

2007

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Recommended Citation

Daniel J. Gifford, *Law and Technology: Interactions and Relationships*, 8 MINN. J.L. SCI. & TECH. 571 (2007).

Available at: <https://scholarship.law.umn.edu/mjlst/vol8/iss2/11>

Law and Technology: Interactions and Relationships

Daniel J. Gifford*

The relations between law and technology are both simple and exceedingly complex. At the most elementary level, technology consists in the application of labor to create a product, to generate a service or otherwise to produce a desired result. Technology develops as ways are found to produce new results or to produce old results using fewer or less costly inputs. Law is generally understood to exist as a set of rules adopted by a society's governing institutions that are applicable to all of its inhabitants.¹ All modern societies have established

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1. See H.L.A. HART, *THE CONCEPT OF LAW* 89-96 (1961). Hart divides rules into "primary rules of obligation" and secondary rules. Primary rules are those that govern behavior and facilitate contracting and other fulfilling activities. Secondary rules are concerned with interpreting, applying, and enforcing primary rules.

institutions charged with making determinations about the applicability and interpretations of these rules. They have also established institutions that enforce the rules. Law and technology interact when legal rules foster or retard the development of technology. They also interact when society decides that technology produces undesirable results and employs legal rules to contain or modify those results.

I. BACKGROUND

It is generally understood that property rights are essential to generating incentives to productive behavior. Because traditional property does not include intellectual creations—such as the design of new technology—society has expanded that regime to include limited forms of protection for intellectually creative acts. Let's briefly review this background.

A. THE LAW, PROPERTY RIGHTS, INCENTIVES, AND TRADE

In defining property rights, the law creates the conditions that are crucial for the development of technology. Without property rights, the world would be a vast commons in which productive incentives would be absent. Few would labor to create wealth if others were free to take it. Property rights enable people to keep the wealth that they create. Property rights, for example, enable the farmer to keep the crops that he raises. These rights provide him with the incentive to farm. Almost all societies have recognized such basic property rights as the right of a farmer to his crops. But a new and crucial dimension is added to property rights when property becomes transferable.

When property is transferable, then the incentives to be productive increase exponentially. When a farmer possesses the right to keep the crops that he raises, he has an incentive to raise crops to feed himself and his family. When he is able to trade his crops for goods or services provided by others, he acquires an incentive to produce more than for his own needs. Transferability means that I have an incentive not only to create goods and services for myself. It means that I have an incentive to create goods and services for others as well, since I will be able to transfer the benefit of my productive activity to others, and they will be able to compensate me by transferring some of their property to me in payment. As discussed below, transferability provides the basis for specialization and scale

economies, and it also underlies the principle of comparative advantage in international trade.

B. INTELLECTUAL PROPERTY AND ITS INCENTIVES

Although property rights are essential to productive incentives, traditional property rights fail to generate incentives for creative activities. If I devise a new product or a new, more efficient way to employ inputs to produce wealth, my creativity can be replicated at will in a society that recognizes rights only in traditional property. Modern societies, therefore, create rights in intellectual creations in order to provide incentives to create as yet unknown technologies or improvements in existing technology. A person who creates a new technology qualifying for patent protection, for example, acquires exclusive rights in his invention for a twenty year period.² The laws creating these rights are generally referred to as intellectual property laws. A common way of viewing these laws is to see them as remedying a market failure by filling a pre-existing gap in property protection.³ Just as tangible property rights transform what would otherwise be an incentive-free commons into a regime that provides productive incentives, intellectual property laws transform parts of a preexisting intellectual commons into a regime that provides incentives for creativity. The intellectual property laws that are most important to the development of technology are the patent and copyright laws. Their importance has been recognized throughout the history of the Republic. Indeed, the U.S. Constitution specifically authorizes Congress to enact both sets of laws in order “[t]o promote the Progress of Science and useful Arts.”⁴ This phrasing reflects the understanding of the Framers that creative activities could be stimulated through the economic incentives that the patent and copyright laws provide.

II. COMPETITION, MONOPOLY, TECHNOLOGY AND THE GENERATION OF WEALTH

We know that free and open markets maximize productive incentives and that competition among sellers maximizes

2. 35 U.S.C. § 154(a)(2) (2000).

3. See, e.g., Daniel J. Gifford, *Innovation and Creativity in the Fine Arts: The Relevance and Irrelevance of Copyright*, 18 CARDOZO ARTS & ENT. L.J. 569, 572-73 (2000).

4. U.S. CONST. art. I, § 8, cl. 8.

societal wealth.⁵ So long as markets operate competitively, goods and services are routed to their highest valued uses. A competitive economic system also fosters productive efficiency in the short run by pressuring producers to employ their most cost-effective techniques and in the long run by replacing the less efficient producers with more efficient producers. Thus, at all times, competition pressures producers to employ the most efficient technologies available to them.

Although competitive markets force producers to act efficiently, the tendencies of monopolies are otherwise. Monopolies tend to restrict production in order to maintain prices at higher-than-competitive levels. In so doing, they deny society those uses of their products whose values are less than the monopoly price but higher than their cost of production. This output restriction is inconsistent with the allocation of society's assets to their highest valued uses and constitutes a social waste that economists often refer to as a "deadweight social loss."⁶ In this respect, monopolies produce allocative inefficiencies. Monopolies, moreover, are also less keyed to productive efficiency, as the incentives to implement new technologies are reduced in monopolistic market structures. While competitive markets are forced by competition to adopt the most efficient technologies as they emerge, monopolies lack that competitive pressure. A monopolist, of course, has an incentive to invest in efficient technology, as that technology will reduce its costs and thereby increase its profits. But because the incentive structure is reduced, the implementation of new technology may be delayed.⁷

Society's embrace of competitive markets as a means of maximizing aggregate wealth exists in a dynamic tension with the use of the exclusive rights over technological developments provided by the intellectual property laws. Because there may

5. See Daniel J. Gifford, Government Policy Towards Innovation in the United States, Canada, and the European Union as Manifested in Patent, Copyright, and Competition Laws, 57 SMU L. REV. 1339, 1340 (2004).

6. See, e.g., ROBERT S. PINDYCK & DANIEL L. RUBINFELD, MICROECONOMICS 348 (5th ed. 2001). The deadweight social loss is the net value of the output that would be produced in a competitive market, but which is not produced by a monopoly. It is the difference between (1) potential buyers' reservation prices that are less than the monopoly price and (2) marginal cost.

7. See Kenneth Arrow, *Economic Welfare and the Allocation of Resources for Invention*, in THE RATE AND DIRECTION OF INVENTIVE ACTIVITY (R.R. Nelson ed., 1969).

be no effective substitutes for some such developments, the exclusive rights provided under the patent law may amount to an economic monopoly. In exercising its monopoly power under the patent, the patentee may, like other monopolists, license the technology at rates that are sufficiently high as to exclude many uses. As a result, society is denied uses of a valuable technology, societal assets are misallocated, and deadweight social loss results.⁸

The tension between intellectual property rights and competition is reflected in the uneasy relationship that has existed, and continues to exist, between the antitrust laws and the intellectual property laws, especially within patent and copyright law. In one view, perceived conflict between the policies of the Sherman Act and patent and copyright laws lacks substance. The competition laws are designed to foster economic welfare and so are the intellectual property laws. The latter employ exclusive rights as a means for generating new technology; and new technology raises societal welfare. The restraints imposed by intellectual property rights holders are in newly created markets that would not have existed had these restraints been barred *ex ante*. In this view, the intellectual property laws do not create restraints that would not exist in their absence. Finally, technology probably is largely responsible for much of our economic welfare, and the intellectual property laws are designed to foster the development of new technology.⁹

There are, however, more sophisticated ways of understanding the relation between the competition laws and the intellectual property laws. It is true that intellectual property laws help to provide the incentives that stimulate the technological innovation that enriches society. But that analysis is overly simple. Intellectual property laws generate both benefits and costs. Their major costs lie in the very exclusivity that they provide rights holders. Those laws not only generate new technology, they also restrict its use. This restriction—however justified as necessary to generate

8. See Daniel J. Gifford, *How Do the Social Benefits and Costs of the Patent System Stack Up in Pharmaceuticals?*, 12 J. INTEL. PROP. L. 75, 82 (2004).

9. See, e.g., Joseph F. Brodley, *The Economic Goals of Antitrust: Efficiency, Consumer Welfare, and Technological Progress*, 62 N.Y.U. L. REV. 1020, 1026 (1987) (“[S]tudies have shown that over the forty-year period from the late 1920s to the late 1960s, at least half of the gain in United States output was due solely to technological and scientific progress.”)

incentives—is nonetheless a social waste. Ideally, a society should limit intellectual property rights to a term in which the marginal social costs of the restraints that they facilitate are less than the marginal social benefits that they provide. Louis Kaplow developed such an analysis over twenty years ago.¹⁰

Observing that the longer the patent term, the greater the incentive to invent, Kaplow assumed that lengthening the patent term would generate additional inventions. But he also pointed out that an increase in the patent term would extend the patent-based restraints on all existing patents—patents on inventions for which the existing term of protection was adequate. Extending the term would both generate marginal social benefits (i.e., new inventions) and marginal social costs (i.e., adding an additional year of restrictions on all other inventions). Although Kaplow's analysis is ingenious, it cannot be easily applied because no one knows how to quantify either the marginal benefits or the marginal costs of inventions. His analysis does, however, provide a conceptual insight into the policy issues latent in tensions between competition laws and intellectual property laws. Moreover, Kaplow's analysis provides a framework for policy judgments. Under simplified but reasonable assumptions, the existing patent term may well produce positive welfare results at the margins.¹¹

III. THE SCOPE OF INTELLECTUAL PROPERTY PROTECTION

The law defines not only the term of intellectual property rights but also their scope. In defining their scope, the law again enters an area of tension. For decades, the competition laws and the intellectual property laws have wrestled with issues of tying and bundling, which are issues that concern the scope of intellectual-property protection. Does my intellectual property right authorize me to insist that purchasers, lessees or licensees use other products along with the protected one? In the early twentieth century, the courts appeared willing to permit a patentee to control the products that could be used with a patented one.¹² Later, the courts developed a doctrine of

10. See Louis Kaplow, *The Patent-Antitrust Intersection: A Reappraisal*, 97 HARV. L. REV. 1813, 1825-26 (1984).

11. See Gifford, *supra* note 8, at 106.

12. See, e.g., *Henry v. A.B. Dick Co.*, 224 U.S. 1, 47-49 (1912); *Heaton-Peninsular Button-Fastener Co. v. Eureka Specialty Co.*, 77 F. 288, 300-01

patent misuse as part of patent law.¹³ During the first half of the last century, the courts treated the tying of a separate product to a patented one as misuse.¹⁴ During the period of misuse, the courts would not enforce the patent. The misuse cases eventually affected the antitrust laws.¹⁵ In the 1960s, the act of tying a product to a patent or copyright became a per se antitrust violation.¹⁶

The tensions between these two sets of laws, however, were a source of continuing readjustment. In the 1952 patent act revision, Congress drew limits on the judicially-developed doctrine of patent misuse.¹⁷ Henceforth, misuse would be limited to the tying involving so-called staple articles of commerce. Products designed specially for use with a patented product could be tied with impunity to a patented product.¹⁸ Congress strengthened its restrictions on the misuse doctrine in 1988.¹⁹ Even as Congress was narrowing the doctrine of patent misuse at mid-century, the courts were expanding the application of the antitrust laws to tying arrangements involving patents. From the late 1940s well into the 1970s, the courts presumed that a patent created market power, and from that presumption created a virtually per se rule against tying arrangements involving patents.²⁰ Although in the 1970s the courts began retreating from their earlier view that tying arrangements were always socially harmful,²¹ it was not until 2006 that the Supreme Court explicitly ruled that a patent

(6th Cir. 1896).

13. See *Mercoid Corp. v. Mid-Continent Inv. Co.*, 320 U.S. 661, 665-68 (1944); *Mercoid Corp. v. Minneapolis-Honeywell Regulator Co.*, 320 U.S. 680, 680 (1944); *Morton Salt Co. v. G.S. Suppiger Co.*, 314 U.S. 488, 489 (1942); *Carbice Corp. of Am. v. Am. Patents Dev. Corp.*, 283 U.S. 27, 33-34 (1931). The origins of the misuse doctrine are traceable to *Motion Picture Patents Co. v. Universal Film Mfg. Co.*, 243 U.S. 502 (1917).

14. See cases cited *supra* note 13.

15. *Minneapolis-Honeywell Regulator Co.*, 320 U.S. at 684 (“[T]he effort made here to control competition in this unpatented device plainly violates the anti-trust laws”).

16. *United States v. Loew’s Inc.*, 371 U.S. 38, 44-45 (1962).

17. 35 U.S.C. § 271 (2000).

18. See 35 U.S.C. § 271 (2000).

19. See Pub. L. 100-703, § 201, 102 Stat. 4676 (codified as amended at 35 U.S.C. § 271 (2000)).

20. See *Times-Picayune Pub. Co. v. United States*, 345 U.S. 594, 608 (1953); *Int’l Salt Co. v. United States*, 332 U.S. 392, 398-402 (1947); *Mercoid Corp. v. Mid-Continent Inv. Co.*, 320 U.S. 661 (1944). See also Daniel J. Gifford, *The Antitrust/Intellectual Property Interface: An Emerging Solution to an Intractable Problem*, 31 HOFSTRA L. REV. 363, 380-81 (2002).

21. *U.S. Steel Corp. v. Fortner Enterprises, Inc.*, 429 U.S. 610 (1977).

would not be presumed to generate market power for purposes of applying the antitrust laws to tying arrangements.²²

Other issues of patent scope have plagued patent law for decades. Patent law is designed to extend protection only to inventions that are advances beyond the capability of ordinary practitioners in the field.²³ And the law protects only what the inventor claims. Yet within these simple rules, troublesome issues constantly emerge. The judicially-developed doctrine of equivalents is designed to extend protection to matter not covered in the claims but which are insubstantial variations of the claimed invention.²⁴ Thus at mid-century the Court extended the scope of a patented welding flux from the combination set forth in the claims (a composition of calcium fluoride with an alkaline earth-metal silicate) to a different combination with the same properties (a combination of calcium fluoride with manganese (a non-earth metal silicate)).²⁵ In recent years, the courts have sharply curtailed the availability of the doctrine of equivalents. Amendments to a patent application are likely to estop a patentee from later relying upon the doctrine of equivalents, especially when the patentee attempts to use that doctrine against variations that were foreseeable at the time of the amendment.²⁶ In the biotech area, the patent law's written description requirement²⁷ limits the doctrine of equivalents in ways that make its ramifications socially problematic. Thus in a leading case, the Federal Circuit ruled that the University of California at Berkeley, which had isolated the DNA coding for rat insulin, could not assert claims to human insulin, even though human and rat insulin are very similar.²⁸ Despite this similarity, the university's claim for human insulin failed because it had

22. *Illinois Tool Works Inc. v. Independent Ink, Inc.*, 126 S.Ct. 1281, 1293 (2006).

23. 35 U.S.C. § 103 (2000).

24. *See Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co.*, 535 U.S. 722, 731 (2002) (referring to the doctrine of equivalents extending to "[u]nimportant and insubstantial substitutes for certain elements" of the patent claims).

25. *Graver Tank & Mfg. Co. v. Linde Air Prods., Inc.*, 339 U.S. 605, 611-12 (1950).

26. *Festo Corp.*, 535 U.S. at 736-40; *Warner-Jenkinson Co., Inc. v. Hilton Davis Chemical Co.*, 520 U.S. 17, 40-41 (1997).

27. *See* 35 U.S.C. § 112 (2000).

28. *Regents of the Univ. of Cal. v. Eli Lilly & Co.*, 119 F.3d 1559, 1559 (Fed. Cir. 1997).

described only the DNA sequence for rat insulin. That description, however, may well have been sufficient to enable others to produce human insulin (by employing the identified sequence to construct a gene probe that would identify the human variant).²⁹

The doctrinal issues discussed above are part of a larger policy conundrum involving questions of how the law should be structured to generate optimum incentives for inventive activity. Is the description requirement being applied in such a stringent manner as to destroy the incentive to invent? A patent on rat insulin loses its commercial value if others can employ that patent as a tool to produce human insulin. The current stringency with which the doctrine of equivalents is interpreted may effectively destroy the commercial benefits of many inventions and thus undermine the very incentives that the law is designed to foster. Professors Dan Burk and Mark Lemley have argued that both the scope of patent protection and the height of the bar posed by the requirement of non-obviousness should vary by field of invention.³⁰ In the bio-tech arena, for example, patents should be difficult to acquire, but, once acquired, should provide extensive protection over a wide area, which is a result that is at odds with the current case law.

The Lemley and Burk approach would help mitigate the problem of the anti-commons that some have suggested may be adversely affecting research and innovation in bio-technology.³¹ The argument is that multiple patents on minor inventions are crowding the available research space, so that potential inventors are discouraged by the need to obtain multiple licenses, thus raising the costs of inventive activity. Raising the standard of non-obviousness in the bio-tech area as they suggest would generate fewer patents, thus freeing up research

29. The *Eli Lilly* court itself acknowledged that the specification may have provided an enabling disclosure. See *Eli Lilly*, 119 F.3d at 1567. See also Carrie A. Morgan, *After the Fire and Rain, Lilly Still Stands*, 31 DAYTON L. REV. 127, 139 (2005); Michael Delmas Plimier, *Genentech, Inc. v. Novo Nordisk & University of California v. Eli Lilly and Co.*, 13 BERKELEY TECH. L.J. 149, 160 (1998).

30. See Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1680-83 (2003).

31. Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 698-701 (1998). See also Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621, 624-25 (1998). But see David E. Adelman, *A Fallacy of the Commons in Biotech Patent Policy*, 20 BERKELEY TECH. L.J. 985 (2005).

space for the development of more valuable inventions.

IV. NEGATIVE EXTERNALITIES

The negative aspects of the law and technology relationship are illustrated in a leading New York case that applied (and modified) classic nuisance doctrine against a cement plant whose emissions of dust and raw materials were damaging nearby landowners.³² Although the court ostensibly refused to make use of private litigation as a means of furthering the public interest in cleaner air by closing the offending plant, the court nonetheless recognized that cost externalities underlay the lawsuit. In its ruling, the court ordered the defendant to compensate the plaintiffs, thus forcing the defendant to internalize the pollution costs that theretofore had been borne by the plaintiffs. The problem in this case—as in almost all pollution cases—is that the adverse effects of a business firm’s discharges into the air or water do not appear on the firm’s books as a cost of its operations nor does the firm bear those costs in any other way.³³ Accordingly, costs that are properly attributable to the firm’s operations are borne by others or by society at large. Federal and state anti-pollution legislation is thus directed towards forcing business firms to internalize these costs. Firms internalize these costs when they compensate affected people (as in the New York case cited above) or when they take action to reduce the levels of the emissions from their plants. When all such firms take such action, they pass on those costs to their customers, who bear the final costs of producing the products that they desire.³⁴

The task of forcing polluting business firms to internalize

32. See *Boomer v. Atlantic Cement Co.*, 26 N.Y.2d 219, 219-20 (1970). The application of traditional nuisance doctrine would have required the court to abate the nuisance by shutting down the defendant’s plant. Because the value of the defendant’s operations greatly exceeded the harm imposed on the plaintiffs, the court instead ordered the defendant to compensate the plaintiffs for their harm. The court thus forced the defendant to internalize as costs that part of its operations that were imposing harm upon the plaintiffs. See discussion of this case in Alexandra B. Klass, *Common Law and Federalism in the Age of the Regulatory State*, 92 IOWA L. REV. 545, 571-72 (2007).

33. See discussion of externalities in PINDYCK & RUBINFELD, *supra* note 6, at 621.

34. See, e.g., Thomas Lundmark, *Systemizing Environmental Law on a German Model*, 7 DICK. J. ENVTL. L & POL’Y, 1, 18 (1998) (discussing internalization of social costs of pollution and their transmission to customers).

their costs was initially carried out through traditional prescriptive regulation.³⁵ In recent years, however, legislators and policy-makers have concluded that the traditional command-and-control approach to pollution reduction is often not the most effective one. As a result, an array of programs involving incentives, pollution caps, trading permits, and stakeholder negotiations have emerged.³⁶ Experience appears to show that the basic idea behind these less coercive approaches is a sound one, but that the programs need to be carefully designed and supervised to prevent abuses.³⁷

V. POSITIVE EXTERNALITIES

To what extent can law be designed to engender enhanced economic growth by, for example, fostering synergistically-employed technologies, the creation of compact skilled labor markets, or the development of advanced technology? Both theory and experience suggest that laws and legal institutions can play significant, but limited, roles in technological development. Law and legal institutions play a significant role in the development of new technology through the intellectual-property laws, as noted above.³⁸ The law and legal institutions play a major role in engendering basic research, for which market incentives are lacking.³⁹ These legal and governmental interventions are general in nature and help to provide stimulus that the market cannot provide.

Law can be effective in promoting economic objectives when it acts as an adjunct to the market. The genius of the patent system is that it provides a legal structure keyed to the market.⁴⁰ The law provides the exclusive rights that act (in

35. See, e.g., J.B. Ruhl, *Regulation by Adaptive Management—Is it Possible?* 7 MINN. J. L. SCI. & TECH. 21 (2005).

36. See, e.g., Mark Seidenfeld, *Empowering Stakeholders: Limits on Collaboration as the Basis for Flexible Regulation*, 41 WM & MARY L. REV. 411, 411-14 (2000); Jeffrey M. Hirsch, *Emissions Allowance Trading Under the Clean Air Act: A Model for Future Environmental Regulations?*, 7 N.Y.U. ENVTL. L.J. 352 (1999) (discussing permit trading and caps).

37. Christopher H. Schroeder, *Prophets, Priests, and Pragmatists*, 87 MINN. L. REV. 1065, 1091 (2003) (discussing, inter alia, successes of cap-and-trade program under the Clean Air Act and the failures of cap-and-trade under analogous California laws).

38. See *supra* text accompanying notes 2-4, 9-10.

39. Most basic research is funded by the federal government. See U.S. CENSUS BUREAU, STATISTICAL ABSTRACT OF THE UNITED STATES: 2001 508 tbl. 769 (2001).

40. See Gifford, *supra* note 8, at 83-84.

conjunction with the market) as the stimulus to invention, but the market is the ultimate determinant of the rewards. The system rewards only those who produce what the market demands. Should government—through law and legal institutions—attempt intervention to foster the growth of particular industrial sectors or business firms, it is likely to fail. An array of proposals for government intervention in particular sectors of the economy were made during the 1980s and early 1990s under the rubric of “industrial policy”.⁴¹ In these situations, the success of government and legal intervention would require legislators or officials to possess greater information than the market. Because this is virtually impossible, government interventions on behalf of particular industries or companies are almost certain to decrease rather than increase overall economic well-being. In addition to the government’s relative lack of knowledge, its attempts at intervention in the economy would be subject to distortion by interest groups seeking assistance, often from the very industries that were in decline and whose future was in doubt.⁴² Yet it would be those industries—because of their close community ties and sometimes large work forces—that would be able to exert substantial political pressure on their behalf. For all of these reasons, government, law, and legal institutions appear incapable of generating positive externalities in particular sectors of the economy.

41. See, e.g., CONGRESSIONAL BUDGET OFFICE, *THE INDUSTRIAL POLICY DEBATE* xiii-xxii (1983), available at <http://www.cbo.gov/showdoc.cfm?index=5320&sequence=0>; *Industrial Policy Symposium*, 5 STAN. L & POL’Y REV. 6 (1993). One commentator described an array of such proposals in the early 1990’s as follows:

[J]oint research and development with the federal government or with federal government support; permitting joint activities that otherwise would be prohibited by antitrust laws; and foreign marketing support. For example, subsidized financing, through the export import bank or other means, and reductions in the costs of operating a business through tax benefits. Things of this sort are all in the category of industrial policy that is being considered at the moment.

Robert C. Cassidy, Jr., *Trade Policy Aspects of Industrial Policy in the U.S.*, 19 CAN-U.S. L.J. 55 (1993). The governmental structures that would facilitate such industrial policies are described in Robert E. Scott, *Sectorial Policies and Participant Commitments: The Keys to Effective Trade and Industrial Policies*, 5 STAN. L & POL’Y REV. 127 (1993).

42. See, e.g., Jim Chen & Daniel J. Gifford, *Law as Industrial Policy: Economic Analysis of Law in a New Key*, 25 U. MEM. L. REV. 1315, 1346-47 (1995).

VI. INTERNATIONAL TRADE AND TECHNOLOGY

A key spur to industrial development in the United States has been its large continent-wide market. This large market has enabled manufacturers to employ technology incorporating scale economies. Conversely, during the late nineteenth century and early twentieth century, Europe was divided into nation-sized markets by protectionist legislation.⁴³ As a result, European manufacturers lacked access to a large market that was conducive to scale economies. Although a tariff barrier also protected U.S. markets during this period, its manufacturers nonetheless had access to the large U.S. domestic market. The negative effects of protection on industrial development that afflicted European manufacturers, accordingly, were muted in this country.⁴⁴

Since the adoption of the General Agreement on Tariffs and Trade⁴⁵ after the conclusion of World War II, the nations of the world have been gradually reducing their tariffs, stimulating an ever increasing amount of international trade. This movement towards freer trade culminated in the creation of the World Trade Organization in 1994 and the associated TRIPS agreement.⁴⁶ The lowering of tariffs and other barriers to trade subjects U.S. industries to competition from abroad (and subjects foreign producers to competition from U.S. producers), thus intensifying worldwide competition. This new competition increases the pressures on all industry participants to develop and employ the most efficient technologies. This intensifying global competition provides a comparative advantage to labor-intensive technologies in developing nations with relatively low wage rates. As a result, U.S.-based producers in labor-intensive industries producing tradable goods are in the process of being replaced by producers from developing nations. At the same time, the adoption of the TRIPS agreement means that the U.S. advantages in the production of creative products (such as in the software,

43. See Daniel J. Gifford, *Trade and Tensions*, 15 MINN. J. INT'L L. 297, 298-99 (2006).

44. See, e.g., discussion in Daniel J. Gifford, *Trade and Tensions*, 15 MINN. J. INT'L L. 297, 299-300 (2006).

45. General Agreement on Tariffs and Trade, Oct. 30, 1947, 61 Stat. A3, T.I.A.S. No. 1700, 55 U.N.T.S. 187.

46. See AGREEMENT ON TRADE-RELATED ASPECTS OF INTELLECTUAL PROPERTY RIGHTS, Annex 1C, April 15, 1994, 1869 U.N.T.S. 299, 33 I.L.M. 1197 (1994) [hereinafter *TRIPS Agreement*], available at http://www.wto.org/english/docs_e/legal_e/27-trips.pdf.

pharmaceuticals, and entertainment industries) will be strengthened, as intellectual property protection extends globally.

The pressures of global competition thus are forcing a reallocation of the technologies employed in each nation in ways that reflect each nation's comparative advantage. Although some temporary hardships will occur, the end result will produce an overall increase in the world's wealth, benefiting all nations. And because the new WTO-TRIPS regime widens protection of intellectual property, the incentives for innovation are increased. These increased incentives should generate additional innovation, which over time will produce increases in global welfare.

VII. LEGAL FAILURES AND MARKET FAILURES

The preceding discussion has referenced various places in which laws and market incentives interact to foster the development and employment of technology, generating increases in aggregate welfare. Yet there remain gaps or failures in these law/market interactions. Market failures are often the result of the failures of the legal system to adequately specify property rights. Intellectual property laws, for example, are required to remedy inadequacies in the property rights regime that the legal system developed in simpler times.⁴⁷ Thus, market failures can often be understood as the result of legal failures. In the twenty-first century, other failures of the law/market relationship are becoming widely appreciated. These newly appreciated failures differ from the law/market failures previously discussed because they are not identified by welfare analyses that use an index of maximizing aggregate economic welfare for measurement.

The pharmaceutical industry provides an example of how law and technology interact both positively and negatively. The current intellectual property system generates incentives for pharmaceutical companies to develop new drugs for the relief of illnesses experienced by the populations of the developed nations. As observed above, the companies are rewarded for their efforts from sales of successful products at supra-competitive prices. It was noted above that a negative (albeit necessary) effect of this system is the short-term waste

47. See *supra* text accompanying notes 2-4.

that results when these higher prices exceed the reservation prices of potential customers.⁴⁸ TRIPs requires that all members of the WTO begin to recognize and enforce intellectual property rights.⁴⁹ Most of these rights involving pharmaceuticals belong to companies from the developed world. As a result, the negative effects of intellectual property rights involving pharmaceuticals are magnified. The legal framework established by the WTO and TRIPs have only gradually began to adjust to these problems.⁵⁰

First, the short-term waste imposed by the denial of life-saving drugs to millions in the under-developed world is immense, dwarfing the dead-weight loss in the developed nations. In the under-developed nations, the lives of millions of people depend upon access to HIV-AIDS drugs. If they cannot receive these drugs because the prices are keyed to the markets of the developed world, then the social loss is staggering. Moreover, in assessing this loss, traditional economic approaches are problematic: it will not do to set the value of a life on the basis of a person's earnings converted into the currency of the developed world, as in euros or dollars. Such an approach would obscure the human tragedy involved. Second, the current international legal system appears to impede any effort by the pharmaceutical companies to reduce their prices in the poorer underdeveloped world. Those companies might benefit themselves as well as millions of potential customers by offering their products at prices keyed to local market conditions. The danger of potential arbitrageurs purchasing their products at these lower prices and reselling them in Europe and North America, however, discourages such a course. This danger is reinforced by The General Agreement on Tariffs and Trade (GATT) Article XI,⁵¹ incorporated into the World Trade Organization Agreement. GATT Article IX appears to prevent governments from interfering with arbitrage operations.⁵²

The provisions of GATT Article XI, however, should be

48. See *supra* text accompanying notes 10-11.

49. See *TRIPS Agreement*, *supra* note 46, at 321.

50. See notes 54 and 55 *supra* and accompanying text.

51. See GENERAL AGREEMENT ON TARIFFS AND TRADE, Annex 1B, April 15, 1994, 1867 U.N.T.S. 187, 33 I.L.M. 1153 (1994) [hereinafter *GATT*], available at http://www.wto.org/english/docs_e/legal_e/06-gatt.pdf.

52. See Daniel J. Gifford, *How Do the Social Benefits and Costs of the Patent System Stack up in Pharmaceuticals?*, 12 J. INTEL. PROP. L. 75, 115-22 (2004).

read in conjunction with Article 31 of the TRIPS Agreement⁵³ that permits governments to subject patentees to a compulsory-licensing regime in cases of national emergency or other circumstances of extreme urgency. The Doha Declaration of 2001⁵⁴ and the subsequent WTO General Council decision of 2003⁵⁵ contemplate an extension of the literal terms of Article 31 to authorize a government to impose compulsory licensing, allowing foreign producers to supply needed pharmaceuticals. But the Council decision took steps to ensure that the imported pharmaceuticals would not be subject to export by arbitrageurs.⁵⁶ This approach towards a broad interpretation of Article 31 may well have implications for the interpretation of GATT Article XI in situations of health emergencies.

Article 31 and its construction in the Doha Declaration and Council decision provide some relief for underdeveloped nations experiencing health emergencies. The effects of the Doha Declaration and Council decision on the interpretation of GATT Article XI and the consequent ability of pharmaceutical companies to offer discount pricing in nations whose governments commit to preventing arbitrage is as yet unclear. Nevertheless, the foregoing matters are broadly suggestive of substantial deficiencies in the way law and pharmaceutical technologies interact in the development and deployment of new products. The intellectual property regime of the developed world appears to generate products needed in that world. But—apart from the limited exemptions available under TRIPS Article 31 and the Doha-generated glosses on its provisions—that regime denies the use of newly-developed pharmaceuticals to the underdeveloped world. In addition, the present system skews research solely toward the needs of the developed world. The western intellectual-property regime provides no incentives for the development of cures for sleeping sickness or other illnesses not found in western nations. Nor does that regime provide incentives for the development of vaccines against tuberculosis, a scourge of underdeveloped nations.

53. *TRIPS Agreement*, *supra* note 46, at art. 31.

54. See World Trade Organization, Ministerial Declaration of 20 November 2001, WT/MIN(01)/DEC/2, 41 I.L.M. 755 (2002).

55. See World Trade Organization, General Council, *Implementation of Paragraph 6 of the DOHA Declaration on the TRIPS Agreement and Public Health*, WT/L/540 (Sept. 2, 2003), 43 I.L.M. 509 (2003).

56. *Id.* at ¶ 2(b).

VIII. CONCLUSION

This very brief review of some of the interplay between law and technology is sufficient to raise serious policy questions about how that interplay can be improved. The current regime has conferred immense benefits on mankind. Yet as the discussion has shown, it is in no way optimal. Vast room for improvement exists, not only in industries such as the pharmaceuticals where the dysfunctions may be more apparent, but in other areas as well, where markets fail to reflect human needs.⁵⁷

57. Markets thus fail to operate as a stimulus to economic development in substantial portions of the world where the legal and other preconditions for their effective operation are lacking. Without outside intervention, vast numbers of people will be condemned to dire poverty. In such circumstances, masses of people lack access to even the most elementary technologies. See JEFFREY D. SACHS, *THE END OF POVERTY: ECONOMIC POSSIBILITIES FOR OUR TIME* (2005). These circumstances call for a reevaluation of the interplays among law, markets and technologies, which is a reevaluation beyond the scope of this brief paper.