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Clearings and Thickets

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by

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Clearings and Thickets³

Compounded over a century, 2 percent annual growth (roughly the recent growth rate of the U.S. economy) increases wealth more than 7 times, and 10 percent annual growth (roughly the recent growth rate of the Chinese economy) increases wealth by almost 14,000 times.⁴ Differences in sustained growth cause one country's wealth to overtake another country faster than the mind can grasp.

Like individuals, nations are highly competitive. Poor nations hope to overtake rich nations, and rich nations fear being overtaken. Besides relative income, individuals and nations care about absolute income. Most people want to live a long time and educate their children absolutely. Life expectancy at birth is 83 years in Japan and 66 years in Bangladesh.⁵ Enrollment in secondary school is 98 percent among Japanese children of the appropriate age and 42 percent in Bangladesh.⁶ Almost everyone would prefer to live at the level of Japan rather than Bangladesh.

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³ Robert Cooter excerpted this presentation from two joint writings with Aaron Edlin: "Chapter 2: Clearings and Thickets" in a preliminary book manuscript tentatively entitled *Introduction to Law and Growth Economics*, and "Overtaking" in *The American Illness*, ed. Frank Buckley (Yale University Press, 2012).

⁴ 1.02 to the power 100 equals 7.2; 1.10 to the power 100 equals 13,781. Growth in national income per capita is a better indicator of welfare than growth in national income. According to the CIA's World Factbook, U.S. population growth rate is roughly 1 percent (among the highest among developed countries), and China's population growth rate is .5 percent.

⁵ Life expectancy at birth, total (years) in 2008, World Bank. <http://data.worldbank.org/indicator/SP.DYN.LE00.IN>. Note that life expectancy is in the 40s in many African countries.

⁶ Data & Statistics on Education for 2007 and 2008, World Bank, <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTEDUCATION/0,,contentMDK:20573961~menuPK:282404~pagePK:148956~piPK:216618~theSitePK:282386,00.html>.

Much contemporary policy discussion concerns redistribution of income, but growth has more powerful effects on human welfare. The lowest wage earners in the U.S. or any country would benefit far more in the long run from a faster growth rate in national income than from redistributing existing national wealth in their favor. Even people who depend on transfer payments would benefit more from faster growth than income redistribution. A faster growth rate increases wages and tax revenues available for transfer payments, and this increase overtakes gains in welfare from redistributing income.⁷ Returning to our previous comparison, 1 percent of an increase of 14,000 is 20 times more than 100 percent of an increase of 7 times.

To appreciate the mathematics of overtaking, consider two sequences of utility in an infinite number of generations. In the first sequence, income per capita grows at a faster rate. In the second sequence, growth is slower and initial utility is higher. The sum of utilities in the first sequence overtakes the sum of utilities in the second sequence whenever policy makers give weight to future generations that is similar to the weight given to the present generation.⁸ Although this “overtaking theorem” concerns infinite time, in practice overtaking occurs quicker than people imagine, because they fail to appreciate fully the effects of compound growth. Given overtaking, anyone who values human welfare should recognize growth’s importance as a policy goal.

In the preceding propositions, “growth” has two attributes lacking in standard measures of national income such as gross domestic product (GDP). The first attribute is sustainability. Growth overtakes other welfare considerations when it is sustainable and continues into the future. Sustainable growth uses

⁷ The largest effect of income redistribution on human welfare is through growth. Sometimes more inequality causes more growth by improving incentives for innovation, as in China after 1980. Sometimes redistributive expenditures promote growth by improving the education and health of workers as with free primary schools and prenatal clinics.

⁸ Robert Cooter and Aaron Edlin, *Maximizing Growth vs. Static Efficiency or Redistribution*, Berkeley Law and Economics Working Paper (2010) prove formally that overtaking always occurs provided the social planner’s preferences for equality are not too strong.

natural resources in fixed supply at a decreasing rate, whereas unsustainable growth uses them at a constant or increasing rate (or a rate that does not decrease fast enough). The second attribute is comprehensiveness. A comprehensive measure of wealth encompasses *all* valuable goods, including non-market goods such as public goods and the environment. By contrast, a partial measure of wealth such as GDP excludes goods that are not sold in markets. When comparing welfare, partial measures may make little sense, because a loss in unmeasured wealth may offset a gain in measured wealth. Thus burning more coal to power air conditioners increases the simplest measure of market income, but it does not necessarily increase a full measure of wealth if pollution increases significantly.

The case for increasing the rate of sustainable, comprehensive growth is compelling, but how is it to be done? Innovation proximately causes sustained growth in income per capita. In fact, innovation is the only way to have sustainable growth in a world of finite resources. Education, communication, transportation, immigration, organization, taxation, and many other factors affect innovation. This essay takes the legal perspective. From this perspective, the normative question of growth economics is, “Which laws increase the pace of economic innovation?”

Property law establishes the ownership of objects by people. Ownership conveys a bundle of rights that describe what people may do with what they own -- possess, use, develop, improve, transform, consume, deplete, destroy, sell, donate, bequeath, transfer, mortgage, lease, loan, exclude, and so forth. By attaching objects to people, property law supplies a framework for making and distributing wealth, which can stimulate or suffocate economic growth. Given the right bundle of rights and effective protection of them, an economy can grow and enrich the nation. Given ineffective protection or the wrong bundle of rights, an economy can decline and impoverish the nation.

Sustained growth comes from economic innovation. Discovering new ideas and developing them usually requires investment by entrepreneurs. An innovator has a temporary advantage over competitors until they catch up. While

the temporary advantage lasts, the innovator enjoys extraordinary profits, which we call “venture profits.” Higher venture profits imply stronger incentives for innovation. To increase the pace of innovation, laws should increase venture profits.

Intellectual property law, which includes patents and copyright law, establishes the ownership of innovations by people. It conveys a bundle of rights to creators as determined by rules. Applied to intellectual property law, the normative question of growth economics is, “Which ownership rules maximize innovation?” In order to increase the pace of innovation, ownership rules should increase venture profits. So the question of this essay is, “Which ownership rules maximize venture profits?”

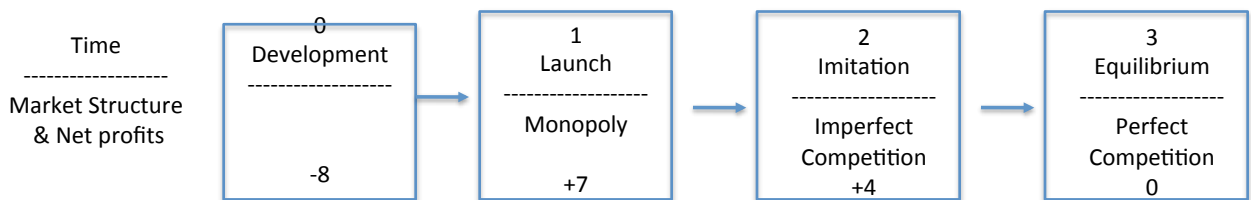
How Intellectual Property Law Promotes Growth

To answer this question, we begin by explaining how innovations become property. Legal ownership sometimes goes to the first person to invent a machine, create a molecule, extract a vaccine, compose a song, write a book, or record a performance. The first person to embody a new idea in an innovation may acquire private ownership of it through patent or copyright law. These two bodies of law convey ownership to intellectual creations, so they are called “intellectual property law.”

Intellectual property rights sometimes increase investment in innovations. Thus Figure 2.1 depicts the payoffs to an innovation over its life cycle, from discovery to obsolescence. Developing a new idea in period 0 costs 8. We assume that the developer receives a patent for the innovation, which prohibits others from using it without his permission. Next the innovation is launched and sold to buyers. When launched in period 1, the innovation has no competitors, so the innovator is a monopolist who receives a payoff of 7. In period 2, imitators develop competing products that substitute for the patented innovation, which reduces the innovator’s payoff to 4. In period 3, the patent expires and competition intensifies. Others can now produce the same goods at the same cost as the innovator. Taking competition to its logical extreme, we assume that

the market is perfectly competitive in period 3 and the innovator's payoff is zero. Summing over the life cycle, the innovator's net payoff equals +3, so developing the innovation is profitable to the innovator. If the innovator can foresee this fact in period 0, it will develop the innovation. Generalizing, the expectation of positive venture profits causes the development of innovations.

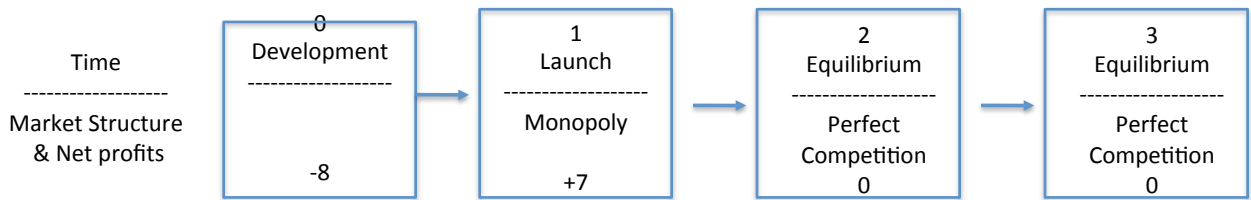
Figure 2.1. Payoff to Innovator with Property Right



The innovator in Figure 2.1 receives an effective patent. However, many innovations are not patentable and many countries have ineffective patent laws. Figure 2.2 illustrates how the numbers might change if the innovator does not receive an effective patent. The innovator in Figure 2.2 spends 8 in period 0 to develop the product. Although the innovator does not receive an effective patent, the innovator still enjoys the temporary advantage of being first to market the innovation. When the innovation is launched in period 1, the innovator has no competitors and enjoys profits of 7. After launch, however, imitators freely copy the innovation, without bearing the cost of developing it. We assume that the market reaches a competitive equilibrium in period 2, so the innovator's payoff is 0 in period 2 and period 3. Summing over the life cycle, the innovator's net

payoff equals -1. Without intellectual property protection, the innovator cannot recover the cost of developing the new idea. If the innovator can foresee this fact in period 0, it will *not* develop the innovation. Generalizing, the expectation of negative venture profits prevents the development of innovations.

Figure 2.2. Payoffs With Developer’s Disadvantage Without Property Right

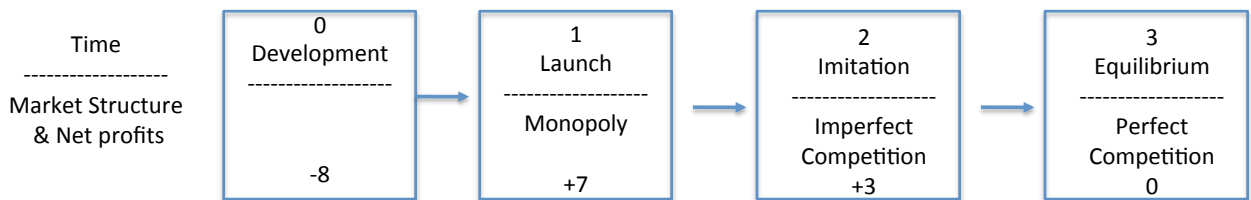


Effective intellectual property law transforms the innovator’s loss in Figure 2.2 into the gain in Figure 2.1. The comparison between the two figures illustrates that intellectual property rights are necessary to innovation when development costs are high relative to the payoff from launching an innovation first. In contrast, some innovations have low development costs relative to the payoff from launching first. This can occur either because the innovation is particularly cheap to develop, or because launching it first yields a big advantage for the innovator. In such cases, intellectual property rights may not be necessary for innovation.

Figure 2.3 illustrates this possibility. As in Figure 2.2, the innovator in Figure 2.3 who develops the product spends 8 on development and does not receive an effective patent. As in Figure 2.2, the launch in period 1 yields profits of 7. The difference between Figures 2.2 and 2.3 occurs in period 2. We

assume that the innovation in Figure 2.3 is a differentiated product that yields a payoff of 3 in period 2. The imitations in period 2 are not quite as good as the original. (In contrast, Figure 2.2 assumes that the imitations in period 2 are perfect substitutes for the original.) Summing over the life cycle in Figure 2.3, the innovator's net payoff equals +2, so developing the product is profitable to the innovator. If the innovator can foresee this fact in period 0, it will develop the innovation, even though it will not receive a patent. Generalizing, an innovation is profitable without intellectual property protection when development costs are low relative to the payoff from launching first.

Figure 2.3. Payoffs With Developer's Advantage and Without Property Right



Besides making an unprofitable innovation profitable, effective intellectual property law can make a profitable innovation more profitable. Thus a patent in Figure 2.3 might increase the payoff in period 2 from 3 to 4, so the innovator's net payoff summed over the life cycle increases from +2 to +3. This conclusion, however, does not generalize. Stronger intellectual property rights for a particular innovation make it more profitable, but stronger intellectual property rights for all innovations can increase or decrease venture profits overall. (More on this comes later.)

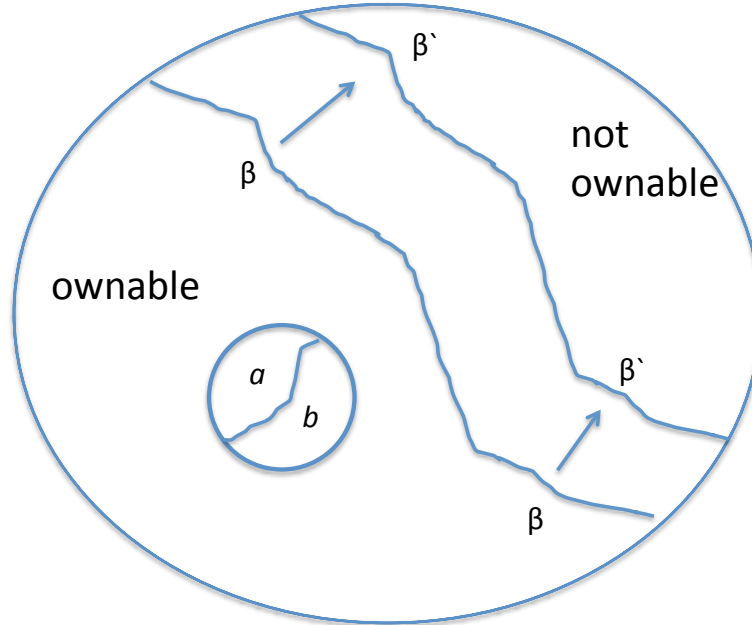
Intellectual property law differs from one country to another and it changes with time. Thus U.S. patent duration is 20 years from the date of filing the patent application. (Before 1995, U.S. patent duration was 17 years from the date the patent issued.) Besides duration, patents also differ in breadth -- a patent on all umbrellas is broader than a patent on umbrellas that open automatically. The duration and breadth of a patent define its scope. The law requires anyone who acts within the scope of someone else's patent to license the right to do so from its owner. Acting within the scope of a patent and without a license infringes it. The owner can sue to prevent future infringements and to recover damages for past infringements.

Patent law strengthens by increasing the number, breadth, or duration of patents. Thus a controversial development recently strengthened US patent law by allowing inventors to patent new business processes, which were formerly considered unpatentable, such as Amazon's patent on "one-click" ordering from its online catalogue. "Stronger patent law" refers to a change in rules that increases the scope of private ownership of innovations, leaving less scope for unowned innovations.

Thus Figure 2.4 divides future innovations into "ownable" and "unownable." A new computer chip is ownable (patentable) and a new metaphor in the English language is unownable (no patent, no copyright). The boundary of the ownable is labeled β . Strengthening the patent system increases ownable innovations and decreases unownable innovations, as indicated in Figure 2.4 by shifting the boundary from β to β' . In effect, stronger patents fence in more of the common land of innovation.⁹

Figure 2.4. Future Innovations

⁹ Increases in the scope of a particular patent do not necessarily increase the scope of patents as a whole. Rather, the scope of a particular patent can increase by decreasing the scope of another patent. Instead of fencing more of the common land of innovation, the fence between patent holders moves to the advantage of one of them and to the disadvantage of the other.

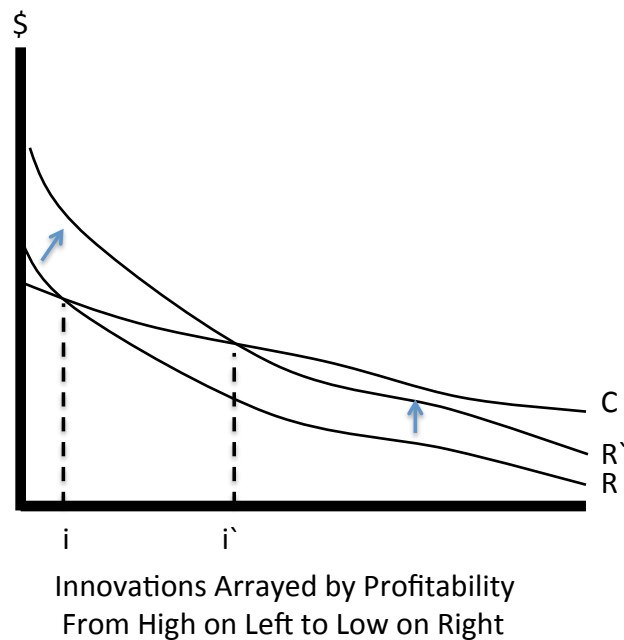


Our discussion of Figures 2.1 to 2.3 explained that stronger patents rights sometimes make unprofitable innovations profitable and profitable innovations more profitable. When stronger intellectual property rights make innovations more profitable, the number of innovations usually increases. To see why, think of an array of new ideas that differ according to the expected profitability of developing them. Innovators develop the ideas that they expect to yield positive profits, and they do not develop the ideas that they expect to yield negative profits. If stronger intellectual property rights increase the expected profits for innovations, some ideas will tip from negative to positive expected profits, so innovators will want to develop them.

Figure 2.5 illustrates this possibility. The horizontal axis indicates an industry's array of possible innovations in decreasing order of profitability. The

curve R indicates revenues given weak patents. The revenue curve R intersects the cost curve C at point i . To the left of i , revenues R exceed costs C, so the innovations will be developed. To the right of i , costs C exceed revenues R, so the innovations will not be developed. The tipping point is i , which equals the number of developed innovations. By assumption, strengthening patents in this industry increases revenues from R to R' . We assume that costs C do not change. With strong patents, the revenue curve R' intersects the cost curve C at point i' , which indicates the number of developed innovations. Thus stronger patents cause the development of innovations to increase from i to i' .

Figure 2.5. Development of Innovations with Weak and Strong Patents



I. How Much Ownership?

What strength of intellectual property rights maximizes innovation? From the preceding discussion, you might think that the general answer is, “The ownership rules that give innovators the strongest property rights.” You might reason that stronger intellectual property rights always increase the profitability of innovating, which causes more of it. If that is what you think, then you are half right. Increased profitability of innovating causes more innovation, all else equal, but stronger intellectual property rights do not always increase the profitability of innovating.

What determines whether stronger patents increase or decrease venture profits? The answer is remarkably simple. A stronger patent transfers wealth to its owner from someone else. The pace of innovation increases or decreases depending on the transfer’s source. Stronger patents increase venture profits in so far as they shift wealth from consumers and producers to innovators, whereas stronger patents decrease venture profits in so far as they shift wealth from one innovator to another.

To see why, contrast consumption, production, and innovation. Households use innovations such as new pharmaceutical drugs for consumption. Stronger property rights for such innovations transfers wealth from consumers to innovators. The prospect of greater wealth causes more ventures to develop pharmaceutical innovations. Thus stronger intellectual property rights for pharmaceuticals cause more innovation in drugs. Whereas consumers mostly use most pharmaceutical drugs, firms mostly use industrial robots for production. Stronger property rights for such innovations in industrial robots transfers wealth from producers to innovators. Since industrial robots are mostly used in production, stronger intellectual property rights cause more innovation in industrial robots. Generalizing, intellectual property rights that transfer wealth from static uses (production and consumption) to dynamic uses (innovation) increase the pace of economic growth.

Besides consuming and producing, innovations are used for innovating. Today’s new molecule is discovered from yesterday’s new molecule; today’s new

operating system is discovered from yesterday's new operating system; today's new power cell is discovered from yesterday's new power cell. Prior innovations often propel subsequent innovations in a cascade. If someone owns yesterday's innovation, then researchers must pay to use it to develop today's innovation. Thus assume that firm B sells its improved operating system to firm C, and firm C uses it to develop a new operating system that is even better. Stronger intellectual property rights increase C's revenues from selling its innovation, and also increase C's cost of using B's innovation.

When innovations are mostly used to make other innovations, do stronger intellectual property rights increase or decrease venture profits overall? The standard economics of monopoly provides the answer. The owner of intellectual property is a temporary monopolist. According to standard economic analysis, the increase in the seller's profits from monopoly is less than the decrease in the buyers' profits. The shortfall is the "dead weight" loss of monopoly.¹⁰ Standard economic theory predicts a dead weight loss -- the gainers gain less than the losers lose. Thus strengthening property rights in a cascade of innovations causes a deadweight loss that reduces the overall profitability of innovating. Venture profits decrease overall by the amount of the deadweight loss. When stronger intellectual property rights redistribute wealth among innovators, the gainers gain less than the losers lose. Generalizing, intellectual property rights that transfer wealth from one dynamic use to another decrease the pace of economic growth.

We have described two opposing effects of stronger intellectual property rights. The first effect is the transfer of wealth from static to dynamic uses. This effect dominates where innovators mostly sell to consumers and producers. For these innovations, strong intellectual property rights maximize the rate of innovation. The second effect is the deadweight loss from monopoly transactions among innovators. The second effect dominates where innovators

¹⁰ Monopoly transfers profits from the buyers to the monopolistic seller. Besides the transfer, some profits disappear in a pure waste. "Dead weight loss" is the pure waste of resources caused by monopoly. For details, see any intermediate microeconomics textbook.

use each other's innovations intensively. Strengthening property rights for innovations in a cascade causes a deadweight loss that reduces the overall profitability of innovating. For these innovations, weak intellectual property rights maximize the rate of growth.

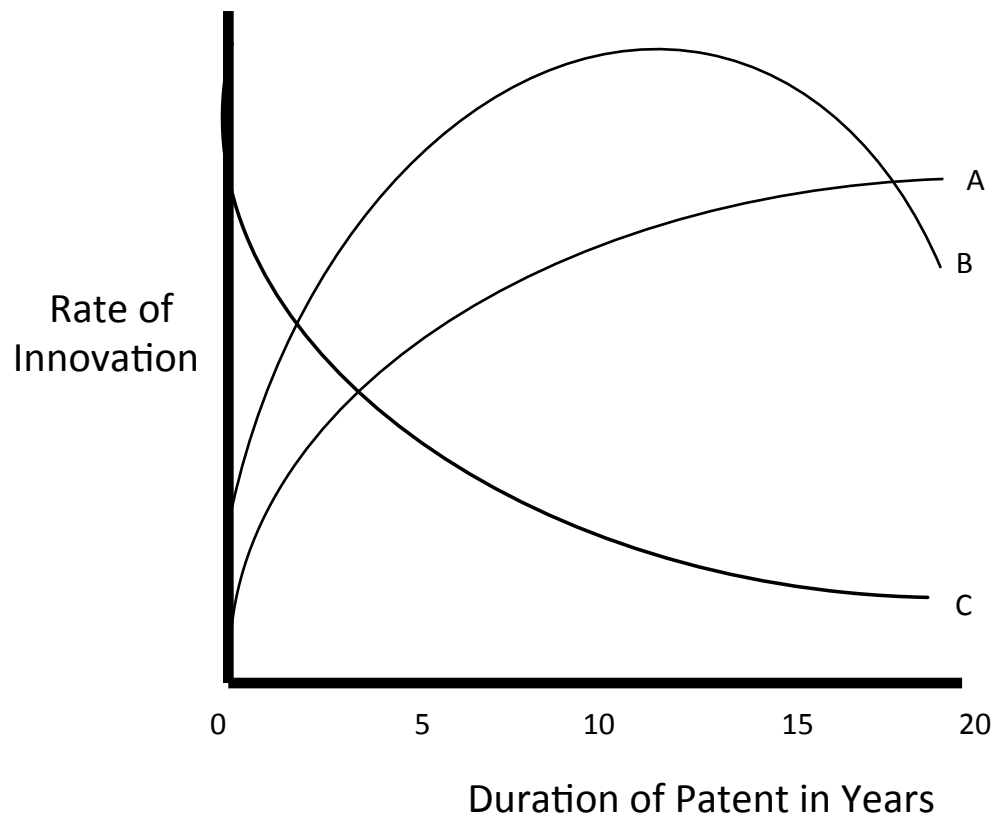
To illustrate graphically, Figure 2.6 depicts some possible relationships between the rate of innovation and patent length, which is one dimension of patent strength. The horizontal axis indicates the length of patents in years, and the vertical axis indicates the rate of innovation. For curve A, the rate of innovation is an increasing function of patent length. Curve A depicts an industry where innovators sell mostly to consumers and producers, such as pharmaceutical drugs. For curve C, the rate of innovation is a decreasing function of patent length. Curve C depicts an industry where innovators especially sell to each other. Thus the computer operating system Unix has many variants, including the one called BSD developed at the University of California at Berkeley and used in Apple computers. BSD is "unowned," or "in the public domain," or "open access". Many observers believe that open access to BSD has increased the rate of innovations based on it.

Before turning to a new topic, we mention another drag of intellectual property rights on innovation. Using someone else's intellectual property requires licensing it, which takes time and effort. The cost of negotiating licenses reduces venture profits and slows innovation. Thus if someone owned the Unix operating system, then anyone who wanted to use it would have to license it. In fact, no one privately owns Unix, so using it does not require negotiating with anyone.¹¹ The deadweight loss from monopoly and the negotiating costs of licensing are both costs of intellectual property rights.¹²

¹¹ This consideration may justify the "research exemption," or the "Hatch-Waxman exemption" in US patent law. Firms that invest in a new drug often need to perform research to gain regulatory approval. The research exemption allows firms to use patented drugs freely for research on regulatory compliance without a license from the patent's owner.

¹² We distinguish between the deadweight loss from monopoly and transactions costs. Other scholars expand the former to include the latter. According to this way of

Figure 2.6. Rate of Innovation and Patent Length



Curve A depicts innovations where the dominant effect of intellectual property rights is the transfer from static to dynamic uses, and Curve C depicts innovations where the opposite is true. Many innovations are in between these pure cases: The transfer effect dominates when intellectual property rights are too weak, and the deadweight effect dominates when intellectual property rights are too strong. In between these extremes, the rate of innovation is maximized.

speaking, zero transaction costs allow perfect price discrimination, which eliminate the deadweight loss.

Curve B in Figure 2.6 depicts this situation, where moderately strong intellectual property rights maximize the rate of innovation. The optimal patent duration of patents is internal for curve B, not extreme as for curves A and C.

To illustrate, J.K. Rowling sold 8.3 million copies of Harry Potter and the Deathly Hallows on the first day of its publication.¹³ Effective copyright law gave Rowling secure ownership of an original expression, so she did not fear that publication would lead to pirating and unauthorized performances in movies or plays. In contrast, Shakespeare made only a few copies of each play that he wrote. (Consequently, humanity almost lost its greatest theatrical legacy.¹⁴) With ineffective copyright laws, Shakespeare profited from selling tickets to performances of his plays, not from their publication. He did not want his plays published because he did not want others to perform them. Ineffective copyright made secrecy necessary for Shakespeare. Everyone can agree that copyright protection for Shakespeare in his day would have disseminated his plays faster, and everyone can agree that extending that protection to the present day would needlessly hinder their dissemination. So the optimal duration of a Shakespearean copyright is found from a curve shaped like B in Figure 2.6.

Lets apply this reasoning to the duration of US copyright. Since its eighteenth century beginning, the United States has lengthened the duration of a copyright until it now stands as the creator's life plus 70 years. To maximize creativity, is copyright's durations about right, too long, or too short? Many scholars believe that a shorter copyright would promote creativity. It's easy to see why. Remote payoffs have little present value. If someone discounts future profits by 10% per year, then the present value of \$100 paid in 70 years is 10 cents. With little present value, remote future profits have little effect on present behavior. Few authors write books so that their heirs will receive royalties 70 years after their death. As the date of creation fades into history, however, the

¹³ Motoko Rich, "Record First-Day Sales for Last 'Harry Potter' Book - New York Times," July 22, 2007, http://www.nytimes.com/2007/07/22/books/22cnd-potter.html?_r=1&oref=slogin.

¹⁴ Greenblatt, Stephen, Will in the World: How Shakespeare Became Shakespeare. (W. W. Norton & Company, New York, 2004)

costs increase to locate the copyright holder and obtain permission to use the book. This cost has prevented Google from distributing many out-of-print books on the Internet. If Google can obtain the right to put these books online, scholars from Peoria to Port Moresby will have equal access to many materials currently accessible only to scholars working in the Harvard library.¹⁵ Many scholars believe that excessive length of US copyright dampens creativity and benefits special interests with influence in Congress.

Curves A, B, and C in Figure 2.6 depict three possible relationships that often exist between the rate of innovation and the strength of intellectual property rights. (We will not discuss other possible shapes besides those depicted in Figure 2.6.¹⁶) For curves with these shapes, a simple rule leads to the maximum: Starting from 0, increase the strength of intellectual property rights so long as venture profits increase. On curve B, the maximum occurs where a small increase in the strength of intellectual property rights does not increase or decrease overall profits in the dynamic sector. Specifically the maximum occurs when a small increase in patent length increases the deadweight loss among innovators by the same amount as the wealth transferred from consumers and producers to innovators.

II. Consolidation

Figure 2.4 depicts boundary β separating owned and unowned innovations, like a fence separating private and common land. Stronger intellectual property rights correspond to a larger area for owned innovations and a smaller area for unowned innovations. We have discussed where to locate this boundary in order to maximize the rate of innovation.

¹⁵ Scholars disagree about the best legal arrangements under which Google should be allowed to proceed. See Pam Samuelson,...

¹⁶ Curve B is a concave function with a unique maximum. Another possibility is a convex function with two local maxima, one for weak intellectual property rights and one for strong intellectual property rights. Another possibility is multiple equilibria. For analyzing many activities, economists assume a concave function with a unique maximum.

Here is a different question: “For owned innovations, how broad should each patent be?” Holding constant the scope of owned innovations, the patent authorities can award few patents with broad scope or many patents with narrow scope. Similarly, a government planner can divide undeveloped land into many small lots or a few large lots.¹⁷ The breadth of patents resembles the size of lots in a new development. Thus assume that firm A invents innovation *a* in Figure 2.4, and firm B subsequently invents innovation *b*. The patent office could decide that the two innovations are really just one innovation and award a patent to A that encompasses *a* and *b*. Alternatively, the patent office could decide that the two innovations are different and award two patents, a patent for *a* to A and a patent for *b* to B.

Instead of waiting for the state to broaden patents, private firms can consolidate them.¹⁸ Each member of a patent pool agrees in advance to cross-license its patents for a given technology to everyone else. Pooling patents thus eliminates market transactions among members who use innovations in the pool. When market transactions disappear, the deadweight loss of monopoly and the negotiating costs of licensing also disappear. Thus assume that firm A plans to develop innovation *a* in Figure 2.4, and firm B plans to develop innovation *b*, and the innovations are interdependent. A and B agree in advance to share information and patents. Thus A acquires the contractual right to use *b*, and B acquires the contractual right to use *a*, without further negotiations or fees.

¹⁷ Once lots are surveyed in a new town, owners can buy and sell them, but they cannot buy or sell a fraction of a lot. Much the same is true for selling a fraction of a patent. Leasing a fraction of a lot or patent is another matter. The owner who cannot sell a fraction of a lot can contract to allow someone to use it. Some theorists think that this fact demarcates the essential difference between property law and contract law. See Merrill and Smith... Similarly, the owner of a patent can contract to allow others to use it, but the owner cannot sell half of a patent to one person and half of it to another.

¹⁸ According to the Coase Theorem, private contracts will correct inefficiencies in default legal rules so long as transaction costs are zero. See Ronald Coase, “The Problem of Social Cost,” *Journal of Law and Economics* 3 (1960): 1-44. Also see Robert Cooter and Tom Ulen, *Law and Economics*, 6th ed., Law and Economics (New York: Addison Wesley, 2011), Chapter 4.

The “patent pool” in this example involves two innovations and two firms, whereas some modern patent pools involve many firms and patents. Why don’t patent pools expand until they form the Universal Patent Pool? It would replace individual ownership with common ownership of patents through cross licensing. Although some patent pools are large, they contain a relatively small proportion of patents and they pose no threat of abolishing private ownership of inventions. Asymmetrical information explains why. Inventors of exceptionally valuable innovations usually know their worth better than outsiders. These inventors do not want to trade their inventions for access to the inventions of others. Each inventor has an incentive to withhold its most promising innovations from a pool and to supply its least promising innovations to the pool. Asymmetrical information about innovations causes distrust, which precludes anything like the Universal Patent Pool.

Instead of pooling patents, private firms can consolidate them by merging. Thus firm A that owns patent *a* can merge with firm B that owns patent *b*, thus forming the firm A+B that owns patents *a+b*. Like pools, mergers eliminate bilateral licensing of innovations and its associated costs – deadweight loss and negotiating costs of licensing. Why don’t technology firms merge into one gigantic firm, thus forming the Universal Innovator Incorporated?

Asymmetrical information inhibits forming the Universal Innovator Incorporated, like it inhibits forming the Universal Patent Pool. To develop an innovative idea in a large firm, the innovator must negotiate with a financial officer for funds. The financial officer will demand to know the details about the innovation and claim ownership of it for the firm. Alternatively, the innovator can quit the large firm, form a startup, and negotiate with outside investors for development funds. (Elsewhere I have discussed how to overcome the “double trust dilemma” that separates new ideas and capital.¹⁹)

¹⁹ See Robert Cooter and Hans-Bernd Schaefer, *Solomon’s Knot: How Law Can End the Poverty of Nations* (Princeton University Press, 2011).

A creative person with new ideas often prefers to negotiate as an equal with outside investors, rather than to negotiate as an employee with the firm's financial officer. This is especially true when the creator believes that he has an exceptionally valuable idea for an innovation. No one should be surprised that innovators using their own ideas and borrowed capital act differently from employees who give their ideas to the firm in exchange for its capital. Compared to large firms, startups are riskier and more profitable for innovators. Innovators especially prefer more risk and higher expected profits when they believe that their innovation is more valuable than others appreciate. Forms of creativity with asymmetrical information and especially high profit expectations – the innovations that often transform industries -- tend to wilt in large firms and sprout in small firms.

When innovative firms fail to combine their patents by merging or pooling, as they often do, patent authorities can do it for them by broadening patents.²⁰ Thus if firm A invents innovation *a* in Figure 2.4, and firm B subsequently invents innovation *b*, the patent office can decide that the two innovations are really just one innovation and award a patent to A that encompasses *a* and *b*. The result is much the same as if A bought B on extremely favorable terms. If A and B foresee these facts before the invention of *b*, then inventive effort will probably shift from B to A. Either A will try to invent *b* and B will not try, or else A will contract with B to develop *b*. Patent authorities should not broaden patents too far for the same reason that the state should not force innovative firms to merge or pool. Very broad patents inhibit creativity much like very large firms and very large patent pools

²⁰ This corresponds to the prescription in the economic analysis of law that default rules should minimize transactions. See Robert Cooter and Tom Ulen, *Law and Economics*, 6th ed., Law and Economics (6th edition, New York: Addison Wesley, 2011), Chapter 9.

III. Conclusion

Which ownership rules maximize the pace of economic innovation? Answering the normative question of growth economics requires comparing two opposite effects of stronger intellectual property rights. The first effect is a transfer from static activities (consumption and production) to dynamic activities (innovation), which increases the profitability and pace of innovation. According to the overtaking theorem mentioned in the introduction, transfers from static activities to dynamic activities increase welfare. So the first effect favors strong intellectual property and more private ownership of innovations. The second effect is the dead-weight loss and licensing costs in dynamic activities, which decreases the profitability and pace of innovation. So the second effect favors weak intellectual property rights and less private ownership of innovations.

A metaphor represents these facts. Think of innovations as shrubs that can grow in a clearing or a thicket. An innovation that does not use other innovations is like a shrub growing in a clearing. Such an innovation is independent from other innovations. With independence, making an innovation does not require using another innovation, so stronger patents increase the innovators' output prices without directly affecting innovators' input prices.²¹ Alternatively, some innovations use other innovations, like a carriage uses wheels. An innovation that uses other innovations resembles a shrub growing in a thicket. Such an innovation is interdependent with other innovations. With interdependence, making an innovation requires using another innovation, so strengthening patents increase the innovator's prices for inputs and outputs. The general prescription is "stronger intellectual property rights for an innovation in a clearing and weaker rights for innovations in a thicket."

This prescription exposes a basic confusion in the standard normative analysis of innovation. When strong patents increase consumer prices, the pace

²¹ In the economy, almost everything affects everything else indirectly. Thus innovation A and B may be separable in production – inventing either of them does not use the other as an input – but they may be substitutes or complements in consumption, so the price of one affects how much people will pay for the other.

of innovation quickens. According to the standard analysis of monopoly, intellectual property should balance the costs of higher consumer prices and the benefits of growth. The standard analysis frames the problem wrongly. By relying on the standard analysis, law and policy for intellectual property have built on the wrong foundation. Growth quickly overtakes the welfare effects of other objectives, including temporary losses to consumers from higher prices. If higher prices to consumers cause faster growth, consumers will lose less than they soon will gain more from better goods and more wealth. For intellectual property, officials should worry little about static losses and much about incentives for foundational and follow-on innovations. Law and policy for intellectual property should maximize the rate of sustained growth, not balance growth against other values. Patents and copyright should have the strength that maximizes the rate of innovation. This is the correct measure of whether patents are too strong or too weak.