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ABSTRACT
TECHNOLOGICAL INNOVATION AND MONOPOLIZATION
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This paper reviews the history of seven "great" U.S. monopolization cases in high-technology fields: Standard Oil (1911), the electric light cases, the AT&T cases, cellophane, Xerox, IBM, and Microsoft. It analyzes the extent to which innovativeness was a successful defense to monopolization charges, the success of remedies in correcting monopoly problems, their impact on incentives for continuing innovation, and the ability of the courts to deal with complex high-technology issues. It concludes that the courts are indeed capable of analyzing innovation - monopolization tradeoffs, but that the process has typically taken far too long, and in the mean time, secure monopoly positions tended to delay, not accelerate, innovation. Changes are proposed for adjudication procedure, notably, greater use of court-appointed experts, and in the duration of patent-based monopolies.

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TECHNOLOGICAL INNOVATION AND MONOPOLIZATION

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Introduction

Especially in industrial product markets, dominant positions are often achieved as a consequence of innovation. In passing the Sherman Act, Congress used without precise definition the word "monopolize" to indicate in Section II how the new law would be violated. From the Congressional debates, it is clear that more was required than merely possessing a monopoly market share. Some antitrust scholars have argued along with economist Joseph A. Schumpeter that when a monopoly position follows from or is accompanied by technological innovation, all Sherman Act bets should be off, in part because temporary monopoly is a natural concomitant of innovation and also because the "creative destruction" associated with innovation inexorably threatens existing monopolies and forces them to behave competitively:[1]

> But in capitalist reality as distinguished from its textbook picture ... the kind of competition which counts [is] the competition from the new commodity, the new technology, the new source of supply, the new type of organization (the large-scale unit of control for instance) -- competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives.... [Such] competition ... acts not only when in being but also when it is merely an ever-present threat. It disciplines before it attacks. The businessman feels himself to be in a competitive situation even if he is alone in his field or if, though not alone, he holds a position such that investigating government experts fail to see any effective competition...

1. Joseph A. Schumpeter, Capitalism, Socialism and Democracy (New York: Harper, 1942), pp. 84-85.

This chapter traces the nonlinear path over which Sherman Act Section II adjudication has evolved for situations in which technological innovation played a prominent role. Ignoring Justice Holmes' admonition that "Great cases like hard cases make bad law,"[2] it addresses the issues by reviewing the history of several "great" U.S. monopolization cases: Standard Oil (1911), the various electric lamp cases, the diverse antitrust actions involving AT&T, the Cellophane case, the Xerox case, the IBM cases, and the various Microsoft cases.

The emphasis is on questions explored at a more abstract and general level in the extensive economic literature on dynamic relationships between market structure and incentives for innovation.[3] Thus, did dominant positions result from acts of unambiguous technological leadership? Or did the seminal inventive activities originate in a wider array of enterprises, from which one firm emerged dominant by dint of either technical superiority or other less clearly laudable courses of conduct? Once dominance was achieved, did innovation continue at high levels of vigor?

The intrinsic difficulty of these questions forces us to ask whether the adjudicating courts can cope effectively with the factual issues arising in innovation-plus-monopolization cases. Can they weigh on a timely basis the causal role of technical superiority as compared to practices that by themselves would support an inference of monopolistic intent? And can they devise remedies that restore competition without jeopardizing incentives for innovation?

This is an ambitious agenda. It is too ambitious to expect final, definitive answers. The author has struggled with some of the issues for four decades, only to conclude that the most favorable environment for technological progress depends upon nuanced circumstances. The most we can hope for is an indication of general tendencies, some suggestions for improvement, and clarification of issues that will continue to be debated. We proceed in rough chronological order.

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2. Dissent in U.S. v. Northern Securities Co., 193 U.S. 197, 400 (1904).

3. For surveys, see Jennifer F. Reinganum, "The Timing of Innovation: Research, Development, and Diffusion," in Richard Schmalensee and Robert D. Willig, Handbook of Industrial Organization (Amsterdam: North-Holland, 1989), vol. I, pp. 849-908; Wesley M. Cohen and Richard C. Levin, "Empirical Studies of Innovation and Market Structure," in ibid., vol. II, pp. 1059-1107; and William M. Baldwin and John T. Scott, Market Structure and Technological Change (Chur, Switzerland: Harwood, 1987).

Standard Oil

To the 21st Century reader, characterizing petroleum refining as high-technology might seem strange. But in its early days, the industry indeed pressed the frontiers of technology. And Standard Oil defended itself, arguing inter alia in its attorneys' brief to the Missouri circuit court that it had innovated both technologically and in the scale economies-enhancing investments by which it aggressively expanded its business:

> They have been unremitting in their efforts to improve the processes of refining, to diversify the useful by-products to be obtained from the refining of petroleum and to introduce them into general use, and these efforts have resulted to their great advantage as well as to the general benefit of the industry and the public at large.... They have made great efforts to solve the problem of refining refractory oils and through the success of these efforts they have been able to utilize to their great advantage oils that otherwise were useless except for fuel purposes.[4]

Emphasized among Standard's innovative accomplishments was the Frasch-Burton process for deriving satisfactory illuminating oil (kerosene) from the high-sulphur oil found in the fields around Lima, Ohio.[5]

One of America's most eminent business historians, Alfred Chandler, argues in an early book that Standard Oil was a leader in the "mass production revolution," and that "the high speed of throughput and the resulting lowered unit cost gave John D. Rockefeller his initial advantage in the competitive battles ... during the 1870s."[6] In a later elaboration, stressing the "unprecedented cost advantages of the economies of scale and scope," he attributes a decline in unit refining costs from 1.5 cents per gallon, observed in 1885 for independent refineries

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4. Brief for Defendants on the Facts, U.S. v. Standard Oil Company (New Jersey) et al., vol. I, pp. 109, 104.

5. Hermann Frasch emigrated to the United States in 1868 at the age of 17 and was employed thereafter by diverse Cleveland area companies. His first patent assigned to Solar Refining, a Cleveland-based Standard affiliate, appears to have been issued in 1891. He previously invented a more famous process for mining sulphur. William Burton later invented the first successful thermal cracking apparatus.

6. Alfred D. Chandler Jr., The Visible Hand: The Managerial Revolution in American Business (Harvard University Press: 1977), p. 256.

having a daily processing capacity of 1,500 to 2,000 barrels per day, to 0.452 cents, realized in Standard's much larger refineries, with capacities of from 5,000 to 6,500 barrels.[7]

7. Alfred D. Chandler Jr., Scale and Scope: The Dynamics of Industrial Capitalism (Harvard University Press: 1990), pp. 25, 21. For my argument that such cost savings were too great to stem from scale economies alone and Chandler's rebuttal, see the Colloquium in the Business History Review, vol. 64 (Winter 1990), pp. 694-695 and 737-738.

Reconsidering the Standard Oil case, Dominick Armentano stresses that refined petroleum prices fell significantly between 1880 and 1897 while Standard's output expanded strongly. From this he concludes that "In short, there was no restriction of supply, and monopoly prices were never realized, even during periods of high market share. Standard was a large, competitive firm in an open, competitive market." In this, however, he commits a fallacy repeated by other scholars. It is easy to show using economic theory that even the tightest of monopolies will expand output over time if the demand it is facing shifts to the right, e.g., because consumers learn the advantages of kerosene as an illuminant, as population grows, and as new geographic markets are reached. And with rightward-shifting demand, prices can fall even under complete monopoly conditions if economies of larger scale are realized and/or technological changes shift cost curves downward.[8] The key questions therefore are factual: how great were the scale economies realized by Standard vis a vis rivals, and to what extent did its innovative efforts contribute uniquely to the decrease in refining and transportation costs?

In adjudicating the Standard Oil case, the courts could not ignore Standard's claims of superior entrepreneurship. The Supreme Court observed, for example, that:

> [I]n a powerful analysis of the facts, it is insisted [by Standard] that they demonstrate that the origin and development of the vast business which the defendants control was but the result of lawful competitive methods, guided by economic genius of the highest order, sustained by courage, by a keen insight into commercial situations, resulting in the acquisition of great wealth, but at the same time serving to stimulate and increase production, to widely extend the distribution of the products of petroleum at a cost largely below that which would have otherwise prevailed, thus proving to be at one and the same time a benefaction to the general public as well as of enormous advantage to individuals.[9]

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8. This is most uniformly true when demand curve shifts are iso-elastic, i.e., when the quantity demanded at any price is multiplied by a constant. Exceptions can readily arise when the shift is parallel -- a case common in textbook analyses, but less common in the real world than iso-elastic shifts.

9. Standard Oil Co. v. United States, 221 U.S. 1, 48 (1911).

Nevertheless, both the Circuit Court of first instance and the Supreme Court manifestly failed to address and resolve the contending claims. The Supreme Court at least admitted the task's difficulty:

> [T]o discover and state the truth concerning these contentions both arguments call for the analysis and weighing ... of a jungle of conflicting testimony covering a period of forty years, a duty difficult to rightly perform and, even if satisfactorily accomplished, almost impossible to state with any reasonable regard to brevity.[10]

Instead, asserting from historical and legal reasoning "an obvious truth" that individuals should not be allowed to secure monopolies by wrongful means, the Circuit Court concluded summarily, "Nor can arguments of reduced prices of product, economy in operation, and the like have weight," commencing its remedial order only two paragraphs later.[11] Similarly, without engaging in the kind of balancing a modern rule of reason analysis might entail, the Supreme Court found that:

> [Standard's] very genius for commercial development and organization which ... was manifested from the beginning soon begot an intent and purpose to exclude others which was frequently manifested by acts and dealings wholly inconsistent with the theory that they were made with the single conception of advancing the development of business power by usual methods, but which on the contrary necessarily involved the intent to drive others from the field and to exclude them from their right to trade and thus accomplish the mastery which was the end in view.[12]

And as a result, Standard Oil was broken into 34 fragments,

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10. Ibid.

11. U.S. v. Standard Oil Co., 178 Fed. 177, 196 (1909).

12. Supra note 9 at 76. In his dissent, Justice Harlan criticized the majority for articulating its "rule of reason" to adjudicate monopolization cases without any evident basis in Congressional intent.

partly delineated by function (e.g., crude oil production, transportation, or refining) and partly geographically.

One might speculate that the courts in Standard Oil attempted no balancing of the evidence on innovation and cost reduction because the job had been done for them, despite the evident lack of judicial gratitude, in a massive study the Bureau of Corporations completed two years before the Circuit Court delivered its opinion. The Bureau's staff observed inter alia that by far the largest declines in the margin between crude petroleum prices and refined product prices occurred between 1866 and 1872, "before the Standard can be said to have exercised any influence,[13] that in the first decade of the 20th Century there was very little difference between the unit costs of Standard refineries and those of its larger rivals (who, it argued, would have been even larger and joined by others but for Standard's restrictive practices),[14] and, on technological innovation:[15]

> It is a familiar fact that whenever any absolutely new industry springs up, particularly one of a complex character, the costs at the outset are exceedingly high and are rapidly reduced with the first few succeeding years.... It is doubtless true that the Standard Oil Company ... was able to secure economies somewhat greater than could have been secured by a number of smaller concerns. It is, however, absurd to contend that no further economies in the industry would have been brought about after 1873 in the absence of the Standard or a similar combination.... The reduction of cost, even by small concerns, has been due to the natural development of the industry and to the general progress of science and invention -- not to the enormous aggregation of capital.

Support for the Bureau's inferences on innovation is provided by an analysis of data the Bureau staff failed to consider (presumably because it was not fashionable in economics to do so at the time, as it is now). From Jacob Schmookler's compilation of U.S. patents issued in various fields, Figure 1 shows the number of petroleum refining patents issued during five-year periods between 1850 and 1929, along with the amount of crude oil produced in the United States during the same periods.[16]

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13. Report of the Commissioner of Corporations on the Petroleum Industry, Part II, "Prices and Profits" (Washington: 1907), p. 625.

14. Ibid. pp. 650-655.

15. Ibid., pp. 625-626.

16. Jacob Schmookler, Statistics of Patents Classified by Industry, United States, 1837-1957, Part II, for Patent Office

The plot is in logarithmic form, so a straight line implies a constant annual growth rate. The growth of patenting is most rapid before Standard Oil was incorporated and began acquiring competitors in 1870. By 1880, Standard had acquired at least 80 percent of U.S. refining capacity. During its period of dominance, patenting shows no growth and is at lower absolute rates than in 1865-69. After the dissolution of the New Jersey Standard Company in 1912, there is new growth and a substantial increase in the level of patenting.

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classes 325 through 332 (undated, mimeographed, University of Minnesota).

More detailed scrutiny suggests that the core components of Standard Oil generated only a small share of the 363 refining patents identified in Schmookler's tabulation for the years 1880-1900. A search was conducted in the Patent Office's Annual Index of Patents covering those years for any patent assignment to an entity with the name "Standard Oil..." plus Anglo-American Oil, Atlantic Refining, Ohio Oil, South Penn Oil, and Solar Refining -- subsidiaries included under Standard's 1882 trust.[17] Only 34 patents, or 9.4 percent of the comparable Schmookler count, could be traced to those Standard entities. More than half of them were for inventions made by Hermann Frasch. It is possible that some inventions made by Standard employees were not assigned to the parent.[18] Additional patents were probably obtained by smaller companies acquired by Standard but not covered in the search. However, since the most important company affiliates were included, Standard's principal operating entities appear to have made few technological contributions other than those associated with Frasch.

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17. The search was hindered by the deteriorated condition of the Index of Patents volumes located in the Patent Office's public search room. The volumes for 1879, 1880, and 1885 were so badly fragmented that systematic consultation was infeasible. Contrary to the original research plan, no search was conducted over a broader list of 52 Standard affiliates, mostly small, for fear of doing further damage to the brittle pages.

18. However, non-assignment could not have been a uniform policy, since assignments were found for several core Standard companies throughout the period. A check for the earlier years 1876-1879 disclosed one patent assigned to William Rockefeller, John D. Rockefeller's brother and business associate. Several additional Standard Oil assignments are not counted here because they were for non-refining inventions -- most of them pertaining to container designs and manufacturing techniques.

There is qualitative support for inferring that Standard was not an outstanding technological innovator during its period of dominance. While the monopolization case was proceeding, the petroleum refining industry was subjected to two technological revolutions. The demand for kerosene illuminating oil -- its principal early product -- was threatened by the advent of electric illumination, but the emergence of the automobile created demand for gasoline, which until then had been a nearly worthless by-product of the refining process. In 1907, 8.0 percent of American homes were wired for electricity; by 1912, the figure had doubled and continued rising to 34.7 percent in 1920. In 1907, 43,000 passenger automobiles were produced; in 1912, 356,000; and after the first million-car year in 1916, factory sales reached 1.9 million in 1920. Using traditional methods, petroleum refiners were hard-pressed to extract enough gasoline to meet the burgeoning demand. A new process for obtaining a much higher fraction of gasoline from a barrel of crude oil -- thermal cracking -- was invented around 1909 by William Burton, co-inventor earlier of the Frasch process and in 1909 head of production at Standard Oil Company of Indiana. Indiana Standard applied to Standard headquarters in New York for authorization to spend $1 million developing and installing thermal crackers. The request was turned down; the invention was considered too dangerous.[19] Only when Standard of Indiana became independent in 1912 could the project go forward. The Burton process was widely licensed. Between 1913 and 1920, when competing cracking processes began to emerge, 91 million (42 gallon) barrels of gasoline had been refined using the Burton process.[20]

The Electric Lamp Industry

If the kerosene lamp repelled the forces of darkness, electric illumination vanquished them. Thomas Edison, every American school child knows, is the one who struck the decisive blow. But the truth is more complex. By the 1870s, the scientific knowledge base required for an incandescent lamp had evolved to a state under which, given the powerful demand for low-cost illumination, the "invention" of electric lamps had

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19. See Daniel Yergen, The Prize (New York: Simon & Schuster, 1991), pp. 111-112; and George S. Gibb and Evelyn H. Knowlton, History of Standard Oil Company: The Resurgent Years: 1911-1927 (New York: Harper, 1956), pp. 116-117. Gibb and Knowlton observe more generally at p. 123 that "Little creative research of an important nature ... was undertaken" by New Jersey Standard.

20. John L. Enos, Petroleum Progress and Profits: A History of Process Innovations (M.I.T. Press, 1962), Appendix Table 1a.

become virtually inevitable.[21] Thus, carbon filament lamps were conceived almost simultaneously between 1879 and 1881 by a number of individuals, including Edison, Great Britain's Joseph Swan (who had experimented with filament lamps as early as 1848), and others. Edison had two advantages: he more than any other perfected an entire system for electric lighting, and he sought patents aggressively. Erroneously believing that patenting was precluded by prior art, Swan lagged Edison in seeking patents. Nevertheless, many companies entered the new business, and a tangle of potentially interfering patents materialized.

21. See William F. Ogburn and D. S. Thomas, "Are Inventions Inevitable?" Political Science Quarterly, vol. 37 (1922), pp. 83-98; and F. M. Scherer, "Economics of Innovation and Technological Change," International Encyclopedia of the Social and Behavioral Sciences (2001), vol. 11, pp. 7531-7533.

The strategies of Edison and the General Electric Company, the successor to the various Edison companies formed in 1891, included vigorous acquisition of other inventors' key patents, restrictive cross licensing of patents when outright acquisition was not possible, merger with competing companies producing electric lamps and ancillary equipment, and, leveraging from a powerful patent position, organization of both national and international cartels.[22] By 1896, General Electric and its cross-licensee Westinghouse dominated the U.S. industry with a combined 75 percent market share, surrounded by a fringe of licensed and unlicensed (typically short-lived) smaller rivals. In 1896 General Electric took the lead in organizing the Incandescent Lamp Manufacturers trade association, which fixed prices, allocated customers, and assigned each member a maximum percentage quota oriented around GE's sales. Cross licenses with European rivals limited the participating companies to their agreed-upon national spheres of influence. As the basic Edison and complementary patents expired, General Electric sustained its dominant position and its ability to orchestrate the cartel through further acquisitions of key patents and rival companies. When the expiration of carbon filament lamp improvement patents weakened its position and after European companies had blazed the trail by introducing lamps with metal (e.g., tungsten and tantalum) filaments, General Electric caught up by developing between 1904 and 1907 superior lamps with ductile tungsten filaments, to which the advantages of argon gas filling were later added.

22. The most comprehensive source on this history is Arthur A. Bright Jr., The Electric Light Industry (New York: Macmillan: 1949). Edison withdrew from the active management of his electric light companies in 1884.

The first government attack on the lamp cartel was initiated in March 1911, two months after the Supreme Court's Standard Oil decision. A consent decree entered on October 12, 1911, enjoined many of the cartel's practices. However, following precedents confirmed in the Bement case,[23] the consent decree did not restrict GE's ability to acquire competing patents or its ability to specify in patent licenses the prices at which the licensees sold their bulbs, assign them market share quotas, and limit the kinds or sizes of lamps they could supply. It did, however, prevent GE from stipulating the prices its own and licensees' downstream distributors could charge. General Electric and Westinghouse circumvented this restriction by designating their retailers as agents, maintaining de jure property rights in the patented lamps carried in retailers' inventories. With restrictive license terms and the agency system substituting for the earlier cartel arrangements, the electric lamp cartel was minimally discommoded. General Electric's share of U.S. lamp production in 1923 was estimated to be 61 percent; Westinghouse's share 16 percent; that of other licensees 9 percent, and other vendors (mostly specialized) 14 percent.[24]

The agency system was challenged under a new antitrust suit in 1924, but it was sustained as legitimate by a district court in 1925 and by the Supreme Court in 1926.[25] Among other things, the Supreme Court reiterated its Bement conclusion that fixing the prices at which direct licensees (e.g., Westinghouse) sold their products was a condition "normally and reasonably adapted to secure pecuniary reward for the patentee's monopoly" -- downplaying the fact that GE's patents were often acquired from would-be rivals in what was transparently an attempt to monopolize the field and that they were conditioned on a rich network of restrictive cross licenses.

Public attitudes toward patent-based cartels changed dramatically during the Great Depression of the 1930s. The failure of the cartel-friendly National Recovery Administration (NRA) to restore prosperity was one reason. Investigations by the Temporary National Economic Committee (TNEC) also altered policy-makers' perceptions, among other things by revealing in detail the stranglehold the Hartford Empire Company and its bottle-making licensees had secured over the glass container industry. At an American Economic Association symposium reviewing the TNEC's findings, later Nobel laureate George

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23. Bement & Son v. National Harrow Company, 186 U.S. 70 (1902).

24. Bright, supra note 22 at 242.

25. U.S. v. General Electric Company et al., 272 U.S. 476 (1926).

Stigler found Hartford Empire "an eloquent example of an evil demanding correction" and concluded flatly that "The case for limitation of restrictive licensing is surely irrefutable."[26] The TNEC findings spurred the Department of Justice to launch a broad investigation of patent system abuses and to initiate numerous complaints challenging patent practices. The electric lamp cartels, national and international, were one target. Westinghouse consented in 1942 to end its cartel participation and license its patents royalty-free, but for General Electric and some licensing partners who chose to fight the battle in court, prosecution was delayed until the end of World War II to avoid distracting executives' attention from the war effort.

26. George J. Stigler, "The Extent and Bases of Monopoly," American Economic Review, vol. 32 Supplement (June 1942), p. 14.

In 1948, the U.S. Federal District Court for the Northern District of Ohio found that General Electric and its licensees had in fact violated Sections I and II of the Sherman Act. Weighing what had been accomplished to provide U.S. consumers with low-cost illumination against the restraints maintained, Judge Phillip Forman concluded:[27]

> The record of General Electric's industrial achievement has been impressive. Its predecessors pioneered the lamp industry and it organized through the years an establishment that stands as a model of industrial efficiency. ... By means of extensive research ... mechanical and technological advances were accomplished ... which made possible a progressive price reduction policy. ... It can take just pride in the more graphic statistic that the price of a 60 watt bulb was 45 cents in 1922 and 10 cents in 1942....
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> On the other hand there can be no doubt that it paced its industrial achievements with efforts to insulate itself from competition. It developed a tremendous patent framework and sought to stretch the monopoly acquired by patents far beyond the intendment of those grants. It constructed a great network of agreements and licenses, national and international in scope, which had the effect of locking the door of the United States to any challenge to its supremacy in the incandescent electric lamp industry arising from business enterprise indigenous to this country or put forth by foreign manufacturers. Its domestic licenses gave fiat to a few licensees whose growth was carefully limited to fixed percentages of its own production and expansion so that over the years its share of the business was not materially diminished and its dominant position was never exposed to any hazard in that direction.

27. U.S. v. General Electric Co. et al., 82 F. Supp. 753, 905 (1948).

The remedial order was deferred to a subsequent stage, concluded in 1953. At the time, General Electric's share of domestic incandescent lamp production was estimated to be 60 percent. The government's petition that half of General Electric's principal lamp production capacity be spun off into a separate entity was denied. However, the restrictive agreements between General Electric and its domestic and foreign licensees were enjoined. General Electric had argued, citing a Supreme Court pronouncement in the Hartford-Empire case,[28] that it should receive appropriate compensation for any patent licenses it was required to issue. However, finding GE and its licensees to be "mounted upon an arsenal of a huge body of patents that can easily overwhelm and defeat competition by small firms," Judge Forman asserted what the Supreme Court had deemed in another compulsory licensing case "sound judicial discretion" and ordered that the lamp patents be dedicated to the public without compensation:[29]

> Royalty free licensing and dedication are but an extension of the same principle, not to be directed indiscriminately, of course, but well within the therapeutic measures to be administered under circumstances such as were made to appear in this case.

Thus, a patent monopoly position engendered when Thomas Edison received his basic carbon filament lamp patent in 1880 ended by judicial decree 73 years later. A Congressional survey found that as of January 1956, nine compulsory licenses had been issued by General Electric and eight by Westinghouse.[30] Price competition from both domestic and foreign sources has undoubtedly intensified since then. In 1985 imports rose to 10.9 percent of domestic firms' output value. The domestic industry

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28. Hartford-Empire Co. et al. v. U.S., 323 U.S. 386, 414 (1944).

29. U.S. v. General Electric Co. et al., 115 F. Supp. 835, 844 (1953).

30. Compulsory Licensing under Antitrust Judgments, Staff Report, Subcommittee on Patents, Trademarks, and Copyrights, Senate Committee on the Judiciary (Washington: 1960), p. 20.

structure, however, was not radically transformed; it continues to be a relatively tight oligopoly, with a four-firm concentration ratio of 93 percent in 1954 and 87 percent in 1992.

AT&T

The early history of AT&T is remarkably similar to that of General Electric. Alexander Graham Bell filed his first telephone patent application on February 14, 1876. Patent no. 174,465 was approved three weeks later. Only a few hours after Bell's initial application was filed, Elisha Gray of Chicago filed a patent application for his own version of the telephone. Bell's first and subsequent patents were assigned to a series of companies that eventually became AT&T; Gray's to the powerful Western Union Company (which in August 1877 turned down an opportunity to purchase Bell's initial patent). Each company began installing or licensing newly-created local firms to install telephone networks. Given the conflicting claims resulting from third-party inventions, various infringement suits were initiated. They were eventually resolved in favor of the Bell derivative companies in a 4-3 decision of the United States Supreme Court.[31] In the mean time, Western Union had also purchased relevant patents from Amos E. Dolbear and Thomas A. Edison. These additional inventions were sufficiently superior to those of Bell that, despite Bell's purchase of an improved transmitter patent, Western Union "methodically beat [Bell] each time the two systems were in direct competition."[32]

Each company found itself threatened by the other's patent claims and telephone system investments. In November 1879 a settlement was reached. Under it, Western Union agreed not to contest the validity of Bell's patents, to cede exclusive rights for the construction and operation of telephone networks to the Bell companies, and to grant Bell rights in 42 existing and any subsequent telephone patents owned by Western Union. The quid pro quo was an agreement by Bell not to compete in the field of telegraphy and to pay between 1879 and 1896 20 percent of Bell's license revenues from its telephone operating company franchisees. In addition, Bell agreed to purchase Western Union's already existing telephone operations.[33]

To consolidate its patent position, the Bell derivative

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31. The Telephone Cases, 126 U.S. 1 (1888).

32. Joseph C. Goulden, Monopoly (Pocket Books: 1970), p. 35.

33. U.S. Federal Communications Commission, staff report, Report on Telephone Investigation (two volumes, mimeo, 1939), vol. I, pp. 183-185, 318, and 356. The early sections of this account rely heavily upon the FCC report.

(AT&T predecessor) companies acquired a 40 percent interest in the Western Electric Company, which had been organized in 1856 to supply telegraph equipment to Western Union and which, when Western Union entered telephony, had made numerous additional telephony inventions. By 1883, AT&T had acquired majority control of Western Electric. Among other things, these actions prevented Western Electric from supplying telephone apparatus to other companies that might compete with the Bell affiliates.

Despite Bell's consolidated patent position, many other companies did try to enter the newly emerging telephone service and equipment supply industries. Bell's largely successful strategy in combatting them was to deny them Western Electric as an equipment supplier and to sue them for infringement when other equipment sources were tapped. Between 1877 and 1893, when the original Bell patent expired, roughly 600 infringement suits were brought. Most of the respondents promptly went out of business when challenged; only a few suits were pursued to the final Supreme Court decision of 1888.[34] With the expiration of another key Bell patent in 1894, however, Bell's ability to exclude competition merely on the basis of its extensive continuing patent portfolio was severely weakened. Again, new companies began providing telephone service, especially in smaller towns Bell had not yet entered but also some directly competing in the larger metropolitan areas. By 1902, there were 1.32 million Bell telephones in use and 1.05 million independent units.

AT&T (incorporated in 1885 and reorganized to control all Bell affiliates in 1900) pursued several strategies to restrain the growth of independent competition. It acquired from outside inventors additional patents, including Lee de Forest's basic triode amplifier tube patent. It continued to bring infringement suits, not all of them successful. Efforts to strengthen this barrier further by purchasing two particularly important equipment manufacturers who supplied the independent telephone companies were defeated by federal and state anti-merger actions in 1906 and 1907.[35] Having steadily increased the "long lines" connections among individual metropolitan telephone systems, AT&T denied interconnection to competing local operating companies and hence deprived them of network advantages.[36] With its superior access to financial capital and its network advantage of long lines interconnectivity, the Bell system engaged in an aggressive program of buying up competitive telephone companies. By 1912,

34. Federal Communications Commission, supra note 29, p. 186.

35. Federal Communications Commission, supra note 33, at 204.

36. On network externalities, see Michael L. Katz and Carl Shapiro, "Systems Competition and Network Effects," Journal of Economic Perspectives, vol. 8 (Spring 1994), pp. 93-115.

Bell control of telephone sets in service had risen to 5.09 million, compared to 3.64 million associated with independent companies.[37]

37. Federal Communications Commission, supra note 33, at 208.

AT&T's continuing efforts to acquire rivals and its refusal to interconnect those who remained independent, however, provoked antitrust intervention beginning in 1913. This led in late 1913 to the so-called Kingsbury commitment,[38] named after a vice president of AT&T. Under it AT&T agreed not to acquire control over any additional competing telephone service companies, to dispose of its controlling stock interest in Western Union (acquired in 1909), and to interconnect its inter-city and local networks with competing companies if they provided standardized connecting lines. The undertaking was modified in 1918 to permit Bell to acquire competing companies if the Bell system in turn spun off an equal number of telephone stations to independent companies. Some independent companies apparently protested that the Kingsbury commitment prevented them from selling out on advantageous terms to AT&T, and in 1921, after the passage of permissive legislation, the Department of Justice voided the commitment. As a result of these changes, the number of independent telephone sets peaked at 4.8 million in 1922 while Bell's network of sets rose to 9.5 million in 1922 and 13.7 million in 1927.

Even before the Kingsbury commitment was negotiated, some of Bell's restrictive policies were relaxed beginning with the return of Theodore Vail to the leadership of AT&T in 1907. Vail believed that telephone service should be a universal monopoly regulated by governmental authority at either the state or federal level. He was also concerned by escalating threats of antitrust intervention. Some (largely ineffective) regulation was exercised by the Interstate Commerce Commission beginning in 1910, replaced in 1934 by the creation of the Federal Communications Commission. Also, recognizing that Bell's ability to block independent competition through patent suits was weakening, Vail authorized Western Electric to begin selling equipment to the independent operators. The loss of leverage motivating independent companies to sell out to Bell in order to gain interconnection with Bell's long lines was apparently compensated by arbitrary toll revenue "divisions" that favored Bell, given the independents' need to connect with Bell in order to supply their patrons with comprehensive nationwide service.[39]

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38. Federal Communications Commission, supra note 33, p. 208. Prior to 1913, 16 states had passed laws requiring interconnection, but some were undermined through technical incompatibilities.

39. Federal Communications Commission, supra note 33, at 213.

The emergence of radio technology posed a new threat to AT&T's increasingly dominant position. With its control of the de Forest triode patent and many improvement inventions, AT&T held a key blocking position. But other companies had equally important patents on related aspects of radio technology. To ensure that advances in the military use of radio did not bog down through a welter of infringement suits, the U.S. Navy required in 1917 (as the United States entered World War I) that the principal patent holders cross-license their patents into a patent pool. After the war, the leading radio patent holders -- AT&T, General Electric, RCA (created as a patent-pooling entity in 1919), and Westinghouse entered into cross-licensing agreements, with each participant receiving exclusive rights to develop its strategic interests -- e.g., for AT&T, to use the patents for wire telephone and telegraph technology and public network radiotelephones. However, the rapid rise of radio broadcasting was not anticipated in the agreements. AT&T began setting up broadcasting stations, initially with WEAF in New York during 1922, and demanding that other radio broadcasters take licenses from AT&T calling for royalty payments and restrictions on the commercial sale of radio time. They initiated political countermeasures, leading Secretary of Commerce Herbert Hoover to declare in 1924:[40]

> I can state emphatically that it would be most unfortunate for the people of this country to whom broadcasting has become an important incident of life if its control should come into the hands of any single corporation, individual or combination.

This controversy led to arbitration over the terms of the original patent pool and eventually, in 1926, to a cross-licensing agreement modification under which AT&T sold its broadcasting operations to RCA and agreed to stay out of broadcasting in return for exclusive "pickup" rights to transmit programs between radio stations over its land telephone lines. The agreement provided that if AT&T failed to furnish the desired services, RCA could so. AT&T retained exclusive rights to all other applications of wire telephony, to commercial two-way radiotelephony operations within the United States, and to the provision of equipment used in the United States for transoceanic radiotelephone calls.[41] This agreement drew an antitrust challenge eventually settled in 1932. The revised agreement did

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40. W. R. Maclaurin, Invention and Innovation in the Radio Industry (New York: Macmillan, 1949), p. 114.

41. See Federal Communications Commission, supra note 33, at 334-336; and Gerald W. Brock, The Second Information Revolution (Harvard University Press, 2003), pp. 36-38.

little to restrict AT&T's ability to control its chosen fields.[42]

42. See Federal Communications Commission, supra note 33, at 340.

With a secure monopoly in telecommunications service and the supply of equipment to its operating companies, AT&T was, according to the FCC's 1939 staff report, slow in introducing such technological innovations as automatic dialing, monolithic handsets, anti-sidetone circuitry, and office switchboards with enhanced features.[43] Following World War II,[44] AT&T continued to delay the implementation of certain technological innovations despite the work of its Bell Telephone Laboratories, called by Fortune magazine in November 1958 "the world's greatest industrial laboratory," responsible among other things for the invention of the transistor,[45] the discovery of cosmic microwave background radiation presumably resulting from "the Big Bang," a leading role in the invention of the laser, and shared development of optical fiber transmission cables. Delayed implementation occurred because Western Electric designs were favored over alternative equipment available on the outside market and through stringent interpretation of its tariff rules barring the attachment of "foreign devices" to Bell's lines and telephones. Examples included Bell's discontinuation of service to customers using answering machines and recording devices not designed by Western Electric; actions to discourage customers from using one-piece telephones, facsimile machines, designer telephones, and speakerphones available on the market; the insistence that large-volume customers use Bell-design office switchboards rather than allegedly superior models available from other sources; and actions taken to prevent the use of Hush-a-Phone (a device attaching to handset speakers to prevent bystanders from overhearing conversations) and the Carterphone, which permitted users to "patch" telephone calls back and forth into over-the-air radio communication devices, including ham radios. The Hush-a-Phone and Carterphone disputes led to

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43. Federal Communications Commission, supra note 33, pp. 323-398 and 404-405.

44. For an analysis of ten postwar innovations showing rapid introduction in some monopoly cases (e.g., touch-tone dialing) but on average faster introduction under more recent competitive conditions, see Howard A. Shelanski, "Competition and Deployment of New Technology in U.S. Telecommunications," 2000 U. Chi. Legal Forum 85, 98-117 (2000).

45. For an obituary observing that a lack of competitive urgency slowed AT&T's use of Bell Laboratories inventions, see "AT&T Inventions Fueled Tech Boom, And Its Own Fall," Wall Street Journal, Feb. 2, 2005, p. 1. Remarkably, Bell Laboratories lagged Northern Telecom of Canada in the development of digital central office switches because Bell failed to extrapolate, consistent with Moore's Law, the future decline of integrated circuit prices. See F. M. Scherer, International High-Technology Competition (Harvard University Press: 1992), pp. 87-88.

regulatory proceedings before the FCC and litigation in the federal courts, precipitating escalating requirements that AT&T lessen its barriers to foreign attachments.[46]

46. Hush-a-Phone Corp. v. U.S., 238 F. 2d 266 (1956); in re Hush-a-Phone Corp., 22 F.C.C. 113 (1957); Carter v. AT&T Co., 250 F. Supp. (1966), aff. 365 F. Supp. 486 (1966), and in re Carterphone, 13 F.C.C. 2nd 420 (1968).

Another exception to Bell's slow innovation pace is revealing. By the end of World War II, radio, radar, and radio tube technology had advanced to the point where transmitting large quantities of information using microwave radio had become feasible. At the same time, the rapid emergence of the television industry created a demand for the ability to carry broad-band TV signals for long distances between various parts of the country. To facilitate microwave technology, the Federal Communications Commission allocated blocks of the microwave radio spectrum for use by relay systems. By 1947, several companies, including Philco, Raytheon, Western Union, General Electric and IBM jointly, and DuMont had applied for microwave spectrum allocations and had either begun or were about to begin construction of experimental microwave relay networks.[47] These ventures were a serious threat to the Bell System's long-established monopoly position in the intercity transmission of all but telegraph signals. Bell responded by developing at record speed its TD-2 radio relay system, initiating service with a New York - Chicago link in September 1950.[48] It simultaneously retarded or blocked rival developments by staking claims to the most desirable relay locations, refusing to interconnect its microwave and telephone facilities with non-Bell microwave systems, and persuading the FCC to restrict the use of key spectrum blocks to common carriers. Through the "crash" TD-2 program, AT&T successfully defended most of its monopoly position in inter-city message transmission -- at least until later regulatory developments altered the environment in the 1960s.[49]

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47. See Donald C. Beelar, "Cables in the Sky and the Struggle for Their Control," Federal Communications Bar Journal, vol. 21 (1967), pp. 27-37.

48. F. M. Scherer, "The Development of the TD-X and TD-2 Microwave Radio Relay Systems in Bell Telephone Laboratories," cleared case study, Harvard Business School Weapons Acquisition Research Project, October 1960.

49. Specifically, the FCC's "Above 890" decision in 1959 followed by the FCC's approval of MCI's radio relay system application in 1969.

Eventually, however, AT&T's efforts to maintain its service and equipment near-monopoly positions induced aggressive antitrust intervention. A complaint was filed in 1949 seeking divestiture of Western Electric from AT&T, fragmentation of Western into three parts, and the end of other restrictive arrangements. Adjudication was delayed by the Korean war. In 1953, Secretary of Defense Charles E. Wilson sent to Attorney General Herbert Brownell a letter observing that the proposed divestiture of Western Electric "seriously threatens the continuation of important work which the Bell System is now carrying forward in the interests of national defense." It urged that "a mere postponement ... does not adequately protect the vital interests involved" and asked that the Justice Department review "how this potential hazard to national security can be removed or alleviated."[50] This paved the way for a consent settlement in 1956 requiring compulsory licensing of roughly 9,000 AT&T patents and limitations on third-party commercial product sales by Western Electric.[51] A Congressional investigation revealed later that the letter was drafted by Bell Laboratories president Mervin J. Kelly.[52] The Western Electric case was cited, along with more recent settlements involving the auto industry and various mergers, in Congressional hearings that led to the so-called Tunney Act, which requires publication of the rationale for antitrust consent decrees and judicial oversight of their provisions.[53]

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50. U.S. House of Representatives, Commitee on the Judiciary, Subcommittee on Antitrust, Consent Decree Program of the Department of Justice (Washington: 1958), Part II, vol. I, pp. 2029-2031.

51. U.S. v. Western Electric Inc. et al., CCH 1956 Trade Cases Para. 68,246 (1956).

52. Supra note 50, pp. 2015-2039.

53. U.S. Senate, Committee on the Judiciary, Subcommittee on Antitrust and Monopoly, Hearings, Antitrust Procedures and Penalties Act (Washington: 1973), and Public Law 93-528 (December

1974).

How AT&T responded to post-1956 Federal Communications mandates allowing companies such as MCI and Datran to commence inter-city service competitive with AT&T and requiring it to interconnect "foreign devices" set the stage for a new monopolization complaint in November 1974. In addition to showing that AT&T and Western Electric held monopoly positions, the government alleged a laundry list of restrictive practices, including failure to interconnect competing carriers with its network on reasonable terms, discriminatory price reductions confined to the markets in which competition had emerged, and much else, which, it alleged, provided proof of intent to monopolize. The government sought divestiture of local Bell operating companies and Western Electric from AT&T and (more tentatively) fragmentation of Western Electric. A clumsily punctuated paragraph in the government's brief also implied that Bell Telephone Laboratories would be separated from the Western Electric manufacturing operations[54] -- a proposal which, if in fact intended, showed serious misunderstanding of how research and development are best conducted. AT&T replied inter alia that its monopolistic positions and the vertical integration of its operations resulted from conscious regulatory policies, and that the restrictive practices of which it was accused were approved, either actively or passively, by the Federal Communications Commission. They reflected among other things regulators' desire to preserve the integrity of the U.S. telecommunications network from technological failures and from "cream-skimming" behavior by new rivals exploiting an accepted uniform-price policy by entering only high-volume, low-cost segments. Equally importantly, there was what the AT&T brief called its "economic and technological defense:"[55]

> [T]he integrated structure of the Bell System which the Government seeks to destroy in this case, and the interactions and common purpose which that structure makes possible, have enabled the Bell System to provide the public with the finest telecommunications system in the world at rates that compare very favorably with those available in any other country.... The Bell System's price and quality performance has only been matched for its record of introducing innovative equipment better to fulfill its service mission.

After the government's case in chief was completed, AT&T moved for summary judgment. Placing little weight on the economic and technological defense, District Judge Harold Greene

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54. Plaintiff's First Statement of Contentions and Proof, Civil Action No. 74-1698 (November 1978), p. 528.

55. Defendants' First Statement of Contentions and Proof Civil Action No. 74-1698 (January 1979), pp.44-45 and 436-437.

concluded that AT&T possessed monopoly power "notwithstanding regulation," adding his supposition that the Federal Communications Commission "may realistically be incapable of effectively regulating a company of AT&T's size, complexity, and power."[56] He ruled further, subject to possible rebuttal in the case's defense phase, that the evidence gave reason to believe that the Bell System had violated the antitrust laws over a lengthy period of time, citing in particular its conduct with respect to the connection of customer-owned equipment, intercity service competitors, and the procurement of equipment.

56. U.S. v. American Telephone and Telegraph Co., 524 F. Supp. 1336, 1359, 1345 (September 1981).

A series of surprises followed. Settlement negotiations already underway at the time of Judge Greene's decision were accelerated, and on January 8, 1982, AT&T and the government announced that they had reached a consent agreement. Twenty-two Bell companies providing preponderantly local telephone service were to be separated from AT&T and reorganized into an unspecified number (eventually, seven) of regional clusters (RBOCs, for Regional Bell Operating Companies). AT&T would retain the interstate service (Long Lines) part of its activities as well as Western Electric and Bell Telephone Laboratories. The parts retained by AT&T, the settlement's rationale implied, were activities that would be exposed to actual and potential competition, whereas the divested regional operating companies were considered to be natural monopolies which would continue to be regulated by the Federal Communications Commission and state authorities.[57] As in 1955, AT&T secured support from other government agencies against divestiture, but even President Reagan's cabinet was unwilling to prevent Assistant Attorney General Baxter from going forward.[58] Restraints from the 1956 consent decree barring Western Electric from commercial sales to non-Bell customers were relaxed, permitting Western Electric to enter the computer industry (which it later did, unsuccessfully) and merchant semiconductor sales. The divested operating companies were required to provide local connection access to AT&T and its rivals on essentially equal but unspecified terms.

Why AT&T accepted this settlement rather than continuing to contest the monopolization charges, insisting as it had for decades that its integration offered major efficiencies, remains somewhat of a mystery. Its management undoubtedly feared that a litigated judgment against it, which Judge Greene's preliminary decision foreshadowed, would lead to crippling treble damages suits. It almost surely overestimated the chances that Western Electric with Bell Laboratories could achieve major success in computers. And it may have been blinded by the tight-money policy pursued by the Federal Reserve Board at the time. With high-grade bond interest rates of 14 percent, the cost of new capital to AT&T was higher than the rates of return on capital allowed by local regulatory authorities for Bell operating companies, which were under pressure to continue investing vigorously. Thus, every million dollars invested by Bell cost more in interest than it yielded in additional regulated returns, making the Bell operating companies a "dog" in the eyes of stock market investors.[59] This anomaly faded by the late 1980s, but by

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57. See Gerald W. Brock, Telecommunication Policy for the Information Age (Harvard University Press, 1994), pp. 157-167.

58. Brock, supra note 57, at 157-159.

59. For a proof, see F. M. Scherer, Industrial Market Structure and Economic Performance (first ed.; Chicago: Rand

then, the divestiture was history.

McNally, 1970), p. 526.

The divestiture itself proved to be more complex than originally contemplated.[60] It was accompanied and followed by tumultuous technological and economic changes: the rapid growth of cellular telephony, which created competition to local Bell operating companies; an explosion of optical fiber cable installations by Bell companies, long-distance telephone rivals, and cable television providers; the emergence and growth of the Internet; and, in the first years of the 21st Century, the appearance of new competition to traditional long-distance voice telephony from voice-over-Internet-protocol service offered by cable TV firms. Rules governing the pricing of access to local telephone company networks were revised repeatedly. Three of the seven divested regional Bell operating companies were acquired by the others, leaving only four. In 1996, AT&T chose to abandon the crown jewel it had defended from antitrust for four decades: it spun off its Western Electric manufacturing subsidiary, renamed Lucent Technologies, along with Bell Telephone Laboratories, because their affiliation with Bell was a disadvantage in selling to non-Bell telecommunication companies. By that time, deprived of annual taxes levied on the Bell operating companies, Bell Laboratories retained only a shadow of its former glory. And in 2005, the original AT&T parent agreed to be acquired by SBC, the merged successor from one of its original regional operating companies.

A crucial question is whether the Bell system divestitures accelerated or retarded the technological changes that were occurring. Since the changes were rapid and revolutionary, it would be hard to infer substantial support for the proposition that they retarded progress. Reorganization surely made the divested Bell operating companies more amenable to purchasing from vendors other than Western Electric, and the resulting competition probably accelerated innovation in at least optical fiber cables and digital central office switches.[61] However, most of the communications technology advances following 1982 were facilitated more by FCC actions opening up the telephone network to "foreign devices" such as computer modems and facsimile machines and allowing providers such as MCI, Sprint, and Datran to build and interconnect their own inter-city cable networks than by the divestiture per se. An analysis by the author of labor productivity growth in the telephone communications industry revealed an average growth rate of 6.08 percent per year between 1952 and 1982, before the divestiture, and 5.59 percent between 1985 and 2000.[62] The series is quite noisy, and the mean

60. See Brock, supra note 57, pp. 167-172 ff.

61. See F. M. Scherer, International High-Technology Competition (Harvard University Press: 1992), pp. 86-97, for case studies.

62. The raw data are found at www.ftp://ftp.bls.gov/pub/

differences are not statistically significant. Since productivity growth tends to be underestimated by the Bureau of Labor Statistics when there is a high rate of product innovation, as there was in the 1990s, the most plausible inference is that divestiture did no perceptible harm.

Cellophane

special.requests/opt/dipts/oaeh3drt.txt and /oaehhirt.txt. The only year in the series with negative productivity growth, -0.2 percent, was 1984, the year of maximum reorganizational turmoil. The analysis was presented at a University of Colorado Law School seminar in October 2003.

Tough precedents articulated by the federal courts in the Alcoa (1945), American Tobacco (1946), A&P (1946-49), motion picture exhibition chain (1944-48), and United Shoe Machinery (1953-54) cases suggested that charges of illegal monopolization could be more readily sustained than they were during the 1920s and 1930s. With the possible exception of United Shoe Machinery, however, technological innovation was not a prominent consideration in those cases.[63]

The Cellophane case was therefore a post World War II test of how the federal antitrust authorities and courts would deal with a technologically progressive monopolist. One might view cellophane now as ancient technology, but when it was introduced to the United States by du Pont in the mid-1920s, it was considered high-technology, as suggested by the lyrics of a 1934 Cole Porter song, "You're the Top:"[64]

> You're the top, you're Mahatma Gandhi,
> You're the top, you're Napoleon brandy.
> . . .

63. Judge Wyzanski's United Shoe Machinery decision in 1953 rejected divestiture of United's single main machine manufacturing plant into three components, but cautioned that the issue might be revisited (as it was in 1968) if more competition in shoe machinery supply did not emerge. An interview with a USM executive by the author in 1958 revealed that, with future divestiture threats hanging over its head, USM was redirecting its research toward diversification opportunities. USM's shoe machinery position declined in subsequent years and the company itself disappeared, initially by merger and then by closure of the Beverly, Massachusetts, plant. The best shoe machinery is now imported preponderantly from Italy. A careful case study would be desirable.

64. From the musical, "Anything Goes."

You're cellophane!

Cellophane was invented in France. In 1923, the E. I. du Pont de Nemours Company entered into a joint venture with the French cellophane producer, La Cellophane, receiving through it exclusive North American patent rights and, more importantly, extensive trade secrets required for successful production. Both companies had roots in rayon production, using similar chemical antecedents. Du Pont later gained full ownership of the U.S. operation. Beginning in the late 1920s it developed and patented coating processes through which cellophane could be made moistureproof and also production process improvements that reduced costs, improved product quality, and made the product easier to use by packagers. In 1930 Sylvania, a Belgium-based company (unrelated to the light bulb producer of identical name), began producing and selling cellophane in the United States. A patent infringement suit by du Pont led to a settlement under which du Pont licensed Sylvania to its patents at a 2 percent royalty rate which, however, increased to at least 30 percent if Sylvania's output exceeded quotas stipulated by du Pont. It was alleged that du Pont, la Cellophane, and other cellophane producers reached spheres of influence agreements under which non-U.S. firms were prevented from selling in the U.S. market, but du Pont executives denied under oath that they had actually participated in those agreements. Du Pont did lobby for and obtained in 1929 U.S. import tariffs of 60 percent (later, 45 percent) that kept virtually all cellophane imports out of the United States. During the 1930s and 1940s, therefore, du Pont, with a share of approximately 75 percent, and Sylvania, with 25 percent, were the only significant suppliers of cellophane in the United States. Except for the early infringement suit against Sylvania and one other minor incident, there was no evidence of du Pont actions like those of General Electric or Standard Oil seeking to prevent entry through extensive patent litigation, predatory pricing, or acquisition of competitors.

In 1947 the Department of Justice charged du Pont with monopolization. A decision in 1953 by Judge Paul Leahy of the U.S. District Court for Delaware began with a review of economic theories and then laid down extensive findings of fact and law.[65] The court's emphasis was on the question of whether the relevant market was cellophane, dominated by du Pont, or flexible packaging materials, in which du Pont's share was less than 20 percent -- too small for a monopolization finding. However, Judge Leahy also ruled that the evidence did not support a finding that du Pont had exhibited more intent to monopolize and exclude competitors than what one would reasonably expect of a company striving for success in its commercial efforts. Rather,

65. U.S. v. E. I. du Pont de Nemours & Co., 118 F. Supp. 41 (1953).

Judge Leahy concluded:[66]

> [Du Pont's] "monopoly" was "thrust upon" it within the true meaning of the [precedential] decisions... and the facts as to how du Pont achieved its position.... [D]u Pont's position is the result of research, business skill and competitive activity. Much of du Pont's evidence was designed to show research, price and sales policies of that Company are responsible for its success and these policies were conceived and carried forward in a coordinated fashion with skill, gaining for du Pont substantial recognition in the packaging industry.... The record reflects not the dead hand of monopoly but rapidly declining prices, expanding production, intense competition stimulated by creative research, the development of new products and uses and other benefits of a free economy.

66. Ibid. at 217, 233.

On the question of market definition, which was the only part of the district court's decision appealed to and broadly sustained by the Supreme Court,[67] Judge Leahy observed that cellophane competed with a broad range of flexible packaging materials, including lower-cost materials such as waxed paper and bleached glassine as well as higher-cost polyethylene, pliofilm, and Saran wrap. Du Pont, he said, competed vigorously, among other things reducing its costs and its average price per pound from $1.06 in 1929 to 38 cents in 1940, to have its cellophane substituted for alternative packaging materials. He continued:[68]

> Du Pont has no power to set cellophane prices arbitrarily. If prices for cellophane increase in relation to prices of other flexible packaging materials it will lose business to manufacturers of such materials in varying amounts for each of du Pont cellophane's major end uses. Relative increases would make competition more difficult to obtain new business.

67. U.S. v. E. I. duPont de Nemours and Company, 351 U.S. 377 (1956).

68. 118 F. Supp. 41, 179.

Judge Leahy's view of the constraints facing du Pont in its cellophane pricing decisions is characterized by some economists as "the cellophane fallacy."[69] The essence of the fallacy is that firms with some degree of product differentiation, and hence some discretion as to what price to charge, will maximize their profits by raising their prices near to, but not all the way up to, the level at which they lose substantial sales as a result of cross-elasticity of demand imparted by the competition from substitute products. In other words, they raise their prices into a range of substantially elastic demand. This concept is illustrated, crudely but with an attempt to track the cellophane facts of the late 1940s, in Figure 2. Du Pont's demand function, given the prices of potential substitute products, is the wavy solid line, giving rise to a wildly fluctuating and discontinuous dash-dash marginal revenue function.[70] The intuition is as follows. At a price of 5 cents per 1,000 square inches, cellophane is (a bit unrealistically) so high-priced relative to substitutes that no sales occur. As the price is reduced, cellophane gains sales volume from high-priced substitutes such as pliofilm and Saran wrap. As the price is reduced further into a range slightly above 2 cents, it captures most of the volume those substitutes otherwise would have enjoyed. But around point B it has largely exhausted the opportunities for capturing such high-quality applications, so demand becomes more inelastic. If however it can bring its price into the one-cent range, it can capture a large volume of applications from low-quality substitutes such as glassine and waxed paper, so demand turns price-elastic again.

Given this curvilinear demand function, which, the author believes, typifies many differentiated product situations,[71] multiple profit-maximizing equilibria exist. One, where the first intersection of marginal cost (dot-dash-dot MC) with marginal revenue occurs, leads to an equilibrium at point A, with a price of roughly 2.6 cents and quantity Q_A. A second equilibrium occurs at point B, with a price of approximately 1.95 cents and quantity Q_B. Of the two, profits -- the summed surplus

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69. The term came to me by oral tradition; its origin is unknown, at least to this author. A predecessor without the word "fallacy" was Donald F. Turner, "Antitrust Policy and the Cellophane Case," 70 Harvard Law Review 281 (December 1956), pp. 288, 297, and 308-310.

70. The curves were plotted using two spliced algebraic equations, simplifying the otherwise difficult task of ensuring that the marginal revenue function was drawn correctly.

71. See also F. M. Scherer and David Ross, Industrial Market Structure and Economic Performance (third edition; Boston: Houghton-Mifflin, 1990), pp. 181-183.

of revenue above marginal cost -- are higher at equilibrium B, so this is what one would expect du Pont to choose. If it raised its price just a fraction of a penny, it would experience massive volume losses to superior substitutes, as Judge Leahy implied -- hence the cellophane fallacy.

How much monopoly power a producer possesses under these conditions depends upon the varying curvature of the demand functions and the relation of the demand function to the marginal cost function. As Figure 2 is drawn, marginal costs are too high for cellophane profitably to capture volume from waxed paper and glassine. But at equilibrium B, the price is roughly twice marginal cost and substantial profits (ignoring fixed costs) are realized. The implication is that the producer facing the conditions of Figure 2 does have appreciable monopoly power, despite substantial substitution possibilities. In a critique of Judge Leahy's decision, economists George Stocking and Willard Mueller argue that close attention should have been paid to du Pont's 24.2 percent average after-tax profit return on investment in its cellophane operations.[72] Judge Leahy acknowledged du Pont's profitability but accorded it little weight.[73]

Figure 1 presents a snapshot in time. In a more dynamic context, Judge Leahy could nevertheless have been correct on the importance of substitution. DuPont did implement technological improvements and reduce cellophane costs substantially over time. If marginal costs had been two cents or more per 1,000 square inches, e.g., in an earlier phase of the cellophane marketing history, there would be only one equilibrium, northwest of point A at a price of roughly 3.4 cents, allowing most higher-priced substitutes to retain their volume. By reducing costs and hence profit-maximizing prices over time, du Pont captured demand from substitute products. But around the 3.4 cent alternate equilibrium, it enjoys substantial discretion over what price to charge -- the essence of monopoly power -- and, again ignoring fixed costs, retains appreciable profits. Cost and price reductions by substitute products could also shift the cellophane demand curve and alter quantities. An analysis more subtle than Judge Leahy's -- one, to be sure, that would overwhelm the econometric competence of du Pont's and the government's economists at the time -- would be needed to resolve the matter correctly.

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72. George W. Stocking and Willard F. Mueller, "The Cellophane Case and the New Competition," American Economic Review, vol. 45 (March 1955), pp. 29-63. See especially Table 3.

73. 118 F. Supp. 41, 179. See also Judge Learned Hand's caveat on the use of profit evidence. U.S. v. Aluminum Company of America, 148 F.2d 416, 426-427 (1945).

Over the long run, rival packaging materials' prices could also change, shifting cellophane's demand curve -- to the left, if technological progress were more rapid in alternative materials than in cellophane. That something like this must have happened is suggested by Census data showing an absolute decline in cellophane sales between 1954 and 1977. Also, in 1954, cellophane sales exceeded the sales of unsupported vinyl and polyethylene film by 14 percent; by 1977, sales of a wider array of plastic film and sheeting exceeded those of cellophane by 14 times.[74]

Xerox

74. U.S. Bureau of the Census, Census of Manufactures, "Industry Statistics" volumes, 1954 and 1977. In 1954, such materials were classified in S.I.C. 2823, "organic chemicals." By 1977, they had been moved to S.I.C. 3079, "miscellaneous plastics products."

Scholars and others who spend their lives working with text appreciate xerography as one of the greatest inventions of the 20th Century. The basic concepts were conceived through independent experiments by physicist Chester Carlson between 1934 and 1938. Several basic patents resulted. Realizing that developing a practical xerographic copying machine was beyond his means, and finding none of the roughly 20 companies he approached willing to pursue his invention, Carlson transferred his patents to the Battelle Memorial Institute, a not-for-profit R&D powerhouse, in exchange for a 40 percent share of profits. Battelle made and patented important improvements on Carlson's concepts, including the use of the photo-conducting element selenium as the image transfer basis. But commercial development required more resources than Battelle could allocate. The Haloid Corporation, with sales of roughly $6 million at the time, was the only business entity willing to take up the challenge. In 1946 Battelle assigned Haloid a non-exclusive license to the xerography patents, amended in 1956 to confer upon Haloid exclusive rights to all existing and improvement xerography patents in exchange for $3.5 million cash and an eventual 1.1 million shares of Haloid stock. Haloid (later renamed the Xerox Corporation) pursued the development and in 1959 introduced to the world the first console plain-paper xerographic copier, the 914. It and subsequent models were enormously successful. Erwin Blackstone has estimated that the approximately $20 million Haloid invested in xerography research and development between 1946 and 1960 yielded an after-tax return of at least 25 percent.[75]

75. Erwin A. Blackstone, "The Copying Machine Industry: A Case Study," Ph.D. dissertation, University of Michigan, 1968, pp. 238-239.

The Xerox Corporation continued to patent improvements on its copying machines, amassing a portfolio of nearly 1,000 patents by the mid-1970s. After winning a priority dispute, it licensed its patents on coated paper xerographic copying to numerous other firms, but defended its exclusive position in lower-incremental-cost plain-paper copying inter alia through infringement suits. With a monopoly on plain-paper copying and 86 percent of total U.S. office copier sales and lease revenue in 1971, Xerox increased its profits through a sophisticated price discrimination strategy.[76] One way of extracting more revenue from high-use customers was to tie the sales of toner (priced at such levels that it was called "black gold" by Xerox insiders) to the use of Xerox copiers. A formal contractual tie was avoided because it would lead to patent misuse and Clayton Act problems, but Xerox sales representatives vigorously urged the use of Xerox toner rather than rival offerings said to be inferior. More importantly, Xerox set prohibitively high sale prices for its machines, inducing virtually all customers to lease rather than purchasing. It offered more economical lease terms to high-volume users than to low-volume customers. Because available substitutes were quite inferior to xerography when only a few copies of an original were to be made, but Xerox machines faced tough competition from multilith and mimeograph machines for high-volume jobs, Xerox machines included a meter that charged much higher per-copy rates on small jobs than on large. Service was bundled with the lease of a Xerox machine, making it difficult for independent service vendors to compete. Plain-paper copier provision outside the United States was allocated to partly-owned Rank Xerox of the United Kingdom and Fuji Xerox of Japan.

In 1973 the Federal Trade Commission, revitalized under new leadership after reports criticizing its performance were published by the American Bar Association and Nader's Raiders, issued a complaint alleging that Xerox had monopolized the copying machine market and a plain-paper copier submarket, thereby violating Section 5 of the Federal Trade Commission Act. The complaint emphasized Xerox's monopoly position, its continuing accumulation of patent barriers to entry, at first through acquisition from Battelle and then through internal development, its lease-only policies, the bundling of service with leases, its extensive pattern of price discrimination, and various other practices. Legally, the patent accumulation charge was a weak reed, because it was unlikely that Battelle could have commercialized xerography, and if not Haloid, then who else? Also, the mere accumulation of patents, however many, through internal research and development had been countenanced under an

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76. The most comprehensive analysis is Blackstone, supra note 75.

earlier Supreme Court dictum.[77] Certainly, the Xerox facts presented much less in the way of exclusionary practices than the other monopolization cases reviewed here. But by 1973, Xerox had enjoyed monopoly sales for 14 years, and by the time a litigation was concluded, it would have possessed a monopoly position for at least the statutory 17 years. This, one might extrapolate from the failures of antitrust in the electric lamp and telephone industries, ought arguably to be a time for therapeutic intervention.

77. Automatic Radio Mfg. Co. v. Hazeltine Research, 339 U.S. 827, 834 (1950).

Xerox chose to negotiate. In mid-1975, a consent agreement was reached and, after Tunney Act procedures, approved by the Federal Trade Commission.[78] The most important provision of the consent decree stipulated that Xerox would grant non-exclusive compulsory licenses to its existing patents, domestic and foreign, and any applied for during the three years following the decree. The first three patents chosen by the applicant for license were to be royalty-free; each additional patent bore a 0.5 percent royalty rate up to a maximum royalty rate of 1.5 percent. Other provisions called for know-how transfer, a ban on multi-model lease price discounts, the publication of toner quality specifications, and a mechanism for resolving disputes over whether a rival toner was unsuitable for use.

One naturally inquires, why did Xerox settle rather than litigating what would be a difficult case for the Federal Trade Commission to win? The answer has been provided by David Kearns, at the time group vice president of Xerox and later its CEO:[79]

> We agreed to forfeit much of our patent protection through licensing arrangements, because McColough [the Xerox chairman] believed that the erosion of our hold on the market would not be that significant. After all, there was our unrivaled sales force to contend with and the two decades of experience building our brand in the marketplace. The patents were simply less important than when Xerox was small and fragile.... We already realized that if we didn't license people new competition would come into the business and infringe our patents anyway. We would sue and they would countersue, claiming antitrust. And the litigation would go on and on. We couldn't conduct a business like that. So once we decided we needed to license people there was no reason not to settle with the FTC.

Subsequent events revealed that both Xerox and the Federal Trade Commission staff had misperceived the competitive situation. Both believed that the principal likely rivals to Xerox would be IBM and Eastman Kodak, both of which had commenced

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78. As director of the FTC's Bureau of Economics, the author co-signed the recommendation that the Commission accept a consent settlement.

79. David T. Kearns and David A. Nadler, Prophets in the Dark: How Xerox Reinvented Itself and Beat Back the Japanese (New York: Harper Business, 1991), pp. 64-65. On the importance of innovators' non-patent advantages, see Richard C. Levin et al., "Appropriating the Returns from Industrial Research and Development," Brookings Papers on Economic Activity (1987, no. 3), pp. 783-820.

their entry into plain-paper copying. As Kearns recalls:[80]

> [W]e were totally blinded by IBM and Kodak. The two of them could throw an awful light into someone's eyes.... It's wrong, however, to think that we were oblivious to the Japanese. My very first summer at Xerox, I remember going to meetings where the Japanese came up for discussion. People would say, "The Japanese are coming. The Japanese are coming." So it wasn't a matter of Xerox not knowing about Japan. In fact, we predicted the Japanese would arrive sooner than they did. But what no one at Xerox seemed to have any good grasp of was the level of quality and the low cost of manufacturing that the Japanese were destined to achieve.

80. Supra note 79 at 75.

Within a few years after the consent decree, Japanese firms such as Canon, Toshiba, Sharp, Panasonic, Konica, and Minolta had achieved significant inroads into the U.S. market with copying machines that were more reliable and lower-priced than those of Xerox. Xerox was forced by this new competition into a strenuous program of "re-inventing" itself. By 1977, at a major Xerox sales conference, Xerox CEO Peter McColough delivered:[81]

> ... a blunt appraisal of the marketplace and Xerox's position in it. In no uncertain terms he made it clear that Xerox was being "out-marketed, out-engineered, outwitted in major segments of our market." He underscored the fact that Xerox would never have it the way it did when it was protected by its patents, when it could take its sweet time developing and introducing products and when it made no difference how much it cost to make something because the company could charge almost whatever it wanted.... Peter stressed ... "We are now faced with the urgent need for change within this company!"

In hindsight, it seems clear that by facilitating the availability of well-designed foreign and domestic copiers and stimulating Xerox's efforts to enhance its competitiveness, the Xerox settlement provided major benefits to the copier-using American public.[82]

IBM

81. Kearns, supra note 79, at 100. See also pp. 68 and 123.

82. See also Timothy F. Bresnahan, "Post-Entry Competition in the Plain Paper Copier Market," American Economic Review, vol. 75 (May 1985), pp. 15-19, and the longer study on which it is based.

Building upon concepts developed for military purposes during World War II, Univac I, the first commercial general-purpose digital electronic computer, was introduced by Remington-Rand in 1951.[83] An attempt by its designers to obtain basic patent protection failed. IBM, which with its tabulating card machines dominated the automatic data processing field, saw its position threatened.[84] It developed a series of electronic computers, the first of which, the IBM 702, was introduced in 1953. After retraining and refocusing its large tabulating card sales force, IBM was much more successful than Remington and other rivals in persuading business organizations to embrace the mysteries of digital computing. By 1955, IBM's share of rapidly increasing general-purpose digital computer installations had risen to 75 percent, and from then until the 1980s, it retained a dominant position. As computer users built their data processing operations around IBM software and data formats, they became "locked in" to new and backward-compatible IBM computer versions. Other firms tried to break the lock by designing computers that emulated the IBM architecture, but without great success. Repair service, needed often in the early days of computing, came bundled with lease or purchase contracts, as in Xerox, making it difficult for outside service firms to flourish. From early on, required to do so under a 1956 consent decree, IBM offered either to lease or sell its computers.[85] Most customers were averse to obsolescence risks and therefore preferred leases. This aggravated a classic dominant firm problem for IBM.[86] Bringing out a more powerful machine led customers to cancel their leases, cannibalizing IBM's existing revenues, to install the newer machine. IBM therefore tended to pursue a "fast second" strategy, delaying the introduction of new machines until inroads from rival machines became a serious threat.[87]

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83. Excellent early histories are Joel Shurkin, Engines of the Mind (New York: Norton, 1984); and Kenneth Flamm, Creating the Computer (Brookings: 1988). This section is adapted from F. M. Scherer, Industry Structure, Strategy, and Public Policy (New York: HarperCollins, 1996), Chapter 7.

84. IBM's tabulating card monopoly was the subject of a consent decree that among other things required compulsory licensing of IBM's computer patents. U.S. v. International Business Machines, Inc., CCH 1956 Trade Cases, para. 68,245.

85. Xerox's leasing and pricing strategies were said to have been modelled on those of IBM.

86. See Gerald O. Brock, The U.S. Computer Industry (Cambridge: Ballinger, 1975), Chapter 7.

87. On the original and more general theory, see W. L. Baldwin and G. L. Childs, "The Fast Second and Rivalry in Research and Development," Southern Economic Journal, vol. 36 (July 1969),

pp. 18-24. A crucial "fast-second" error by IBM occurred after its antitrust contest with the government was concluded. To avoid cannibalizing mainframe computer sales, it delayed using Intel's new 32-bit 80386 microprocessor in its personal computers until 1987, seven months after Compaq did so. It rapidly lost leadership in PCs.

As fringe rivals redoubled their innovative efforts with transistorized models during the early 1960s, IBM was induced to escalate the fast second strategy on its ambitious System 360 development. To avert customers' defection to more advanced rival machines, it not only accelerated the development, but announced the complete 360 line before development had proceeded far enough to ensure that quality goals and delivery dates could be met. Particularly serious slippage occurred on its time-sharing machines and the high-end System 360/90 targeted at Control Data Corporation's superior scientific data processing computer and expected from the outset to incur substantial out-of-pocket losses. A successful Sherman Act suit by CDC followed. By embodying standardized plug-in interfaces, System 360 also created another problem. Part of IBM's strategy was to price entry-level computers low but sustain high margins on peripherals such as add-on memory, tape drives, and disk drives. Since inexperienced customers almost always underestimated their need for peripherals, the sale of a computer at a low price informally "tied" customers to the purchase of high-margin peripherals. With System 360's standardized interfaces, plug-compatible peripheral manufacturers (PCMs) proliferated. To combat them IBM pursued an array of strategies, including the sale of "fighting machines" at arguably predatory prices, lease plans with discounts tailored to lock customers in until rival peripherals were unprofitable; moving control functions into the central processing unit, where they could be altered to render rival peripherals inoperative; delaying the release of interface information to the disadvantage of competitive peripheral developers; and changing the traditional sales price vs. lease price ratio to undermine the profitability of firms that leased rival peripherals to IBM computer users. More private antitrust suits followed, most of which IBM eventually won, in part because contemporary decision-making memoranda had been screened by internal counsel to ensure that they contained no "smoking gun" language.

On January 17, 1969, the last day of the Johnson Administration, the Department of Justice filed a broad Sherman Act complaint against IBM, alleging monopolization and citing most of the practices outlined above.[88] After extensive discovery, the trial in Southern District of New York federal court began in 1975 and continued into 1981.[89] IBM fiercely contested the government's allegations -- on defining the market as "general-purpose digital computers;" on how much pricing discretion it

88. The case had been vetted by President Johnson's Council of Economic Advisers and was vetted again by Richard Nixon's Council. The PCM practices were added in a later amendment.

89. The author was initial economist witness of several appearing for the government.

enjoyed; on the relevance of IBM's high accounting profits as an indicator of monopoly; on whether IBM's pricing was predatory and on alternative tests for predation;[90] on IBM's "fast second" innovation strategy, renamed "leapfrogging;" on whether there was such a thing as software "lock-in;" on customers' preferences for leases and bundled service; and on many other facets of IBM's practices.[91] The presiding judge was unwilling or unable to bring the parties to focus issues and expedite the trial. The government's team was led by senior Department of Justice attorneys with much trial experience, but a limited understanding of economics and high-technology issues, who ceded much of the trial's strategic direction to staff economists.

As the trial neared completion, the Reagan Administration took office. A new Assistant Attorney General, William Baxter, began a thorough review of the case's merits (along with the parallel AT&T case). On January 8, 1982, he announced simultaneously the consent settlement reached in AT&T along with his decision to abandon the IBM case -- thirteen years after its initiation. In Baxter's asserted view, "continuing the case

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90. See Phillip Areeda and Donald F. Turner, "Predatory Pricing and Related Practices under Section 2 of the Sherman Act," Harvard Law Review, vol. 88 (February 1975), pp. 697-733, which was apparently written as a result of consulting for IBM, and which precipitated a string of articles presenting alternative theories.

91. For the best summary of IBM's economic case, see Franklin Fisher et al., Folded, Spindled, and Mutilated: Economic Analysis and U.S. v. IBM (MIT Press: 1983). The best statement of the government's case is Richard T. DeLamarter, Big Blue: IBM's Use and Abuse of Power (New York: Dodd, Mead, 1986).

would be an expensive and ultimately futile endeavor,"[92] in part because events since the case commenced had significantly transformed computer industry structure. In particular, IBM had reacted too slowly to retain leadership in top-end scientific computer placements, it had been thoroughly defeated at the lower end by mini-computer makers such as Digital Equipment, Data General, Tandem, and Prime; and the personal computer revolution was underway.

An appropriate epitaph is found in the memoirs of IBM's chairman, Thomas J. Watson Jr.:[93]

> Looking back, I see a lot of sad irony in the whole affair. I think a lot of people would agree that at the outset the Justice Department's complaint had merit. IBM was clearly in a commanding position in the market, and some of our tactics had been harsh. We eliminated many of these practices ourselves, and our overall record during the case was pretty clean... [T]he case stretched on unresolved for so long that before it was over history showed my argument ... to have been right. IBM kept growing, but the computer industry grew even more, and the natural forces of technological change etched away whatever monopoly power we may have had.

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92. Memorandum of William F. Baxter to the U.S. attorney general, January 6, 1982.

93. Thomas J. Watson Jr. (with Peter Petre), Father, Son & Co.: My Life at IBM (New York: Bantam, 1990), p. 415. See also my review of the DeLamarter book, Antitrust Bulletin, vol. 32 (Fall 1987), 829, 840.

Despite dissuasion by the U.S. government, the European Commission persisted in a parallel antitrust complaint against IBM. In August 1984 a settlement was negotiated under which IBM agreed to "unbundle" all add-on memory but the minimum amount needed for machine operation and to provide in advance the interface information needed for peripheral manufacturers to attach their products to IBM computers.[94]

Microsoft

94. On the consequences, see F. M. Scherer, "Microsoft and IBM in Europe," Antitrust & Trade Regulation Report, January 24, 2003, pp. 65-66.

IBM was slow in recognizing the possibilities of personal computers, lagging even more than one might expect under a "fast second" theory.[95] In its crash catch-up development program to introduce the first IBM PC on August 12, 1981, IBM departed from its usual practice of developing its own operating system and instead chose one it believed (somewhat erroneously) to be already available. It licensed MS/DOS from a fledgling Seattle software house, Microsoft, which obtained it from another firm, Seattle Computer Products. Microsoft secured from SCP non-exclusive rights for $50,000 and later exclusive rights for $925,000. IBM's imprimatur convinced business enterprises that personal computers were more than a children's plaything, and sales soared. Since IBM's contract with Microsoft was nonexclusive, a PC "clone" industry emerged using the MS/DOS operating system. The large number of PCs, from IBM and clones, residing on desktops induced applications software houses to assign first priority to writing applications programs -- thousands of them -- running on the MS/DOS platform. Superior availability of applications software in turn stimulated consumers to prefer desktop computers running MS/DOS, giving Microsoft a leading position in the provision of operating systems.

Personal computer pioneer Apple sought to escape this snowball effect by introducing in January 1984 its Macintosh computer, the first economically-priced desktop computer to offer a graphical user interface (GUI) (conceived but not successfully commercialized by the Xerox Corporation's Palo Alto Research Center). Commissioned by Apple in 1982 to write applications programs for the Macintosh, Microsoft learned the Macintosh operating system's structure and devised its own GUI operating system, Windows, pre-announced in November 1983 but not available to consumers until two years later. A suit by Apple alleging that Windows infringed the Macintosh copyright's "look and feel" was unsuccessful. So also were the early under-powered versions of Windows, but Windows 3.0, rolled out in May 1990, became a spectacular market success. One reason for the success of Windows 3.0 was that it resided on an MS/DOS platform and could therefore run applications programs written for either MS/DOS or Windows. Software houses offering the leading PC application programs at the time were focusing their GUI efforts on IBM's OS/2 operating system, which both IBM and Microsoft predicted would be the PC operating system of the future. But Microsoft was ready with its Excel spreadsheet and WORD word-processing programs optimized for Windows 3.0, and it soon captured a dominant position in office applications programs to complement its 85 to 90 percent share of desktop computer operating systems

95. For a complementary sociological explanation, see Clayton M. Christensen, The Innovator's Dilemma: When New Technologies Cause Great Firms To Fail (Harvard Business School Press: 1997).

placements. By choosing not to "port" Excel and WORD to operating systems other than Windows and Macintosh, Microsoft enhanced what came to be called an "applications barrier to entry" congealing the preferences of users trained on and loyal to Excel and WORD.

Microsoft's dominance was investigated in the early 1990s by the Federal Trade Commission, which reached no decision to act, and then by the Department of Justice, which filed a complaint in July 1994. The complaint addressed an array of Microsoft practices, including premature product pre-announcement to combat rival products and unfair advantages allegedly possessed by Microsoft applications program writers through earlier and more complete knowledge of operating system interface parameters. But the negotiated consent decree filed on the same day as the complaint remedied mainly Microsoft's practice of charging computer assemblers a royalty for every PC they sold, whether it contained a Microsoft operating system or one offered by competitors. To install a rival's Windows clone, therefore, the PC producer paid twice, which was unattractive, solidifying Microsoft's dominance. The consent decree banned this practice. Reviewing the proposed decree under the Tunney Act, District Judge Stanley Sporkin rejected it, stating that it was insufficient to correct other named abuses.[96] Microsoft appealed. The Appellate Court found that Judge Sporkin had exceeded his authority and remanded the case to a new judge with instructions to enter the decree.[97]

The mid-1990s brought a new threat to Microsoft's dominance. The Internet evolved from a Department of Defense computer-linking system in the 1970s through the National Science Foundation's NSFnet to an open system in 1995. The extensive installation of optical fiber cables made it possible to transmit computer data inexpensively, and the relaxation of AT&T's "foreign attachments" restrictions permitted easy coupling of computers with telephone - cable networks. In November 1994 Netscape introduced a full-scale test version of its Navigator browser, which made it possible for computer users to access materials stored on servers throughout the world. It achieved extraordinarily rapid growth in 1995. Microsoft officials saw in Navigator a threat to the dominant position of Windows. Software writers might write applications programs not to Windows, but target them to Internet servers, optimized for applications program interfaces (APIs) exposed by a "middleware" browser such as Navigator, and allowing computer users to combine a browser

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96. U.S. v. Microsoft Corporation, Civil Action 94-1564, Memorandum Opinion, February 14, 1995.

97. U.S. v. Microsoft Corporation, 56 F. 3rd 1448 (District of Columbia Circuit, 1995).

with a stripped-down operating system to bypass Windows. Meeting with Netscape officials in June 1995, Microsoft officials allegedly offered Netscape 20 percent equity financing in exchange for Netscape's limiting its browsers to older Windows operating systems and leaving the nascent market for significantly improved Windows 95 to Microsoft. Netscape refused. Microsoft thereupon denied Netscape Windows 95 API information until two months after Windows 95 was on the market, putting Navigator software writers at a disadvantage. In December 1994 Microsoft had licensed an alternative browser, Spyglass, from a small firm. It revised the Spyglass instructions to create Internet Explorer, which in late 1995 it began including on a separate diskette free with every copy of Windows 95, forcing Netscape to follow suit and offer Navigator free to all customers. Microsoft also brought pressure to bear upon computer assemblers, threatening them with Windows license cancellation, forfeiture of discounts, or other retaliatory measures if they favored Navigator over Internet Explorer.

At about the same time Sun Microsystems devised a new programming language, Java, for Internet applications. Sun's announced intention was to make Java a universal language with a compiler that would run applications written for it on any computer operating system, with or without Microsoft operating systems. Microsoft officials saw Java as another threat that would divert applications program writers from writing first for Windows. In March 1996 Microsoft contracted with Sun to include unmodified Java compilers with Windows. But to prevent Java from becoming a universally available standard, it changed the Windows Java installations so that applications written for them would not run on the standard Java system.

In the fall of 1997 Microsoft took another decisive step. It announced that Windows 98, to be marketed beginning in mid-1998, would have its Internet Explorer browser physically bundled with the operating system, so new PC buyers could not avoid installing Explorer with Windows 98. When this happened in 1998, it accelerated the increase in Explorer's usage share relative to Navigator. The announcement prompted the Justice Department to sue, alleging that physical bundling of Internet Explorer violated the 1995 consent decree. District Judge Thomas Penfield Jackson issued a preliminary injunction requiring that Microsoft provide a version of Windows 98 from which Explorer was unbundled. But Microsoft had bargained hard to have language in the 1995 consent decree stating that Microsoft was not prohibited from "developing integrated products," deleting from a government draft four trailing words, "which offer technological advantages."[98] This permissive language was stressed in the

98. See John Heilemann, "The Truth the Whole Truth and Nothing But the Truth," Wired, November 2000, p. 275, which provides a fascinating chronicle of the later Microsoft case's

Appellate Court's reversal.[99] The Court reserved judgment on whether the bundling independently violated the Sherman Act.

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procedural history.

99. U.S. v. Microsoft Corp., 147 F. 3d 935 (D.C. Circuit 1998).

Stung by this defeat, the Department of Justice filed a more sweeping complaint accusing Microsoft of violating Sherman Act Sections I and II, citing the practices articulated in the previous three paragraphs and others. Judge Jackson scheduled a "fast track" trial, among other things limiting each party to 12 trial witnesses plus two rebuttal witnesses. The trial began in October 1998 and lasted 76 days. The government took the unusual step of having as its lead counsel a prominent private-sector antitrust attorney, David Boies, who had been second-in-command on IBM's defense team in the 1970's litigation. Another curious feature of the government's otherwise vigorous prosecution was the failure to present testimony on Microsoft's profits, which, a private study had shown, translated to an extraordinary 88 percent return on invested capital for 1998 when one did the accounting properly.[100] The government's case was strengthened by a plethora of e-mail messages among Microsoft executives explaining how and why the company was taking strategic actions against various rivals and uncooperative business partners -- discovered, apparently, because the company's leaders had chosen not to implement the thoroughgoing antitrust compliance programs maintained by most U.S. companies with a dominant market position.

On November 5, 1999, Judge Jackson issued lengthy findings of fact indicating that Microsoft's market position and its practices constituted probable Sherman Act violations.[101] He found inter alia that the bundling of Internet Explorer with Windows 98 had improved the quality of Web browsing software, reducing its cost, and increasing its availability, "thereby benefitting consumers."[102] However, to the detriment of consumers, Judge Jackson added, the bundling forced computer assemblers to ignore consumer demand for a browserless version of Windows, increased confusion, degraded system performance, and restricted memory.[103] He concluded with an admonition:[104]

> Most harmful of all is the message that Microsoft's actions have conveyed to every enterprise with the potential to innovate in the computer industry. Through its conduct

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100. Remedies Brief of Amici Curiae Robert E. Litan et al., April 27, 2000, Appendix p. 2. The probable reason was that the government's lead economic expert, Franklin Fisher, had testified in U.S. v. IBM that profitability data were meaningless.

101. U.S. v. Microsoft Corp., 84 F. Supp. 2d 9 (1999).

102. Ibid., para. 408.

103. Ibid. para. 410.

104. Ibid., para. 412.

> toward Netscape, IBM, Compaq, Intel, and others, Microsoft has demonstrated that it will use its prodigious market power and immense profits to harm any firm that insists on pursuing initiatives that could intensify competition against one of Microsoft's core products. Microsoft's past success in hurting such companies and stifling innovation deters investment in technologies and businesses that exhibit the potential to threaten Microsoft. The ultimate result is that some innovations that would truly benefit consumers never occur for the sole reason that they do not coincide with Microsoft's self-interest.

Judge Jackson thereupon engaged Appellate Judge Richard Posner to mediate between the government and Microsoft with the objective of finding mutually acceptable remedies. Four months of mediation yielded no positive result. On April 3, 2000, Judge Jackson issued conclusions of law, finding that Microsoft had violated Sherman Act Section I through its tying of Internet Explorer to Windows 98 and Sherman Act Section II through monopolization and attempted monopolization. He asked plaintiffs to file a brief on remedies and consolidated actions brought by 19 state attorneys general with the federal government case. The plaintiffs then proposed that Microsoft be divided into two separate companies, one with responsibility for applications and one for operating systems. They requested diverse prohibitions against bundling "middleware" products within the Windows operating system unless an otherwise identical unbundled version was offered, against contractual ties, and against exclusive dealing arrangements. In addition, Microsoft would be required to provide information to third-party software developers needed to ensure that their software interoperates effectively with the Windows operating system. On June 7, 2000, the Court ordered that the plaintiffs' proposed remedies be implemented without significant changes.[105]

Needless to say, Microsoft appealed. And from that point on, the tide turned against the plaintiffs. The Supreme Court denied certiorari and remanded the appeal to the District of Columbia Court of Appeals for en banc hearing. The Clinton Administration left office, and a new team was appointed by President George W. Bush. The Bush team chose to have the appeal argued by Solicitor General staff with no prior connection to the case and minimal understanding of its facts and economic principles.[106] In its decision, the Appellate Court sustained the

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105. U.S. et al. v. Microsoft Corp., 97 F. Supp. 2d 59 (2000).

106. "Upfront: Trustbusters: Did Microsoft Catch a Break?" Business Week, March 12, 2001, p. 14. The author listened to the proceedings on public radio and reached the same conclusion.

lower court's finding that Microsoft had monopolized the personal computer operating system market through its dominant position and its conduct.[107] It vacated, however, Judge Jackson's conclusion that Microsoft had attempted to monopolize a browser market, ruling that the market had been insufficiently defined. It remanded for further analysis on a rule of reason basis Judge Jackson's decision that Microsoft's bundling of Internet Explorer with Windows was a per se violation of Sherman Act Section II, observing that:[108]

> Microsoft does not dispute that many consumers demand alternative browsers. But on industry custom Microsoft contends that no other firm requires non-removal because no other firm has invested the resources to integrate web browsers as deeply into its OS as Microsoft has.... Microsoft contends not only that its integration of IE into Windows is innovative and beneficial but also that it requires non-removal of IE.... Microsoft argues that IE and Windows are an integrated physical product and that the bundling of IE APIs with Windows makes the latter a better applications platform for third-party software. It is unclear how the benefits from IE API's could be achieved by quality standards for different browser manufacturers. We do not pass judgment on Microsoft's claims regarding the benefits from integration of its APIs. We merely note that these and other novel, purported efficiencies suggest that judicial "experience" provides little basis for believing that, "because of their pernicious effect on competition and lack of any redeeming virtue," a software firm's decisions to sell multiple functionalities as a package should be "conclusively presumed to be unreasonable and therefore illegal without elaborate inquiry as to the precise harm they have caused or the business excuse for their use."

Because it chose not to sustain two of the three broad violation findings, which might arguably render the divestiture remedy excessive, and also because it believed Judge Jackson had erred by not holding hearings on the efficacy of the proposed remedies, the Appellate Court vacated the remedial order and remanded the matter to a lower court for reconsideration. And because, it said, Judge Jackson had violated judicial canons by talking to representatives of the press before the proceedings had ended and made to them disparaging remarks about Microsoft's good faith, the Appellate Court disqualified Judge Jackson from further

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107. U.S. v. Microsoft Corp., 253 F. 3d 34 (June 2001).

108. Ibid., at 88, 90.

participation in the case. A new district Judge, Coleen Kollar-Kotelly, was appointed to preside over the remaining proceedings.

In renewed negotiations, Microsoft and the Department of Justice agreed upon a settlement without divestiture or mandatory unbundling provisions. The settlement was widely criticized in the press as mild and insufficient.[109] Ten state attorneys general dissented and elected to pursue their own remedy proceedings -- ultimately, with little effect. The government chose not to follow through on the appellate court's invitation to retry the bundling issue on a rule of reason basis. After complex hearings, a final judgment with remedial order was issued by Judge Kollar-Kotelly in November 2002 -- five years after the initial complaint against Microsoft's bundling announcement.[110] It required non-discriminatory licensing of the Windows operating system at publicized terms, barred restrictive agreements limiting computer assemblers' freedom to feature middleware competitive with Microsoft's and retaliation by Microsoft against firms that installed rival software, and required disclosure of interface specifications and communications protocols used by Microsoft middleware software to interoperate with the Windows operating system, along with other procedural measures.

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109. See e.g. "It's Still a Safe World for Microsoft," New York Times, November 9, 2001, p. 27; "An Unsettling Settlement," The Economist, November 10, 2001, pp. 57-58; "Settlement or Sellout?, Business Week, Nov. 19, 2001, pp. 112-116; "Slapping Microsoft's Wrist" (editorial), Business Week, November 19, 2001, p. 152; and "Skepticism in Senate Panel Over Accord with Microsoft," New York Times, December 13, 2001, p. D1. See also the Reuters news dispatch of February 9, 2005, in which Judge Kollar-Kotelly is quoted as saying that her job was not to ensure that new competition is stimulated, but only to make sure that Microsoft abides by the agreements reached.

110. State of New York et al. v. Microsoft Corporation, 224 F. Supp. 2d 76, 266 (November 2002).

Throughout the litigation extending from 1997, Microsoft argued that limitations on its ability physically to integrate (i.e., bundle) software features with its operating system would be an unjustifiable constraint on its ability -- indeed, its right -- to innovate. The claim must be received with a grain of salt, because in Microsoft's history since the early 1980s, licensing or cloning other firms' software innovations, to be sure with Microsoft's own improvements, vastly predominated over coming up with successful, really new software features. And equally clearly, strategic objectives -- disadvantaging rival vendors -- played a major or even decisive role in its bundling decisions.

Despite being put on notice in 1997 that it risked antitrust prosecution through strategic bundling, Microsoft in May 1999 physically integrated its Windows Media Player, which up to that time had been supplied as a separate product, into its Windows operating systems. This bundling action became one key focus, along with Microsoft's promotional claims that Microsoft server software interoperated more smoothly than rival server software with ubiquitous Microsoft desktop operating systems because of secret communications protocols and Microsoft's superior knowledge of APIs, of a major European Commission competition policy complaint and adverse decision.[111] In April 2004 the Commission ordered Microsoft to market Windows versions with Windows Media Player unbundled and to undertake much more extensive disclosure of applications interface specifications and communications protocols than had been required by the United States courts. Microsoft attempted to stay implementation of the remedies until appeals had been exhausted (which could consume several years), but its petition to stay to the European Court of First Instance was denied in December 2004.[112]

Conclusion

Reviewing the history of seven great monopolization cases, one is forced to a mixed verdict on whether the antitrust authorities are able competently to deal with structural monopoly and related sustaining practices in high-technology industries. In a majority of the cases, it took far too long, and in some

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111. Commission of the European Communities, Commission Decision, Case COMP/C-3/37.792 (Microsoft), April 21, 2004.

112. Order of the President of the Court of First Instance, Case T-201-04R, 22 December 2004, found at http://curia.eu.int/cgi-bin/gettext.pl?lang=en&num=7995877. The author appeared as a witness on behalf of Real Networks in the hearing and consulted previously for Sun Microsystems in its litigation against Microsoft.

instances several attempts, to come to grips with the problems. By the time the courts were ready for judgment, technological and economic changes had radically altered the environment in which the remedies originally sought would apply. This holds true also for the unusually expeditious Microsoft litigation, which, at least in the United States, achieved little or nothing in the end. The most rapid solutions were achieved through negotiated consent decrees, which require a belief on the part of respondents that they will not be seriously disadvantaged. In Xerox and AT&T (1982), the corporate settlers were probably too optimistic -- the decrees did open up avenues for substantially enhanced technological competition. In early cases, the courts shunned balancing technological gains, measured in terms of actual performance or theoretical arguments for patent accumulation, against strategies that suppressed competition. In later cases the courts' balancing record is more mixed. In Microsoft, Judge Jackson struggled admirably to weigh the benefits of browser integration against competitive harm, but his efforts were insufficient to convince a skeptical Court of Appeals fearful of impeding technological progress and reluctant to undertake the job on its own.

The courts' adjudication of complex technological tradeoff questions would be facilitated if the presiding judge were able to retain as a clerk an expert with the requisite specialized knowledge. Judge Jackson attempted to do so in Microsoft, but was blocked in 1998 when Microsoft objected to his choice. Securing unbiased expertise is undoubtedly difficult, but its solution must lie within the bounds of judicial ingenuity.

From the great cases reviewed here, it would appear that dominant firms have accumulated far more monopoly power than is necessary to motivate and sustain the most rapid and beneficial rate of technological progress. All seven of the seminal products that gave rise to monopolization actions were invented or initially developed by entities other than the eventual monopoly or by small firms that only later grew to dominance. In several cases, such as electric lamps, the telephone, and computers, early inventions were made simultaneously but independently by multiple sources of initiative. In many instances, once a single firm came to dominate a new technology, it was palpably resistant to innovation after its position was secured. And in several such cases, the "fast second" phenomenon was evident: dominant firms delayed feasible innovations until their dominance was threatened by an upstart. Quite generally, the underlying economic literature suggests, new competition and the threat of being left behind -- Schumpeter's "creative destruction" -- are the most powerful spurs to innovation for well-established enterprises.[113]

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113. For wide-ranging historical evidence, see Burton Klein, Dynamic Economics (Harvard University Press, 1977).

This suggests a reorientation of policy. The benefit of the doubt in high-technology monopolization matters ought to be resolved in favor of keeping structural and behavioral barriers to innovative new entry as low as possible. Even for cases in which monopoly was the natural result of significant innovation rather than other exclusionary practices, it implies skepticism toward monopoly positions that have been sustained through the accumulation of internally-developed patents for longer than the 20 years contemplated in current patent law. The "for limited Times" language in Article I, Section 8, of the U.S. Constitution should be taken seriously in order to promote the progress of science and the useful arts. Since properly conservative courts are unlikely to change the law in this direction without Congressional guidance, appropriate legislation should be enacted to ensure the vibrancy of U.S. industrial technology in a world of increasingly tough technological challenges from abroad.