Harvard Journal of Law & Technology
Volume 30, Number 2 Spring 2017

A QUANTITATIVE APPROACH TO DETERMINING PATENTABLE SUBJECT MATTER

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TABLE OF CONTENTS

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* The author is a J.D. candidate at Harvard Law School. This Note was written for the Harvard Law School Spring 2015 course "Intellectual Property and Innovation." The author would like to thank Professor John Golden at the University of Texas School of Law for his valuable suggestions and encouragement. The author would also like to thank Professor Benjamin Roin for his excellent teachings of cases and philosophy in Patent Law, which inspired this Note in the first place.

I. INTRODUCTION

The Patent Act has historically adopted broad language on the issue of patentable subject matter. Section 101 of the Patent Act states that "[w]hoever 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."[1] In the committee reports accompanying the 1952 Patent Act, Congress claimed it intended the statutory subject matter of patents to "include anything under the sun that is made by man."[2] In reality, however, that broad scope has been narrowed by three judge-made exceptions, each established by a long line of cases:[3] laws of nature, natural phenomena, and abstract ideas.[4] These three terms are typically used by the courts to cover the basic tools of scientific and technological work, such as scientific principles, mathematical algorithms, and mental processes. The judicial exceptions are powerful in that an invention could be patent-ineligible, even if it satisfies one of the categories of eligibility specified in Section 101 of the Patent Act. Even though the Supreme Court recites that patentable subject matter is "only a threshold test,"[5] determining patent eligibility has proved to be a long struggle for the judicial system, especially regarding the exceptions, because of a lack of judicial guidance. For example, the Federal Circuit at one time used the machine-or-transformation test[6] to determine whether a claimed process fell within the judicial exceptions. The Supreme Court struck down the sole existing test to determine patent-eligibility of a claimed process, but the Court offered no clear alternative.[7] Instead, the Court simply looked to a handful of precedent processes and declared whether the claimed process fell

1. 35 U.S.C. § 101 (2012).

2. Diamond v. Chakrabarty, 447 U.S. 303, 309 (1980) (citing S. REP. No. 82-1979, at 5 (1952); H.R. REP. No. 82-1923, at 6 (1952)).

3. These cases include, for example, *Chakrabarty*, 447 U.S. at 309; Gottschalk v. Benson, 409 U.S. 63, 67 (1972) (referring to the prohibited category as "[p]henomena of nature, . . . mental processes, and abstract intellectual concepts"); Parker v. Flook, 437 U.S. 584, 589 (1978) (emphasizing that a "principle" or "fundamental truth" is not patent eligible); Rubber-Tip Pencil Co. v. Howard, 87 U.S. 498, 507 (1874) (holding that "[a]n idea of itself is not patentable").

4. *See, e.g.*, Diamond v. Diehr, 450 U.S. 175, 185 (1981) (stating that the Court "has undoubtedly recognized limits to § 101 and every discovery is not embraced within the statutory terms. Excluded from such patent protections are laws of nature, natural phenomena, and abstract ideas."). Occasionally, other terms have been used to describe these judicial exceptions, such as physical phenomena, scientific principles, systems that depend on human intelligence alone, disembodied concepts, mental processes, and disembodied mathematical algorithms and formulas, but the fundamental ideas are the same.

5. Bilski v. Kappos, 561 U.S. 593, 602 (2010) [hereinafter *Bilski*].

6. *See, e.g.*, *In re* Bilski, 545 F.3d 943, 956 (Fed. Cir. 2008) (en banc). A claimed process would pass the machine-or-transformation test and thus would be patent eligible under Section 101 if: (1) it is tied to a particular machine or apparatus, or (2) it transforms a particular article into a different state or thing.

7. *See, e.g.*, *Bilski*, 561 U.S. at 594.

within the exceptions.[8] Both the precedents selected and the comparisons seemed arbitrary and offered little guidance for future cases. As Justice Stevens observed, "[t]he Court . . . never provides a satisfying account of what constitutes an unpatentable abstract idea . . . . [T]he Court's musings on this issue stand for very little."[9] As a result, the Federal Circuit essentially retains the machine-or-transformation test, and adds only a ceremonial procedure of asking whether the process really does fall into the exceptions, which almost never results in a different patentability ruling from the machine-or-transformation test anyway.[10] The Supreme Court, however, often reverses these decisions from the Federal Circuit while offering minimal guidance for future cases,[11] exacerbating the judicial struggles with these exceptions.

The exceptions exist ostensibly to serve the purposes of the Patent Act.[12] Therefore, we should examine what the goals of the Patent Act are and ask whether, by granting the patents to a certain category of inventions, we are achieving those goals. This Note takes a utilitarian point of view, because a utilitarian rationale for patent law is set forth explicitly in Article I of the U.S. Constitution.[13] In addition, American law students uniformly learn that the goal of the patent system is to achieve explicitly utilitarian aims.[14] Under the utilitarian view that this Note is focused on, the ultimate goal of having a patent system is to draw out and make available to the public new and useful inventions that would not have been invented absent the system.[15] To achieve this ultimate goal, there are smaller objectives that the Patent Act tries to achieve: to encourage (1) the creation of inventions, (2) the disclosure

8. *Bilski* analyzes *Benson*, 409 U.S. at 64–67, 70–71; *Flook*, 437 U.S. at 585–86, 588–90; and *Diehr*, 450 U.S. at 182, 184, 175, 177, 191–92, 195. *Bilski*, 561 U.S. at 601–11.

9. *Id.* at 621 (Stevens, J. concurring).

10. *See, e.g.*, CyberSource Corp. v. Retail Decisions, Inc., 654 F.3d 1366, 1374–78 (Fed. Cir. 2011); Ass'n for Molecular Pathology v. U.S. Patent & Trademark Office, 689 F.3d 1303, 1324–26 (Fed. Cir. 2012).

11. *See, e.g.*, Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 133 S. Ct. 2107 (2013).

12. *See Bilski*, 561 U.S. at 601–02 (noting that "while these exceptions are not required by the statutory text [of the Patent Act], they are consistent with the notion that a patentable process must be 'new and useful'").

13. U.S. CONST. art. I, § 8, cl. 8 (granting Congress the power 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").

14. *See* David S. Olson, *Taking the Utilitarian Basis for Patent Law Seriously: The Case for Restricting Patentable Subject Matter*, 82 TEMP. L. REV. 181, 183 n.1 (2009).

15. There are three major theories supporting the patent system: natural rights, distributive justice, and consequentialist/utilitarian arguments. The natural rights theory is based on John Locke's labor theory of property, which holds that those who have mixed their labor into unowned land have a property right to it. The distributive justice theory holds that patents are rewards to the inventors' initiative. The utilitarian theory views the patent system as a means to maximize social utility by encouraging innovation. *See* Sigrid Sterckx, *Patents and Access to Drugs in Developing Countries: An Ethical Analysis*, 4 DEVELOPING WORLD BIOETHICS 58, 62–67 (2004).

of inventions, and (3) further development, dissemination, and commercialization of inventions.[16] Without the incentives of the patent system, some inventions may never be created, and many that are created may be kept secret, making future development of such inventions impossible. Meanwhile, the patent system also strives to discourage overprotection, which is a form of taxation that would stifle future innovation.[17]

Instead of devising standards that attempt to construe the statutory language, this Note explores the approach of directly weighing the benefits and costs that arise from granting patents to a category of inventions. When the benefits outweigh the costs, patents should be granted; otherwise, they should not. Part II of this Note considers what factors measure such benefits and costs. Part III proposes a method to quantify each factor, and formulates a model based on a simple cost-benefit analysis. Part IV of this Note applies this model to determine the patent-eligibility of several categories of inventions under dispute. Part V concludes.

While others have previously proposed that patentable subject matter should be determined by applying a strict utilitarian analysis on a category-by-category basis,[18] a quantitative model detailing what factors come into play and how has never been studied. This model hopes to change the current focus on asserting whether an invention fits into one of the exceptions, and instead focus efforts on achieving the broader goal of the patent system: namely, to incentivize innovation.

II. FACTORS CONSIDERED FOR A QUANTITATIVE MODEL TO DETERMINE PATENTABLE SUBJECT MATTER

This Part first sets out the factors that measure the benefits of granting patents. These factors include research and development ("R&D") and imitation costs of an invention. The Part describes why these factors are important factors in advancing the goal of the patent system to incentivize innovation. Afterwards, this Part determines the cost of granting patents, which is predominated by the taxation on future innovation built upon patented work. These factors form the building blocks for the quantitative model.

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16. *See* John M. Golden, *Principles for Patent Remedies*, 88 TEX. L. REV. 505, 510–11 (2009). *See also* Olson, *supra* note 14.

17. *See* Justin R. Orr, *Patent Aggregation: Models, Harms, and the Limited Role of Antitrust*, 28 BERKELEY TECH. L.J. 525, 534 (2013) (noting that "[t]he sheer quantity of issued patents . . . and the difficulty of identifying relevant patent claims means . . . some other valid patent might spring up [post-investment,] possibly leading to imbalances in bargaining power and excessive litigations that combine to tax current production and future innovation.").

18. *See* Olson, *supra* note 14, at 202.

A. R&D Costs Are a Measure of the Benefits Arising from Granting Patents

The R&D cost of an invention is one of the measures of how much benefit may be derived from granting a patent to the invention. This is because the prize of a patent grant is needed for the creation, disclosure, and commercialization of an invention with high R&D costs more than for one with a low R&D costs. The following Sections explain this proposition.

1. Creation of Inventions

Many useful inventions, particularly those requiring cutting edge research, are created at immense cost. Research requires costly reagents and lab equipment, as well as high salaries for skilled labor.[19] Taking everything into account, it is not unusual to see research grant proposals that request hundreds of thousands of dollars for inventing a single product. In fact, the National Institutes of Health ("NIH") calculated that the average size of one Research Project Grant ("RPG") for the year 2014 was $472,827; a historical high.[20]

The cost of developing useful inventions is rising, as pointed out by the Ewing Marion Kauffman Foundation, a think tank.[21] There is an ongoing trend that radical innovation is getting more complex because the low-hanging fruit in many disciplines is gone.[22] As a result, no rational market players would invest in useful innovation in the absence of exclusive rewards, because other companies could exploit the research output, jeopardizing the profitability of the investment.[23] Therefore, the higher the R&D cost is for a given innovation, the greater the need for the protection of the patent system — such as the promise of twenty-year exclusivity — to draw out the invention.[24] Therefore,

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19. *See* LAM ACTION, WHY IS SCIENTIFIC RESEARCH SO EXPENSIVE?, at 1–2 (2015), http://lamaction.org/wp-content/uploads/2015/06/Scientific-research-expenses-explained.pdf [https://perma.cc/5CCS-KYJ2].

20. *See* Sally Rockey, *2014 By the Numbers*, OFF. OF EXTRAMURAL RES. OF THE NAT'L INST. OF HEALTH (Dec. 31, 2014), https://nexus.od.nih.gov/all/2014/12/31/2014-by-the-numbers/ [https://perma.cc/5BV2-DDA5].

21. *See* Jordan Bell-Masterson, *Innovation Series: The Rising Costs of Invention*, THE EWING MARION KAUFFMAN FOUND. (Mar. 24, 2015), http://www.kauffman.org/blogs/growthology/2015/03/innovation-series-increasing-costs-of-invention [https://perma.cc/Q5XH-W788].

22. *See, e.g.*, BARRY BOZEMAN & CRAIG BOARDMAN, RESEARCH COLLABORATION AND TEAM SCIENCE: A STATE-OF-THE-ART REVIEW AND AGENDA 50 (2014); George Johnson, *Hills to Scientific Discoveries Grow Steeper*, N.Y. TIMES (Feb. 17, 2014), https://www.nytimes.com/2014/02/18/science/hills-to-scientific-discoveries-grow-steeper.html?_r=0 [https://perma.cc/R9QB-7K6E].

23. *See* KALYAN C. KANKANALA, GENETIC PATENT LAW AND STRATEGY 4 (1st ed. 2007).

24. 35 U.S.C. § 154(a)(2) (2012).

granting patents for inventions with high R&D costs accords more benefits to society by encouraging investment in innovative research.

In short, high production costs act as a disincentive for development when there is uncertainty regarding the ability of the potential producer to gain profits and recover costs. For illustration, the invention of Halloween lawn bags (lawn bags that look like jack-o-lanterns when filled with yard waste)[25] had almost zero R&D cost. Therefore, the inventors might well have made such bags when the idea came to mind, whether or not there was a promise of future market exclusivity. On the other hand, absent an alternative government scheme for rewards or funding, no rational company would start looking for an Alzheimer's drug target without knowing that, once the target is discovered, the patent on the drug target will help the company recoup the original research cost.

2. Disclosure of Inventions

The disclosure of inventions is critical in order for society to derive maximum benefit from an invention. Inventions that are kept secret by inventors prevent or dramatically slow the cumulative advancement of science and technology. Keeping inventions secret may also lead to wasteful duplication of investment in similar technologies. Thus, one of the goals of the patent system is to encourage the disclosure of inventions to the public. All else being equal, inventions with high R&D costs will need the patent system more than their low-cost counterparts to achieve the goal of public disclosure. This is because investors who spend more on R&D will be more worried about not recouping their investment if the invention is copied or stolen.[26] Patent protection can assuage these concerns by providing an exclusive term of use which will increase the likelihood that an investment can be recouped.[27] This is a second mechanism by which granting patents to inventions with high R&D costs accords greater benefits to society.

3. Development and Commercialization of Inventions

The public will not enjoy the full benefits of an invention unless it is developed and commercialized. The discovery of a drug molecule or

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25. U.S. Patent No. 310,023 (filed Nov. 6, 1989).

26. *See* Anthony Arundel, *The Relative Effectiveness of Patents and Secrecy for Appropriation*, 30 RES. POL'Y 611, 621 (2001) (finding that for product innovations, secrecy is more important to small firms than to large ones; using firm size as a proxy for R&D investment in each product, projects with high R&D costs need the patent system more than those with low R&D costs).

27. While trade secrets themselves might offer adequate protection for inventions that are difficult to recreate, patent protection is nevertheless a useful method to encourage disclosure more generally. *See* Section II.B, *infra*, for an analysis on the issue of imitation costs.

the invention of a prototype alone without mass production does not do much good to society. Development and commercialization can often be as expensive, if not more so, as performing scientific research, such that some of the best research results could not be properly introduced into industry without the guarantees afforded by patent rights, languishing only in academic publications.[28] In the pharmaceutical industry, for example, the identification of a drug target comprises only a small fraction of the R&D process.[29] The full development process for a drug is heavy work, and it often takes another ten years[30] and hundreds of millions of dollars[31] for the target to be fully commercialized into a marketable drug.

The patent system is designed to encourage the creation and further development of these costly but important products by awarding exclusivity to the inventors, so that they can recoup the cost of development and commercialization.[32] An invention could be conceived but not commercialized because there is little promise that the development costs could be recouped. One such example is bexarotene (brand name Targretin), a cancer drug that was discovered to be a promising target for Alzheimer's disease.[33] The target was already identified by prior inventors, but needed new clinical trials and approval from the Food

28. *See* NAT'L RESEARCH COUNCIL AND RUSSIAN ACAD. OF SCIS., TECHNOLOGY COMMERCIALIZATION: RUSSIAN CHALLENGES, AMERICAN LESSONS 75 (1998).

29. *See* Jeffrey Strovel et al., *Early Drug Discovery and Development Guidelines: For Academic Researchers, Collaborators, and Start-Up Companies*, *in* ASSAY GUIDANCE MANUAL 3, 9 (Sitta Sittampalam et al., eds., Eli Lilly & Co. and the Nat'l Ctr. for Advancing Translational Sci., 2016) (Table 1 estimates that in the R&D of a new chemical entity, target identification takes 1 year and costs $200,000, while the development of such target takes 8 years and cost approximately $9 million).

30. Hans-Jürgen Federsel, *Chemical Process Research and Development in the 21st Century: Challenges, Strategies, and Solutions from a Pharmaceutical Industry Perspective*, 42 ACC. CHEM. RES. 671–80 (2009).

31. Joseph A. DiMasi et al., *Cost of Innovation in the Pharmaceutical Industry*, 10 J. HEALTH ECON. 107, 131–32 (1991).

32. *See* Richard T. Rapp & Richard P. Rozek, *Benefits and Costs of Intellectual Property Protection in Developing Countries*, 24 J. WORLD TRADE 75, 81, 84 (1990) ("[Without] protection, other entities can use the results of the innovative effort without compensating the innovator. Unable to recoup the costs of his effort, the innovator has no incentive and waits for others to expend the effort to develop new products or improve methods of producing established products.").

33. *See* Paige E. Cramer et al., *ApoE-Directed Therapeutics Rapidly Clear β-Amyloid and Reverse Deficits in AD Mouse Models*, 335 SCIENCE 1503, 1506 (2012).

and Drug Administration ("FDA") to bring the drug to market for treatment of Alzheimer's disease.[34] Despite starkly positive results in laboratory research,[35] fundraising to commercialize the drug was difficult: the development team took almost a year to gather the funding because "there ha[d] been little interest in developing a drug that w[ould] soon be[come] available generically."[36] The patents on Targretin began to expire in 2012,[37] and the same molecule cannot be patented twice, even if it is later found to have new uses.[38] Without the promise of effective patents, the development cost would be more difficult to recoup. This problem is not limited to the drug development context. For any invention with development costs, inventors may hesitate to bring a product to market. As explained above, patent exclusivity can mitigate this problem by increasing the likelihood that an inventor can recoup development costs through commercialization.

Another — perhaps still debatable — aspect of development and commercialization is the patent system's coordination function.[39] Patents often serve as signals for inventors to coordinate their research efforts to avoid duplicative investment in the same innovation.[40] One can imagine that if multiple pharmaceutical companies invest billions of dollars in the same drug target at the same time, racing towards commercialization of the same drug, the social waste would be devastating.

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34. *See* Brie Zeltner, *Cleveland Clinic Starts Trial of Cancer Drug to Treat Alzheimer's Disease*, CLEVELAND.COM (Sept. 16, 2013), http://www.cleveland.com/healthfit/index.ssf/2013/09/cleveland_clinic_starts_trial.html [https://perma.cc/7E4G-E6W7]. Note that drugs approved for the treatment of one purpose may not be prescribed for treatment of another purpose without going through clinical trial again, which is another round of drug development.

35. *See* Cramer, *supra* note 33, at 1503.

36. *See* Zeltner, *supra* note 34.

37. *Id.*

38. *See* Ted T. Ashburn & Karl B. Thor, *Drug Repositioning: Identifying and Developing New Uses for Existing Drugs*, 3 NAT. REV. DRUG DISCOV. 673, 673 (2004). It is possible to obtain a method patent for the old drug to cover the new use, but method patents are difficult to enforce. *See* Rebecca S. Eisenberg, *The Problem of New Use*s, 5 YALE J. HEALTH POL'Y L. & ETHICS 717, 720 (2005) ("The discovery of a new use for an old drug might support a patent on a method of treatment, but such a patent offers little effective protection against generic competition once the drug itself is off-patent and may lawfully be sold for an older, unpatented use."); Rebecca S. Eisenberg, *The Role of the FDA in Innovation Policy*, 13 MICH. TELECOMM. & TECH. L. REV. 345, 351 (2007) ("Patents on particular methods of treatment involving the use of a drug are generally considered less valuable, because they cannot be used to stop competitors from selling the same product for other uses.").

39. *See* Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 276 (1977) (Patents act as a signal that "puts the patent owner in a position to coordinate the search for technological and market enhancement of the patent's value so that duplicative investments are not made and so that information is exchanged among the searchers."). Some commentators have questioned the coordination function of granting patents. *See* Stephen Yelderman, *Coordination-Focused Patent Policy*, 96 B.U. L. REV. 1565, 1568 (2016) (noting that "the patent system is ill-equipped to play these roles, is outmatched by superior approaches to these problems, or is otherwise best left to its traditional rewards-focused responsibilities").

40. *Id.*

On the other hand, if multiple people are simultaneously inventing pencils with erasers attached to the tips, it is not nearly as socially wasteful because the R&D costs for this invention are negligible compared to the R&D costs in drug development. In fact, in the case of pencil development, any coordination gains may be outweighed by the loss of competition in the pencil industry if patents are granted to such an invention, since this basic improvement would likely still be developed without exclusivity guarantees.[41] The coordination that the patent system provides is therefore much more valuable when R&D costs are higher and more difficult to recoup than when they are lower. However, a more in-depth study on the balance of the gain from coordination and the loss from the absence of competition is needed.

B. The Costs of Imitation Can Serve as a Measure for Benefits Arising from Granting Patents

1. Inventions with Low Imitation Costs Need Patent Protection to Fend Off Copycats

One key aspect of promoting commercialization of a new technology and realizing the full benefits of the patent system is prohibiting copycats. After all, an inventor would be reluctant to mass produce or even discuss her invention with potential investors if she fears someone else could easily steal an idea in which she invested much effort and expense.[42]

One of the most intuitive defenses against such imitation is to keep the manufacturing process a trade secret. But trade secrets may not be practical. Reverse engineering, one of the most common methods of imitation, is a standard industry practice in the traditional manufacturing,[43] semiconductor,[44] and computer software industries.[45] With the development of ever more powerful analytical instruments, what could have been kept a secret in the past might now be reverse-engineered without much effort.[46]

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41. *See* Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 844, 872 (1990).

42. *See* Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1661 (2003) ("[N]o one will invest in R&D if the costs of R&D fall exclusively on the innovator, but the benefits of that research can be freely appropriated by all.").

43. Pamela Samuelson & Suzanne Scotchmer, *The Law and Economics of Reverse Engineering*, 111 YALE L.J. 1575, 1582 (2001).

44. *Id.* at 1595.

45. Andrew Johnson-Laird, *Reverse Engineering of Software: Separating Legal Mythology from Actual Technology*, 5 SOFTWARE L.J. 331, 331 (1992).

46. *See* Jean Thilmany, *The Rise of Reverse Engineering*, AM. SOC'Y OF MECHANICAL ENGINEERS (2012), https://www.asme.org/engineering-topics/articles/modeling-computational-methods/the-rise-of-reverse-engineering. [https://perma.cc/8YZA-SPVD]. On the other hand, other laws and terms of use may separately prohibit reverse engineering. *See*

In light of these new trends, more and more inventions could benefit from the protections offered by the patent system. For inventions with low imitation costs, the patent system allows inventors to freely disclose their inventions to potential investors without fear that the fruits of their inventions will be appropriated. Thus, the patent system encourages commercialization of inventions with low imitation costs. In addition, the patent system allows inventors to safely contract with other firms possessing complementary information and technology.[47] Assuming the invention's research and development costs are significant and cannot reliably be recouped in the market, inventions with low imitation costs need the patent system to allow for their full development and commercialization.

2. Inventions with High Imitation Costs Need Patents to Draw Out the Disclosure of Inventions

Owners of inventions with high costs of imitation have less fear of copycats; however, when the cost of imitation becomes prohibitively high, inventors have a strong incentive to simply keep their inventions as trade secrets to enjoy a longer period of exclusivity. But when inventors opt to use trade secrets, society is left worse off. Given the cumulative nature of science and technology, where one idea often inspires many more, a delay in access to new information will inhibit innovation.

This danger can be mitigated by the patent system. Granting patents and offering a twenty-year guaranteed exclusivity to inventions with high imitation costs offsets the risk of the inventor turning to trade secrecy. Thus, inventions with high imitation costs need the patent system to draw out disclosure of the inventions, allowing future innovation to build upon them. This point is illustrated by the reaction to the Supreme Court's ruling in the *Myriad* case, where isolated breast cancer genes were denied patents.[48] Identifying disease-causing genes is difficult and costly,[49] and would be technically challenging to imitate.[50] After the ruling, the National Cancer Institute hosted the Ethical and

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Bowers v. Baystate Techs., Inc., 320 F.3d 1317 (Fed. Cir. 2003) (holding that the Copyright Act did not preempt or narrow the scope of competitor's shrink wrap license agreements, which prohibited reverse engineering).

47. *See* Kitch, *supra* note 39, at 277.

48. *See generally* Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 133 S. Ct. 2107 (2013) (holding that naturally occurring DNA segments are not patent eligible).

49. *See, e.g.*, Ass'n for Molecular Pathology v. U.S. Patent and Trademark Office, 689 F.3d 1303, 1344, 1349 (Fed. Cir. 2012).

50. Myriad does not distribute its BRCA gene primers; instead patients have to send their DNA samples to Myriad. *See* Genetic Testing Process, MYRIAD GENETICS, https://myriad.com/healthcare-professionals/about-genetic-testing/genetic-testing-process/ [https://perma.cc/8T9M-QULK] ("For testing, a small amount of blood will be drawn or a

Regulatory Issues in Cancer Research ("ENRICH") Forum in November 2013, titled "The Myriad Mire: Patents and Trade Secrets in the Age of the Genome."[51] One of the leaders of the forum, Eleonore Pauwels, stated that the *Myriad* decision "could make the trade-secret route look more attractive to the biotech industry, including to Myriad itself."[52] Pauwels's comments echoed a 2011 *New York Times* piece in which Myriad's chief executive, Peter Meldrum, said, "If I had my druthers, I would not want to go into a new market in a heavy-handed fashion, trying to enforce patents."[53] To realize the full benefits of an invention, those with high imitation costs should be granted patents to encourage disclosure of the technology and facilitate coordination among competitors.

For patents with intermediate imitation costs, inventors cannot be confident that their inventions will not eventually be imitated, and thus the public has a lower need for disclosure. However, unless their R&D costs are extremely high, inventors likely are not so worried about copycats that they desperately need the patent system in order to commercialize their inventions. Thus, for these inventions, the importance of the patent system is the lowest compared to the previous two categories.

In general, taking into account the full imitation cost spectrum, the importance of granting a patent as a function of cost of imitation can be loosely illustrated in Figure 1:

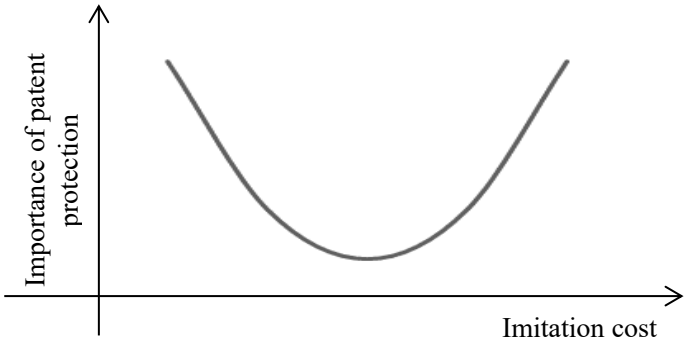

Figure 1: Importance of Patent Protection as a Function of Imitation Cost

saliva sample is taken and sent to Myriad for analysis."). Thus, a competitor cannot reverse engineer the gene primers due to a lack of access to the product.

51. Chris Palmer, *The Myriad Decision: A Move toward Trade Secrets?*, THE NIH CATALYST NEWSL., Mar.–Apr. 2014, at 9.

52. *Id.*

53. Andrew Pollack, *Despite Gene Patent Victory, Myriad Genetics Faces Challenges*, N.Y. TIMES (Aug. 24, 2011), http://www.nytimes.com/2011/08/25/business/despite-gene-patent-victory-myriad-genetics-faces-challenges.html [https://perma.cc/R2AZ-MPXB].

C. The Social Cost of Granting Patents Is a Function of the Resulting Taxation on Future Innovation

The cost of granting a patent mainly comes in the form of the resulting inhibition of future innovation that builds upon existing inventions.[54] In the field of biomedical research, there looms the danger of competing patent rights in upstream research overlapping and preventing useful and affordable products from reaching the marketplace.[55] This concern is not unique to biomedical research, and could extend to any area when either of two conditions is met: (1) when granting patents to too many "concurrent fragments" that are required to develop potential future products, or (2) when granting patents to a long chain of upstream patents that require "stacking licenses," blocking downstream inventions.[56] The software realm has increasingly fulfilled the first condition because software patents have relatively long lives relative to the fast-changing software market.[57] The situation is worsened by the fact that new software products often encompass hundreds or even thousands of smaller components of code that might be patented already.[58] Obtaining licensing deals with each individual inventor is an arduous (and perhaps prohibitively expensive) task, and in many situations, it is also difficult for a new product inventor to become aware of patents that cover minor functionality in his or her product.[59] The bio-

54. *See* Alberto Galasso & Mark Schankerman, *Patents and Cumulative Innovation: Causal Evidence from the Courts*, 130.1 Q.J. Econ. 317, 323 (2015) (asserting that "patents can also create a dynamic cost by blocking valuable sequential innovation").

55. *See* Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 698–99 (1998).

56. *Id.* at 699.

57. *See* Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CALIF. L. REV. 1, 6 (2001) (noting that "[t]he software industry is characterized by a culture of reuse and incremental improvement," which results in a "short effective life of software innovations."). This "short effective life of software innovation" signals a fast-changing market. It contrasts with the 20 long years of exclusivity enjoyed by software patents along with patents from other industries).

58. *See* Mark A. Lemley, *Ignoring Patents*, 2008 MICH. ST. L. REV. 19, 19–20 (2008).

59. One infamous example of a small component patent taxing future software is *Lucent Techs., Inc. v. Gateway, Inc*., 580 F.3d 1301 (Fed. Cir. 2009). Lucent accused Microsoft's Outlook, Money, and Windows Mobile software of using the "date picker" feature, which was patented by Lucent. *Id.* at 1317. For anyone who has used any one of these Microsoft products, it is clear there are many more components than just a date picker function. *Id.* It is also difficult to believe anyone reasonably bought these products just because they could pick a date in a dropdown box. *Id.* Nonetheless, the jury initially awarded Lucent a lump-sum royalty payment of approximately $358 million, *id.* at 1309, although this case was eventually settled between the two parties after suits in several courts. *Microsoft and Alcatel-Lucent Settle Most Patent Suits*, N.Y. TIMES (Nov. 16, 2008), http://www.nytimes.com/2008/12/16/technology/16iht-16alcatel.18741804.html [https://perma.cc/4BHV-5QG3].

logical sciences are a field that fulfills the second condition: "as upstream owners stack overlapping and inconsistent claims on potential downstream products," downstream product development is deterred.[60]

III. A QUANTITATIVE COST-BENEFIT ANALYSIS MODEL

This Part quantifies the factors described in Part II, including patents' societal benefits, which are a function of inventors' R&D and imitation costs, and societal costs, which are a function of the taxation that patent rights impose on future innovation. This Part then proceeds to build a simple cost-benefit analysis model. The model produces a determination factor, calculated by dividing benefit by cost. Whether patents should be granted for a certain category of invention depends on whether the determination factor crosses the threshold value of 1.

A. Benefits

1. Quantification of R&D Costs

Now that it is established that R&D costs are a key factor to evaluate, I proceed to quantify this factor. Most industries publish the average cost of R&D.[61] One approach is to use time-to-market as a proxy for R&D costs, which is a reasonable estimation because costs are generally positively correlated with time spent on a project.[62] However, sometimes a long time-to-market could signal a lower priority for the products rather than truly high R&D costs. Here, I propose an approach that grades R&D costs on a scale of 1 to 5 against benchmarks established using Standard & Poor's Industry Surveys. These industry surveys are readily accessible to the public and contain relevant information needed for the model that I propose. On the high end of R&D costs is the pharmaceutical industry. In its report for the pharmaceutical industry, Standard & Poor's survey states that because "new drugs represent the lifeblood of the pharmaceutical industry, the percentage of a company's sales that it devotes to R&D can have an important impact on future trends in sales and earnings."[63] Further, "[f]or

60. *See* Heller & Eisenberg, s*upra* note 55, at 699.

61. For example, PricewaterhouseCoopers publishes a report on R&D spending by region and industry every year. strategy&, *The Global Innovation 1000: Comparison of R&D Spending by Regions and Industries*, PRICEWATERHOUSECOOPERS (2017), http://www.strategyand.pwc.com/global/home/what-we-think/innovation1000/rd-intensity-vs-spend-2015 [https://perma.cc/6LRG-U4AN].

62. *See* Benjamin N. Roin, *The Case for Tailoring Patent Awards Based on Time-to-Market*, 61 UCLA L. REV. 672, 672 (2014).

63. JEFFREY LOO, STANDARD AND POOR'S, INDUSTRY SURVEYS, HEALTHCARE: PHARMACEUTICALS 33 (2014), https://gskkr.files.wordpress.com/2015/01/healthcare-products-and-services.pdf [https://perma.cc/H9H2-C7BH].

the drug industry overall, this percentage in the aggregate is higher than for any other industry."[64]

From the report, it can be seen that R&D is not only critical for the future of the entire pharmaceutical industry, but that the R&D cost is higher than in any other industry. Thus, I assign the R&D cost of the pharmaceutical industry a value of "5" on the R&D cost scale.

The next level on the R&D scale includes industries where R&D has strategic importance and the costs are relatively high. For example, in the software industry, spending on R&D provides critical support for the new product pipeline, because in the digital age, revenue depends on a fast cycle time to produce fancy new products.[65] Standard and Poor's industry survey notes that "[t]o remain competitive, software vendors must support consistently high levels of R&D spending . . . Thus, it is not unusual to see computer industry R&D costs of 10% to 20% of revenues, a considerably higher percentage than for most other industries."[66] Industries where R&D cost is higher than most others receive a value of "4" on the R&D cost scale.

A value of "3" is given to industries with intermediate R&D costs, such as the chemical industry where R&D is important[67] but the level of activity is limited.[68]

A value of "2" is assigned to industries where R&D does not play an important role and is not part of the core business model. For example, Standard and Poor's industry reports on the property-casualty insurance industry and on the investment services industry do not mention research and development costs or emphasize the importance of innovation.[69] This is not surprising since they are not innovation-

64. *Id.*

65. *See* Hugo Sarrazin & Johnson Sikes, *Competing in a Digital World: Four Lessons from the Software Industry*, MCKINSEY & COMPANY (Feb. 2013), http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/competing-in-a-digital-world-four-lessons-from-the-software-industry [https://perma.cc/MJB4-2HDZ] ("Managers have to worry about competitors leapfrogging them with ever-faster cycle times, courtesy of such software-enabled techniques as rapid prototyping and real-time testing.").

66. SCOTT KESSLER, STANDARD AND POOR'S, INDUSTRY SURVEYS, COMPUTERS: SOFTWARE 26 (2014), https://gskkr.files.wordpress.com/2015/01/computers-software.pdf [https://perma.cc/YFW4-J5EL].

67. *See* Chemical Industry Education Centre, *The Chemical Industry*, ESSENTIAL CHEMICAL INDUS. (Jul. 21, 2013) (stating that "research and development is crucial to the industry's evolution"), http://www.essentialchemicalindustry.org/the-chemical-industry/the-chemical-industry.html [https://perma.cc/BUK2-CA9W].

68. *See* CHRISTOPHER B. MUIR, STANDARD AND POOR'S, INDUSTRY SURVEYS, CHEMICALS 27 (2014) (stating that the chemical industry is "characterized by limited research and development . . . spending and a strong emphasis on reducing feedstock, energy requirements, and labor costs through engineering process improvements"), https://gskkr.files.wordpress.com/2015/01/chemicals.pdf [https://perma.cc/Y4YS-8BVS].

69. *See* CATHERINE A. SEIFERT, STANDARD AND POOR'S, INDUSTRY SURVEYS, INSURANCE: PROPERTY-CASUALTY 21–29 (2014) [hereinafter INSURANCE REPORT], https://gskkr.files.wordpress.com/2015/01/insurance-property-casualty.pdfz[https://perma.cc/AAJ9-6F2Q]; *see also* KENNETH LEON, STANDARD AND POOR'S,

driven industries. While some may argue that substantial innovation has taken place in the last couple of decades, new ways to hedge risks[70] do not drive the industry.[71] Thus, the R&D cost for this class of inventions is categorized as low and benchmarked to have a value of "2" on the R&D cost scale.

Finally, a value of "1" on the R&D cost scale is reserved for categories of inventions with trivial R&D costs — inventions that essentially cost nothing to make. These categories are rare, but one potential category includes inventions that most children come up with easily, such as swinging a swing sideways[72] or exercising your cats with a laser pen.[73] This category of inventions costs next to nothing to research and develop.

To summarize, the quantification of R&D costs is presented in Figure 2.

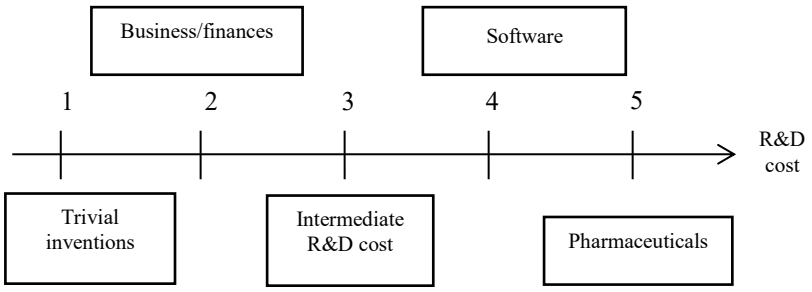

Figure 2: R&D Cost Quantification Scheme

2. Quantification of Cost of Imitation

There are many methods to quantify the cost of imitation. This Note proposes determining cost of imitation by borrowing the person-having-ordinary-skill-in-the-art ("PHOSITA") standard used to determine obviousness and using it to create numerical benchmarks.[74] This method essentially asks what a person having ordinary skill in the art would consider the imitation cost to be.

INDUSTRY SURVEYS: INVESTMENT SERVICES 22–27 (2014) [hereinafter INVESTMENT SERVICES REPORT], https://gskkr.files.wordpress.com/2015/01/investment-services.pdf [https://perma.cc/J3ME-VPE4].

70. *See* U.S. Patent Application Serial No. 13/567,426 (filed Aug. 6, 2012).

71. *See, e.g.*, INSURANCE REPORT, *supra* note 69, at 9–20; *see also* INVESTMENT SERVICES REPORT, *supra* note 69, at 10–21.

72. *See* U.S. Patent No. 6,368,227 (filed Nov. 17, 2000).

73. *See* U.S. Patent No. 5,443,036 (filed Nov. 2, 1993).

74. *See* Michael Abramowicz & John F. Duffy, *The Inducement Standard of Patentability*, 120 YALE L.J. 1590, 1604 (2011).

The standard is straightforward: if a PHOSITA can identify the route of imitation fairly easily using standard laboratory equipment, the cost of imitation is benchmarked at a value of "2." Take, for example, the small-molecule pharmaceutical industry. Since there is only one small molecule that needs to be identified, a PHOSITA would point out that reverse engineering can be done by using a combination of standard instruments found in the laboratory of a pharmaceutical company.[75]

In contrast, if a PHOSITA finds it cumbersome to identify the route of imitation, or if the imitation requires extraordinary equipment that a typical laboratory does not possess, this cost of imitation is benchmarked to be a value of "4." This represents a category of innovation that is technically challenging and financially costly to imitate.

Based on the benchmark for values of "2" and "4," it is reasonable to assign a value of "1" to be trivially easy to copy — one can simply look at the invention and replicate it. A value of "3" represents an imitation cost that is intermediate according to a PHOSITA. A value of "5" is designated for inventions that are extremely difficult to copy.[76]

To summarize, the quantification of the cost of imitation is presented in Figure 3.

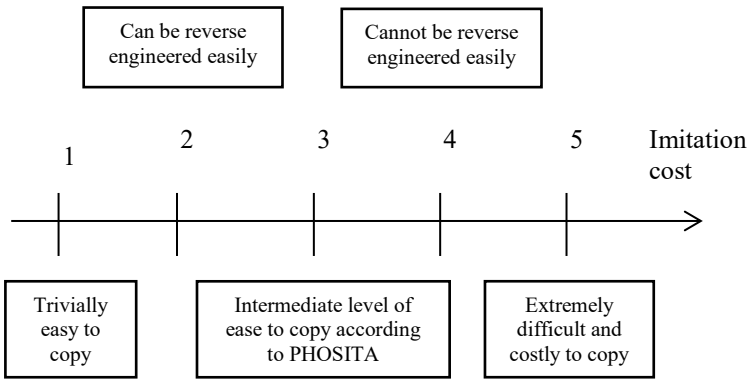

Figure 3: Cost of Imitation Quantification Scheme

75. *See* Arvind K. Bansal & Vishal Koradia, *The Role of Reverse Engineering in the Development of Generic Formulations*, PHARMATECH.COM (Aug. 2, 2005), http://www.pharmtech.com/role-reverse-engineering-development-generic-formulations; Benjamin N. Roin, Solving the Problem of New Uses, MICH. ST. L. REV. (Oct. 1, 2013) (forthcoming 2014) (manuscript at 9), https://papers.ssrn.com/sol3/papers2.cfm?abstract_id=2337821 [https://perma.cc/E4CA-XQC7] ("Most small-molecule drugs are relatively easy to reverse engineer and duplicate . . . .").

76. Take, as an example, the device used to wrap cable for a tire's inner thread manufactured by Goodyear Tire & Rubber. The rival company had to engage in corporate espionage to get the technology. *See* NORTON PALEY, HOW TO OUTTHINK, OUTMANEUVER, AND OUTPERFORM YOUR COMPETITORS: LESSONS FROM THE MASTERS OF STRATEGY 73 (2013).

C. Cost: Quantification of Patents' Taxation on Future Innovation

A simple method of quantification for taxation on future innovation is proposed based on the nature of the technology. For inventions that are somewhat discrete, such as those in the small-molecule pharmaceutical industry, the taxation factor is benchmarked at a value of "2."[77] Discrete inventions are unlikely to create concurrent fragments and block downstream innovation by upstream licensing; thus, the taxation value is low.[78] Inventions already showing signs of notable taxation, such as inventions in the software industry, are benchmarked to have a taxation value of "4." Consequently, a value of "1" is assigned to classes of inventions that are not taxing at all on future technology, "3" is assigned to intermediate levels of taxation, and "5" is assigned to inventions that are broadly and fundamentally preempting, such as the laws of physics.

The benchmark scheme is represented in Figure 4.

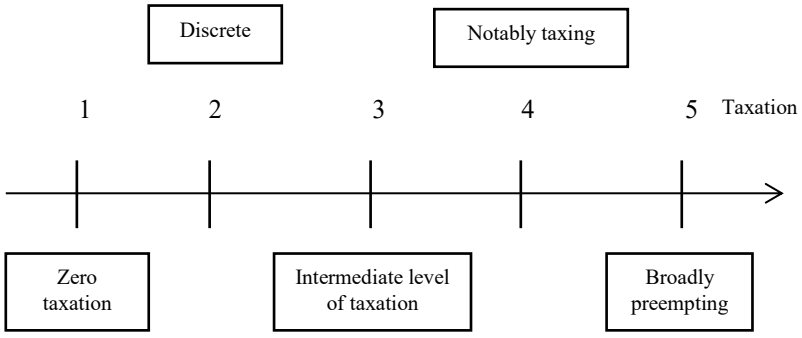

Figure 4: Taxation on Future Innovation Quantification Scheme

D. Cost-Benefit Model

The basic model for determining patentable subject matter for each category of inventions can be characterized as follows:

$$D = \frac{B}{C}$$

D is the determination number, B is the benefits arising from granting patents for a category of inventions, and C is the cost of doing so. A ratio of 1 is the threshold for differentiating whether patents impose greater costs or benefits. When $D > 1$, benefits outweigh costs, and the

77. *See* Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 880 (1990).

78. *See* Heller & Eisenberg, *supra* note 55, at 699.

category of inventions should be patent eligible; otherwise, the category should be patent-ineligible. Further, let R denote R&D costs, I denote cost of imitation, and T denote taxation. As discussed in previous Parts, inventions with high R&D costs and extremely high or low imitation costs need the patent system the most to incentivize healthy innovation. Therefore, these factors dictate the benefits of granting patents, and are the factors in the numerator. Taxation on future innovation is the cost of granting patents, and is thus in the denominator. Hence, D can be expressed again as:

$$D = \frac{B(R, I)}{C(T)}$$

The exact form of B as a function of R and I, and C as a function of T, should be determined empirically. For demonstration purposes, this Note proposes that the benefit correlates with R&D costs because, as discussed in Section II.A, granting patents to inventions with higher R&D costs generates more benefit to society. A linear correlation is chosen for simplicity of illustration of the model. B is proposed to be a quadratic function of imitation costs for two reasons: (1) the functional form reflects that the importance of granting patents is the highest for both extremes of the imitation cost and lowest for the middle level of imitation cost, and (2) squaring gives heightened effects to the extremes. Finally, cost is assumed to be linearly correlated with taxation for simplicity. Based on these assumptions, a sample model can be represented as below:

$$D = \frac{\alpha R + \beta[(I - 3)^2 + 1]}{T}$$

where α and β are weights assigned to R&D costs and imitation costs. For demonstration purposes, in the rest of the Note, α and β take on values of 2/3 and 1/3, as R&D costs are often believed to be more important than imitation costs.[79] These weights, however, can be adjusted based on the needs of policymakers. Note that cost of imitation is adjusted mathematically so that the whole imitation factor falls into the range of 1 to 5 — just like the factors R and T.[80]

IV. APPLICATIONS

The model developed in this Note is applied to three categories of inventions: isolated human genes, software, and business methods. These categories are selected because their patent-eligibility has been controversial. This Part explores the reasons for debate over these three

79. *See* Burk & Lemley, *supra* note 42, at 1661.

80. This is achieved by subtracting the imitation cost factor, I, by 3, which is the medium level of imitation costs. The quadratic term is added by 1 to shift the parabola such that the entire factor of $(I - 3)^2 + 1$ falls in the range of 1 to 5.

categories, and applies the model to determine whether they should be patent eligible based on a cost-benefit analysis.

A. Isolated Human Genes

As the *Myriad* case illustrates, courts have struggled with the patent-eligibility of isolated human gene sequences.[81] It was much debated whether these genes are natural phenomena, and thus excluded from patentability.[82] The Supreme Court even delved deeply into microbiology to determine which chemical bonds are broken in order to decide whether isolated genes are "natural."[83] The model developed in this Note takes a different view by performing a utilitarian cost-benefit analysis. Applying the model proposed in this Note, I first decide the values of R, I, and T. The R&D costs to discover these genes are high,[84] but probably not as high as for pharmaceuticals since no clinical trials are needed. Therefore, the R factor is set at 4. It is extremely difficult and costly to copy isolated human gene sequences, because patentholders like Myriad do not make their product accessible for reverse engineering.[85] Therefore, the I factor is assigned a value of 5. The invention is fairly taxing on future innovation because before its patent was struck down, Myriad had already placed restrictions on certain uses of its genes in the context of research.[86] This taxation is notable, and therefore the T factor has a value of 4. The taxation value is not assigned a 5 because it is not "broadly preempting" — patenting the BRCA genes does not preempt patenting other genes. Substituting these values into the model, we obtain a determination number of $D = 1.083$, which suggests that isolated human genes should be patent eligible, but barely.

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81. *See generally* Ass'n for Pathology v. Myriad Genetics, Inc., 133 S. Ct. 2107 (2013); Ass'n for Molecular Pathology v. U.S. Patent and Trademark Office, 689 F.3d 1303 (Fed. Cir. 2012).

82. *See Myriad Genetics*, 133 S. Ct. at 2109–10; *see also Ass'n for Molecular Pathology*, 689 F.3d at 1325.

83. *See Myriad Genetics*, 133 S. Ct. at 2110.

84. *See Ass'n for Molecular Pathology*, 689 F.3d at 1325.

85. *See supra* note 50.

86. *See* Aaron S. Kesselheim et al., *Gene Patenting — The Supreme Court Finally Speaks*, 369 NEW ENG. J. MED. 869, 870 (2013).

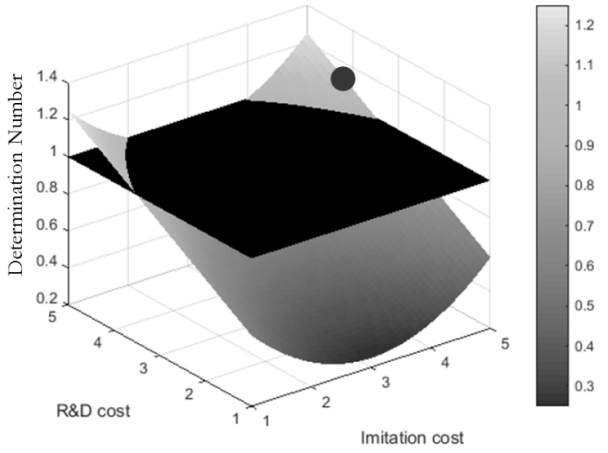

Figure 5: Isolated Human Gene Patent Eligibility[87]

As can be seen from Figure 5, the taxing nature of this class of inventions sets a high bar for patent eligibility, and this class crossed the threshold only because of a combination of high R&D costs and high imitation costs. The fact that the determination number comes out to be very close to the threshold of 1 suggests that the benefits only slightly outweigh the costs of granting patents to this category of inventions. This further explains why patent-eligibility is so controversial in the area of isolated human genes.

B. Software

Novel and nonobvious software has been a controversial subject matter[88] because courts often consider it an unpatentable mental process.[89] Thus, the judicial system struggles to determine whether it falls within the abstract idea exception. I now apply the model to test whether inventions in the software industry should be patent eligible.

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87. This surface plot shows a determination number of $D = 1.083$, as a function of R and I for the scenario $T = 4$. The horizontal surface represents the threshold value of 1, so if the determination number rests above the threshold surface, benefits outweigh costs, and vice versa. The dot represents the determination value for this category of inventions.

88. *See* Martin Goetz & Brian J. Love, *Should Patents Be Awarded to Software?*, WALL STREET J. (May 12, 2013), https://www.wsj.com/articles/SB10001424127887323335404578444683887043510 (last visited May 4, 2017).

89. *See, e.g.*, CyberSource Corp. v. Retail Decisions, Inc., 654 F.3d 1366, 1372 (Fed. Cir. 2011) (holding that claims for a software detecting credit card fraud were invalid).

Applying the quantitative model, we first evaluate the R&D cost of software inventions. R&D costs vary within the software industry depending on the product. This model uses an average industry value of 4, due to the significant spending on R&D for this industry as described in Section III.A.1. The imitation cost of software is relatively high, as most software remains proprietary. Source code is kept secret, and end user license agreements prohibit reverse engineering.[90] Therefore, the imitation cost factor I receives a value of 4. As discussed previously, software patents are very taxing on future innovation because software often builds on many previous components and the industry changes quickly. In fact, software patents are so taxing that many companies forbid their employees from reviewing patents for fear of being sued for willful infringement of others' claims,[91] even though the infringement could be accidental. This is clearly contradictory to the intent of the patent system, and therefore software inventions receive a T value of 4, for notable taxation.

Substituting the values of R and T into the model equation, we obtain a determination number $D = 0.833$. As a result, software is not patent eligible based on the proposed model, as shown in Figure 6.

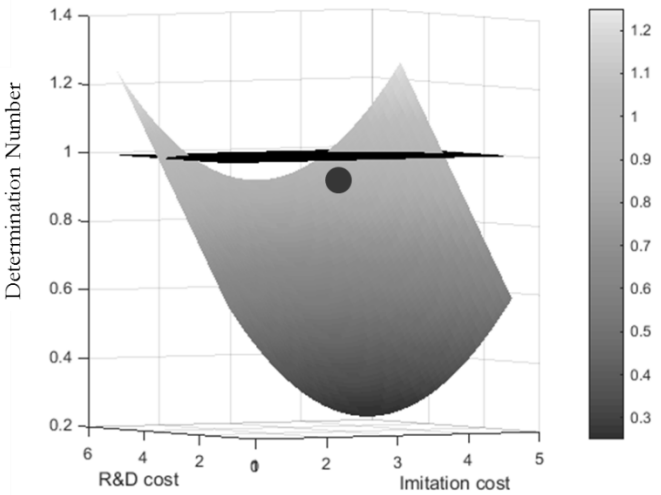

Figure 6: Software Patent Eligibility[92]

90. *See Proprietary Software Definition,* LINUX INFO. PROJECT (July 3, 2005), http://www.linfo.org/proprietary.html [https://perma.cc/X288-SVAF].

91. *See* Edwin Taylor & Glenn Von Tersch, *A Proposal to Shore up the Foundations of Patent Law that the* Underwater *Line Eroded*, 20 HASTINGS COMM. & ENT. L.J. 721, 737 (1998).

92. This surface plot shows determination number of $D = 0.833$ as a function of R and I for the scenario of $T = 4$.

Although R&D costs and imitation costs are both high for software, the highly taxing nature of software industry sets a high bar for patent-eligibility. This outcome suggests that something should be done to alleviate the problem of existing software patents taxing future innovation. Many solutions have been proposed by scholars, such as shortening the lifespan of software patents[93] or creating a compulsory licensing scheme.[94] If these schemes are implemented, patents on software inventions could provide a net benefit, because the taxation factor *T* would be much lower.

C. Business Methods

Business method patents have traditionally been allowed in the U.S., but they have been controversial.[95] The idea of patenting abstract business methods is troubling on many levels. Intuitively, people are not used to the idea that companies could be granted temporary exclusivity on a business strategy. As Professor Rochelle Dreyfuss has pointed out, the world would have been very different if the concepts of frequent flyer miles and junk bonds were allowed to be patented, and thus he concluded, "[t]he trend toward expanding protection deserves attention, with the advent of business method patenting deserving the most attention of all."[96] On the other hand, some argue that the "debate over the patentability of business method inventions . . . reflects the growing economic importance of such discoveries."[97]

Applying the quantitative model, we first evaluate the R&D cost of coming up with an innovative business method. There is generally little R&D cost related to business and trading in general, as they are not research-driven industries.[98] The industry surveys on banks, insurance, and investment conducted by Standard & Poor's did not mention R&D in this industry.[99] That is not to say business methods are never innovative. Dreyfuss's examples of frequent flyer mile programs and junk bonds are useful and creative business methods with wide adoption in

93. *See* Kirk D. Rowe, *Why Pay for What's Free?: Minimizing the Patent Threat to Free and Open Source Software*, 7 J. MARSHALL REV. INTELL. PROP. L. 595, 617 (2008) (advocating for a seven-year software patent term).

94. *See* Catherine Parrish, *Unilateral Refusals to License Software: Limitations on the Right to Exclude and the Need for Compulsory Licensing*, 68 BROOK. L. REV. 557, 587 (2002).

95. *See* John R. Allison & Emerson H. Tiller, *The Business Method Patent Myth*, 18 BERKELEY TECH. L.J. 987, 990 (2003).

96. Rochelle C. Dreyfuss, *Are Business Method Patents Bad for Business?*, 16 SANTA CLARA COMPUTER & HIGH TECH. L.J. 263, 264 (2000).

97. Daniel F. Spulber, *Should Business Method Inventions Be Patentable?*, 3 J. LEGAL ANALYSIS 265, 328 (2011).

98. *See* INSURANCE REPORT, *supra* note 69; *see also* INVESTMENT SERVICES REPORT, *supra* note 69.

99. *Id.*

our economy. But unlike a new cancer drug, for example, most business methods do not require teams of highly skilled workers laboring for ten years in a laboratory to develop, nor do they require four stages of clinical trials involving hundreds of human patients to be approved for marketing. Therefore, the R&D cost for business methods is low compared to other industries, and thus the value of R is assigned to be 2.

Business methods have extremely low imitation costs. When the first company rolled out frequent flyer miles, competitors could copy the scheme and roll out the same plan within a short period of time.[100] Thus, the value for cost of imitation is 1.[101]

In terms of taxation, some have pointed out that the claims of business method patents often tend to be overly broad and thus discourage potential future innovation.[102] Others come to the opposite conclusion.[103] Therefore, the taxation value of business methods likely ranges between 2 and 4. The arguments on both sides of this debate are strong, and it is worth looking into whether it would be possible to chart a path in the middle. Thus, I have chosen a value of 3 for T.

Substituting the R, I, and T values into the model equation, we get a determination number of exactly 1 (shown in Figure 7). This means the benefits of patenting business methods is equivalent to the costs of doing so. The patent-eligibility of business methods is a real nail-biter, as it is in common practice.

100. *See* Dreyfuss, *supra* note 96.

101. This cost of imitation could be different in business-to-business interactions or in practices practiced internally. In these cases, they should form their own special business method categories not considered here.

102. *See* Mark A. Lemley et al., *Life After Bilski*, 63 STAN. L. REV. 1315, 1329 (2011).

103. *See* Allison & Tiller, *supra* note 95, at 1035.

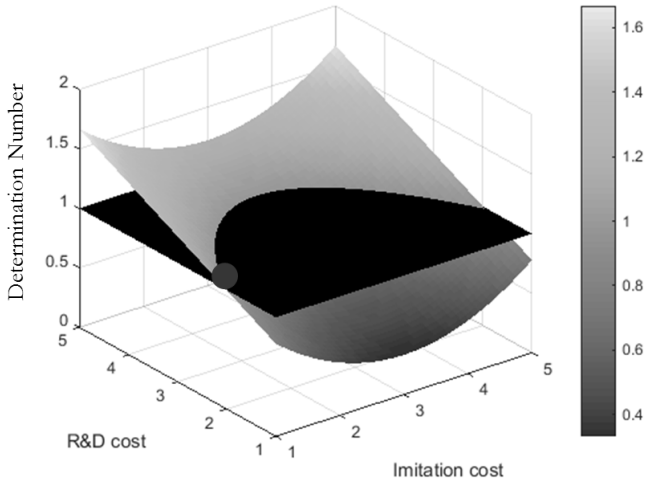

Figure 7: Business Method Patent Eligibility[104]

V. CONCLUSION

Current court controversies regarding patentable subject matter present substantial opportunities to make sensible standards to determine which class of inventions should be patent eligible. The approach developed here endeavors to assist with that undertaking.

First, the quantitative model developed here considers the R&D costs of a given class of inventions. Those with high R&D costs can be invented and developed only with the promise of temporary exclusivity granted by the patent system, without which the public may never get the inventions because the inventors could not justify the costs of making them. Inventions that require larger R&D investments also pose higher risks for investors: absent the promise of temporary market exclusivity, investment crucial for the commercialization of these inventions would be difficult to obtain. Finally, the coordination function served by the patent system is more important for inventions with high R&D costs because duplicative efforts to research costly inventions are especially wasteful.

The second factor considered is imitation costs. Inventions with low imitation costs could easily be copied and their market stolen by competitors. Competitors would have the ability to charge a cheaper price for their product because they did not invest in the initial invention of the technology. Patent protection is therefore important for inventions with low imitation costs. However, patents may still be

104. This surface plot shows determination number $D = 1$ of as a function of R and I for the scenario of $T = 3$.

valuable when imitation costs are high in order to encourage disclosure. Inventions that are difficult to imitate are in danger of being kept secret, and the knowledge of how to create and develop the invention theoretically may never fall into the public domain. Therefore, inventions with imitation costs on both extremes have an increased need for patent protection, while those with intermediate imitation costs have less of a need for patent protection.

After considering the two factors measuring patent benefits, the costs of granting patents were considered. The goal of establishing the patent system was to encourage innovation. However, some categories of inventions are especially prone to the "tragedy of the anti-commons" — when "too many concurrent fragments of intellectual property rights . . . or . . . too many upstream patent owners . . . stack licenses on top of the future discoveries of downstream users,"[105] the granting of patents comes at great social cost. Patents that overly impede future invention should not be granted at all.

Patents generate exclusivity. Exclusivity, even if temporary, has an adverse effect on markets and should not be handed out without genuine need. Therefore, determining what constitutes patentable subject matter is a decision-making process that can benefit from systematic analysis. The model proposed here employs a quantitative analysis of several important factors for granting patent protection: it parses out inventions that genuinely need patent protection in order to be invented, developed, and commercialized from those that do not based on whether the benefits of granting patents outweigh the potential adverse effects on future innovation. As a result, this quantitative model can help guide agency and court decisions on questions of patentable subject matter in the future.

105. Heller & Eisenberg, *supra* note 55, at 699.