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Calibrating Patent Lifetimes

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CALIBRATING PATENT LIFETIMES

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ABSTRACT

The patent system could better achieve its primary mission of incentivizing technological innovation by moving away from the one-size-fits-all 20-year term for patents and moving to a system of varying durations for different categories of invention. The current patent duration is arbitrary, the result of entrenched historical accident. Allowing upward variance from the 20-year term in discrete categories of invention offers the prospect of boosting innovation in impoverished technological sectors. Allowing downward variance in other categories would benefit overall social welfare by removing needless technological monopolization and associated deadweight loss.

Current economic models and available economic data do not allow for the academic calculation of optimal patent lifetimes in the real world. This paper proposes practical procedural mechanisms to gather and synthesize information about innovation incentives and returns, and to make use of that information in decision-making paradigms that would vary patent terms to make the patent system more economically beneficial than it currently is.

An appendix to this paper uses theoretical evolutionary biology to criticize economic theorists who have suggested that very long or even infinite durations for patents may be optimal.

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INTRODUCTION

Human societies have always sought to increase their standard of living. The most obvious means employed the conquest and enslavement of other societies. Today, in our more civilized world, we are left to expand our economy through innovation, both technological and artistic.

As growth mechanisms, conquest and innovation share a common problem: the free-rider dilemma. A warring society must expect that individuals who have the choice between serving in the military or refusing service—while reaping the benefits of a victorious war no matter what—should rationally choose to refuse service. If everyone makes this choice, the conquering will come to a halt. Thus, a system of compulsory military service is usually required to overcome free-rider effects. An innovating society must expect that firms, which have the choice of expending R&D themselves or freely copying the innovations of others, will rationally choose to copy. It is a familiar argument: If innovators have their works freely copied, competition will drive down the price of the innovative products to the price of production, exclusive of R&D costs. If innovators cannot recoup the costs of their innovations, they will not innovate.

Patents and copyrights are our society's flagship vehicles for overcoming the free-rider dilemma with regard to technological and artistic innovation. By granting a term of monopoly rights in the form of a patent, the government provides a mechanism for innovators to appropriate their returns from R&D expenditures.

Yet despite the importance our society has assigned to them, patents are a remarkably crude mechanism for providing incentives to innovate. First, patent protection is either *on* or *off*: If an invention meets the threshold standards of patentability, it is accorded full protection. If it barely misses, the patent regime gives it no protection. Even more striking is that virtually all patentable inventions in the United States, whether paper-clip improvements or revolutionary molecules, are accorded a one-size-fits-all 20-year term of monopoly rights.[1]

This paper argues that varying adjustments to the duration of patent monopoly rights offers the potential to better calibrate incentives so as to grow the economy in a more efficient and effective way. Part I examines the vehicle of patents, compares the patent regime to other incentive mechanisms, both real and hypothetical, and

1. Pharmaceuticals are an important exception. *See infra* Part IV.

suggests that patents are potentially, if not necessarily, the most promising such mechanism. Part II discusses the problems with the current patent regime. Part III analyzes the levers of the patent regime—how different legal entitlements and extra-legal conditions affect the value of patents and their quality of appropriability, i.e., their effectiveness in appropriating returns on R&D. The rest of the paper then proceeds on the assumption that adjustments to the patent regime should be done through a manipulation of their duration. Part IV reviews examples of differential durations that may be found in current and past intellectual-property systems. Part V evaluates various ways of manipulating patent duration, first proposing certain ad hoc or incomplete recommendations, then analyzing the substantive problems involved in creating prescriptions for patent-duration reform, and finally discussing reform from a procedural perspective, advancing promising decision-making paradigms.

I. CHOOSING PATENTS AS AN INNOVATION INCENTIVE

Patents or patent-like incentives are certainly not the only incentives for innovation. There are several alternative schemes, both in theory and in current practice, which may serve as incentives to overcome traditional free-rider effects. This section will review these alternatives and conclude that, while other incentives should not be excluded, patent is an important scheme that deserves our attention, both in terms of analyzing it and in trying to fix its weaknesses.

We can conceptualize incentive mechanisms as comprising three distinct categories. The first category consists of **legal** solutions to the free-rider dilemma. These systems use coercive power to create and enforce rights and redistribute resources. The second category is that of **anarchic** or **quasi-legal** systems, which depend on goodwill and a sense of moral duty rather than coercive enforcement. The third category—which is the most important empirically—is that of **business-based** mechanisms for incentivizing innovation. These are business tactics used by firms to finesse their way into appropriating returns from their R&D investments despite the potential for free-rider effects. These business techniques take advantage of market conditions and the decision-making characteristics of customers.

Legal solutions all aspire to make society better off or to uphold some other philosophical value. Anarchic and quasi-legal solutions also aspire to achieve social value, but unlike legal regimes, they usually assume a certain level of selfless behavior from individuals. Business-based solutions are powered by the desire for equity-holder

profits and not society-wide benefit. Thus, it is not surprising that these managerial mechanisms for appropriating returns from R&D often conflict with the welfare of persons outside the firm.

A. Legal Schemes for Appropriation

The following legal incentive structures are arranged in order roughly from most to least desirable.

Monopoly Rights—The most familiar varieties of intellectual-property protection are some form of limited-duration monopoly rights—a government-granted set of exclusive rights that may be exercised only by the creator or by persons licensed by the creator. Traditional forms of government-granted limited-term monopoly rights include utility patents, design patents, plant patents, and copyrights. More recently, *sui generis* limited-term monopoly rights have been created for semiconductor mask works,[2] boat hull designs,[3] and, in the European Union, database rights.[4] Monopoly rights are supposed to stimulate the innovation and creation of intellectual property and, at the same time, provide for the transfer of the protected works into the public domain upon the expiration of the rights. In addition to allowing the appropriation of returns from the innovation, the grant of monopoly rights allows the innovator to control the destiny of the innovation during the term. This control means that creators may appropriate not only monetary returns from their innovations but also the psychic reward of being able to control their own creations. On a more utilitarian level, some have argued that this control allows for a more well-managed exploitation of the innovation.[5] In the case of patents, the innovation must be publicly disclosed as a condition of receiving a patent.[6] This facilitates competition after the expiration of the term and lowers the price of the product of the innovation to the production cost.

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2. Semiconductor Chip Protection Act of 1984, 17 U.S.C. § 901–14 (2000).

3. Vessel Hull Design Protection Act of 1998, 17 U.S.C. § 1301-08 (2000).

4. Counsel Directive 96/9, 1996 O.J. (L 77) 27.3.96 (EC), *available at* http://europa.eu.int/ISPO/infosoc/legreg/docs/969ec.html (last visited Jan. 8, 2006).

5. *See* Edward Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265 (1977). For a critique, *see* Robert P. Merges & Richard R. Nelson, *Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 842 (1990).

6. In contrast to patent, copyright does not require public disclosure as a condition of protection. Copyrighted material may be registered with the Library of Congress but not be available to the general public. Software developers have taken advantage of this policy for the protection of their code.

Government Rewards—A system most convincingly advanced by Steven Shavell and Tanguy van Ypersele proposes giving governmentally funded and administered rewards to inventors as an alternative to the grant of monopoly rights.[7] Shavell and van Ypersele suggest several economic reasons why such a system would be preferable, including a reduction in deadweight loss that is normally associated with a non-discriminatory monopoly pricing of the products of the innovation and the legal clearance for other inventors to work immediately to improve the design. There are, however, several difficulties with a government-rewards system. First, it appears that it would be very difficult, as an administrative matter, to determine the proper level of reward.[8] Second, when improvements are made to existing inventions, it would be difficult to determine the relative worth of the two inventions in the final product.[9] Perhaps even more confounding, the proposal raises the question of what ought to be considered a rewardable innovation. A government rewards system could go beyond the scope of the current patent regime to cover unpatentable innovation—which, despite its lack of coverage by the current patent regime, is economically very important. But defining such rewardable innovation for the purposes of the reward scheme could be intractably difficult.[10] Finally, the

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7. *See* Steven M. Shavell & T. van Ypersele, *Reward Versus Intellectual Property Rights*, 44 J.L. & ECON. 525 (2001). *See also* Steve P. Calandrillo, *An Economic Analysis of Property Rights in Information: Justifications and Problems of Exclusive Rights, Incentives to Generate Information, and the Alternatives of a Government-Run Reward System*, 9 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 301 (1998).

8. Shavell and van Ypersele propose using sales data and surveys to determine the proper level of reward, and they further suggest that if the rewards system were optional, then the availability of the choice of patent protection would incentivize the government to keep rewards high. Even if the rewards were usually too low, the authors argue, the availability of the choice could only be economically advantageous, because when the rewards system was chosen, there would be gains from elimination of deadweight loss, and the rewards system would incentivize the development of innovations for which the patent system does not provide sufficient reward.

9. Shavell and van Ypersele acknowledge this difficulty. In patent, where one inventor holds the patent on the underlying invention and the other inventor owns the patent on the improvement, the inventors are said to have "blocking" patents, and any product manufactured with the improvement would require licenses from both inventors. Thus, in the patent regime, such problems are solved, at least theoretically, by Coasian bargains between the holders of the blocking patents. That is, where transaction costs are zero, the parties will come to an agreement to make the product, because both will gain more than they would in absence of a bargain. Shavell and van Ypersele seem to doubt the real-world application of Coasian theory, calling attention to the situation in which Robert Fulton, the inventor of the steamboat, refused the licenses that would have allowed the manufacture of steamboats with the improvements of other inventors.

10. Patents are granted to only a limited class of innovations that meet the standards of nonobviousness, utility, and novelty, and which can be reduced to a series of concrete claims.

Shavell and van Ypersele system could have undesirable distributional consequences, which could, in turn, give rise to problems of overall welfare loss.[11]

Government Subsidies—Many governments currently stimulate innovation by providing subsidies in the form of tax relief or cash grants. This system is the reverse of the Shavell and van Ypersele system of *ex post* rewards.[12] Subsidies are granted *before* research is undertaken. The disadvantage of subsidies compared with a rewards system is that it is far more difficult to estimate what the value of an innovation will be *ex ante* than it is to do so *ex post*. Therefore, government subsidies retain all the administrative problems of a rewards regime and additionally incur information problems that rewards regimes would not have. On the other hand, subsidies may allow firms and researchers to undertake R&D projects that they might not otherwise be able to finance, especially if those projects have a social value that exceeds their business value.[13] Subsidies also

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Inventions that do not meet these requirements, however, can often be of tremendous economic importance. Yet the patent system does nothing to overcome the free-rider problems associated with such innovations. Instead, the slack in the system is picked up by the economically troublesome and highly criticized trade-secret regime. Accepting, *arguendo*, that trade secret is less economically desirable than patent, then one of the great promises of a reward system is that it could cover these non-patentable innovations. But, because trade secrets protect such ethereal creations as "know how" and "undeveloped ideas," deciding exactly what counts as a rewardable innovation could become a boundless problem. This problem would be similar to the problem Shavell and van Ypersele acknowledged with regard to improvement patents, but because of the fuzziness and undefined nature of trade-secret-style innovation, the magnitude problem would be many times greater.

11. As Shavell and van Ypersele see it, the rewards system would raise money from general income taxes. This decouples the use of intellectual property from the payment for it. Thus, a non-consumer of intellectual property, such as a person who prefers to sit at home and knit all day, will pay for movies, music, and software for everyone else. Since movies, music, and software, to take three examples, can be and increasingly will be downloaded via the Internet, a rewards-system would mean that people would have to pay virtually nothing for these products, because the per-unit production costs are basically zero. Since media production is a huge, multi-billion-dollar industry, the distributional effects of this system would not be trivial. Such distributional effects could lead to overall social welfare loss because of the disconnect between the individual consumer's willingness to pay and the intellectual-property producer's willingness to produce or innovate. Thus, there could be a new kind of free-rider problem in which high-volume consumers of intellectual property become free riders off of low-volume consumers. Without being required to pay for the intellectual property out of their own pockets, consumer preferences may be skewed from a normal competitive market ideal, resulting in the creation of too much intellectual property.

12. Even though government grants are provided before a research project is undertaken, they effectively have an *ex post* character to the extent that they are awarded to researchers who have a track record of success in creating useful innovation.

13. Assuming a perfectly operating capital market, inventors seeking to create innovations with business value would receive financing for research without the help of the government. As noted in the text, however, if the social value of the innovation exceeds the business or

put the risk on the government and not on the innovator. The potential importance of this transference of risk is highlighted if we conceive of the value not as a function of the end-product of the innovation but as a function of the activity of searching for innovation.[14] Government subsidies could be accompanied by a requirement of public disclosure or a requirement that the fruits of the research be placed in the public domain.[15]

Trade Secrets—Trade secrets are ideas, know-how, or information that may be protected by what is largely a contract regime with special remedies.[16] Trade secret doctrine has the advantage of protecting a broad and indeterminate set of innovations—going well beyond the range that is susceptible to patent, copyright, or other forms of monopoly-rights protection. The disadvantages of trade secrets are substantial, however. Because firms can legally appropriate other firms' innovations by duplicating their work, the trade-secret system encourages redundant expenditure of R&D money, which is wasteful from a societal perspective. Of the four legal regimes for incentivizing innovation, only trade secret is

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investment value, then government subsidies would allow the development of beneficial innovation that would be ignored by capital markets.

14. Economic models could include insurance or risk-spreading investment devices to neutralize this benefit of government subsidies as compared to patents or government rewards. But these devices might not take into account the full value of non-fruitful research. Non-fruitful research adds to technological knowledge by teaching how not to attempt to solve a certain problem, and it may increase society's industrial innovative capacity by teaching skills and know-how to specific persons involved in the non-fruitful effort. Both of these society-wide benefits are appropriate for government intervention even in the presence of fanciful economic assumptions. Furthermore, subsidies may allow creativity to flourish among researchers, allowing them to pursue big breakthroughs with a low chance of success, rather than incentivizing them to pursue a steady stream of smaller advances that would better attract investment capital through the establishment of a good track record. Because of the foregoing, it may occasionally be better to think of R&D itself as the desired innovative activity rather than looking to end-product innovations.

15. While a public-domain requirement seems sensible after the government has paid for the inventive work, the Bayh-Dole Act of 1980 provides that when researchers working under government contract create a patentable invention, they are entitled to "first dibs" on the patent. This policy has been hotly criticized. *See* Brett Frischmann, *Innovation and Institutions: Rethinking the Economics of U.S. Science and Technology Policy*, 24 VT. L. REV. 347 (2000).

16. To create trade secret protection, generally speaking, confidentiality agreements are required of everyone to whom the secret is disclosed. If the secret, despite the agreements protecting it, is told to someone outside of the firm's circle of confidants, the firm may then bring an injunction against the wrongful appropriator of the secret information, blocking it from manufacturing products or carrying out processes that are covered by the trade secret. If a rival firm acquires the knowledge on its own, without the help of corporate spies or turncoats, then no injunction may be brought. Rival firms may either develop the innovation in a completely independent manner or may "reverse engineer" their competitor's product, figuring out how to make it based on an analysis of its final form. Either method is perfectly acceptable under law.

incompatible with a requirement that the innovation pass into the public domain at some point. Patent regimes currently do this, and government subsidies and government rewards could. But trade secrets have no expiration or other mechanism for transference to the public, so they are a source of either perpetual losses from monopoly pricing, or, at some point, duplicative R&D expenditures.

Overlap of Legal Incentives—These legal regimes can be mixed and matched, either in co-extensive applications or as alternatives at the inventor's option. The exception is that patents and trade secrets cannot be applied to the same invention. This is because, in receiving a patent, explicit instructions are released to the public detailing how to make and use the invention.

B. Anarchic or Quasi-Legal Schemes for Appropriation

Other mechanisms for incentivizing innovation exist independently of legislative action, either as regimes that are only enforced as community-based values, or as regimes that have grown out of, and depend upon, community-based values. Two general anarchic incentives are discussed first, followed by a discussion of two incentive structures that have traditionally been applied to software, but could be applied to patentable inventions as well.[17]

Non-Profits—Non-profit associations may allow for the appropriation of R&D expenditures, and are especially well-suited to do so where the social value of an invention exceeds its business value. Examples include charities that specialize in raising money for research to fight specific diseases, such as leukemia or muscular dystrophy. These incentives can be given out to innovators either in the form of *ex post* rewards or *ex ante* research grants.

Pride / Internal Motivation—An internal desire to invent for self-actualization or pride can also be a powerful non-monetary incentive to innovation.[18] The romantic image of the inventor working alone in a laboratory is still a powerful one in American culture.[19] In the case of freeware—computer programs that are given freely by their programmers to all other computer users—pride and

17. Software is usually protected by copyright and not by patent, although patent protection is available in some cases. Copyleft and shareware models are considered here in part because they are incentives to technological innovation, even if they are not direct competitors to the current patent regime, and in part because they could be adapted for patentable inventions.

18. *See* Lloyd Weinreb, *Copyright for Functional Expression*, 111 HARV. L. REV. 1149, 1226 (1998).

19. *See* Justin Hughes, *The Philosophy of Intellectual Property*, 77 GEO. L.J. 287 (1988).

perhaps the desire to hone programming skills are the only incentives applicable, since any direct monetary reward has been waived.

Copyleft / Patleft—Some computer programmers—known as "hackers"—use a system called "copyleft," which combines copyright, contractual licensing, and anarchic values to aid their system of working as individuals to build large programs with multiple authors.[20] Hackers retain the copyright in their programs and distribute them to others only on the condition that they accept a license requiring those programmers who add to the code to make their derivative work open to others on the same terms as the license given to them.[21] This same scheme—call it "patleft"—could be used with patentable inventions.[22]

Shareware—For computer programs, programmers can release their programs for free public distribution with a request that those who use the programs voluntarily pay a licensing fee to the programmer. While traditionally used for copyrightable works, the shareware scheme could be used for patentable inventions as well.

C. Business-Based or Managerial Appropriation Schemes

Legal scholars studying the patent system often ignore the considerable incentives for innovation that are provided by business or market conditions. Returns on R&D can often be finessed through superior management technique or marketing strategy.[23] As mentioned above, unlike legal or anarchic incentives, business-based incentives are morally neutral and often have consequences that are

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20. *See* Robert W. Gomulkiewicz, *Symposium: Licensing in the Digital Age*, 36 HOUSTON L. REV. 179, 185-86 (1999).

21. While copyleft requires the copyright and contract regimes to function, I have placed it in among anarchic / quasi-legal mechanisms because the values upon which it operates are not legal. The legal side of copyleft is not a way of coercing those in the hacker community to obey. It is a means of keeping the non-hacker portion of the population from intruding upon the hacker community and upsetting its shared ideas about duties and values.

22. A "patleft" regime would be much less tenable because of the time and expense involved in procuring a patent. Obtaining a patent requires the creation of substantial documentation, the payment of significant fees, and, in many cases, a substantial volume of back-and-forth correspondence with the patent office. Compare this to copyrights, for which legal protection arises upon the act of creation and does not require registration or the payment of fees.

23. Unfortunately, the reciprocal is true in that business scholarship has tended to neglect the legal regime when discussing innovation. The effects of this lack of thinking about legal regimes in business, however, are not limited to scholarship. When business scholars and professionals fail to fully consider the legal options available, the efficiency of those legal regimes is altered. *See, e.g.*, the discussion of the disuse of the patent system, *infra* Part II.C.

unarguably harmful to overall societal welfare.[24] Their discussion is important here because business-based strategies help to define the context within which legal mechanisms work. Moreover, where business-based incentives have negative social-welfare effects, we may wish to attempt to subvert their operation in the course of creating legal doctrine and improving the patent system.

These business-based incentives—as they are presented here—overlap with one another to a considerable extent. This list is not meant to be comprehensive. Rather, the goal of the list is to illustrate the kinds of business-borne incentives that can overcome the free-rider effect without the additional enticement of government-mandated or community-created incentive structures. The schemes are arranged roughly in order from most helpful for social welfare to the most harmful to social welfare, although such a ranking is made less meaningful by the considerable overlap among categories.

Lead Time / First-Mover Advantages—Of the business-based incentives that have been discussed in legal literature, "lead time," also referred to as the "first-mover advantage," appears to be the most often cited. "Lead time" refers to the lag between rival firms with regard to a certain technology. Lead time can be abetted by the trade secret legal regime—i.e., trade secret can help to preserve lead-time.[25] Even if the enabling technical information is public knowledge, however, a rival manufacturer may still lag behind the leader because it takes time to hire or retrain personnel, to retool or purchase new equipment, and to change the focus of the firm's managerial and marketing efforts. The "first-mover" advantage may not dissipate

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24. Under most circumstances, it would be better to refer to these "business-based incentives" as "business-based strategies" for extracting profit from innovation. They can fairly be called "business-based incentives" because, insofar as the strategies are seen as successful in appropriating returns from innovation, they will serve as incentives to innovate. They are not, however, "incentives" in the sense that someone or something has created them with the intent of inducing innovation. In this sense, business-based "incentives" are distinct from incentives of the legal regime, such as patents and copyrights, where there is stated intent on the part of policymakers to provide incentive effect. As the term is used here, "business-based incentives," are, for the most part, byproducts of market realities. Freely using the term "business-based incentives" in this paper emphasizes the comparison of such constructs to legal or societal incentives. Nonetheless, it is important to avoid the impression that "business-based incentives" are or were formed from some intent to promote certain conduct.

25. Note also that secret-keeping by a firm is not the same as having a trade-secret legal regime. Without legal protection for trade secrets, companies could still keep secrets, but they would have to do so through the goodwill of their employees earned by the carrot of positive rewards—as opposed to the stick of the trade-secret regime. Even if the goodwill of employees is minimal, however, secrets kept by a company will at least delay competitors. This will aid the innovating firm in attaining lead-time and first-mover advantages.

entirely when new competitors enter the market. The firm that debuts the new technology may be able to stay ahead of rivals because of its earlier start. Several factors contribute to keeping such a firm in a dominant position in the market, including, for instance, a reputation for better quality.[26]

Sales and Service Efforts—Many businesses compete not on the basis of the underlying technology, but on the basis of superior efforts in sales and service.[27] With such an incentive, the innovation itself is a more minor reason for customers to purchase a certain item than the sales-and-service support that goes with it.

Quickness—Some innovating firms are able to appropriate returns from the technologies they have developed by "moving quickly down the learning curve." That is, such firms appropriate greater returns simply by being very quick with improvements and with the acquisition of know-how about how to use the new technology.[28]

Manufacturing Capacity—A rival firm, seeking to copy technology from an innovator, may have all the necessary information about the technology, but without the manufacturing capacity, the rival will suffer by not being able to get the product to market fast enough. Gary P. Pisano and Steven C. Wheelwright suggest that if a firm ensures that product innovation goes hand-in-hand with manufacturing innovation, that firm will enjoy tremendous advantages over rivals who must figure out how to get the innovation to market themselves.[29] One way in which innovating businesses can be sure to take full advantage of this effect is to create cross-disciplinary "tiger teams" that include personnel from manufacturing, product design, marketing, and finance to take a holistic view of the project. This kind of holistic understanding would be much more difficult to achieve for a company that begins by copying the technology rather than developing it internally.

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26. *See* Michael Abramowicz, *Perfecting Patent Prizes*, 56 VAND. L. REV. 115, 174 (2003).

27. Theoretically, sales-and-service should not be an incentive for innovators, because the sales-and-service advantages could be applied to a business where there was no need to innovate (or to the same business, in the case where the innovation was foregone). Nonetheless, managers cite sales-and-service as a way in which they appropriate returns from R&D. *See* Richard C. Levin et al., *Appropriating the Returns from Industrial Research and Development*, 3:1987 BROOKINGS PAPERS ON ECON. ACTIVITY 783, 797, 816.

28. *See id.* The same logic applies here.

29. *See* Gary P. Pisano & Steven C. Wheelwright, *The New Logic of High-Tech R&D*, HARV. BUS. REV. Sept.–Oct. 1995, at 93.

Increasing Returns—The strategic concept of increasing returns is that as some firms scale up—especially new, technology-intensive firms, as opposed to older, more traditional heavy industry—they will be able to gather increased returns from marginal sales.[30] In other words, as companies sell more, they will tend to sell more. The bigger a market force the company is—the bigger it will get. Increasing returns is a snowball effect. According to W. Brian Arthur, these increasing returns can be because of "customer groove-in"—the unwillingness of a customer to change products because of familiarity and investments in training.[31] Also contributing to increasing returns are "network effects"—the advantages of buying another product from the supplier of previous such products because the products work together in a network.[32] An example of network effects would be the tendency of people to buy a certain brand of video game console because their friends already own the same brand of console, thus allowing the friends to swap games back and forth and use peripherals interchangeably. The idea of increasing returns is distinct from the first-mover advantage discussed above: The increasing-returns effect works to the benefit of those who are big—regardless of whether or not they were first.

Establishing a Proprietary Architecture—If the product that contains the innovation must work with other products in some sort of overarching architecture, then controlling that architecture as a proprietary system allows the better appropriation of investments in R&D.[33] The best-known example of this is the Microsoft Corporation, which was able to sell a tremendous amount of application software because of its control over the dominant Windows operating system. Charles R. Morris and Charles H. Ferguson note that these effects may allow inferior technology to be rewarded more greatly than superior technology.[34]

The first-mover advantage and sales-and-service efforts are societally beneficial incentives in that their beneficiaries rely on competitive practices to retain the edge that allows them to appropriate greater profits. Quickness and manufacturing capacity are also positive from a policy perspective; although their relation to

30. *See* W. Brian Arthur, *Increasing Returns and the New World of Business*, HARV. BUS. REV., July–Aug. 1996, at 100.

31. *See id.* at 103.

32. *See id.*

33. *See* Charles R. Morris & Charles H. Ferguson, *How Architecture Wins Technology Wars*, HARV. BUS. REV., Mar.–Apr. 1993, at 86.

34. *Id.*

customers is a bit attenuated, learning faster and having the capacity to get the product to market faster means that there will be better products, available more quickly. The incentives of increasing returns and proprietary architectures, however, are more troublesome and seem to have unfortunate effects on social welfare. Both schemes can directly lead to customers buying sub-optimal products or services.

D. Why Pursue Patent Reform?

Considering the foregoing alternatives, patents appear to be an excellent tool for providing incentives for innovation. Neither other legal regimes, nor anarchic systems, nor business-based incentives can completely replace the patent system.

Looking first at only the legal regimes, it is clear that trade secret is a less-than-optimal solution for all of the innovations it covers because of the economic losses resulting from the duplicative R&D and reverse engineering it engenders. With regard to government subsidies, government rewards, and patent, it may be that the best solution is a regime that combines all three of these. There are no characteristics of the three that require any of them to be the exclusive legal regime. Subsidies may be used when certain social advantages are desired—such as illuminating dead-end avenues for research and training greater numbers of researchers. Based on the work of Shavell and van Ypersele, a regime that allows a choice of patent and government rewards may be the best. It follows that the existence of a better patent system allows for a better overall option regime.[35]

Trade-secret protection might be better eliminated or weakened, but only if some other form of less costly incentive could replace it. Currently, trade secret provides incentives for many innovations that are not patentable.[36] Expanding the scope of subject matter protectible by patents could be such a solution.

In terms of real-world applicability, an overhaul of the patent system—even if far fetched—is more likely than the implementation of a rewards system. Steven Calandrillo has suggested that the patent system may be preferable to the rewards system simply because it is so entrenched.[37]

35. Or at least not a worse one. The option regime would be better with a better patent system assuming that at least some inventors took advantage of the patent option.

36. *See supra* note 10 and accompanying text.

37. *See supra* note 7.

Thus, looking only to the alternative legal regimes, both on practical and theoretical grounds, the betterment of the patent system deserves considerable attention.

Anarchic / quasi-legal incentives may form important incentives for innovation, but such a system seems doomed to be incomplete for all the standard reasons that anarchy is criticized, the foremost being that it cannot work without a sufficiently close community which inspires feelings of duty to the group. In our global society, this seems unlikely to happen generally, although it is clear that it can and does happen under specific circumstances, such as with people united by common affliction or within close-knit ad hoc communities. Finally, even without empirical evidence that anarchic incentives are incomplete in their stimulation of innovation, from a theoretical perspective, it would be better to have the alternative of the legal regime of patent, so long as some innovators took advantage of it.

The business-based incentives discussed above similarly do not displace a patent regime. First of all, they are clearly incomplete in the sense that they do not provide proper incentives for all innovation—i.e., some still fall victim to the free-rider dilemma. Even worse, some of these mechanisms are clearly harmful to overall social welfare. Legal regimes, including patent, should be used to mitigate or eliminate the effect of these harmful business-based mechanisms.

Having established the importance of the patent regime, Part II examines the problems with the current regime, which we might seek to change through patent reform.

II. PROBLEMS WITH THE CURRENT PATENT REGIME

This Part discusses two lines of analysis that indicate that there would be substantial benefit to undertaking reform of the current patent regime. First, as a matter of logic, patent policy is presumptively inefficient in terms of the duration of patent protection. Second, empirical evidence bears out this logical conclusion.

A. The Presumptive Problem with 20 Years

Unlike the complex and discriminating regulations found in the tax code or securities regulation, patent law has a marked lack of sophistication, providing a fixed term of 20 years regardless of the invention or the industry from which it comes.[38]

38. Note, however, that pharmaceutical patents are subject to specially lengthened durations because of the long process of FDA approval to which pharmaceuticals are subject.

The duration of patent protection is important because it involves a trade-off. Traditionally, patent has two objectives: to incentivize innovation and to encourage its disclosure. The price our society pays for these benefits is 20 years of monopoly pricing. Assuming that inventions vary in terms of the costs incurred in producing them and the benefits they will confer in terms of economic welfare, then it must be the case that our static 20-year offering price is often wrong. We must be paying too much or too little for many, if not all, inventions. Where we pay too much, we unnecessarily lose general societal wealth to the pockets of inventors. Where we do not offer enough, we must not be getting all the innovation that we ideally ought to have.[39]

The one-size-fits-all 20-year duration certainly *seems* arbitrary, and history proves that it in fact is. Prior to the 20-years-from-filing duration, U.S. law granted a 17-year term starting on the date the patent is issued. The origins of this 17-year duration are in the 17th-century English Statute of Monopolies. The statute set patent length at 14 years, which was the time it took to train two seven-year apprentice craftsmen. The United States adopted this 14-year length and added a provision to permit a seven-year extension to 21 years. Later, Congress eliminated this optional extension and replaced it with a term of 17 years—the number midway between 14 and 21.[40] The 20-year term was adopted to bring the U.S. system into alignment with the requirements of the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights ("TRIPs").[41] Because the U.S. Patent & Trademark Office often takes somewhere in the neighborhood of three years to issue a patent, the effective level of protection conferred by the 17- and 20-year terms ends up being similar.[42]

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39. *See* Richard Gilbert & Carl Shapiro, *Optimal Patent Length and Breadth*, 21 RAND J. OF ECON. 106 (1990) (Gilbert and Shapiro propose that patent lifetimes should be infinite). *See also* text surrounding *infra* note 92 and *infra* Appendix.

40. *See* C. Michael White, *Why a Seventeen Year Patent*, 38 J. PAT. OFF. SOC'Y 839 (1956).

41. Pub. L. No. 103-465 (Uruguay Round Agreements Act, implementing change from 17 years from issuance to 20 years from application; codified at 35 U.S.C. § 154); *see* Gerald J. Mossinghoff & Vivian S. Kuo, *World Patent System Circa 20XX, A.D.*, 38 IDEA 530, 538 (1998).

42. The switch from 17-years-from-issue to 20-years-from-filing has spurred some to argue that patent terms will be effectively lengthened, while others have argued the switch will shorten effective patent lifetimes. For a review of the arguments on both sides, *see* Patricia Montalvo, Comment, *How Will the New Twenty-Year Patent Term Affect You? A Look at the TRIPs Agreement and the Adoption of a Twenty-Year Patent Term*, 12 SANTA CLARA COMPUTER & HIGH TECH. L. J. 139, 155-62 (1996).

B. Superfluousness of Patents

Empirical data indicates that many *patented* inventions would have been developed without the existence of patents.[43] This suggests that in such cases the availability of patents is inefficient.[44] If they are unnecessary to create the incentive for the innovation, then their issuance can only cause losses from monopoly pricing without offsetting gains in an overall increase in innovation.[45]

Economist Edwin Mansfield conducted surveys with business executives to gain data on how many inventions would not have been developed without the incentive of patents. His data showed that 65 percent of inventions in pharmaceuticals would not have been introduced to the market without the incentive of the patent regime.[46] In other industries, including office equipment, motor vehicles, rubber, and textiles, Mansfield found no evidence that patent protection was necessary for the development or marketing of any invention.[47]

Despite the relative ineffectiveness of patents for appropriating returns, more than half of patentable inventions were patented regardless of whether patents were necessary to induce their development, because such patents were useful as bargaining chips and as means to delay potential competitors.[48] This is direct evidence that the patent system is, at least in some circumstances, overly generous in its rewards, providing incentives beyond the inducement threshold. Correspondingly, it indicates that the patent system is causing social welfare loss from the delay of competition and from tipping the scales in negotiations that would presumably otherwise reach more efficient results.

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43. *See, e.g.*, Edwin Mansfield, *Patents and Innovation: An Empirical Study*, 32:2 MGMT. SCI. 173, 180 (1986).

44. Of course, even if the patent award was not a necessary incentive for the innovation itself, it could still be necessary as an incentive to disclose the invention, rather than hold it as a trade secret.

45. Judge Richard Posner wrote in a dissent and concurrence to *Roberts v. Sears, Roebuck & Co.*, 723 F.2d. 1324, 1346 (7th Cir. 1983), that the nonobviousness standard for patentability should be interpreted such that only inventions which would not have been invented *but for* the incentive of a patent should be considered nonobvious. Inventions that would have been invented anyway are, according Posner, "obvious" under the patent statute.

46. *See* Mansfield, *supra* note 43, at 175.

47. *See id.* at 174-75.

48. *Id.* at 176.

C. Disuse of the Patent System

Research also shows that in the case of *patentable* inventions (as opposed to *patented* inventions, discussed above), most such inventions would have been developed even if patent protection had not been available.[49] Economic research indicates that patents are the lifeblood of some industries, such as pharmaceuticals, but are largely ineffective in other industries, such as electrical equipment, office equipment, and textiles.[50] This does not necessarily lead to the conclusion that patents ought not to be granted to these latter industries, but it does indicate a potential weakness of the system. It may mean that protection should be strengthened through the lengthening of patent durations for these industries. Where the patent system is not utilized, there is the potential that greater utilization of patents would lead to a substantial gain in social welfare by either increasing innovation or encouraging inventors to eschew trade secret protection.

III. LEVERS FOR OPTIMIZING THE PATENT SYSTEM

Proposed methods for improving the incentive effects of, and minimizing the losses associated with, the patent system rely on manipulating one of the dimensions of patent protection. Most discussion of patent policy has centered on the manipulation of one or more of three important levers that control the overall shape of patent protection: duration, scope, and enforcement. There are other dimensions, however, such as antitrust law, international geographic coverage, general economic conditions, and manager attitudes / business strategy, which ought to be considered along with the traditional levers. Changes along these dimensions have important effects on the shape of the overall incentive that patent law provides.

This discussion concludes that, once one accedes to the proposition that patent law should be reformed, duration is an excellent choice as a lever for calibrating patent incentives.

A. Levers Available to Us

Duration—The length of protection is the simplest lever for manipulating the overall reward that patent provides. Most obviously, the statutory term for patents can be raised or lowered from its current

49. *See id.* at 176 (many patentable inventions are not patented because firms opt instead for trade-secret protection).

50. *See* Levin, *supra* note 27, at 797.

20 years. There are more complex changes that can be made to duration, however, such as altering the event that triggers the start of the term (from the date of issuance of the patent, for instance, to the date of filing the application).[51] Additionally, duration can be broken up, so that a term is shorter, but with the possibility of extensions.[52] The extensions could be based on a number of factors, including the simple willingness to pay extension fees.[53] A more sophisticated system could impose differential terms based on various characteristics of inventions and/or their economic properties, or more specifically, according to the industry or invention class into which they fall.

Scope—The breadth or scope of a patent is doctrinally much more complicated than duration. A change in scope can include modifying the kinds of inventions that can be patented. The move to approve the patentability of business methods reflects a manipulation of this variable.[54] Robert Merges and Richard Nelson have noted that while duration is a matter of settled law, scope is, to a great extent, under the control of the courts, and therefore provides more promise for creating reform.[55]

Enforcement—The enforceability of patents includes issues regarding the evidentiary, procedural, and economic hurdles to using the legal system to stop the infringement of a patent, and what

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51. Such a change was made in the United States so that U.S. law would be in compliance with the terms of the TRIPs agreement—the event triggering the running of the term was changed from the issuance of the patent to the filing of the application.

52. F.M. Scherer, *Nordhaus' Theory of Optimal Patent Life: A Geometric Reinterpretation*, 62 AM. ECON. REV. 422, 427 (1972) (Scherer proposed making extensions contingent upon a showing of one or more of various economic conditions, such as the market being small compared to the research costs). Compare this approach to the *ex post* reward system of Shavell and van Ypersele, *supra* Part I.A.2.

53. The U.S. patent system requires maintenance fees of patent holders in order for the full term of 20 years to be realized. The patent issuance fee only pays for the first four years of monopoly rights. Progressively larger maintenance fees are required prior to the fifth year, prior to the ninth year, and prior to the 13th year. These maintenance fees in January 2006 for "large entities" were $900 for year-5 through year-8, $2,300 for year-9 through year-12, and $3,800 for year-13 though year-20. See 37 C.F.R. 1.20(e)–(g). Half of those amounts are assessed for "small entities," which includes individuals and small businesses. See *id* and 37 C.F.R. 1.27(a). The maintenance fees may be considered small compared to the costs of prosecuting a patent. Nonetheless, the fee requirement creates the mild effect of variable patent terms based, indirectly, on the importance of the invention, with inventions that can attract more capital (and are therefore presumptively more important) receiving longer terms that those inventions that cannot.

54. *See* State Street Bank & Trust Co. v. Signature Financial Group, 149 F.3d. 1368, 1375 (Fed. Cir. 1998).

55. *See* Merges & Nelson, *supra* note 5, at 839-40.

remedies are available once infringement has been proven. For instance, Ian Ayers and Paul Klemperer have proposed that uncertainty and delay in enforcement are economically beneficial because they help to reduce deadweight loss.[56]

Antitrust Law—The monopoly rights conferred by a patent are not absolute, and they are restricted in their application by antitrust law. The greater leeway patent holders have under antitrust law, the more their monopoly rights will be worth and the greater their overall reward will be.[57] Louis Kaplow has proposed that permitted practices that would potentially be outlawed under antitrust law should be permitted where there is a high-incentive-to-loss ratio.[58]

Compulsory Licensing—Laws that allow patent holders to be compelled to grant licenses to willing manufacturers are another way in which patent rewards may be shaped.[59] Even though the fees for compulsory licenses could be set so as to secure the inventor monopoly profits, the existence of a rival producer of the patented good could still disadvantage the patent holder. This could happen, for instance, when the licensee gains manufacturing and marketing experience during the patent term that allows the licensee to be in a dominant market position as the patent expires. Otherwise, such a firm would just be beginning the process of learning to manufacture and market the invention after the patent expires. In this manner, compulsory licensing would lower the reward by decreasing the monopoly effects that benefit the patent holder.[60]

Geographic Coverage / Internationalization—The international expansion of the availability of patent protection through TRIPs and other agreements is perhaps the most important contemporary manipulation of patent rewards.

Economic Conditions—As with any other economic topic, macroeconomic variables will change the parameters of a microeconomic model. As the economy expands, less R&D will

56. Ian Ayres & Paul Klemperer, *Limiting Patentees' Market Power without Reducing Innovation Incentives: The Perverse Benefits of Uncertainty and Non-Injunctive Remedies*, 97 MICH. L. REV. 985, 986-87 (1999).

57. *See* Louis Kaplow, *The Patent-Antitrust Intersection: A Reappraisal*, 97 HARV. L. REV. 1813, 1824 (1984).

58. *Id.* at 1824.

59. *See* Pankaj Tandon, *Optimal Patents with Compulsory Licensing*, 90:3 J. OF POL. ECON. 470 (1982).

60. *Cf.* 17 U.S.C. § 115 (2000) (compulsory licensing scheme under the U.S. Copyright Act allowing musical artists to make "cover versions" of published musical compositions).

provide greater returns, regardless of legal variables.[61] Likewise, when the economy is poor, the subsequent reward from R&D will fall.

Business and Management Conditions—The attitudes, fashions, training, and psychology of business managers may also have a large impact on the real-world effects of the patent system. Concluding that patents were largely ineffective as incentives in many industries, Richard C. Levin et al. questioned why firms pursued patents anyway.[62] One explanation they offered is that patents may be used as a means to measure the performance of employees involved in R&D.[63] For start-ups looking for financing, patents have been cited as performing an important signaling function, indicating to venture-capital firms that some start-ups have better potential than their rivals. These business attitudes toward patents and patent holders may or may not be rationally based.

B. Why Choose Patent Duration?

One of the chief advantages of manipulating duration rather than another lever lies in duration's doctrinal simplicity. Changing duration is not the complicated affair that changing the scope or enforcement of patents would be. Manipulation of scope requires changing doctrines of what inventions are patentable or the rights to which someone is entitled once they are given a patent. One can theoretically discuss lowering the nonobviousness requirement, for example, by 50 percent, but expressing such a change in a way that it could be implemented would be complex. Manipulation of enforcement is doctrinally complicated in a similar manner.[64]

Burk and Lemley have encouraged courts to embrace a policymaking role in patent law by developing an approach of differential application of doctrines to different technologies and industries.[65] For example, Burk and Lemley urge that small-molecule

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61. The effect of favorable economic conditions is especially powerful when combined with the globalization of patent protection, since it involves both an expansion of markets and an increase in the economic power of each one of those markets.

62. *See* Levin, *supra* note 27, at 798.

63. *See id.*

64. In a regime of public enforcement, a policy maker could simply enlarge or shrink the budget of enforcement personnel. But in a regime of primarily private enforcement—as is the case with patent—the manipulation of the level of such private enforcement would require changing the law, such as by changing the rules of litigation procedure in patent cases.

65. Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575 (2003).

chemistry needs fewer patents that are broader in scope to properly encourage innovation. To accomplish this, they suggest that courts strengthen the doctrine of equivalents for small-molecule chemicals while relaxing the requirement that the patent applicant fully disclose how to make and use the invention.[66] Burk and Lemley's prescription could raise a host of troubles. First, the more complicated a solution is, the more error prone it will be. Using a wide array of patent doctrines, any one of which may be manipulated in multiple ways, introduces needless opportunity for blunder. Doctrinal changes may be misunderstood by courts attempting to apply precedent. Additionally, such changes may have unforeseen consequences through interaction with other doctrines or by being applied in different factual contexts. Another problem with the approach of policymaking by the courts is that it promises to take too long—especially here, where the goal is to calibrate incentives to innovate. Evolving the law through shifting jurisprudence is—and should be—a slow process. Courts take small steps, building on the work of other opinions. Even watershed cases announcing significant departures from prior doctrine can create more questions than answers, requiring a round of observer commentary and subsequent judicial opinions before people understand what the impact will be. The need to incentivize more innovation in a certain research sector may have dissipated by the time the doctrine is developed and understood and before its impact has been felt in industry.

The numeric quality of duration is also advantageous in that it allows for fine-tuning of the system. Doctrines of scope or enforcement can be reworded or switched on and off, but duration has the prospect of allowing infinite gradations in making the slight adjustments to the size of the patent reward.

Furthermore, the simple numeric quality of duration means that the effects of its manipulation would be more predictable than manipulation of other variables would be. While changing an evidentiary presumption or a doctrine of claim interpretation could have unforeseeably mild or extreme effects, tinkering with the duration of patents is not similarly worrisome. Changing the duration from 20 years to 19.8 years would be slight enough that one could predict with confidence that the resulting change in R&D investment would be minute. Duration has a comfortable quality of facilitating an "ease in" to change, in part because it allows for on-going experimentation and adjustment with minimal risk.

66. *See id.* at 1686-87.

IV. PAST AND CURRENT DIFFERENTIATION OF PATENT DURATION

The idea of issuing patents of various durations is not new. There have been various proposals for differentiated durations for categories of patents, and, under existing laws in the United States and abroad, there are many examples of varying durations for patents and patent-like *sui generis* intellectual-property rights.

In the United States, pharmaceutical patents provide an example of patents with a different duration. The Drug Price Competition and Patent Term Restoration Act of 1984[67] took pharmaceuticals out of the general milieu of uniform patent terms. Because the Food and Drug Administration requires lengthy trials and studies before approving drugs for market, the effective life of pharmaceutical patents was half of the then-current statutory term of 17 years.[68] To restore some of this loss, the 1984 legislation adjusted the duration of pharmaceutical patents according to a formula whose inputs are the FDA review time and clinical testing time. One study estimated that the act added about three years to the useful life of the average pharmaceutical patent, resulting in an effective patent life of 11.8 years.[69] Thus, even with the special extension afforded by the 1984 law, the effective life of drug patents is of shorter duration than other U.S. patents, yet the pharmaceutical industry nonetheless finds patents to be highly effective in appropriating returns from R&D.[70]

Where the pharmaceutical industry, one of the most patent-advantaged industries, maintains tremendous incentive to innovate despite having patent duration effectively shortened by approximately one-third, there is strong reason to believe that the incentive provided by the patent system may be much more than is necessary for this or other industries.

Plant patents in the U.S. system, which protect asexually reproduced plant varieties, have the same term as utility patents—20 years from the date of application. But the Plant Variety Protection Act provides a different, longer term of patent-like protection to sexually reproduced varieties[71]—20 years from the date of issuance

67. Pub. L. No. 98-417 (patent extension provisions codified at 35 U.S.C. § 156).

68. *See* Grabowski & Vernon, *Longer Patents for Lower Imitation Barriers: The 1984 Drug Act*, 76 AM. ECON. REV. 195 (1986).

69. *See id.* at 197. One should note that the change in patent duration was part of a package of reforms that also increased the ability of rival drug manufacturers to make and sell generic equivalents to brand-name drugs after the expiration of the relevant patents.

70. *See* Levin, *supra* note 27; *see also* Mansfield, *supra* note 43.

71. 7 U.S.C. § 2321, et seq. (2000).

for most plants, and for trees and vines—which are slower to mature—the term is 25 years from the date of issuance.[72]

Other countries have had variable durations for patents. The German system once carried a full term for a major patent and a three-year term for a minor patent, renewable at successively higher fees.[73] In 1950, in the era before TRIPs, the Swiss system provided for a maximum patent duration of 15 years after the filing of the application for all inventions except pharmaceuticals and chemicals, which were accorded patent protection of not longer than 10 years.[74] Egypt, Kuwait, and Libya limited patent protection for pharmaceuticals to 10 years as late as 1999, even though these countries all had a 15-year term that started running with the filing of the application for patents generally.[75] Historically some countries provided government officials with the discretion to extend patent durations for inventions that were considered to be especially important.[76]

Proposals for and experiments with petty patents are another example of differential terms for different kinds of inventions.[77] Australia provides a shorter term of protection to inventors who desire a less expensive and faster method for obtaining patent protection.[78]

Within the United States, the Semiconductor Chip Protection Act of 1984 creates special protection for the etched designs on microprocessor chips.[79] Although the protection provided by this act is not patent protection per se, because the act is designed to incentivize technology innovation, it is a relevant example of differing terms of protection based on the nature of the innovation. The act, aimed at the fast-moving computer industry, provides for a 10-year term of protection.[80] On the software side of the computer industry, some commentators have called for shorter durations for

72. 7 U.S.C. § 2483(b) (2000).

73. *See* Howard Gensler, *Property Law as an Optimal Economic Foundation*, 35 WASHBURN L.J. 50 (1995).

74. *See* Josh Lerner, *Supplemental Material on the Evolution of Global Patent Policy*, http://www.people.hbs.edu/jlerner/PatPolSum.pdf (last visited Jan. 8, 2006).

75. *See id.*

76. *See id* at 15.

77. *See generally*, Mark D. Janis, *Second Tier Patent Protection*, 40 HARV. INT'L L.J. 151 (1999).

78. *See id.* at 165-66.

79. 17 U.S.C. § 902, et seq. (2000).

80. 17 U.S.C. § 904 (2000).

software patents, in part because the software business is so fast moving.[81]

As a proposed change to patent duration for a specific field of innovation, Amazon.com CEO Jeff Bezos—under fire from many in the Internet community for Amazon's patent on "1-click ordering"—posted a letter in which he called for shorter durations for business method patents and software patents.[82]

V. PROPOSALS FOR REFORMING PATENT LIFETIMES

Once we have decided that the 20-year term is presumptively unfit and that revising it is a potentially significant source of societal benefit, then there are several ways in which we can tackle its reform. Broadly speaking, each of our proposed solutions could be placed into one of two categories: (1) incomplete or ad hoc fixes that suggest only **relative values** of patent protection—i.e., an up-or-down movement in duration—or (2) comprehensive systems that suggest **absolute values** for patent duration. In this latter "comprehensive" category, there are both substantive and procedural levels on which we could view the problem. Both are discussed.

Proceeding on the substantive level, the most straightforward avenue for progress in finding absolute values would be to create or adopt an economic model to tell us what the optimal life of a patent would be, given certain inputs, and then gather empirical data corresponding to those inputs. By running the empirical data through the model, we should be able to find discrete patent categories to which we could attach differing lifetimes. These categories should have two properties: 1) The categories should group inventions that share economic characteristics that are determinants of optimal patent life according to the model, and 2) the categories should be straightforward and clear enough so that patents can be assigned to a category at the time of issuance with little wiggle room for litigation or administrative appeal. With categories constructed in this way, and with a proper model and the proper empirical data, we should be able to prescribe carefully targeted durations for each category.

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81. *See* Peter S. Menell, *Tailoring Legal Protection for Computer Software*, 39 STAN. L. REV. 1329, 1364-65 (1987).

82. *See* Jeff Bezos, An Open Letter from Jeff Bezos on the Subject of Patents (Mar. 9, 2000), *available at* http://www.oreilly.com/news/amazon_patents.html (last visited Jan. 8, 2006); *see also* Troy Wolverton, *Amazon CEO Sees Solutions in Patent Reform*, CNET NEWS.COM (Mar. 9, 2000), *available at* http://news.com.com/Amazon+CEO+sees+solutions+in+patent+reform/2100-1017_3-237801.html (last visited Jan. 8, 2006).

Unfortunately, the empirical data that is available does not provide all the necessary inputs for the models that have been created.[83]

We can also view the problem of establishing absolute values on a procedural level. That is, instead of focusing on the substantive answer to what the categories are and what the duration for each should be, we might instead propose a process for setting such values. This line of analysis shows much more promise. It may be, and appears to be the case currently, that prescribing specific values is beyond the scope of any academic effort. Perhaps substantive prescriptions should be created only through the outcome of some real-world process. Discussed below are several possibilities for such real-world processes.

A. Ad hoc / Relativistic Manipulation of Patent Durations

Postponing the problem of finding absolute values, first discussed are "ad hoc" policies that are based on observations about the levers that control the overall reward provided by the patent regime.[84]

i. Where Globalization Increases, Patent Durations Should Decrease

All other things being equal, evolving expansion of international patent protection militates in favor of a contraction of duration. As discussed in Part II, the aggregate action of various international treaties has created a general trend of increasing the territory included in patent protection. This globalization results in a larger market in which an inventor may appropriate returns from innovative R&D. A larger market, in turn, means a greater financial reward is available to the monopoly-rights holder. Because of the special nature of intellectual property, this leads to the conclusion that the patent reward should be decreased to offset this market-territory expansion. This analysis suggests that the globalization of patent protection has

83. *See* discussion *infra* Part III.B.

84. Discussed in *supra* Part II. Tradeoffs between antitrust and patent duration are discussed by Kaplow, *supra* note 57. His observation and accompanying policy guidelines are another example of ad hoc patent manipulation in addition to the ones mentioned here. The difference is that the ad hoc manipulations described here are ones in which the non-patent levers either cannot or should not be manipulated, making it clear that patent duration (or some other patent lever) ought to be manipulated to offset the effect. With regard to the intersection of patent and antitrust law, there seems to be no reason to choose the manipulation of patent durations to offset changes in antitrust law, since both are under the control of Congress and the federal courts.

amounted to a free ride for patent-holding firms.[85] Lower patent durations would be a convenient means for achieving this offset.[86]

Begin with the observation that R&D is not economically scalable. In other words, R&D is made up almost exclusively of fixed costs with little or no variable costs. The cost of developing a new form of computer memory, for instance, is the same whether the resulting product is sold only in the United States or whether it is sold on all continents.[87] Assume, *arguendo*, that in the United States, the term of protection for computer memory inventions were correctly calibrated. If this were the case, the system would be offering the proper amount of incentive and inducing the proper amount of innovation. Now that patent protection has expanded overseas, there is a greater reward for each patentee. This must lead either to too much innovation, draining resources away from other sectors of the economy, or to the same amount of innovation, but with an unnecessary loss to social welfare because of an inefficiently long or wide monopolization from the patent.

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85. As a political matter, it is clear that patent-intensive firms have a powerful interest in attaining and retaining this globalization advantage, even if it is not socially beneficial. Because of the strength of such special interests, and because TRIPs is a fait accompli at this point, providing for a minimum duration of 20 years, the prospects for changing this system are, of course, low. *See* Agreement on Trade-Related Aspects of Intellectual Property Rights art. 33, Apr. 15, 1994, 1869 U.N.T.S 299; 33 I.L.M. 1197.

86. One caution to note in lowering patent durations to coincide with increased globalization is that not all inventors seek overseas patents. Even those who do may not chose to seek a patent in every jurisdiction that offers one. Patent prosecution can be an expensive process, and obtaining a patent in a country with a small market for the invention may not be worthwhile. For such inventors, a U.S. patent, or patents in a handful of important jurisdictions, may provide enough incentive to innovate without the availability of patents in other countries. To account for the effects of these transaction costs in obtaining patents in other jurisdictions, patent duration could be incrementally lowered for each overseas patent obtained, but lowered by a small enough amount that there would continue to be incentive to patent in overseas jurisdictions. Under such a system, an innovating firm that held only a U.S. patent would have a full term, and consumers outside the United States would reap a social welfare benefit of gaining innovation without offsetting monopoly pricing. On the other hand, an innovating firm that held patents in many jurisdictions would receive a somewhat lowered period of protection in all of them, providing for social welfare gains for consumers in the years during which the patents would have been enforceable but for the term shortening occasioned by multi-jurisdiction patenting. Finally, it should be noted that if the trend toward globalization advances to the point that patents are available in all or many jurisdictions with only insignificant transaction costs, then there would be no need to couple lowering of duration to the extent of multi-jurisdiction patenting for a given invention.

87. There are, of course, laboratory and legal expenses incurred in certifying products for other countries, most notably drugs, but these expenditures are probably better thought of as marketing costs than as R&D costs, at least for our purposes here. The legal and regulatory expenses incurred for international expansion serves only to lower the marginal gain from expansion, not to change the financial analysis of the underlying R&D.

The geographic coverage of the patent itself is an unlikely place to look for inefficiency, since globalization presumably leads to greater efficiency through economies of scale and via effects predicted by the theory of competitive advantage.[88] Thus, the proper place to correct the inefficiency is in the manipulation of the duration of patents.

The proper adjustment for duration of patents vis-a-vis globalization of patent protection would be easy to determine. One needs only to calculate the size of the increase in the market—probably through a measure such as gross domestic product—and then make an adjustment upwards in protection to offset the costs associated with launching a product in a new country. Reasonable approximations of these costs would not pose a difficulty for empirical research.

ii. Patent Durations Should be Responsive to Changes in Macroeconomic Conditions

It was observed above that in a poor economy, the same amount of R&D spending will produce lesser returns, all else being equal, than when the economy is expanding. What are the policy implications of this observation? We might attempt to index patent protection to key economic indicators. This would allow the ongoing calibration of the patent system so that rewards from R&D would be insulated from cyclical downturns and reined-in during a period of heated economic expansion.[89] Of course, the changing of patent

88. It may be the case, however, that because of the differing economic conditions of various countries that the more efficient solution would be to not have patent protection for foreign inventions in some lesser-developed countries, since the incentives can come from developed countries that can better afford them. The efficient solution may not be reached through treaty negotiations because of the tremendous bargaining advantage that developed nations wield on behalf of their intellectual-property intensive constituents.

89. In regards to relating patent length to economic variables, Frank Partnoy has done work on integrating interest rates into models of optimal patent length. *See* Frank Partnoy, *Finance and Patent Length*, U. San Diego Law & Econ Research Paper No. 19 (2001), *available at* http://ssrn.com/abstract=285144 (last visited Jan. 8, 2006). He suggests that lower interest rates indicate lower optimal patent terms, and higher interest rates indicate longer optimal patent terms. *See id.* at 18. The higher that interest rates rise, the longer patent terms will need to be to provide adequate incentives. Partnoy's models indicate that a one-percent shift in interest rates roughly results in a one-year shift in the optimal patent term. *See id.* at 5. Partnoy's analysis of interest rates and patent terms, however, does not address the question of what other economic factors accompany changing interest rates. Central banks may raise or lower interest rates to offset undesirable macroeconomic conditions, such as inflation, excessive borrowing, depressed business or consumer spending, etc. These conditions themselves may affect the inventive activity of innovating firms. Therefore, tying patent terms to interest rates should be considered within the context of other economic variables to which interest rates move in reaction.

durations would not merely serve to insulate industries, but would have its own economic effects.[90]

A more germane and promising application of changing patent durations would be to discriminate among industrial sectors.[91] One might look for persistent inter-industry differences in economic conditions, and then award longer patent protection for inventions that serve economic sectors with a decreased ability to pay and award shorter patent protection for inventions that serve wealthy economic sectors with better underlying economic conditions. Before pursuing such a policy, of course, we would have to consider that the reason for differences in underlying economic conditions may be due to the desirable effects of market-driven transfer of capital from less economically important sectors to sectors with a greater promise for increasing bottom-line societal welfare.

Keeping in mind this reservation, changing patent durations among industries could be fruitful where some industries are characterized by highly elastic demand curves and thus are more vulnerable to cyclical economic effects. One specific example is an industrial sector that is characterized by a large proportion of cash-poor start-up companies. Higher patent durations might help allay the concerns of skittish venture-capital firms during economic downturns. An international application of this idea might be that for countries that are attempting to incubate industrial sectors, a higher patent duration would shield young R&D-intensive firms from changing economic conditions that could cause capital to evaporate.

Suppose, for example, spending on consumer electronics is down, and interest rates have been lowered to boost consumer spending. In such a situation, one would have to question whether it would be advisable to lower patent incentives for the already depressed consumer electronics industry. One could imagine that larger patent incentives, provided through longer terms, might produce "gotta have it" innovations that would precipitate a boost to consumer spending.

90. One could imagine using patent durations as a general device for alternately heating up and cooling off the economy when prudent. Such a device would probably be inferior to manipulation of interest rates because the mechanism of interest rates has a more immediate and far-reaching effect. Holders of stock in patent-intensive corporations could respond immediately to the announcement of a patent duration increase or decrease, but the actual effect on corporate profits would take years to materialize. And, of course, patent-intensive companies are only a segment—although a large one—of the economy. Interest rates, on the other hand, affect every company and investor, and the investment decisions that are based on interest rates are immediate. Thus, the economy would respond much more quickly to changes in interest rates than patent-duration changes.

91. Partnoy analyzes the differential structure of cash flows of returns from innovation among types of inventions and concludes that such differences indicate that terms should vary among industries accordingly. *See* Partnoy, *supra* note 89, at 22-27. Specifically, Partnoy's analysis supports a conclusion that financial-services patents should have shorter durations than those for pharmaceuticals. *See id.* at 26-27.

B. Substantive Prescriptions for Categories and Durations

As opposed to the above-discussed "ad hoc" mechanisms for reforming patent duration, making substantive prescriptions for optimal patent life requires a model, workable categories, and empirical data.

i. Models for Optimal Patent Life

Substantial literature has focused on the question of what the optimal length of patents should be.[92] In general, the topic has received considerably more attention from microeconomists than from legal scholars. Economists have developed various models to calculate optimal patent life. Even without empirical data to fill them out, these economists have been able to make some predictions about general situations that call for a relatively longer patent life. Unfortunately, the economists' results are often at odds with one another.

William Nordhaus developed models of optimal patent life using inputs such as cost of R&D and the social value of inventions. His work indicated that optimal patent life is extremely sensitive to changes in elasticity of demand, the discount rate, and the size (or importance) of the invention that is being considered. Depending on these values, his equations show an optimal lifetime ranging from 1.1 to 34 years.[93] Part of this sensitivity, he maintained, was because of the flatness of the welfare function he used. Once a patent reached a life of between six and 10 years, the welfare function flattened, indicating that as patent lifetimes are lengthened, there is little effect on social welfare, as he defines it. He notes that this is not the case for very important inventions, for which social welfare losses are greater as patent terms are lengthened.

Nordhaus's modeling indicates that although optimal patent life may change greatly depending on the industry, kind of invention, and even outside economic circumstances, the life of a patent may not

92. *See* WILLIAM D. NORDHAUS, INVENTION, GROWTH, AND WELFARE: A THEORETICAL TREATMENT OF TECHNOLOGICAL CHANGE (MIT Press 1969); F.M. Scherer, *Nordhaus' Theory of Optimal Patent Life: A Geometric Reinterpretation*, 62 AM. ECON. REV. 422 (1972); Pankaj Tandon, *Optimal Patents with Compulsory Licensing*, 90 J. OF POLITICAL ECON. 470 (1982); Richard Gilbert & Carl Shapiro, *Optimal Patent Length and Breadth*, 21 RAND J. OF ECON. 106 (1990); Paul Klemperer, *How broad should the scope of patent protection be?*, 21 RAND J. OF ECON. 113 (1990); Louis Kaplow, *The Patent-Antitrust Intersection: A Reappraisal*, 97 HARV. L. REV. 1813 at 1823 (1984).

93. *See* Nordhaus, *supra* note 92, at 81-82.

matter much as long as it is greater than a certain number of years, which, depending on the variables, ranges from six to 10 years.[94]

Of course, the practical value of Nordhaus's work considered alone is quite limited, since he admits to having very little confidence in the empirical information that he uses with the model. Additionally, Nordhaus gives us reasons to believe that finding high-confidence empirical data would be very difficult.[95] According to Nordhaus, "easy inventions," meaning those that yield a large benefit relative to R&D costs, deserve a shorter duration of patent protection.[96]

Following up on the work of Nordhaus, F.M. Scherer attempted to refine and simplify Nordhaus's model.[97] Recognizing that there is considerable difficulty in applying this model to patent reform, since an *ex ante* calculation of social welfare value is impracticable or impossible, Scherer proposed a flexible system in which patentees would initially be given a shorter term, but might be granted an extension if they could meet the burden of proving that their invention deserved greater protection because of R&D costs and social welfare.[98] The transaction costs associated with this method would be very large, of course, and such a system would need to inspire enough confidence in inventors that they would believe they would be well compensated for deserving inventions.

Another theoretical perspective is one offered by Richard Gilbert and Carl Shapiro, who introduced analysis of patent scope alongside duration.[99] Their models assume that there is a trade-off between duration and scope—an increase in "scope" meaning greater offensive rights against a greater range of products or processes. The trade-off, according to Gilbert and Shapiro, is that a longer duration will compensate an inventor for a narrowing of scope, and a larger scope will compensate an inventor for a shorter duration. Because Gilbert and Shapiro found that any incremental increase in scope had greater deleterious effects on social welfare than the offsetting increment of duration, they concluded that an infinite duration may be optimal, as it minimizes the patent's scope.[100]

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94. *See id.* at 83-84.

95. *See id.* at 86.

96. *See id.* at 79.

97. *See* Scherer, *supra* note 92.

98. *See id.* at 427.

99. *See* Gilbert & Shapiro, *supra* note 92.

100. *See id.* Two things to note: First, Kaplow demonstrates the economic fallacy of this thinking. *See supra*, note 57, at 1826–28. Second, because inventors and corporate stockholders

As discussed above, ideally these models would work with inputs of reasonably ascertainable information and provide differential results for categories that are clear enough for the placement of inventions *ex ante*, and with a minimum of potential for dispute about the categories to which the inventions ought to belong. Nordhaus's and Scherer's models are not very helpful in this regard. They depend upon inputs such as the importance of the invention, which is difficult or impossible to calculate *ex ante*, and which would likely involve expensive litigation or administrative costs if calculated *ex post*.

ii. Finding the Proper Categories

The difficulty in calculating the inputs for the theoretical treatment of optimal patent life is also at the root of the problem in assigning inventions to sensible categories. Where an input is difficult to calculate *ex ante*, it is correspondingly unhelpful in dividing inventions into groups.

In fact, there has been little scholarly attention as to what differential categories might serve the purpose of better calibrating the patent system. As the above discussed models propose, we might try to divide inventions into different categories based on their underlying economic characteristics (such as costs involved and surplus generated) and/or their technological characteristics (such as how much of a breakthrough they are). The problem with these categories is that they require information that is difficult, expensive, or even impossible to obtain in advance of the invention's introduction to the market.

Industrial sectors, however, show promise as helpful categories. Industries differ greatly from one another in technological progress, including the rate of progress and the sources of innovation.[101] It is well accepted among economists that technological opportunity—the ease and inexpensiveness with which new innovation can be pursued—differs from industry to industry.[102] Because of this, the

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of inventing firms have finite lifetimes, an infinite patent provides no more incentive that a patent that lasts approximately 100 to 200 years. This conclusion follows from theoretical evolutionary biology. Please see the Appendix for a fuller explanation.

101. *See* Pari Patel and Keith Pavitt, *Patterns of Technological Activity: Their Measurement and Interpretation*, in Handbook of the Economics of Innovation and Technological Change 15, 33 (1995).

102. *See* Wesley Cohen, *Empirical Studies of Innovative Activity*, in Handbook of the Economics of Innovation and Technological Change 183, 214 (1995). *See also* Ashish Arora et al., "R&D, Knowledge Spillovers, and Competitions among Firms with Asymmetric

patent system will have different incentive effects in different industries.[103] Incidental to empirical economic work, some scholars have suggested that evaluation of the patent system ought to be done on an industry-by-industry basis. These investigating economists have usually used SIC codes—standardized industrial classifications—to define these industries. Because there is economic evidence to suggest that there is considerable variation in the characteristics of innovation from one industry to another, industrial categories have considerable appeal.

Unfortunately, there is a substantial amount of variation within broad industry classifications. Starting, however, from an arbitrary 20-year duration for basically all categories of invention, any division into sensible categories, no matter how large, would still tend toward better economic efficiency.

Aside from industrial sectors, there are other possibilities for categories. The U.S. Patent & Trademark Office uses a six-digit class / subclass scheme to catalog all inventions in order to facilitate future searches for anticipatory prior art during the examination process. Using this cataloging system, or something similarly complex, as a basis for varying patent durations would provide a much sharper economic stylus than SIC categories would. A new antibiotic, a new pain reliever, and an improvement in microencapsulation technique for oral drug delivery are all pharmaceutical-industry inventions, but they all have very different markets and therefore would presumably have different ideal incentive structures. This variation in incentives, of course, indicates that differential patent durations across these categories would be beneficial. One should note that, unfortunately, the TRIPs agreement forbids *reducing* patent protection based on fields of technology. Therefore, reforms of this type would require modification of TRIPs.[104] There is no barrier, however, to *extending* protection for certain categories of inventions.

iii. Empirical Research

There has been substantial empirical economic research into the effectiveness of patents in allowing firms to appropriate returns from

Technological Capabilities," HEINZ SCHOOL OF MANAGEMENT WORKING PAPER, *available at* http://www.heinz.cmu.edu/wpapers/detail.jsp?id=131 (last visited Jan. 8, 2006) (explaining how the different dynamics of knowledge spillover among industries affects the incentives those industries have to innovate).

103. *See* Robert P. Merges, *Intellectual Property in Higher Life Forms: The Patent System and Controversial Technologies*, 47 MD. L. REV. 1051, 1057-58 (1988).

104. *See* Mossinghoff & Kuo, *supra* note 41 at 538.

their R&D investments, as well as into inter-industry differences in innovation.[105] Multiple empirical studies have confirmed that patents are highly effective in appropriating returns in only certain industries.[106] This kind of data, however, provides only part of the equation. As was illustrated with the above-discussed economic models, optimization of the patent system requires information on social welfare loss from monopoly pricing, as well as information on what constitutes the inducement threshold—the bare minimum amount of protection required to cause the firm to produce the desired innovation. Because of these limitations, current empirical data does not match up with theoretical models to provide a complete toolkit for making prescriptions about patent life.

Richard C. Levin and others have conducted considerable research on the effectiveness of patents in various industries.[107] In presenting their data, they have urged that patent policy be scrutinized on an industry-by-industry basis.[108] While robust in terms of the breadth and depth of the sample, Levin's research is limited in that it only provides a picture of how effective patents are for firms seeking to appropriate maximum returns on their R&D investments.

At least in serving the purposes of prescribing differential patent durations, there are some serious shortcomings in the empirical research conducted thus far. First, the research concentrates on the effectiveness of patents in appropriating returns on R&D, which, although substantially related to incentives to innovate, is not identical. This is the case first because past returns on R&D are only one factor for determining the desirability of undertaking certain R&D. Other factors may include perceived differences in future returns and reasons for getting patents other than appropriation of R&D. Therefore, incentives and appropriability can diverge.[109] Second, and more importantly, incentives are only one side of the patent policy equation; the other issue is the loss to social welfare caused by the monopoly pricing and deadweight loss.

105. *See generally* Cohen, *supra* note 102, at 226.

106. *See* Levin, *supra* note 27; Mansfield, *supra* note 43; *see also* Cohen, *supra* note 102.

107. *See* Levin, *supra* note 27.

108. *See id.* at 816.

109. These can include entry to foreign markets and evaluation of inventive-employee performance. *See* Mansfield, *supra* note 43, at 176.

iv. Models, Categories, and Empirical Research Considered Together

At this time there exists no model, appropriate categories, and empirical data that will all work together to provide a complete solution to finding optimal durations for patents. We must either wait for the day when academic economists will make advancements on the empirical or theoretical fronts that will allow a complete solution, or we must look outside of academia for a real-world process that will compile and synthesize the information for us.

C. Procedural Prescriptions for Finding Appropriate Durations

Surrendering, for the time being, the battle for a combination of empirical data and theoretical modeling that would provide substantive answers, there is promise in investigating the feasibility of a decision-making paradigm that will do that work for us. Such a system needs not only some guarantee of accuracy, but also credibility and political strength in order to be effective. There are a number of possibilities for such a system, many of which could be combined with others. The list below is not meant to be exhaustive, but is meant instead to highlight certain points along a spectrum of procedural schemes.

i. Legislative Democratic Process

We could open up the matter of patent durations to Congress (or other legislatures in other countries), who, through normal means of assignment to committee and public hearings, could create categories of invention and prescribe durations for them.[110] This is unlikely to happen, as Congress ordinarily tries to avoid such regulatory fine-tuning, preferring instead to delegate that responsibility to administrative agencies. Additionally, direct congressional action would also be undesirable because, given the economic characteristics of the problem, Congress is highly likely to come up with the wrong result.

Congress is good at creating compromises among political power interests. Not all the players in an optimal patent system, however, would come to Washington to testify before Congress, and even if they did, many would be crippled in terms of credibility. The public at large and consumers of various innovation products bear the brunt of

110. *Cf.* Partnoy, *supra* note 89, at 29-33 (discussing Congress setting different durations for different industries).

patent-protected monopoly pricing, so the interests of society as a whole are likely to lose out to special interests on Capitol Hill who are armed with considerable lobbying power. Without sufficient input representing consumers of innovation and society at large, the democratic process is likely to prescribe more protection than is efficient for overall welfare. Rich clients can hire the best lobbyists—and the best lobbyists often can bend the law to the desire of their clients.

Furthermore, there is likely to be an imbalance in the kinds of firms that would involve themselves in the lobbying effort. Established R&D-intensive firms are likely to be on the first plane to Washington, pushing for higher levels of protection to increase the returns on their R&D investments.

Unlikely to be heard are market entrants, a category that includes both established firms coming from other industries and entrepreneurial start-up ventures. These waiting-in-the-wings competitors may have an important effect on prices and competition—even before these competitors fully materialize. Yet in their inchoate state they will not, of course, be able to wage much of a lobbying effort. Entrants may be interested either in shorter or longer periods of patent duration, depending on their circumstances. In some situations, patents may be used by established firms to prevent start-ups and other entrants from competing. Start-up ventures, however, may have a special interest in patent protection for themselves, because the other tools for appropriating returns from R&D, such as investments in sales-and-service efforts and quick ramping up for production to ensure lead time, may not be available to cash-poor start-ups.[111]

Occupying a space between established R&D-intensive firms and unmaterialized start-ups is the category of companies that are not originators of R&D, but are instead skilled absorbers of it.[112] These firms, existing in large numbers outside the United States, can specialize in copying successful electronics or pharmaceutical designs. They serve an important function in taking a growth-oriented leading-edge technology and turning it into a commodity with lower margins, thus providing greater accessibility to consumers. Commodity-oriented copying enterprises are also likely to be underrepresented in terms of Capitol Hill power.

111. *See* Levin, *supra* note 27, at 797.

112. *See* Cohen, *supra* note 102, at 230.

Potentially offsetting the lack of lobbying from firms in weaker positions could be the existence of a collective-action problem for established industry players, since spending money on lobbying, at least in this instance, is money spent helping an entire industrial sector, including one's competitors. This would probably not be a problem for oligopolistic sectors where relatively few multi-national corporations control the market—such as with oil or pharmaceuticals. The benefits accruing to individual companies would be so high, and the costs of lobbying so low, that all oligopoly players would likely participate.

ii. Administrative Lawmaking

National legislatures could delegate the determination of patent durations and the boundaries of categories to a politically insulated administrative lawmaking process. The advantages of this method would be that the agency would be less affected by the political power-imbalance between large R&D firms on one hand and consumers and R&D-absorbing firms on the other hand. Even then, however, the agency would have limited information upon which to make decisions about what the patent duration should be. As discussed, there are substantial shortcomings in current modeling and empirical research for custom tailoring patent durations. That being said, the agency might be able to adjust the patent term for some industries or categories of invention up or down in a relative sense, for which the models do seem to provide some basis.

The agency could and would, of course, hear public comment from interested parties. The above-noted problems in bringing some key players into the process, however, would persist. One possible solution would be to hire management consultants and lawyers to represent the interests of absent parties—that is, the consuming public at large, market entrants, and commoditizing R&D-absorbing firms. Entrepreneurial firms might be well-represented by the venture-capital industry, but because venture capital can be very spread out, there are collective action problems associated with VC firms spending significant time negotiating on behalf of future clients.

iii. Trade Consortia and Negotiated Patent Durations

Traditional law-and-economics theory tells us that if we get the interested parties into negotiation with one another, and there are no interfering conditions such as information disadvantages and irrational negotiating behavior, then we ought to reach an optimal

result. Could we do the same for patent durations? If the patent categories were set in advance, then the trick would be getting all the affected actors to the negotiating table.[113]

This negotiation process would have problems similar to those faced by legislative or administrative lawmaking processes. With many inventions, an entire chain of consumers might be represented by the first consumer in the distribution chain after the patent holder. For instance, if the invention were an improvement in hard-drive read-write heads, then manufacturers of hard drives could represent customers further down in the distribution chain. Getting representatives for entrants is a more difficult problem, but the "hired guns" approach of bringing in consultants and lawyers might work here as well.[114]

iv. Presumptions and Burden-Setting in an Adversarial Proceeding

Rather than attempting to gather together all the voices necessary for prescribing optimal patent durations, we might instead set out categories of inventions and a schedule for reducing their attendant durations. We could then allow companies in various industries to come forward to a court or administrative agency and meet a burden of proof for showing why such industries need elevated protection in order to produce a desirable amount of innovation while minimizing the loss to social welfare. Such petitioners could also pursue higher durations than the original 20 years. The benefits of such a scheme are that it avoids the *ex ante* need to evaluate all categories for optimal terms, and it puts the burden of proof on the affected industry, which has access to the raw empirical data that could make the case for longer patent durations. Scholarly studies attempting to collect empirical data face the difficult task of convincing busy executives to spend time and money compiling data without any direct benefit to the firms for which those executives work. With the incentive of gaining direct benefits, these firms would produce much better information if they were required to establish a case to overcome a burden of proof.

There could be a collective-action problem with regard to this system as well, since the litigation expenses of one company would

113. *Cf.* J.H. Reichman, *Legal Hybrids Between the Patent and Copyright Paradigms*, 94 COLUM. L. REV. 2432, 2545 (1994).

114. *Cf.* Partnoy, *supra* note 89 at 33-35 (discussing a voting system in which market participants would vote on patent length).

pay for the potential increase in patent duration for the entire industry. A simple way to fix this would be to reimburse the expenses of challenging companies through an increase in patent fees for that sector.

Of course, raising patent durations beyond the optimal level causes social welfare loss even though the innovating firms themselves would continue to benefit. For this reason, the petitioners should be opposed by some kind of government-counsel adversary who opposes cases in the same way one would in an ordinary case before a court, including using discovery tools such as depositions and subpoenas for documents. If the petitioners were required to plead a specific duration, then the judge or agency hearing the petition could either decide for or against that duration, rather than being required to sort through the evidence to determine the proper duration. This pleading requirement would encourage petitioners not to overreach in their requests for longer durations. More importantly, this system would force the industry to do the analysis on optimal duration; thus, this scheme would match the incentive to do the analytical work with the holders of the data needed for the analysis.

An important problem with this process is that it may leave out inventors in politically and financially weak industrial sectors. These may be the industries where market inefficiencies are causing the greatest problems, and thus those industries with the greatest need for increased incentives for innovation. The presumptive lowering of patent durations in the absence of action would further weaken these already weak sectors. A separate organization of government counsel could be created to be a defender for innovators so situated.

v. Automatic or Semi-Automatic Algorithmic Systems

It might be possible to devise a system of entering information about innovation activity, patent effectiveness, incentives, and loss to social welfare into an algorithm or economic model, which could then prescribe the correct patent duration on an ongoing basis. The results could either directly vary patent protection or could be presented to a committee that would scrutinize the results and tinker with the suggested prescriptions based on public comment.

At first glance, such a system has all the problems discussed in connection with attempting to substantively prescribe patent durations based on academic study. The potentially greater promise here, however, is incorporating the required information-gathering into the system. For instance, many patent holders are stockholder

corporations that are required to file periodic financial statements with the Securities & Exchange Commission. Those reporting requirements could be amended so that firms with patents had to disclose those patents and the earnings and R&D expenditures associated with them. This kind of information is not readily available now. Currently, the financial statements of IP-intensive companies often provide little or no information about the value of their intellectual assets—despite the clear importance of this data.[115] Indeed, firms might help themselves by endeavoring to better understand the value of their patents and other intellectual property.[116] If companies should be doing a better job of analyzing and collecting information about the returns from R&D for the benefit of themselves and their investors, it would be a fair imposition to require companies to keep such records for purposes of government-mandated reporting.

Another potential government-mandated reporting requirement that would provide information for economic models would be to require patent holders to register the sale, terms, and amount—under seal, of course—of all transfers and licenses of U.S. patents with the Patent & Trademark Office or some other administrative agency. Using the government to coerce the collection of this information into a database could allow the creation of working economic models that academic economists would never be able to build through mere precatory requests for companies to hand over information about their internal economic calculus of innovation.

Less ambitious than scrapping the 20-year term and starting over again would be to use the 20-year term as a starting point, then apply economic modeling and empirical information generated from government-mandated reporting combined with general macroeconomic data to find over-rewarded and under-rewarded sectors of innovation. Such information might identify the optimal level of innovation in a certain category of invention and show whether the current level of innovative activity is above or below that optimal level. Given this value, some administrative mechanism, perhaps an automatic one not requiring the input of any administrative

115. *See* Gavin Clarkson & Lynda M. Applegate, *Intellectual Asset Valuation*, HARVARD BUSINESS SCHOOL PUB. NO. 801-192 (2000) at 1.

116. Clarkson and Applegate discuss industry's reliance on rules of thumb for determining royalties rather than use of significant quantitative analysis to determine what the innovation is actually worth. Using rules of thumb, Clarkson and Applegate write, licensors could wind up "leaving money on the table," or licensees could overpay, making them worse off than if they had not licensed the technology at all. *Id.* at 5.

decision-makers, could slowly adjust the duration of patents up or down until the desired level is reached.

Regardless of modeling and inputs, the system could be tempered with maximum and minimum terms set by law and could be set up in such a way that change in durations of patents would be slow, so as not to shock any industrial sectors. Perhaps durations could change by no more than one year on an annual basis.

The changes could come in two varieties. First, and most intuitively fair, adjustments to patent duration would be only for yet-to-be-issued patents, such that a patent issued for 22 years would stay that way permanently, with no duration adjustments made post-issuance. This *ex ante* perspective makes sense if patents are primarily a tool for incentivizing innovation, rather than a means for justly compensating innovating firms for their labors. One could propose, however, that patent-category durations be determined *ex post*. For example, a patent originally issued with a term of 20 years could, depending on economic and financial data collected after issuance, be terminated after only 19 years. This offers the possibility of stemming loss of social welfare more rapidly by ending monopolies earlier. It does, however, introduce a risk element that is new to R&D sectors. More worrisome, an *ex post* manipulation of the term would have the undesirable effect of punishing an industry for doing well: If there is a tremendous amount of innovation, the system would shorten patent durations in order to distribute the social welfare surplus. Under such a rubric, the best position for a firm to be in would be the lone successful innovator in a slumping R&D sector, reaping a higher-than-required reward for the innovation it has undertaken. This effect might actually be beneficial in beckoning entrants to underperforming sectors.

CONCLUSIONS

The patent system may or may not be the best way to provide incentives for innovation, but since patent appears to be a necessary component of the optimal incentive scheme, it rightly deserves the attention of scholars in providing proposals for how to increase its beneficial effects and decrease its disadvantages.

The ad hoc manipulations suggested by this paper show considerable promise for improving the current patent system. Although finding the optimal duration for patents and the optimal categories in which to place them is currently beyond the capabilities of economists, the ad hoc reforms discussed above could create a net

gain in societal welfare by taking into account effects of globalization and macroeconomic variables.

In searching for absolute values, economists have failed to provide the models and empirical data that could work together to create substantive prescriptions for absolute values of patent durations. Since achieving optimal or near-optimal patent duration is an important and worthy goal, however, we should consider delegating this task to some carefully thought-out system that can use a reliable procedure to come up with better solutions than the current 20-year term. Among those reviewed here, the presumption / burden-setting method would be the easiest and simplest to implement. The trade-consortia / negotiation method offers promise for a more comprehensive solution, which could be tried alongside or as a replacement for a presumption / burden-setting method. Finally, an automatic / algorithmic system holds even more promise, but would require better information than we currently have. Compelling the gathering and disclosure of that information as a condition of patent protection could provide the necessary data to create automatic / algorithmic systems. A system of manipulating patents in a relativistic way—either up or down from the current duration—offers a solidly assured means of making the patent system better than it is, even if such a system falls short of achieving an ideal solution.

Patents are our greatest legal effort for fueling technological progress and creating wealth so as to attain higher standards of living. Yet the patent regime has been the subject of little innovation itself. The potential reward for the global economy in increased technological innovation and human progress is very high. We therefore ought to vigorously explore transforming the existing patent system into a more complex and sophisticated engine of economic growth.

APPENDIX: BIOLOGY AND ECONOMIC INCENTIVE HORIZONS

The application of theoretical biology suggests that infinite or very long patent lifetimes would not have any greater incentive effect than finite patents with a duration beyond a certain horizon, which I would estimate to be roughly in the neighborhood of 100 to 200 years.[117] The same is true for copyright.[118]

To begin with, note that the vast majority of intellectual-property creation and property ownership is reducible to actual living persons, and people, of course, do not live forever. Although corporations are potentially eternal in duration, their stockholders are natural persons, all of whom will die at some point. Trusts and non-profit corporations *can* be said to have infinite lifetimes that are irreducible to natural lives, but we will assume that their stock ownership in innovating firms is minimal.[119]

Of course, future royalties can be bargained away for lump-sum cash payments—as anyone watching commercials on late-night cable television is likely to know. But the net present value of royalties earned far in the future is, of course, virtually worthless in the present. Even a billion dollars in royalties captured 200 years from now would be worth pocket change today.

But inventors and artists may be interested in more than a monetary gain for themselves. What about passing patents and copyrights along as inheritance? Certainly some creators will be motivated to accumulate wealth for their children or, perhaps, for their grandchildren. But looking beyond 200 years, we are in the realm of great-great-great-great-great-grandchildren.[120] Is anyone

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117. *See* Gilbert & Shapiro, *supra* note 92 (suggesting infinite duration). *See also* Partnoy, *supra* note 89, at 20, 25 (suggesting that with high interest rates, an infinite patent duration may be optimal).

118. For an argument that copyright should be capable of being extended indefinitely for reasons other than providing incentives to create, *see* William M. Landes & Richard A. Posner, *Indefinitely Renewable Copyright*, 70 U. CHI. L. REV. 471 (2003).

119. If it turns out, for example, that charitable entities are a significant source of funding for research and development leading to patents the charitable entity will own, then it is at least plausible that a board of trustees might make be induced to make a decision about funding research based on the promise of endless returns from an infinite patent.

120. Assuming an average childbearing age of 30, a person will have a great-great-great-great-great-grandchild at 210 years after his or her own birth, each such descendant being 1/128th related to that person. If the average childbearing age is younger, the descendant will be even more distantly related. If the age is 20, at 200 years there would be great-times-eight-grandchildren, each 1/1024th related to the ancestor. Even if the average childbearing age were much older, for example 50, then at 200 years one's great-great-children would be born, related by 1/16.

likely to be motivated by the potential future existence of these unknown distant relations?

Each parent is exactly 1/2 related to each of his or her children. That is, the child carries half of the genes of each parent. It follows that a grandparent is 1/4 related to each grandchild. Carrying out the math, a person is only 1/128 related to his or her great-great-great-great-great-grandchild.

While biology indicates that people should care about the wealth of those closely related to them in future generations, there are horizons in time beyond which people simply will not be incentivized by accumulation of wealth in progeny. These "horizons" are not hard-and-fast thresholds, but are, instead, indefinite boundaries that are determined by natural selection.

Samuel Clemens, better known under the pen-name Mark Twain, argued before British Parliament and the U.S. Congress for perpetual copyright. But even in doing so, he was compelled to admit that his interests in the duration of his works ended well short of eternity. In testimony before Congress in 1906, Clemens said about the then-proposed term of the life of the author plus 50 years:

> I think that would satisfy any reasonable author, because it would take care of his children. Let the grand-children take care of themselves. That would take care of my daughters, and after that I am not particular. I shall then have long been out of this struggle, independent of it, indifferent to it.[121]

There is not enough space here to provide a thorough explanation of the relevant biological theory as it regards natural selection and altruistic behavior.[122] I will provide only a quick sketch here.

There are two foundational observations to make. First, note that natural selection works on the level of the gene, not the species, group, or individual. This means that genes will spread through an evolving population if they cause the exhibition of a trait that tends to cause the passing on of copies of those genes. Second, note that each individual has a pair of complimentary genes, one from the mother

121. *Arguments Before the Committees on Patents of the Senate and House of Representatives, Conjointly, on S. 6330 and H.R. 19853*, 59th Cong. 116-21 (1906), *reprinted in* Samuel L. Clemens, *Copyright in Perpetuity*, 6 GREEN BAG 109, 110 (2002).

122. For a comprehensive, carefully made case for the biological theory (sometimes called "sociobiology") used for the analysis herein, *see* RICHARD DAWKINS, THE SELFISH GENE (Oxford U. Press 1989).

and one from the father. The chance for passing on any given gene to an offspring is 1/2.

So, for example, assume there is a gene for wanting to feed one's children.[123] This "childcare gene" would be evolutionarily successful, because it would add to the health and, eventually, the reproductive capacity, of individuals who were carrying that gene. Such a gene would, of course, also add to the reproductive capacity of offspring who were not carrying that gene.

Although genes do not have conscious goals, it can be helpful to phrase the explanation as if they did: The childcare gene only has a 50-percent chance of hitting its target. Call this the gene's "wasted effort." This makes the gene less evolutionarily fit than if it could somehow direct the parent to only care for children that had the gene. Because of the structural and functional biology of humans, however, genes tend not to function this way. Nonetheless, the childcare gene would be more successful than alternative genes that coded for an absence of childcare, because the offspring of couples without the gene would be disadvantaged compared to the offspring having a 50-percent chance of holding the gene. Then, inheritors of the childcare gene will care for their own offspring, enhancing the gene's prospects for survival and reproduction.

As noted, a grandparent is exactly 1/4 related to his or her grandchildren. Genes for grandchild-care would also be successful, but such genes would have a "wasted effort" of 75 percent, since only 25 percent of grandchildren, on average, would be carrying the grandchild-care gene.

With great-grandchildren, 1/8 related to each of their great-grandparents, altruistic behavior should be even less. As the genetic relations grow smaller, there will be less and less accompanying altruism. At some point, the relation becomes so attenuated, perhaps at 1/8 or smaller, a gene for altruism toward descendants would cease to provide significant evolutionary advantage. Even without disadvantageous effects, a gene conferring only a slight advantage may be lost in evolutionary noise—the random effects of the environment and the interactions of other genes. In addition, a gene that provided for altruistic behavior toward distant descendants might be evolutionarily unfit if it caused care to be taken away from closer relatives.

123. The "gene" discussed here is an imaginary one for the purposes of a simple model.

The foregoing suggests that intellectual property creators will not care about the financial rewards created by patents and copyrights beyond a certain point in time, perhaps the likely death of their grandchildren. This is because human altruism should not, on the basis of theoretical biology, be expected to extend substantially into the generations beyond. Humans should have a strong desire to help themselves and their children, but not, as explained, their great-great-great-grandchildren.

The exact dividing line is perhaps unknowable, although more careful analysis with reference to scientific data could provide a more specific range. But the principle alone is significant: The human animal cannot be expected to undertake some endeavor or forego something in the present for the promise of helping distant relations. Likewise, the law should not create intellectual property incentives with the vague idea that it perhaps could.

Venturing away from patents and copyrights for the moment, if it were true that people wanted to help their distant descendants, we might expect to see a demand for financial products that could make this happen. People could purchase special savings bonds that matured hundreds of years from now. That way, anyone could use their lunch money to make a great-great-great-great-great-grandchild extremely rich. It seems people would rather eat lunch than give some distant descendant a life of luxury and leisure. By contrast, it is unremarkable that people might work their whole lives to have a modest house on a small plot of land to leave for their children. I think it is fair to say that the intuitive result matches the theoretical conclusion.

Yet there is another, even larger problem with undertaking some endeavor to benefit, for instance, great-great-great-great-great-grandchildren. In a stable population, the average couple will raise an average of two children—each child replacing one parent—for a population that neither grows nor shrinks. If everyone has two children each, then everyone will have four grandchildren, eight great-grandchildren, and—carrying out the math—128 great-great-great-great-great-grandchildren. If all the great-times-five-grandchildren get an equal share of royalties every year, each such share may not be much at all. Publishing royalties on even a moderately successful book would be thinly divided at such a generation.

At some point, the rights become divided up among so many people that they are nearly worthless to any one person. Recent scientific analysis has indicated that all humans alive today may share

a single common ancestor who lived perhaps as recently as 3,500 years ago.[124] If an Adam or Eve had invented the wheel 3,500 years ago, would we really want our share of the royalties? We would pay just as much as we receive. Even more absurd is the case where a long-dead inventor is the ancestor of many, but not all living humans. Suppose that the inventor of crucial improvements in plow design, who lived about 1,000 years ago, was an ancestor of a third of today's world population. Should the other two-thirds of the world pay a surcharge on food to the one-third of the world luckily related to the inventor? More to the point, would any inventor be spurred on to work harder and invent more because of the promise of being the distant progenitor to some lucky fraction of the world's population? The answer is clearly no.

This crude sketch of natural-selection theory shows that it is specious to argue that infinite or very long patent lifetimes or copyright terms will offer any more incentive than relatively short, finite durations.

124. Douglas L. T. Rohde, Steve Olson & Joseph T. Chang, *Modelling the recent common ancestry of all living humans* 431 NATURE 431, 562-66 (2004).