain from using or licensing an invention but also affirmatively sue others would significantly increase the compensation that patentees would demand from those affected by their technologies. Additionally, such an agreement would raise significant difficulties of monitoring and enforcement. Such complications of an affirmative duty would undermine negotiations between a patentee and those harmed by a technology to internalize negative externalities.

In addition to this theoretical complication, bargaining with patentees to internalize externalities faces a significant practical difficulty: high transaction costs. As Demsetz observed, when transaction costs are high, internalization of externalities is not feasible even with properly delineated property rights.[204] A primary way that transaction costs increase is with the number of parties involved in negotiations. Pollution cases, which involve large numbers of affected parties, are a classic example.[205]

On the "victim" side, patented technologies can impose negative externalities on an enormous number of people. The large number of victims raises coordination costs and jeopardizes negotiations aimed at internalizing those externalities. In the land context, imagine that a factory belches pollution that bothers not just a single neighbor, but all the residents of a town. Here, the large number of harmed parties raises transaction costs and hampers negotiations aimed at achieving efficient outcomes.[206] In the technological context, this dynamic is amplified by several orders of magnitude. Unlike a rivalrous plot of land, technology is nonrivalrous and scales easily. A patented technology, such as Facebook's filter bubble, can impose externalities on millions (or billions) of people. It would be prohibitively expensive for so many people to coordinate, say, a payment to Facebook to prevent it from deploying this technology (and committing to sue anyone else who used it). In addition to the sheer problem of numerosity, such collective

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204 *Id.* at 348.

205 Stewart E. Sterk, *Intellectualizing Property: The Tenuous Connections Between Land and Copyright*, 83 WASH. U. L.Q. 417, 455 (2005); *see, e.g.*, Boomer v. Atl. Cement Co., 257 N.E.2d 870, 875 (N.Y. 1970).

206 *See* DUKEMINIER, KRIER, ALEXANDER, SCHILL & STRAHILEVITZ, *supra* note 168, at 32; Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral*, 85 HARV. L. REV. 1089, 1119 (1972).

efforts are subject to free riding, monitoring, and policing costs, which would be greatly amplified given the large number of people involved.[207]

In the real property realm, empirical studies have shown that large numbers of victims can overcome coordination problems, particularly when they are members of a shared community.[208] However, coordination costs are much higher when technologies—rather than activities on a particular parcel of land—harm individuals. Although uses of land can impose negative externalities on a wide swath of people, geographic proximity largely constrains those effects; after all, smoke, noise, and odor only carry so far.[209] This is not the case for patented technologies, which can generate negative externalities unconstrained by location. Furthermore, the large number of people harmed by a technology would, in general, share no communal or social bond that could assist in massively coordinating a response to a negative externality.[210]

Consider, for example, the legions of professional drivers who may be displaced by patented autonomous vehicle technology. As mentioned, the White House Council of Economic Advisors predicts that autonomous vehicles threaten 2.2 to 3.1 million driving-based jobs in the United States.[211] It would be virtually impossible for all of those drivers to coordinate a payment to owners of autonomous driving patents to cease use of this technology. Even if there were a collective effort to organize payment, many drivers would likely not participate and seek to free ride on the contributions of others.

Transaction costs are also problematic on the innovator side. Demsetz posits that persons adversely affected by a technology could negotiate with the technology "originator" to internalize externalities.[212] However, it is unclear how this would actually work in practice. Even if

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207 *See* DUKEMINIER, KRIER, ALEXANDER, SCHILL & STRAHILEVITZ, *supra* note 168, at 32 (discussing how free riders raise transaction costs and undermine coordinated efforts to internalize externalities).

208 *See* Parchomovsky & Siegelman, *supra* note 174, at 77–82 (exploring the virtual absence of holdouts when a polluter bought out an entire town).

209 There are exceptions, of course. For example, emissions contributing to acid rain and global climate change can affect huge numbers of people.

210 *Cf.* Frischmann, *Demsetzian*, *supra* note 35, at 664 ("In the real world at least, there are externalities that cannot realistically be internalized because of collective action problems, imperfect information, transaction costs, and the diffuseness of their distribution."). In the specific example of people harmed by social media networks, one could argue that such individuals may possess a shared community. Furthermore, the technology that harms them could help coordinate negotiations with Facebook. Even so, coordination costs would be substantial.

211 EXEC. OFF. OF THE PRESIDENT, *supra* note 91, at 15.

212 Demsetz, *Property Rights*, *supra* note 13, at 359.

professional drivers could coordinate amongst themselves, with whom would they have to negotiate? A logical starting point would be manufacturers and distributors of autonomous vehicles. These companies likely invented and patented some technologies used in their vehicles while licensing some patents from others. However, numerous firms are developing autonomous vehicles, and negotiating with all of them raises transaction costs. In the land context, this would be akin to residents having to negotiate not with one factory belching pollution, but with multiple factories owned by different parties. In addition to sheer numerosity, holdouts would also hamper negotiations—if nine autonomous vehicle manufacturers agreed to be bought off, the tenth would have an incentive to hold out for supranormal compensation.[213]

Moving beyond manufacturers, if professional drivers sought to negotiate with actual patentees, the problem gets worse. Most technological products comprise numerous (sometimes, thousands) of patented components.[214] For example, an autonomous driving system may rely on dozens of different patented technologies covering sensors, processors, methods for calculating trajectories, and user interfaces. If autonomous vehicles threaten to displace human drivers, with which patentees must drivers transact to internalize that externality? It would be very difficult to identify a "core" basket of patented technologies that aggrieved parties would have to suppress to truly inhibit autonomous vehicles. Identifying such a core would be particularly difficult given that for most technical functions, any number of alternate technologies (patented or unpatented) could serve as adequate substitutes.

In sum, while patents may reduce transaction costs, the prospect of negotiating to internalize negative externalities would be virtually impossible in many real-world settings.[215] Unlike the factory belching pollution, patented technologies impose negative externalities on enormous numbers of unconnected people unconstrained by geography. Even if such large numbers of people could coordinate, they would likely have to deal with numerous technology distributors and/or

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213 DUKEMINIER, KRIER, ALEXANDER, SCHILL & STRAHILEVITZ, *supra* note 168, at 32–33.

214 *See, e.g.*, Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1590 (2003) ("Machines of even moderate complexity are composed of many different pieces, and each of these components can itself be the subject of one or more patents."); Alan Devlin, *Antitrust Limits on Targeted Patent Aggregation*, 67 FLA. L. REV. 775, 796 (2015) (noting that in industries such as telecommunications, IT, and semiconductors, products routinely comprise large numbers of patented components).

215 The highly indeterminate nature of patent scope further compounds the difficulty of negotiating over patents. Unlike property rights, which feature rather clear metes and bounds, the precise boundaries of a patent are difficult to discern. *See* Frischmann & Lemley, *supra* note 8, at 275.

patentees to effectively internalize externalities. Rather than a one-to-one exchange, negotiations over negative innovation externalities are many-to-many transactions that are highly difficult in the real world.

The persistence of high transaction costs even in the presence of patents reveals an important Coasean insight. The Coase theorem, as conventionally understood, posits that in a world of zero transaction costs, parties will bargain to an efficient outcome regardless of the initial allocation of entitlements.[216] However, Coase's overarching insight is that when transaction costs are nontrivial (as is overwhelmingly the case in the real world), parties will not always bargain to achieve an efficient outcome, and the initial allocation of entitlements can matter considerably.[217] Given the infeasibility of Coasean bargaining to internalize the externalities of patented inventions, the initial allocation of entitlements is likely to be quite sticky. And as far as the patent system is concerned, the initial allocation of entitlements allows patentees to claim a share of the upside of their inventions while not accounting for any of their external costs.

3. Patents Do Not Establish Duties to Limit Harms to Others

Unlike physical property rights, patents lack a more direct mechanism for internalizing externalities: they impose no duties on patentees to limit harms to others. Recall that property rights in land establish several duties for landowners that limit their negative externalities.[218] This is evident in doctrines governing nuisance, groundwater, lateral support, and subjacent support. There are no corresponding duties in patent law.[219] Patents confer a right to exclude others from practicing an invention,[220] but no duties to limit or even consider the harms of one's invention on third parties. As discussed

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216 *Cf.* Frischmann & Marciano, *supra* note 173, at 347–49.

217 *Cf. id.* at 348–49.

218 *See supra* Section III.B.3.

219 Patents are a very pared-down form of property right. In addition to imposing no duties on patentees, patents do not even establish an affirmative right for patentees to practice their inventions. MERGES & DUFFY, *supra* note 151, at 56 ("Unlike other forms of property, however, a patent includes *only* the right to exclude *and nothing else*.").

220 *See* 35 U.S.C. § 271(a) ("Except as otherwise provided in this title, whoever without authority makes, uses, offers to sell, or sells any patented invention, within the United States or imports into the United States any patented invention during the term of the patent therefor, infringes the patent.").

above, patent law's historical requirement of moral utility, which can somewhat play this function, is largely a dead letter.[221]

Going further, there is no widely distributed right to not be harmed by patented technologies. The law of nuisance creates both duties and rights. In Hohfeldian terms, a landowner's duty to refrain from interfering with the property of others is the "jural correlative" of another landowner's right to be free from interference.[222] Coupled with the fact that virtually all land is owned by someone, the right to be free from interference creates a powerful constraint against property owners imposing externalities on others. This system of rights and duties has no analog in patent law. While nearly all land is owned (and thus implicates a right to be free from undue interference), there is no widely distributed "anti-technology" right to be free from unreasonable harms from technology—patented or otherwise.[223] Such a right, held widely, could do much to compel the internalization of negative innovation externalities. Of course, there are other bodies of law that limit what one can do with a patented invention, just as there are other bodies of law that limit what one can do on one's land. However, unlike physical property rights, there is little intrinsic to patents themselves that performs this externality-internalizing function.

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Comparing physical property rights and patents casts in starker relief the uniqueness of patent law's externality asymmetry. Patents exist to internalize positive externalities from technological innovation. In so doing, they help shore up incentives to invent. Physical property rights serve a similar function; they encourage landowners to reap what they sow by allowing them to internalize positive externalities from productive land use. Physical property rights are symmetrical in that they also help internalize negative externalities through several mechanisms. Patents, however, are asymmetric in lacking these mechanisms. Patents do not resolve tragedies of the commons; rather, they encourage rapid exploitation of technologies in a way that can

221 *See supra* notes 138–40 and accompanying text.

222 Wesley Newcomb Hohfeld, *Some Fundamental Legal Conceptions as Applied in Judicial Reasoning*, 23 YALE L.J. 16, 30 (1913).

223 In somewhat analogous fashion, Professors Abraham Bell and Gideon Parchomovsky argue for granting negative easements (what they call antiproperty rights) to landowners adjoining parks to prevent development of green spaces. Abraham Bell & Gideon Parchomovsky, *Of Property and Antiproperty*, 102 MICH. L. REV. 1, 5 (2003).

exacerbate negative externalities. Patents do not realistically facilitate transactions whereby technology owners and those harmed by technology can negotiate to internalize externalities. Unlike physical property rights, patents create no duties to limit harmful effects on others.

Crucially, these arguments do not depend on accepting the contested view that intellectual property is property. Foundational economic theory associates exclusive rights, in general, with internalizing both positive and negative externalities. Furthermore, the principal expositor of that theory specifically argued that patents and physical property rights operate similarly in this regard.[224] This Article, however, argues that this received wisdom is misguided. It next turns to normatively assessing patent law's externality asymmetry.

IV. NORMATIVE ASSESSMENT OF PATENT LAW'S EXTERNALITY ASYMMETRY

While patents promote the invention of remarkable technologies—from smartphones to medicines—they do little to internalize the negative externalities that technologies inevitably produce. Having established the descriptive claim that patents asymmetrically internalize positive but not negative externalities, this Part turns to a normative assessment of this asymmetry. To do so, this Part first explores the overarching normative objectives of the patent system. It argues that the patent system aims to maximize efficiency in the allocation of resources for innovation rather than maximize innovation at all costs. It rejects the argument that patent law's externality asymmetry is benign or even beneficial, and it contends that this asymmetry contributes to a host of social ills. In particular, this asymmetry impairs innovative efficiency, distributive equity, and fairness.

A. *The Normative Objectives of Patent Law*

To assess patent law's externality asymmetry, it is useful to first clarify the overarching normative objectives of patent law. The Constitution authorizes Congress to establish a patent system "To promote the Progress of Science and useful Arts."[225] As courts and

224 *See supra* note 203 and accompanying text.

225 U.S. CONST. art. I, § 8, cl. 8.

commentators have long observed, this provision establishes a broadly utilitarian objective for the patent system.[226] Patents exist not to reward individual inventors but to advance society-wide technological progress.[227] With this in mind, several points are worth exploring in greater detail.

First, it is important to clarify that the overarching aim of the patent system is to maximize efficiency in the allocation of resources for innovation, not to maximize innovation itself. It is universally recognized that patents exist to promote innovation.[228] However, it is also clear that the patent system does not aim to maximize innovation at all costs. After all, we do not want all of our social resources devoted to innovation to the exclusion of providing food, shelter, and other goods. If maximizing innovation were the objective of patent law, it could do much more to incentivize inventive activity. For example, it could couple exclusive rights with government grants, give tax breaks to patentees, or lower the threshold for obviousness to induce the creation of more incremental advances.[229] Rather than aiming to promote innovation at all costs, patents aim to promote innovation in a way that maximizes social welfare.[230] As economists would say, the

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226 Burk & Lemley, *supra* note 214, at 1597 ("[C]ourts and commentators widely agree that the basic purpose of patent law is utilitarian: We grant patents in order to encourage invention.").

227 Graham v. John Deere Co. of Kansas City, 383 U.S. 1, 8–9 (1966).

228 *See, e.g.*, Bilski v. Kappos, 561 U.S. 593, 617 (2010) (Stevens, J., concurring) ("[T]he patent system is intended to protect and promote advances in science and technology . . . ."); Ted Sichelman, *Purging Patent Law of "Private Law" Remedies*, 92 TEX. L. REV. 517, 529 (2014) ("In the United States, the overriding goal of patent law is to promote technological innovation.").

229 One must be careful here. As has long been recognized, some increases in patent incentives may lead to less rather than more innovation. This is particularly true when "upstream" technologies are inputs to the creation of "downstream" technologies. In such cases, increasing the strength of patents on upstream inputs may impair the development of downstream technologies, a phenomenon that has attracted significant scholarly attention. That being said, there are ways in which the patent system could increase incentives to invent that would not hamper subsequent innovation.

230 John M. Golden, *Principles for Patent Remedies*, 88 TEX. L. REV. 505, 509 (2010) ("I generally assume a utilitarian goal that is standard in modern accounts: the patent system should act to promote the development, disclosure, and use of new technologies, ideally in a way that maximizes social welfare."). For the sake of analysis, this Article adopts the standard conception of welfare as consisting of aggregate individual preference satisfaction. However, it acknowledges other potential measures of welfare, such as subjective happiness and objective criteria of well-being. *See, e.g.*, John Bronsteen, Christopher Buccafusco & Jonathan S. Masur, *Welfare as Happiness*, 98 GEO. L.J. 1583, 1586 (2010) (arguing for a conception of welfare based on subjective happiness or positive affect); Ofer Tur-Sinai, *Technological Progress and Well-Being*, 48 LOY. U. CHI. L.J. 145, 150 (2016) (advocating an objective conception of welfare). Notably, allocations of resources for innovation would arguably deviate even further from socially optimal levels under either of these alternative conceptions of welfare.

patent system aims to maximize efficiency in the allocation of resources for innovation.[231]

To achieve this efficient allocation, the patent system enables a market-based system of technological development. Economists, including Demsetz, have long argued that markets allocate resources more efficiently than centralized planning.[232] It would be exceedingly difficult for a government to know the socially optimal mix of technologies to invent and develop at any given time. However, as economist Friedrich Hayek famously observed, markets and prices harness information from millions of producers and consumers about preferred resource allocations.[233] The patent system exploits the informational and efficiency advantages of markets by establishing property rights in new inventions.[234] By conferring exclusive rights upon inventors, the patent system enables markets for technology and allows voluntary transactions (mediated by prices) to guide the production and distribution of new inventions. The assumption (or hope) is that the market will allocate resources efficiently, at least better than any other alternative.

However, markets sometimes fail. As economists since at least Pigou have recognized, private returns (prices) of activities do not always accurately signal social returns and capture all relevant costs and benefits. And one important reason why markets fail—and prices do not signal social returns—is externalities.[235] Indeed, the patent system is itself born from one form of market failure (positive externalities), and it is ironic that it ignores another (negative externalities). Again, patent law does not seek to maximize technological innovation at all costs; social costs such as the opportunity cost of allocating resources to innovation instead of other pursuits are part of the efficiency calculus.

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231 More precisely, it aims for dynamic efficiency, which may require compromising static allocational efficiency. Lemley, *Property*, *supra* note 35, at 1059–65.

232 *See* Demsetz, *Information and Efficiency*, *supra* note 153, at 11–14; Frischmann, *Demsetzian*, *supra* note 35, at 654 ("According to neoclassical economic theory, *the market* is an economic system that relies on the price mechanism to efficiently coordinate productive activities and allocate resources to their most productive use."); Frischmann, *Spillovers Theory*, *supra* note 42, at 804–05.

233 F.A. Hayek, *The Use of Knowledge in Society*, 35 AM. ECON. REV. 519, 525 (1945); *see also* Demsetz, *Information and Efficiency*, *supra* note 153, at 12 (noting that markets have advantages over governments in producing information "on the desired directions of investment and on the quantities of resources that should be committed to invention").

234 Kapczynski & Syed, *supra* note 123, at 1911–21; Tur-Sinai, *supra* note 230, at 156.

235 Not surprisingly, another term for an externality is an "unpriced factor." Schall, *supra* note 25, at 984.

This Article highlights another important cost that the patent calculus overlooks: negative externalities from patented inventions.

Second, it is clear that the patent system does not exist to reward individual inventors. The Supreme Court has long disavowed that the patent system aims to maximize private gains, emphasizing the public nature of patent rights. In *Graham v. John Deere*, the Court noted that Thomas Jefferson, the architect of the U.S. patent system, "rejected a natural-rights theory in intellectual property rights and clearly recognized the social and economic rationale of the patent system."[236] More recently, the Court reaffirmed this view by likening patents to "public franchises" where the government "take[s] from the public rights of immense value, and bestow[s] them upon the patentee."[237] A system that allows patentees to internalize positive externalities of their inventions but does little to internalize negative externalities seems well designed to maximize patentee profits. But this has never been a goal of the patent system.

Third, while efficiency represents the dominant objective of patent law, other values such as distributive equity and fairness have some normative claim on the patent system. The patent system reveals a commitment to distributive values in policies that widen access to patented technologies, encourage the development of technologies that serve marginalized communities, and broaden participation by underrepresented inventors.[238] Commentators have also persuasively argued that fairness provides a foundational justification for the patent system.[239] In a broader sense, like property law and other legal regimes, patent law must be attentive to norms of fairness to maintain social esteem and compliance.[240] Thus, while efficiency represents the most prominent normative lens through which to evaluate the patent system, nonwelfarist values like distributive equity and fairness are highly relevant as well.

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236 Graham v. John Deere Co. of Kansas City, 383 U.S. 1, 8–9 (1966).

237 Oil States Energy Servs., LLC v. Greene's Energy Grp., LLC, 138 S. Ct. 1365, 1373–74 (2018) (alterations in original) (citation omitted).

238 Peter Lee, *Toward a Distributive Agenda for U.S. Patent Law*, 55 HOUS. L. REV. 321 (2017) [hereinafter Lee, *Distributive*].

239 *See* ROBERT P. MERGES, JUSTIFYING INTELLECTUAL PROPERTY 8 (2011) ("At its heart [intellectual property] is about basic fairness: the scope of a property right ought to be commensurate with the magnitude of the contribution underlying the right.").

240 *See* Thomas W. Merrill & Henry E. Smith, *The Morality of Property*, 48 WM. & MARY L. REV. 1849, 1854 (2007) ("[W]hen legal protection of property is out of sync with common morality, we often see widespread disregard of legally recognized property rights.").

B. *Potential Advantages of Patent Law's Externality Asymmetry*

Some might argue that patent law's internalization of positive but not negative innovation externalities is not problematic. They may even go further to argue that this reflects a well-functioning patent system. After all, robust incentives to invent seem to advance the constitutional objective of the patent system, which is to promote innovation. According to this view, forcing patentees to internalize the negative externalities of their inventions would chill invention and undermine this aim.

As discussed above, however, this argument misunderstands the goals of the patent system. The patent system seeks not to promote innovation at all costs but to provide for the efficient allocation of resources for innovation. Efficiency must consider the benefits and costs of technological development, and negative externalities must be part of the calculus. More broadly, the impetus to encourage invention at all costs betrays a narrow and misguided view that technology is invariably a net social positive and that more technology is always better. However, technology is not costless. While technological designs may be nonrival, the scarce inputs that create them are not;[241] labor, physical capital, and financial capital devoted to innovation cannot be used for other worthy social ends. Furthermore, as this Article has argued, some technologies generate significant negative externalities that reduce (and perhaps even wholly outweigh) their contribution to social welfare.

C. *The Harms of Patent Law's Externality Asymmetry*

This Section argues that patent law's externality asymmetry contributes to a host of social ills. It will primarily examine how patent law's ineffectiveness in internalizing negative externalities undermines efficiency, the dominant objective animating the patent system. In short, patents may overincentivize innovation, incentivize the wrong mix of innovations, and provide suboptimal incentives for technological design. Moving beyond efficiency concerns, this Section then argues that patent law's externality asymmetry also undermines distributive equity, as those bearing the costs of innovation externalities are often underresourced relative to patentees. Finally, this Section argues that patent law's externality asymmetry impairs fairness by

241 Smith, *Intellectual Property*, *supra* note 135, at 1758.

allowing inventors to foist external costs on others while internalizing external benefits.

1. Efficiency

Most importantly, patent law's externality asymmetry undermines patent law's primary objective of innovative efficiency.[242] At a broad level, this deficiency manifests in two ways. First, the inability of patents to internalize negative externalities drives a wedge between private returns and social returns from innovation.[243] Like the factory belching pollution, some inventions would not be worth deploying if inventors had to internalize negative externalities. Second, the patent system distorts incentives even further because it does not symmetrically ignore positive and negative externalities (which, in some grand social calculus, may in some contexts cancel out).[244] Rather, it asymmetrically allows inventors to internalize positive but not negative externalities.

As a preliminary matter, one must distinguish this argument from the commonly asserted contention that the patent system should aim to maximize innovative efficiency, leaving distributive considerations to other bodies of law, namely the tax system.[245] It is important to emphasize that internalizing externalities itself is important to maximizing efficiency (although, as we shall see, it also has distributive benefits). This Article's critique sounds in the dominant logic of efficiency; to allocate resources for innovation efficiently, the patent system must account for externalities. Patent law's externality

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242 *Cf.* Kapczynski, *supra* note 153, at 981 (noting IP scholarship's prevailing focus on the value of efficiency).

243 Schall, *supra* note 25, at 984.

244 *Cf.* Frischmann, *Demsetzian*, *supra* note 35, at 670–72 (observing that property rights, like externalities, can distort market allocations). This Article goes further to argue that the precise design and subject matter of property rights can significantly impact their distortionary potential. For instance, the absence of any nuisance-like duty in patents significantly inhibits their ability to internalize negative externalities, particularly when compared to property rights in land.

245 *See generally* LOUIS KAPLOW & STEVEN SHAVELL, FAIRNESS VERSUS WELFARE (2002); Louis Kaplow & Steven Shavell, *Any Non-Welfarist Method of Policy Assessment Violates the Pareto Principle*, 109 J. POL. ECON. 281 (2001); Louis Kaplow & Steven Shavell, *Notions of Fairness Versus the Pareto Principle: On the Role of Logical Consistency*, 110 YALE L.J. 237 (2000); Louis Kaplow & Steven Shavell, *Why the Legal System Is Less Efficient than the Income Tax in Redistributing Income*, 23 J. LEGAL STUD. 667 (1994).

asymmetry fails to do this, thus introducing three distortions that undermine efficiency.[246]

a. Patents May Overincentivize Innovation

First, at the broadest level, patents likely overincentivize innovation. A system that allows inventors to capture a significant share of the external benefits of their inventions while bearing no responsibility for their external harms will tend to incentivize innovation beyond the socially optimal level. Put differently, if patentees internalized some of the harms that their inventions imposed on others, there would be less innovation. This could occur in at least two ways. First, if patents effectively facilitated transactions between inventors and individuals harmed by patented technologies, voluntary exchanges would lead to such individuals paying patentees to not deploy those technologies.[247] Second, if patentees bore greater accountability for the harms of their technologies on third parties, they would be less likely to invent. For example, if Mark Zuckerberg and other Facebook engineers knew that patenting their "filter bubble" technology would force them to bear some of the costs of ideological polarization, they might have thought twice before developing it.[248]

This insight offers a new gloss on the economic argument that patents can induce socially wasteful "patent races." This account contends that patents overincentivize innovation when prevailing firms capture more than a particular fraction of total surplus.[249] By providing too great a reward, the patent system can induce too many inventors to chase exclusive rights, thus resulting in wasteful and duplicative effort.[250] To this existing account, this Article adds the insight that

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246 This Article thus adds to the list of distortions that commentators have attributed to patents. *See, e.g.*, Kapczynski & Syed, *supra* note 123, at 1905 (arguing that patents distort inventive behavior in favor of technologies that are more amenable to excludability).

247 Technically, internalizing externalities in this manner would depress incentives to innovate but not necessarily incentives to invent. Inventors would still have incentives to invent and patent technologies that produced negative externalities. If negative externalities exceeded private gains from deploying a technology, a patentee could expect that individuals harmed by the technology would pay her to suppress it. However, internalizing externalities in this fashion would decrease incentives to *innovate*, which refers to actually putting an invention into practice. SCHUMPETER, *supra* note 132, at 84.

248 More precisely, one could say that forcing patentees to internalize the negative externalities of their inventions would discourage patenting, not necessarily invention itself. But to the extent that patenting is perceived as a valuable incentive to patent, a decrease in the attractiveness of patenting would also lead to a decrease in invention.

249 Einer Elhauge, *Tying, Bundled Discounts, and the Death of the Single Monopoly Profit Theory*, 123 HARV. L. REV. 397, 440 (2009).

250 Kapczynski, *supra* note 153, at 984.

patents also overincentivize innovation by allowing inventors to ignore negative externalities. Both sides of the coin—increasing rewards and neglecting costs—drive overinvestment in innovation. Due to the one-way incentives provided by patents, society is likely investing too much in innovation to the exclusion of other valuable uses of scarce human, physical, and financial capital.[251]

b. Patents May Incentivize the Wrong Mix of Innovations

Second, patents may incentivize the wrong mix of innovations. Due to patent law's externality asymmetry, innovations that create high negative externalities (which patentees can ignore) are likely to be overrepresented relative to their socially optimal level. In a stylized example, assuming that both gas-guzzling internal combustion engines and more fuel-efficient hybrid engines have similar prices and demand curves, the patent system provides equal incentives for inventors to invent both. The fact that gas guzzlers generate significantly greater negative externalities than hybrids is not accounted for in any way by the patent system. This is part and parcel of a larger difficulty in which market prices—particularly in the presence of externalities—do not accurately reflect the social costs and benefits of various resources.[252] Therefore, patents not only overincentivize innovation in general, they also distort the allocation of innovative resources toward producing and deploying more technologies generating high negative externalities than would be socially optimal.

c. Patents Provide Suboptimal Incentives for Technological Design

Third, at the most granular level, patent law's externality asymmetry may provide suboptimal incentives for technological design. For instance, if inventors were more directly accountable for the

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251 It is important to add a caveat here. This Article calls for greater accounting of the negative externalities of technology. In so doing, it implicitly calls for greater accounting of the positive externalities of technology as well. It is possible that, for a given patented technology, a full accounting of positive and negative externalities (along with private gains and losses) would reveal that producing that technology is still socially efficient even though it creates significant third-party harms. For other technologies, positive and negative externalities might roughly cancel each other out, so that the market allocation of resources for such technologies approximates the socially optimal allocation. At a more macroscopic level, however, the patent system likely systematically overincentivizes investment in innovation in general because it ignores negative innovation externalities.

252 *See* Frischmann, *Spillovers Theory*, *supra* note 42, at 808 (noting that externalities cause demand-side distortions "in terms of lost signals about what consumers want and where investments should be directed"); *cf.* Kapczynski, *supra* note 153, at 978 ("In an IP system, price influences not only who has access to such goods, but also which goods are produced in the first place.").

negative externalities of their technologies, they would design their technologies differently.

Take, for example, patented predictive policing technology. Such technology offers obvious benefits by allowing police departments to better allocate law enforcement resources. As noted, however, inventors hardwired this technology with the "broken windows" theory of policing that may lead to racial profiling and other negative externalities. If patentees were more accountable for the third-party harms of their inventions, they would be more likely to engineer safeguards against such harms. In this case, accounting for such third-party harms might lead the inventors to remove the "broken windows" algorithm from their invention or program automatic prompts to guard users against implicit bias. Attentiveness to negative externalities may lead an inventor to engineer a technology in a way that retains valuable functionality while reducing external costs. However, the present patent regime, which does not hold inventors accountable for negative externalities, does not provide this incentive.[253]

2. Distributive Concerns

In addition to undermining efficiency, patent law's externality asymmetry also harms distributive equity. It is probably a fair assumption that the median patentee is wealthier than the median nonpatentee. It is beyond doubt that the median Facebook employee is wealthier than the median U.S. citizen adversely affected by Facebook's filter bubble technology. A system that allows patentees to internalize positive externalities from their inventions while disregarding negative externalities exacerbates this wealth inequality. Patentees earn innovation-related rents while foisting uncompensated costs on other, less wealthy parties.[254]

It bears noting that while conventional economic wisdom views distributive concerns as orthogonal to efficiency, that is not always the case. Given the principle of diminishing marginal utility, "pure" wealth transfers from poorer to richer persons not only impair distributive

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253 As discussed further below, a host of "downstream" regulations—from tort law to technology-specific laws—can help internalize externalities from innovations, patented and otherwise. Such regulations also provide incentives to guide "upstream" engineering decisions toward reducing negative externalities. However, the persistence of significant negative externalities from technology suggests that such mechanisms are incomplete.

254 *See* Korinek & Stiglitz, *supra* note 32, at 367–68 (discussing pecuniary externalities in the form of wage decreases due to AI-based technology).

justice, they also reduce overall welfare. After all, the thousandth dollar earned by a low-wage worker contributes more to overall welfare than the five millionth dollar earned by a high-wage innovator.[255] And given that social welfare functions are likely to be averse to inequality, innovation that exacerbates inequality also decreases overall welfare.[256] This Section discusses the value of distributive equity in and of itself, but it acknowledges that such equity can also enhance efficiency, the lodestar of welfare analysis.

Negative innovation externalities impose uncompensated costs on third parties, thus exacerbating wealth gaps between innovators and affected individuals. This is true of technological externalities, which have real resource effects on external parties.[257] Facebook's filter bubble, which increases the profits of a fabulously wealthy company, depresses the utility functions of ordinary citizens, who must expend more effort to cut through misinformation and maintain civil political discourse. While the patentees of predictive policing systems profit from licensing their technology, their technology imposes costs on marginalized members of society who may be victims of biased algorithms.

The distributive harms of negative innovation externalities are also evident with pecuniary externalities. Recall that pecuniary externalities operate directly through the price system and result in wealth transfers between economic agents.[258] While many economists regard pecuniary externalities as irrelevant to overall efficiency, this is not the case; where markets are not competitive or where transactions do not occur, pecuniary externalities can directly harm overall welfare.[259] Furthermore, as discussed previously, distributive inequities arising from pecuniary externalities can indirectly diminish welfare through varying marginal utilities of wealth and social utility functions that value equality.[260] Moreover, whether or not pecuniary externalities impair efficiency, distributive inequities can be troubling in their own right and justify at least partial internalization of negative externalities.[261]

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255 *See id.* at 369; William W. Fisher & Talha Syed, *Global Justice in Healthcare: Developing Drugs for the Developing World*, 40 U.C. DAVIS L. REV. 581, 604 (2007).

256 Korinek & Stiglitz, *supra* note 32, at 359.

257 *See supra* notes 25–26 and accompanying text.

258 *See supra* notes 27–28 and accompanying text.

259 *See supra* notes 29–31 and accompanying text.

260 See *supra* notes 255–56 and accompanying text.

261 Korinek & Stiglitz, *supra* note 32, at 368 ("Even if the equilibrium reached after an innovation is Pareto efficient, the pecuniary externalities lead to redistributions and imply that there are winners and losers.").

Take, for example, autonomous vehicles that threaten the jobs of millions of professional drivers. Economists regard this as a pecuniary rather than technological externality because it operates through the market system by depressing wages.[262] Welfare analysis probably suggests that the macroscopic benefits of this technology outweigh its costs, and this Article does not suggest using the patent system or other regulatory levers to suppress this innovation. However, autonomous vehicles do produce troubling negative externalities in the form of regressive wealth redistribution that may warrant intervention. And patent law's externality asymmetry contributes to these negative externalities. Autonomous vehicles are a subset of AI-based innovations that have attracted significant concern for their ability to intensify wealth inequalities.[263] Economists predict that self-driving cars will decrease wages for professional drivers[264] and that automation in general may lead to widespread unemployment.[265] It bears emphasizing that job losses implicate more than just economic harms given that jobs provide psychological rewards such as meaning, dignity, and fulfillment.[266] On the other hand, manufacturers and owners of autonomous vehicles—and the patentees of the underlying technology driving these vehicles—will benefit. These distributive inequities have real social and political salience; Andrew Yang and Elon Musk have cited the potential for automation to displace workers to justify a universal basic income.[267] Aside from impairing efficiency, patent law's externality asymmetry can contribute to troubling distributive effects.

3. Fairness

Finally, patent law's externality asymmetry also undermines fairness. It does so in at least two ways. First, the very existence of a

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262 *See, e.g.*, *id.* at 354.

263 *Id.* at 351 ("We believe that the primary economic challenge posed by the proliferation of AI will be one of income distribution.").

264 *Id.* at 368.

265 *Id.* at 377.

266 *Id.* at 381.

267 Catherine Clifford, *Elon Musk: Robots Will Take Your Jobs, Government Will Have to Pay Your Wage*, CNBC (Jan. 29, 2018, 4:45 PM), https://www.cnbc.com/2016/11/04/elon-musk-robots-will-take-your-jobs-government-will-have-to-pay-your-wage.html [https://perma.cc/6DS6-QFAF]; Tim Higgins, *Elon Musk Lays Out Worst-Case Scenario for AI Threat*, WALL ST. J. (July 15, 2017, 5:32 PM), https://www.wsj.com/articles/elon-musk-warns-nations-governors-of-looming-ai-threat-calls-for-regulations-1500154345 [https://perma.cc/875B-GLXZ]; Yang, *supra* note 90.

negative externality compromises fairness because it is a cost imposed on third parties without their consent. Citizens whose electorate is impoverished because of a social media network, hardworking drivers who lose their livelihoods to automation, and individuals unconstitutionally searched by police because of an algorithm can all claim to have been treated unfairly. It is one thing to be harmed by technology when one is aware of and accepts certain risks, such as when a patient takes a drug and experiences uncomfortable but anticipated side effects. It is another thing to be harmed by technology through processes over which one has no control or even input. While much normative analysis focuses on efficiency and, to a lesser extent, distributive concerns, there is a palpable element of unfairness to having to bear the costs of someone else's actions.

Second, patent law's externality asymmetry exacerbates this unfairness by allowing patentees to profit from their inventions while not holding them accountable for third-party costs.[268] As the term "asymmetry" implies, there is something unbalanced and uneven about a one-way ratchet in which patentees can internalize a meaningful share of the positive externalities of their inventions but do not have to internalize any of their negative externalities. As legal scholar Camilla Hrdy argues in the context of patented automation technology, "[T]he owners of this intellectual property, such as Eli Whitney, NCR Corp., Google, and Uber, profit. But they do not internalize the full costs that those same inventions impose on workers across the economy—workers whose skills are now made obsolete by the advancement of technology."[269] As mentioned, the patent system is both receptive to and constrained by common conceptions of fairness.[270] Beyond impairing efficiency and distributive goals, patent law's externality asymmetry is also troublingly unfair.

V. POLICY PRESCRIPTIONS AND THEORETICAL IMPLICATIONS

This Article has argued that patents asymmetrically internalize positive but not negative externalities associated with technological innovation. While foundational economic theory asserts that patents function similarly to physical property in internalizing externalities, this Article has shown otherwise; physical property rights internalize

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268 *Cf.* Korinek & Stiglitz, *supra* note 32, at 378 (exploring the perceived unfairness of workers having their wages decrease while entrepreneurs' incomes increase).

269 Hrdy, *supra* note 11, at 347.

270 *See supra* note 240 and accompanying text.

negative externalities in several ways that do not apply to patents. This Article has further argued that patent law's externality asymmetry contributes to a variety of social ills by undermining efficiency, distributive equity, and fairness.

The overarching policy implication of this analysis is that there is little reason to think that the patent system achieves a socially efficient mix of innovations. This is an important realization given that defenders of the patent system point to voluntary, property rights–based market exchanges as the paragon of efficiency.[271] This presumption of efficiency overlooks a basic economic point: prices do not signal social value—and markets do not allocate resources efficiently—in the presence of externalities. Commentators have explored how the patent system undersupplies innovations that generate significant *positive* externalities.[272] For instance, due to compromised demand signals and the difficulties of capturing positive externalities, markets tend to undersupply "infrastructural" technologies that facilitate wide swaths of downstream productive activities.[273] This Article adds the insight that the patent system oversupplies innovations that generate significant negative externalities. Considering both distortions, it is highly doubtful that the patent system (or any market-based system of technological development) gets the socially optimal level of innovation correct.[274]

Importantly, this critique of the patent system arises within the dominant idiom of economic efficiency. The patent system has attracted criticism on several normative grounds outside the dominant law-and-economics objective of efficiency. In particular, commentators have argued that the patent system should be more attentive to

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271 *See, e.g.*, Daniel F. Spulber, *How Patents Provide the Foundation of the Market for Inventions*, 11 J. COMPETITION L. & ECON. 271, 272 (2015) ("I demonstrate that patents support the market for inventions . . . by establishing what I term 'the market for innovative control' that provides incentives for efficient investment . . . ."); Tur-Sinai, *supra* note 230, at 155–56 (describing but not endorsing this position).

272 *See* Gregory N. Mandel, *Innovation Rewards: Towards Solving the Twin Market Failures of Public Goods*, 18 VAND. J. ENT. & TECH. L. 303, 310–12 (2016) (examining this phenomenon in the underproduction of environmental technologies, which generate significant positive externalities).

273 Frischmann & Lemley, *supra* note 8, at 279.

274 As noted, it is possible that in a full accounting of positive and negative externalities for a patented invention, they will roughly cancel each other out so that the market allocation of the invention approximates the socially efficient allocation. *See supra* note 251. It is more likely, however, that the patent system introduces two distortions that compound rather than counteract each other: the patent system underincentivizes inventions that generate high positive externalities, and it overincentivizes inventions that generate high negative externalities.

distributive justice and fairness.[275] Others have advocated alternate measures of welfare other than the dominant paradigm of preference satisfaction, such as subjective welfare or objective well-being.[276] This Article is sympathetic to many of these critiques. Importantly, however, it reveals that the patent system falls short even on its conventional terms. Even within the dominant paradigm of efficiency and welfare maximization (as defined by preference satisfaction), the patent system misallocates resources for innovation by ignoring negative externalities (and many positive ones as well). Thus, even law-and-economics defenders of the patent system should favor correctives to better achieve their goal of innovative efficiency.

This Part turns to the implications of these findings for policy and theory. It advances two related policy changes. First, it proposes a modest requirement that patent applicants disclose reasonably foreseeable social implications of their technologies as a condition of obtaining a patent. Such disclosure would force patentees to consider the potential externalities of their inventions, and it would also generate useful private information for policymakers to craft regulatory responses to emerging technologies. Second and relatedly, this Part argues for greater integration of the patent system and other regulatory frameworks to internalize negative externalities from innovations. A wide array of legal interventions—from environmental regulation to tort liability to tax law—internalize the negative externalities of technologies, patented and otherwise. Policymakers should view these nonpatent mechanisms as essential to achieving the patent system's goal of efficiently allocating resources of innovation. Furthermore, this Part shows how the patent system can be a valuable source of information to inform and improve such regulatory responses. Finally, this Part explores several broader implications of this Article. In particular, it cautions against undue technological optimism in innovation law and policy, and it adds greater nuance to the widely accepted view that property rights internalize externalities.

A. *A Modest Role for the Patent System in Internalizing Negative*

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275 *See, e.g.*, Lee, *Distributive*, *supra* note 238, at 325 (arguing for greater attention to distributive values in the patent system); MERGES, *supra* note 239, at 8 (arguing that fairness is central to intellectual property law).

276 *See, e.g.*, Bronsteen, Buccafusco & Masur, *supra* note 230, at 1585–86 (advocating a subjective conception of welfare centered on happiness); Tur-Sinai, *supra* note 230, at 149–51 (arguing for a conception of welfare based on objective well-being).

Externalities

The present inability of the patent system to internalize negative externalities gives rise to an important question: What is the proper role of the patent system in performing this function? This Article argues that it can only play a limited role. This is somewhat ironic given that, by incentivizing investments in innovation, the patent system causes (or at least exacerbates) many of these negative externalities. For a variety of reasons, however, the patent system is ill-suited to directly internalize negative externalities from many patented inventions.

First, the patent system is a blunt instrument that lacks the granularity of other regulatory mechanisms to internalize innovation externalities. The development and application of a technology presents numerous potential opportunities for internalizing negative externalities. Consider, for instance, the invention and deployment of an internal-combustion engine that emits large amounts of greenhouse gases when operated at high capacity. One could internalize the negative externalities of this engine by, for instance, banning it outright,[277] discouraging its development by denying its patentability, or regulating or taxing its use by end users. In many cases, innovation externalities depend significantly on how parties use a technology. For instance, perhaps utilizing the engine at less than full capacity greatly reduces emissions, which suggests the appropriateness of some kind of regulation to limit such use. However, the patent system has no ability to regulate how parties *use* a technology and is a rather blunt instrument for internalizing externalities. At most, the patent system can determine if an invention gets a patent.[278] It cannot directly force an inventor to redesign a technology or require that downstream parties only use it in a particular manner. As discussed further below, other legal mechanisms that feature greater granularity play a valuable role in internalizing negative externalities from innovations in a more contextual and use-based manner.[279]

Additionally, the patent system features several pragmatic and institutional constraints that limit its ability to internalize externalities from patented inventions. First, there are challenges of timing and foreseeability. Many negative externalities from patented inventions are

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277 *See* Hrdy, *supra* note 11, at 353–54 (discussing bans on technology).

278 *Cf.* Diamond v. Chakrabarty, 447 U.S. 303, 317 (1980) ("The grant or denial of patents on micro-organisms is not likely to put an end to genetic research or to its attendant risks. . . . Whether respondent's claims are patentable may determine whether research efforts are accelerated by the hope of reward or slowed by want of incentives, but that is all.").

279 *See infra* Section V.B.

speculative at the time of invention and patent prosecution. Even if inventors or patent examiners could foresee these externalities, they could not precisely predict their scope and magnitude. Second and relatedly, the PTO lacks institutional competence to identify and evaluate negative externalities. PTO examiners are experts in technical fields, but they are not experts in identifying negative externalities from technologies.[280] As noted, these same institutional competence limitations contributed to the demise of the moral utility doctrine.[281]

While this analysis suggests that the patent system should play a modest role in internalizing innovation externalities, it can still make valuable contributions. Some might argue that the patent system should not concern itself with internalizing externalities because other regulatory mechanisms are better situated to do so. This Article does not argue that the patent system should displace these other internalizing mechanisms; rather, it should supplement them. The persistence of significant negative externalities from patented technologies—even those subject to downstream regulation—suggests that existing regulations are inadequate, perhaps due to lack of enforcement or legislative and regulatory capture. Internalizing mechanisms can be additive; for some kinds of inventions, there is good reason to utilize both the patent system and downstream regulations to more fully internalize negative externalities. It may be particularly appropriate to use the patent system to internalize negative externalities where an invention's negative externalities are intrinsic to its purpose or design and less dependent on how someone uses it. In such cases, denying patentability can significantly discourage the development and dissemination of such inventions (without resorting to outright bans). Indeed, this kind of logic informed the moral utility requirement, which historically denied the patentability of "immoral" inventions such as methods of assassination.[282]

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280 Timothy R. Holbrook, *The Expressive Impact of Patents*, 84 WASH. U. L. REV. 573, 602–03 (2006) ("The PTO is not in a position to assess all of the potential consequences of a given invention, whereas, through the disclosures of the patentee, they are in a relatively good position to assess the benefits.").

281 *See supra* note 140 and accompanying text. In addition to the PTO, courts are also limited in their ability and willingness to evaluate the negative externalities of novel inventions. For example, in determining whether a genetically modified microorganism constituted patentable subject matter, the Supreme Court famously declined to assess the potential harmful effects of genetic engineering. *See Chakrabarty*, 447 U.S. at 317 ("What is more important is that we are without competence to entertain these arguments—either to brush them aside as fantasies generated by fear of the unknown or to act on them. The choice we are urged to make is a matter of high policy for resolution within the legislative process after the kind of investigation, examination, and study that legislative bodies can provide and courts cannot.").

282 *See supra* notes 138–40 and accompanying text.

Finally, as elaborated further below, the patent system can play a valuable role in generating information about emerging and potentially problematic inventions, thus assisting policymakers in crafting appropriate regulations to internalize those inventions' negative externalities.

Various reforms could enhance the patent system's capacity to internalize the negative externalities of patented inventions. Focusing on automation technologies, economists Anton Korinek and Joseph Stiglitz argue that shortening the patent term could mitigate the pecuniary externalities of automation by redistributing some innovator surplus to workers and consumers.[283] Legal scholar Camilla Hrdy has proposed requiring inventors of automation technologies to disclose the negative effects of their inventions, with the possibility of denying patents on technologies that displace significant numbers of jobs.[284]

This Article proposes a more general, disclosure-based method to help internalize negative externalities from patented technologies in all fields of innovation. Within this proposal, patent examiners could flag individual patent applications for additional disclosure if they raised significant potential for negative externalities. Patent applicants would then be required to disclose potential harms by including a "Societal Impacts" section in their application. Importantly, this disclosure would operate as a purely procedural requirement. If flagged, patent applicants would have to disclose all reasonably foreseeable harms of their technology, but such disclosures would typically not be the basis for rejecting the application.[285] By largely eliminating the threat of denying patentability, this requirement would encourage patent applicants to provide the most candid and thorough disclosure of potential technological harms.

While this proposal faces significant challenges of compliance, it still represents a valuable improvement over the status quo. At the margin, such a disclosure requirement would encourage some patent applicants to sincerely grapple with the consequences of their invention. It is possible, however, that many applicants subject to this "Societal Impacts" requirement would not take it seriously. However, while patent examiners would generally not reject patent applications on substantive grounds due to disclosed externalities, they could reject applications on procedural grounds if they had reason to believe that an

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283 Korinek & Stiglitz, *supra* note 32, at 374.

284 Hrdy, *supra* note 11, at 354–55.

285 An exception would arise in extreme and obvious cases where disclosed harms would justify rejecting the patent application under the current, watered-down version of the moral utility requirement.

applicant had not fully disclosed societal impacts in good faith.[286] It is also possible that patent applicants would file long, boilerplate lists of potential adverse impacts akin to risk disclosures submitted by public companies in response to Securities and Exchange Commission requirements. Such mandatory disclosures have been variously criticized as both overreporting and underreporting risks, neither of which is ideal.[287] Here again, the patent examiner's procedural review could prevent patent applicants from simply filing long lists of generic risks that are both overinclusive and insufficiently tailored to the particular invention at issue. Over time, a kind of "prior art" of model Societal Impacts statements would emerge, thus making it easier for patent applicants and examiners to recognize effective disclosures.

This decidedly modest proposal would help internalize negative externalities in two ways.[288] First, it would be a *consideration*-forcing mechanism that would compel inventors to identify, contemplate, and evaluate the potential harms and social implications of their inventions. Almost by definition, parties do not account for externalities when pursuing a course of action. Of course, inventors may be aware of the negative externalities of their technologies and do nothing to mitigate them. However, for some inventors, awareness of harmful third-party effects may spur behavioral change. In rare cases, such awareness may lead an inventor to abandon an invention. More likely, however, it may

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286 This proposal would also allow patent applicants to submit an amended Societal Impacts disclosure in response to an initial rejection by the patent examiner. This raises a technical question regarding priority. Generally, the disclosure of a patent application is fixed at the time of filing, though patent applicants frequently amend the claims during prosecution. *See* 35 U.S.C. §§ 132, 251. If an applicant introduces "new matter" into the disclosure, she risks losing her priority date and instead establishes a later (and less favorable) priority date corresponding to the date she introduced the new matter. Implementation of this proposal would require that the Societal Impacts section would not be subject to the prohibition against introducing "new matter." Relatedly, implementing legislation should clarify that the Societal Impacts statement would not be regarded as part of the specification for purposes of satisfying requirements of patentability or construing claims.

287 Virginia Harper Ho, *Disclosure Overload? Lessons for Risk Disclosure & ESG Reporting Reform from the Regulation S-K Concept Release*, 65 VILL. L. REV. 67, 70 (2020).

288 One of the virtues of this modest approach is that it heeds Demsetz's famous caution against comparing existing (imperfect) institutional arrangements to an ideal norm. *See* Demsetz, *Information and Efficiency*, *supra* note 153, at 1 ("[T]hose who adopt the nirvana viewpoint seek to discover discrepancies between the ideal and the real and if discrepancies are found, they deduce that the real is inefficient."). In light of the failure of patents and markets to internalize negative externalities, one might turn to more aggressive government regulation to perform this function. While greater regulation may be warranted, such an approach entails significant cost, complications, and inefficiencies. The present proposal is a modest, actionable suggestion to increase private information disclosure without mobilizing significant new government intervention.

motivate inventors to redesign their inventions to reduce negative externalities. As in the example above, forcing inventors to consider the negative implications of predictive policing may lead them to engineer certain safeguards against biased algorithms.[289]

Additionally, this proposal would help fill the gaps left by existing downstream regulations that already internalize negative externalities from technology. Inventors undoubtedly consider some downstream regulations—such as environmental laws and tort liability—when designing new technologies. However, some negative externalities—such as increased political polarization from Facebook's filter bubble—do not fit comfortably within existing regulations or causes of action. A requirement for patentees to consider the broad social implications of their inventions would encourage them to confront a wider set of negative externalities that downstream regulations do not currently address.

Notably, this proposal dovetails with actual and proposed practice in other areas of scientific research that conditions certain rewards on disclosing the social implications of one's research. For decades, the National Science Foundation has evaluated funding proposals on two criteria: intellectual merit and "broader impacts," which considers whether and how a project helps achieve wider societal goals.[290] Additionally, scientists have suggested that peer reviewers consider the social implications of research when determining whether to recommend article manuscripts for publication.[291]

Second, and perhaps more importantly, this proposal would be an *information*-forcing mechanism that would generate information about patented inventions from particularly knowledgeable sources—inventors themselves. In so doing, this proposal would sidestep institutional competence limitations of patent examiners, who are not experts in identifying the third-party costs of new technologies. As elaborated further below, such private information about social media, autonomous vehicles, big data, and other innovations would be highly

289 *See supra* Section I.D.3.

290 NAT'L SCI. FOUND., PERSPECTIVES ON BROADER IMPACTS 1 (2014), https://www.nsf.gov/od/oia/publications/Broader_Impacts.pdf [https://perma.cc/8VKS-VJP4].

291 *See* Hecht et al., *supra* note 71 ("Peer reviewers should require that papers and proposals rigorously consider all reasonable broader impacts, both positive and negative."); *see also* Amy Bruckman, *"Have You Thought About . . . ": Talking About Ethical Implications of Research*, 63 COMMC'NS ACM, Sept. 2020, at 38, 38 (encouraging researchers to confront and discuss the potential negative effects of technologies).

valuable to policymakers when crafting interventions to address problematic technologies or uses of technology.[292]

B. *Integrating the Patent System with Other Regulatory Mechanisms to Internalize Negative Externalities*

Given the modest nature of this proposal, the broader prescription arising from this Article is greater integration of patent and nonpatent mechanisms in a holistic policy framework to internalize negative externalities from technological innovation.

In recent years, scholars have fruitfully explored the importance of nonpatent policy levers in supplementing the patent system and promoting innovation. For instance, government grants, tax breaks, and prizes fill sizable gaps in the patent system in generating and distributing new technologies.[293] Notably, these are "affirmative" mechanisms that encourage innovative activity. In the language of externalities, they are subsidies aimed at helping innovators internalize more of the positive externalities of their creations.

This Article explores the flip side of this dynamic by highlighting the significant negative externalities of patented technologies and the need to internalize them. This Article has further shown that the patent system is limited in its ability to internalize negative externalities. However, many other areas of law operate as "restrictive" mechanisms that internalize negative externalities from technology—patented or otherwise. In so doing, these mechanisms help fill significant gaps in the patent system; indeed, "downstream" regulation is generally superior to the patent system in internalizing externalities because it is more granular in nature and can regulate particular uses of technologies. For instance, environmental laws regulate greenhouse gas emissions,[294] pesticides,[295] and toxic substances.[296] The Food and Drug Administration regulates drugs, and it may require drug manufacturers to develop Risk Evaluation and Mitigation Strategies for particularly

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292 *See infra* Section V.B.

293 *See generally* Hemel & Ouellette, *Pluralism*, *supra* note 122 (comparing various policy options for promoting innovation).

294 Clean Air Act, 42 U.S.C. § 7521(a)(1); *see* Massachusetts v. EPA, 549 U.S. 497, 528 (2007) (holding that the EPA has authority to regulate gas emissions from new motor vehicles).

295 Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. § 136.

296 Toxic Substances Control Act, 15 U.S.C. § 2601.

risky drugs.[297] Tort law—particularly products liability law—can internalize negative externalities from poorly designed technologies.[298] Congress has been debating numerous proposals to modify Section 230 of the Communications Decency Act to impose greater liability on social media companies for content posted on their platforms.[299] A primary legal mechanism for internalizing externalities is Pigouvian taxation.[300] For instance, a carbon tax would help internalize negative externalities from all carbon-emitting technologies (including patented inventions).[301] Commentators have also proposed taxing owners of patents on automation technology and redistributing gains to displaced workers.[302] Local jurisdictions can also act; for example, San Francisco has prohibited the police and other government agencies from using facial recognition technology.[303]

This Article calls for greater integration of patent and nonpatent mechanisms to internalize negative externalities from innovation. Such integration should occur on both conceptual and pragmatic levels. At a conceptual level, policymakers should recognize that "restrictive" laws and regulations that internalize negative externalities from innovation are not wholly external to the patent system's objectives. While such restrictive mechanisms appear unhelpful or even antagonistic to the patent system's aim of promoting technological progress, this Article argues that they are essential for the patent system to achieve its

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297 *See* Michael A. Carrier & Brenna Sooy, *Five Solutions to the REMS Patent Problem*, 97 B.U. L. REV. 1661, 1665–68 (2017); Susan C. Nicholson, Janet Peterson & Behin Yektashenas, *Risk Evaluation and Mitigation Strategies (REMS): Educating the Prescriber*, 35 DRUG SAFETY 91, 92 (2012).

298 For instance, plaintiffs have sued Tesla for deaths caused by its vehicles while using semi-autonomous driving technology. *See* Boudette, *supra* note 86; Jason Murdock, *Tesla Faces Lawsuit After Model X on Autopilot with "Dozing Driver" Blamed for Fatal Crash*, NEWSWEEK (Apr. 30, 2020, 4:45 AM), https://www.newsweek.com/tesla-lawsuit-model-x-autopilot-fatal-crash-japan-yoshihiro-unmeda-1501114 [https://perma.cc/DR5F-DJ5V]; Jamin Xu, *Liability of Tesla's Autopilot System Under California Tort Law*, B.C. INTELL. PROP. & TECH. F. (June 5, 2017), http://bciptf.org/wp-content/uploads/2017/06/Liability-of-Teslas-Autopilot-System-FINAL-EDITS-1.pdf [https://perma.cc/34C3-965D].

299 Meghan Anand et al., *All the Ways Congress Wants to Change Section 230*, SLATE (Mar. 23, 2021, 5:45 AM), https://slate.com/technology/2021/03/section-230-reform-legislative-tracker.html [https://perma.cc/79WQ-PF7J].

300 *See* Liscow & Karpilow, *supra* note 60, at 390–91; Jonathan S. Masur & Eric A. Posner, *Toward a Pigouvian State*, 164 U. PA. L. REV. 93 (2015).

301 *See* Korinek & Stiglitz, *supra* note 32, at 370 (discussing carbon taxes).

302 *See, e.g.*, *id.* at 371; Hrdy, *supra* note 11, at 358–59.

303 Kate Conger, Richard Fausset & Serge F. Kovaleski, *San Francisco Bans Facial Recognition Technology*, N.Y. TIMES (May 14, 2019), https://www.nytimes.com/2019/05/14/us/facial-recognition-ban-san-francisco.html?smid=url-share [https://perma.cc/U4UH-MSDQ].

objectives.[304] Patent law does not aim to maximize innovation at all costs; it seeks efficiency in the allocation of resources for innovation. Patents, however, are unlikely to achieve this goal because they asymmetrically internalize positive but not negative innovation externalities. In essence, patents provide too much acceleration and not enough braking. Restrictive mechanisms outside of patent law can correct for patent law's externality asymmetry and help achieve more efficient outcomes. In this sense, environmental law, food and drug regulation, tort law, communications law, taxes, and other regulatory mechanisms are not external to the patent system but play a critical role in achieving its goals.

Scholars recognize that "affirmative" mechanisms such as public funding, tax incentives, and prizes both complement and support the patent system's aims. In symmetric fashion, "restrictive" mechanisms that internalize externalities from innovation also support the patent system's aim of efficiently allocating resources for innovation.

At a pragmatic level, this Article also argues for strengthening connections between the patent system and other forms of technological regulation, primarily by providing valuable information. Many technologies generating significant negative externalities in society today, from filter bubbles to autonomous vehicles to predictive policing, began as patented inventions. While the patent system is not well equipped to internalize the negative externalities of such inventions directly, it is uniquely positioned to generate information about them. In the classic formulation of the patent quid pro quo, inventors receive valuable exclusive rights in exchange for disclosing the technical details of a novel invention.[305] The inducement of exclusive rights, however, can motivate even more disclosure, for instance into the foreseeable social ramifications of a new technology.[306] Such privately generated information is highly valuable in alerting policymakers to impending problems from emerging technologies and helping them craft appropriate responses utilizing environmental law, food and drug

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304 On a somewhat related note, Tejas Narechania has explored how patents can conflict with certain policy objectives advanced by agencies other than the PTO. Tejas N. Narechania, *Patent Conflicts*, 103 GEO. L.J. 1483, 1486 (2015). While his focus is different, this Article makes the broader point that some of these conflicts should not be perceived as conflicts at all; patent policy should welcome some regulation of technologies and curtailing of exclusive rights to advance its overarching objective of increasing efficiency in the allocation of resources for innovation.

305 Universal Oil Prods. Co. v. Globe Oil & Refin. Co., 322 U.S. 471, 484 (1944) ("[T]he quid pro quo [for the patent grant] is disclosure of a process or device in sufficient detail to enable one skilled in the art to practice the invention once the period of the monopoly has expired . . . .").

306 *See supra* Section V.A.

regulation, tax law, or any number of other regulatory levers.[307] Such information can allow the patent system, which is not well positioned to internalize negative externalities directly, to support downstream regulations that can internalize externalities in a nuanced and contextual manner.

It bears emphasizing that not all negative externalities warrant internalization, and policymakers must decide when efficiency, distributive equity, fairness, or other considerations justify intervention.[308] Furthermore, internalization is a dynamic rather than static analysis. As Brett Frischmann reminds us, "[T]he benefits and costs of internalization must include not only impacts on internalizing actors but also impacts on third parties."[309] Thus, for instance, internalizing a negative externality for one party could generate a cascade of difficult-to-predict positive or negative externalities for others. Given the complexity of these interdependencies, policymakers can make better decisions regarding whether and how to internalize innovation externalities when they rely on better information.

C. *Broader Implications: Technological Realism and the Limits of Property Rights*

At a broader level, this Article argues for greater technological realism in innovation law and policy. From individual technologies that enhance our daily lives to macroscopic contributions to economic growth, the benefits of innovation are undeniable. Technological optimism clearly informs the patent system, which exists to promote technological progress. Such optimism also informs patent policy and scholarship; while patent scholars debate whether patents are good or bad in particular situations, the unstated assumption is that technology itself is good and, all things being equal, more technology is better.[310] However, technology creates costs as well as benefits. More technology does not always advance social welfare, especially when that technology creates negative externalities. Greater technological realism—a measured accounting of the costs and benefits of technology—will lead to more enlightened innovation policy.

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307 *See* Diamond v. Chakrabarty, 447 U.S. 303, 317 (1980) (noting the role of "investigation, examination, and study" in crafting legislative responses to new technologies).

308 *See supra* Section I.A; *cf.* Frischmann, *Demsetzian*, *supra* note 35, at 668 ("In the end, the benefits of internalization must be carefully assessed rather than assumed.").

309 Frischmann, *Spillovers Theory*, *supra* note 42, at 812.

310 *See* Bair, *supra* note 11, at 33–36.

This Article ends by considering the implications of patents and cutting-edge technologies for foundational property theory. Demsetz famously argued that property rights internalize externalities. Furthermore, he generalized beyond the land context to argue that property rights serve this function in numerous settings, including intellectual property.[311] As this Article has shown, however, the precise subject matter, context, and design of property rights are crucial to their ability to internalize externalities. In the land context, property rights cover rivalrous assets, facilitate negotiations between a relatively small number of parties, and create affirmative duties to not harm others. These parameters are very different for patents, which internalize positive externalities but do little to internalize negative ones. In sum, this Article questions the foundational belief that granting exclusive rights, in and of itself, will substantially internalize externalities. And where property rights and private ordering do not perform this function, public intervention can play a valuable role in advancing efficiency and other normative objectives.

CONCLUSION

Technology generates significant positive externalities, a dynamic reflected in the very existence of the patent system itself. This Article has called attention to the less appreciated fact that technology also generates significant negative externalities. Foundational economic theory suggests that internalizing positive and negative externalities is important for achieving efficient resource allocation. This Article has argued that patent law exhibits a striking asymmetry in this regard: while patents exist to internalize positive externalities, they do very little to internalize negative externalities associated with innovation. Patent law's externality asymmetry is particularly notable in light of influential theory positing that property rights are critical to internalizing both kinds of externalities. In the land context, property rights mitigate negative externalities in several ways that are largely inapplicable to patents. Patents do not resolve tragedies of the commons, and they encourage rapid exploitation of technologies rather than measured considerations of their third-party harms. Patents do not realistically facilitate efficiency-maximizing negotiations between technology owners and parties harmed by their technologies. Finally, patents create no duties for patentees to mitigate (or even consider) the harms of their

311 Demsetz, *Property Rights*, *supra* note 13, at 359.

technologies on external parties. Patents are a one-way ratchet that allows patentees to profit from their inventions while not holding them accountable for their third-party costs.

Patent law's externality asymmetry is problematic for several reasons. Most prominently, it undermines patent law's primary aim of efficiency. By ignoring negative externalities, the patent system overincentivizes innovation, incentivizes the wrong mix of innovations, and provides suboptimal incentives for technological design. Beyond diminishing efficiency, patent law's externality asymmetry also undermines distributive equity and fairness. While the patent system's ability to internalize negative externalities is limited, this Article proposes compelling patent applicants to disclose the potential harms of certain technologies as a condition of obtaining a patent. This is a decidedly modest proposal, and this Article also highlights the need to integrate patent and nonpatent regulatory mechanisms to internalize the negative externalities of technologies—patented and otherwise. It calls for greater technological realism in innovation law and policy, and it questions the fundamental association of property rights and market exchanges with efficient allocations of resources. Market allocations are not always efficient (particularly in the presence of externalities), and while technology offers significant promise, it also creates significant perils.