

THE DANGER OF UNDERDEVELOPED PATENT PROSPECTS

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Commentators have long recognized that much of the work of commercializing an invention occurs after a patent issues. They have not recognized, however, that by the time market conditions make commercialization potentially attractive, the remaining patent term might be sufficiently short such that a patentee will not develop an invention to the extent that the patentee would if more patent term remained. This concern about patent underdevelopment provides a counterweight to patent prospect theory, which urges that patents be issued relatively early in the invention process. While the patent system reduces this risk by requiring a substantial degree of achievement before patenting, underdevelopment may still be a problem for some inventions, and in particular, in the field of genomics. A possible solution is a system of patent extension auctions under which a patentee would always be allowed to request such an auction, but could win it only by substantially outbidding third parties. Under such a system, patentees would call for auctions only when the benefits of ownership continuity, and thus of continued patent development, are relatively high.

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INTRODUCTION

Those who possess property for a limited time tend to exercise less care with it than do those who expect to own the property in perpetuity. For example, an individual renting a car may not treat the car as well as one might if one owned it. Similarly, in the real property context, a life tenant has suboptimal incentives to maintain or improve the property while possessing it. Real property law adequately addresses this danger with the doctrine of waste, which requires that “the life tenant exercise[] the ordinary care of a prudent person in preserving and protecting the property” and “commit[] no acts that would permanently injure the remainder interest.”¹ Yet there is one field of property law in which, although temporary ownership is ubiquitous, courts and commentators have ignored the possibility that owners have insufficient incentives to maintain or develop the property right. This field is patent law.²

¹ *Life Estate: Termination Because of Waste*, REAL EST. L. REP., Mar. 1997, at 5, 5 (citing *McIntyre v. Scarbrough*, 471 S.E.2d 199 (Ga. 1996) as providing a useful illustration of the doctrine); see Thomas W. Merrill & Henry E. Smith, *The Property/Contract Interface*, 101 COLUM. L. REV. 773, 822–24 (2001) (discussing the evolution of the law of waste in the landlord-tenant context). I am grateful to John Duffy for first pointing me to the analogy between nondevelopment of patents and waste of real property.

² While some commentators have considered whether intellectual property law may tolerate waste, they have not elaborated on the nature of that waste or recognized that the finite patent term makes the danger of waste particularly severe. See Edwin C. Hettinger, *Justifying Intellectual Property*, 18 PHIL. & PUB. AFF. 31, 42–44 (1989) (noting that the incentive to charge high prices for intellectual property might create waste, but not considering the danger of underdevelopment of the patent right); Justin Hughes, *The Philosophy of Intellectual Property*, 77 GEO. L.J. 287, 328–29 (1988) (noting that patent law may risk waste by not requiring the owner to commercialize the property, but not indicating why such failure to commercialize is a problem); see also *supra* note 1 and accompanying text (discussing the concept of waste).

A patent owner receives a patent only for a limited time, namely a period of twenty years from the date the owner files the patent application.³ Although the issuance of the patent reflects a determination that the patentee has created a new and nonobvious invention,⁴ the receipt of the patent is not the last step in the process of innovation. Instead, the patentee must still commercialize the invention in order to realize profits.⁵ This process might include improving manufacturing technologies or conducting further scientific tests.⁶ Before a full rollout of patented products, the patentee will often perform limited market tests to ensure that commercialization will be profitable.⁷ In fact, even after placing the product on the market, the patentee might still need to undertake marketing and advertising expenditures to inform the public about its benefits.⁸ Like the expenditures that a life tenant might make to improve real property, these expenditures have the potential to improve the value of the property right. Just as a life tenant may refuse to improve the real property in the same way one who owned the remainder interest would, so too might a patentee refuse to undertake commercialization expenses that would maximize the joint interests of the patentee and the public.

Perhaps the problem of patent underdevelopment has received no systematic attention because the problem is less severe in the intellectual property context than in the real property context. Real property often requires continuous maintenance and can benefit from periodic improvements, while intellectual property, once developed and commercialized, does not always require the additional infusion of resources. For example, when a patentee completes the necessary scientific testing of an invention before the patent term expires, the cost of maintaining the knowledge produced by such scientific testing might be negligible. A patent owner who improves owned intellectual property may also receive an additional reward for doing so. For example, when the patentee further advances the patented technology so as to justify the award of an improvement patent, the patent's life is

³ 35 U.S.C. § 154(a)(2) (2000).

⁴ See *id.* § 103(a).

⁵ See generally F. Scott Kieff, *IP Transactions: On the Theory & Practice of Commercializing Innovation*, 42 HOUS. L. REV. 727 (2005) (considering the implications of new institutional economics on the commercialization of innovation).

⁶ See, e.g., *id.* at 735, 752.

⁷ See *infra* Part I.A.1; Part II.B.1–2.

⁸ See *infra* Part II.B.3.

effectively prolonged.⁹ To the extent that this is the case, patent underdevelopment does not pose substantial concerns.¹⁰

It would be a mistake, however, to conclude that the design of a patent system is irrelevant to patent underdevelopment. First, if patent underdevelopment rarely occurs, it may be because the patent system already includes protections that help alleviate the problem of underdevelopment. Some patent systems explicitly penalize nondevelopment, for example, by imposing compulsory licensing when a patentee fails to take active steps to commercialize an invention.¹¹ While the United States does not adhere to this approach, the structure of its patent system indirectly limits patent underdevelopment. In particular, since U.S. patent law imposes nontrivial prerequisites before an innovator can obtain a patent,¹² an inventor ordinarily will have already made substantial investments. As a result, completing the innovation process will require less money than if major inventive challenges remained after a patent issues. In turn, a patentee will be less likely to decide that it is not worthwhile to spend the remaining, relatively smaller amount necessary to commercialize the patent. This observation suggests that proposals to grant patents based on only a small degree of inventive efforts may be flawed and thus provides a counterweight to Edmund Kitch's famous "prospect theory" of patent law.¹³

Second, even if patent underdevelopment is rare, it might still pose great concerns within particular technological fields. Even when the patent system does not directly protect commercialization activi-

⁹ See 35 U.S.C. § 101 (allowing patents for "new and useful improvement[s]" of inventions). See generally Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989, 1000–13 (1997) (outlining patent law's approach to improvements).

¹⁰ But see *infra* Part II.C (suggesting that the finiteness of a patent term might suboptimally reduce patentees' incentives to make improvements—even patentable improvements—to their inventions).

¹¹ European law permits compulsory licensing when a patentee has abandoned an invention. See Ronald E. Myrick, *Influences Affecting the Licensing of Rights in a Unitary European Market*, 4 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 81, 95–96 (1993). Requiring outright abandonment to punish underdevelopment makes sense because such a binary test does not require courts to determine what constitutes "underdevelopment." For an argument that patent rights should not be surrendered even when a patentee fails to practice the underlying invention, see F. Scott Kieff, *Coordination, Property, and Intellectual Property: An Unconventional Approach to Anticompetitive Effects and Downstream Access*, 56 EMORY L.J. 327, 426–27 (2006).

¹² See, e.g., 35 U.S.C. §§ 101–103 (delineating the requirements for patenting inventions in the United States).

¹³ See Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 266 (1977). For a brief statement of the prospect theory and an overview of its criticisms, see A. Samuel Oddi, *Un-Unified Economic Theories of Patents—The Not-Quite-Holy Grail*, 71 NOTRE DAME L. REV. 267, 281–82 (1996).

ties, it may provide a long enough term for development to occur.¹⁴ However, it often will be in the patentee's interest to delay commercial implementation until relatively late in the patent term. Indeed, Kitch observed long delays between the initial issuance of a patent and the eventual commercialization of the patented technology.¹⁵ This observation builds on Yoram Barzel's theory that permitting patentees to delay an invention may increase private and social welfare.¹⁶ Although Barzel recognized that delay may also have costs,¹⁷ neither Barzel nor Kitch recognized the possibility that long delays before commercialization increase the risk of underdevelopment, or even nondevelopment, of patents. The patent system encourages delay when it grants patents on mere "prospects" before commercialization activity is economical. By the time a patent would be worth exploiting, a patentee in a system with finite patent terms might expect to recover too small a portion of development costs to justify seeking a patent.

At first, the problem of patent underdevelopment might appear to be only a temporary obstacle—if only a few years of patent term remain by the time a patent is worth exploiting, there is the consolation that the patent will soon fall into the public domain. However, the prospect of an invention falling into the public domain actually suggests that the problem of underdevelopment is more serious in the patent context than in the real property context. While a life tenant can negotiate with the owner of the remainder interest, with the former agreeing to improve or maintain the property given some contribution from the latter, similar negotiations are not possible for a patent owner facing a patent term that is soon to expire. It is impossible to accommodate the interests of all entrepreneurs who might later like to commercialize the patent¹⁸ or, moreover, the end users who might benefit from development during the patent term. Indeed, because of the potential for free riding, each person who might benefit from development of the patent during the patent term will have little incentive to contribute to the patentee's present development efforts.

Moreover, the eventual placement of a patent in the public domain does not guarantee that it will be developed. Suppose, for example, that scientific testing is needed to determine whether

¹⁴ Even Kitch assumes that there generally will be sufficient patent term for commercializing an invention. See Kitch, *supra* note 13, at 284–85.

¹⁵ See *id.* at 272 (listing numerous inventions' patent and commercialization dates).

¹⁶ See Yoram Barzel, *Optimal Timing of Innovations*, 50 REV. ECON. & STAT. 348 (1968).

¹⁷ *Id.* at 348, 354–55 (noting that invention might occur inefficiently late because an inventor cannot capture the full social benefit of an invention).

¹⁸ Each entrepreneur hoping to sell or improve the patented product after the patent term will have an incentive to free ride on the patentee's development activities and on any subsidy to the patentee provided by other similarly situated entrepreneurs.

commercialization of a patented invention would be feasible. With the patent in the public domain, any private party desiring to perform such scientific testing must also consider the possibility that third parties will free ride on the information its tests produce. If such testing produces only information but not an invention that itself can be patented, private actors will have little incentive to invest in it; they will anticipate that if the scientific testing indicates that the product will be successful, other competitors will also enter the market. The same argument applies to commercial experiments, such as market tests that assess public demand for the invention or for products that might incorporate the patented invention. Although inventors can keep the results of marketing tests secret, competitors might still be able to obtain enough information about sales and public demand to determine whether to enter markets themselves after the original patent term expires. Thus, incentives to experiment at all, whether scientifically or commercially, decrease toward the end of the patent term.

Sometimes, of course, first-mover advantages alone will suffice to spur the development of technologies.¹⁹ But when such advantages, even in combination with the remaining patent term, are insufficient to motivate a patentee, third parties might also be unwilling to bear the expense of commercialization after the patent expires. In other words, if the patentee does not believe that the value of the existing patent term is worth the expense of development and commercialization, it is unlikely that other possible developers would find the expense justified, unless one possesses some advantage in commercialization over the patentee and is unable to bargain successfully with the patentee during the patent term. As a result, the development of some inventions that would be commercialized with a longer patent term might be diminished or delayed.

How significant is the problem of patent underdevelopment? Because our patent system is actually not much of a prospect system,²⁰ the problem will likely pose concerns for only a minority of patents—particularly embryonic patents, i.e., patents on inventions that still need a great deal of development. Moreover, whether the problem

¹⁹ See generally William T. Robinson et al., *First-Mover Advantages from Pioneering New Markets: A Survey of Empirical Evidence*, 9 REV. INDUS. ORG. 1 (1994) (providing an overview of the econometric literature analyzing the extent of first-mover advantages). More recent work has emphasized the possibility that first movers may suffer from some systematic disadvantages. See generally Marvin B. Lieberman & David B. Montgomery, *First-Mover (Dis)Advantages: Retrospective and Link with the Resource-Based View*, 19 STRATEGIC MGMT. J. 1111 (1998) (summarizing the existing literature and research theories discussing first-mover advantages). For a discussion of the implication of first-mover disadvantages for the patent system, see F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. REV. 697, 708–09 (2001), which notes that second movers often benefit from a first mover's success.

²⁰ See *supra* notes 12–13 and accompanying text.

will affect a particular patent turns on a variety of factors. The danger of patent underdevelopment will be less severe where the costs of developing a patent after issuance are low. The risk will also be lower where initial requirements for obtaining a patent are more rigorous since the patentee will be less likely to abandon the project after already making the required substantial investment.²¹ At the other extreme, patents on gene sequences and other embryonic inventions may come at such an early stage in the research process that patent underdevelopment is of great concern. Patent nondevelopment will also be more problematic when the estimates of the value of a commercialized patented product are more uncertain and volatile. When a particular patent will prove worthless absent the occurrence of some contingency that can make the patented invention extremely valuable, such as the development of other technologies for which the patented invention would be a complement, an inventor's incentive is to patent early and wait to see whether the contingency occurs before sinking substantial development costs into the patent.

Because the underdevelopment problem applies only to a subset of patents, any solution must carefully target such cases, lest the cure be worse than the disease. One possible solution to underdevelopment is authorizing patent extensions. Patent extensions would reduce underdevelopment because a patentee considering investments during the original patent term would be able to realize the benefits of the investment during the extension period. However, legislatively authorizing individual extensions to patent terms likely will not identify the patents for which the social benefits of such extensions exceed their costs. Granting an administrative authority the power to increase patent terms selectively would encourage considerable rent seeking, since all patentees would claim that they would invest far more with a patent extension than without. Indeed, patentees might have a perverse incentive to limit investment early in the patent term in the hope of persuading the agency that much commercialization work remained and that, therefore, an extension is warranted. Consequently, an adequate solution must limit the possibility that patentees could receive windfalls from patent extensions in order to curtail such perverse incentives.

In light of these considerations, auction mechanisms form a promising solution. Auctions limit the windfalls that private parties can obtain from governmentally granted property rights. Carefully designing the structure of the auction and the rules governing availability of auctions could limit patent extensions to those cases in which

²¹ Requiring commercialization before an inventor can obtain a patent could greatly reduce this problem, but such requirements would produce considerable costs. See *infra* Part I.B.2 (illustrating the benefit of granting patents at a relatively early stage).

patent underdevelopment is a significant concern. This Article proposes a possible design for patent extension auctions that would limit their use to those fields where underdevelopment seems likely. In this system, a patentee could request an auction for a patent extension before the end of a patent term. To keep the patent, however, the patentee would have to top the bid of the highest third-party bidder by a substantial markup. A patentee who calls for an auction and then loses would be required to pay some penalty. The patentee will thus have an incentive to call for an auction only where the benefits of ownership continuity are relatively large.²² Although this Article does not seek to definitively determine what the markup should be, it offers a back-of-the-envelope calculation suggesting about 25%. Presumably, initial experiments with patent extension auctions would involve much higher markups so that the first extensions granted would be for patents for which the underdevelopment problem is especially severe.

This Article proceeds as follows: Part I will show how combining two recent theoretical perspectives on patent law focusing on opposite ends of the innovation process—one on the time at which patent races begin and one on the period after patents are issued—helps to explain the problem of patent underdevelopment. Part I continues by offering a simulation model that demonstrates both the danger of patent underdevelopment and the way the patent system indirectly combats underdevelopment by requiring significant achievement before patent issuance. Part II offers a tentative empirical assessment of the degree to which the patent underdevelopment problem remains despite the high threshold for patentability. Although it would be difficult to design an empirical test to measure underdevelopment, it is possible to identify the types of patents for which the problem of underdevelopment is likely to be most severe and the types of development activities that patentees, particularly when late in the patent term, may forego. Finally, Part III introduces the proposal for patent extension auctions, considering both the possibility that the government would decide whether to call for a patent extension auction and

²² Additional rules would ensure that a patentee who values the patent far more than third parties but not because of the potential benefits of ownership continuity will not call for an auction. In particular, the auction system would allow a third-party winner at the auction to sell the patent back to the patentee but only at the end of the original patent term. *See infra* Part III.B.2(a). As a result, a third party who recognizes the special value of the patent extension to the patentee would bid the full value of the patent extension to the patentee (ignoring bargaining costs). Anticipating this, the patentee would not call for an auction because, absent some benefit of ownership continuity, the patentee would be unable to pay a profitable markup above the third party's bid. However, a third party will not factor the benefit of ownership continuity into its bid because the rule preventing sale during the patent term will prevent the third party and the patentee from reaching an agreement guaranteeing such continuity.

the proposal outlined above in which a patentee has the discretion to demand an auction.

I

A THEORETICAL MODEL

Underdevelopment occurs when a patentee decides not to invest in development expenses that the patentee would have undertaken had there been a longer patent term. To simplify the analysis, this Part will focus on the most extreme form of patent underdevelopment: patent nondevelopment. This occurs when a patentee decides to abandon a patent that the patentee would have commercialized if longer patent protection were available. To assess the theoretical danger of patent nondevelopment, however, one must more thoroughly examine the patent process and determine how such a situation might arise. At least two questions ground this inquiry: First, why would a patentee decline to undertake the relevant development expenses earlier in the patent term? Second, looking still further back in time, why would a patentee create the invention and apply for the patent so long before development is feasible?

Each of two recent theoretical works can provide answers to one of these questions, but a complete understanding of the patent underdevelopment problem combines insights from both. The first question finds a straightforward answer in Shaun Martin and Frank Partnoy's "Patents as Options" theory.²³ Martin and Partnoy recognize that a patent provides its holder a series of options, including a litigation option (should a third party arguably infringe the patent) and a development option to commercialize the invention.²⁴ An uncommercialized patent is simply a patent whose development option has not been exercised. John Duffy addresses the second question by analogizing the patent process to an auction in which the inventor who agrees to spend money on inventing earliest wins the right to the patent.²⁵ Thus, inventors might need to engage in inventive activity and seek patents well before commercialization is possible, lest they lose the patent race.²⁶ Combining these insights, competition among

²³ Because Martin and Partnoy have not yet released the paper in which they develop this theory, the summary given here is based on a presentation they gave at Washington University on November 4, 2005. See Video recording: Presentation by Shaun Martin & Frank Partnoy at Conference on Commercializing Innovation, held by Washington University School of Law, Center for Research on Innovation & Entrepreneurship (Nov. 4, 2005) [hereinafter Martin & Partnoy Presentation] (available at <http://law.wustl.edu/CRIE/videos/CI11.4-5.06/03martinpartnoy.ram>).

²⁴ See *id.*

²⁵ See John F. Duffy, *Rethinking the Prospect Theory of Patents*, 71 U. CHI. L. REV. 439, 445 (2004).

²⁶ See *id.*

inventors forces patenting at an early stage—often so early, in fact, that patentees are unsure whether exercising the patent’s development option will ever be worthwhile.

This analysis can help answer a longstanding puzzle about the patent system: why so many patents go unlicensed and thus appear to be worthless.²⁷ While a partial answer to the puzzle is likely that patent acquisition serves a signaling function,²⁸ that might not be the entire story.²⁹ Perhaps an additional answer is that many patentees obtain patents for their option value and then frequently fail to develop the patents due to lack of profitability under the limited patent grant.³⁰ This possibility is disturbing not only because the patent process itself is expensive,³¹ but also because of the possibilities of nondevelopment or underdevelopment of an invention. Though one might assume that uncommercialized patents are not worth commercializing, and thus that the private loss associated with worthless patents is of relatively little social significance, it is only truly safe to assume that uncommercialized patents are not worth commercializing *given the limited patent grant*. If patentees abandon patent rights when term extensions would lead to commercialization—and thus to both private and social benefits—then the patent system may be failing to optimize social welfare compared to a system in which it would be more difficult to obtain patents when the possibility of commercialization is uncertain.

²⁷ Mark Lemley roughly estimates that only about five percent of issued patents are ever licensed. Mark A. Lemley, Essay, *Rational Ignorance at the Patent Office*, 95 Nw. U. L. REV. 1495, 1507 (2001).

²⁸ See Clarisa Long, *Patent Signals*, 69 U. CHI. L. REV. 625, 645–46, 648–49 (2002) (arguing that because the number of patents a firm obtains correlates with less measurable attributes of a firm that are of interest to potential investors, firms may even choose to acquire patents with little economic value).

²⁹ For a critique of the signals hypothesis, see Gideon Parchomovsky & R. Polk Wagner, *Patent Portfolios*, 154 U. PA. L. REV. 1, 21–22 (2005).

³⁰ Commentators before Martin and Partnoy likened a patent to a stock option in that it may or may not be exercised or developed. See F. Russell Denton & Paul J. Heald, *Random Walks, Non-Cooperative Games, and the Complex Mathematics of Patent Pricing*, 55 RUTGERS L. REV. 1175, 1194–95 (2003). Commentators have also analogized patents to lottery tickets. See, e.g., Jonathan A. Barney, *A Study of Patent Mortality Rates: Using Statistical Survival Analysis to Rate and Value Patent Assets*, 30 AIPLA Q.J. 317, 328 n.30 (2002); F.M. Scherer, *The Innovation Lottery*, in EXPANDING THE BOUNDARIES OF INTELLECTUAL PROPERTY: INNOVATION POLICY FOR THE KNOWLEDGE SOCIETY 3, 4–7, 15 (Rochelle Cooper Dreyfuss et al. eds., 2001) (observing that patent returns may fit a Pareto distribution, which has a longer and thicker tail than a log normal distribution, and thus that owning large patent portfolios may not entirely diversify risk). Such analogies and observations underscore the conception that patent holders have the option to develop patents as they see fit and may thus choose not to develop the patents at all. These commentators have not, however, noted that the option characteristics of patents may lead to their acquisition at such an early time as to inhibit development within the patent term.

³¹ See Lemley, *supra* note 27, at 1498–99 (estimating the cost of a patent prosecution to be between \$10,000 and \$30,000 per patent).

Part I.A elaborates on these works, and Part I.B reports the result of a simulation that incorporates an insight inherent in the Martin and Partnoy analysis into a numerical example that Duffy employed to illustrate his model. Although neither Martin and Partnoy nor Duffy recognize that our system of finite patent terms produces the danger of patent nondevelopment,³² an appreciation of the central insights of both brings to light that the problem is more worrisome than either analysis taken alone would suggest. While Duffy ignores patent nondevelopment because he assumes that the costs and benefits of patenting are known in advance,³³ Martin and Partnoy do so because they disregard how competition among patent racers may lead to acquisition of patents long before commercialization becomes feasible.³⁴ A dynamic model incorporating uncertainty shows how patent nondevelopment can become a danger and how the patent system can limit this danger.

A. Options and Auctions

1. *Patents as Options*

The central observation underlying the Martin and Partnoy analysis is that the future is always uncertain.³⁵ Someone who owns a patent cannot be sure how profitable commercialization of the patent will be or even how much it will cost to complete the commercialization process. The future, however, tends to become clearer as we move toward it. It therefore sometimes makes sense to wait before irreversibly investing substantial resources in developing a patent whose value is currently uncertain. A central observation of “real options theory”³⁶ is that part of an option’s value is the right to wait for more information about whether the option will be worth exercis-

³² See Duffy, *supra* note 25; Martin & Partnoy Presentation, *supra* note 23. In a subsequent article (written after Duffy read a draft of this Article), Duffy recognizes the nondevelopment problem. See John F. Duffy, Embryonic Patents: Prospects, Prophecies and *Pedis Possessio* (2005) (unpublished manuscript, on file with author). Duffy notes that patent law tries to avoid the problem through the “abandoned experiment” doctrine, which excludes abandoned experiments from the prior art and thus allows others to obtain patents on the technology. See *id.* at 33–35. The doctrine, however, does not apply to a technology that is patented prior to abandonment, and so it does not address the patent nondevelopment problem. Duffy also suggests that patent law might allow a third party to repatent the commercialized realization of an abandoned patented invention. See *id.* at 36–38. As Duffy recognizes, however, “[c]urrent U.S. patent law has no clear doctrine permitting” such repatenting. *Id.* at 36.

³³ See Duffy, *supra* note 25, at 465–66.

³⁴ See Martin & Partnoy Presentation, *supra* note 23.

³⁵ See *id.*

³⁶ See generally REAL OPTIONS AND INVESTMENT UNDER UNCERTAINTY: CLASSICAL READINGS AND RECENT CONTRIBUTIONS (Eduardo S. Schwartz & Lenos Trigeorgis eds., 2001) (containing many important contributions to the field).

ing.³⁷ Indeed, in most contexts, there would be no reason to purchase an option over the underlying asset if it is apparent at the time of the purchase that it will later make sense to exercise the option. Because a patent functions as an option or as a series of options, part of its value lies in the right of the patent owner to wait for the optimal moment to decide whether to exercise those options.³⁸ While such waiting is optimal for the patentee, it increases the risk of patent nondevelopment and may be suboptimal for social welfare.

The increase in value of a patent based on a holder's right to forestall development is substantially due to the possibility of new information about the patent's potential profitability. By waiting an additional year before making a decision to initiate the development process, a patentee loses a year of potential profits but gains the possibility of greater certainty about the potential profitability of commercialization. Suppose, for example, that it will cost \$1 million to commercialize a patent with twenty years remaining and that the patentee believes that there is a 50% chance of a good result—a product worth \$2 million in present discounted value—and a 50% chance of a bad result—a product worth nothing. For simplicity, assume risk neutrality and that each year of the patent term would contribute equally to the present discounted value because revenues will increase in value at the same rate as the discount rate. The decision whether to commercialize appears to be a close one, and if waiting were impossible, the patent would effectively be worth nothing.

Waiting a year to commercialize the patent means that, absent new information, the good result scenario will provide only \$1,900,000 because of the lost year of sales. Suppose, however, that the patentee expects new information to arise in that year of waiting. Further suppose a 50% chance that this information will indicate that the good result is now 60% likely and a 50% chance that this information will indicate that the good result is now 40% likely. Then the patentee should wait. By waiting, the patent has an expected value of $0.5 \times 0.6 \times (\$1,900,000 - \$1,000,000) + 0.5 \times 0.4 \times \$0 = \$270,000$. The right to delay by one period thus increases the expected value of the patent from \$0 to \$270,000.

³⁷ See, e.g., Avinash Dixit, *Investment and Hysteresis*, in REAL OPTIONS AND INVESTMENT UNDER UNCERTAINTY: CLASSICAL READINGS AND RECENT CONTRIBUTIONS, *supra* note 36, at 153, 154; Robert McDonald & Daniel Siegel, *The Value of Waiting to Invest*, in REAL OPTIONS AND INVESTMENT UNDER UNCERTAINTY: CLASSICAL READINGS AND RECENT CONTRIBUTIONS, *supra* note 36, at 253–54.

³⁸ See Martin & Partnoy Presentation, *supra* note 23 (discussing patents as including the options to abandon the patent or delay development). The numerical example in the following paragraph also concretely illustrates how the right to wait until the optimal moment to develop a patent increases a patent's value.

It will rarely be obvious at the time a patent is issued exactly how long the patentee should wait before making a decision about commercialization. At each time period, the patentee will recognize that it may be worth waiting until the next time period before fully developing the patent. In the interim, the patentee might undertake some limited development or experimentation to better assess whether additional tentative steps or full-fledged development efforts are financially justified. It might appear that the finiteness of the patent term would reduce the patentee's incentive to wait relative to a hypothetical world of infinite patent terms; after all, in our own lives, deadlines make us move more quickly. The analogy, however, does not strictly apply. The economic decision to wait an additional time period depends on the possibility that new information might develop compared to the value of lost sales attributable to delay. In the end, a rational patentee will not necessarily hurry because of the finite patent term. Finiteness limits delay only to the extent that confining the patent to a particular term may limit uncertainty.

The finiteness of the patent term, however, does significantly affect the patentee's incentives: it makes it much more likely that the patentee will eventually abandon the patent altogether. As Martin and Partnoy recognize and the numerical example above reinforces, the right to abandon a patent and save the money that would otherwise fund development of that patent increases the value of the patent right.³⁹ Although Martin and Partnoy worry that patentees will sometimes find the litigation option more attractive than the development option,⁴⁰ they do not make the broader point that even absent a right to litigate without developing a patent, the amount of development activity itself might be inadequate from a social welfare perspective. Martin and Partnoy identify solutions that focus on reducing the value of litigation options by increasing the exercise price of those options.⁴¹ For example, a fee-shifting regime for patent litigation might discourage patentees from filing frivolous litigation.⁴² These solutions might be worth considering because the availability of attractive options such as the litigation option reduces the probability that the patentee will exercise the development option. However, one should also consider other approaches to addressing patent nondevelopment.

An alternative approach that might appear sensible would be to increase the length of the original patent term. Patent nondevelopment, after all, is a result of the finite nature of the patent term. With

³⁹ See Martin & Partnoy Presentation, *supra* note 23.

⁴⁰ See *id.*

⁴¹ See *id.*

⁴² See *id.*

an infinite patent term and negligible costs of maintaining a patent, a currently undeveloped patent might prove valuable in the future. Indeed, because economies grow over time, patents with infinite terms should become more valuable over time as well, unless substitutes for the patented technologies are developed in the interim. Therefore, the danger of nondevelopment might appear to produce an argument for systematically longer patent terms than would otherwise be optimal. To assess the potential effects of longer patent terms, we must turn to John Duffy's model of the patent system as an auction, a model that counterintuitively counsels in favor of increasing the patent term even in the absence of a direct concern about patent nondevelopment.⁴³ Ironically, we will see that the concern about patent nondevelopment ultimately complicates Duffy's approach.

2. *Patents as Auctions*

While Martin and Partnoy consider the incentives of inventors who have already received patents, Duffy focuses on the incentives of inventors who race against one another in competition for the patent.⁴⁴ Earlier commentators noted the similarity between races and auctions in contexts including patent law,⁴⁵ but they ignored an aspect of this analogy that is crucial to patent policy. A race, the earlier scholars realized, amounts to an "all-pay" auction in which each participant must pay the amount of its bid at the auction's end, and participants with higher bids have greater chances of winning.⁴⁶ This analysis tends to assume that patent races are like races at track meets in which all racers start only when the gun goes off.⁴⁷ Duffy's insight is that inventors can improve their "bids" and thus their chances of winning the race by committing resources at an earlier time.⁴⁸ The patent race is thus more like a treasure hunt in which each contestant may start at any time, and those who drag themselves out of bed to start the hunt earlier have an advantage over the others. As this hunt would end earlier than one in which the starting time was fixed, so too would a patent race end earlier when participants are welcome to begin racing whenever they please.

⁴³ See Duffy, *supra* note 25, at 493–96.

⁴⁴ See generally *id.* (discussing various theories explaining patent races, their outcomes, and the social utility of the patent system).

⁴⁵ See, e.g., Wolfgang Leininger, *Escalation and Cooperation in Conflict Situations*, 33 J. CONFLICT RESOL. 231, 233 (1989).

⁴⁶ See *id.*; see also Michael R. Baye et al., *Rigging the Lobbying Process: An Application of the All-Pay Auction*, 83 AM. ECON. REV. 289 (1993) (providing an additional application of the all-pay auction model).

⁴⁷ See sources cited *supra* note 46.

⁴⁸ See Duffy, *supra* note 25, at 443–45 (discussing patentees' incentives to invest in patents as early as possible to gain exclusive rights to the invention).

Because the patent term is finite, inventors are racing not only to be the first to obtain a patent but also, in effect, to place the invention into the public domain at the earliest possible time.⁴⁹ As a result, the patent race provides a benefit to society, and because of this Duffy analogizes it to a Demsetzian auction.⁵⁰ In 1968, Harold Demsetz argued that instead of directly regulating the prices monopolists charged and the quality of services they provided, the government might instead hold an auction for the right to be a monopolist and award the franchise to the bidder who commits to the best price-quality package.⁵¹ Similarly, the government awards a patent to one of the inventors who begins the race first,⁵² thus agreeing to commit the invention to the public at the earliest possible time. If the auction is competitive, the Demsetzian approach to monopoly regulation pushes down participants' returns to zero economic profit.⁵³ So too can the implicit patent auction lead inventors to start racing at a point when they will earn no economic profit from doing so.⁵⁴

The model of patents as Demsetzian auctions makes the patent nondevelopment problem more severe. To the extent that patent races push patenting to a very early stage, the risk that it will not be worth exercising the patent development option increases. Duffy does not recognize the danger of patent nondevelopment because he assumes that the costs and benefits of patenting are certain.⁵⁵ In the absence of uncertainty, an inventor would never expend the substantial resources required to patent an invention and then fail to commercialize it. Uncertainty, however, makes it apparent that patents are options, and so long as there is some chance that the option will be worth exercising, an inventor may have an incentive to seek a patent. Moreover, an inventor will sometimes be willing to enter a patent race very early because of the possibility that an invention will be more valuable than expected.⁵⁶ Thus, an inventor might obtain a patent fully expecting that the patent term will not be long enough to allow

⁴⁹ See *id.* at 493–96.

⁵⁰ See *id.* at 475–80; see also Harold Demsetz, *Why Regulate Utilities?*, 11 J.L. & ECON. 55, 63 (1968).

⁵¹ See Demsetz, *supra* note 50.

⁵² See Duffy, *supra* note 25, at 443–44. Duffy recognizes that research is probabilistic, and in extending his model, he assumes that inventors will only have some probability in each period of successfully meeting the requirements for patentability. See *id.* at 480–83.

⁵³ See *id.* at 477 (“Where patent rights are limited in time, a competition to patent earlier will resemble a Demsetzian auction in that, by trying to be first to patent, the competing inventors are also vying to diminish their rents by placing the patent in the public domain sooner.”).

⁵⁴ See *id.* at 481 (assuming that “firms’ expected profits are zero”).

⁵⁵ See *id.* at 465–66 (making assumptions about the costs and benefits of patenting without allowing for uncertainty).

⁵⁶ See *id.* at 466 (“[P]rivate firms race to capture the rewards implicit in a patent grant. If the rewards are too great . . . then the firms will ‘over-race’ . . .”).

development of the patent, but betting on a small chance that the patent might be worth pursuing within the patent term.

Adding uncertainty to Duffy's model or early patenting to the Martin and Partnoy framework not only makes the patent nondevelopment problem more severe than it would otherwise seem, but also makes an appropriate solution more elusive. Part I.A.1 has already shown that Martin and Partnoy's analysis seems to support a proposal to lengthen patent terms.⁵⁷ Interestingly, in a separate article, Duffy also argues for longer patent terms.⁵⁸ While lengthening the patent term might seem likely to delay the introduction of inventions into the public domain, instead it makes acquiring patents more attractive and thus leads to invention at an earlier time. Under certain assumptions in one of Duffy's mathematical models, this increased incentive effect dominates the delay effect—at least if the lengthening of the patent term is announced early enough to allow patent racers to respond by entering the patent races earlier.⁵⁹ Lengthening the patent term thus leads to inventions being committed to the public domain at an *earlier* time.⁶⁰ Duffy's analysis reverses the ordinary intuition: Longer (but nonretroactive⁶¹) patent terms will not benefit inventors as a class because more will compete and in turn drive down profits, but they will benefit the public because inventions will fall into the public domain sooner.⁶²

Longer patent terms might also appear to alleviate patent nondevelopment, but this is uncertain. If longer patent terms in fact result in patents entering the public domain even earlier, then it may never become worthwhile to exercise a development option that otherwise would have been worth exercising. There are, again, two competing effects. On the one hand, the longer patent term means that if commercialization occurs relatively early, there will be more time periods in which the inventor can reap the benefits of commercialization, and the incentive to exercise the development option at some point before patent expiration will be greater. On the other hand, earlier invention might not mean earlier commercialization, and the effective patent term might be shorter. Assuming that increasing the length of

⁵⁷ See *supra* Part I.A.1.

⁵⁸ See John F. Duffy, A Minimum Optimal Patent Term (Jan. 9, 2003) (unpublished manuscript, available at <http://www.ssrn.com/abstract=354282>) (offering a model suggesting that an optimal patent term is at least as long as the existing patent term).

⁵⁹ See *id.* at 4 ("The increased patent term causes innovation to occur earlier but the change in the time of innovation is less than the increase in patent term.").

⁶⁰ See *id.*

⁶¹ Duffy has argued against providing windfall retroactive term extensions for intellectual property rights. See *infra* note 190 and accompanying text.

⁶² See Duffy, *supra* note 58, at 29–31; Duffy, *supra* note 25, at 494–96.

the patent term only affects the particular invention at issue,⁶³ increasing the length of the original patent term would not change the particular year in which it will make sense to commercialize a patent. But after that year, there will be fewer years remaining in the patent term, and if the longer patent term indeed made the date at which the invention enters the public domain earlier, there will be less incentive to exercise the development option. This story suggests there is a trade-off in a longer patent term, though different from the one between static and dynamic efficiency that scholars have long imagined.⁶⁴ Rather, a longer patent term can lead to some inventions entering the public domain earlier, but it can also lead to a greater number of abandoned inventions. There might well be other, more complicated stories,⁶⁵ but ultimately the welfare effects of systematic patent term extensions appear quite complicated.

B. A Re-Rethinking of Prospect Theory

Even if the problem of patent nondevelopment does not justify a longer patent term, patent term extensions might still be useful on a case-by-case basis if their availability could be limited to those particular patents subject to a risk of nondevelopment. Part III will consider whether this approach is feasible. The combination of the Martin and Partnoy approach⁶⁶ and the Duffy approach,⁶⁷ however, points to a different possible solution: increasing the minimum threshold for patentability and thus decreasing the proportion of commercialization and invention expenditures needed after a patent issues. Though concerned that the patent litigation option might be too attractive in comparison to the patent development option, Martin and Partnoy do not consider this approach, perhaps because they implicitly assume

⁶³ This assumption might be unjustified. For example, it might not make sense to commercialize a particular invention until another, complementary invention is developed. However, increasing the length of the patent term could also lead to earlier development of that invention.

⁶⁴ See generally WILLIAM D. NORDHAUS, *INVENTION, GROWTH, AND WELFARE* 76–86 (1969) (providing the leading account of the competing effects of a longer patent term).

⁶⁵ For instance, if inventors anticipate that they will be unable to commercialize their inventions until a particular date, precisely the opposite result may occur: a reduced risk of nondevelopment, but a delayed introduction of the invention into the public domain. Suppose that it will not be feasible to commercialize a particular invention, not yet created, until the year 2025. Suppose further that under the existing patent system, invention and patenting would occur in 2015, and the patent therefore would expire in 2035. If the patent term is lengthened by five years, but commercialization still cannot occur until 2025, invention will take place no earlier than 2010 with patent expiration still occurring in 2035. Because the invention will likely be more expensive to create in 2010 than in 2015, at least in present discounted value terms, invention is likely to occur after 2010—say, perhaps, in 2011. As a result, the patent will expire in 2036.

⁶⁶ See Martin & Partnoy Presentation, *supra* note 23; *supra* Part I.A.1.

⁶⁷ See Duffy, *supra* note 25; *supra* Part I.A.2.

that the dates of invention and patenting are fixed.⁶⁸ In *Rethinking the Prospect Theory of Patents*, however, Duffy considers the issue directly but ends up offering the opposite recommendation: that patents should be granted at a very early stage when they are mere patent prospects.⁶⁹

Yet, Duffy's recommendation might not be sound once one considers patent nondevelopment, because the prospect approach increases the risk of nondevelopment. A theoretical appreciation of patent nondevelopment is important not only because reforms proposing to combat it could improve the efficiency of the patent system but also because unrelated reforms that fail to recognize nondevelopment could further aggravate the problem. Moreover, the patent system to some extent already takes the nondevelopment concern into account, whether surreptitiously or not, by requiring substantial achievement before issuing patents. Consideration of patent nondevelopment thus provides a richer positive explanation for the patent system's standard of patentability.

To understand how concerns about patent nondevelopment might counsel against the prospect theory, we must first understand how Duffy's recognition that the time of invention is endogenous to the patent system supports the prospect approach.⁷⁰ If obtaining a patent requires only minor inventive efforts, the patent race will be shorter.⁷¹ This means that each participant in the race stands to lose less money if someone else receives the patent.⁷² Inventors will anticipate that the length of the patent race will be shorter and thus that the amount of money sunk by those who lose the patent race will be smaller.⁷³ Thus, the expected cost of racing is lower, and inventors will begin racing earlier than they otherwise would.⁷⁴ This analysis provides an important new defense of the patent prospect approach. Even if, as some commentators have suggested,⁷⁵ inventive activity will develop more rapidly if inventors are racing against one another, it

⁶⁸ See Martin & Partnoy Presentation, *supra* note 23.

⁶⁹ See Duffy, *supra* note 25, at 471–72 (illustrating the thesis).

⁷⁰ See *id.* at 465–75.

⁷¹ See *id.*

⁷² See *id.*

⁷³ See *id.*

⁷⁴ See *id.*

⁷⁵ See, e.g., Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 908 (1990) (“Public policy . . . ought to encourage inventive rivalry, and not hinder it. . . . [A] rivalrous structure surely has its inefficiencies. But such a structure . . . seems a much better social bet than a regime where only one or a few organizations control the development of any given technology.”); see also Mark A. Lemley, *Ex Ante Versus Ex Post Justifications for Intellectual Property*, 71 U. CHI. L. REV. 129, 141–42 (2004) (concluding that the empirical literature supports the proposition that research will progress faster when no initial inventor is able to control it); Tim Wu, *Intellectual Property, Innovation, and Decentralized Decisions*, 92 VA. L. REV. 123, 127–31 (2006) (arguing that de-

still might be useful for patent law to declare winners to races quickly because the promise of a quick end to the race will make the race start earlier. While the original basis of Kitch's prospect theory was that issuing early and broad patents provided useful *ex post* incentives, for example by allowing inventors to better coordinate inventive activity,⁷⁶ Duffy's argument suggests that the prospect approach offers benefits before the patent is issued.⁷⁷

The debate over prospect theory is central to assessing how high the hurdle for patentability ought to be, and Duffy's contribution helps to demonstrate that concerns about wasteful duplication of effort should matter even to those who adhere to the traditional reward approach to patent law. Wasteful duplication matters not only because it suggests that resources are being diverted from other activities, but also because the prospect of such duplication will discourage research in the first place.

Nonetheless, the concern about patent nondevelopment provides a countervailing concern that questions the wisdom of imposing low hurdles for patentability. Imposing minimal requirements for obtaining a patent will decrease both the price of the patent option and the chance that the option will never be exercised. To the extent that the patent system acts as an auction for a reduced patent term, it might advance social welfare by accelerating the entry of an invention into the public domain, but it also might reduce social welfare by increasing the risk that an inventor will not develop or commercialize it.

Duffy's analysis ultimately highlights why nondevelopment of patents might be an even more serious problem than waste in the real property context.⁷⁸ If the patent process functions as a declining-term auction, then effective patent terms might be quite short. Inventors will not seek patents if they know for certain that, by the time they complete development, there will not be sufficient term remaining to allow them to recoup their costs. But, the expected net benefits of development might change after a patent is issued, and a project that initially appeared likely to be profitable might become unprofitable. Moreover, the possibility that the expected net benefits will rise might lead inventors to obtain patents very early for their option value, even when it seems likely that developing them will never be profitable.

centralized decisionmaking, as occurs in the absence of patent protection, might produce more breakthrough inventions).

⁷⁶ See Kitch, *supra* note 13, at 276 (“[A] patent ‘prospect’ increases the efficiency with which investment in innovation can be managed. . . . [T]he patent owner [is] in a position to coordinate the search for technological and market enhancement of the patent’s value so that duplicative investments are not made . . .”).

⁷⁷ See Duffy, *supra* note 25, at 465–75.

⁷⁸ See *supra* note 1 and accompanying text (discussing how real property law addresses the problem of waste).

To make these points more formally, I will begin with a numerical example that Duffy uses to explain his case,⁷⁹ and I will then show how adding uncertainty to the model might alter Duffy's conclusions. In the numerical example, a single firm will obtain a patent during the first year in which obtaining the patent would produce positive rents, recognizing that if it did not incur the costs necessary to obtain the patent in that year, another firm would.⁸⁰ The invention produces social benefits that grow at an annual rate of 5%, reaching \$10 per year in 2010 and higher levels beyond.⁸¹ The cost of the invention is \$100 in the year in which the invention occurs, but continuing with Duffy's numbers, a prospect patent costs only \$1 in the year it is obtained with the invention then costing \$99 to complete in the year of invention.⁸² Finally, the annual rate of return on capital (i.e., the discount rate) is 10%.⁸³

With these assumptions, I will calculate the present discounted value of the net social benefits of the prospect system and of a stylized nonprospect system in which no patent is granted until an invention is fully developed. For each system, I will also calculate the year in which patenting and commercialization will occur (which will, by definition, be the same year for the nonprospect system). The ultimate goal of this analysis is to show how the problem of patent nondevelopment might strengthen the case for a nonprospect system. To demonstrate this, I will integrate a point suggested by Martin and Partnoy—that the costs and benefits of patenting may be uncertain⁸⁴—directly into the Duffy model. To provide a more complete analysis of the threshold for patentability, however, I will first relax some other assumptions in Duffy's model: first, that the public obtains no value from a patent during the patent term besides what is captured by the patentee; and second, that a patent race always produces a unique winner.

1. *Appropriability of Social Surplus*

In the simplest version of his model, Duffy illustrates that a patent prospect system can produce patenting, and thus entry into the public domain, two years earlier than a nonprospect system could.⁸⁵ His sim-

⁷⁹ See Duffy, *supra* note 25, at 465–66. Duffy does not explicitly calculate the social benefit of a prospect system versus that of a nonprospect system. While he notes that the prospect system produces the social gain of inventions entering the public domain sooner, *see id.* at 469, he does not note that this gain is partly offset by the innovation's being introduced later in a prospect system than in a nonprospect system.

⁸⁰ *See id.* at 465–66.

⁸¹ *See id.*

⁸² *See id.*

⁸³ *See id.*

⁸⁴ *See supra* Part I.A.1.

⁸⁵ *See* Duffy, *supra* note 25, at 469.

ple example illustrates a previously unrecognized consequence of Barzel's point that the right to delay inventive efforts benefits the patentee.⁸⁶ If returns to the patentee increase social welfare, then it follows that the patentee's right to delay can also increase social welfare. It might seem at first glance, however, that the right to delay would cause a decrease in social welfare since it would delay the introduction of the invention into the public domain. Barzel placed aside this effect—and the interest of the public besides the inventor—by assuming that an inventor could appropriate the full social surplus of an invention.⁸⁷ He recognized, however, that relaxing this assumption might mean that invention would occur too late, rather than too early.⁸⁸

Duffy's analysis is important because it shows that the right to delay can benefit not only the inventor but also the public.⁸⁹ By considering the effects of patent expiration, Duffy's model relaxes the assumption in Barzel's model that the patentee captures all the social surplus of the invention. Duffy continues to assume that "the patentee captures all of the social benefits *during the patent term*."⁹⁰ However, this assumption is unrealistic because a patentee is unlikely to be able to engage in perfect price discrimination or prevent all uncompensated uses of the information in the patent. On relaxing this assumption, it becomes clear that even if the prospect system causes invention to occur earlier than it would in a nonprospect system, it might also reduce social welfare by inefficiently delaying patent development.

Figure 1 illustrates the effect of allowing the portion of rents that are appropriable to vary.⁹¹ The x-axis reports the proportion of the patent's social benefits that the patentee, rather than the public, is able to appropriate. The left y-axis reports the present discounted value of the patent's total social benefits, including both those captured by the patentee and those captured by the public. The curves beginning at the lower-left of the graph show this value in both a pros-

⁸⁶ See Barzel, *supra* note 16, at 349.

⁸⁷ See *id.* at 349–50; see also Duffy, *supra* note 25, at 440–41 (citing Barzel, *supra* note 16, at 352 n.11) ("Barzel had suggested that . . . the social surplus associated with the innovation [could be] preserved[] if the government assigned or auctioned off exclusive claims to develop technological opportunities at a very early time—before any resources were expended on developing the technology.")

⁸⁸ See Barzel, *supra* note 16, at 354–55, 355 tbl.2.

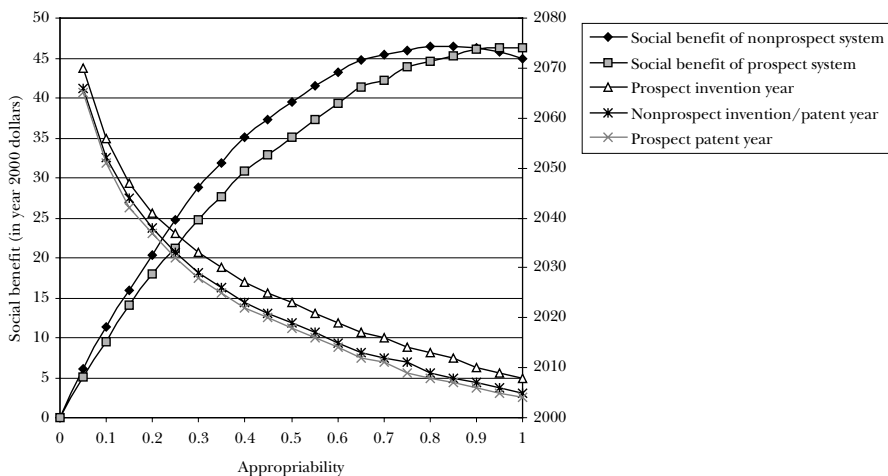
⁸⁹ See Duffy, *supra* note 25, at 469.

⁹⁰ *Id.* at 466 (emphasis added).

⁹¹ The numbers used to derive the data in this and subsequent charts were obtained from a computer program developed in C++. This program, which is available from the author, calculates benefits and costs from the year 2000 to the year 2250 and discounts those benefits and costs to the year 2000. Because the discount rate is higher than the rate of growth, the effect of years beyond 2250 on the present discounted value of social welfare in the year 2000 is trivial.

pect system and a nonprospect system for each possible appropriability proportion. The right y-axis represents years, and the curves beginning at the upper-left show the year that patenting will take place in prospect and nonprospect systems and the year that invention will be completed in a prospect system.⁹²

FIGURE 1. EFFECT OF VARYING APPROPRIABILITY ON SOCIAL BENEFIT AND YEARS OF PATENTING AND INVENTION



As Duffy's analysis suggests,⁹³ a prospect system leads to slightly earlier patenting yet later invention than a nonprospect system, regardless of the proportion of social benefit that the inventor can capture. When the inventor can appropriate all of the patent's social benefits during the patent term, a prospect system produces greater total discounted social benefits than a nonprospect system would, although the difference is very small. At lower levels of appropriability, however, a nonprospect system produces somewhat greater social benefits than a prospect system. The delay between the acquisition of the prospect patent and the date of invention is socially excessive because the patentee does not fully internalize the social benefits of earlier development of the invention. Thus, a prospect system might cause excessive delay when the spillovers from patents are relatively high.⁹⁴

⁹² Note, again, that in a prospect system, the inventor can delay completion of an invention until after she obtains a patent, whereas in a nonprospect system, the inventor must complete development of the invention in order to obtain a patent.

⁹³ See Duffy, *supra* note 25, at 465-75.

⁹⁴ For studies suggesting that there are considerable spillovers from patents as well as from other research and development, see Timothy F. Bresnahan, *Measuring the Spillovers from Technical Advance: Mainframe Computers in Financial Services*, 76 AM. ECON. REV. 742, 752-54 (1986), and Edwin Mansfield et al., *Social and Private Rates of Return from Industrial Innovations*, 91 Q.J. ECON. 221, 233-35 (1977).

2. *Multiple Participants in the Race*

This numerical example, of course, should not lead to a conclusion that nonprospect systems dominate prospect systems in the real world, since only slight changes in assumptions could reverse that conclusion.⁹⁵ Most significantly, Duffy argues that a significant virtue of a prospect system is that it reduces duplicative efforts to develop an invention.⁹⁶ In Figure 1, however, there is no duplication of efforts. Instead, the first inventor willing to bear the costs of the invention simply spends the needed sums immediately and wins the race.

Figure 2 modifies this system by assuming that two firms are competing for the patent and investing equal resources toward obtaining the patent until, at the moment of patenting, the patent is issued to one firm or the other. In this figure, the benefit of limiting duplication ensures that a prospect system comfortably dominates a nonprospect system for the full range of appropriability values. A principal reason for this is that, with the prospect approach, invention occurs much earlier because the promise of reduction in duplicative effort leads the firms to start racing earlier. Of course, this figure should not lead one to conclude that a nonprospect system necessarily dominates the prospect system either. With changes in some of Duffy's other assumptions, the nonprospect system can once again catch up to the prospect system. In particular, consider the possibility that the award of a patent may not end a patent race.

Under Kitch's view of prospect theory, patents should be granted early and broadly.⁹⁷ While Duffy argued that patents need not be broad, his model implicitly assumes that patents are sufficiently broad to ensure that there is only one winner of the patent race.⁹⁸ Yet patents using a variety of technologies might nevertheless target the same consumer market. For example, although Prozac was the first selective serotonin reuptake inhibitor (SSRI) on the market, a number of other SSRIs since its introduction have earned patents and market share.⁹⁹ Each drug might have distinct characteristics that make it

⁹⁵ For example, it would be more realistic to assume that once the invention enters the public domain, social benefits increase somewhat because deadweight loss no longer exists. This seems likely to have only a slight effect in Figure 1, however, because the dates of patenting in the prospect and nonprospect systems appear to be quite close.

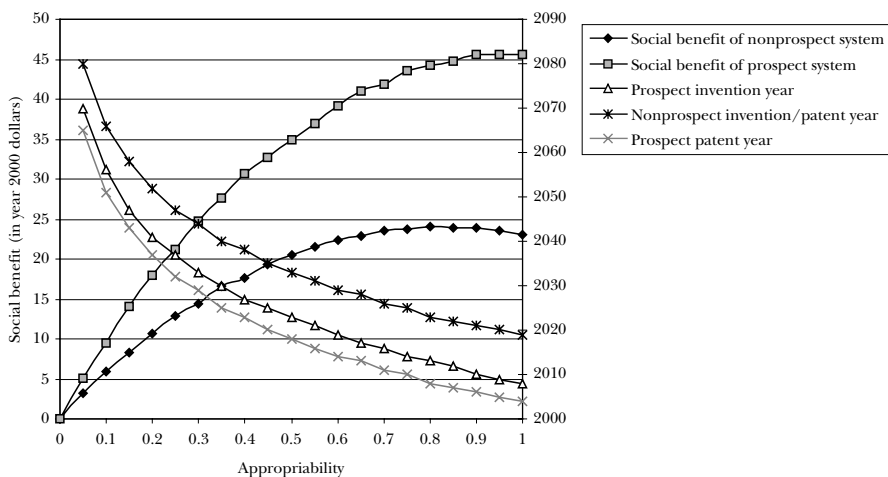
⁹⁶ See Duffy, *supra* note 25, at 469–75; see also *id.* at 443–44 (noting that this is not necessarily counterbalanced by increased competition to obtain the patent prospect because earlier patenting can also dissipate rents).

⁹⁷ See Kitch, *supra* note 13, at 267–70.

⁹⁸ See Duffy, *supra* note 25, at 499–500.

⁹⁹ See *Which SSRI?*, MED. LETTER ON DRUGS & THERAPEUTICS (The Med. Letter, Inc., New Rochelle, N.Y.), Nov. 24, 2003, at 93 (providing an overview of different SSRIs). William Landes and Richard Posner also use SSRIs to demonstrate that a patent race may have multiple winners. See WILLIAM M. LANDES & RICHARD A. POSNER, *THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW* 301–02 (2003).

FIGURE 2. TWO FIRMS COMPETING FOR THE PATENT



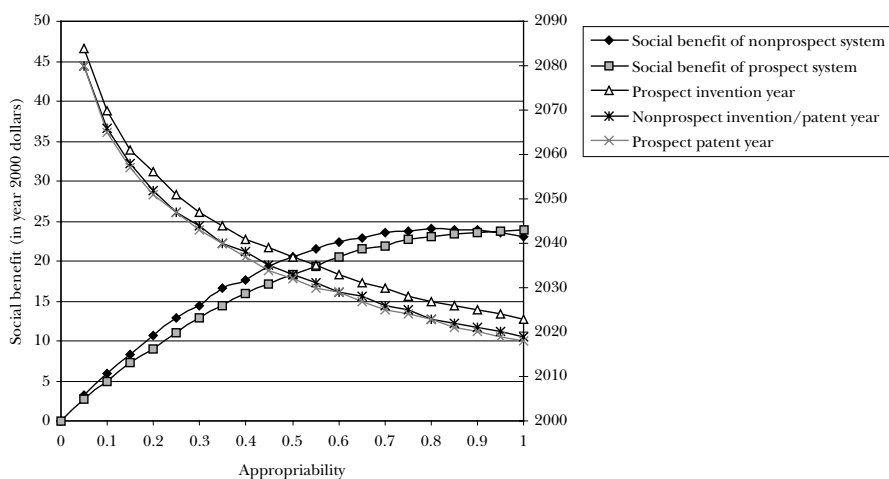
better for a certain patient than is any other drug.¹⁰⁰ To the extent that “inventing around” produces patents with overlapping functionality, however, the same inefficiency that might characterize patent races can still exist. In effect, when different inventors pursue different technological means to the same or a similar outcome, a patent race can have multiple winners.

As Figure 3 shows, the existence of multiple winners of a patent race largely eviscerates the benefits of a prospect system relative to a nonprospect system. As in Figure 2, two firms are racing against one another for patents, but in Figure 3 both firms obtain patents. Unsurprisingly, the dramatic benefits of the prospect system in reducing duplication disappear. In Figure 3, even though the patentees are working on different technological means to the same end, they are nonetheless effectively duplicating one another’s efforts after receiving the patents. The prospect system thus differs from the nonprospect system only in that the prospect system continues to allow inventors to delay innovation, as in Figure 1. Once again, there is a slight advantage for the prospect system with complete appropriability of social surplus and a slight advantage for the nonprospect system with incomplete appropriability of social surplus. Thus, granting patents early will improve welfare only to the extent that early patents succeed in discouraging other players from engaging in further inventive activity.

Figure 3 does not take into account that a patent system that results in multiple patents targeting the same consumer demand might

¹⁰⁰ See *Which SSRI?*, *supra* note 99, at 93 (“Some patients who fail to respond to one SSRI may respond to another, possibly because of differences in tolerability.”).

FIGURE 3. TWO FIRMS COMPETING FOR TWO PATENTS



produce other benefits, such as reduced prices and a greater selection of products available to consumers.¹⁰¹ These considerations, however, generally militate against a prospect system that gives broad control to a patentee. After all, a patentee might not develop a product within the scope of the original patent that would benefit some subset of consumers relative to the original product. This holds true even if a competitor would develop the product in a world in which the second product was not covered by the first product's patent. The patentee, unlike the competitor,¹⁰² takes into account that some of the customers of the new product will be changing over from the old product. If greater product development and variety benefit consumers,¹⁰³ then broad prospect rights are likely undesirable. Thus, the possibility of alternative technologies serving the same market demand further undermines the case that a prospect system necessarily dominates a nonprospect system.

¹⁰¹ These benefits partly justify a recent proposal for a nonexclusive patent system. See John S. Leibovitz, Note, *Inventing a Nonexclusive Patent System*, 111 YALE L.J. 2251 (2002) (arguing for a patent system that would grant patents to more than one participant in the patent race).

¹⁰² This failure of a market entrant to care that some of its business comes at the expense of existing market participants is known in the industrial organization literature as "demand diversion" or "business stealing." See, e.g., N. Gregory Mankiw & Michael D. Whinston, *Free Entry and Social Inefficiency*, 17 RAND J. ECON. 48, 49 (1986) (explaining how this failure may lead to economically efficient entry).

¹⁰³ Note that the economic literature on product differentiation suggests that it is possible to have too many or too few differentiated products in an imperfectly competitive market. See, e.g., Avinash K. Dixit & Joseph E. Stiglitz, *Monopolistic Competition and Optimum Product Diversity*, 67 AM. ECON. REV. 297 (1977).

3. *Uncertainty of Costs and Benefits of Patenting*

The analysis so far might appear to indicate that the consequence of the delay between the patent grant and the date of invention in a prospect system is slight, at least relative to the consequence of duplicative efforts. Delay, however, can have a pernicious effect that assumptions underlying Figures 1 through 3 obscure: delay increases the risk that a patentee will decide *not* to develop a patent. In the analysis so far, patentees will never receive patents that they later regret because the benefits and costs of developing a patent are entirely predictable. In reality, however, this is not the case. After a patent is issued, the patentee's estimate of the demand for the patented product or process might change, as might the patentee's estimate of the cost of development. If benefits turn out to be smaller or costs turn out to be greater than anticipated, the patentee might decide not to develop the patent within the patent term.

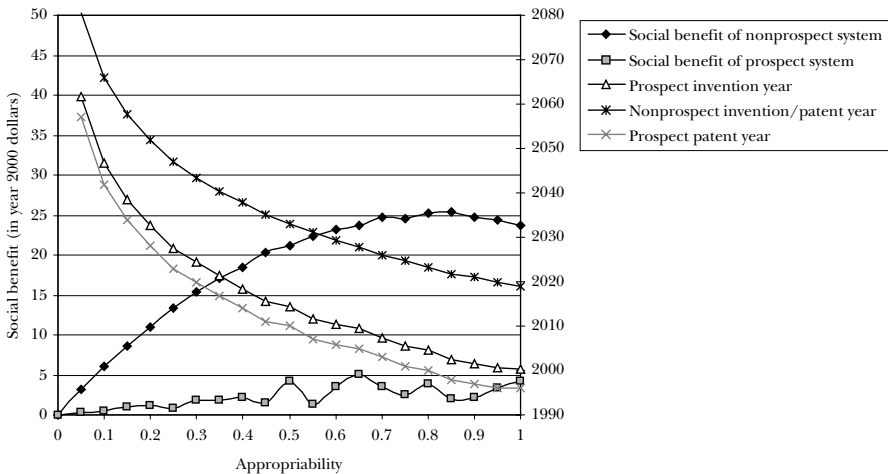
Figure 4 illustrates the result of a simulation model incorporating such uncertainty. The simulation introduces a stochastic shock that occurs immediately after the year in which a prospect patent would be obtained. This shock changes the anticipated benefits by an amount randomly selected from a uniform distribution of -25% to 25% and also results, independently, in the anticipated costs changing by an amount randomly selected from the same distribution. In a prospect system, the decision whether and when to seek a patent depends on these distributions. For each appropriability value (in 0.05 increments), the patent race begins in the first year in which the average private benefit from racing is anticipated to be positive, based on 1000 simulations of the costs and benefits of patenting in different years and taking into account the benefit of being able to delay invention after the award of the patent. As Figure 4 demonstrates, even with this relatively simple model and relatively small level of uncertainty, the results are dramatic.¹⁰⁴ The nonprospect system now easily dominates the prospect system. In a large percentage of cases,¹⁰⁵ the prospect patent is obtained so early that the invention is never developed, and thus no social benefits result. This is so even though Figure 4 assumes

¹⁰⁴ In Figure 3, the prospect invention year line reflects only those cases in which the patent is in fact developed. In a more realistic model, almost every potential invention will eventually be developed even if it is in the public domain. Such a model, however, would only make the results here stronger by providing a longer average delay between invention and development.

¹⁰⁵ For example, when the appropriability factor is 0.5, the invention is developed in the prospect system only 5.4% of the time. Note again that in Figure 3, the prospect invention year refers to the average year of invention only in those cases in which the invention is in fact developed. The development rate predictably increases with higher levels of appropriability. Note that this simulation begins in 1980, not 2000, because uncertainty made it profitable to acquire patents earlier. The prospect patent year line, which is cut off in the graph, descends to 1996 with appropriability equal to 1.0.

that two firms are competing for the patent and that the patent race will end as soon as one firm receives a patent.

FIGURE 4. UNCERTAINTY AS TO THE COSTS AND BENEFITS OF PATENTING



Negative shocks are not the primary explanation for this dramatic change. Rather, the possibility of positive shocks, which leads to earlier patenting, increases the risk of patent nondevelopment. When patenting is relatively inexpensive, it may be worthwhile to obtain a patent even when the chances that the patent will be practical to develop are very low. In these cases, inventors obtain patents for their option value, and there is a substantial risk that they will not have enough patent term in which to develop their inventions.

Nonetheless, Figure 4 should not be read as a criticism of our patent system. Indeed, this analysis might support the existing patent system for two reasons. First, the development of a patent will sometimes produce improvement patents, and an inventor will be willing to invest in development if that investment will effectively extend the patent term. Figure 4 implausibly assumes that when there is insufficient patent term to justify development of the invention, the patentee will *never* develop the invention. More realistically, first-mover advantages will eventually make it profitable for someone—perhaps the original patentee—to develop both the invention and a patentable improvement in exchange for a patent on the improvement.¹⁰⁶ Of course, the same risk of nondevelopment applies to improvement patents, so these too might not be developed. Nonetheless, the danger of nondevelopment strengthens the case for a patent system that allows

¹⁰⁶ See *supra* note 19 and accompanying text.

improvement patents. Thus, the analysis counters arguments that improvement patents inappropriately allow patentees to extend the lives of their patents.¹⁰⁷

Second, and more importantly, our patent system is not a pure prospect system but actually lies somewhere between the prospect and nonprospect approaches. For most inventions, it seems likely that the patentee must spend more than 1% of the cost of the invention process—the assumption in Duffy's numerical example—before the patent will issue.¹⁰⁸ The analysis in Figure 4 suggests only that an extreme version of a prospect system might lower social welfare by increasing nondevelopment. Increasing the hurdle for patentability will increase the cost of the patent option and decrease the cost of completing the commercialization process. Accordingly, requiring a greater investment before a patent issues will lessen the danger that inventors will patent so early that they will have an insufficient patent term in which to develop the invention. Assuming that in our patent system the process of invention generally costs considerably more than 1% of the full costs of development,¹⁰⁹ our patent system might strike a roughly appropriate balance between granting prospects too early and granting them too late. While Kitch's and Duffy's arguments in favor of a prospect system remain powerful, further analysis

107 Cf. Thomas L. Irving & Michael D. Kaminski, *Double Patenting: One Way, Two Ways, Whose Delay?*, 1 U. BALT. INTELL. PROP. L.J. 180, 185–87 (1993) (considering policy justifications in support of the doctrine preventing “double patenting” of the same invention as a means of extending the patent term).

108 Further simulations performed by the present author (but not worth reporting in detail here) reveal that if eligibility for a patent requires 10% of the cost of the invention process, the development rate rises to about 82% if half of the social benefit is appropriable, and with 50% of the cost of the invention process demanded, all inventions are developed. But this should not lead to complacency that nondevelopment is not a problem because the assumed shock distribution, with an absolute value averaging 12.5%, is very conservative. Many patented products will have substantial uncertainty about their cost of completion and especially about their benefit since many developed products turn out to be commercial disasters. With 50% of the cost of the invention process demanded in the prospect system and an absolute average shock of 37.5%, only about 25% of inventions will be developed; thus, a nonprospect system will produce greater social value. As these numbers suggest, confident assessments about the relative merits of prospect and nonprospect systems require more empirical analysis of the information available to inventors. A more complete model would also need to consider the effects of asymmetric information among racers and the possibility that different racers may have information about the relative success of other racers' efforts.

109 For an argument that the patent system does not in fact give as much control over future development as Kitch claims because the patent statutes limit the patentee's monopoly to his claim and provide no basis for monopolizing future technology, see Roger L. Beck, *The Prospect Theory of the Patent System and Unproductive Competition*, 5 RES. L. & ECON. 193, 194–95 (1983). The requirements for a patent, moreover, are nontrivial so it may be unrealistic to assume that patents are granted when a patentee completes only a tiny fraction of the work.

of the nondevelopment problem suggests that these arguments can be taken too far.

II

TOWARD AN EMPIRICAL ASSESSMENT

Patent underdevelopment is difficult to measure empirically. Two questions illustrate this problem. First, how might patentees have behaved differently if it were possible to obtain a longer patent term? Second, would their different behavior have had positive or negative consequences for social welfare? The first question is counterfactual, and absent a natural experiment in which some patents randomly receive patent term extensions, little, if any, data exists from which to extrapolate an answer. Measuring what is happening in the patent system is difficult enough,¹¹⁰ but trying to measure what might happen in a different patent system is virtually impossible absent experimentation. Even if the additional number of patents that would be commercialized given patent term extensions were available, analyzing the impact on social welfare presents challenges. Although scholars have developed methodologies for patent valuation,¹¹¹ calculating social benefits will be more difficult still.¹¹²

Despite difficulties in measuring these benefits, one can nonetheless progress in assessing the patent underdevelopment problem by identifying particular situations in which underdevelopment or nondevelopment might arise. The theoretical model of Part I suggests that the patent system already partially responds to the danger by establishing a relatively high threshold for patentability. Part II.A develops a corollary: the problem of patent underdevelopment will be greatest where patent protection is provided at an early stage. Except to the extent countered by the legal system, patent underdevelopment will be a danger in technological fields for which the patent system most resembles a prospect system—those fields in which a great deal of development must occur after patenting. Whether patent underdevelopment occurs also depends on the degree of legal protection to which development activities will be entitled. Part II.B

¹¹⁰ For examples of works that seek to overcome these difficulties, see John R. Allison et al., *Valuable Patents*, 92 GEO. L.J. 435, 437 (2004), which analyzes results from a detailed study of litigated patents to determine what makes a patent valuable, and James Bessen & Eric Maskin, *Sequential Innovation, Patents, and Imitation 1–2* (Mar. 2006) (unpublished manuscript, available at <http://www.sss.ias.edu/publications/papers/econpaper25.pdf>), which analyzes the impact of patent protection on the software industry.

¹¹¹ See, e.g., Denton & Heald, *supra* note 30, at 1180, 1182 & n.26 (citing various methodologies and proposing a new patent valuation method using the Black-Scholes equation for stock options pricing).

¹¹² See sources cited *supra* note 94 (seeking to measure spillovers from research activity).

identifies three types of development activities—scientific experimentation, market experimentation, and marketing—that produce information that a patentee cannot protect with intellectual property rights. Finally, Part II.C assesses whether the underdevelopment problem vanishes where the development activity consists of improving the invention. Although improvements are generally patentable, some may be unpatentable or not worth patenting. Moreover, inventors may have socially suboptimal incentives late in the patent term to develop even patentable improvements.

A. Embryonic Inventions

The existing patent system's standards for granting patents are stringent.¹¹³ An invention must be new and nonobvious,¹¹⁴ and although many commentators criticize courts and the patent office for frequently issuing patents for inventions that fail to meet these requirements,¹¹⁵ the language of the patent law presumes to weed out inventions that are plainly anticipated in the prior art (or, at least, in easily accessible prior art).¹¹⁶ Perhaps more importantly for the purpose of this Article, a patentee must describe the invention so as to enable a person having ordinary skill in the art to create it.¹¹⁷ To meet the doctrinal requirements, an inventor ordinarily will have to think carefully about the invention and the "best mode" for practicing it.¹¹⁸ Patentees will hesitate to undertake the costs of inventing and patenting if it is likely that the options the patent provides will not be worth exercising.

Nonetheless, the law gives inventors considerable leeway by not requiring patentees to reduce their invention to practice so long as they satisfy the enabling description requirement.¹¹⁹ As John Duffy

¹¹³ See 35 U.S.C. §§ 101–103 (2000) (requiring the patentee to satisfy subject matter requirements and standards of novelty, utility, and nonobviousness).

¹¹⁴ *Id.* § 103(a).

¹¹⁵ See, e.g., ADAM B. JAFFE & JOSH LERNER, *INNOVATION AND ITS DISCONTENTS* 32–34 (2004) (citing patents granted for a peanut butter and jelly sandwich, the process of toasting bread, and a method of swinging on a swing).

¹¹⁶ See 35 U.S.C. §§ 101–103.

¹¹⁷ See *id.* § 112. Some debate whether the written description and enablement requirements are distinct or are one and the same. See *Univ. of Rochester v. G.D. Searle & Co.*, 375 F.3d 1303, 1304 (Fed. Cir. 2004) (Newman, J., dissenting) (noting a "burgeoning conflict in pronouncements of this court" regarding § 112).

¹¹⁸ See 35 U.S.C. § 112; *Teleflex, Inc. v. Ficosa N. Am. Corp.*, 299 F.3d 1313, 1330 (Fed. Cir. 2002) (setting forth a two-pronged test for compliance with the best mode requirement). See generally Kenneth R. Adamo, *What's Better, What's Best – The Best Mode Requirement in U.S. Patent Practice*, 73 J. PAT. & TRADEMARK OFF. SOC'Y 811 (1991) (discussing policies behind the best mode requirement and how courts typically apply the doctrine).

¹¹⁹ See 35 U.S.C. § 112; *W.L. Gore & Assocs. v. Garlock, Inc.*, 721 F.2d 1540, 1557 (Fed. Cir. 1983) ("A patent is invalid only when those skilled in the art are required to engage in *undue* experimentation to practice the invention."). As early as 1888, the Supreme Court held that, to qualify for a patent, an inventor need only "describe[] his method with suffi-

points out in a recent article, patent law tolerates embryonic invention.¹²⁰ For example, “[n]o working models are required,”¹²¹ and indeed “[t]he inventor need not ever have built or tested the invention.”¹²² Granting patents early may reduce wasteful duplication and encourage earlier patent races,¹²³ but as this Article suggests, prospect theory might also increase the risk of patent underdevelopment.¹²⁴ To exercise the patent’s development option,¹²⁵ the inventor will eventually need to create a working model or build and test the invention. The postpatenting cost of exercising the development option will be greater if that cost includes these activities, and a patentee facing a high postpatenting exercise price will be less likely to develop the option. If, instead, these activities were prerequisites to receiving a patent, then patenting might occur later. Once a patent issues, the patentee might be more likely to further exercise the development option.

In some fields, such as the pharmaceutical industry, the cost of developing inventions is particularly high. Even Mark Lemley, who is generally critical of Kitch’s prospect theory and of the possibility that awarding a patent might provide *ex post* as well as *ex ante* benefits,¹²⁶ has acknowledged that the pharmaceutical industry might be an example in which the prospect theory is both descriptively accurate and normatively justifiable.¹²⁷ The patent system could hypothetically issue patents only after the Food and Drug Administration (FDA) approves a manufacturer’s drug based on that manufacturer’s studies establishing safety and effectiveness. But there would be obvious problems with such a regime. For instance, pharmaceutical companies might be less willing to invest in the early stages of research if they could not maintain their findings as trade secrets, since competitors might specialize in testing promising substances found by others. The existing approach, however, is also flawed. In particular, a pharmaceutical company might receive a patent on a drug and then not

cient clearness and precision to enable those skilled in the matter to understand what the process is, and . . . point[] out some practicable way of putting it into operation.” *The Telephone Cases*, 126 U.S. 1, 536 (1888).

¹²⁰ See Duffy, *supra* note 32, at 6.

¹²¹ *Id.*; see *In re Strahilevitz*, 668 F.2d 1229, 1232 (C.C.P.A. 1982) (holding that § 112 does not require the patentee to submit working models to obtain a patent).

¹²² Duffy, *supra* note 32, at 6.

¹²³ See *supra* Part I.B.2.

¹²⁴ See *supra* Part I.B.

¹²⁵ See Martin & Portnoy Presentation, *supra* note 23.

¹²⁶ See Lemley, *supra* note 75, at 131–32.

¹²⁷ *Id.* at 141 (“Prospect theory is needed when control over subsequent development is a necessary part of the incentive to produce the pioneering invention in the first place, as is arguably true with pharmaceuticals.”).

develop that drug as much as it would if patent protection were granted at a later stage of development.

Given the uniquely high cost of developing pharmaceutical products, it should not be surprising that Congress has responded with remedies to the patent nondevelopment problem. For example, the Orphan Drug Act provides seven years of exclusivity to a drug company that is willing to take the drug through the clinical testing and governmental approval processes.¹²⁸ Congress thus recognized that, even if a given medication existed, there might be insufficient incentives for any company to conduct the scientific testing needed to establish the drug's safety. Although the Act focuses specifically on drugs for diseases suffered by 200,000 or fewer individuals,¹²⁹ it also protects manufacturers in cases where they do not reasonably expect to recover their research costs through domestic sales.¹³⁰ The Act even protects a drug that still has some patent term remaining,¹³¹ thus in effect allowing the pharmaceutical company to extend the patent term.

The Hatch-Waxman Act¹³² provides additional remedies for the patent underdevelopment problem.¹³³ That Act extends pharmaceutical patent terms for half of the time needed to investigate the new drug plus the time taken by the FDA to review the new drug application.¹³⁴ Congress thus recognizes that some inventions require greater development time and costs. To that end, the statute extends the patent term to reduce the risk that a patentee will not find exercising the development option worthwhile or, still worse, that a patentee will not create such inventions in the first place. Interestingly, the statute addresses the concern of patent underdevelopment with a stick as well as a carrot. If a patentee is not diligent in developing an invention over a period of time, the statute subtracts the period of nondiligence from the sum of the terms used to calculate the patent

¹²⁸ Orphan Drug Act, Pub. L. No. 97-414, 96 Stat. 2049 (1983) (codified as amended at 21 U.S.C. §§ 360aa-360ee (2000)). The seven-year exclusivity provision is found at § 360cc(a).

¹²⁹ See 21 U.S.C. § 360bb(a)(2)(A).

¹³⁰ See *id.* § 360bb(a)(2)(B).

¹³¹ See Orphan Drug Amendments of 1985, Pub. L. No. 99-91, 99 Stat. 387 (codified as amended at 21 U.S.C. § 360cc (2000)).

¹³² Drug Price Competition and Patent Term Restoration (Hatch-Waxman) Act of 1984, Pub. L. No. 98-417, 98 Stat. 1585 (codified as amended in scattered sections of 15, 21, 28, & 35 U.S.C.).

¹³³ For an overview of Hatch-Waxman and its legislative history, see Gerald J. Mossinghoff, *Overview of the Hatch-Waxman Act and Its Impact on the Drug Development Process*, 54 *FOOD & DRUG L.J.* 187 (1999).

¹³⁴ See 35 U.S.C. § 156(c)(2) (2000). The statute, however, allows for a maximum extension period of five years and no more than a fourteen-year period of market exclusivity. See *id.* § 156(c)(3), (d)(5)(E).

extension period.¹³⁵ Thus, recognizing the problem of patent nondevelopment is as important in explaining and justifying existing features of the patent system as it is in suggesting reforms.

Within the pharmaceuticals area, the problem of patent underdevelopment might be particularly acute in genomics.¹³⁶ Identifying a genetic sequence is only the first step toward discovering a particular therapeutic use for that sequence. One danger of granting patents in gene sequences is that, by the time researchers see a therapeutic use on the horizon, the patent might have expired¹³⁷ or too little patent term will remain to make research financially worthwhile. Nonetheless, property rights in genetic sequences might reduce the risk of duplicative research and assure potential researchers that others will not free ride off of their efforts. The Patent and Trademark Office's (PTO) Utility Guidelines solve this problem in part by requiring that applications for gene sequences demonstrate a specific and substantial utility,¹³⁸ but broader property rights coupled with a longer patent term might further increase development incentives.

Industry-specific responses such as the Orphan Drug Act, the Hatch-Waxman Act, and the Utility Guidelines help limit the danger of patent underdevelopment, and the theory developed in this Article justifies including such legal regimes as supplements to the patent system within our system of innovation. Nonetheless, such protection cannot provide confidence that the patent system has entirely conquered the danger of patent underdevelopment. For example, these responses might be inadequate to foster an optimal amount of research and development in genomics, and there is no guarantee that the additional periods of exclusivity from the Orphan Drug Act and the Hatch-Waxman Act are long enough to prevent underdevelopment of nongenomic drugs. Moreover, patentees might develop

¹³⁵ See *id.* § 156(c)(1).

¹³⁶ For a general discussion of the science of genomics and recent developments in the field, see Helen M. Berman & Rochelle C. Dreyfuss, *Reflections on the Science and Law of Structural Biology, Genomics, and Drug Development*, 53 UCLA L. REV. 871, 880–83 (2006).

¹³⁷ Cf. *id.* at 884–85 (noting that “lead optimization,” just one stage in the drug development process, can take “several years” to finish and costs between two and four million dollars). The genomics revolution also presents a related problem: once it becomes feasible to test many people for individual genetic variations, researchers will need to test many existing treatments to determine which groups of the population can benefit from those treatments. But, without protection for the underlying treatments, there will be little incentive to engage in such testing. See Arti K. Rai, *Pharmacogenetic Interventions, Orphan Drugs, and Distributive Justice: The Role of Cost-Benefit Analysis*, 19 SOC. PHIL. & POL'Y 246, 249–51 (2002).

¹³⁸ See Utility Examination Guidelines, 66 Fed. Reg. 1092, 1093 (Jan. 5, 2001). The concern animating the Guidelines was not the problem of patent nondevelopment, but simply the concern that patents were being granted without sufficient inventive accomplishment. See generally Lawrence T. Kass & Michael N. Nitabach, *A Roadmap for Biotechnology Patents? Federal Circuit Precedent and the PTO's New Examination Guidelines*, 30 AIPLA Q.J. 233, 248–65 (2002) (providing an overview of the Guidelines).

many inventions in other technological fields if more patent term remained. The importance of “prophetic”¹³⁹ claims over anticipated research results in the biotechnology sector¹⁴⁰ and in other technological areas¹⁴¹ signals the necessity of continued development after the patent is issued. The next section identifies the specific types of development that patentees might not perform without extended periods of exclusivity.

B. Nonpatentable Development

One possible solution to the patent underdevelopment problem is for the patent system to reward development activity with a patent term extension. Part II.A noted that the Hatch-Waxman Act adopts a version of this approach,¹⁴² and Part III will consider the possibility of a systematic approach to patent term extensions. The patent system, however, already has a built-in mechanism for providing additional patent term for development activities: the system of improvement patents. If a party improves on a patented invention and the improvement meets the criteria for patentability, the party can obtain an improvement patent.¹⁴³ When the recipient of an improvement patent is a third party, both the original inventor and the third party own “blocking” rights, which prevent the other from practicing the improved technology during the term of the relevant patents.¹⁴⁴ When the original inventor receives an improvement patent, there is no blocking and the original inventor receives a fresh patent term. The patent system, however, still permits third parties to practice the original invention after the end of the original term.

By rewarding parties with exclusivity when they improve the original invention, the patent system encourages parties to engage in de-

¹³⁹ Under patent-claiming rules, “[s]imulated or predicted test results and prophetic examples . . . are permitted in patent applications.” U.S. PATENT & TRADEMARK OFFICE, U.S. DEP’T OF COMMERCE, MANUAL OF PATENT EXAMINING PROCEDURE § 608.01 (p), at 600-99 (8th ed., 5th rev. 2006), available at http://www.uspto.gov/web/offices/pac/mpep/mpep_e8r5_0600.pdf.

¹⁴⁰ See, e.g., Harold C. Wegner & Stephen B. Maebius, *The Global Biotech Patent Application*, in BIOTECHNOLOGY LAW: BIOTECHNOLOGY PATENTS & BUSINESS STRATEGIES IN THE NEW MILLENNIUM 87, 96–97 (PLI Intellectual Prop., Course Handbook Series No. G-666, 2001) (discussing the tradition of prophetic claiming of biotech patents).

¹⁴¹ See, e.g., *Energy Absorption Sys., Inc. v. Roadway Safety Servs., Inc.*, No. 96-1264, 1997 WL 368379, at *5 (Fed. Cir. July 3, 1997) (discussing the prophetic examples doctrine in the context of a mechanical invention).

¹⁴² See *supra* notes 132–35 and accompanying text.

¹⁴³ See *supra* note 9 and accompanying text.

¹⁴⁴ See Lemley, *supra* note 9, at 1010 (“The original patent owner can prevent the improver from using his patented technology, but the improver can also prevent the original patent owner from using the improvement. Unless the parties bargain, no one gets the benefit of the improvement.”). See generally Michael S. Mireles, *An Examination of Patents, Licensing, Research Tools, and the Tragedy of the Anticommons in Biotechnology Innovation*, 38 U. MICH. J.L. REFORM 141, 168 (2004) (explaining the phenomenon of blocking patents).

velopment activity that the finite patent term might otherwise discourage. Nonetheless, improvement patents are not a complete solution to the patent underdevelopment problem because some forms of patent development do not entitle the original patent holders to new patents.¹⁴⁵ And, if third parties can free ride on these same development activities after the patent term, patentees might have insufficient incentives to undertake them during the patent term. These development activities include performing studies to assess the effectiveness of the invention, testing commercially the public's demand for the invention, and informing consumers or others about the invention.

1. *Scientific Testing*

The most obvious, though perhaps not the most commercially significant, form of unpatentable development activity is scientific testing.¹⁴⁶ As evidenced by statutes such as the Orphan Drug Act, the need to encourage scientific testing of inventions is particularly acute for pharmaceuticals.¹⁴⁷ However, a wide range of inventions might benefit from further testing to determine how well the invention will perform in the marketplace. If tests reveal that an invention will not perform well, the results will help the patentee make an informed decision about whether to fully commercialize it. In addition, the less patent term remaining, the more incentive patentees have to commercialize products without testing them and thus without finding solutions to potential problems.

Yet, the patent system cannot adapt by merely granting improvement patents on scientific testing because it is generally impossible to distinguish the scientifically tested invention from the original. Therefore, if the patent system granted a patent holder a new patent for the mere act of engaging in scientific testing, it would essentially provide a mechanism through which all patent holders could extend their patent terms *ad infinitum*, unless patent offices applied a subjective test that asked whether such testing is sufficiently important to justify a patent term extension.

¹⁴⁵ An additional reason is that improvement patents may provide suboptimal incentives even for patentable development activities. See *infra* Part II.C.

¹⁴⁶ Edmund Kitch recognized how important it is for patentees to engage in scientific testing of their inventions but assumed that the underlying patent would provide them with sufficient incentives to do so. See Kitch, *supra* note 13, at 277 ("Absent a patent, firms have less than the optimal incentive to invest in providing information about and techniques for using the new technology."). But, because patents only protect an invention for a finite period, they too provide less than optimal incentives for patentees to invest in scientific testing.

¹⁴⁷ See *supra* notes 128–30 and accompanying text.

If the scientific research points to a new use for the original invention, however, the patentee may be able to obtain an improvement patent since the current patent system permits parties to obtain patents on new uses for existing inventions.¹⁴⁸ For example, a use patent might cover the use of a previously invented drug for a new medical condition.¹⁴⁹ However, such improvement patents may be difficult to obtain because the “new” use may have been obvious, even if it was not obvious that the new use would be effective.¹⁵⁰ In addition, a use patent might be difficult to enforce because the patentee may be unable to determine whether consumers are using the invention for its original purpose, as opposed to its new purpose, and for which purpose sellers are encouraging consumers to use the invention.¹⁵¹

Unsurprisingly, courts have been skeptical of efforts to obtain broad patent protection for scientific studies. For example, the Federal Circuit recently upheld a district court’s invalidation of a patent for growing and eating cruciferous sprouts, such as broccoli, to reduce the level of carcinogenic substances and the risk of cancer.¹⁵² The patentee argued that it had discovered a new method for “selecting the particular seeds that will germinate as sprouts rich in glucosinolates.”¹⁵³ The court, however, held that, “[w]hile [the patentee] may have recognized something about sprouts that was not known before, [the patentee’s] claims do not describe a new method.”¹⁵⁴ With its claim rejected, the patentee had no access to additional patent protection. As a result of the Federal Circuit’s decision, patentees may not have the incentive to research known but unproven scientific hypotheses about public domain products, such as cruciferous sprouts, or even about their own products. Given the difficulty that courts would face in determining the extent to which a particular experiment reduced scientific uncertainty, the Federal Circuit’s decision is likely a good one, but its effect may require the patent system to provide parties with nonpatent innovation incentives, such as governmental scientific grants, to encourage research on patented or once-patented inventions.

¹⁴⁸ See 35 U.S.C. § 101 (2000).

¹⁴⁹ See, e.g., Rebecca S. Eisenberg, *The Problem of New Uses*, 5 YALE J. HEALTH POL’Y L. & ETHICS 717, 720 (2005).

¹⁵⁰ See, e.g., *Allegheny Drop Forge Co. v. Portec, Inc.*, 541 F.2d 383, 386 (3d Cir. 1976) (“A new use for an old process or product is patentable if the new use or application is itself not ‘obvious’ to one skilled in the art.”).

¹⁵¹ See, e.g., Eisenberg, *supra* note 149, at 720 (“The discovery of a new use for an old drug might support a patent on a method of treatment, but such a patent offers little effective protection against generic competition once the drug itself is off-patent and may lawfully be sold for an older, unpatented use.”).

¹⁵² See *In re Cruciferous Sprout Litigation*, 301 F.3d 1343 (Fed. Cir. 2002).

¹⁵³ *Id.* at 1351.

¹⁵⁴ *Id.* at 1352.

While it is difficult to determine whether a particular decision not to engage in testing is attributable to the limited amount of patent term remaining, anecdotal evidence suggests that drug manufacturers are less willing to conduct trials near patent expiration. For example, a *New York Times* editorial noted that when NitroMed conducted full testing of its heart failure drug, BiDil, it did so only in a population of African-American patients when “[s]ome experts believe[d] that . . . it would have been possible to devise a better study to test the drug in a broad population, not just a single racial group.”¹⁵⁵ But, with the patent on the underlying drug expiring in 2007,¹⁵⁶ NitroMed had insufficient incentives to conduct tests on the general population and targeted only a narrow group, recognizing that it could obtain a use patent for using the drug to benefit the targeted group. If enough patent term remained on the underlying drug, NitroMed might have had an incentive to test the drug on a broader population. While NitroMed did engage in *some* testing of the drug, other patentees might forego *any* testing in such a situation.

2. *Commercial Experimentation*

Patents generally encourage commercial experimentation, but as with scientific testing, this encouragement may be suboptimal due to the limited patent term. Some inventions might be so significant that they are obviously worth commercializing. In far more cases, it will be obvious by the end of the patent term that the underlying invention is not worth commercializing. But some inventions might have an uncertain probability of commercial success. Patent protection provides incentives for inventors to experiment commercially with their patented products, because without such protection, third parties might be able to free ride off the information gleaned from the inventor’s commercial experiments.¹⁵⁷ Consequently, the more the patent system limits a patent term, the less incentive a patentee has to engage in beneficial commercial experiments.

The problem of inventors’ not engaging in sufficient commercial experimentation is particularly severe for inventions that have a small probability of large commercial success and a great probability of failure. Once an invention falls into the public domain, someone considering commercializing the invention faces the prospect of bearing the entire cost of the experimentation if it fails. If it succeeds, the original

¹⁵⁵ See Editorial, *The First Race-Based Medicine*, N.Y. TIMES, June 19, 2005, § 4, at 11.

¹⁵⁶ See *id.* NitroMed received an improvement patent for using the drug on African-American patients. See U.S. Patent No. 6,784,177 (filed Aug. 2, 2002) (issued Aug. 31, 2004).

¹⁵⁷ See Kieff, *supra* note 19, at 708–09 (noting the advantage enjoyed by a second-mover since “mere knowledge of a first mover’s success eliminates a great deal of risk from the second mover’s decision whether to embark on the same enterprise”).

experimenter is likely to enjoy a larger market share than subsequent entrants due to trademark protection.¹⁵⁸ But third parties will soon enter the market and claim some portion of the market share that the initial commercial experimenter would enjoy in a regime of perpetual patent protection. Because of other costs of perpetual protection, the current patent system only protects patents for a limited time; as a result, inventors will forego at least some experiments that they otherwise would have undertaken.

Given the considerable gap that often exists between the dates of invention and initial commercial experimentation,¹⁵⁹ the finite patent term might discourage many commercial experiments. That does not mean, however, that the inventor or some third party will never put the underlying inventions through commercial testing. Eventually, as the potential market for an invention grows and its production costs fall, some entrepreneur might find it worthwhile to perform the commercial test and enjoy whatever advantages lead time and trademark law provide. But the finite patent term might still considerably delay commercialization. Empirical calculation of the length of such delays may be impossible. Nevertheless, one can speculate that since commercial experimentation occurs in all technological areas, the absence of sufficient incentives for commercial experimentation is an even more serious problem than the absence of sufficient incentives for scientific experimentation.

3. *Marketing and Advertising*

Even a patentee who has fully scientifically tested an invention and has decided to commercialize it must still decide how much to market and advertise it. Some commentators argue that advertising can be economically efficient because it provides information to consumers and may result in lower prices.¹⁶⁰ The less patent term remaining, however, the less advertising patentees will engage in since third parties can enter the market and free ride off of their advertising investment. This conclusion has empirical support. Studies suggest, for example, that pharmaceutical companies sharply cut back on mar-

¹⁵⁸ See Gideon Parchomovsky & Peter Siegelman, *Towards an Integrated Theory of Intellectual Property*, 88 VA. L. REV. 1455, 1473–74 (2002). Gideon Parchomovsky and Peter Siegelman have argued that “leveraging” a patent through a trademark is socially optimal because it increases a patentee’s incentive to invent without increasing deadweight loss. See *id.* at 1473–86.

¹⁵⁹ See, e.g., Kitch, *supra* note 13, at 272 tbl.1.

¹⁶⁰ See Timothy J. Muris, *California Dental Association v. Federal Trade Commission: The Revenge of Footnote 17*, 8 SUP. CT. ECON. REV. 265, 293–97 (2000) (surveying reports on the effects of advertising on the cost and quality of products).

keting expenses shortly before a patent falls into the public domain.¹⁶¹

The more difficult empirical question is the extent to which advertising, on a general level, is socially suboptimal. Some economists suggest that advertising may lead to societal inefficiency by inducing consumers to purchase products that they do not need.¹⁶² To the extent this is so, the finite patent term raises rather than lowers social welfare by decreasing advertising. When the patent term ends, third parties will enter the market and introduce competition. This competition will lead to additional advertising, which may increase inefficiency as advertisers seek to induce customers to purchase their product over another party's product, even though there are no real quality differences among them.¹⁶³ Any complete empirical analysis is likely to produce different conclusions for different inventions, but in at least some situations, the finiteness of the patent term might lead to advertising that provides less useful information to consumers.

C. Patentable Improvements

Thus far, the analysis has focused on development activities that produce information upon which a third party can free ride. To the extent that a development activity results not only in information but also in a new patentable invention, an improvement patent can provide renewed protection and reduce the danger of patent underdevelopment.¹⁶⁴ Nevertheless, the availability of improvement patents does not ensure optimal incentives to engage in research aimed at improving inventions.

First, consider incentives during the original patent term. Suppose, for example, that a potential inventor anticipates that research will lead to improvements that, if incorporated into the patentee's product, could lead to an additional \$1 million profit during the original patent term. If the patentee is the potential inventor, then the patentee will be able to retain all of the additional profits that result from improvements during the patent term. Patenting the improvement might, as always, produce spillovers in the form of information

¹⁶¹ See, e.g., Ernst R. Berndt et al., *The Long Shadow of Patent Expiration: Generic Entry and RX to OTC Switches*, in SCANNER DATA AND PRICE INDEXES 229, 261 (Robert C. Feenstra & Matthew D. Shapiro eds., 2003), available at <http://faculty.london.edu/mkyle/Rx%20to%20OTC%20paper.pdf> (reporting that pharmaceutical companies decrease their spending on drug advertising in the years before the patent expires).

¹⁶² See, e.g., Nicholas Kaldor, *The Economic Aspects of Advertising*, 18 REV. ECON. STUD. 1, 5-6 (1950-51).

¹⁶³ See *id.*; see also Avinash Dixit & Victor Norman, *Advertising and Welfare: Another Reply*, 11 BELL J. ECON. 753, 753 (1980) (suggesting the possibility of socially inefficient competitive advertising).

¹⁶⁴ See *supra* text accompanying notes 143-44.

or consumer surplus.¹⁶⁵ Even placing aside these spillover concerns, third parties may have suboptimal incentives to create improvements. Because the patentee and the improver can each block the other from practicing the improved invention during the patent term,¹⁶⁶ the parties will have to negotiate an agreement, meaning that the surplus from the improvement must be shared between the improver and the original patentee. Sometimes, a patentee might precommit to giving away a relatively large portion of this surplus to improvers in order to generate more improvements, but this may be difficult to accomplish and may not result in the intended benefit.¹⁶⁷ Thus, at least during the remainder of the patent term, the incentives of a third-party improver to engage in research and development may be suboptimal.

The economics of improvements become even more complicated when we consider the years following the conclusion of the original patent term. The major problem in this context is that different improvements may be substitutes for one another. To take an extreme example, suppose that there are two mutually incompatible improvements to an invention, and either improvement would allow the patentee of that improvement to earn an additional \$1 million in profit. If both improvements are created, however, each might be worth only \$500,000, or even less, as a result of price competition between the rival improvers. Ironically, the possibility of a second improver may mean in some circumstances that no one will improve at all or that improvements will come later. The danger of inadequate incentives to improve will be especially acute if the first improvement produces valuable information about the size of the market.¹⁶⁸

The recent developments in the prospect theory of patent law discussed above provide a framework for understanding this concern.¹⁶⁹ Because patent protection provides considerable control over the development of improvements, a patentee need not worry too much about competition from rival improvers,¹⁷⁰ or at all about

¹⁶⁵ See *supra* note 94.

¹⁶⁶ See Mireles, *supra* note 144, at 168. Obviously, the original patentee can practice the original invention but cannot practice the improvement. See *id.* The improver can practice neither the original invention nor the improvement without a license from the original patentee. See *id.*

¹⁶⁷ See Oren Bar-Gill & Gideon Parchomovsky, Essay, *The Value of Giving Away Secrets*, 89 VA. L. REV. 1857, 1860 (2003) (suggesting that patentees do this by publishing without patenting aspects of their inventions).

¹⁶⁸ Suppose there is a 50% chance that there will be no market for the improved product and a 50% chance that consumers will be willing to spend enough extra for the improved product to produce an additional \$2 million for a single improver. If the underlying invention remained under patent protection, then the patentee would be willing to invest up to \$1 million in the improvement.

¹⁶⁹ See *supra* Parts I.A.2, I.B (discussing Duffy's model).

¹⁷⁰ See Duffy, *supra* note 25, at 489–90 (arguing that the patentee has an advantage, though only a limited one, over competitors in the search for improvements). If, however,

the prospect of rivals making substitutes to the patentee's own improvements, since the patentee can block such improvements during the patent term.¹⁷¹ Because this protection assures patentees that they will be able to reap the benefits of their research and development on improvements, it could lead to earlier and greater investment. Once the patent falls into the public domain, however, these benefits are lost. Thus, when only a relatively short portion of a patent term remains, incentives to make improvements might be suboptimal. Because of the possibility that patentees will lose a hypothetical patent race to improve a patent nearing expiration, both the patentee and third parties might not find it worthwhile to enter the race at all. To be sure, the possibility of improvement patents results in considerably better incentives to engage in development activities that might produce such patents, but aggregate investment in such activities might still be lower than if a longer patent term remained.

In addition, improvement patents do not encourage development activities that might produce improvements but that will not subsequently receive patent protection. One reason improvements might not be patented is that they do not themselves meet the standards of patentability. For example, the Patent and Trademark Office could conclude that a particular improvement would have been obvious to a person having ordinary skill in the art,¹⁷² even though such a person will obviously not work for free. Even some valuable and innovative improvements might not obtain patent protection,¹⁷³ though the PTO's relatively relaxed standards suggest that this problem is not terribly severe.¹⁷⁴ Moreover, even if all improvements are potentially patentable under current patent administration practices, some improvements might be too small to justify the expense of patent prosecution.¹⁷⁵ These concerns might be of relatively little economic significance, but they further justify the concern that nearing the end of patent protection might lead to a decrease in development expenditures.

assuring patentees that they will be able to win the race for improvement will lead to earlier searches for such improvements, Duffy's analysis arguably provides a basis for granting patentees a stronger property right.

¹⁷¹ See Mireles, *supra* note 144, at 168.

¹⁷² See 35 U.S.C. § 103(a) (2000).

¹⁷³ See Douglas Gary Lichtman, *The Economics of Innovation: Protecting Unpatentable Goods*, 81 MINN. L. REV. 693, 712-14 (1997) (discussing the possibility that some significant inventions will be ineligible for patent protection).

¹⁷⁴ See generally JAFFE & LERNER, *supra* note 115 (documenting the problem of overly relaxed standards and suggesting potential reforms).

¹⁷⁵ See *supra* note 31 (discussing the cost of patent prosecution).

III A POSSIBLE SOLUTION

The discussion so far suggests that patent law presents a central tradeoff—a postpatenting version of the classic tradeoff between providing incentives to invent and ensuring access to inventions. If a patent term is too short, the patentee might have socially insufficient incentives to develop the patent by engaging in nonpatentable research and commercialization activities, but if it is too long, excessive deadweight loss will result. Unfortunately this tradeoff cannot simply be optimized even in theory by setting the patent term to an appropriate length, since if a patent race amounts to an implicit patent auction,¹⁷⁶ longer nominal patent terms will push inventive activity earlier and result in shorter effective patent terms.

An alternative approach might be to allow patentees some power to delay the issuance of their patents. Indeed, the practice of continuing applications combined with the old system that measured patent life from the time of issuance,¹⁷⁷ as opposed to the time of filing,¹⁷⁸ effectively accomplished this result. The serious drawbacks to this system included the creation of “submarine patents” that enabled patentees to defeat other inventors’ reasonable expectations by intentionally delaying patent prosecution, only to later allow the patent to “surface unexpectedly and take competitors by surprise.”¹⁷⁹ In theory, the patent system could provide a formal mechanism for allowing delayed initial effectiveness of a patent while still ensuring immediate issuance. An inventor would then be able to delay patent issuance until the patent is most valuable. While this type of system would provide the benefit of encouraging the invention of fundamental building-block technologies long before they become commercially useful, it would also have serious drawbacks. In some cases, a delay would amount to no more than an extension of the patent monopoly because other firms would be unwilling to use a technology that they knew would later fall under patent protection. In other cases, firms might not delay at all, despite the danger of patent underdevelopment, in order to gain the benefits to reputation of being the first to market.

As a practical matter, the patent system accommodates the patent underdevelopment concern with a separate policy lever, namely the

¹⁷⁶ See *supra* Part I.A.2.

¹⁷⁷ Prior to 1995, the patent term was seventeen years from the date of issuance. See Uruguay Round Agreements Act, Pub. L. No. 103-465, § 532(a), 108 Stat. 4809, 4984 (1994) (codified as amended at 35 U.S.C. § 154 (2000)); see also Mark A. Lemley & Kimberly A. Moore, *Ending Abuse of Patent Continuations*, 84 B.U. L. Rev. 63, 80 (2004).

¹⁷⁸ See 35 U.S.C. § 154(a)(2).

¹⁷⁹ See Lemley & Moore, *supra* note 177, at 79–80.

designation of the quantum of achievement required for a patent to issue.¹⁸⁰ While requiring more achievement up front reduces the risk of patent underdevelopment, it also increases inefficient duplication and is, in the end, a crude policy response. This system exercises the policy lever at the beginning of the patent term when the risk of underdevelopment is least clear. Thus, even if the patent system sought to account explicitly for the risk of nondevelopment, doing so prematurely would frustrate that already difficult endeavor. This leaves two possible sets of strategies for penalizing underdevelopment: one involving a stick and the other a carrot.

The stick approach would impose an affirmative requirement that the patentee proceed with development. Europe utilizes such an affirmative requirement by demanding compulsory licensing in the absence of development.¹⁸¹ A more drastic affirmative requirement, which Oren Bar-Gill and Gideon Parchomovsky came close to endorsing in a recent article,¹⁸² would require that such patents be placed in the public domain. These stick approaches run into serious problems, however. Presumably, mere token development expenses would not count, but that means courts would need to engage in difficult line-drawing problems to determine how much development should count as enough. More worrisome is the likelihood that such legal requirements would encourage patentees to engage in wasteful pseudodevelopment simply to preserve the value of their development options. An even more fundamental problem with the stick approach is that the remedy may be worse than the disease. Once the patent is in the public domain, no one will have an incentive to develop it,¹⁸³ and presumably no one who could benefit from a compulsory license will want to develop a product that the initial patentee, who unlike the licensee did not have to pay a license fee, did not think would be profitable.

¹⁸⁰ See 35 U.S.C. §§ 101–103.

¹⁸¹ See *supra* note 11 and accompanying text.

¹⁸² See Oren Bar-Gill & Gideon Parchomovsky, Essay, *A Marketplace for Ideas?*, 84 TEX. L. REV. 395 (2005). The authors argue that those who conceive of ideas that need development should get intellectual property protection but then be required to auction their ideas to potential idea developers. See *id.* at 399–402. If the high bidder in the development stage fails “to produce a patent or product within a given time period, say two years,” *id.* at 421, then the idea would be placed in the public domain, *id.* at 418–19. Because this idea regime is virtually identical to the existing patent regime, see *id.* at 426–27 (imposing traditional requirements for patentability along with a requirement of “developability”), the proposal is effectively close to one that would combine mandatory auctions with a development requirement. To the extent that nondevelopment is a significant concern for their proposal, a better approach might be to penalize a nondeveloper by reauctioning the intellectual property right and by making auction revenues payable to the government.

¹⁸³ See *supra* pp. 1069–70. Thus, a development mandate will only achieve its goal if placing the idea in the public domain successfully deters nondevelopment and did not often actually need to occur.

Though the infeasibility of the stick approach suggests that a carrot might be needed, it would be difficult to develop a suitable carrot within the patent term. While the government can provide research subsidies, efficiently targeting those subsidies to situations in which nondevelopment is a particular danger would be difficult. Instead, a carrot is probably best offered near the end of the patent term when the additional development activities an extended patent term would enable and the costs of extended protection should be clear. There may be instances, for example, in which it is clear that a product simply will not be developed in the absence of a patent extension, even if the patent is placed in the public domain, and thus, the public would be better off with a patent extension than without it.

A relatively naïve way to implement the carrot would be for Congress or an administrative agency to grant patent extensions. In the early nineteenth century, Congress occasionally granted patent term extensions in individual cases.¹⁸⁴ In the 1980s, Congress enacted a few specific extensions to compensate patentees for time lost to premarket review by the FDA,¹⁸⁵ and in 1984, Congress enacted a systematic patent extension program for inventions that required FDA premarket review.¹⁸⁶ Pharmaceuticals might well be a category of invention in which the risk of nondevelopment is particularly high because of the expensive and nonpatentable commercialization activities that patentees must undertake.¹⁸⁷ However, Congress acted primarily based on fairness concerns rather than on concrete concerns about patent nondevelopment.¹⁸⁸ The predictable result of any case-by-case patent extension grant is rent seeking, and the patents most likely to justify lobbying expense—and thus to receive extensions—are likely those that have already shown strong commercial success, not necessarily those that need additional time. Of course, anticipating the possibility of an extension might stimulate additional development effort. But an ad hoc case-by-case extension system provides little guarantee that extensions will be anything but windfalls. In short, the carrot should not be too sweet.

Patent extension auctions present a straightforward means of providing patent extensions without the inadvertent side effect of creating windfalls. In a simple patent extension auction regime, the right

¹⁸⁴ For a history of nineteenth-century private patent extension bills, see Richard M. Cooper, *Legislative Patent Extensions*, 48 *FOOD & DRUG L.J.* 59, 59–62 (1993).

¹⁸⁵ See *id.* at 62–73.

¹⁸⁶ This program is known as the Drug Price Competition and Patent Term Restoration (Hatch-Waxman) Act of 1984, Pub. L. No. 98-417, 98 Stat. 1585 (codified as amended in scattered sections of 15, 21, 28, & 35 U.S.C.). See Cooper, *supra* note 184, at 62–73; *supra* notes 132–35 and accompanying text.

¹⁸⁷ See *supra* Part II.A.

¹⁸⁸ See Mossinghoff, *supra* note 133, at 188.

to a patent extension term would be auctioned to the highest bidder, which might not be the original patentee. The same approach can be used for copyrights. William Landes and Richard Posner have suggested that indefinite copyright terms might be optimal,¹⁸⁹ but this argument by itself does not justify providing certain copyright holders with the windfall of copyright extensions. As John Duffy has noted, if the benefits of extending existing copyright terms exceed the costs of deadweight loss, auctioning the copyright rather than granting the extension automatically to the copyright holder might still accomplish this result.¹⁹⁰ A straightforward second-price sealed bid auction¹⁹¹ allows the holder of an intellectual property right to receive an extension, but only by paying the government what the right would be worth to the next highest bidder. If the original right holder wins the auction, the right holder will still receive a small award equal to the difference between its valuation and the second-highest valuation. The expectation of such small payments would slightly strengthen the reward function of the intellectual property system and thus increase incentives to invest in future inventions and copyrights. Thus, in the long run, these small windfalls would not be transfer payments but would instead be part of the incentive to create.

That patent extension auctions can largely eliminate windfalls while reducing the risk of patent nondevelopment does not mean that they are optimal. Since extending a patent term, like extending a copyright term, will impose a deadweight loss, an auction should occur only when the social benefit of reducing the risk of nondevelopment exceeds the costs. These costs include not only deadweight loss but also the administrative costs of the auction and the research costs of bidders. Parts III.A and III.B consider the government and the patent holder as alternative decision makers of whether patent extension auctions should occur. Although this Article argues that both approaches might increase welfare, giving the patent holder incentives to make a socially optimal decision is the more intriguing choice. Because patent law applies in largely the same way across all technology

¹⁸⁹ See William M. Landes & Richard A. Posner, *Indefinitely Renewable Copyright*, 70 U. CHI. L. REV. 471 (2003).

¹⁹⁰ See John F. Duffy, *Intellectual Property Isolationism and the Average Cost Thesis*, 83 TEX. L. REV. 1077, 1094 (2005) (“In a world where . . . government-conferred property rights are increasingly auctioned rather than gifted,” laws providing intellectual property extensions “look more anomalous, and there is a general and principled theory for resisting them . . .”).

¹⁹¹ In a second-price sealed bid auction, the winner pays the amount of the second-highest bid; this gives each bidder an incentive to bid the bidder’s actual valuation. See William Vickrey, *Counterspeculation, Auctions, and Competitive Sealed Tenders*, 16 J. FIN. 8, 20–23 (1961) (introducing this auction form and discussing its benefits).

classes and all inventions,¹⁹² variables such as the patent term necessarily reflect crude attempts at balancing costs and benefits.¹⁹³ Although the government might seek to tailor patents to the characteristics of particular inventions,¹⁹⁴ that task, if feasible, is more likely to be accomplished by harnessing the information of private parties.

A. Government-Decreed Patent Extension Auctions

Consider first a regime in which the government could decide case-by-case whether to auction a patent extension. Conceivably, such an auction might take place just when a patent was about to fall into the public domain. The auction would thereby ensure additional years in which development activities could occur. However, the patentee would still have little incentive to engage in nonpatentable development activities in the final years of the patent term. For example, a marketing campaign to inform consumers of the benefits of a patented product might be useful primarily to ensure robust sales after the patent is set to expire.¹⁹⁵ Even if the patentee anticipates that a patent extension will be auctioned at the end of the patent term, the patentee will be unable to harness these marketing benefits since the patent extension will be worth more to all bidders. In effect, the marketing campaign would increase the amount that the patentee would have to pay at auction to receive the patent.

More specifically, assume there is a cash auction with payment due to the government¹⁹⁶ and a marketing campaign that would cost \$500,000 and would increase the value of the patent during the extension period by a present discounted value of \$1,000,000. The campaign then would not be worthwhile. The patentee would have to pay the \$1,000,000 in the form of a higher bid. If the marketing campaign did not affect pre-expiration sales, even anticipating victory in the auction, the campaign would end up costing \$1,500,000 for

¹⁹² *But cf.* Dan L. Burk & Mark A. Lemley, *Is Patent Law Technology-Specific?*, 17 BERKELEY TECH. L.J. 1155, 1183–85 (2002) (arguing that although the rules of patent law are the same across technology areas, in practice their application varies by industry).

¹⁹³ *See* Duffy, *supra* note 58, at 1 (“The problem of fixing an optimal patent term . . . is generally viewed as achieving a balance between the incentives necessary to encourage innovation and the inefficiencies associated with the exclusive right.”).

¹⁹⁴ For an analysis of the possible benefits and costs of individualized tailoring of intellectual property protection, see Glynn S. Lunney, Jr., *Patent Law, the Federal Circuit, and the Supreme Court: A Quiet Revolution*, 11 SUP. CT. ECON. REV. 1, 39–48 (2004). For an article suggesting the possibility of nonuniform patent terms with patentees selecting their own patent terms based on a fee schedule, see Francesca Cornelli & Mark Schankerman, *Patent Renewals and R&D Incentives*, 30 RAND J. ECON. 197, 197–98 (1999).

¹⁹⁵ *See supra* Part II.B.3.

¹⁹⁶ Payment ought to be to the government rather than to the patentee. Otherwise, the patent extension auction is simply a patent extension program in disguise, and the patentee would always be able to keep the patent by entering a very high bid.

\$1,000,000 in benefit. Of course, a patent extension auction immediately following patent expiration does not mean that nonpatentable development activities will cease altogether. If the extension is for a sufficiently long period, the winner of the auction, whether the original patentee or a third party, will have an incentive to launch the marketing campaign. The campaign, however, will have been inefficiently delayed until the expiration of the original patent term.

Alternatively, the government could hold an auction five years before the end of the patent term for the patent right in a period immediately following the patent term. Under this approach, if the patentee won the extension, the patentee would have an incentive to continue development activity in the closing years of the patent term. Even if a third party won the extension, the patentee and the auction winner could negotiate agreements to ensure continued development, since the auction winner could pay some of the development costs.

It is challenging to determine the optimal time to hold the auction. The earlier the patent extension auction occurs, the weaker the available information about the necessity of the extension will be. Holding the auction at the beginning of the patent term would provide the strongest assurance against patent nondevelopment—at least assuming the patentee wins the extension—but the least certainty about whether the benefits of the auction are worth the additional deadweight loss.

The central question for government-decreed patent extension auctions is whether the government, either acting through Congress or through an administrative agency, will do a good job determining whether and when to hold the auctions. False negatives—inefficient decisions *not* to hold auctions—at least leave the patent system no worse than the status quo, but false positives—inefficient decisions to hold auctions—could mean unjustified increases in deadweight loss.¹⁹⁷ The attraction of auction revenue might lead the government to hold auctions that amount to inefficient taxes. Of course, this is nothing new, since the government must always make decisions about how to raise revenue. But even if a particular auction is inefficient, it might be less so than the alternative means of raising the same revenue. Auctioning monopoly rights to fields that could be competitive is likely an inefficient approach to revenue generation,¹⁹⁸ but if holding such auctions allows patentees to internalize the benefits of their

¹⁹⁷ See Parchomovsky & Siegelman, *supra* note 158, at 1462.

¹⁹⁸ See Michael Abramowicz, *Perfecting Patent Prizes*, 56 VAND. L. REV. 115, 200–05 (2003) (arguing that the monopoly distortion from patents is generally greater than the distortion associated with taxation).

development expenses,¹⁹⁹ it might raise welfare. The question—a difficult one—is whether adding an additional method of government revenue generation will tend to increase or decrease efficiency.

An important consideration is the effect of the government's power on rent-seeking activities. Because auctions limit the windfalls that private parties will receive, they will generate less rent seeking than pure government largesse.²⁰⁰ Since the auction itself provides a mechanism for dissipating rents, additional rent dissipation will occur only to the extent that a particular party will benefit from an auction. With patent extension auctions, patentees will generally be eager to lobby for auctions only if they believe that they will win and have a substantial advantage over other potential bidders. One such advantage is continuous ownership; the patentee, unlike any third party, will be able to capture the benefits of development activities that occur during the original patent term, including the benefits realized during the original term and the extension period. Thus, although other factors might also give a patentee an advantage over third parties,²⁰¹ patentees will have a greater incentive to lobby for patent extension auctions when the costs of underdevelopment are high. The lobbying expenses are still a social cost,²⁰² but at least there is a rough correlation between cases in which patentees will seek extension auctions and cases in which such extension auctions will be socially beneficial.

B. Patentee-Decreed Patent Extension Auctions

Giving a patentee the exclusive power to seek a patent extension auction can reduce the social cost of lobbying expenses. The obvious danger is that the patentee will inefficiently invoke the auction option. Patentees might anticipate that they will have some advantage over other bidders, but this advantage might not be the advantage of continuous ownership. For example, the patent might be complementary to another patent in the patentee's portfolio, or the patent might help the patentee extend its monopoly into another market.²⁰³ Ideally, the patentee would elect the option only when the advantage that it en-

¹⁹⁹ The more common situation in which taxes may promote internalization involves negative externalities. See generally ARTHUR CECIL PIGOU, *THE ECONOMICS OF WELFARE* (Transaction Publishers 2002) (1920) (providing the classic defense of using taxation to internalize negative externalities). A patent extension achieved through an auction may allow internalization of the positive externalities of patent development.

²⁰⁰ Cf. Abramowicz, *supra* note 198, at 209–10 (discussing the typical problem of rent seeking in the current patent context).

²⁰¹ See *infra* notes 203, 209 and accompanying text.

²⁰² See Abramowicz, *supra* note 198, at 210.

²⁰³ For an overview of how the owner of an intellectual property right might seek to tie the protected product with another to extend the owner's market power, see Troy Paredes, Comment, *Copyright Misuse and Tying: Will Courts Stop Misusing Misuse?*, 9 HIGH TECH. L.J. 271, 298–302 (1994).

joys is attributable to ownership continuity.²⁰⁴ A relatively simple auction regime can provide a reasonable assurance that this ideal is achieved. Part III.B.1 describes this mechanism, Part III.B.2 elaborates particular details, and Part III.B.3 considers some variations.

1. *The Mechanism*

The auction mechanism would work as follows: Congress would specify a field of technology, or perhaps even individual patents, in which patent underdevelopment seems a likely problem. In theory, Congress might apply the auction mechanism to the entire patent system, but at least initially, much more narrow experimentation would be preferable. In the authorized field, a patentee at any time would be able to request an auction for a patent extension and to specify, perhaps within limits, the length of time of that extension. The patentee initially would not bid in the auction. After third parties have had a chance to bid, the patentee would then be given an opportunity to purchase the patent extension for a set markup over the top bid. For example, if the statute authorizing patent extension auctions declared the markup to be 25%, and the high bid at the auction was \$1,000,000, then the patentee would have an opportunity to purchase the patent extension for \$1,250,000.²⁰⁵ If the patentee declined the purchase, then the high bidder would win the auction, paying an amount equal to the bid of the second-highest bidder.²⁰⁶

An auction that results in transference of the patent to a third party might be a social failure, for such auctions would increase dead-weight loss without increasing the incentive to develop the patent within the original patent term.²⁰⁷ The third parties must, however,

²⁰⁴ A patent extension might be useful for reasons other than patent underdevelopment, such as when the patentee has special expertise in price discriminating and, thus, in improving efficiency. See generally Harold Demsetz, *The Private Production of Public Goods*, 13 J.L. & ECON. 293, 301–02 (1970) (explaining how price discrimination can improve efficiency in the provision of public goods). Here, however, I have focused solely on whether an auction mechanism might solve the patent underdevelopment problem.

²⁰⁵ A variant would require the patentee to submit a sealed bid at the same time third parties submit sealed bids and then would award the patentee the patent if and only if its sealed bid exceeded the next highest by at least the markup. In this regime, third parties could offer bids as percentages of the patentee's bid up to a specified maximum. This might be useful if third parties are not expected to have good information about the patent's value. A third party would then need to consider only the extent to which the patent would be less valuable to it as a result of the lack of ownership continuity and the transaction costs associated with selling the patent back to the patentee after the expiration of the original term.

²⁰⁶ See *supra* note 191 and accompanying text (discussing the second-price sealed bid auction approach).

²⁰⁷ Conceivably, auctions could reduce the cost of that failure. For example, the government might use the auction mechanism suggested by Michael Kremer. See Michael Kremer, *Patent Buyouts: A Mechanism for Encouraging Innovation*, 113 Q.J. ECON. 1137, 1146–48 (1998). Under that mechanism, an auction would be used to value a patent, but

have some incentive to participate in the process to ensure a competitive bidding regime. The difficult task is to ensure that patentees have incentives to call for auctions only when they actually expect a strong probability of winning, while at the same time ensuring at least some reasonable third-party bids. Ordinarily, patentees will already have some incentive not to call for auctions that they do not expect to win. They might be worse off with the patent in the hands of a third party than with the patent in the public domain, particularly where the patentee wishes to sell directly a good or service represented by the patent. It would be straightforward to add additional incentives not to call an auction, such as requiring a patentee to pay the high bidder a penalty percentage of its high bid if the patentee declines the option to purchase the patent extension.²⁰⁸ This would have the additional benefit of increasing auction competitiveness, which would likewise increase if the high bidder received a percentage of the purchase price when the patentee does exercise the patent extension option.

2. *The Details*

a. *Post-Auction Sales of Term Extensions*

Two rules are essential for cases in which a third party purchases the patent term extension:

First, the purchaser cannot be allowed to sell the patent extension to the original patentee during the original patent term. Otherwise, even where a patentee is clearly the most efficient patent owner, a third party's bid will be based on its estimate of the original patentee's valuation. The difference between what the original patentee is willing to pay and what the third party is willing to pay would be attributable to the anticipated combined bargaining costs of the transfer negotiation. Instead, the auction mechanism will work appropriately only if the difference derives from the benefit of development within the original patent term. To force the third party to consider only its own valuation of the patent, and not the possible increased benefits from patent development, the third party must be barred from resel-

would consummate with only some low positive probability. *See id.* at 1147. With high probability, the price signals from the auction would help derive a value to compensate the patent holder who, in this case, is the winner of the patent extension at the initial auction. *See id.* There are obvious affinities between my proposal and Kremer's: both seek to use information from bids for patents at auction to overcome problems with the patent system. *See id.* The ends, however, are opposite. Kremer's proposal is potentially useful when there are efficiency advantages to placing a patent in the public domain, while the approach described here is useful when there are efficiency reasons to prevent a patent from falling into the public domain. They could, however, be combined to account for cases in which the patentee's initial decision turns out to be mistaken.

²⁰⁸ The optimal markup would decline with an increase in the penalty percentage because the penalty percentage would make the option of declining the extension less attractive.

ling the patent during the patent term. Likewise, the original patentee should be prevented from selling the remainder of the original patent term to the purchaser of the extension period.

Second, the purchaser should be allowed to sell the patent extension to the original patentee *after* the original patent term has expired or once expiration is so close that it would be too late for the original patentee to engage in further meaningful patent development within the patent term. This rule ensures that the user who values the patent most—the highest-valuing user—holds the patent. It also assures that the difference between the original patentee's valuation and the third party's valuation derives from the benefit of development of the patent within the original patent term and not from some other factor that makes the patent particularly valuable to the patentee. Critically, this rule will not undermine the previous one. A patentee who loses a patent extension auction ordinarily will not be willing to undertake development costs with the hope of recouping them by buying the patent extension after the original patent term expires. Because development would make the patent more valuable, the patentee would have to pay the extension-right holder for the increase in value attributable to the patentee's own development expenses.

Suppose, for example, that a patent needs no further development, but that it is twice as valuable to the patentee than to the highest-valuing third-party bidder. Because no further development is needed, the unique value to the patentee must come from market power during the patent extension term; for example, such unique value may come from the fact that the patent will be more valuable as part of a patent portfolio than alone.²⁰⁹ If a third party could not sell the patent extension back to the original patentee during or after the original patent term, then the third party would not incorporate this unique value into its bid. Thus, as long as the markup was less than 100% (and, in the interest of simplicity, disregarding the possibility of penalties), the patentee would win the patent extension but for reasons contrary to the goals of the patent extension auction system. However, if the third party anticipates being able to sell the patent extension back to the original patentee, the third party will also anticipate being able to capture the full amount of the markup and thus will bid as much as the patentee. Anticipating this result, the patentee will not call for an auction in the first place.

²⁰⁹ See generally Parchomovsky & Wagner, *supra* note 29 (arguing that patents may be more valuable as part of patent portfolios than alone).

b. *Determination of the Markup*

Aside from overseeing the auction and determining whether contracts assigning patents meet the above rules, the government would not be involved in the auction mechanism. Patent holders would have an incentive to call for and, ultimately, win an auction only where the benefits of patent ownership continuity are sufficiently great to justify paying the markup. The challenge for the government is determining the size of that markup. If the markup is too low, then relatively small benefits from continuity will lead to auctions even if significant deadweight loss results. Our existing patent system, however, which does not allow extensions, is tantamount to a system with an infinite markup. Initially, a government creating a system of patent extension auctions might start with a very high markup so that only a few auctions would be held and studies could assess whether the extensions benefited the public. Then, if patent extension auctions appeared to increase public welfare, the government might gradually lower the markup. Conceivably, the government might eventually offer different markups for different patents, since the amount of deadweight loss might vary depending on factors such as the ease with which price discrimination can be accomplished. Such a system has its drawbacks, however, since individuation would encourage rent seeking.

A simple algebraic argument suggests that an approximation of the optimal markup is 25%. Let m represent the markup, let v represent the total value of the patent extension to the highest-valuing third-party user, let s represent the social benefit of increased ability to develop the patent, and let p represent the proportion of this benefit that the patentee will privately capture. The patentee will call for an auction if $ps > mv$. The government would like to induce an auction if and only if $s > d$, where d represents the deadweight loss resulting from the patent extension. Thus, the government should set $m = pd/v$. With linear demand, $d/v = 0.5$.²¹⁰ Meanwhile, the patentee is unlikely to be able to price discriminate perfectly, but one can reasonably assume that the additional producer surplus attributable to the development will be equal to the additional consumer surplus, so that $p = 0.5$. Therefore, the government should set $m = 0.25$ to reach an optimal result. To be sure, these assumptions are gross simplifications, and the analysis, which assumes perfect information on the part of the patentee, disregards the possibility that the patentee will ever need to pay a fine.

²¹⁰ See, e.g., Douglas Gary Lichtman, *Pricing Prozac: Why the Government Should Subsidize the Purchase of Patented Pharmaceuticals*, 11 HARV. J.L. & TECH. 123, 132 n.21 (1997) ("When facing linear demand and zero marginal cost, a monopolist maximizes profit by selling to exactly half the consumers. Geometrically, this means that [consumer surplus] = [deadweight loss] = $(0.5 * [\text{producer surplus}])$.").

3. *The Variations*

a. *Alternative Auction Currencies*

We have assumed so far that the auction currency would be cash payable to the government. In a separate paper addressing the possibility that auctions of rights to inventive fields might serve as alternatives to the current patent system, I noted that such auctions might use different currencies.²¹¹ The same argument applies to the patent extension auctions contemplated here. A benefit of the cash-to-government approach is, of course, that it provides the government with revenue. Alternative auction currencies, however, could potentially help advance specific goals of the patent extension auction system. This section considers two alternative auction currencies. Additionally, the government could hold a “multiple currency auction” using some formula to aggregate bids that span different components.

First, the currency might be cash to be invested in development activities, rather than cash to be paid to the government. If the patent holder intends to engage in substantial development activity during the time remaining in the original patent term, then the patent holder will outspend the high bidder, who would not have incentives to spend money until after the patent term. Where the patent holder would spend significantly more on development than would any third party, the additional deadweight loss from a patent extension is worth suffering. This approach would encourage more total investment in patent development than the cash-to-government approach. A weakness of this approach is that it limits the auction winner’s flexibility if changes in circumstances make further patent development inadvisable. In addition, for this approach to work, the government would need to be able to assess whether funds are, in fact, being spent on development activities.

Second, if injunctive relief were disallowed during patent extension periods, the auction currency could be patent damages. Ian Ayres and Paul Klemperer have noted that, in the absence of injunctions, lowering patent damages effectively reduces the price patentees will charge for their inventions.²¹² Patentees will set prices anticipating the possibility of unauthorized competition, and patentees and licensees negotiate in the shadow of potential lawsuits. The winning bidder in the initial auction therefore might be the party that offers to accept the smallest proportion of patent damages. The original patentee would receive a patent extension only if she agreed to

²¹¹ See Michael Abramowicz, Patent Auctions 43–44 (2005) (unpublished manuscript, on file with author).

²¹² See 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, 1028–31 (1999).

accept an even smaller proportion of patent damages. This system would therefore require a markdown, rather than a markup. The benefit of this approach is that lower prices reduce deadweight loss, partly offsetting the concern that patent term extensions will result in continued high prices for consumers.

A problem with this approach is that agreements to charge low prices may lead to patent underdevelopment. If the goal is to encourage development, then allowing a patentee to capture only a small proportion of surplus can be counterproductive. Even more troubling is that a third party could offer the best bid by agreeing to only nominal damages, and a patentee could accept even more nominal damages but then not further develop the patent. Thus, a bid for a low price would likely need to be accompanied by some form of cash payment or investment commitment so that the level of patent damages would not be too low. Increasing the amount of cash committed decreases the danger that the auction currency itself will reintroduce the problem of patent underdevelopment but increases the likelihood of deadweight loss. Alternatively, the auction structure could be reversed, with a relatively low, fixed level of patent damages accompanying the patent term extension and bidders offering cash or investment commitments.²¹³

b. *Repeated Extensions*

Regardless of the auction currency, the process might be repeated iteratively. As the end of the patent extension period approaches, the patentee will consider whether to demand another auction and seek another extension.²¹⁴ The patentee should have roughly appropriate incentives in determining when to request a patent extension auction and how long an extension to request. Each time, the patentee will have an incentive to wait long enough to ensure that additional development will be needed, but also to seek an extension early enough to ensure that it will be able to recoup its development expenses. Similarly, the patentee will want a relatively short patent extension term so that it does not end up paying a premium for a portion of the patent term where it has no competitive advantage over the victorious third party. But the patentee will also want a relatively long patent extension term to ensure that it will own the patent long enough to recoup its development expenses. While

²¹³ Ayres and Klemperer provide a general argument for lowering the level of patent damages and for limiting injunctive relief, but a jurisdiction seeking to implement their proposal could set the price level without holding an auction. *See id.*

²¹⁴ Conceivably, a third party that won an auction could also seek another patent extension. The third party's victory, however, would ordinarily signal that the benefits of ownership continuity were not as high as the patentee thought they might be.

this does not prove that the patentee's privately optimal decision will be socially optimal, the balance of considerations likely places the patentee in a better position than the government to determine when patent extension auctions should occur and how long term extensions should be.

c. *Copyright Term Extensions*

The result of a system where patent term extensions are repeatedly auctioned would be a regime of indefinitely renewable patents²¹⁵ analogous to the regime of indefinitely renewable copyrights suggested by Landes and Posner.²¹⁶ There are differences between the two regimes. In the patent extension auction system, the price of renewal would vary with the value of the intellectual property right, and the intellectual property right holder would generally have an incentive to seek renewal only when it would be socially beneficial. Auctioning copyright term extensions through any means would accomplish the first of these two goals but would not necessarily accomplish the second. While auctioning copyright extensions through a method analogous to the patent term extension auctions described here might attempt to accomplish the second goal, underdevelopment is not likely to be a great concern in copyright law because the copyright owner can obtain a new copyright on a derivative of the original work.²¹⁷ Moreover, especially since the enactment of the Copyright Term Extension Act in 1998,²¹⁸ the copyright term is sufficiently long that a copyright holder will probably spend little marketing the original work, and there will be little need for commercial experiments to test the public's demand for the original.

In copyright, there is thus less danger of underdevelopment than overdevelopment, producing what Landes and Posner refer to as "congestion externalities."²¹⁹ For example, Landes and Posner justify

²¹⁵ Mark Lemley interprets the theory that intellectual property rights may ensure the efficient management of property to imply that "there seems little reason to terminate that right after a period of years." See Lemley, *supra* note 75, at 131. Indeed, my analysis suggests that a definite termination may not be optimal. Lemley might overstate the point, however, because those who advance what he refers to as "ex post" justifications for intellectual property concede that intellectual property rights have costs, including deadweight loss. See *id.* at 129. The challenge, which I seek to meet here, is to find a way to extend patents just long enough to allow for efficient management and development of the property rights up until the point where the cost of further extensions would exceed their benefit.

²¹⁶ See Landes & Posner, *supra* note 189.

²¹⁷ See 17 U.S.C. § 106(2) (2000).

²¹⁸ *Id.* §§ 302–304.

²¹⁹ Landes & Posner, *supra* note 189, at 484–88; see Michael Abramowicz, *A Theory of Copyright's Derivative Right and Related Doctrines*, 90 MINN. L. REV. 317 (2005) (arguing that the derivative right is justified in part because it reduces the number of derivative works made).

the long copyright term based on a concern that if Mickey Mouse were in the public domain, different authors might use him in different ways, thus blurring the character and reducing the total social value that the character produces.²²⁰ A slightly different mechanism, in conjunction with a shorter initial copyright term, might provide an efficient way of allowing long copyright terms only in cases where congestion externalities are an issue. For example, the initial auction might be for three different licenses to the copyrighted work. The copyright holder would then have an opportunity to keep the copyright without giving away a license by paying an amount equal to some multiple of the average of the top three bids. The copyright holder's valuation is likely to be particularly high relative to the bids for licenses when the competition among the licensees poses a risk of oversaturating the public or causing inconsistent development of the copyrighted work.

CONCLUSION

Although intellectual property commentators have long discussed the optimal length of the patent term, they have assumed that the existing term is long enough to give patentees sufficient incentives to commercialize their patented inventions. Two new developments, one empirical and one theoretical, make such assumptions problematic. First, patents are increasingly granted on embryonic inventions, particularly in the field of genomics. Such inventions may require study for a period longer than the patent term. Second, economic models of intellectual property suggest that inventors may acquire patents for their option value at a relatively early stage of development. By the time a patent option would be worth exercising if most of the patent term remained, so little time may remain that commercialization would not be feasible.

The patent system includes some mechanisms that significantly limit the underdevelopment problem. First, by imposing substantial requirements for patenting, the patent system reduces the proportion of expenses that need to be made after patenting. The patent underdevelopment concern thus provides a counterweight to the prospect theory of patents, which argues that patents should be granted early. Second, improvement patents can effectively extend the patent term. However, they may not be available for some types of development activity, including scientific experimentation, commercial testing and marketing, and research producing subpatentable inventions.

²²⁰ See Landes & Posner, *supra* note 189, at 487–88 (“Not only would the public rapidly tire of Mickey Mouse, but his image would be blurred, as some authors portrayed him as a Casanova, others as catmeat, others as an animal-rights advocate, still others as the henpecked husband of Minnie.”).

As a result, patent extensions, though probably welfare decreasing for the vast majority of inventions, might enhance social welfare for a small subset.

Auctions for patent term extensions provide a possible solution to the patent underdevelopment problem. Under this approach, a patentee would be able to call for such an extension before the end of the patent term. The patentee, however, would need to offer a bid substantially exceeding that of the runner-up to win the extension, and a patentee who calls for, but does not win, an auction would pay a fine. This approach will result in patent extensions only where the value of continuity of patent ownership is relatively high. These will be cases in which the patentee would like to make investments during the remainder of the original patent term that would pay off primarily in the extension period and, thus, where the degree of patent underdevelopment would otherwise be high.

