ANTI-INTELLECTUALISM IN AMERICAN INTELLECTUAL PROPERTY

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The thesis of this Article is that the venerable principle that abstract ideas are not patentable does not rest on a solid foundation. I approach the problem by way of the Supreme Court's reinvigoration of patent eligibility doctrine—arguably the most important recent development in patent law. The modern Court has grounded the exclusion of abstract ideas on the rationale that they are "basic tools" or "building blocks" of future scientific discovery such that their patenting would "preempt" a great deal of downstream innovation. I argue that this rationale is infirm because the building-block potential of abstract ideas signifies not just the cost of monopolizing them but also the benefit of incentivizing them, which is what a patent is meant to do. Specifically, for the preemption rationale to work, it must be true that the costs of patent protection increase at a greater rate than its benefits as an invention becomes more abstract, satisfying what I call a "single-crossing condition." But there is no reason to suppose that this condition holds. Nor are the other justifications for the abstract-ideas exclusion convincing, as I find from a systematic review of caselaw and commentary. For the most part, the reasons given for distinguishing abstract ideas are either not reasons—they just restate the conclusion in different terms, or not distinguishing—they provide plausible arguments against patenting that apply just as well to other (non-abstract) subjects of patents. In the end, there appears to be no better reason for excluding abstract ideas than that we have always done it.

This pessimistic verdict does not necessarily imply that the Supreme Court's recent intervention in patent eligibility has been net harmful; it may well be that reinvigorated subject matter exclusions provide a fast track to get rid of bad patents. But my analysis does imply that the benefits of the new approach have nothing to do with excluding abstract ideas as such. It thus helps separate what is good from what is bad in the new eligibility doctrine. More broadly, this Article critically reexamines a foundational principle which long predates the new eligibility doctrine and which pervades the whole of patent law. Some implications of this foundational reexamination are probably too profound to have much practical chance of implementation. But the analysis also points to doctrinal tweaks, substantive and procedural, that can improve patent law on the ground.

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A patent system must be related to the world of commerce,
rather than to the realm of philosophy.
- *Brenner v. Manson*, 383 U.S. 519, 536 (1966)

INTRODUCTION

In the past decade, the Supreme Court breathed new life into the doctrine of patentable subject matter (aka patent eligibility) after the Federal Circuit had left it for dead.[1] The revival of the doctrine—which holds that "laws of nature, natural phenomena, and abstract ideas" are not eligible for patent protection[2]—is arguably the most important development in patent law over the past few decades. It has propelled the question of patent eligibility from relative obscurity to the forefront of patent practice and scholarship.[3] Judges of the Federal Circuit, which has exclusive jurisdiction over patent appeals, have voiced deep concern over the Court's new doctrine.[4] The Patent and Trademark Office has scrambled to offer guidelines for its interpretation.[5] Congress has considered amending the law.[6] Scholars, too, have been active in this policy debate: Some have criticized the eligibility exclusions[7] while others have offered qualified defenses or have sought to rationalize and explain the Court's jurisprudence.[8]

This Article joins the new patent eligibility debate—but only as an entry point to examining a much deeper, and more longstanding, principle. My ultimate object is not to judge the desirability of the Supreme Court's intervention (though I will speak to that too) but rather to

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[1] The four cases responsible for the revival are Bilski v. Kappos, 561 U.S. 593 (2010); Mayo Collaborative Servs. v. Prometheus Lab'ys, Inc., 566 U.S. 66 (2012); Assoc. for Molecular Pathology v. Myriad Genetics, Inc., 569 U.S. 576 (2013); Alice Corp. v. CLS Bank International, 573 U.S. 208 (2014).

[2] *Prometheus*, 566 U.S. at 70; *Alice*, 573 U.S. at 216.

[3] [Some measures of this: (1) portion of pages dedicated to patent eligibility in leading patent and IP casebooks before and after the Court's quartet; (2) Westlaw search for relevant terms in caselaw before and after the quartet; (3) Westlaw search for relevant terms in scholarly articles before and after the quarter; (4) the fact that some leading pre-quartet articles on patent law, in the Background section explaining the requirements of patentability to a generalist law audience, did not even mention patentable subject matter.]

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[7] *See, e.g.*, Michael Risch, *Everything Is Patentable*, 75 TENN. L. REV. 591 (2008); Ted Sichelman, *Funk Forward: Funk Brothers Seed Co. v. Kalo's Pernicious Effects on Patentable Subject Matter in Prometheus and Otherwise*, *in* INTELLECTUAL PROPERTY AT THE EDGE: INFORMATION LAW (Rochelle Dreyfuss & Jane Ginsburg eds., 2014); Dmitry Karshtedt, *The Completeness Requirement in Patent Law*, 56 B.C. L. REV. 949 (2015); David O. Taylor, *Confusing Patent Eligibility*, 84 TENN. L. REV. 157 (2016); Christopher M. Holman, *The Mayo Framework Is Bad for Your Health*, 23 GEO. MASON L. REV. 901 (2016).

[8] *See, e.g.*, Mark Lemley, Michael Risch, Ted Sichelman, & R. Polk Wagner, *Life After Bilski*, 63 STAN. L. REV. 1315 (2011); Rochelle C. Dreyfuss & James P. Evans, *From Bilski Back to Benson: Preemption, Inventing Around, and the Case of Genetic Diagnostics*, 63 STAN. L. REV. 1349 (2011); Katherine Strandburg, *Much Ado About Preemption*, 50 HOUSTON L. REV. 563 (2012); Alan J. Heinrich & Christopher T. Abernethy, *The Myriad Reasons to Hit "Reset" on Patent-Eligibility Jurisprudence*, 47 LOY. L.A. L. REV. 117 (2013); Dan L. Burk, *The Curious Incident of the Supreme Court in Myriad Genetics*, 90 NOTRE DAME L. REV. 505 (2014); Andrew Beckerman-Rodau, *Patent Eligible Subject Matter: Protecting the Public Domain*, 72 BAYLOR L. REV. 233 (2020); Talha Syed, *Reconstructing Patent Eligibility*, 70 AM. U. L. REV. 1937 (2021).

rigorously probe the underlying principle that abstract ideas are not patentable. The importance of applying this principle has increased since the Court's new intervention, but the principle itself long predates the intervention. Its roots in American jurisprudence go back to the mid-Nineteenth Century[9] and in English jurisprudence to a half century earlier.[10] Indeed the principle is so foundational that is often stated as a self-evident truth.[11] But I shall argue that this foundational canon does not rest on a solid foundation.

I begin my critical reexamination by scrutinizing the Supreme Court's modern rationale for excluding abstract ideas, which it calls "preemption." The idea is that laws of nature, natural phenomena, and abstract ideas are "the basic tools of scientific and technological work," such that patenting them would "preempt" or "tie up" a great deal of downstream innovation.[12] "Upholding the patents," the Court has said, "would risk disproportionately tying up the use of the underlying natural laws, inhibiting their use in the making of further discoveries."[13] I argue that this rationale is faulty because it misses the simple but vital point that greater cost signifies concomitantly greater benefit. The value of an invention to future inventive activity does not only signal the *costs* of monopolizing certain uses of the invention; it also signals the *value* of the invention and, thus, of incentivizing it. The Court is correct that the more valuable an invention is to future invention, the more socially costly its monopolization is; but it somehow misses the corollary that the more valuable an invention is to future invention, the more socially valuable the invention is. The very fact that raises monopoly costs also heightens the imperative of providing creative incentives, which is what patents do.

So the Court's analysis rests—logically, it must rest—on the assumption that the social costs of patenting an invention increase at a greater rate than the social benefits as the invention moves up the spectrum of abstractness. It bears repeating this point, for it is a necessary, albeit unarticulated, premise of the Court's theoretical argument: An invention has social value, and part of its social value is as fodder for future invention. The greater the fodder value of an invention, the more harmful it is to monopolize it, as the Court has recognized; but, by the same token, the greater the fodder value of an invention, the more important it is to incentivize it. For an increase in an invention's abstractness (and hence its fodder value)[14] to tip the scales in favor of unpatentability, as per the Court's rationale, it must be true that the increase in abstractness raises the social costs of intellectual property protection at a greater rate than it raises social benefits. To put a fine point on it, the graph of the costs and benefits of patenting as a function of an invention's abstractness must look something like this:

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[9] *See* Le Roy v. Tatham, 55 U.S. (14 How.) 156 (1853); O'Reilly v. Morse, 56 U.S. (15 How.) 62 (1854).

[10] *See* Boulton & Watt v. Bull (1795) 2 Blackstone (H.) 463, 126 E.R. 651; Neilson *v.* Harford (1841) 151 E.R. 1266, Webster's Patent Cases 295.

[11] *See* Strandburg, *supra* note 8, at 571 (noting that even in *LeRoy*, the earliest American case often cited on the question of patent eligibility, the Court took the exclusion of abstract ideas "essentially as self-evident").

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[14] Some commentators have contested the premise that more abstract inventions have greater value as fodder for downstream innovation. *See* Strandburg, *supra* note 8, at 577-78 ("Not all [p]henomena of nature, . . . mental processes, and abstract intellectual concepts have sweeping downstream impact."). I shall not contest this assumption—which seems fairly reasonable to me as far as categorical assumptions go—but shall rather argue that it is an insufficient basis for categorical exclusion. *See infra* note 41.

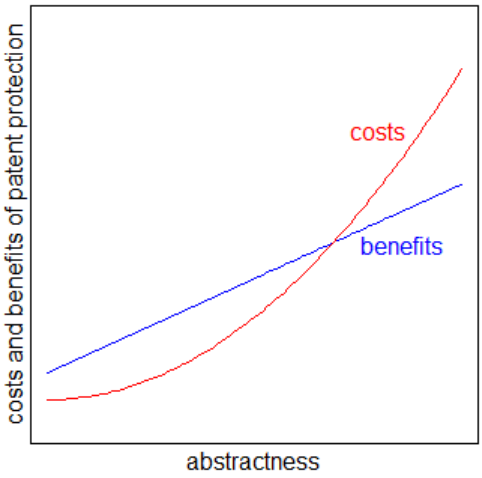

Figure 1: The social costs and benefits of patent protection as a function of an innovation's abstractness, as implicitly hypothesized by the Supreme Court.

What is important in this figure is not the precise functional forms plotted but its illustration of a necessary assumption for the validity of the Court's preemption rationale—that the benefits of patent protection should increase at a greater rate than its costs in an invention's abstractness, such that the benefit-cost balance flips from positive to negative beyond some level of abstractness. I shall call this crucial assumption the *single-crossing condition*.[15] But the Court has offered no reason, and there is no reason, to suppose that this necessary condition holds. So the preemption (or "building blocks" or "basic tools") rationale is infirm.[16]

A thorough analysis of the abstract-ideas exclusion, however, demands more than rebutting the preemption rationale. In more than a century and a half of jurisprudence bearing on the question, the Supreme Court has also offered other rationales for the exclusion. Commentators have amplified some of these rationales and have offered their own. Synthesizing the jurisprudence and commentary, I identify six additional principal arguments against patenting abstract ideas: (1) that the exclusion is justified by analogy to the exclusion of ideas from copyright, (2) that patenting abstract ideas would result in vague or overbroad claims, (3) that patenting abstract ideas would give an innovator a monopoly over a multitude of unforeseen applications, (4) that patenting abstract ideas would prevent people from thinking about or doing research, (5) that abstract ideas are discoveries, not inventions, and (6) that as a matter of comparative institutional analysis, non-IP regimes of incentivizing innovation are better suited to abstract ideas. I show that all these arguments are wanting. For the most part, these

[15] This refers, obviously, to the fact that the cost and benefit curves cross once. I take the term from economics, where it pops up in different contexts including social choice theory, mechanism design, and contract theory. *See, e.g.*, TORSTEN PERSSON & GUIDO TABELLINI, POLITICAL ECONOMICS: EXPLAINING ECONOMIC POLICY 23 (2000); BERNARD SALANIÉ, THE ECONOMICS OF CONTRACTS 31-32 (2d ed. 2005). For a precise, formal statement of the condition, see *infra* note 42.

[16] Other commentators have noted that the Court is improperly insensitive to the benefits of incentivizing broad upstream technologies. *See, e.g.*, Sichelman, *supra* note 7, at 13-14; Strandburg, *supra* note 8, at 581 (citing Sichelman). But to my knowledge no one has pursued the Court's preemption rationale to its logical conclusion to identify and discuss the necessary assumption of a single-crossing relationship between patenting benefits and costs.

distinguishing rationales are either not rationales or not distinguishing—some of them merely restate or rephrase the exclusion without actually providing a reason for it while others provide plausible reasons against patenting that apply just as well to other (non-abstract) subjects of patents.

In particular, the argument based on institutional choice, which in some ways provides the most plausible rationale for the abstract-ideas exclusion, is based in part on ignoring the problem of *endogeneity*. That is, the argument takes certain features of the production of basic science as given, using them as evidence in support of an IP regime that excludes basic science, without recognizing that those features are the product of having just such an IP regime. For example, the fact that basic science seems to attract a greater portion of people who are not driven by the profit motive is partly an artifact of the fact that the unavailability of patents greatly reduces the profit potential of doing basic science; therefore, grounding one's defense of the present system on differential profit motives among basic and applied scientists amounts to circular inference.[17] Failure to seriously engage the counterfactual of an IP regime that embraces abstract ideas ultimately dooms the institutional argument.

My analysis does not spell out an argument for patentability; it spells out an argument for equality. What I show is that *different* treatment of abstract and applied ideas does not make sense. Therefore, an institutional designer proceeding from first principles and working from scratch would do better to give them the same treatment. Whether that treatment is to make them all patentable or all unpatentable depends on one's views of the pros and cons of intellectual property rights compared to other innovation policy regimes, a question beyond the scope of this Article (or any one article, for that matter).[18]

Debunking the rationales for second-class treatment of abstract ideas has profound implications for patent law. The most profound apparent implication—that basic and applied science should be treated equally, either both patentable or both unpatentable—has approximately zero practical chance of implementation. But this Article's theoretical contribution does have practical payoffs. It helps us see that what is good about the Supreme Court's renewed engagement with patent eligibility has nothing to do with the preemption rationale nor even more broadly with the exclusion of abstract ideas. In this light, the fact that the Court's doctrinal test for implementing the abstract-ideas exclusion is unmoored from the exclusion's rationale—a feature astutely pointed out by Katherine Strandburg and others[19]—is revealed as a blessing rather than a curse. It is theoretically incoherent but it produces better outcomes than a coherent test would. Specifically, the virtue of the Court's intervention is that provides a procedural fast track to invalidate bad patents—albeit patents that are bad for reasons other than being abstract.[20] This suggests both procedural and substantive improvements. Procedurally, courts would do well to develop doctrines designed to make certain patent validity determinations early in the litigation process. Substantively, a broad abstract-ideas exclusion

[17] *See infra* notes 129-143 and accompanying text.
[18] For a brief survey of different views on this question, see *infra* notes 117-118, 125-127 and accompanying text.
[19]
[20] See Gugliuzza and others.

could be replaced with more targeted exclusions for questionable patents in areas like business methods and software.

The rest of this Article is organized as follows. Part I reviews and synthesizes the jurisprudence of patentable subject matter. Part II is the theoretical heart of the paper. I begin in Part II.A by distinguishing the three classic subject matter exclusions—abstract ideas, laws of nature, and natural phenomena—and explaining why my analysis does not apply to natural phenomena. Then in Part II.B I discuss the standards that an acceptable argument for excluding abstract ideas must meet, and in Parts II.C-II.J I show why none of the extant arguments meets these standards. The theoretical discussion concludes in Part II.K by connecting patent law's second-class treatment of abstract ideas to broader currents of anti-intellectualism in American culture. Part III discusses policy implications. The last Part concludes.

I. THE AGES OF PATENTABLE SUBJECT MATTER

[This Part lays out the development of patent eligibility doctrine. The story is familiar: The categorical exclusions developed early in the caselaw. Different rationales are often mixed together, and sometimes it's unclear whether a case is about patent eligibility or some other requirement of patentability. Some Supreme Court cases interpret the exclusions more stringently than others. Then the Federal Circuit comes in and over the course of two decades waters down the subject matter exclusions. The Supreme Court intervenes to revive the exclusions beginning with *Bilski* and ending with the two-step test in *Alice*.]

[I would appreciate your feedback on how detailed to make this section. Able summaries and syntheses of the caselaw appear in other commentators' work, and I am loath to take too long before getting to my main arguments. One option is to have a short section here and have a more detailed discussion of the cases in an appendix. I have marked the following cases for discussion (though of course I won't be able to discuss them all in detail). If I have missed an important case, please let me know.]

1. Origins: before the 1952 Patent Act
   Boulton & Watt v. Bull (1795) 2 Blackstone (H.) 463, 126 E.R. 651; *Wyeth v. Stone*, 30 F. Cas. 723, 727 (C.C.D.Mass.1840) (No. 18,107) (Story, J.); *Neilson v. Harford* (1841) 151 E.R. 1266, Webster's Patent Cases 295; *Le Roy v. Tatham*, 55 U.S. (14 How.) 156 (1853); *O'Reilly v. Morse*, 56 U.S. (15 How.) 62 (1854); *Rubber-Tip Pencil Co. v. Howard*, 87 U.S. 498 (1874); *Dolbear v. Am. Bell Tel.*, 126 U.S. 1 (1888); *Parke-Davis v. Mulford*, 189 F. 95 (S.D.N.Y. 1911); *Am. Fruit Growers Brogdex*, 283 U.S. 1 (1931); *Mackay Radio v. RCA*, 306 U.S. 86 (1939); *Funk Brothers Seed Co. v. Kalo Inoculant Co.*, 333 U.S. 127 (1948)
2. From the 1952 Act to the Federal Circuit's Creation
   Gottschalk v. Benson, 409 U.S. 63 (1972); *Parker v. Flook*, 437 U.S. 584 (1978); *Diamond v. Chakrabarty*, 447 U.S. 303 (1980); *Diamond v. Diehr*, 450 U.S. 175 (1981)
3. The Federal Circuit's Dominion

Amgen, Inc. v. Chugai Pharm. Co., 927 F.2d 1200 (Fed. Cir. 1991); *In re Alappat*, 33 F.3d 1526 (Fed. Cir. 1994); *State St. Bank & Trust Co. v. Signature Fin. Grp.*, 149 F.3d 1368 (Fed. Cir. 1998); *AT&T v. Excel Communications*, 172 F.3d 1352 (Fed. Cir. 1999); maybe *JEM Ag Supply v. Pioneer Hi-Bred*, 534 U.S. 124 (2001)

4. The Supreme Court's intervention
   Lab. Corp. of Am. Holdings v. Metabolite Labs., Inc., 548 U.S. 124 (2006) (Breyer, J., dissenting from dismissal of cert.); *Bilski v. Kappos* (2010); *Mayo v. Prometheus* (2012); *Assoc. for Molecular Pathology v. Myriad* (2013); *Alice v. CLS Bank* (2014)

II. REEXAMINING THE ABSTRACT-IDEAS EXCLUSION

The foregoing survey of caselaw points up four main rationales—often not distinctly identified—for patent law's categorical subject matter exclusions: (1) the argument that these categories preexist any inventor's innovation, (2) a concern about the vagueness or overbreadth of claims falling in these categories, (3) a concern about giving an innovator too many rights over unforeseen applications of her idea, and (4) the argument that these categories comprise "basic tools" or "building blocks" of future innovation, such that monopolizing them would "preempt" or "hamstring" a wide swath of downstream innovation. The Supreme Court's modern quartet of decisions, especially since Justice Breyer's opinion for a unanimous Court in *Prometheus*, synthesized the prior caselaw and elevated the preemption rationale to prominence. Scholars have elaborated these arguments and added their own, including (5) an argument, related to but distinct from the preemption rationale, that patenting in these categories would hamstring not only innovation but research and thought itself, (6) an argument that patent's exclusions are justified by analogy to copyright's exclusion of ideas, and (7) a comparative-institutional argument that basic science is best left to non-IP regimes of innovation policy. In this Part I take on and assess these arguments. First, though, it is necessary to understand what exactly these excluded categories mean and which of them my analysis targets.

A. Category Definitions and Scope Conditions

The Supreme Court in its century and a half of jurisprudence on the subject has used sundry formulations to identify patent law's subject matter exclusions.[21] Since *Prometheus*, the Court has settled on the three-part formulation "laws of nature, natural phenomena, and abstract ideas."[22] Commentators sometimes meld these categories together or confuse one with another. But they are different, as their names suggest, and a thorough analysis of their theoretical grounding must start by identifying what each category means. The point here is not to craft philosophically airtight definitions out of a rage for ontology or classification but rather to supply

[21] E.g., "laws of nature," "phenomena of nature" and "the work of nature" (*Funk Bros.*, 333 U.S. at 130); "laws of nature, physical phenomena, and abstract ideas"(*Flook*, 437 U.S. at 598-99 (Stewart, J., dissenting); *Chakrabarty*, 447 U.S. at 309); "[p]henomena of nature, . . . mental processes, and abstract intellectual concepts" (*Gottschalk*, 409 U.S. at 67); "a scientific truth" (*Mackay*, 306 U.S. at 94); "an idea of itself" (*Rubber-Tip Pencil*, 87 U.S. (20 Wall.) at 507); "[a] principle, in the abstract," "a new power," and "any other power in nature" (*Le Roy*, 55 U.S. at 175).

[22] *Prometheus*, 566 U.S. at 70; *Myriad*, 569 U.S. at 589; *Alice*, 573 U.S. at 216. The same formulation had previously appeared in *Diehr*, 450 U.S. at 185.

working definitions so we know what we talk about when we talk about each category.[23] An added benefit of this approach, as we shall see, is that it shows how the three different categories might implicate different policies.

Here is my definitional scheme: *Abstract ideas* are ideas that can be expressed with little or no recourse to real-world referents. *Natural phenomena* are phenomena existing or occurring in nature that can be readily perceived by the senses. *Laws of nature* are also relationships or phenomena in nature, but they are not so readily perceivable and instead operate, so to speak, "underneath." In this scheme, then, *laws of nature* is an intermediate category that borders *abstract ideas* on one side and *natural phenomena* on the other.

More concretely, here are some examples of abstract ideas:

- $\frac{d}{d\theta} sin(\theta) = cos(\theta)$.
- If f and g are differentiable functions and $h(x) = f\big(g(x)\big)$ then $h'(x) = f'\big(g(x)\big)g'(x)$.
- Let f be a continuous real-valued function on $[a, b]$ and define F, for all $x \in [a, b]$, as $F(x) = \int_a^x f(t)dt$. Then F is uniformly continuous on $[a, b]$ and differentiable on (a, b), and $F'(x) = f(x)$.
- Let f be a real-valued function defined and integrable on $[a, b]$ and F a continuous function on $[a, b]$ such that, for all $x \in (a, b)$, $F'(x) = f(x)$. Then $\int_a^b \mathrm{f(x)dx} = \mathrm{F(a) - F(b)}$.
- No three positive integers a, b, c satisfy the equation $a^n + b^n = c^n$ for any integer value of n greater than 2.
- Given individual preferences over at least three alternatives, there is no rule for aggregating such preferences over a group of individuals that meets the three criteria of weak Pareto efficiency, independence of irrelevant alternatives, and non-dictatorship (where the relevant terms are defined formally in the footnote).[24]

The first two examples are elementary rules of differentiation, the third and fourth are statements of the Fundamental Theorem of Calculus, the fifth is Fermat's Last Theorem (or Fermat's Conjecture), and the sixth is Arrow's Impossibility Theorem. As the examples show, abstract ideas are often expressible in mathematical form, and they are comprehensible without reference to tangible real-world things.[25] This does not mean, of course, that they have no real-world analogues or applications: The first four results from calculus have innumerable applications in physics and engineering, and the last example has profound implications for political philosophy and the design of social institutions. The last example is also notable in that

[23] Talha Syed also offers working definitions. *See* Syed, *supra* note 8, at 1977-78. I think my understanding of the categories is fundamentally consonant with his, but I work a little harder on the categories' definitions and examples and boundaries, which pays off for the rest of my argument.

[24] Formal statement: …

[25] One can get bogged down in philosophical debates about the relation of mathematics to "the real world"—whether mathematical truths are invented or discovered, and whether these truths are internal or external—but such debates are not useful for understanding the subject matter exclusions. *See infra* note 115 and accompanying text.

it seems a little less abstract than the others. Although the terms of the proposition can be defined in a fully abstract way (see footnote 24), the proposition would seem to be little more than a hollow play on concepts if the external referents were stripped away. The last example thus brings us close to the boundary between abstract ideas and laws of nature.[26]

Here, then, are some examples of laws of nature:

- In a closed thermodynamic system (meaning one where there is no transfer of matter in or out), the change in internal energy of the system is equal to the difference between the heart supplied to the system and the work done by the system on its surrounding. That is, $\Delta U = Q - W$.
- The relationship between entropy (*S*) and the number of possible microstates (Ω) of a thermodynamic system is described by the equation $S = k_B ln\Omega$ where k_B is Boltzmann's constant, equal to 1.380649×10^{-23} J/K.
- $E = mc^2$.
- Genetic information flows only in one direction, from DNA, to RNA, to protein, or from RNA directly to protein. In simpler terms, DNA makes RNA, and RNA makes protein.
- Every point mass attracts every other point mass by a force along the line intersecting them, which force is proportional to the product of the two masses and inversely proportional to the square of the distance between them. That is, $F = G\frac{m_1 m_2}{r^2}$ where *G* is the gravitational constant.

The first example is the first law of thermodynamics, the second is Boltzmann's equation (or Boltzmann's entropy formula), the third is the annoyingly famous formula for mass-energy equivalence, the fourth is the Central Dogma of molecular biology, and the fifth is the modern statement of Newton's law of gravity. These examples illustrate the point made before that *laws of nature* is an intermediate category. Many of the laws given in the examples are, like abstract ideas, expressible in mathematical form. The difference, though, is that here the terms in the mathematical equations refer to real-world things. For example, $E = mc^2$ does not hold for some generic or abstract *E*, *m,* and *c* but rather refers to the energy of a particle in its rest frame (*E*) measured in Joules, the particle's mass (*m*) measured in kilograms, and the speed of light (*c*) measured in meters per second.

On the other side, the examples show the affinity of laws of nature with natural phenomena. The Central Dogma, for example, expresses a real-world phenomenon; but, because it is not readily perceived by the senses (indeed it was not understood until the mid-Twentieth Century), it is more usefully called a law of nature than a natural phenomenon. The gravity formula is another instructive example: At the level of detail expressed in the fifth bullet point, the concept of gravity is not readily perceivable by the senses, so it is more properly classified as

[26] However, perhaps inartfully, I chose an example that arguably implicates a law of *society* rather than a law of *nature* (assuming such a distinction can be maintained). This raises the question of where the "results" of social science (as opposed to natural science) stand in relation to patents. The question is theoretically fascinating, and perhaps not practically insignificant, but it must be deferred to another day.

a law of nature than a natural phenomenon; however, on a less precise level—such as, "if you throw up an apple it's bound to come down"—the notion of gravity is sufficiently immediately perceptible that it would be more usefully classified as a natural phenomenon.

Here, then, are some examples of natural phenomena: rain, earthquakes, a particular earthquake, lightning, Steamboat Geyser, the Americas, the variegated golden frog (*Mantella baroni*). These, unlike the phenomena listed above in the second set of bullet points, are immediately perceptible to the senses, so I classify them as natural phenomena rather than laws of nature.

An alternative classification scheme would be to say that laws of nature refer to *processes* whereas natural phenomena refer to *things*. But this superficial scheme has been appropriately rejected by the Supreme Court.[27] It would have difficulty classifying hybrid process-things like rain, lightning, and earthquakes, which the caselaw would classify as natural phenomena, so I prefer my distinction based on ready sensory perception.

Moreover, my work on defining patent law's three categorical exclusions shows that they implicate different policies.[28] In particular, natural phenomena are fundamentally different from abstract ideas and laws of nature. It seems to me—without wishing to foreclose deeper investigation of the theoretical grounding for their patent eligibility—that natural phenomena are susceptible to at least three powerful arguments against patent eligibility that do not apply to the other categories.

First, natural phenomena are already "out there" or "preexisting" in an immediate sense that does not apply to abstract ideas or laws of nature (excepting laws of nature that fall into the borderland with natural phenomena). This problem cannot be ameliorated by saying that it's a problem of novelty rather than patent eligibility, nor by saying that although the phenomenon itself might have been preexisting, *knowledge of it* was not.[29] The first argument is unavailing because it is too mechanistic and fails to see the point of categorical rules. The fact that the basis for a categorical exclusion is a proto-novelty basis does not vitiate the categorical exclusion. If it is true that a category of works systematically and routinely fails novelty—which the natural phenomena category, as defined, does—then it makes sense to exclude the category *in toto*. That

[27] Parker v. Flook, 437 U.S. 584, 593 (1978) ("The rule that the discovery of a law of nature cannot be patented rests not on the notion that natural phenomena are not processes, but rather on the more fundamental understanding that they are not the kind of 'discoveries' that the statute was enacted to protect.").

[28] That is, as we shall see, I have defined the categories in such a way that my theoretical argument will apply cleanly to abstract ideas and laws of nature but not to natural phenomena. Of course, whether you prefer one or another definitional scheme should not change your assessment of my argument, but you would have to adjust the scope of the argument to see how it applies to the categories as you have defined them—a question of terminology, not of substance. For example, if you define "laws of nature" differently, you will see that my argument applies to abstract ideas and to some but not other laws of nature.

[29] *Cf.* Syed, *supra* note 8, at 1937 ("In a nutshell, . . . the object of patent rights is always and only an intangible space of 'knowledge of' something, and never some 'thing' itself."). Syed's statement that patent law "only" protects knowledge of something and "never" the thing itself is too strong. For example, the owner of a patent on a chemical compound has a right to exclude others from using or making or selling the compound itself, irrespective of anyone's state of knowledge. *See* 35 U.S.C. § 271(a). But Syed is right to underscore the additional importance of knowledge and distinguishing that knowledge from a physical thing as such.

is the point of having categorical exclusions. The second argument is also unavailing because, given the definition of ready perceivability by the senses, even *knowledge of* natural phenomena has existed since time immemorial. Recall the discussion of the difference between some hazy notion of gravity (natural phenomenon) and a precise formulation of its workings (law of nature).

Second, and related to the first point, the problem of identifying the proper patentee would be insurmountable because knowledge of natural phenomena, being readily perceived by the senses, is impossible to pin down to any one person. (It is immaterial, and only a point of semantics, whether you choose to call that person an "inventor" or a "discoverer.") This problem is compounded by the tendency of one community—especially one that is militarily or economically more powerful—to limit the idea of knowledge to its *own* knowledge, disregarding other communities' more longstanding knowledge of the same thing. Witness, for example, Columbus's "discovery" of the Americas. There is thus both an insurmountable conceptual problem and a compounding political-economic difficulty.

Finally, given the tangible thingness of many natural phenomena, the problem of private rights in *them* (as opposed to their knowledge) belongs more properly to property than intellectual property law. Problems of first possession and multiple pursuers are similarly best handled by property law.

I stress again that I do not mean to foreclose deeper theoretical discussion of the problem of patenting natural phenomena. But I do mean to say that my argument questioning the theoretical underpinning of categorical exclusions does not apply to them. I am instead concerned with the venerable principle, echoed endlessly by courts and commentators, that patents are appropriate for "applied technology" or "applied science" but not for "basic science." My arguments questioning the basis for this distinction thus apply to abstract ideas and laws of nature—or, out of abundance of caution, to abstract ideas and those laws of nature that do not fall into the borderland with natural phenomena. Throughout the Article I use the shorthand "abstract ideas" to refer to these categories.

B. The Standards of Argument

For the abstract-ideas exclusion to make sense, there must be reasons for distinguishing abstract ideas from other subjects of patents. These distinguishing reasons must meet two requirements: They must be *reasons* and they must be *distinguishing*. The first requirement means that a proffered reason should not beg the question; it should not simply *restate* the exclusion or the distinction between abstract and applied ideas, albeit in different terms. The task is instead to justify it. To say that abstract ideas are "a fundamental truth; an original cause; a motive,"[30] that they are "part of the storehouse of knowledge of all men . . . free to all men and reserved exclusively to none,"[31] that they are "humanity's common heritage,"[32] that they are part

[30] *Le Roy*, 55 U.S. at 175.
[31] *Funks Bros.*, 333 U.S. at 130.
[32] In re Bilski, 545 F.3d 943, 1013 (Fed. Cir. 2008) (Rader, J., dissenting), *aff'd sub nom.* Bilski v. Kappos, 561 U.S. 593 (2010).

of "a kind of commons, where they are available to all of humanity's use,"[33] that they constitute "basic understanding" rather than "applied interventions,"[34] that they implicate the "distinction between basic and applied knowledge,"[35] that they are a species of "knowing *that*" rather than "knowing *how*,"[36] that patent law should "keep[] the basic results of open science in the public domain"[37]—these are all just different ways of stating the conclusion without getting closer to why.[38]

The second requirement for a distinguishing reason is that it must distinguish abstract ideas from other subjects of patents—it must be a reason against patenting that applies to abstract ideas but not (or not as strongly) to other subjects. There are plausible reasons for questioning the efficacy of our patent system as compared to alternative institutional designs of innovation policy such as reliance on public or private prizes, fellowships, government funding for scientific research, compulsory licensing, market mechanisms such as first-mover advantage, trade secrecy, norms and "intrinsic" rewards, and combinations of these.[39] It is acceptable, of course, for supporters of the abstract-ideas exclusion to argue that some of these mechanisms are better suited than patents to the protection of abstract ideas. But such an argument would not supply a sufficient basis for second-class treatment of abstract ideas. For the question is not whether an alternative institutional design outperforms patents in the context of abstract ideas; the question is whether an alternative institutional design outperforms patents *to a greater extent* in the context of abstract ideas than in other contexts. Otherwise the argument would be an argument against patents altogether, not against the patenting of abstract ideas. A justification for the abstract-ideas exclusion must justify the *different* treatment of abstract ideas.

C. The Preemption/Building Block/Basic Tools Rationale

Having defined our terms and the scope and standards of argument, we are now in position to assess the different rationales for excluding abstract ideas from patents. The Supreme Court's latest version of patent eligibility law is based on the preemption rationale, and many of the other rationales come back to preemption, so it makes sense to start with that. Recall that the Court's reason for excluding abstract ideas is that they can serve as "basic tools" or "building blocks" of future innovation, so a patent monopoly on them would "preempt" or "hamstring" a great deal of future innovation.[40] The assumption that abstract ideas have greater potential than more applied ones to serve as tools for future invention strikes me as fairly plausible, as far as

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[33] Strandburg, *supra* note 8, at 615.
[34] Syed, *supra* note 8, at 1945.
[35] Peter Lee, *Inverting the Logic of Scientific Discovery*, 19 Harvard J.L. & Tech. 79, 101 (2005).
[36] Syed, *supra* note 8, at 1981 (emphasis in original).
[37] Strandburg, *supra* note 8, at 616.
[38] To be fair to the courts and commentators cited in this paragraph, some are simply restating the reasons as they find them in the caselaw, and for some the question-begging is ultimately succeeded by an attempt at actual justification. Overall, though, an unfortunately large part of the discourse on justifying the abstract-ideas exclusion is devoted to rephrasing the conclusion.
[39] *See, e.g.*, Michael J. Burstein, *Exchanging Information Without Intellectual Property*, 91 Tex. L. Rev. 227 (2012) (outlining some non-IP routes to promoting the diffusion of information). For different perspectives on IP protection, *see infra* notes 117-118, 125-127 and accompanying text.
[40]

such categorical assumptions go, and I shall not contest it for present purposes.[41] The real problem with the Court's rationale is its failure to see that such greater "building block" potential underscores not just a greater cost of patenting the idea but also a greater benefit of incentivizing it, which is what a patent is meant to do.

Thus, for the building-block argument to yield a conclusion of unpatentability, it must be that the benefits of incentivizing the discovery of basic scientific tools through intellectual property rights are outweighed by the costs of such rights. Something must happen as an invention moves up the spectrum of abstractness that overturns the patent system's conclusion that the access costs are justified by the incentive benefits (provided the other requirements of patentability are met). An increase in abstractness must raise social costs at a greater rate than it raises social benefits, such that the benefit-cost balance flips from positive to negative beyond some level of abstractness. This key assumption—the *single-crossing condition*—is illustrated in Figure 1, which I reproduce here for ease of reference.[42]

[41] Katherine Strandburg has contested this assumption. She writes, "Not all [p]henomena of nature, . . . mental processes, and abstract intellectual concepts have sweeping downstream impact." Strandburg, *supra* note 8, at 577-78. This is an important observation in that it cautions us not to confuse the concept of abstractness with the concept of downstream impact. (For discussion of this and other conceptual conflations, see *infra* notes 72-76 and accompanying text.) I also agree with Strandburg that "not all" abstract ideas have great downstream impact. But the right question is not whether *all* abstract ideas have great potential to be useful in downstream research; the validity of a categorical rule does not depend on all elements of the category falling within its sweep. The right question, rather, is whether abstract ideas have a significantly greater tendency to be of use in downstream innovation than more applied ones. The Court does not strike me as unreasonable in answering this question in the affirmative. It is not unreasonable to suppose that, all else equal, abstract ideas are, by virtue of being basic or fundamental, of wider use in downstream research. Of course it is possible to conceive of a particular applied idea that has greater downstream impact than a particular abstract idea—due, for example, to greater downstream potential in the former's scientific-technological domain. However, holding the scientific-technological context and other factors constant, it is reasonable to suppose that abstractness is positively correlated with downstream usefulness.

[42] The figure is useful as a heuristic. To enable a nice graphic representation, it assumes that costs and benefits are continuous in abstractness and it portrays them as a function only of abstractness. For those who would like to be more rigorous, a formal statement of the single-crossing condition is as follows: Let $x \in X \subset \mathrm{R}^{\mathrm{n}}$ denote the relevant attributes of an invention, let x_i denote (increasing) abstractness, and let $b: X \rightarrow R^+$ and $c: X \rightarrow R^+$ be the benefits and costs of patentability (respectively). Then, for the preemption argument to be valid, the following condition must hold when all other patentability requirements are met: $\exists\, x_i^* \in X_i$ such that $b(x) - c(x) > 0 \quad \forall\, x_i < x_i^*$ and $b(x) - c(x) < 0 \quad \forall x_i > x_i^*$.

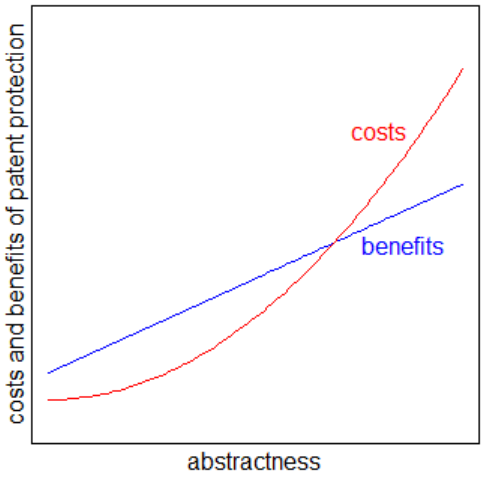

Figure 2 [same as Figure 1]: The social costs and benefits of patent protection as a function of an innovation's abstractness, as implicitly hypothesized by the Supreme Court.

However, the Court has never explained why increased abstractness should raise the costs of patent protection more than it raises the benefits. It has never explained why it thinks the single-crossing condition holds. Indeed the Court has never made explicit that such a relationship is a necessary premise of its argument, let alone offer a compelling theoretical justification (forget empirical evidence) for it. There is, as far as I can tell, no good reason to think that the relationship holds. As discussed, the very increase in value that implies a greater deadweight loss of monopolization also implies a greater benefit of incentivization. There is no sound theoretical reason for thinking that abstraction raises costs more than it raises benefits—just as there is no sound theoretical reason for positing such a differential effect on costs and benefits along any number of factually meaningful but legally immaterial dimensions of invention (e.g., the scientific field of the invention, the materials used in the invention, or whether the inventor habitually wears red socks). For all we know, it could be that abstraction raises benefits at a greater rate than it increases costs, as in the lefthand panel of Figure 3. Or it could be that abstraction raises costs and benefits at the same rate, as in the righthand panel of Figure 3. Again, the figures are meant only to illustrate the logic of my argument. The functional form of the relationship between abstraction and costs-benefits does not matter. What matters is the figures' illustration of the unfounded assumption that abstraction raises the costs of patent protection to a greater degree than its benefits, such that the costs overtake the benefits for sufficiently abstract inventions. In the absence of any compelling reason for assuming that the single-crossing condition holds, the preemption rationale crumbles.

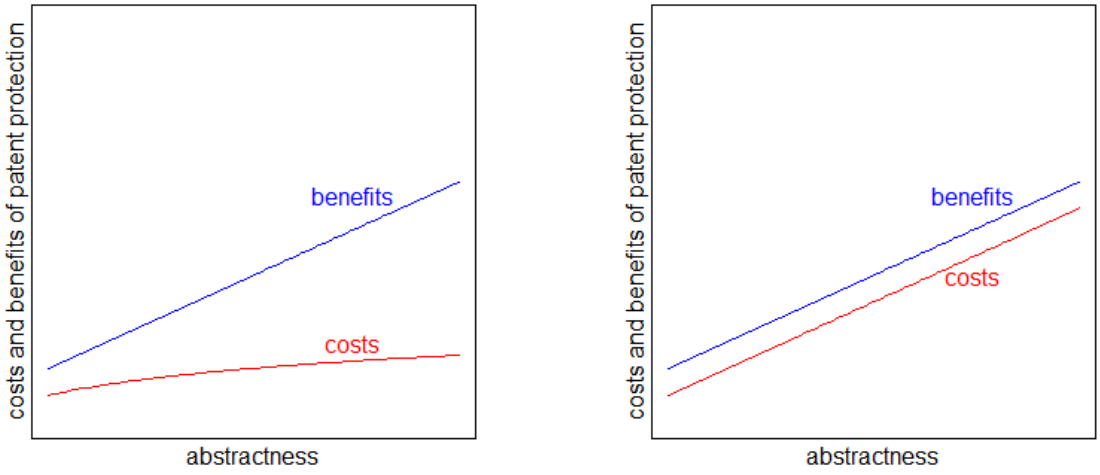

Figure 3: The social costs and benefits of patent protection as a function of an innovation's abstractness, hypothesized differently than the Supreme Court. In the lefthand panel, abstractness raises benefits faster than it raises costs; in the righthand panel, abstractness raises benefits and costs at the same rate.

D. The Analogy to Copyright's Exclusion of Ideas

Another rationale for patent law's exclusion of abstract ideas proceeds by analogy to copyright law's exclusion of ideas. This argument is rarely invoked by courts or commentators,[43] but I have heard it several times from students in my intellectual property survey class (in which I teach copyright before patents). Though the thrust of this argument is the same as preemption, it is an important argument because the copyright analogy throws certain issues into sharper relief. Engaging it not only sharpens our understanding of the abstract-ideas exclusion but also clarifies some fundamental differences between patent and copyright law.

The argument by analogy proceeds as follows. It is black-letter law that copyright protects an *expression* of an idea, not the idea itself.[44] This "idea-expression dichotomy," which is of longstanding judicial pedigree, is now codified in section 102(b) of the Copyright Act: "In no case does copyright protection for an original work of authorship extend to any idea, procedure, process, system, method of operation, concept, principle, or discovery, regardless of the form in which it is described, explained, illustrated, or embodied in such work."[45] A corollary of the idea-expression dichotomy is the merger doctrine, which holds that there can be

[43] *But see* Peter Lee, *The Evolution of Intellectual Infrastructure*, 83 Wash. L. Rev. 39, 43-44, 64 (2008) (analogizing patent law's subject matter exclusions to copyright's idea-expression dichotomy on the grounds that both doctrines allow exclusive rights in "applications" but not in "intellectual infrastructure" that serves as a building block of future creative work).

[44] *E.g.*, Mazer v. Stein, 347 U.S. 201, 217 (1954) ("Unlike a patent, a copyright gives no exclusive right to the art disclosed; protection is given only to the expression of the idea—not the idea itself.").

[45] 17 U.S.C. § 102(b).

no copyright in expression where that expression is the only means, or one of very few means, to effectuate or articulate an idea.[46] Part of the rationale for the idea-expression dichotomy is that copyrighting ideas would amount to monopolizing the constituents of future expression—almost like monopolizing language itself—imposing intolerable costs on society.[47] But if bottling up the source of future expression by giving exclusive rights to ideas is not permitted in copyright law, shouldn't bottling up the tools of future innovation by giving exclusive rights to the results of basic science be prohibited in patent law? Does copyright's exclusion of ideas justify patent's exclusion of abstract ideas? Or, by contrast, does undermining the preemption rationale in patents destroy the theoretical grounding for the idea-expression dichotomy in copyright?

The answer to all these questions is no. To see why, it is useful to distinguish two facets of the idea-expression dichotomy—first, its exclusion of scientific or technical or practical ideas and, second, its exclusion of aesthetic or literary or artistic ideas (for lack of better terms).[48] In its first aspect, the idea-expression dichotomy performs what one might call a "channeling" function: taking scientific-technical-practical innovations out of the realm of copyright, which is designed with its minimal threshold and greater duration of protection for aesthetic creations, and sending them to patent, with its meatier examination and more stringent requirements designed for technical innovations.[49] The principle is nicely illustrated by the classic case *Baker v. Selden*, where the Supreme Court held that there could be no copyright in certain accounting forms in a book describing a system of bookkeeping.[50] The Court first explained that protecting the bookkeeping method itself is the job of patents, not copyright:

> To give to the author of the book an exclusive property in the art described therein, when no examination of its novelty has ever been officially made, would be a surprise and a fraud upon the public. That is the province of letters-patent, not of copyright. The claim to an invention or discovery of an art or manufacture

[46] *See, e.g.*, Sepehr Shahshahani, *The Design of Useful Article Exclusion: A Way Out of the Mess*, 57 J. COPYRIGHT SOC'Y U.S.A. 859, 875 (2010) ("Out of the fundamental idea-expression dichotomy grows an important corollary—the merger doctrine. This doctrine holds that although copyright generally protects expression, it does not extend to expression when protecting an expression would be tantamount to protecting its underlying idea. This means that when there are but a few effective expressions of an idea—when for all practical purposes the idea 'merges' with its expression—copyright does not protect the expression, lest by doing so it also protect an idea.").

[47] *See* Lee, *supra* note 43, at 59-60 (interpreting the idea-expression dichotomy as a device to "maintain creative infrastructure in the public domain as the raw building blocks of expression"); Leslie A. Kurtz, *Copyright: The Scenes a Faire Doctrine*, 41 Fla. L. Rev. 79, 96 (1989) (justifying the uncopyrightability of ideas and *scènes à faire*, or stock genre elements, on the grounds that they are "elements of vocabulary needed to construct a work").

[48] BJ Ard also distinguishes these two facets, advocating the term "systems-method exclusion" for the first in order to avoid confusion with the second. *See* BJ Ard, *Creativity Without IP? Vindication and Challenges in the Video Game Industry*, 79 WASH. & LEE L. REV. 1285, 1320-22 (2022). I shall use the term "idea-expression dichotomy" to cover both aspects, as does the caselaw.

[49] *See* Shahshahani, *supra* note 46, at 885 ("[T]he merger doctrine directs ideas from the realm of copyright to patent in view of the bedrock principle that ideas are not copyrightable. This principle is supported by ample policy considerations: Monopolies in ideas are generally costlier to society than monopolies in expression, and their grant should therefore be subject to more stringent requirements than a modicum of originality. This heightened threshold is provided by the patent regime's novelty and non-obviousness requirements.").

[50] 101 U.S. 99, 100 (1879).

> must be subjected to the examination of the Patent Office before an exclusive right therein can be obtained.[51]

And, because the bookkeeping forms were necessary to using the method, the forms could not be copyrighted either (an application of the merger doctrine).[52]

The second facet of the idea-expression dichotomy applies to what one might call aesthetic ideas—such as the idea of a love story between a poor boy and a princess, or the sonata form in classical music, or genre tropes and conventions (*scènes à faire*) like a pirate with a wooden leg or a *femme fatale* in a film noir.[53] Here the principle is not that such ideas should be channeled to another regime of intellectual property protection but that they are not protectible at all. The principle is illustrated by Learned Hand's beautiful opinion in *Nichols v. Universal Pictures Corporation*, which held that the copyright in a popular play about a Jewish boy and an Irish Catholic girl falling in love and marrying despite their fathers' religious exclusiveness was not violated by a film also featuring a Jewish boy and an Irish girl falling in love over their parents' objections.[54] Judge Hand wrote, "A comedy based upon conflicts between Irish and Jews, into which the marriage of their children enters, is no more susceptible of copyright than the outline of Romeo and Juliet."[55] In other words, allowing such a copyright would come close to monopolizing the general idea of a love story between children of hostile families.[56]

With these two facets of copyright's idea-expression dichotomy in mind, let us now bring in patent's abstract-ideas exclusion. The first facet clearly does not justify the exclusion by analogy because there is no alternative IP regime for patent law to channel abstract ideas to.[57] Less obviously, the second facet also does not provide a good analogy. The reason goes back to the essence of the different kinds of contribution that the copyright and patent systems aim to incentivize. Copyright's domain is artistic creativity, and in that domain abstraction is not an important contribution. Soul-enriching art manifests itself not in the general or abstract statement of propositions or feelings but in the particular expression given to those feelings. The grandest peaks of artistic achievement become platitudes when reduced to an abstract statement of their underlying ideas. The glory of heroism, the pangs of love and loss, the presence and immediacy of nature, determination in face of adversity—these ideas are utter banalities that communicate nothing of the profound beauty of, respectively, Beethoven's *Eroica* symphony, the ghazals of Hafez and Sa'di, Basho's haiku, Hemingway's *Old Man and the Sea*. "Progress" in the artistic sphere cannot possibly mean the production of such banalities, and their promotion

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[51] *Id.* at 102. Note that, in this late Nineteenth Century text, the term "art" is used to mean "method."
[52] *Id.* ("And, of course, in using the art, the ruled lines and headings of accounts must necessarily be used as incident to it.").
[53] *See, e.g.*, Lee, *supra* note 43, at 61.
[54] 45 F.2d 119, 123 (2d Cir. 1930).
[55] *Id.* at 122.
[56] The court also held that there was no violation of copyright in the play's characters because the film took no more than "stock figures" and "prototypes." *Id.*
[57] Of course, some might argue that the protection of abstract ideas or basic science is best left to innovation-policy regimes *outside* of IP, an argument that will be contended with in Part II.I below.

cannot be the *raison d'être* of copyright.[58] In the scientific sphere of patents, by contrast, abstractions *are* emphatically a contribution. The laws of thermodynamics, the fundamental theorem of calculus, and the Fourier inversion theorem are not banalities—they were deep, difficult, useful findings that opened vast vistas to human understanding and innovation. In science, unlike in art, it is not the case that the abstract idea is trivial and the contribution is in expression; to the contrary, uncovering and articulating and proving the abstract idea is sometimes far more profound and difficult than its subsequent adaptation for use.[59] Thus, whereas in copyright the protection of abstract ideas forecloses entire fields to artistic creativity without any corresponding benefit, abstract ideas are eminently worth incentivizing in patent.

Figure 3 illustrates the point. In copyright, unlike in patents, the single-crossing assumption is eminently well-justified. Indeed, not only is it true that the social costs of copyrighting a creation increase at a greater rate than its social benefits as the creation becomes more abstract; it is probably true that social benefits *decrease* in abstractness.

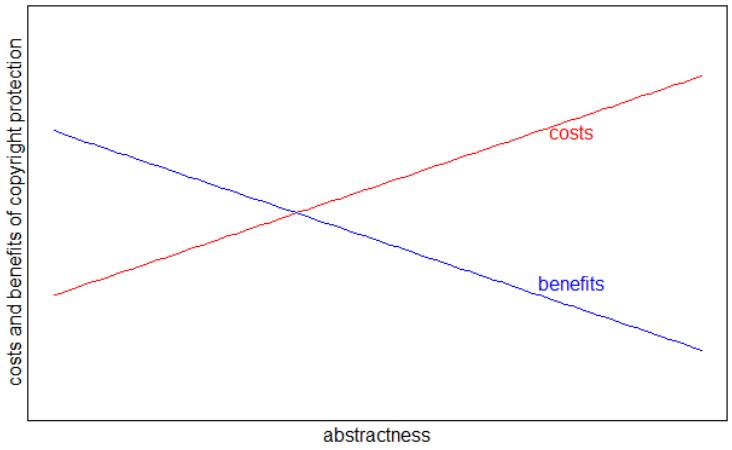

Figure 4: The social costs and benefits of copyright protection as a function of the creation's abstractness

In short, copyright's idea-expression dichotomy does not support patent's abstract-ideas exclusion by analogy. By the same token, busting the foundation for the abstract-ideas exclusion does not weaken the support for the idea-expression dichotomy.

E. The Vagueness/Overbreadth Rationale

Another rationale offered in support of the abstract-ideas exclusion is to weed out vague or overbroad patent claims. The *Morse* case articulated such a concern early on, holding that Morse's "claim is too broad, and not warranted by law."[60] Commentators have picked up on this

[58] *See* U.S. Const. art. I, § 8, cl. 8 (authorizing Congress to "promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries").
[59] *See, e.g.*, Abraham Flexner, *The Usefulness of Useless Knowledge*, 179 Harper's Mag., June/Nov. 1939, at 544-45 (describing Marconi's contribution to the invention of radio as "practically negligible" compared to the earlier scientific work of Maxwell and Hertz).
[60] *Morse*, 56 U.S. at 113.

concern.[61] In an oft-cited article, Mark Lemley, Michael Risch, Ted Sichelman, and R. Polk Wagner recast the abstract-ideas exclusion as "an overclaiming test," arguing that "the rule against patenting abstract ideas is an effort to prevent inventors from claiming their ideas too broadly. By requiring that patent claims be limited to a specific set of practical applications of an idea, the abstract ideas doctrine both makes the scope of the resulting patent clearer and leaves room for subsequent inventors to improve upon—and patent new applications of—the same basic principle."[62] The authors explain, "As claims become broader—and necessarily more general and abstract—they become more indefinite and difficult to understand, and more likely to ensnare future inventions embodying the inventive principle."[63] This rationale is similar to the preemption rationale in that it is concerned with broad downstream effects, but it is distinct to the extent that it posits that more abstract claims are more likely to be vague or overbroad.[64]

The rationale is unpersuasive. To begin, the problem of vagueness or overbreadth is not a problem of patentable *subject matter*; it is a problem of improper claim *scope*, and patent law has separate doctrines designed specifically to deal with that. The set of doctrines known as disclosure, now codified in section 112 of the Patent Act, are aimed precisely at weeding out overbroad and vague claims.[65] Disclosure has at least three aspects: enablement, written description, and claim definiteness.[66] The enablement requirement disallows claims beyond what the inventor has actually invented or what the materials disclosed in her patent application would enable skilled practitioners in the field to produce. For example, in the celebrated *Incandescent Lamp* case the Supreme Court invalidated a claim for any "incandescing conductor for an electric lamp [made] of carbonized fibrous or textile material" where the inventor had only invented one species of conductors made of such material (namely, carbonized paper), which did not work well.[67] The written description requirement likewise ensures that the patent's

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[61] *See* Kevin Emerson Collins, *Bilski and the Ambiguity of "An Unpatentable Abstract Idea,"* 15 LEWIS & CLARK L. REV. 37, 42 (2011) (arguing that one facet of the problem with a claim that courts often call an abstract idea is that it "is extremely broad and reaches far beyond the technologies disclosed in the specification . . . and deep into after-arising technologies"); Lemley et al. *supra* note 8, at 1315 ("Recasting the abstract ideas doctrine as an overclaiming test").

[62] Lemley et al., *supra* note 8, at 1315.

[63] *Id.* at 1337-38.

[64] Strandburg discusses vagueness and preemption together under the heading "Overbroad Downstream Impact." Strandburg, *supra* note 8, at 573-82. As we shall see, the vagueness rationale does collapse onto the preemption rationale on one level, but it also makes a distinct claim that deserves to be addressed on its own merits.

[65] *See* 35 U.S.C. § 112 ("The specification [in a patent application] shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention. . . . The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.").

[66] *See id.* There is also a "best mode" requirement in § 112(a), but this requirement is relatively insignificant in modern practice. *See* PETER MENELL, MARK LEMLEY, ROBERT MERGES, & SHYAMKRISHNA BALGANESH, INTELLECTUAL PROPERTY IN THE NEW TECHNOLOGICAL AGE 280 (2021 ed.) (devoting a cursory two paragraphs to the requirement and noting that it is "difficult . . . to police").

[67] Consol. Elec. Light Co v. McKeesport Light Co. (Incandescent Lamp Case), 159 U.S. 465, 468 (1895). "If the patentees had discovered in fibrous and textile substances a quality common to them all, or to them generally, as distinguishing them from other materials, such as minerals, etc., and such quality or characteristic adapted them peculiarly to incandescent conductors," explained the Court, then "such claim might not be too broad." *Id.* at 472.

specification provides sufficient notice of exactly what the claimed invention is.[68] And the claim definiteness requirement disallows claims that are insufficiently clear.[69] It would seem odd, given these doctrines specifically designed to curb improperly broad or vague claims, to assign the same task to a categorical exclusion of subject matter.

This would not be so odd, perhaps, if there were some reason to think that abstract ideas as a category are particularly susceptible to vagueness or overbreadth problems. But there is no reason to think that. One searches the caselaw and commentary in vain for the articulation of any plausible reason why abstract ideas are as a rule more vague or unclear or overbroad than applied ideas. To the contrary, given the greater potential of abstract ideas to be expressible in the language of mathematics, abstract ideas tend to be *more* precise. Recall the examples given in Part II.A of abstract ideas—all unpatentable, and all far clearer than most patent claims we have ever seen.

Seeking to distinguish their abstract-ideas-as-overclaiming interpretation from the § 112 disclosure requirements, Lemley and coauthors explain that § 112 is about "whether the *disclosure* is sufficient to warrant the claims" whereas "[o]verclaiming under § 101 . . . is primarily concerned with removing obstructions to follow-on innovation. . . . In the words of the Supreme Court, such claims 'wholly pre-empt' all present and future uses of the inventive principles."[70] On this account, however, the vagueness/broadness rationale collapses back onto the preemption rationale and fails for the same reasons. Namely, the argument fails to recognize that a greater potential to serve as fodder for future innovation signals not only a greater cost of monopolization but also a greater benefit of incentivization, and it fails to offer any reason to think that the single-crossing condition on the social benefits and costs of patenting is satisfied.[71]

In this connection it is also important to point out a conceptual problem in Lemley and coauthors' "overclaiming" argument—a conflation of the concept of abstractness or basicness on the one hand with breadth or generality or impact on the other.[72] As discussed, it is not unreasonable to assume (as the Supreme Court has) that greater abstractness is positively

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In fact, however, the patentees had only invented a conductor made of carbonized paper, which had proved unsuccessful and was discontinued. *Id.* at 471. Producing a workable conductor out of carbonized fibrous or textile material was not possible except by substantial "independent experiments," so "the patent is void." *Id.* at 474.

[68] *See, e.g.*, Gentry Gallery, Inc. v. Berkline Corp., 134 F.3d 1473, 1479 (Fed. Cir. 1998) ("To fulfill the written description requirement, the patent specification must clearly allow persons of ordinary skill in the art to recognize that the inventor invented what is claimed.") (brackets, citations, and quotation marks omitted).

[69] Nautilus, Inc. v. Biosig Instruments, Inc., 572 U.S. 898, 910 (2014) ("[W]e read § 112 . . . to require that a patent's claims, viewed in light of the specification and prosecution history, inform those skilled in the art about the scope of the invention with reasonable certainty. The definiteness requirement, so understood, mandates clarity, while recognizing that absolute precision is unattainable.").

[70] Lemley et al., *supra* note 8, at 1330 (quoting *Bilski*, 561 U.S. at 610).

[71] *See supra* Introduction and Part II.C.

[72] *See, e.g.*, Lemley et al. *supra* note 8, at 1337-38 ("As claims become broader—and necessarily more general and abstract—they become more indefinite and difficult to understand, and more likely to ensnare future inventions embodying the inventive principle."); *id.* at 1339 (observing, under the heading of "identifying abstract ideas," that claims are "too broad when they assert coverage over general ideas unmoored to any specific use"); *id.* (stating that the "generative nature" of a field, meaning whether research in the field builds successively on prior research, is a consideration in identifying whether an invention is abstract); *id.* at 1340 ("[C]laims that are not described and enabled are also more likely to be abstract.").

correlated with greater downstream impact[73]—but that does not mean that the two concepts are the same. And although it might be that, holding the technological context fixed, increasing abstractness implies broader impact, there is no warrant to think that broadening a claim necessarily implies greater abstraction.[74] For example, a claim for "An incandescing conductor for an electric lamp, of carbonized fibrous or textile material" is broader than one for "The incandescing conductor for an electric lamp, formed of carbonized paper," but it is in no sense more abstract.[75] Broadness and abstractness are different, though the authors conflate them. A confusion between abstractness and sweepingness is also present in some of the caselaw.[76]

Relatedly, in Lemley and coauthors' interpretation, the abstract-ideas exclusion becomes a way to effectuate not just a prohibition on *over*claiming but a prohibition on *broad* claiming altogether. That is why, in the end, the overclaiming rationale collapses back onto the preemption rationale.[77] But the(se) rationale(s) cannot get any help from a general prohibition against the patenting of broad claims or claims with great downstream impact. That is because there is no such prohibition in patent law. Of course there is a prohibition on claims beyond what you have invented or disclosed, but there is no doctrine that says you cannot claim a broad invention *that you have actually invented and disclosed* (provided the other requirements of patentability are met).[78] As the dissent in *Morse* pointed out, "The patent law and judicial decisions may be searched in vain for a provision or decision that a patent may be impugned for claiming no more than the patentee invented or discovered."[79] The Court in the *Telephone Cases* took the same line, rejecting the contention that Bell's patent should be invalidated because he had made a great and sweeping invention:

> It may be that electricity cannot be used at all for the transmission of speech, except in the way Bell has discovered, and that therefore, practically, his patent

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[73] *See supra* note 41.

[74] *But see* Lemley et al., *supra* note 8, at 1337-38 ("As claims become broader—and necessarily more general and abstract—they become more indefinite and difficult to understand, and more likely to ensnare future inventions embodying the inventive principle."). This key passage embodies two distinct errors: (1) It confuses generality with abstractness, (2) it asserts, without any support, that more abstract claims are "more indefinite and difficult to understand."

[75] The examples are from the *Incandescent Lamp Case*, 159 U.S. at 468.

[76] *See, e.g., Benson*, 409 U.S. at 65 ("Here the 'process' claim is so abstract and sweeping as to cover both known and unknown uses of the BCD to pure binary conversion.").

[77] *See supra* notes 70-71 and accompanying text.

[78] There was historically such a thing as claim "overbreadth" or "undue breadth" doctrine, but the doctrine addressed § 112 concerns, mostly lack of enablement and sometimes indefiniteness. *See* In re Cavallito, 282 F.2d 357, 360 (C.C.P.A. 1960); In re Rainer, 305 F.2d 505, 508-09 (C.C.P.A. 1962); In re Boller, 332 F.2d 382, 386 (C.C.P.A. 1964); In re Grier, 342 F.2d 120, 126-27 (C.C.P.A. 1965); In re Corr, 347 F.2d 578, 580 (C.C.P.A. 1965); In re Borkowski, 422 F.2d 904, 910 (C.C.P.A. 1970); In re Skrivan, 427 F.2d 801, 805 (C.C.P.A. 1970); In reb Fouche, 439 F.2d 1237, 1242-43 (C.C.P.A. 1971); In re Hawkins, 486 F.2d 569, 575-76 (C.C.P.A. 1973); *see also* In re Vaeck, 947 F.2d 488, 492 n.20, 495-96 (Fed. Cir. 1991); *see generally* Charles E. Bruzga, *A Review of the Benson-Flook-Diehr Trilogy: Can the Subject Matter Validity of Patent Claims Reciting Mathematical Formulae Be Determined under 35 U.S.C. Section 112?*, 69 J. Pat. & Trademark Off. Soc'y 197, 199 (1987) (interpretating *Benson*, *Flook*, and *Diehr* in terms of an "overbreadth doctrine" tracing to the enablement requirement of § 112). With the arguable exception of *Morse*, I am not aware of a judicial opinion espousing a prohibition on broad claims as such—even those that the inventor has actually invented and disclosed.

[79] *Morse*, 56 U.S. at 135 (Grier, J., concurring and dissenting).

> gives him its exclusive use for that purpose; but that does not make his claim one for the use of electricity distinct from the particular process with which it is connected in his patent. It will, if true, show more clearly the great importance of his discovery, but it will not invalidate his patent.[80]

But *should* there be a general prohibition on broad claims, even if such a prohibition finds no support in patent doctrine? One might think that an argument grounded in diminishing marginal utility supports such a prohibition. The argument would be that because the marginal benefit to a patentee declines as the rewards to a patent increase, limiting the scope of a patent to specific applications is a good way to limit social costs while preserving incentives to innovate.[81]

As a general matter, the logic of diminishing marginal returns is sound. But, as a justification for the exclusion of abstract ideas, the argument fails on multiple fronts. First, it misidentifies the level at which costs and benefits are to be measured. The relevant question for the abstract-ideas exclusion is whether the costs of a patent *to society* increase at a greater rate than its benefits to society *as an invention becomes more abstract* such that the costs exceed the benefits if (and only if) the invention falls beyond a certain level of abstractness—the single-crossing condition. The diminishing-returns argument does not answer that question. Rather, it says that the benefits *to a patentee* increase at a decreasing rate *as the patent rewards increase*. These are two separate relationships, and the second does not illuminate the first. That is, it does not follow from the fact that *a patentee's* marginal returns *from increasing patent exclusivity rewards* are diminishing that *society's* marginal returns from *increasingly abstract inventions* should also be diminishing.

The diminishing-returns argument supplies a good reason for capping the exclusivity rewards that the patent system gives to a patent holder. It helps explain, for example, the wisdom of short patent terms.[82] But it's a general principle that is not limited to abstract ideas; it applies with as much force to other categories of invention. Nor would it make sense to cap the *subject matter* of the patent—as opposed to, say, its term length—to effectuate the diminishing-returns logic. That is because, unlike term limitations, subject matter limitations distort creative incentives at the level of selecting what to innovate. Knowing that abstract innovations will not be rewarded except in application, even when the innovation covers and enables more than the application, potential innovators become more likely to channel their inventive effort into areas of applied science and technique, and the more abstract-minded ones may choose not to innovate at all.[83]

To sum up, the vagueness/overbreadth rationale is unpersuasive for a host of reasons. It supplies no reason to think that more abstract ideas are more likely to be vague (the contrary

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[80] *Telephone Cases*, 126 U.S. at 535.

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[82] And short copyright terms, though the Supreme Court has not been sympathetic to policing copyright terms as a matter of constitutional law. *See* Eldred v. Ashcroft, 537 U.S. 186 (2003) (upholding the constitutionality of the Sonny Bono Copyright Term Extension Act of 1998, which extended existing copyright terms by an additional 20 years).

[83] One may argue that there are other ways of incentivizing innovation in basic science that work better than the IP system, but that is a separate argument from diminishing returns. It will be dealt with in Part II.I below.

seems more likely). It confounds a problem of claim scope, which is governed by its own specific doctrines (disclosure), with a problem of patentable subject matter. And to the extent it is distinguishable from disclosure concerns, it collapses back onto the preemption rationale and fails for the same reasons. Finally, neither the preemption nor the vagueness/broadness rationale can claim any support from a more general prohibition on the patenting of broad claims because there is no such prohibition in patent law and because such a prohibition would not make sense.

F. The Problem of Unforeseen Applications

Another rationale for the abstract-ideas exclusion that is closely related to the three preceding ones is that an abstract idea may have many embodiments or applications that its creator did not intend or even envisage.[84] It might be that these unforeseen applications constitute a greater theoretical or practical contribution than the original innovation. To give the original creator an exclusive right that could block subsequent innovators from exploiting these valuable and originally unknown follow-on innovations might be too great a social cost to bear.[85]

To the extent this argument suggests that abstract ideas should not be patentable because they are "too useful" as building blocks of future innovation,[86] that point was answered in the preemption section.[87] And to the extent the argument is taken to mean that patenting abstract ideas may give someone an exclusive right to make or use something that she did not invent or enable, it overlaps with the vagueness/broadness argument that was just discussed.[88] But the unforeseen-applications argument can also be interpreted to suggest something distinct. In this interpretation the problem is not with overbroad *affirmative* rights but with overbroad *negative* rights. Appreciating this distinction requires looking closely at how patent doctrine allocates rights between original and follow-on innovators.

In a nutshell, the law is that a patent does not give the patentee an exclusive right to practice someone else's follow-on innovation that comes within the scope of the original patent claim but constitutes a sufficient advancement over the original to meet the requirements of patentability; to the contrary, the follow-on innovator may independently patent such an improved innovation.[89] However, the original patentee may block the follow-on innovator from practicing the new invention, just as the follow-on patentee may block the original patentee from

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[84] *See Benson*, 409 U.S. at 68 (complaining that "the 'process' claim is so abstract and sweeping as to cover both known and unknown uses" of the process); *Morse*, 56 U.S. (15 How.) at 113 (rejecting Morse's claim on the grounds that it would encompass many improvements that "some future inventor, in the onward march of science, may discover").

[85] *See* Strandburg, *supra* note 8, at 573 (referring to the concern that "the inventor has been awarded rights over many embodiments that he or she did not invent, imposing unwarranted constraints on those who later invent them").

[86] Collins, *supra* note 61, at 58-59 ("[T]he defining trait of this type of abstract embodiment from a policy perspective is . . . that it is *too* useful. . . . In other words, the claim [in *Benson*] described a set of methods that are fundamental building blocks of progress in that they are part of the basic tools of scientific and technological work.") (citations and quotation marks omitted).

[87] *See supra* Part II.C.

[88] *See supra* Part II.E.

[89] *See generally* 35 U.S.C. § 101 (authorizing patents in "any new and useful improvement" of an existing invention); *see also* Prima Tek II, L.L.C. v. A-Roo Co., 222 F.3d 1372, 1379, 1379 n.2 (Fed. Cir. 2000).

practicing it (though not from practicing the original invention).[90] This situation is referred to as "blocking patents."[91] To illustrate, suppose Ahmad concocts and patents a new chemical compound (Glachomycetirin) that is useful in polishing wood. Bethany later discovers that Glachomycetirin is also useful in treating skin rashes, and invents a process for turning it into an ointment that can safely be applied to skin for that purpose. Assuming that Bethany's innovations otherwise meet the requirements of patentability—for example, the discovery of Glachomycetirin's new properties and the process of turning it into an ointment were novel and nonobvious—Bethany can obtain a patent on the new ointment and the process of producing it. At that point, Bethany cannot use or market her ointment without Ahmad's license, nor can Ahmad do the same without Bethany's license (though Ahmad can continue to use and market Glachomycetirin in its original wood-polishing application).[92]

As the foregoing summary illustrates, blocking patents is a rather ingenious device for managing rights between original and follow-on innovators. It incentivizes the original creator by giving her rights extending to the full limit of what she has invented while also providing incentives for follow-on innovators by giving them rights over the use of their improvements.[93] The balance thus struck by the doctrine, which also facilitates mutually profitable agreement to bring the improvement to practice, has been amply praised by commentators.[94] On the whole, then, blocking patents gives us more rather than less confidence in the capacity of the patent system to handle innovations with a multitude of potential unforeseen applications.

This is not to say, however, that patent law strikes the perfect balance between the rights of original and follow-on innovators. It might be contended that in situations of bargaining breakdown, such as when the improvement would render the original application obsolete or cut into its market, the law should give the follow-on innovator more leverage to force the breakthrough, for example by providing for a compulsory license (though this is a problem more relevant to applied than abstract upstream innovations).[95] Or it might be thought that some follow-on work, particularly scientific verification or testing of the original innovation, should be

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[90] *Prima Tek II*, 222 F.3d at 1379, 1379 n.2.

[91] *Id.*

[92] For a real-world example involving drugs for treatment of hepatitis C, see Janet Freilich, *Paths to Downstream Innovation*, 55 U.C. DAVIS L. REV. 2209, 2216-17 (2022).

[93] *See id.* at 2217-18 (explaining that blocking patents doctrine "promotes downstream innovation by giving downstream innovators leverage to negotiate with upstream patent holders to extract value from the invention," "give[s] both the upstream and downstream innovators incentive to reach an agreement to commercialize the fruits of the combined innovation," and "reflects a careful balance" of interests).

[94] *See id.*; *see also, e.g.*, Robert P. Merges, *Intellectual Property Rights and Bargaining Breakdown: The Case of Blocking Patents*, 62 Tenn. L. Rev. 75, 81 (1994) ("Blocking patents thus represent an interesting property rights institution that balances incentives for pioneers with incentives for independent inventors to push pioneering technology forward."); Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 Tex. L. Rev. 989, 991-92 (1997) (praising blocking patents and suggesting that copyright should adopt an analogous "blocking copyrights" rule).

[95] *See* Joseph A. Yosick, *Compulsory Patent Licensing for Efficient Use of Inventions*, 2001 U. Ill. L. Rev. 1275, 1293-98 (2001) (reviewing various causes of bargaining breakdown in the context of blocking patents and arguing that "[c]ompuslory licensing would resolve these deadlocks"); Merges, *supra* note 94, at 104-05 (reviewing the patent statutes of various non-American jurisdictions that provide for compulsory licensing in some cases of blocking patents).

allowed to proceed without requiring a license, a problem to be discussed more extensively in the next section.[96] These, however, are questions of patent scope and infringement, not of patentable subject matter. They concern what someone else should be permitted to do in the face of an existing patent, not whether certain inventions should be categorically ineligible, especially given that the problems apply broadly to all upstream-downstream conflicts and not just to abstract ideas. Indeed, as mentioned, some aspects of the conflict, such as a new application rendering an old one obsolete or cutting into its market, apply with greater force to applied than abstract upstream innovations. So the problem of unforeseen applications does prompt one to think harder about how the patent system manages conflicts between pioneering and follow-on innovators, but it does not provide a persuasive justification for the abstract-ideas exclusion.

G. The Prohibition of Thinking

Another concern that might justify the exclusion of abstract ideas is that their protection may amount to monopolizing thought itself. To the extent abstract ideas constitute raw elements of creative or intellectual or scientific activity, one might worry that covering them with intellectual property might prohibit others from thinking about a subject. In other words, as Katherine Strandburg has put it, "the rationale for the per se exclusion of abstract ideas from patentability [might be] that patents should not intrude on the autonomy of human thought."[97] This is related to the building-block rationale discussed in Part II.C, but it is an even graver concern. For the fear here is not just tying up future innovation but restricting research and thought itself. Such a fear might have assumed greater proportion since 2002, when the Federal Circuit eviscerated the "research exception" or "experimental use defense" that exempted certain kinds of scientific research from patent liability.[98]

This rationale has not figured prominently in the justifications given by courts and commentators for patent law's exclusion of abstract ideas. But it raises potentially grave concerns that deserve to be taken seriously. Ultimately, the anti-thinking rationale does not provide a strong basis for excluding abstract ideas, for two reasons. First, it is clear that the Patent Act does not prohibit thinking about a patented principle or its subject matter. Second, how an upstream patent regulates incentives for downstream research is a question of patent scope and infringement, not patentable subject matter.

As a matter of positive law, the anti-thinking concern is overstated because the act of thinking does not come within the Patent Act's definition of infringement. Nor does research per se. The Act defines infringement as the unauthorized making, using, offering to sell, selling, or

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[96] *See infra* notes 98-106 and accompanying text.

[97] Strandburg, *supra* note 8, at 591.

[98] *See* Madey v. Duke Univ., 307 F.3d 1351, 1362 (Fed. Cir. 2002) ("In short, regardless of whether a particular institution or entity is engaged in an endeavor for commercial gain, so long as the act is in furtherance of the alleged infringer's legitimate business and is not solely for amusement, to satisfy idle curiosity, or for strictly philosophical inquiry, the act does not qualify for the very narrow and strictly limited experimental use defense."); *see also* Freilich, *supra* note 92, at 2219 (noting that the research exception had come into disfavor by the late Twentieth Century and was "essentially eliminated" by *Madey*).

importing of a patented invention.[99] Nowhere does it list thinking about or researching a patented invention as an infringing act. The Federal Circuit explained this important principle of (non)infringement in a recent case:

> Classen's position . . . appears to have been that the [patent] claims are infringed if the subject thereof is the subject of study, analysis, verification, or other scientific inquiry. . . . Classen's view of its claims appears to have been that they covered 'thinking" about their subject matter. That is, of course, incorrect. The information in patents is added to the store of knowledge with the publication/issuance of the patent. An important purpose of the system of patents is to negate secrecy, and to provide otherwise unknown knowledge to the interested public. . . . The disclosure required by the Patent Act is the *quid pro quo* of the right to exclude. In turn, the subject matter of patents may be investigated and verified and elaborated; the technological/scientific contribution to knowledge is not insulated from analysis, study, and experimentation for the twenty years until patent expiration.[100]

Importantly, the principle that thinking about a patented invention does not constitute infringement stands independent of any research exception. The research exception insulates an otherwise infringing act from liability;[101] the point here, by contrast, is that the act of thinking does not come within the definition of infringement.

In drawing attention to well-established law that thinking is not an act of infringement I do not mean to imply that all is well with how our patent system deals with downstream research. The question of how a patent system can promote creative incentives for upstream inventors while preserving the freedom to undertake follow-on research is one of the most fundamental questions of innovation policy, one that has inspired a voluminous literature in law[102] and social science.[103] I do not claim that the Patent Act by its definition of infringement

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[99] 35 U.S.C. § 271(a) ("[W]hoever 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.").

[100] Classen Immunotherapies, Inc. v. Biogen IDEC, 659 F.3d 1057, 1072 (Fed. Cir. 2011) (citations and quotation marks omitted).

[101] For example, in the classic case often cited as a progenitor of the research exception, Justice Story opined that *making* a patented machine, which unlike thinking *is* one of acts listed in the Patent Act's definition of infringement, would not constitute infringement if done merely for purposes of scientific investigation: "it could never have been the intention of the legislature to punish a man, who constructed such a machine merely for philosophical experiments, or for the purpose of ascertaining the sufficiency of the machine to produce its described effects." Whittemore v. Cutter, 29 F. Cas. 1120, 1121 (C.C.D. Mass. 1813).

[102] *See, e.g.*, Rebecca Eisenberg, *Patents and the Progress of Science: Exclusive Rights and Experimental Use*, 57 U. Chi. L. Rev. 1107 (1989) (analyzing the proper scope of an experimental use exception from patent liability to promote scientific progress); Lemley, *supra* note 94 (analyzing how the copyright and patent laws balance the rights of original and follow-on innovators); Maureen A. O'Rourke, *Toward a Doctrine of Fair Use in Patent Law*, 100 Colum. L. Rev. 1177 (2000) (arguing that patent law should adopt a doctrine akin to copyright fair use to reconcile the creative incentives provided by patents with the interest in follow-on innovation); Freilich, *supra* note 93 (cataloguing the ways in which downstream research may proceed with or without a patentee's permission and proposing a broad research exception to channel the direction of follow-on research).

strikes this fundamental balance just right. After all, though research per se is not an infringing act, many activities that are frequently undertaken in connection with research do come within the statutory definition of infringement.[104] That is why a number of commentators have advocated more robust immunity for research.[105] I am sympathetic to this position, but I do not see it as a problem peculiar to abstract ideas. It is, rather, an endemic and important problem of patent policy in general. And it is one which, doctrinally, is most often and most usefully thought of in terms of the patent right's scope and the definition of infringement and defenses thereto, not in terms of patentable subject matter.[106] After all, the concern here is with *what someone else does* with the patented invention, not with the nature of the invention (which is perhaps why, quite appropriately, the anti-thinking concern has not played a major part in courts' and commentators' justification of the abstract-ideas exclusion). To the extent abstract ideas are foundations of downstream research, making them patent eligible would make the imperative of recalibrating the research exception ever more imperative. But a concern that patents should not prohibit thinking or downstream research, well-founded as it is, does not provide a good justification for excluding abstract ideas from the subject matter of patents.

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[103] *See, e.g.*, Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. Econ. Persp. 29 (1991) (exploring the implications of the cumulative nature of innovation on the optimal design of patent law); Fiona Murray & Scott Stern, *Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge?: An Empirical Test of the Anti-Commons Hypothesis*, 63 J. Econ. Behav. & Org. 648 (2007) (finding a modest negative effect of patents on follow-on innovation when comparing citation patterns between articles associated and not associated with a patent); Alberto Galasso & Mark Schankerman, *Patents and Cumulative Innovation: Causal Evidence from the Courts*, 130 Q.J. Econ. 317 (2015) (finding that patent invalidation leads to an average 50 percent increase in citations to the patent but that the effect varies widely depending on the research area); Bhaven Sampat & Heidi L. Williams, *How Do Patents Affect Follow-On Innovation? Evidence from the Human Genome*, 109 Amer. Econ. Rev. 203 (2019) (finding that gene patents had little or no effect on follow-on innovation in the form of scientific publications, pharmaceutical clinical trials, or diagnostic tests); Janet Freilich & Sepehr Shahshahani, *Measuring Follow-On Innovation*, https://papers.ssrn.com/abstract_id=4268690 (finding that gene patents which were close to expiration caused an increase in follow-on research but those that were far from expiration had no effect).

[104] *See* Freilich, *supra* note 92, at 2218 ("Most downstream research requires conducting one of those actions [enumerated in the § 271(a) definition of infringement]. For example, to discover a new use for Teflon, one would have to conduct experiments using Teflon—an act of infringement. To discover a new way of making Teflon, one would have to make Teflon—an act of infringement. To discover a new combination of Teflon and other chemicals, one would have to use (and possibly make) Teflon—an act of infringement.").

[105] *See, e.g.*, Eisenberg, *supra* note 102, at 1078 (recommending that research done to check whether a patented invention works should be exempt from liability and research that may improve a patented technology or its alternatives should be exempt from an injunction remedy); Rochelle Dreyfuss, *Protecting the Public Domain of Science: Has the Time for an Experimental Use Defense Arrived?*, 46 Ariz. L. Rev. 457, 471-72 (2004) (proposing a scheme whereby a nonprofit research institution that cannot get a reasonable license from a patentee is permitted to use the patented technology upon signing a "waiver . . . requir[ing] the institution to promptly publish the results of work conducted with the patented technology and to refrain from patenting discoveries made in the course of that work"); Katherine J. Strandburg, *What Does the Public Get? Experimental Use and the Patent Bargain*, 2004 Wis. L. Rev. 81, 83 (2004) (arguing that "a well-designed experimental-use exemption from infringement liability can promote faster cumulative technological progress without significantly diminishing incentives to invest in the original invention"); Freilich, *supra* note 92, at 2267-69 (proposing a "broad research exception").

[106] *See* Dreyfuss, *supra* note 105, at 468 (arguing that changing the definition of patentable subject matter is not a good way of fostering a "creative environment" for research because it does "not change the dual character of the fruits of modern science"—namely, that its fruits can constitute fundamental research and end products at the same time—and further may lead to under-incentivization of activity in excluded subject matters).

H. The Invention-Discovery Dichotomy

Another argument against the patentability of abstract ideas could be that they are discoveries, not inventions.[107] This does not sound like a persuasive argument as a matter of positive law—the Patent Act uses both "discovers" and "invents" to describe acts that could entitle one to a patent[108]—but the argument is worth pausing on as a normative justification. At one level, the argument amounts to semantics or question-begging. If all that the labels "discovery" and "invention" do is separate patent-ineligible abstract ideas from patent-eligible applications, then saying that abstract ideas should not be patentable because they are discoveries does no more than restate the conclusion that abstract ideas should not be patentable. To make the argument non-vacuous, one would have to identify some feature of discoveries, in contradistinction to inventions, that makes them ineligible for patenting.

One apparent distinguishing feature is that discoveries point to something *preexisting* whereas inventions create something new.[109] Similarly, the invention-discovery dichotomy could be taken to distinguish "human-made" things from things that are "already out there" in nature.[110] The argument could be that only the former should be patent-eligible because only they owe their existence to human ingenuity.[111]

To the extent the discovery-invention dichotomy is meant to rule out patenting things that are "preexisting" or "out there" in an immediately perceptible sense, I have already incorporated that idea in my definition and exclusion of "natural phenomena" in Part II.A. Recall that I defined natural phenomena as phenomena existing or occurring in nature that can be readily perceived by the senses. I gave as examples rain, earthquakes, a particular earthquake, lightning, Steamboat Geyser, the Americas, and the variegated golden frog (*Mantella baroni*).[112] As discussed more extensively in Part II.A, there are three reasons to doubt that natural phenomena, as defined, are suitable for patent protection: Their discovery or invention cannot be attributed to any person's ingenuity; the right discoverer or inventor cannot be pinpointed; and to the extent

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[107] *See* Dana Remus Irwin, *Paradise Lost in The Patent Law? Changing Visions of Technology in The Subject Matter Inquiry*, 60 Fla. L. Rev. 775, 788-89 (2008) (explaining that one of the "broad categories of subject matter" excluded by pre-Twentieth Century cases was "aspects of the natural world that were merely discovered by an inventor but not applied").

[108] 35 U.S.C. § 101 ("Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.").

[109] *See* Parker v. Flook, 537 U.S. 584, 593 n.15 (1978) ("The underlying notion [that justifies the subject matter exclusion] is that a scientific principle, such as that expressed in respondent's algorithm, reveals a relationship that has always existed.").

[110] *See* Syed, *supra* note 8, at 1943 (stating that "a central refrain of courts" is that the excluded subject matter "already exist 'out there,' prior to any human ingenuity").

[111] *Id. See also* In re Bilski, 545 F.3d 943, 1013 (Fed. Cir. 2008) (Rader, J., dissenting), *aff'd sub nom.*, Bilski v. Kappos, 130 S. Ct. 3218 (2010) ("Natural laws and phenomena can never qualify for patent protection because they cannot be invented at all. After all, God or Allah or Jahveh or Vishnu or the Great Spirit provided these laws and phenomena as humanity's common heritage."); Collins, *supra* note 61, at 57 (claiming that principles such as the law of gravity or $E = mc^2$ "would be inherently anticipated under section 102, as the states of affairs described by the claims long predated their discovery by humankind").

[112] *See supra* Part II.A (defining and discussing "natural phenomena").

finding a physical thing may be thought worthy of remunerating or incentivizing, the problem belongs in the sphere of property rather than intellectual property law.[113] I do not claim that these considerations definitively rule out the patent eligibility of natural phenomena; but at least it's clear that they are different from abstract ideas and laws of nature, and my arguments in this Article do not apply to them. Apart from pointing to natural phenomena, a category that I have already excluded from the analysis, the discovery-invention dichotomy is not satisfying at a theoretical level or as a guide to patent policy.

At a theoretical level, beyond the obvious examples captured by the definition of natural phenomena, the dichotomy between new human-made things and preexisting natural things is not particularly robust. Although it is probably unproblematic to say, for example, that a bicycle is human-made whereas a stone is natural, the classification cannot be made for many objects. Take, say, a human-planted tree. Is it natural or human-made? If it's natural, does that imply that it should never be patentable—regardless of how innovative the process of breeding the tree might be, or how different the tree is from trees that existed prior to human breeding? Why should the answer be different for a drug (many drugs, after all, are derived from natural ingredients)? More troublingly, the manmade-versus-natural classification is impossible to apply to the *principles* or *knowledge* that make inventions work. That is crucial because what a patent protects is not just a physical object but also the use of knowledge and principles in constructing or using the object.[114] Are the mathematical, physical, and engineering truths that make a bicycle or a car engine or a nuclear power plant run human-made or natural? What about a breakthrough in understanding them? There is no satisfying pre-policy answer to these questions. Even in the realm of mathematics, the most abstract of the sciences, there are unresolved philosophical debates over whether its constructs and truths are discoveries or inventions.[115]

More damning than the theoretical instability of these distinctions is their irrelevance to the question of patent eligibility. The standard justification for intellectual property rights is to create incentives to provide public goods that would otherwise be under-provided because their nonrivalrous and nonexcludable nature makes it possible for others to copy and disseminate them at very little cost.[116] This rationale is theoretically plausible, albeit debatable[117] and hotly debated.[118] But, whatever one's view may be of the rationale for IP, what is clear is that its

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[113] *See supra* Part II.A.

[114] *See* Syed, *supra* note 8, at 1937, 1942, 1943 *et passim.*

[115] *[philosophy of math citations].

[116] *See generally* Sepehr Shahshahani, *The Role of Courts in Technology Policy*, 61 J.L. & Econ. 37, 40 (2018) (explaining the rationale and citing the caselaw articulating it); 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 (National Bureau of Economic Research ed., 1962) (explaining that in the absence of some form of protection, trading on information is plagued by the "paradox" that the value of the information cannot be known before it is disclosed but the information is effectively transferred once it is disclosed).

[117] *See* Shahshahani, *supra* note 116, at 50 (noting that "there is no consensus on the optimal degree of intellectual property protection" and reviewing different sides of the debate); Richard Gilbert, *A World without Intellectual Property?*, 49 J. Econ. Literature 421 (2011) (reviewing a range of scholarly views on IP protection).

[118] *Compare, e.g.*, Michele Boldrin & David Levine, *The Case Against Intellectual Property*, 92 Amer. Econ. Rev. 209 (2002), *and* Michele Boldrin & David Levine, Against Intellectual Monopoly (2008) (arguing for IP abolition),

validity does not depend on whether the innovation being incentivized is best characterized as a discovery or an invention. Neither the public good aspect of an innovation nor its value depends in any way on that classification. Take, for example, Guglielmo Marconi's "invention" of radio following the groundbreaking work of James Clark Maxwell, whose theoretical work predicted the existence of electromagnetic waves ("radio waves"), and of Heinrich Hertz, who experimentally verified the waves' existence.[119] The public good characterization (nonrivalrous and nonexcludable) applies equally to the more basic discoveries of Maxwell and Hertz as to later applications by Marconi. Nor can it be said that the more abstract underlying principles were in any sense less innovative or difficult or worthy of incentivization than their applications; if anything, the opposite was true,[120] as is often the case.[121] The necessity for a patent right, then, does not depend on the innovation-discovery classification.

I. Non-IP Regimes to Incentivize Basic Science

A final justification for the abstract-ideas exclusion rests on a comparative institutional analysis of basic and applied science. The argument is that intellectual property rights do a good job incentivizing applied science and technology, but non-IP regimes are better suited at promoting basic science.[122] This is a serious argument, and some commentators acknowledge it as the ultimate basis for the subject matter exclusions.[123]

Before assessing the argument, it is useful to repeat a point about the standards that an acceptable comparative-institutional argument must meet: An acceptable comparative-institutional argument must *distinguish* abstract ideas from other subjects of patents—it must be a reason against patenting that applies to abstract ideas but not (or not as strongly) to other subjects.[124] It is thus not enough to demonstrate (or, more realistically, to plausibly suggest) that a non-IP regime would do better than IP in governing the production of basic science; it must be shown that the non-IP regime's advantages are greater in basic science than in applied science. Otherwise the argument would be an argument against patent rights *tout court*, not against patent rights in basic science. The superiority of an IP-based regime to other institutional arrangements for incentivizing innovation is very much an unsettled and speculative proposition: More than 60 years ago, Firtz Machlup concluded his careful survey of the patent system by stating that

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with Ronald A. Cass & Keith N. Hylton, Laws of Creation: Property Rights in the World of Ideas (2013) (arguing for strong IP rights).

[119] There is dispute over whether Marconi should be credited with inventing the radio. *See generally* Marconi Wireless T. Co. of Am. v. United States, 320 U.S. 1 (1943); Sungook Hong, Wireless: From Marconi's Black-Box to the Audion (2001). That dispute is immaterial here, as I am concerned with the comparison between the basic science groundwork and the application, not with who deserves most credit for the application.

[120] *See, e.g.*, Flexner, *supra* note 59, at 544-45 (describing Marconi's contribution as "practically negligible" compared to the earlier scientific work).

[121] *See supra* Part II.A (providing examples of abstract ideas that were demanding to derive); *supra* Part II.C (giving examples of abstract ideas in the scientific context and showing that in that context, unlike in arts and literature, the abstract statement of a working principle of an innovation is far from trivial).

[122] *See, e.g*, Syed, *supra* note 8, at 1945-46 ("[W]hile the [applied] spaces of knowledge, being functional, are apt candidates for patent protection, the [basic spaces] are not: their generation is better suited to the alternative innovation policy of publicly funded, open science.").

[123] *See id.* at 1946 ("It is this 'basic' versus 'applied' distinction that lies at the core of ineligibility case law.").

[124] *See supra* Part II.B.

"[n]o conclusive empirical evidence is available to decide" the conflict between pro-patent and anti-patent views.[125] Today, despite the mass of social scientific evidence (and even greater mass of polemic) brought to bear on the question,[126] strong scholarly disagreements remain.[127] But the question here is not whether patent rights should exist; the question is whether there is a reason to extend patent rights to all sorts of innovations but not to basic science. A justification for the abstract-ideas exclusion must justify the *different* treatment of abstract ideas.

Reviewing the literature, I see two main non-conclusory rationales under the comparative-institutional umbrella.[128] The first rationale is that the people engaged in basic science are motivated not so much by financial profit as by values such as advancing the frontiers of science, curiosity, the intrinsic pleasures of discovery, and scientific status.[129] As such, adding the promise of financial rewards from patents would do little to add fuel to basic scientists' drive to innovate while burdening society with monopoly deadweight loss and access costs.[130] Mark Golden, in his revealing study of the American biotechnology ecosystem, succinctly articulates this view:

> What do the background dominance of publicly funded research and public sector values tell us about the foreground issues of patent law? Most fundamentally, they tell us that current concerns about the possible overextension of American patent law are justified. By extending its reach to subject matter traditionally reserved for the public domain of natural science, patent law risks creating obstacles to future research and invention without adding proportionately to the actual motivations of those who do the inventing.[131]

The argument from motivations has not been a centerpiece of judicial rationales for the abstract-ideas exclusion, and one can see why: It seems a little unfair to punish scientists for being pure, to tell them the system shall give you less money because you are less of a

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[125] Fritz Machlup, An Economic Review of the Patent System 79 (1958). *See also id.* at 80 ("[T]he safest 'policy conclusion' is to 'muddle through.'").

[126] *See supra* note 103 and *infra* note 145 (reviewing some of the social scientific literature).

[127] *See supra* notes 117-118 (outlining different views and disagreements).

[128] In addition to these two rationales, discussed below, Syed builds the comparative institutional case for the abstract-ideas exclusion on the idea that basic science "serves as a *foundational platform* for all subsequent researchers." Syed, *supra* note 8, at 1982. That, however, is essentially the same as the building block rationale discussed in Part II.C.

[129] *See, e.g.*, John M. Golden, *Biotechnology, Technology Policy, and Patentability: Natural Products and Invention in the American System*, 50 Emory L.J. 101, 144 (2001) ("[M]ost researchers are strongly motivated by public sector values—values that prize the advancement and wide dissemination of scientific and technical knowledge, and, less altruistically, support a "credit economy" in which personal achievement is tied to status, reputation, and academic empire building."); Syed, *supra* note 8, at 1985 ("Th[e] case [for excluding abstract ideas] hinges on the tight link between *basic knowledge* and the comparative virtues of the *internally driven* exploratory trajectory of peer production, as compared to *applied knowledge* and the comparative virtues of *externally oriented* search processes of market production.").

[130] Golden, *supra* note 129, at 144 ("To the extent that public sector values are the dominant source of motivation for scientific and technological innovation, the need for the personal monetary inducements provided by patents is reduced."); Syed, *supra* note 8, at 1991 (justifying the abstract-ideas exclusion in part on the basis that "at the level of individual motivation, scientists tend to be animated as much or more by the internal and social rewards of scientific activity—its intellectual gratifications and peer recognition—as by material incentives").

[131] Golden, *supra* note 129, at 110.

moneygrubber. However, given the creative-incentives framework, which is the dominant framework governing American intellectual property law and the one under which this Article proceeds, the argument is a serious one.[132] It would be a strong argument against patentability if it were true that in the incentive-access tradeoff of IP, the availability of patents for abstract ideas would add to access costs while doing little to advance creative incentives.

The strength of this rationale depends on the accuracy of its claims about scientists' creative motivations. As someone who left a BigLaw job for a PhD program, where I collected about a tenth of my previous income but spent a happy five years in intellectual pursuits, I would be the last to doubt the nonpecuniary attractions of the life of the mind. I do wonder, however, about the distinguishing power of such stories. The motivations rationale does not seem to divide the world according to patent law's subject matter exclusions. In other words, the line between primarily profit-motivated and not primarily profit-motivated innovators does not often track the line between patentable applied science and unpatentable basic science. The management consultants quoted by Golden on the importance of nonmonetary motivations for employee innovation are speaking of "inventor-type people" in the context of *applied* science in industry.[133] The "industry practice" discussed by Golden comes from the same context.[134] Indeed the "geek" or "nerd" type straddles the basic and applied worlds. Steve Wozniak, the Apple cofounder, is one prominent example of a tech innovator who embraced what Golden calls "public-sector values."[135] Unlike his non-engineer cofounder Steve Jobs, Wozniak has an aversion to accumulating great wealth which he has expressed in quasi-religious terms[136] and which he has confirmed by his career decisions.[137] Just as there are many basic scientists who are in it in for the love of pure science, there are many applied scientists who are in it for the love of tinkering and to serve others. Benjamin Franklin, for example, refused on principle to patent his inventions.[138] Other scientists worked on subjects with great potential for profitable applications but were too taken with the intrinsic worth of their inquiries to care about

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[132] For brief discussion of this basic framework, see *supra* notes 116-118 and accompanying text.

[133] *See* Golden, *supra* note 129, at 159-60 (*quoting* Nino S. Levy, Managing High Technology and Innovation 28 (1998) and Peter S. Cohan, The Technology Leaders: How America's Most Profitable High-Tech Companies Innovate Their Way to Success 38 (1997)).

[134] *Id.* at 160.

[135] *See id.* at 153-57 (defining "public-sector values," which give low priority to financial profit).

[136] *See* Jonathan Varian, *Apple Co-Founder Steve Wozniak Talks Innovation, Microsoft, and Being Introverted*, Fortune, Apr. 21, 2017, https://fortune.com/2017/04/21/steve-wozniak-apple-microsoft/ ("I do not invest. I don't do that stuff. I didn't want to be near money, because it could corrupt your values. . . . I went the other way. I did not want to be one of them. I invested early in things like museums in the city I love, San Jose. . . . I really didn't want to be in that super 'more than you could ever need' category.").

[137] *See* Emmie Martin, *Why Apple Co-Founder Steve Wozniak Doesn't Trust Money*, CNBC, Apr. 21, 2017, https://www.cnbc.com/2017/04/21/why-apple-co-founder-steve-wozniak-doesnt-trust-money.html (contrasting Wozniak's $100 million net worth with Jobs's $10.2 billion and noting that "[o]ne initial reason for this divergence in net worth is Wozniak's disinterest in money from the start. Back in 1980, he offered $10 million of his own stock to early Apple employees, something Jobs refused to do. He later called the move 'the right thing' to do.").

[138] *See* Benjamin Franklin, The Autobiography of Benjamin Franklin (1793), *available at* https://www.ushistory.org/franklin/autobiography/page55.htm ("Governor Thomas was so pleased with the construction of this stove, . . . that he offered to give me a patent for the sole vending of them for a term of years; but I declined it from a principle which has ever weighed with me on such occasions, viz., That, as we enjoy great advantages from the inventions of others, we should be glad of an opportunity to serve others by any invention of ours; and this we should do freely and generously.").

applications. When Heinrich Hertz, the first to experimentally verify the existence of electromagnetic waves, which were essential in enabling wireless communication (hence the name "radio waves"), was asked about the practical implications of his work, he replied, "Nothing, I guess."[139] Michael Faraday apparently had a similar attitude about his seminal work on electricity.[140] Moreover, some of the most prominent movements with a nonprofit, communitarian attitude toward innovation, such as the open-source software movement, come from the world of technology and applied science, not basic science.[141] In short, though the stories about basic scientists' nonmonetary creative motivations are supported by compelling personal anecdotes, there are similarly compelling examples on the applied side.[142]

But these are details. Let us assume, for the sake of argument, that the proportion of people who are not strongly motivated by pecuniary considerations is significantly higher in basic science than applied science. There is a deep problem in inferring from that that the introduction of patents would do little to incentivize more creative work in basic science. That deep problem is *endogeneity*. What the proponents of the creative-motivations rationale are missing is that *the mix of motives and characteristics of innovators in basic science is endogenous to the innovation policy regime governing basic science*. The proportion of profit-motivated people in a field depends on the field's profit potential, which in the context of innovation-producing fields depends on the availability of intellectual property rights for the innovations. When one of two adjacent career paths offers systematically greater promise of financial rewards through IP rights, it is no surprise to see a greater proportion of profit-motivated people drawn to that path.

These observations about endogeneity have an important policy implication: *You cannot accurately estimate the impact of a change in patent-eligibility policy by reference to the current motivations of innovators in basic science because a change in policy would change the selection of innovators and their motivations.* Just as the *current* mix of innovator characteristics is a

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[139] Quoted in Sean Carroll, The Particle at the End of the Universe: How the Hunt for the Higgs Boson Leads Us to the Edge of a New World 122 (2013). Hertz's full statement on the usefulness of his findings is worth quoting because it illustrates his pure attitude: "It is of no use whatsoever. This is just an experiment that proves Maestro Maxwell was right [Maxwell had theoretically predicted the existence of electromagnetic waves]. We just have these mysterious electromagnetic waves that we cannot see with the naked eye. But they are there." Andrew J. Norton, Dynamic Fields and Waves 83 (2000).

[140] *See* Flexner, *supra* note 59, at 546 ("His earlier discoveries have led to the infinite number of practical applications by means of which electricity has lightened the burdens and increased the opportunities of modern life. His later discoveries have thus far been less prolific of practical results. What difference did this make to Faraday? Not the least. At no period of his unmatched career was he interested in utility. He was absorbed in disentangling the riddles of the universe, at first chemical riddles, in later periods, physical riddles.").

[141] *See generally* Eric S. Raymond, The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary (1999); Yochai Benkler, *Coase's Penguin, or, Linux and The Nature of the Firm*, 112 Yale L.J. 369 (2002).

[142] And, just as there are compelling examples of "applied" scientists who are not much motivated by money, there are many examples of "basic" scientists who leveraged their work to launch hugely lucrative careers. For example, Herbert Boyer, whose work on a restriction enzyme produced by E coli that cuts DNA into pieces with overhanging strands was a foundation for the field of genetic engineering, moved from academia to industry early on to cofound Genentech, the first biotechnology company. *See* GENENTECH, *Our Founders*, https://www.gene.com/about-us/leadership/our-founders (last visited Dec. 25, 2022); WHATISBIOTECHNOLOGY, *Professor Herbert Boyer*, https://www.whatisbiotechnology.org/index.php/people/summary/Boyer (last visited Dec. 25, 2022).

function of the current IP regime, the *future* mix will be affected by the future regime. Greater availability of patent rights could (and theoretically would be expected to) change the *selection* of innovators into the field. That would be expected to accelerate the rate of basic scientific innovation—not just by adding fuel to the creative fire of those who were already doing basic science but by bringing in new people who otherwise would not have entered the field.[143] In sum, the argument that making abstract ideas patent-eligible would not add much to creative incentives because current innovators in the area are not primarily profit-motivated is profoundly circular.

Nor can the argument be saved by contending that we should not mess with the incentive structure of basic science because the current levels of production serve us well.[144] It is very difficult to estimate the optimal rate of innovation in basic science (or in any other area of innovation, for that matter). And the lack of meaningful experience with the relevant counterfactual—that is, with an innovation policy system that *does* award patents for abstract ideas—makes it almost impossible to compare and judge innovation rates under different regimes.[145] So it is unclear on what basis legal commentators can take comfort in the current state of affairs.

To go by the judgment of many scientists, things are *not* just fine. After highlighting how a few techniques developed by basic biological research enable much of current applied biological and biomedical research, Isobel Ronai and Paul Griffiths conclude that "[b]asic research is not sufficiently valued by the scientific reward system, funding agencies, or the general public."[146] Robbert Dijkgraaf, a prominent theoretical physicist who served as director of the Institute for Advanced Study, has warned that "the state of scholarship [in basic science] has now reached a critical stage" following a decades-long "retrenchment" from the strong pro-science position of the postwar decades.[147] Dijkgraaf points to steadily declining public funding of basic science coupled with diminished support from an increasingly short-termist private

[143] Some of the results that might be expected from a change in patent policy have already materialized due to changes in patenting culture and in industry that have made remunerative careers more available. Two decades ago, Golden wrote that the "supermajority" of life science PhDs employed by government labs, universities, and research institutes, as opposed to biotech industry, "appears safe for years to come." Golden, *supra* note 129, at 146. In fact the supermajority has been eliminated. *[Citations, statistics, and discussion.]

[144] *Cf.* Golden, *supra* note 129, at 110 ("[O]ver-emphasis on patent protection risks displacing a system of public sector values that appears to have served science and society well.").

[145] There is, however, a rich literature in innovation economics that attempts to use credible causal identification strategies to estimate the effect of patent policy on innovations. The historical strand of this work is particularly relevant for researchers trying to isolate the effect of different policy regimes (as opposed to the effect of patenting *given* a particular policy regime). *See* *[citations to Petra Moser and others]; *see also supra* note 103 (summarizing some of the empirical literature on the effect of patents on follow-on innovation). The "local" nature of the identified effects in the historical studies, combined with deep differences between their contexts and the present American context, makes it hard to draw policy-relevant inferences from these works (though it's still better than proceeding by *ipse dixit*). Moreover, I do not know of studies particularly bearing on the question of the patentability of abstract ideas.

[146] Isobel Ronai & Paul E. Griffiths, *The Case for Basic Biological Research*, 25 Trends in Molecular Med. 65, 66 (2019).

[147] Robbert Dijkgraaf, *The World of Tomorrow*, *in* Abraham Flexner, The Usefulness of Useless Knowledge 1, 33 (2017).

industry.[148] "As a consequence of the priorities and politics of the time, basic research is too blithely given short shrift, its budget often ending up as the remainder of a growing series of subtractions."[149] Similar warnings have been sounded by prominent scientists and scientific institutions.[150] All this makes a "fine as it is" attitude hard to sustain.

Nor can one rescue the motivation-based argument by reference to "norms of science" such as "openness and sharing," "disinterestedness," and "impartiality."[151] This statement of the norms is idealized to the point of misdescription.[152] More fundamentally, relying on current norms to justify the current institutional structure suffers from the same endogeneity fallacy as relying on individual motivation.

A second comparative-institutional justification for the abstract-ideas exclusion is that the road from basic scientific discovery to commercially fruitful application is long and uncertain, so basic science would not be adequately incentivized if it were left to market-based mechanisms such as patents which are focused on short-term rewards.[153] The argument's premise is sound: There are many examples of basic scientific innovations with applications that were not realized or developed until long after the initial abstract breakthrough—from how Newtonian/Leibnizian calculus undergirds the marvels of modern engineering, to the use of Maxwell's classical theory of electromagnetic radiation in radio and television broadcasts, to the application of mathematical group theory in spectroscopy, to the use of Einstein's theory of relativity in the design of GPS devices, to how quantum theory helps with work on microprocessors and lasers, to the use of basic biochemical discoveries in genetic engineering and cloning.[154] But this is a curious argument to employ as a justification for the abstract-ideas exclusion—because it shows

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[148] *Id*. at 33-34.

[149] *Id.* at 35. Interestingly, Dijkgraaf's warnings echo those sounded eighty years ago by his predecessor Abraham Flexner, the American educator who founded the Institute as "a paradise for scholars" for "the unobstructed pursuit of useless knowledge." Flexner, *supra* note 59, at 552.

[150] *See, e.g.*, Eric Hand et al., *A Back Seat for Basic Science*, 496 Nature 277 (2013); Massachusetts Institute of Technology, The Future Postponed: Why Declining Investment in Basic Research Threatens a U.S. Innovation Deficit (2015), https://dc.mit.edu/sites/default/files/Future%20Postponed.pdf; Robbert Dijkgraaf, *We Need More "Useless" Knowledge*, Chron. Higher Ed., Mar. 2, 2017; Craig A. Tovey, *In Defense of Basic Research*, 355 Science 804 (2017); Giuliana Viglione, *NSF Grant Changes Raise Alarm about Commitment to Basic Research*, 584 Nature 177 (2020).

[151] Syed, *supra* note 8, at 1992.

[152] I have a sibling and a spouse with active research careers in basic science, one in pure mathematics and one in biology, and their experiences cannot be farther from this idealistic description. As for "openness and early sharing," they report that people in their fields would never transparently share early drafts or even present posters with early results out of fear of getting "scooped" by competitors. As for "impartiality (in reviewing others' work)," I have seen drafts of articles stuck in peer review for months or years due to a competitor strategically holding them up. Of course, this is not to say that more genuinely collaborative people do not exist in basic science—just as they do in applied science and technology—but a rosy picture of scientific norms is at odds with experience and does not distinguish basic from applied science. Golden's descriptions of scientific norms, which are based on evidence and attuned to competitive, careerist concerns and their tension with genuine collaboration, seem more realistic. *See* Golden, *supra* note 129, at 155-56 *et passim*.

[153] *See* Syed, *supra* note 8, at 1988 ("[M]any of the benefits of [basic] research will only come to fruition far down the line, long past the short-to-medium term time horizons of market actors, whose private discount rate is higher than any plausible social one. Market prices, then, will systematically under-value basic research.").

[154] *See* Flexner, *supra* note 59, at 545-48; Dijkgraaf, *supra* note 147, at 18-20; Ronnai & Griffiths, *supra* note 146, at 65-66.

that basic science needs *more*, not less. It may well be that, given the long and uncertain monetary payoffs of basic science, public funding would still be necessary even if patents were made available. But it's hard to see how this argues against patentability. If no work would have been done on applications during the term of the patent, then the patent will have done no harm; meanwhile, for basic discoveries that do have plausible short-term applications, the patent adds to creative incentives.

A possible counterargument is that the availability of a patent may do harm by "crowding out" other motivations. The idea is that the very prospect of profit may turn away those who are attracted to science for reasons other than short-term monetary gain, or may reorient their values, to the ultimate detriment of the level and direction of basic research. I have not seen this argument deployed by proponents of the abstract-ideas exclusion, except in passing speculation,[155] but it is an argument worth pausing on. A nice illustration of the idea comes from Uri Gneezy and Aldo Rustichini's study of a child daycare facility which introduced fines for parents who were late to pick up their children.[156] Rather than ameliorate the daycare's difficulties with late-arriving parents, the introduction of fines led to an *increase* in late arrivals.[157] One interpretation of this finding is that by putting a dollar figure on the act of being late, the fine system led parents to reinterpret it as something they could pay for in a market framework (hence the title *A Fine Is a Price*), obviating any moral or norms-based compunctions they may have had about forcing the daycare staff to stay overtime.[158] It could be argued by analogy that the introduction of patent-based financial incentives might diminish the nonmonetary motivations of pure scientists or might turn away more purely motivated innovators.

This is a clever argument, but entirely too speculative to ground a fundamental canon of the patent system. To begin, the "crowding out" interpretation is not the only plausible interpretation of the daycare study. As Gneezy and Rustichini acknowledge, an equally plausible interpretation is that the fine system ruled out *more* drastic forms of punishment for lateness or repeated lateness, such as expelling the child; by completing the incomplete contract governing what happens if a parent is late, the fine system might have reassured parents that paying a nominal fine is the *only* consequence of being late, making them less punctual.[159] Some other studies in this area are even less supportive of a motivation-crowding interpretation. In another study, Gneezy and Rustichini's conclusion was not that monetary incentives decrease performance (whether by crowding out or other mechanisms) but rather that their effect is nonmonotonic: A small monetary incentive reduced performance relative to no monetary reward, but a large monetary incentive boosted performance (hence the title *Pay Enough or Don't Pay at All*).[160] The authors found that they can best explain their results by the

[155] *See* Golden, *supra* note 129, at 145 ("Second (and somewhat more speculatively), by commercializing research, the government could drive away, or demoralize, those attracted by the relative asceticism of modem science.").
[156] Uri Gneezy & Albert Rustichini, *A Fine Is a Price*, 29 J. Legal Stud. 1, 1 (2000).
[157] *Id.* at 3.
[158] *Id.* at 13-14.
[159] *Id.* at 3, 10-11. Indeed this is the first interpretation advanced by the authors.
[160] Uri Gneezy & Also Rustichini, *Pay Enough or Don't Pay at All*, Q.J. Econ. 791, 793-95 (2000).

information-based, incomplete-contract mechanism, not the motivation-crowding one.[161] Given the "small change" involved, none of these experimental settings seems generalizable to the patent context, but the higher-payment condition is more comparable. Other studies have gone one way or the other,[162] and the literature is on balance inconclusive.[163] A very recent study, critically reviewing over 100 prior tests and reporting on a well-designed field experiment that fills in many earlier studies' methodological holes, concludes that "results on output, productivity and quits are most consistent with a standard economics model than with a crowding-out one."[164]

In addition to these weighty empirical concerns, there is a conceptual problem with embracing motivation-crowding as a justification for excluding abstract ideas: The argument could apply equally to *applied* science. If we accept the premise that patents crowd out nonpecuniary motivations, we should be concerned that patents are already doing that in applied science and technology. We do not know, after all, that the current mix of innovators and motivations in those areas is optimally calibrated. Accepting this rationale would thus be a general argument against patentability, not an argument against the patentability of abstract ideas. We are back at the important requirement that a distinguishing reason must distinguish.

J. An "Unprincipled" Argument

I would like to close the discussion of possible justifications for the abstract-ideas exclusion with a justification that has not been put forth by courts or commentators but which I suspect animates some of their resistance to patent eligibility. That justification does not rest, as a principled justification must, on any distinction between abstract ideas and other subjects of patents. Rather, it rests on a general aversion to patents. It proceeds from a place of skepticism about the value of patents or, more specifically, from a place of concern about the overprotective

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[161] *Id.* at 807 ("[T]he most convincing explanation seems to us to be based on cognitive arguments: contracts, social or private, are usually incomplete, and regulate an interaction in a situation of incomplete information. The introduction of a reward modifies some of the terms of the contract, but also provides information.").

[162] *Compare, e.g.*, Bruno S. Frey & Felix Oberholzer-Gee, *The Cost of Price Incentives: An Empirical Analysis of Motivation Crowding-Out*, 87 Amer. Econ. Rev. 746, 746 (1997) (finding that financial incentives lessened residents' willingness to host a noxious facility, and attributing it to motivation crowding), *with* James Heyman & Dan Ariely, *Effort for Payment: A Tale of Two Markets*, 15 Psychol. Sci. 787, 787 (2004) (distinguishing "social markets" from "monetary markets" and finding that "monetary markets are highly sensitive to the magnitude of compensation, whereas social markets are not," but that "mixed markets (markets that include aspects of both social and monetary markets) more closely resemble monetary than social markets").

[163] *Compare* Edward L. Deci, Richard Koestner, & Richard M. Ryan, *A Meta-Analytic Review of Experiments Examining the Effects of Extrinsic Rewards on Intrinsic Motivation*, 125 Psychol. Bull. 627, 627 (1999) (a meta-analysis finding that extrinsic rewards "significantly undermined free-choice intrinsic motivation"), *with* Judy Cameron & W. David Pierce, *Reinforcement, Reward, and Intrinsic Motivation: A Meta-Analysis*, 64 Rev. Educ. Research 363, 363 (1994) (a meta-analysis finding that "overall, reward does not decrease intrinsic motivation"), *and* Judy Cameron, Katherine M. Banko, & W. David Pierce, *Pervasive Negative Effects of Rewards on Intrinsic Motivation: The Myth Continues*, 24 Behav. Analyst 1, 1 (2001) (another meta-analysis finding that "in general, rewards are not harmful to motivation to perform a task").

[164] Constança Esteves-Sorenson & Robert Broce, *Do Monetary Incentives Undermine Performance on Intrinsically Enjoyable Tasks? A Field Test*, 104 Rev. Econ. & Stat. 67, 67 (2022). This article also contains a useful, concise review of the literature and its methodological shortcomings. *See id.* at 67-68.

character of the present American patent system.[165] The idea is that the cons of patenting are real and immediate—costlier access to patented innovations—but the pros in terms of creative incentives, though theoretically plausible, are not empirically well-established, and the benefit-cost balance does not look good compared to other innovation policy regimes that do not involve temporary monopolies.[166] Even one that is not so unconvinced of the general usefulness of patents may be more specifically concerned about certain features of the American patent system that are too favorable to patentees at the expense of end users and downstream innovators.[167] The attitude of such an observer might be to embrace the abstract-ideas exclusion as a *second best* solution where the first best might be a world without patents or with patents that are drastically curtailed in scope or duration. In other words, one's attitude might be that "I will take a reduction in patent rights anywhere I can get it; if it happens to be for abstract ideas, so be it."

As mentioned, this justification is unprincipled in the sense that it fails to distinguish abstract ideas from other subjects of patents. But it need not be unprincipled in a broader sense. The argument *is* principled to the extent that its suspicious attitude toward patents derives from well-thought-out policy concerns about the costs and benefits of patents or of the present patent system. If we accept the premise that the present patent system is generally way overprotective of patent rights, which is not a crazy premise to accept, then it is hard to rule out the possibility that any random curtailment of patent protections might be net beneficial. It is true that if the policy distinction between abstract and applied ideas is essentially arbitrary, as I have argued it is, then the patent system's recognition of this arbitrary distinction distorts incentives, especially at the level of potential innovators' selection into or out of basic science;[168] however, for a person who thinks patents should be nonexistent or drastically weaker, it does not seem impossible that the costs of this distortion could be overcome by the benefits of patent curtailment. So, given such a skeptical baseline policy position, it would be hard to fault someone for taking whatever they can get.

For those who find themselves in this skeptical camp, I hope the value of this Article is to bring them face to face with their real reason for embracing the abstract-ideas exclusion. There is a world of difference between accepting the abstract-ideas exclusion on the basis that there is a policy-relevant distinction between abstract and applied ideas—which has been the avowed position of courts and commentators so far—and accepting it as an arbitrary distinction that might nevertheless do more good than harm because better policy proposals are out of reach. As scholars rather than pure advocates, we should be loath to embrace a specious argument just because it leads to desired outcomes. What is more, greater clarity about our reasons for

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[165] *See* Shahshahani, *supra* note 117, at 50 n.12 (noting that "[i]t is fair to say . . . that most legal and economic experts consider the present [IP] system to be overly protective" and citing a range of skeptical expert views); *see also, e.g.*, Burstein, *supra* note 39 (providing a critical view of IP compared to other ways of promoting information diffusion); Eli Dourado & Alex Tabarrok, *Public Choice Perspectives on Intellectual Property*, 163 Pub. Choice 129 (2015) (critically reviewing the IP system with a focus on political economy and regulatory capture).

[166] For a brief survey of conflicting perspectives, see *supra* notes 117-118, 125-127 and accompanying text.

[167] *See supra* note 165; *see also, e.g.*, James Bessen & Michael J. Meurer, Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk (2008) (a comprehensive and critical review of the patent system, emphasizing the system's failure to provide clear notice of property rights).

[168] *See supra* Part II.I.

supporting a doctrine helps achieve greater clarity about how we think of the doctrine and its alternatives. Recognizing that the real reason the abstract-ideas exclusion might do more good than harm has nothing to do with abstract ideas as such has implications both for the design of the exclusion and for thinking about other means of achieving the same ends. Those implications will be discussed in Part III.

K. Upshot: Anti-Intellectualism in American Intellectual Property

I have teased out and examined various arguments that can be put forth to justify patent law's second-class treatment of abstract ideas, and I have found them all unconvincing. The upshot is that the categorical exclusion of abstract ideas is inconsistent with the American tradition of intellectual property protection, which seeks to balance creative incentives against access costs. But the exclusion is consistent with another American tradition—the tradition of anti-intellectualism. Patent law's second-class treatment of abstract ideas is harmonious with a prominent streak in American thought of contempt for the exercise of the thinking power in the abstract and as an end in itself, as opposed to its exercise as a means to some concrete functional end. The distinction, as Richard Hofstadter elaborated it more than half a century ago, is between "intelligence" as an "excellence of mind" directed to immediate problem solving and "intellect" as the "contemplative side of mind" that "ponders, wonders, theorizes, criticizes, imagines."[169] The "most impressive illustration" of Americans' dual attitudes, Hofstadter thought, is found in "the American regard for inventive skill as opposed to skill in pure science."[170] Which brings us right back to the problems of patent law that we have been discussing.

The words "consistent with" in the last paragraph were chosen carefully. My claim is not that patent law's second-class treatment of abstract ideas was *caused by* anti-intellectual attitudes. Nor do I claim that any commentator defending this exclusion harbors such attitudes, nor that the Supreme Court's revival of patent eligibility limitations was motivated by an anti-intellectual impulse on the part of the Justices. The Justices' personal motivations are unknowable at this time. If I were to speculate about them, I would venture that the Court's move was entirely well-intentioned and in keeping with its recently renewed scrutiny of a Federal Circuit that, pursuant to a few decades of practically unsupervised lawmaking, was taking patent law wayward.[171] But the generally salutary thrust of the Court's renewed interest in patent law does not help the feebleness of the abstract-ideas exclusion. And whatever the *cause* of this longstanding error might have been, its *effect* is undoubtably anti-intellectual.

Connecting the abstract-ideas exclusion to the anti-intellectual current in American thought is useful because it helps situate patent doctrine in a broader intellectual-historical framework. It is also useful because it shines a light on connecting threads between seemingly disparate strands of patent law. The task of probing the broader intellectual history and fleshing

[169] RICHARD HOFSTADTER, ANTI-INTELLECTUALISM IN AMERICAN LIFE *PINCITE (1963).
[170] *Id.* *pincite
[171]

out the intra-patent-law connections must be left to future work. But I will give one example from another area of patent law that seems to me similarly infected with anti-intellectual vibes.

In *Brenner v. Manson*, a leading case on the "utility" requirement of patentability,[172] the Supreme Court invalidated a patent on a newly invented process for making a known steroid on the basis that the inventor had not disclosed any utility for the steroid.[173] The Court held, among other things, that demonstrating that the steroid's "potential usefulness is under investigation by serious scientific researchers" is not sufficient to show that it is useful.[174] The majority opinion is dripping with disdain for any results of basic science that do not have an immediate cash value, and includes the statement that gave this Article its epigraph: "A patent system must be related to the world of commerce, rather than to the realm of philosophy."[175] Justice Harlan, in dissent, explained that science often proceeds from fundamental discovery to commercially useful applications in several steps and worried that allowing a patent only after the last steps are taken would under-incentivize the production and prompt publicization of basic scientific research.[176]

Brenner is instructive not only because it evinces the same anti-intellectual spirit that pervades patent eligibility jurisprudence but also because it employs the same dubious arguments. Echoing the preemption and vagueness rationales, the Court stated, "Until the process claim has been reduced to production of a product shown to be useful, the metes and bounds of that monopoly are not capable of precise delineation. It may engross a vast, unknown, and perhaps unknowable area. Such a patent may confer power to block off whole areas of scientific development."[177] But, like proponents of the vagueness rationale, the Court never explained why the fact that an invention does not have an immediate known application is at all relevant to whether its boundaries are precise.[178] And, like proponents of the preemption rationale, it did not explain why it was concerned about conferring rights that "*block off* whole areas of scientific development" but unconcerned about incentivizing basic inventions that *open up* "whole areas of scientific development." We may never have a rigorous basis to know whether, in the final balance, the incentive benefits of patents outweigh the access costs, but we

[172] *See generally* 35 U.S.C. § 101 (requiring that an invention be "useful" to be patentable).
[173] 383 U.S. 519 (1966).
[174] *Id.* at 531.
[175] *Id.* at 536 (quoting Application of Ruschig, 343 F.2d 965, 970 (C.C.P.A. 1965)).
[176] *Brenner*, 383 U.S. at 539 (Harlan, J., concurring in part and dissenting in part) ("What I find most troubling about the result reached by the Court is the impact it may have on chemical research. Chemistry is a highly interrelated field and a tangible benefit for society may be the outcome of a number of different discoveries, one discovery building upon the next. To encourage one chemist or research facility to invent and disseminate new processes and products may be vital to progress, although the product or process be without 'utility' as the Court defines the term, because that discovery permits someone else to take a further but perhaps less difficult step leading to a commercially useful item. In my view, our awareness in this age of the importance of achieving and publicizing basic research should lead this Court to resolve uncertainties in its favor and uphold the respondent's position in this case.").
[177] *Id.* at 534.
[178] *Cf. id.* at 538 (Harlan, J., concurring in part and dissenting in part) ("How far opaque drafting may lessen the public benefits resulting from the issuance of a patent is not shown by any evidence in this case, but, more important, the argument operates against all patents, and gives no reason for singling out the class involved here.").

have no reason to think the benefit-cost balance somehow flips from positive to negative when we move from applied technique to basic science.

[Note: I'm not sure where to put this Part (II.K). I have put it here because I thought it nicely capstones the discussion of rationales for the abstract-ideas exclusion. On the other hand, the previous Part (II.J) is also a nice capstone, and it leads more naturally to the discussion of policy implication in Part III. One option would be to save this Part for the Conclusion, which would then be a lengthier and more substantive than the typical law-review Conclusion. I would appreciate any thoughts on this.]

III. IMPLICATIONS

This Article's contribution is, in the first place, theoretical. I have reexamined a foundational canon of American patent law and found it wanting. If in the course of this reflection on basic science I have contributed something to basic understanding of patent law, then I am satisfied that the work was worthwhile. But the basic contribution also has some implications for doctrine, and this Part attends to them.

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CONCLUSION

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