TRANSFERRING INNOVATION

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INTRODUCTION

Universities have served as the birthplace of innovation in a wide range of disciplines. In the past, entire industries have blossomed from technology initially created at universities. Consequently, there is a consistent desire to transfer innovation from universities to the private sector. There is also an additional desire to transfer technology from universities more extensively and more efficiently for the broader benefit of society. Not surprisingly, transferring university-originating innovations to the private sector has been an active arena for legislative reform such as the Bayh-Dole Act and for scholarly criticisms and analysis.

This essay analyzes the information submitted in annual reports from 1996–2003 by ninety-four universities to the Association of University Technology Managers (AUTM). My analysis shows that university technology transfer activities continue to be predominantly patent-centric and revenue-driven with a single-minded focus on generating licensing income and obtaining reimbursement for legal expenses. University technology transfer activities do not extend far beyond this narrow focus; commercialization activities (e.g., number of start-up companies) and strategies to transfer innovation, more broadly, do not figure prominently. In fact, universities do not engage in a broad range of activities that might result successfully in a transfer of university-originating innovation to different sectors in society.

In this work, I urge that universities must go beyond generating revenue, actively pursue entrepreneurial and commercialization activities, and readily embrace alternative technology transfer methods, such as open collaborations, free participant use agreements, and royalty-free licensing. Such steps likely would result in the adoption and dissemination throughout society of university innovations. In order to embrace this comprehensive approach to transferring innovation, university technology transfer offices (TTOs) need to broaden substantively their business models and restructure themselves within the university hierarchies so that the incentives they (the

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TTO and its employees) face are compatible with a broader vision of technology transfer.

This essay is organized as follows. Part I discusses university patenting activities prior to the passage of the Bayh-Dole Act in 1980. Part II examines the purpose and the effect of the Bayh-Dole legislation. In Part III, this essay analyzes the role, structure, and business model of university TTOs. In addition, Part III includes an empirical analysis of annual reports regarding technology transfer activities submitted by ninety-four academic institutions to the AUTM from 1996 to 2003, as well as insights and criticisms that flow from the empirical analysis concerning the technology transfer practices employed by universities. Finally, Part IV studies other criticisms of university patenting activities, and Parts V and VI focus on measures and incentives that may be employed to restructure, expand, and improve university-based technology transfer.

I. UNIVERSITY PATENTING BEFORE 1980

For a long time, industry representatives have turned to the laboratories of universities as sources for scientific innovations.[1] After World War II, the federal government became more involved with the funding of university research when Vannevar Bush made a report at President Franklin D. Roosevelt's request emphasizing the potential value of government funding of basic research at universities.[2] Bush's report was in part a response to the success of the Manhattan Project, which had shown the government how vital university research could be to national defense.[3] This new emphasis led to an increase in government funding for basic research, but the open science norms of academia that emphasized wide dissemination of research results often deterred researchers from seeking protection for their inventions.[4] These open science norms, along with the somewhat complicated procedure of obtaining title to government-funded inventions, likely resulted in a very low emphasis on patenting university research.

The year 1980 represented a turning point in the patent field, in part due to the passage of the Bayh-Dole Act.[5] Some scholars (somewhat incorrectly) assert that all government-funded inventions belonged to the

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1. *See infra* Part I.A–B.

2. Howard W. Bremer, *University Technology Transfer: Evolution and Revolution, in* COUNCIL ON GOVERNMENTAL RELATIONS, 50TH ANNIVERSARY: 1948–1998, at 13, 13–14 (1998), *available at* http://www.cogr.edu/docs/Anniversary.pdf.

3. COUNCIL ON GOVERNMENTAL RELATIONS, THE BAYH-DOLE ACT: A GUIDE TO THE LAW AND IMPLEMENTING REGULATIONS 1 (1999) [hereinafter COGR GUIDE], *available at* http://www.cogr.edu/docs/Bayh_Dole.pdf. Vannevar Bush also emphasized the importance of university research to innovation in industry. *Id.*

4. Charles R. McManis & Sucheol Noh, The Impact of the Bayh-Dole Act on Genetic Research and Development: Evaluating the Arguments and Empirical Evidence to Date 17–18 (Aug. 13, 2006) (unpublished manuscript), *available at* http://www.law.berkeley.edu/institutes/bclt/ipsc/papers2/mcmanis.doc.

5. See *infra* Part II for a discussion of the Bayh-Dole Act.

government prior to the passage of the Act and place little emphasis on university inventions for which the university controlled the patent.[6] Admittedly, most universities did not become very involved in technology transfer prior to the passage of the Act, in part due to the complexity of obtaining patent rights in government-funded inventions.[7] However, it would be incorrect to assert that universities simply were not patenting discoveries, since several quite significant exceptions indicate extensive university involvement in the commercialization of inventions.[8] Three of the most significant examples of patenting efforts associated with universities prior to 1980 are the Wisconsin Alumni Research Foundation (WARF), the Research Corporation, and the Cohen-Boyer Patents concerning recombinant DNA.[9] As noted below, the formation of WARF and the Research Corporation represented attempts to promote the commercialization of important discoveries by university inventors in the early twentieth century. Significantly, both of these pre-Bayh-Dole technology-transfer entities were formed with the purpose of using patents to ensure consistent quality of subsequent developments instead of just obtaining financial rewards for the inventors.

6. *See, e.g.*, Tanuja V. Garde, *Supporting Innovation in Targeted Treatments: Licenses of Right to NIH-Funded Research Tools*, 11 MICH. TELECOMM. & TECH. L. REV. 249, 254–55 (2005) (asserting that prior to passage of the Bayh-Dole Act, *all* patents on government-funded research belonged to the government). This may have been the default rule, but it does not take into account actions that universities could take to retain patent rights in government-funded research findings. For example, consider the actions associated with the Cohen-Boyer patents. *See infra* Part I.C.

7. *See* Rebecca Henderson, Adam B. Jaffe & Manuel Trajtenberg, *Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting, 1965–1988*, 80 REV. ECON. & STAT. 119, 121 (1998) (stating that before 1980, universities had to seek a title rights waiver from the funding agency in order to profit from a patent on federally funded research findings); Ted Sabety, *Nanotechnology Innovation and the Patent Thicket: Which IP Policies Promote Growth?*, 15 ALB. L.J. SCI. & TECH. 477, 485–86 (2005); Julia Porter Liebeskind, *Risky Business: Universities and Intellectual Property*, ACADEME ONLINE, Sept.–Oct. 2001, *available at* http://www.aaup.org/AAUP/pubsres/academe/2001/SO/Feat/Lieb.htm; Robert E. Litan et al., *Commercializing University Innovations: A Better Way* 6 (Nat'l Bureau of Econ. Research, Working Paper JEL No. O18, M13, 033, 034, 038, 2007), *available at* http://www.kauffman.org/pdf/NBER_0407.pdf (quoting Senator Robert Dole's reference to the pre-1980 process of allowing a university to retain patent rights as being a "hideous example of over management by the bureaucracy").

8. *See* DAVID C. MOWERY, RICHARD R. NELSON, BHAVEN N. SAMPAT & ARVIDS A. ZIEDONIS, IVORY TOWER AND INDUSTRIAL INNOVATION: UNIVERSITY-INDUSTRY TECHNOLOGY TRANSFER BEFORE AND AFTER THE BAYH-DOLE ACT IN THE UNITED STATES 53 (2004). The birth of technology transfer may be traced to the 1879 discovery and subsequent patenting of saccharine by a scientist at Johns Hopkins University. William R. Brody, President, Johns Hopkins Univ., Remarks Inaugurating the Biomedical Engineering Lecture Series: From Minds to Minefields: Negotiating the Demilitarized Zone Between Industry and Academia (Apr. 6, 1999), *available at* http://web.jhu.edu/president/speeches/1999/biomlec.html.

9. *See infra* Part I.A–C. The Cohen-Boyer patents were applied for in 1974, but the first patent was not granted until 1980, shortly before the effective date of the Bayh-Dole Act. Kenneth Sutherlin Dueker, *Biobusiness on Campus: Commercialization of University-Developed Biomedical Technologies*, 52 FOOD & DRUG L.J. 453, 494 (1997).

A. *The Wisconsin Alumni Research Foundation*

WARF was formed in 1925 to aid in the commercialization of a discovery by the University of Wisconsin–Madison concerning the fortification of foods with vitamin D using ultraviolet radiation.[10] The inventor, Harry Steenbock, knew the invention had the potential to eliminate rickets, but felt that this goal likely would not be met without proper management of the invention.[11] Steenbock chose to seek patent protection because he believed that patent protection would lead to better quality control over subsequent developments and ensure that this method of fortification would be used in the best interest of public health.[12] Because the university did not want to take title to Steenbock's patent, Steenbock contacted a number of Wisconsin alumni and worked with them to create the Wisconsin Alumni Research Foundation.[13]

During the 1960s, WARF negotiated with the U.S. Department of Health, Education, and Welfare (DHEW), which was then the agency with authority over the National Institutes of Health (NIH),[14] to ensure that WARF would receive title to inventions developed with DHEW funds.[15] WARF continued to commercialize faculty inventions prior to and following the Bayh-Dole Act and was a very active supporter of the Act as it was being developed in Congress.[16] WARF still constitutes an active and successful technology transfer association, with its revenues accounting for five percent of the total research budget at the University of Wisconsin-Madison.[17] Currently, WARF holds the patents on several lines of

10. *Id.* at 456.

11. Wisconsin Alumni Research Foundation, Steenbock and WARF's Founding, http://www.warf.org/about/index.jsp?cid=26&scid=33 (last visited Mar. 24, 2009).

12. *Id.*

13. Bhaven N. Sampat & Richard R. Nelson, The Emergence and Standardization of University Technology Transfer Offices: A Case Study of Institutional Change 8–9 (Sept. 16–18, 1999) (unpublished manuscript), *available at* http://www.isnie.org/ISNIE99/Papers/nelson.pdf.

14. MOWERY ET AL., *supra* note 8, at 43.

15. Carl E. Gulbrandsen, Managing Dir., Wis. Alumni Research Found., The Kastenmeier Lecture at the University of Wisconsin Law School: Bayh-Dole: Wisconsin Roots and Inspired Public Policy (Nov. 3, 2006), *in* 2007 WIS. L. REV. 1149, 1157 (explaining that the efforts eventually resulted in negotiation of an Institutional Patent Agreement (IPA) with the U.S. Department of Health, Education, and Welfare (DHEW)). Carl Gulbrandsen, however, implies that the Bayh-Dole Act gives more credibility to the Wisconsin Alumni Research Foundation's (WARF) claims of title to federally funded inventions. He goes so far as to suggest that the inventions currently owned by WARF would instead be owned by federal agencies in the absence of Bayh-Dole, even though the IPAs that WARF negotiated with federal agencies seem to have fulfilled that role on their own. *Id.* at 1158–59.

16. Dueker, *supra* note 9, at 456 (providing a table of information of significant biomedical inventions commercialized by WARF); Press Release, Wis. Alumni Research Found., WARF Receives National Medal of Technology (Mar. 17, 2005), *available at* http://www.warf.org/news/news.jsp?news_id=178.

17. Dueker, *supra* note 9, at 457 (reporting WARF's revenues as of 1997).

embryonic stem cells.[18] These patents became a very valuable asset after the federal government prohibited development of new cell lines.[19]

B. *The Research Corporation*

The Research Corporation, which was active in managing university patent portfolios in the decades before Bayh-Dole, was founded by Frederick Cottrell around 1912, initially to commercialize Cottrell's invention of an electrostatic precipitator.[20] While not interested in revenue, Cottrell believed that his invention would not be commercialized by firms unless it was protected by a patent.[21] This focus on technology transfer rather than profit is a view that was shared by WARF and reinforces the idea that university technology transfer is based on achieving effective commercialization of university inventions.

The Research Corporation eventually branched out and supplied patenting services to many universities, including the Massachusetts Institute of Technology (MIT).[22] Unfortunately, the Research Corporation occasionally failed to manage its clients' patents effectively, leading in one case to a loss of the Research Corporation's contract with MIT.[23] Part of this failure has been attributed to the Research Corporation's tendency to manage all patents in the manner that it managed patents in the life science areas.[24] Another possible reason for the decline of the usage of the Research Corporation by universities is that it began to educate its clients in the early 1970s about how to apply for their own patents. Thus, many universities started to handle the patent application process themselves.[25] For example, Stanford University was a client of the Research Corporation until 1969, when Neils Reimers joined Stanford's faculty and formed the Office of Technology Licensing (OTL).[26]

C. *The Cohen-Boyer Patents*

In the early 1970s, two scientists working in laboratories at the University of California and Stanford University developed a method of

18. Wisconsin Alumni Research Foundation, Technologies: Stem Cells, http://www.warf.org/technologies.jsp?techfield=Stem+Cells (last visited Mar. 24, 2009).

19. Mark A. Lemley, *Are Universities Patent Trolls?*, 18 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 611, 617 (2008). On March 9, 2009, President Barack Obama signed an executive order that lifted the ban on federal funding for embryonic stem cell research. *See* Scott Wilson, *Obama Reverses Bush Policy on Stem Cell Research: The Ban on Federal Funding Is Lifted*, WASH. POST, Mar. 10, 2009, at A10.

20. MOWERY ET AL., *supra* note 8, at 59; Sampat & Nelson, *supra* note 13, at 11.

21. MOWERY ET AL., *supra* note 8, at 59.

22. *Id.* at 63.

23. *Id.* at 72.

24. *Id.* at 83.

25. Sampat & Nelson, *supra* note 13, at 19.

26. Interview by Sally Smith Hughes, Reg'l Oral History Office, The Bancroft Library, Univ. of Cal., Berkeley, with Niels Reimers, Dir., Office of Tech. Licensing, Stanford Univ., in Berkeley, Cal. (May 8, 1997), *available at* http://content.cdlib.org/xtf/view?docId=kt4b69n6sc&brand=calisphere&doc.view=entire_text.

splicing genes, a discovery credited as the basis for much of the modern biotechnology industry.[27] Neils Reimers of the Stanford OTL persuaded the scientists to apply for a patent in 1974, and the scientists filed the application just one week before the deadline (after that deadline, the patent application would have been rejected because of prior publication).[28] The OTL also had to negotiate an institutional patent agreement with the NIH, which had funded most of the research.[29] The first of the patents was granted in 1980, shortly before the enactment of the Bayh-Dole Act.[30] The patents, known collectively as the Cohen-Boyer patents, were licensed broadly and nonexclusively, greatly aiding in the accessibility of this new technology as genetic research developed along with modern biotechnology.[31] Stanford specifically elected not to charge a higher royalty, in spite of urging by at least one alumnus.[32] In 1989, Stanford even created special provisions lowering the licensing fees and royalty rates that small firms would have to pay to license the Cohen-Boyer patents.[33] The Cohen-Boyer patents expired in 1997, but not before bringing in a substantial amount of revenue and resulting in many developments in biotechnology for the better part of the previous two decades.[34] The Cohen-Boyer patents serve as a true success story of university patenting, and the patents' success would not have been possible if universities could not patent government-funded inventions prior to the passage of the Bayh-Dole Act.

II. THE BAYH-DOLE ACT

From a patent standpoint, the Bayh-Dole Act was a very significant piece of legislation during the 1980s, because it led to an increase in nonprofit organizations' involvement in the patent system. The law made it easier for nonprofit recipients of government funds (such as universities) to seek patent protection for the resulting invention while reserving a nonexclusive,

27. Dueker, *supra* note 9, at 491.

28. *Id.* at 494; Interview with Niels Reimers, *supra* note 26. According to Niels Reimers's own account, Reimers persuaded Stanley Cohen (who specifically did not want to patent the discovery) to file a patent application, explaining that filing an application would ensure that Cohen's discovery would be commercialized most effectively and that the license process also could include requirements that the licensee follow safety guidelines. *Id.*

29. *Id.*

30. Dueker, *supra* note 9, at 495.

31. *Id.*; *see also* Mark A. Lemley, *Patenting Nanotechnology*, 58 STAN. L. REV. 601, 611 (2005).

32. Maryann P. Feldman, Alessandra Colaianni & Connie Kang Liu, *Lessons from the Commercialization of the Cohen-Boyer Patents: The Stanford University Licensing Program*, *in* 2 INTELLECTUAL PROPERTY MANAGEMENT IN HEALTH AND AGRICULTURAL INNOVATION: A HANDBOOK OF BEST PRACTICES 1797, 1800 (Anatole Krattiger et al. eds., 2007), *available at* http://www.iphandbook.org/handbook/resources_and_tools/Publications/links/ipHandbook%20Volume%202.pdf.

33. *Id.*

34. Walter W. Powell & Jason Owen-Smith, *Universities and the Market for Intellectual Property in the Life Sciences*, 17 J. POL'Y ANALYSIS & MGMT. 253, 264 (1998) (noting that the patents brought in $66.3 million in licensing revenue between 1980 and August of 1996).

royalty-free license for the government and those acting on behalf of the government. In addition, the Act reserved march-in rights to allow the government to step in if it was found that the invention was not being exploited effectively.[35]

The Bayh-Dole Act was only one of several sweeping changes in patent law in the early 1980s. Other changes included the U.S. Supreme Court's 1980 case, *Diamond v. Chakrabarty*,[36] where the Court held that genetically engineered microorganisms were patentable subject matter, and the establishment in 1982 of the U.S. Court of Appeals for the Federal Circuit as the appeals court for patent claims.[37]

Prior to the passage of the Bayh-Dole Act, the government agencies responsible for funding research did not have a uniform policy concerning the fate of the potential intellectual property rights in the fruits of government-funded research.[38] The Bayh-Dole Act established such a uniform policy, providing that patents for the results of government-funded research may be held by the research entity, and that the entity may issue exclusive licenses to promote the commercialization of the results.[39] In part because of the variety of other changes to the patent system around the same time, some scholars have questioned how significant the Act truly

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35. Bayh-Dole Act of 1980, 35 U.S.C. §§ 200–212 (2006).

36. 447 U.S. 303, 317 (1980). Many scholars credit *Diamond v. Chakrabarty* with the growth of patenting in the biotechnology industry. *See, e.g.*, Dueker, *supra* note 9, at 494; Garde, *supra* note 6, at 253; Peter Mikhail, Hopkins v. CellPro*: An Illustration that Patenting and Exclusive Licensing of Fundamental Science Is Not Always in the Public Interest*, 13 HARV. J.L. & TECH. 375, 376 (2000).

37. Many scholars note that the creation of the U.S. Court of Appeals for the Federal Circuit was a very important turning point in patent law for two reasons: first, the Federal Circuit was perceived as more likely to uphold a patent than other courts; second, the Federal Circuit provided a level of consistency and reliability in patent law that did not exist before, since patent decisions at the appellate level were made by different courts across the country. John M. Golden, *Biotechnology, Technology Policy, and Patentability: Natural Products and Invention in the American System*, 50 EMORY L.J. 101, 125–26 (2001); *see also* Jonathan M. Barnett, *Cultivating the Genetic Commons: Imperfect Patent Protection and the Network Model of Innovation*, 37 SAN DIEGO L. REV. 987, 997 (2000). *See generally* Dueker, *supra* note 9, at 465; Arti K. Rai & Rebecca S. Eisenberg, *Bayh-Dole Reform and the Progress of Biomedicine*, LAW & CONTEMP. PROBS., Winter/Spring 2003, at 289, 290.

38. U.S. GEN. ACCOUNTING OFFICE, TECHNOLOGY TRANSFER: ADMINISTRATION OF THE BAYH-DOLE ACT BY RESEARCH UNIVERSITIES: REPORT TO CONGRESSIONAL COMMITTEES 3 (1998) [hereinafter GAO, TECH TRANSFER], *available at* http://eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/15/9a/9c.pdf. DHEW, for example, had a policy of negotiating IPAs with universities, while the U.S. Department of Defense (DoD) allowed universities to retain title if the universities followed "approved" patent policies. MOWERY ET AL., *supra* note 8, at 45.

39. MOWERY ET AL., *supra* note 8, at 113–26; *see also* Gary Pulsinelli, *Share and Share Alike: Increasing Access to Government-Funded Inventions Under the Bayh-Dole Act*, 7 MINN. J. L. SCI. & TECH. 393, 398–99 (2006) (noting the two alternatives that funding agencies might have adopted before Bayh-Dole: a license policy where title resides with the inventor and the government keeps a license to use the technology; or a title policy where the government retains full title and thus owns all of the resulting patents).

was, but all scholars tend to agree that the Act had at least some effect on the geography of the patent system.[40]

A. *Purpose*

Commentators disagree about the specific purpose of the Bayh-Dole Act. The data presented in support of the passage of the Bayh-Dole Act included information that the government funding agencies owned 28,000 patents, but that fewer than five percent of those patents were licensed to industry.[41] The Bayh-Dole Act was passed in 1980 with the purpose of promoting the transfer of technology developed as a result of government funding.[42] Some scholars articulate the purpose more broadly, asserting that the Bayh-Dole Act was passed to allow the public to receive more benefits from university research through the commercialization of the inventions.[43] A persuasive minority, however, urges that the simple purpose behind the Bayh-Dole Act was standardization of policies.[44] Some scholars within that

40. *See, e.g.*, MOWERY ET AL., *supra* note 8, at 1; Dueker, *supra* note 9, at 465; F. Scott Kieff, *Facilitating Scientific Research: Intellectual Property Rights and the Norms of Science—A Response to Rai and Eisenberg*, 95 NW. U. L. REV. 691, 695 (2001) (noting that, before 1980, it was much harder to obtain and defend a patent, which could explain why more universities did not seek patents on inventions); Lemley, *supra* note 31, at 617; Mikhail, *supra* note 36, at 375.

41. COGR GUIDE, *supra* note 3, at 2. *Contra* McManis & Noh, *supra* note 4, at 12 (noting that the data used in support of the Act was flawed); *infra* note 45.

42. 35 U.S.C. § 200 (2006); WENDY H. SCHACHT, CONG. RESEARCH SERV., THE BAYH-DOLE ACT: SELECTED ISSUES IN PATENT POLICY AND THE COMMERCIALIZATION OF TECHNOLOGY 4–5 (2006), *available at* http://www.ncseonline.org/NLE/CRSreports/07Jan/RL32076.pdf; Barnett, *supra* note 37, at 995; Garde, *supra* note 6, at 255; Lemley, *supra* note 31, at 617; *Innovation's Golden Goose*, ECONOMIST TECH. Q., Dec. 14, 2002, at 3, 3 (referring to the Bayh-Dole Act as "[p]ossibly the most inspired piece of legislation to be enacted in America over the past half-century" and noting that the Act caused universities to become "hotbeds of innovation" overnight). *But see* MOWERY ET AL., *supra* note 8, at 91 (acknowledging the primary argument that few of the government-owned patents were licensed, but pointing out that such justification was based on incomplete information, since the government-owned patents surveyed were patents held by the DoD).

43. *See* Margo A. Bagley, *Academic Discourse and Proprietary Rights: Putting Patents in Their Proper Place*, 47 B.C. L. REV. 217, 232 (2006); Pulsinelli, *supra* note 39, at 394; Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 97 (1999). This is also the argument set forth by Richard Levin of Yale University, who asserts that the Bayh-Dole Act's purpose was to assist in the commercialization of government-funded inventions "'for the benefit of humanity.'" SCHACHT, *supra* note 42, at 9 (quoting Richard Levin). From the industry perspective, many feared in the 1980s that U.S. industry was lagging behind other industrialized nations. *See, e.g.*, Powell & Owen-Smith, *supra* note 34, at 256.

44. *See* Lorelei Ritchie de Larena, *The Price of Progress: Are Universities Adding to the Cost?*, 43 HOUS. L. REV. 1373, 1375 (2007) (asserting that the Bayh-Dole Act came about to standardize "the rules regarding ownership of patents on inventions created using federal research funds" (citing 35 U.S.C. § 200 (2000)); Rebecca S. Eisenberg, *Public Research and Private Development: Patents and Technology Transfer in Government-Sponsored Research*, 82 VA. L. REV. 1663, 1663 (1996); Litan et al., *supra* note 7, at 6; *see also* SCHACHT, *supra* note 42, at 2–3 (stating that the Bayh-Dole Act was intended to create a uniform national policy that would reduce bureaucracy and encourage commercialization of inventions); Dueker, *supra* note 9, at 462 (referring to the Bayh-Dole Act as "the first-ever federal uniform patent policy" and noting that the act replaced twenty-two separate statutory

minority question whether the reported underlicensing of government-held patents was overestimated due to a selection bias. Those scholars probably are referring to patents that were held by the U.S. Department of Defense (DoD), which implemented a pre-Bayh-Dole policy that made it much easier for inventors to hold the patent than for the government to do so.[45] Finally, though the Bayh-Dole Act may have resulted in increased revenue for universities, increasing revenue for universities was not a direct purpose of the Act.[46]

B. *Effect*

In the decade after the enactment of the Bayh-Dole Act, there was a substantial increase in patenting by universities.[47] Scholars still debate whether this increase stemmed solely from Bayh-Dole.[48] Patenting by universities was on the rise prior to the passage of the Act, and, following the passage of the Act, universities were seeing increases in the amount of funding they received from industry.[49] Not surprisingly, these circumstances led to a "chicken or the egg" debate. On one hand, the Bayh-Dole Act might have caused the increase in university patenting; on the other, the demand for the passage of the Bayh-Dole Act could have resulted from increased patenting activity by universities.[50] However, comparing university research in the United States during the 1980s with the progress of the biotechnology industry in other countries after the passage of Bayh-Dole lends credence to the idea that the Bayh-Dole Act in fact played a

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provisions); Pulsinelli, *supra* note 39, at 398–99 (not stating that standardization was the primary purpose, but acknowledging how differently the funding agencies operated and discussing whether various agencies practiced a title policy or a license policy).

45. MOWERY ET AL., *supra* note 8, at 91 (noting that the data indicating that the government-owned patents were underlicensed was based on DoD patents, which was misleading because the DoD followed a patent policy that manifested a bias toward the inventor retaining the patent rights to the invention); Eisenberg, *supra* note 44, at 1702.

46. *See* Rochelle Dreyfuss, *Protecting the Public Domain of Science: Has the Time for an Experimental Use Defense Arrived?*, 46 ARIZ. L. REV. 457, 464 (2004) (noting that the Act "was enacted to promote technology transfer through licensing, and not specifically to enrich universities" (citing Eisenberg, *supra* note 44)).

47. Bagley, *supra* note 43, at 231; Michael S. Mireles, Jr., *States as Innovation System Laboratories: California, Patents, and Stem Cell Technology*, 28 CARDOZO L. REV. 1133, 1149 (2006) (referencing increases in economic activities that occurred after the passage of the Act, but without drawing a conclusion about causation); University of Pittsburgh Office of Technology Management, Inventors Handbook, X. Appendices, http://www.otm.pitt.edu/sc.php?page_title=X.+APPENDICES (last visited Mar. 24, 2009) (noting that universities reported being issued fewer than 250 patents per year prior to 1980, but that in 1993, universities responding to the Association of University Technology Managers (AUTM) survey received an average of 1600 patents). *But see* MOWERY ET AL., *supra* note 8, at 36 (noting that, while the Bayh-Dole Act accelerated the growth of patenting by universities, the acceleration was still in line with a then-existing trend toward increased patenting by universities).

48. *See generally* MOWERY ET AL., *supra* note 8.

49. Henderson et al., *supra* note 7, at 121–22.

50. *Id.* at 121.

substantial role in the success of new biotechnology firms in the United States.[51]

As is true with any major legislation, the Bayh-Dole Act is not without its critics. The Bayh-Dole Act has been credited with creating the biotechnology industry, but critics have pointed out that, by acting under the authority of Bayh-Dole, universities have actually contributed to high pharmaceutical costs (even as these actions were increasing the accessibility of the new biopharmaceutical developments).[52] Other critics have blamed the Bayh-Dole Act for the development of an "anticommons," due to the excessive patenting of upstream research results, and for skewed research agendas, delays in publication of research results, and increased conflicts of interest for academic researchers.[53] Some critics acknowledge that the Bayh-Dole Act led to financial benefits in the short term, but warn that the Bayh-Dole Act will prove to yield a more detrimental effect on science in the long term.[54]

Although there is not an irrefutable causal relationship, the formation of university TTOs increased and more patent applications for university inventions were filed after the Bayh-Dole Act was passed.[55] A debate arose concerning whether the increase in patenting activity may have harmed the quality of university inventions. A widely cited empirical study by Rebecca Henderson, Adam Jaffe, and Manuel Trajtenberg found a decrease in the relative importance of university patents (as measured by the number of citations to the patent) by the mid-1980s,[56] though this finding was later revealed by a subsequent empirical study to have been the result of a

51. McManis & Noh, *supra* note 4, at 14–16. It is worth noting, however, that domestic patenting increased across the board during the 1980s, which at least one empirical study has attributed to a general surge in innovation during that time period. *See* Samuel Kortum & Josh Lerner, *What Is Behind the Recent Surge in Patenting?*, 28 RES. POL'Y 1, 21 (1999).

52. de Larena, *supra* note 44, at 1387.

53. Mireles, *supra* note 47, at 1136–37; *see also* SCHACHT, *supra* note 42, at 24–23 (citing critics expressing concerns about the patenting of research tools); Janet Rae-Dupree, *When Academia Puts Profit Ahead of Wonder*, N.Y. TIMES, Sept. 7, 2008, at BU4 (expressing concern that the Bayh-Dole Act has "distorted the fundamental mission of universities" as universities begin to act more like corporate research laboratories); Liebeskind, *supra* note 7. Janet Rae-Dupree's interpretation of this dispute in the *New York Times*, however, promptly was criticized on the Patently-O Blog. Patently-O Blog, http://www.patentlyo.com/patent/2008/09/nytimes-univers.html (Sept. 8, 2008, 2:18 PM).

54. *See, e.g.*, Ted Agres, *The Costs of Commercializing Academic Research: Does University Licensing Impede Life Science Research and Development?*, SCIENTIST, Aug. 25, 2003, at 58 (quoting Paul Berg, Director Emeritus, Beckman Center for Molecular and Genetic Medicine, Stanford University).

55. MOWERY ET AL., *supra* note 8, at 101, 106, 111 (providing tables showing post-1980 increases in patenting by the University of California, Stanford University, and Columbia University); Litan et al., *supra* note 7, at 7 (referring to the development and increased importance of university TTOs as unintended consequences of the Bayh-Dole Act); Sampat & Nelson, *supra* note 13, at 22 (noting that there were 25 university technology transfer offices (TTOs) in 1980 and over 200 in 1999).

56. Henderson et al., *supra* note 7, at 124.

truncation bias.[57] Likely as a result of the increased prevalence of university TTOs, AUTM enjoyed a substantial growth in membership following the passage of the Bayh-Dole Act.[58]

III. UNIVERSITY TECHNOLOGY TRANSFER OFFICES

The role, structure, and business model of university TTOs can vary significantly depending on the university and the academic discipline involved in the technology transfer activity that is taking place. Not surprisingly, many critics have very strong opinions about what TTOs should or should not be doing when it comes to patenting and licensing. However, there is not a simple answer about what a TTO should be doing in order to be more successful, since many factors contribute to a TTO's success.[59] One potential factor to consider is the quality and volume of the resources available to the TTO. An empirical study by Joshua Powers found that universities with older TTOs, larger TTOs, and more highly reputable science and engineering faculty grant more licenses than universities that are not as resource rich in those areas.[60]

TTOs have been criticized for being too driven by revenue generation.[61] A study that Richard Jensen and Marie Thursby conducted by surveying

57. Bhaven N. Sampat et al., *Changes in University Patent Quality After the Bayh-Dole Act: A Re-examination*, 21 INT'L J. INDUS. ORG. 1371, 1379 (2003). One potential explanation for the apparent initial decline in importance of university patents is that, on the whole, university patents were being cited later than control group patents. Thus, the original Rebecca Henderson et al. study did not encompass the full breadth of citations to university patents. *Id.* at 1373–74. Bhaven Sampat and his colleagues further point out that a longer delay before a patent is cited does not necessarily mean that the patent has less importance and could actually indicate that the patent has more importance. *Id.* at 1388.

58. Sampat & Nelson, *supra* note 13, at 22 (noting that the AUTM had 150 members in 1984, compared with 1500 in 1999); *cf.* COGR GUIDE, *supra* note 3, at 3 (specifying that the AUTM was comprised of 2178 members in 1999). The Association of University Technology Managers (AUTM) was founded in 1974 for the purpose of addressing the concern that government-funded university inventions were not being adequately commercialized. Association of University Technology Managers, About AUTM, http://www.autm.net/AM/Template.cfm?Section=About (last visited Mar. 24, 2009).

59. Timothy R. Anderson, Tugrul U. Daim & Francois F. Lavoie, *Measuring the Efficiency of University Technology Transfer*, 27 TECHNOVATION 306, 316 (2007). Timothy Anderson and his colleagues completed an empirical study concerning the efficiency of TTOs and provided suggestions about different areas to look into for further research on the topic, including the organizational structure of the TTO, the possible effect of the region in which the TTO is located, and the difference in efficiency between TTOs in the United States and TTOs in other countries. *Id.*

60. Joshua B. Powers, *Commercializing Academic Research: Resource Effects on Performance of University Technology Transfer*, 74 J. HIGHER EDUC. 26, 37–39 (2003).

61. *See, e.g.*, Megan Ristau Baca, iBrief, *Barriers to Innovation: Intellectual Property Transaction Costs in Scientific Collaboration*, 2006 DUKE L. & TECH. REV. 4; *see also* Lemley, *supra* note 19, at 618 (noting that university TTOs that are more focused on revenue generation in the short run will tend to grant exclusive licenses); Litan et al., *supra* note 7, at 3–4 (stating that university TTOs have focused on revenue generation instead of on the commercialization of university inventions). Robert Litan and his colleagues even go as far as to refer to the current dominant TTO model as the "revenue maximization model." *Id.* at 7; *cf.* Gilles Capart & Jon Sandelin, Models of and Missions for Transfer Offices from

technology managers led to a finding that TTOs tend to place more emphasis on licensing revenue when measuring the TTOs' success.[62] According to the survey, however, the perceived importance of commercialization of inventions is just slightly less than that of licensing revenue, indicating that TTOs take seriously their role in implementing the Bayh-Dole Act.[63]

Among other obstacles, TTOs traditionally must overcome the difficulty of breaking even—typically, it takes between five and ten years for a TTO to break even, if it does at all.[64] This may be due to TTOs' extensive patenting in search of the next "blockbuster" patent—for instance, patenting every new biopharmaceutical substance in case one will be the next big pharmaceutical breakthrough.[65] Blockbuster patents, however, are very

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Public Research Organizations (2004) (unpublished manuscript), *available at* http://www-leland.stanford.edu/group/OTL/about/documents/JSMissionsModelsPaper-1.pdf (providing eight possible points to consider when forming a mission statement for a TTO, but specifically advising against making revenue generation a top priority). *But see* Dueker, *supra* note 9, at 470 (stating that the primary goal of TTOs is commercialization and designating revenue generation as a secondary concern); Powell & Owen-Smith, *supra* note 34, at 258 (listing the prospect of large financial returns as constituting "the most compelling factor to universities" when universities consider how to manage research findings).

62. Richard Jensen & Marie Thursby, *Proofs and Prototypes for Sale: The Licensing of University Inventions*, 91 AM. ECON. REV. 240, 243–45 (2001). The study looks at the priorities that TTO managers place on various possible outcomes of TTO activities. The other outcomes that the study requested that the managers consider were commercialization of inventions; licenses executed; sponsored research; and patents. *Id.* at 244. Revenue from licensing received the most rankings of "extremely important" or "moderately important" in surveys where the TTO managers were asked to evaluate the importance of these outcomes to TTOs and university administration. *Id.*

63. *Id.* at 245.

64. Bagley, *supra* note 43, at 234; Rae-Dupree, *supra* note 53 (noting that data indicate that "fewer than half of the 300 research universities actively seeking patents have managed to break even from technology transfer efforts," with two-thirds of all licensing revenue tracked by the AUTM being spread between thirteen research universities (citing JENNIFER WASHBURN, UNIVERSITY INC.: THE CORPORATE CORRUPTION OF HIGHER EDUCATION (2005)).

65. *See* de Larena, *supra* note 44, at 1381–82 (referring to the "lottery" effect, whereby university TTOs file a large number of patent applications because of the small chance that one might result in huge returns); *see also* MOWERY ET AL., *supra* note 8, at 83–84 (referring to the Research Corporation's attempts to maximize income by searching for blockbuster patents as one reason for its failure); Litan et al., *supra* note 7, at 8 (stating that TTOs place more emphasis on commercializing inventions that have the potential to result in the biggest, fastest payback and less emphasis on inventions that have significant potential in the long run). *But see* Jerry G. Thursby & Marie C. Thursby, *Who Is Selling the Ivory Tower? Sources of Growth in University Licensing*, 48 MGMT. SCI. 90, 93 (2002) (referencing a study that showed that many TTOs apply for patents only when they believe a licensee could be found relatively easily); McManis & Noh, *supra* note 4, at 25 (discussing studies revealing that only a minority of university inventions are patented, typically only after careful market analysis to ensure that a licensee would be found); Cornell Center for Technology Enterprise and Commercialization, Technology Transfer Process, http://www.cctec.cornell.edu/inventors/techtransferprocess.php (last visited Mar. 24, 2009) (providing a disclaimer for researchers that not all inventions would be considered appropriate for patenting). One university TTO that does not engage in such extensive patenting is the Technology Transfer Department (TTD) at the University of California at Berkeley, which cites the high cost of filing patent applications (between $10,000 and $20,000) as a reason for the TTD's inability to seek patents on all inventions submitted to

rare, and patenting everything in the hopes of finding the next blockbuster patent will become very expensive very quickly.[66] For example, consider the biopharmaceutical industry. Data suggests that for every FDA approved drug, a company has typically reviewed between 5000 and 10,000 compounds.[67] With essentially a one in 10,000 chance that a biopharmaceutical compound would even become an FDA-approved drug, the numbers would get outright miniscule if patenting decisions were based on a desire to find a blockbuster drug, which requires product sales in excess of $500 million per year.[68]

A. *Impeding Innovation?*

Some scholars have expressed concern that universities are obtaining too many patents, leading to a risk of what Michael Heller and Rebecca Eisenberg termed a "tragedy of the anticommons."[69] Under this theory, an anticommons would result in delayed innovation due to the excess of patents that must be licensed before researchers can conduct innovative research, since each patent along "the road to product development" increases transaction costs.[70] Though not specifically referring to an anticommons, William Brody (then-president of Johns Hopkins University) also expressed a warning that excessive patenting by universities could

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the office. Lawrence Berkeley National Laboratory, Technology Transfer: For Berkeley Lab Researchers: How the Tech Transfer Licensing Process Works, http://www.lbl.gov/Tech-Transfer/researchers/how-tt-works.html (last visited Mar. 24, 2009).

66. *See* MOWERY ET AL., *supra* note 8, at 83–84 (noting how difficult it is to predict which patent will be the next blockbuster, and thus that a patent licensing portfolio should not be managed with the sole goal of maximizing income); *cf.* Goldie Blumenstyk, *A Contrarian Approach to Technology Transfer*, CHRON. HIGHER EDUC., Mar. 12, 2004, at A27 (noting that tech transfer professional Gerald Barnett suggested that TTOs use university technologies to build relationships with industry instead of looking for patents that will bring in a large amount of revenue); Andy Guess, *Easing Friction Over Tech Transfer*, INSIDE HIGHER ED, July 18, 2007, http://www.insidehighered.com/news/2007/07/18/patent.

67. OFFICE OF TECH. TRANSFER, NAT'L INSTS. OF HEALTH, U.S. DEP'T OF HEALTH & HUMAN SERVS., NIH RESPONSE TO THE CONFERENCE REPORT REQUEST FOR A PLAN TO ENSURE TAXPAYERS' INTERESTS ARE PROTECTED (2001), *available at* http://www.ott.nih.gov/policy/policy_protect_text.html.

68. *Id.*

69. Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCIENCE 698, 698 (1998) (addressing the concern that an excess of rights in a resource could lead to underuse). The idea of the anticommons can be compared to multiple toll booths along the same road. When too many people hold exclusionary rights in property (here, a patent), the anticommons theory holds that research and innovation are impeded or outright halted because permission cannot be obtained from all of the holders of exclusionary rights. *See* de Larena, *supra* note 44, at 1376, 1424–25 (stating that patents are sometimes appropriate, but that universities have been overpatenting irresponsibly and should "patent less and license more").

70. *See* Heller & Eisenberg, *supra* note 69, at 699; *see also* Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting* 8 (Univ. of Cal., Berkeley Competition Policy Ctr., Working Paper No. CPC00-11, 2000), *available at* http://repositories.cdlib.org/iber/cpc/CPC00-011 (discussing patent thickets and the blocking effect that patents can have on downstream research, such as in the biotechnology industry under the theory proposed by Michael Heller and Rebecca Eisenberg).

delay commercialization.[71] Heller and Eisenberg assert in their article that a delay due to increasing privatization of upstream research is visible in biomedical research.[72] Critics of the anticommons theory have asserted that its effects have not actually been felt in the context of biotechnology.[73] An empirical study conducted by John Walsh, Ashish Arora, and Wesley Cohen concedes that the preconditions for an anticommons are present in biotechnology.[74] However, the study then provides survey results indicating that the patenting of research tools and other upstream developments have generally not been viewed as having a substantial negative effect on further developments in research.[75] On the other hand, a conflicting empirical study by Fiona Murray and Scott Stern examines patent-paper pairs and concludes that citations to research findings in papers decline after a patent is obtained on those results.[76] Murray and Stern's conclusion suggests that a significant number of researchers may actually choose to abandon a specific research project that would build on another scientist's research paper after a patent associated with that paper is granted.[77]

One of the ways to potentially measure the effects of increased patenting of university research is to examine the pace of knowledge exploitation by industry: if it takes a long time for industry to take advantage of results from university research, that might indicate that increased patenting by universities has slowed down progress in that industry.[78] The results of Kira Fabrizio's recent empirical study indicate that there has been a slowdown of development in industry as university patenting has increased,

71. Brody, *supra* note 8. William Brody further suggests that it may actually be a bad idea for universities to patent at all. *Id.*

72. *See* Heller & Eisenberg, *supra* note 69, at 698; *see also* Agres, *supra* note 54, at 59 (referencing a study that revealed a substantial percentage of researchers who reported being deterred from researching genetic tests by fear of patent infringement).

73. *See* Heather Hamme Ramirez, Comment, *Defending the Privatization of Research Tools: An Examination of the "Tragedy of the Anticommons" in Biotechnology Research and Development*, 53 EMORY L.J. 359, 371 (2004) (defending the privatization of upstream biotechnology developments by asserting that patents on such developments encourage innovation rather than hinder it).

74. John P. Walsh et al., *Effects of Research Tool Patents and Licensing on Biomedical Innovation*, *in* PATENTS IN THE KNOWLEDGE-BASED ECONOMY 285, 293–96 (Wesley M. Cohen & Stephen A. Merrill eds., 2003)

75. *Id.* at 298. The study, however, was primarily concerned with whether research tool patents had the potential to cause the termination of studies that were in progress. The paper does, however, acknowledge the possibility that high licensing costs could prevent utilization of patented research tools by small start-up firms and university labs. *Id.* at 301–02.

76. Fiona Murray & Scott Stern, *Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge? An Empirical Test of the Anti-commons Hypothesis*, 63 J. ECON. BEHAV. & ORG. 648 (2007).

77. *Id.* at 673. The authors interpret this finding as evidence that patents have a negative impact on the diffusion of scientific information. *Id.* at 683. The study examined patent-paper pairs for scientific articles published in the journal *Nature Biotechnology*. *Id.* at 651.

78. Kira R. Fabrizio, *University Patenting and the Pace of Industrial Innovation*, 16 INDUS. & CORP. CHANGE 505, 506 (2007).

which Fabrizio suggests may be due to delays relating to the universities' property rights in the upstream research results.[79]

In addition to the danger of an anticommons, it has also been observed that overpatenting by universities could lead to universities being treated more like commercial actors, resulting in loss of special allowances traditionally afforded to universities, like the common-law experimental use defense.[80] The true negative impact of losing the common-law experimental use defense, however, is still being debated.[81]

If indeed universities are overpatenting, some scholars have proposed turning to patent law to curb this trend and decrease the number of patents being granted to universities.[82] To best understand how patent law may be used to prevent overpatenting, one must first turn to a couple of theories concerning the purposes that patents serve. Just as the Bayh-Dole Act may be interpreted as having several purposes, scholars have noted that patents may serve many purposes. Two purposes commonly addressed in the context of the Bayh-Dole Act are patents as providing incentives for commercialization[83] and patents acting as signals.[84]

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79. *Id.* at 524.

80. *See* Dreyfuss, *supra* note 46, at 468; *see also* Madey v. Duke Univ., 307 F.3d 1351, 1360–62 (Fed. Cir. 2002) (holding that universities are in the business of research and education and thus are not eligible for an experimental use defense based on use of a patented invention in university research).

81. *See* Wendy Thai, Note, *Toward Facilitating Access to Patented Research Tools*, 6 MINN. J. L. SCI. & TECH. 373, 375–76 (2004) (noting the tendency within industry against suing universities for patent infringement). *Compare* Dreyfuss, *supra* note 46, at 468 (warning that universities could face substantial costs if patent owners started suing universities for patent infringement), *and* Ruth E. Freeburg, Comment, *No Safe Harbor and No Experimental Use: Is It Time for Compulsory Licensing of Biotech Tools?*, 53 BUFF. L. REV. 351, 393 (2005) (asserting that *Madey* eliminated the experimental use exemption for research tools, that it is possible to have very broad patents on upstream technology, and that the lack of a broad infringement exemption combined with the potential for broad patents has the capacity to seriously stifle innovation in biotechnology), *with* Elizabeth A. Rowe, *The Experimental Use Exception to Patent Infringement: Do Universities Deserve Special Treatment?*, 57 HASTINGS L.J. 921, 954 (2006) (arguing against special treatment for universities by providing an experimental use exemption to begin with and noting the unlikelihood that the *Madey* decision would result in any change to university lab behaviors or any increase in infringement actions brought against universities), *and* Richard J. Bauer, Comment, *Why Not Try the Experiment and Stop Pointing the Finger? Modern University Research Unaffected by a Narrow Experimental Use Exception*, 24 TEMP. J. SCI. TECH. & ENVTL. L. 121, 135 (2005). *See generally* JOHN R. THOMAS, CONG. RESEARCH SERV., SCIENTIFIC RESEARCH AND THE EXPERIMENTAL USE PRIVILEGE IN PATENT LAW 9–13 (2004), *available at* http://fas.org/sgp/crs/RL32651.pdf (reviewing the arguments in favor of and against an experimental use exemption for universities).

82. *See* Dreyfuss, *supra* note 46, at 468; Lemley, *supra* note 31, at 628; *cf.* Golden, *supra* note 37, at 108–10.

83. Garde, *supra* note 6, at 278 (differentiating between incentives to innovate (commercialize) and incentives to invent); Kieff, *supra* note 40, at 698 (discussing patents as incentives for commercialization); Lemley, *supra* note 19, at 620–21; McManis & Noh, *supra* note 4, at 9. Other scholars have put forth the idea that patents may serve as incentives to invent, incentives to disclose, and incentives to design around earlier inventions, in addition to serving as incentives to commercialize. Richard Li-Dar Wang, *Biomedical Upstream Patenting and Scientific Research: The Case for Compulsory Licenses Bearing*

In examining the necessity of patenting by universities, the perceived purpose served by the patents can provide significant insight. If patent rights purely provide incentives for commercialization, universities clearly should obtain patents so that the research results may be more effectively commercialized. However, if patent rights only truly act as signals, then the value to a university of holding an expansive patent portfolio is questionable at best, since universities likely would possess patent portfolios covering many different areas of study. Thus, a university would have limited ability to use its broad patent portfolio as a signal of its strength in any particular discipline. This is in part due to the wide variety of channels that universities may use to engage in technology transfer apart from patenting.[85] If patents only act as signals, then they are a much more expensive method of signaling than the other well-established methods of attracting industry attention to promote commercialization, such as publications, consulting relationships between faculty and industry, and industry-sponsored research.

In addition to the overarching purpose that patents serve, patents may mean different things to different parties. For example, Katherine Strandburg suggests that some university researchers seek patents not for royalty profits, but instead for the purpose of maintaining exclusive control over subsequent research.[86]

When expressing concern about the potential for an anticommons or for overpatenting in general, many scholars have suggested possible solutions. One method that has been suggested is to reform patent law to make it more difficult to obtain a patent to begin with, such as by strengthening various requirements of patent law.[87] Strengthening the utility requirement, for

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Reach-Through Royalties, 10 YALE J.L. & TECH. 251, 265 (2008). However, these alternatives have largely been dismissed in the context of the patenting by universities. Golden, *supra* note 37, at 165–66.

84. *See* de Larena, *supra* note 44, at 1385 (noting that patents act as signals to show that a university is "industry-friendly"); Clarisa Long, *Patent Signals*, 69 U. CHI. L. REV. 625, 627–28 (2002) (exploring the various things that a patent portfolio can signal to others); *see also* Golden, *supra* note 37, at 166–67. John Golden dismisses the incentive to invent theory in favor of viewing patents as a means of attracting investment capital by exhibiting the firm's money-making ability to potential investors. He refers to this as the "resources for innovation" theory, which he says was also the driving theory behind passage of the Bayh-Dole Act. *Id.* However, this theory essentially just encompasses the notion of using a patent as a signal of the value of investing in the small firm. *Id.* at 167. *But see* Pulsinelli, *supra* note 39, at 393.

85. MOWERY ET AL., *supra* note 8, at 179.

86. *See* Katherine J. Strandburg, *Curiosity-Driven Research and University Technology Transfer*, *in* 16 ADVANCES IN THE STUDY OF ENTREPRENEURSHIP, INNOVATION AND ECONOMIC GROWTH: UNIVERSITY ENTREPRENEURSHIP AND TECHNOLOGY TRANSFER: PROCESS, DESIGN, AND INTELLECTUAL PROPERTY 93, 109 (Gary D. Libecap ed., 2005). The fact that WARF and the Research Corporation were each founded for a similar purpose gives credence to this theory. *See supra* Part I.A–B.

87. *See* Golden, *supra* note 37, at 110, 181 (suggesting stricter enforcement of the patentability standards of novelty, nonobviousness, and utility, with heightened enforcement of the utility requirement having "the greatest immediate potential for imposing sensible

instance, might render it impossible to obtain a patent on upstream research results, since such results are a significant distance away from being a marketable product.[88] One of the issues that has prompted this sort of discussion is the patenting of gene sequences where it is not even known what role a particular gene sequence performed.[89] In the context of gene sequences, it has been proposed that a strengthened utility requirement would prevent excessive patenting and thus leave the sequences freely available for further research down the line.[90] This proposal may be criticized as being a slightly circular solution to the problem of overpatenting, since it basically proposes reducing the number of patents granted to universities by reducing the number of patents issued.

Other scholars have suggested either reforming the Bayh-Dole Act, or exercising provisions of the Act that have traditionally not been exercised fully, such as the march-in provision and the grant-back rights.[91] The Act, for example, reserves a nonexclusive, royalty-free license to the federal government, as well as any entity practicing the invention "for or on behalf of the United States."[92] If this provision were exercised and universities were deemed to be practicing an invention "on behalf of the United States," it could remove potential obstacles to university usage of certain patented research materials.[93] Exercising the grant-back rights in this way, however, would currently be very difficult due to the lack of a database listing government-funded inventions that may be subject to this provision.[94]

Because of its broad language, the march-in provision is potentially controversial. The provision contains language that authorizes the funding agency to step in when necessary to achieve "practical application" of a

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restrictions on prima facie patentability"); Lemley, *supra* note 31, at 628 (also encouraging strengthening the utility requirement).

88. Golden, *supra* note 37, at 181.

89. *Id.* at 129.

90. Teresa M. Summers, Note, *The Scope of Utility in the Twenty-First Century: New Guidance for Gene-Related Patents*, 91 GEO. L.J. 475, 493 (2003).

91. *See* de Larena, *supra* note 44, at 1377 (stating that wider usage of the march-in provision and grant-back rights could help allay criticisms of university patenting); Lemley, *supra* note 31, at 628; Pulsinelli, *supra* note 39, at 434 (noting that the NIH has never exercised its march-in rights); Sabety, *supra* note 7, at 510; *see also* de Larena, *supra* note 44, at 1394–95 (suggesting use of the grant-back rights of the Bayh-Dole Act to give universities the authority to practice inventions on behalf of the government, thus eliminating many situations where universities might need to seek licenses before conducting research). *See generally* National Institutes of Health, CellPro March-In Petition Documents, http://www.nih.gov/icd/od/foia/cellpro/ (last visited Mar. 24, 2009); CellPro and Bayh-Dole March-In Rights, http://www.cptech.org/p/cellpro/ (last visited Mar. 24, 2009). *But see* Dreyfuss, *supra* note 46, at 469–70 (noting that "[n]arrowing patents will only lead people to apply for more of them" and suggesting instead the implementation of an experimental use defense similar to fair use in copyright law); McManis & Noh, *supra* note 4, at 5 (criticizing commentators who say that there is a lack of empirical evidence showing the benefits of Bayh-Dole while, at the same time, calling for legislative reform of Bayh-Dole to fix what the authors refer to as "potential problems in the operation of the Act").

92. 35 U.S.C. § 202(c)(4) (2006).

93. *Id.*; MOWERY ET AL., *supra* note 8, at 93; de Larena, *supra* note 44, at 1395.

94. de Larena, *supra* note 44, at 1395.

government-funded invention.[95] However, the provision is flanked by many qualifications and is generally viewed as a last resort. Thus, it is not as drastic as it appears.[96] In the twenty-eight years since the Bayh-Dole Act was passed, the NIH—though it is one of the major federal funding agencies that provides research grants to universities[97]—has never exercised the march-in rights, despite such action being requested on multiple occasions.[98]

B. *An Empirical Assessment of University TTOs*

In order to analyze the range of activities, priorities, and performance of TTOs, I collected data from the annual reports submitted to AUTM by ninety-four institutions in the United States between 1996 and 2003. I obtained information about the Licensing Survey, which, combined with the data in the eight-year reports, provides an historical record of licensing-related parameters from fiscal years 1996 to 2003. These parameters are intended to measure the factors that influence the technology transfer process, including licensing, entrepreneurship, and the like.

1. Summary Statistics

The summary of the descriptive statistics of the dependent and independent variables is included in Table 1, as shown in the Appendix.[99] The mean, median, maximum, minimum, and standard deviation for each variable are listed in this table. Note that the mean for virtually all the variables is significantly larger than the median. In addition, the standard deviation is much larger than the mean for all the dependent and independent variables.

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95. 35 U.S.C. § 202(f)(2); *see also* de Larena, *supra* note 44, at 1392.

96. de Larena, *supra* note 44, at 1392; *see also* Michael S. Mireles, *The Bayh-Dole Act and Incentives for the Commercialization of Government-Funded Invention in Developing Countries*, 76 UMKC L. REV. 525, 530 (2007).

97. GAO, TECH TRANSFER, *supra* note 38, at 5. The General Accounting Office (GAO) provides 1995 data showing that the NIH accounted for approximately 98% of the $6.5 billion in federal funds allocated to universities by the Department of Health and Human Services (DHHS). The contributions from DHHS accounted for the most substantial share of federal funding to universities in 1995, with the National Science Foundation (NSF) and DoD contributing approximately $1.7 billion and $1.6 billion, respectively. *Id.*; *see also* NAT'L SCI. FOUND., FEDERAL SCIENCE AND ENGINEERING SUPPORT TO UNIVERSITIES, COLLEGES, AND NONPROFIT INSTITUTIONS: FY 2005 (2007), *available at* http://www.nsf.gov/statistics/nsf07333/pdf/nsf07333.pdf.

98. For example, in 1997, CellPro asked the NIH to exercise its march-in rights under Bayh-Dole, but the request was denied because there was no clear benefit. Garde, *supra* note 6, at 256. More recently, the NIH received letters from members of the public requesting that the NIH exercise its march-in rights to control the pricing of the drug Ritonavir. The NIH denied this request in 2004, concluding that such an action was an "'extraordinary remedy'" that was not appropriate to address a pricing issue. *Id.* at 257 (quoting OFFICE OF THE DIR., NAT'L INSTS. OF HEALTH, IN THE CASE OF NORVIR® MANUFACTURED BY ABBOTT LABORATORIES, INC. (2004) [hereinafter NORVIR REPORT], *available at* http://www.ott.nih.gov/policy/March-in-norvir.pdf); *see also* NORVIR REPORT, *supra* (providing the official NIH response concerning the request).

99. All tables and figures referenced in Parts III.B.1 to III.B.3 appear in the Appendix.

The maximum values for all the variables are also more than an order of magnitude greater than the mean. All these observations point to a single conclusion—that the distribution of the data is strongly skewed to the right, with a few large outliers for each variable of interest.

2. Performance Index

I have also formulated and calculated a Performance Index for each year and for all years combined based on a composite measure of TTO performance (see Appendix). In doing so, I took into account all the key indicia of performance as specified by the TTOs in their reports to the AUTM. The Performance Index is calculated as follows:

First, I calculated the Adjusted Net Income (*adjincome*) by using the following formula:

adjincome = (*lirecd* – *lipdin* – *explgf* + *reimlg*) – 12000 x *licfte* – 60000 × *othfte*,

wherein:

lirecd is "Licensing Income,"

lipdin is "Income Paid to 3rd Party,"

explgf is "Expended Legal Fees,"

reimlg is "Reimbursed Legal Fees,"

licfte is "Licensing FTE (full time equivalent)," and

othfte is "Other FTE (full time equivalent)."

I obtained the Performance Index (*performancindex*), which employs the Adjusted Net Income, from the following formula:

performancindex = *std*(*lcgnli*) + *std*(*actlic*) + *std* (*lcexcl*) + *std*(*lcn_ex*) + *std*(*invdis*) + *std*(*usptis*) + *std*(*strtup*) + *std*(*adjincome*) + *std*(*nptapp*) + *std*(*tptapp*) + *std*(*totexp*),

wherein:

std is the normalized value, which is the distance of one data point from the mean divided by standard deviation of the distribution,

lcgnli is "Licenses Generating Income,"

actlic is "Cumulative Active Licenses,"

lcexcl is "Licenses on Exclusive Basis,"

lcn_ex is "Licenses on Non-Exclusive Basis,"

invdis is "Invention Disclosures,"

usptis is "U.S. Patents Issued,"

strtup is "Number of Start-Ups,"

nptapp is "New Patent Applications,"

tptapp is "Total Patent Applications," and

totexp is "Research Expenditures."

A summary of the descriptive statistics for the Performance Index is shown in Table 2. The frequency histogram of the Performance Index of all years and the boxplot of the Performance Index are shown in Figures 1 and 2. As with the summary statistics for the independent and dependent variables, the distribution of the Performance Index is skewed to the right, with a few large values contributing to a dramatic shift to the right. The vast majority of university TTOs are unprofitable or barely profitable in real terms. As shown in Figures 3 and 4 and in Table 9, it is the performance of the top few universities that are the real anomalies compared to all the other university TTOs. Hence, and as we shall see in greater detail in the next section, the existence of university TTOs cannot be justified simply on financial terms. Rather, it is their overall economic impact on society through the societal benefits that follow from transferring university-originating innovation that provides a meaningful rationale for their existence.

3. Regression Results

Multiple linear regressions and the stepwise model selection by Mallows' Cp criterion were performed to build up the best model for the dependent and independent variables for each year and also for the sum of all the years.[100]

Tables 3–8 and Tables 10–12, as shown in the Appendix, summarize the regression results of the best models that were selected for each of the dependent variables at issue. The performance index of each TTO in Table 3 strongly correlates to the number of licensing personnel (measured in full-time equivalent, or FTE), the number of nonlicensing personnel (FTE), the number of new patent applications, and the number of U.S. patents issued. When the top and bottom 5% of the Performance Index are removed, the negative correlation to research expenditures seen in Table 3 drops out in Table 4, indicating that this negative correlation was an anomaly caused by the outliers. Table 3 shows that the Performance Index is obtained by devoting additional human resources to patenting activities; the performance parameters constituting the index are heavily influenced by significant patenting activity in terms of applying and obtaining U.S. patents.

This behavior is also seen in Table 5, where licensing income is maximized by investing in licensing and nonlicensing personnel and by increasing patenting activity. Note that the number of invention disclosures

100. See Appendix for additional details.

in Table 5 does not seem to matter, since, without translating the invention disclosures into issued patents under the approach followed by the TTOs, there is no significant increase in licensing income. Table 6 shows the linear regression results for running royalties, and it tracks the behavior for licensing income very closely. It is clear from Table 7 that the more aggressive a TTO is in obtaining patents and in enforcing its legal rights by expending legal fees, the greater the likelihood that these legal fees expended by the TTO will then be reimbursed in the future by a licensee.

It is clear from the summary statistics in Table 1 that the number of start-ups that are generated by a TTO over the eight-year period is very small (median of 1, mean of 2). The number of start-ups in Table 8 is strongly predicted by the research expenditures, the number of invention disclosures, and the age of the TTO. Table 8, when taken together with Tables 5 and 6, shows that TTOs are not primarily concerned with entrepreneurship, commercialization, or technology transfer, all of which can create significant societal benefits. Rather, they are focused on maximizing revenue by obtaining patents and licensing them.

Next, I examined the factors affecting the patent applications and issued patents generated by universities, as indicated in Tables 10–12. Table 10 shows the variables that influence the number of issued U.S. patents. Table 10 illustrates that it costs approximately $7.7 million (1/0.12985) to obtain one issued U.S. patent and that a TTO obtains one issued U.S. patent for every seven (1/0.14916) invention disclosures that are submitted to it. This result indicates that research expenditures at universities are directed toward activities that do not necessarily generate patentable inventions. The TTOs, on the other hand, are focused on activities within their control (pursuing both patenting and licensing), and they are not engaged in activities that maximize the transfer of university-originating innovation generated through research expenditures for the benefit of society, outside of patent-centered licensing. Hence, innovation products such as novel software are less likely to be the focus of technology transfer activities to the extent that they are not embodied in a software patent. More broadly, university innovation that is not reduced to a patent or a patent application is not likely to be the subject of TTO commercialization activities and other strategies to transfer that innovation from the university to society at large.

IV. OTHER CRITICISMS OF UNIVERSITY PATENTING AFTER THE BAYH-DOLE ACT

A. *The "Relationship with Industry" Taint*

With increased involvement in patenting and industry, research universities have been described as now serving as both "creators and retailers of intellectual property" and acting as both "resource and catalyst" for economic innovation.[101] Some scholars have expressed concerns about the effects of increased patenting and closer relations with industry.[102] In 2000, professors at the University of California at Berkeley met to express concerns about the university's recent $25 million funding contract with Novartis that effectively gave Novartis the first opportunity for licensing about one-third of the discoveries that came out of the Department of Plant and Microbial Biology in the College of Natural Resources.[103] A survey revealed that over half of the faculty of the College of Natural Resources were concerned about the possible negative effects on academic freedom and sharing of ideas as a result of such substantial involvement by Novartis in department research.[104] The architect of the deal with Novartis defended the deal by asserting that it would enhance the university's research and suggesting that substantial industry involvement was necessary because of decreases in state and federal funding.[105] The Novartis contract lasted until 2003, and, in part because of the potential inefficiency of such wide-scale funding, it seems somewhat unlikely that similar contracts will become prominent and widespread in the future.[106]

One of the concerns stemming from industry involvement is that sources of research funding could require researchers to refrain from publishing findings for a period of time. This concern has been confirmed by at least one empirical study.[107] David Blumenthal and his colleagues conducted a survey of life sciences firms in 1994, which revealed that 82% of the firms surveyed sometimes required information to be kept confidential so that a patent application could be filed.[108] Fifty-eight percent of the firms stated that they sometimes require that the results be kept confidential "for more than six months in order to file a patent application."[109] However, the paper also asserts that university-industry collaboration is essential in order to commercialize university research findings and to yield the optimal benefit to the public. Blumenthal therefore urges the universities to exercise more control over contracts with industry in order to ensure that the universities protect academic priorities.[110]

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101. Powell & Owen-Smith, *supra* note 34, at 257, 258 (quoting Daryl Chubin, NSF Division Director).

102. *See* Bagley, *supra* note 43, at 221 (blaming patents for increased secrecy among academics); Rebecca S. Eisenberg, *Academic Freedom and Academic Values in Sponsored Research*, 66 TEX. L. REV. 1363, 1375–77 (1988) (noting the potential for compromise of academic values as a result of sponsored research); Sheldon Krimsky, Book Review, ACADEME ONLINE, Sept.–Oct. 2005, *available at* http://www.aaup.org/AAUP/pubsres/academe/2005/SO/BR/krim.htm (reviewing WASHBURN, *supra* note 64).

103. Eyal Press & Jennifer Washburn, *The Kept University*, ATLANTIC MONTHLY, Mar. 2000, at 39, 39–40.

104. *Id.* at 40.

105. *Id.* at 40–41.

106. Andrew Lawler, *Last of the Big-Time Spenders?*, 299 SCIENCE 330, 331 (2003).

107. David Blumenthal et al., *Relationships Between Academic Institutions and Industry in the Life Sciences—An Industry Survey*, 334 NEW ENG. J. MED. 368, 371 (1996).

108. *Id.*

109. *Id.*

110. *Id.* at 373.

A few scholars have pointed out that increasing corporation-like behavior by universities has the potential to harm the research arm of the university, such as by causing universities to effectively forfeit the common-law experimental use defense to patent infringement.[111] Other scholars, on the other hand, point out the benefits of close interaction with industry.[112] For example, even if the common-law experimental use exception is not a viable defense, the close relationship between universities and their industry counterparts has led to an informal research exception. Thus, university researchers typically do not have to worry about being sued for patent infringement by patent holders in industry.[113] Also, university researchers have opportunities to work on more applied areas with more tangible ramifications when they are working in conjunction with industry.[114]

Several scholars have also noted a danger that the increased university-industry interaction has tainted the direction of research, resulting in skewed agendas at best and skewed results at worst.[115] Others have countered such criticisms by pointing out that universities in this country

111. Dreyfuss, *supra* note 46, at 464 (addressing the potential impact of *Madey*, which effectively denied the common law research exemption to university researchers). *Contra* McManis & Noh, *supra* note 4, at 40–42 & n.188 (asserting that the *Madey* decision did not change the experimental use exemption, but rather that it merely affirmed that universities were not excused from the prohibition from "experimenting with" a patented research tool).

112. *See* Dueker, *supra* note 9, at 470.

113. *See* Garde, *supra* note 6, at 262; *see also* Eliot Marshall, *Patent on HIV Receptor Provokes an Outcry*, 287 SCIENCE 1375, 1377 (2000) (noting that the chief executive of a company that owns a patent on an HIV receptor gene has explicitly stated that the company will not use the patent to block academic professionals from using the gene for research purposes).

114. *See* Dueker, *supra* note 9, at 468–69.

115. *See* Dreyfuss, *supra* note 46, at 464 (stating that, after the increased focus on patents made universities look more like commercial actors, the *Madey* court treated universities like commercial actors and took away the common-law experimental use defense); Golden, *supra* note 37, at 180; Risa L. Lieberwitz, *The Corporatization of the University: Distance Learning at the Cost of Academic Freedom?*, 12 B.U. PUB. INT. L.J. 73, 100, 102 (2002) (suggesting that the Bayh-Dole Act encourages unacceptable corporatization of universities, and that the shift toward corporate goals alters the purpose of the research); Press & Washburn, *supra* note 103, at 42 (providing an example of a researcher at Brown University, David Kern, who lost his position at the university because he published his findings concerning a new lung disease contracted by employees at the nylon company where Kern worked as a consultant). Mildred Cho, a senior research scholar at Stanford, suggests that it is rare to find researchers who come forward with research results in spite of pressure from employers. *Id. See generally* SCHACHT, *supra* note 42, at 19–22 (noting that some critics have expressed concern about conflicts of interest, publication delays, and skewed research agendas as a result of close industry ties); Powell & Owen-Smith, *supra* note 34, at 268 (noting concerns that commercial activities could potentially "compromise scientific impartiality by introducing the profit motive into research"); Strandburg, *supra* note 86. *But see* MOWERY ET AL., *supra* note 8, at 14–15 (implicitly denying any increasing commercialization of universities based on further interaction with industry and pointing out that American universities were always closely connected with industry, even to the extent of coming up with entirely new fields of study to address problems faced by industry actors (such as electrical engineering, first offered by MIT in 1882)); Thursby & Thursby, *supra* note 65, at 102 (stating that an increase in the filing of patent applications should be attributed more to the increasingly industry-friendly behavior of university administrators than to a shift in the focus of researchers).

have long maintained a close relationship with local industry, in some cases even creating entirely new areas of academic study for the purpose of addressing local industry concerns (such as the case of the emergence of engineering training at universities).[116]

B. *Harm to Academic Values*

Scholars have also noted the danger of possible interference with academic freedom and academic priorities.[117] For example, a scientist's behavior might be affected by the agenda or intentions of the industry actor for whom the scientist is conducting research. In addition to concerns about increasing corporatization of universities and possible overpatenting,[118] scholars have also expressed concerns that patenting by universities results in the public paying twice for an invention: first, paying for the research; and then, paying increased product and service costs to compensate for the licensing fees.[119]

One of the concerns of the scientific community is over the impact of increased patenting on the behavior of researchers in terms of decreasing participation by publication. A study by Fabrizio and Alberto Di Minin revealed that patenting and publication are complementary activities, with university-assigned patents correlating with increased publication.[120] If there is no discernable trade-off between patenting and publication, is there a trade-off between whether the researcher focuses on applied or basic research? Results of a survey conducted by Marie Thursby and her colleagues imply that there is not such a trade-off.[121]

Another potential danger is that patenting could cause innovation to slow in a particular field. A recent empirical study by Fabrizio, suggesting a relationship "between an increase in university patenting and a slowdown in the pace of knowledge exploitation in a given technology area," provides support for this concern.[122]

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116. MOWERY ET AL., *supra* note 8, at 13, 15.

117. *See* Bagley, *supra* note 43, at 250–51 (asserting that the pressures of patenting can lead to increased secrecy and harm the sense of community within academia); Lieberwitz, *supra* note 115, at 128, 134 (maintaining that the corporatization of the university undermines academic freedom); *see also* KEVIN G. RIVETTE & DAVID KLINE, REMBRANDTS IN THE ATTIC: UNLOCKING THE HIDDEN VALUE OF PATENTS 12 (2000) (noting the "potential conflict of interest between academic freedom and the desire to profit from the research fruits of that freedom"). *But see* Dueker, *supra* note 9, at 470 (asserting that working closely with industry can benefit academia).

118. *See supra* Part IV.A.

119. *See* de Larena, *supra* note 44, at 1383.

120. Kira R. Fabrizio & Alberto Di Minin, *Commercializing the Laboratory: Faculty Patenting and the Open Science Environment*, 37 RES. POL'Y 914, 926 (2008).

121. Marie Thursby, Jerry Thursby & Swasti Gupta-Mukherjee, *Are There Real Effects of Licensing on Academic Research? A Life Cycle View*, 63 J. ECON. BEHAV. & ORG. 577, 595–96 (2007). The results imply that basic and applied research receive relatively equal treatment throughout the faculty member's career, with more research being done in the early stages of her career. If anything is the subject of a trade-off that places more emphasis on applied research, it appears to be leisure time. *Id.* at 596.

122. Fabrizio, *supra* note 78, at 522.

C. *Universities as "Patent Trolls"*

One of the dangers that university TTOs should keep in mind when considering patenting and licensing is the danger that their actions could be interpreted as the actions of "patent trolls." Although scholars consistently have denied that universities are patent trolls,[123] the perception endures; a university with a patent is typically a nonpracticing patent holder that seeks licensees for the patents it holds, which closely resembles the behavior of patent trolls.[124] An entity that others perceive as a patent troll will appear much less sympathetic, and cooperation and compromise might be more difficult to come by. This perception is thus something that universities and their TTOs should take great care to avoid.

V. RESTRUCTURING TECHNOLOGY TRANSFER ACTIVITIES

The primary focus of this essay is on evaluating, understanding, and refocusing the overall efforts of university TTOs. The Bayh-Dole Act was passed with a goal of promoting commercialization of government-funded inventions, but several scholars have expressed concern that university TTOs are focused more on revenue generation than on commercializing inventions. As discussed in Part III and the Appendix, the AUTM data and empirical analysis certainly support this conclusion.[125]

There are several ways to structure a TTO, and many ways to engage in technology transfer to promote the commercialization of university inventions, but sources indicate that TTOs may not currently be taking full advantage of the variety of tools available. Robert Litan and his colleagues suggest that university TTOs should shift away from the current "revenue maximizing" model of TTO operations and move toward a "value maximizing model."[126] The body of research indicates that TTOs would be

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123. Jeremiah S. Helm, Comment, *Why Pharmaceutical Firms Support Patent Trolls: The Disparate Impact of* eBay v. MercExchange *on Innovation*, 13 MICH. TELECOMM. & TECH. L. REV. 331, 335 (2006) (differentiating universities from "patent trolls" because universities are active innovators).

124. The term patent troll derives from the behavior of some entities in surprising researchers or marketers with a patent and demanding that the infringer purchase a license. *See* Lemley, *supra* note 19, at 613 n.2. Some individuals in various industries view universities as patent trolls in this regard, especially when universities attempt to patent everything regardless of what it is. One critic goes so far as to call universities "'crack addicts'" that are dependent on licensing revenue. *See id.* at 615, 622–24 (quoting Chuck Fish, Comments at the Fordham Annual Conference on International Intellectual Property Law and Policy (Apr. 22, 2006)).

125. *See supra* note 61; Part III.B (noting the views of several scholars concerning TTOs and revenue generation).

126. Litan et al., *supra* note 7, at 13–15. The Litan study points out four potential value-maximizing models: free agency (allow the inventors to shop around for a different TTO); regional alliances; Internet-based approaches (for example, using a website like iBridge Network, http://www.ibridgenetwork.com (last visited Mar. 24, 2009)); and allowing faculty to retain title to their inventions and hoping that successful faculty occasionally donate to the university. *Id.* The authors appear to suggest that the latter would be the best model for TTOs to follow. *Id.*

more effective if each TTO adapted its activities to the different demands of various academic disciplines and/or technology sectors. If a TTO decides to patent a given technology, the office has several choices concerning how to license the patent: Should the patent be licensed exclusively, or nonexclusively? If exclusive licensing is desired, should the licensing be exclusive across all fields, should the exclusive license only apply to one field, or should there perhaps be a time limit concerning exclusivity?

A. *Decentralized or Centralized*

TTOs can be structured in a variety of ways—the two primary approaches are a centralized model and a decentralized model. One approach that scholars have suggested using to adjust TTO activities to the environment is to restructure the TTO in a decentralized manner.[127] A decentralized office would likely make it easier to treat different disciplines in different ways. This would probably solve the aforementioned problem of TTOs treating all academic fields in the same way, since each TTO department would possess expertise in the most effective methods of carrying out technology transfer in the given academic discipline or technological field.

One concern arising from the centralized versus decentralized question pertains to staffing. Some scholars have examined TTOs and concluded that TTOs struggle because the offices are not staffed adequately.[128] A decentralized office might be more expensive to staff if the university were to make efforts to hire individuals with expertise in the various specific academic areas. However, staffing a decentralized office with individuals with experience in the focal areas would likely pay for itself over time since the office would engage in fewer wasted efforts based on lack of understanding of the academic specialty.

B. *Decision Making Based on an Area of Technology*

A majority of scholarly articles in this area examine university patenting in the context of the life sciences, especially biotechnology and

127. *See id.* at 11 (stating that using a single, central office would not optimize commercialization); *see also* Kristen Osenga, *Rembrandts in the Research Lab: Why Universities Should Take a Lesson from Big Business to Increase Innovation*, 59 ME. L. REV. 407, 419–20 (2007). TTOs on campuses could be structured using a decentralized model, where different academic disciplines would be handled by their own technology transfer teams, or by using a centralized model, where one technology transfer team would handle all of the tech transfer across the entire university. As Kristin Osenga indicates in her article, universities might also elect to have their TTO tasks handled by outside entities. *Id.* Most scholars who discuss these models do not use the terms "centralized" and "decentralized," but several express concern with the concept of the centralized model. *But see* Rochelle Cooper Dreyfuss, *Collaborative Research: Conflicts on Authorship, Ownership, and Accountability*, 53 VAND. L. REV. 1161, 1229 (2000) (noting that university TTOs can act as middlemen to help collaboration efforts between different university areas, indicating a potential strength of the centralized TTO).

128. *See* de Larena, *supra* note 44, at 1412; Osenga, *supra* note 127, at 433–34.

biopharmaceuticals.[129] This is in part because the life sciences account for a substantial amount of the patenting done by universities,[130] which might be attributed to the nature of the fields within the life sciences. For example, the investment required to develop a compound in the pharmaceutical industry is very high,[131] but a whole finished pharmaceutical product might contain just a single patented compound and have the potential for a large amount of revenue.[132] This results in a huge potential value for one exclusively licensed biopharmaceutical patent if that patent eventually leads to development of a new "blockbuster" drug.[133]

In other disciplines, however, the same pattern does not hold true. In the engineering fields, for example, a single patent may be vital to a finished product, while only being one of many such patents required. Therefore, the comparative value of each individual patent is consequently much lower.[134] Furthermore, in an empirical study, Ajay Agrawal and Rebecca Henderson examined patterns of patenting and publishing in two engineering-related departments at MIT and found that patenting was typically not as important as publication in transferring knowledge from the university to the public.[135] With the exception of biotechnology, pharmaceuticals, and possibly nanotechnology (though this has not been determined conclusively, since the field is still very new), most industries do not view patents as being important for technology transfer.[136] It is also widely accepted that different industries rely on patents to different degrees to appropriate benefits from the marketplace for their innovation. For these reasons, a TTO should base its evaluation of research results (patent or do

129. *See, e.g.*, Dueker, *supra* note 9; Golden, *supra* note 37; Christopher M. Holman, *Biotechnology's Prescription for Patent Reform*, 5 J. MARSHALL REV. INTELL. PROP. L. 318 (2006); Pulsinelli, *supra* note 39; *see also* COGR GUIDE, *supra* note 3, at 8 (describing the social importance of Bayh-Dole by citing an AUTM survey that found that 70% of the active licenses of respondent universities were in the life sciences). *But see* Lemley, *supra* note 31; Sabety, *supra* note 7.

130. *See* Powell & Owen-Smith, *supra* note 34, at 259–60 (noting that, from 1989–1994, the three most common classes of inventions for which universities pursued patents were in the life sciences field).

131. *See* CONGRESSIONAL BUDGET OFFICE, RESEARCH AND DEVELOPMENT IN THE PHARMACEUTICAL INDUSTRY 19–20 (2006), *available at* http://www.cbo.gov/ftpdocs/76xx/doc7615/10-02-DrugR-D.pdf.

132. *See* de Larena, *supra* note 44, at 1432–33 (noting that pharmaceuticals tend to be big winners in technology transfer, and also that they are the biggest investment risks).

133. *Id.*

134. *Id.*

135. Ajay Agrawal & Rebecca Henderson, *Putting Patents in Context: Exploring Knowledge Transfer from MIT*, 48 MGMT. SCI. 44, 59 (2002). The two departments were the Department of Mechanical Engineering and the Department of Electrical Engineering and Computer Science. *Id.* at 45.

136. *See* SCHACHT, *supra* note 42, at 3–4; Sampat & Nelson, *supra* note 13, at 32. Wendy Schacht notes that the importance of patents varies across different industries, and that an industry's view of the importance of patents depends on the monetary and time costs associated with duplicating the fruits of labor in the industry. Patents, she continues, are valued more highly by industries with low duplication costs. SCHACHT, *supra* note 42, at 3–4.

not patent, nonexclusive or exclusive, etc.) at least in part on the technological field.[137]

One of the lessons that the Research Corporation learned the hard way was that the methods used for licensing patents in one academic discipline do not necessarily work as well in other academic disciplines.[138] The Research Corporation's techniques for patenting and licensing in all areas were the same methods they successfully used in patenting and licensing in the life sciences, but these methods did not translate as well into areas like electrical engineering.[139] Thus, even though the majority of "successful" patents granted to universities are in the life sciences area,[140] technology transfer activities will remain predominately unsuccessful if university TTOs treat all academic areas as if commercialization can best be accomplished using the same methods as those that succeed in the life sciences.

Apart from considerations pertaining to the general research area, the specific stage of development is also important. Research results that are further away from ultimate commercial usage are commonly referred to as upstream inventions. Many scholars have examined whether TTOs should patent "upstream" inventions, and several scholars tend to favor nonexclusive licenses for upstream technology.[141] Other scholars,

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137. MOWERY ET AL., *supra* note 8, at 190–91 (instructing TTOs to adjust their IP policies to accommodate differences among various areas instead of treating research in all areas just like biomedical research).

138. *Id.* at 69 (looking at the history of the Research Corporation and concluding that expertise in the patenting/licensing process of one area did not translate to comparable strength in other areas); *see also* Lemley, *supra* note 19, at 611–12 (urging that the goal of TTOs should be maximizing the social impact of technology instead of profiting from licensing, and, thus, patenting should be conducted based on however the most positive effect will be realized); Sabety, *supra* note 7, at 513–14 (noting that wide exclusive patenting works well in the pharmaceutical area, but not as well when the patent is just one of many patents comprising a cumulative technology required for the finished product).

139. *See* MOWERY ET AL., *supra* note 8, at 69.

140. GAO, TECH TRANSFER, *supra* note 38, at 19 (noting in 1998 that visits to ten major universities revealed that the more "marketable" technologies tended to be in the life sciences and that a 1996 AUTM survey revealed that 80.2% of the technology licensing revenues of survey respondents came from inventions in the life sciences).

141. Lemley, *supra* note 19, at 617–18 (suggesting that "enabling technologies" be licensed nonexclusively to allow room for improvement); Pulsinelli, *supra* note 39, at 412 (warning that exclusive licenses on patents of basic discoveries or tools can interfere with scientific progress); Sabety, *supra* note 7, at 508–09 (encouraging nonexclusive licenses for foundational intellectual property in the nanotechnology area). *But see* MOWERY ET AL., *supra* note 8, at 8 (discouraging the patenting of research tools); Golden, *supra* note 37, at 177 (noting that there is evidence indicating that patents on research materials impede downstream development); Rai, *supra* note 43, at 112, 136–44 (noting that MIT has a presumption against patenting upstream products and providing a balancing test for whether patenting would be desirable: if (transaction costs) + (creativity costs) < (invention costs) + (pure development costs), then patent protection is probably desirable); McManis & Noh, *supra* note 4, at 46–47 (citing a recent article that characterized biotechnology science research results as an "'uncongested common resource'" (quoting David A. Adelman, *A Fallacy of the Commons in Biotech Patent Policy*, 20 BERKELEY TECH. L.J. 985, 986 (2005)); Brody, *supra* note 8 (stating that nonexclusive licenses with reasonable fees to cover the cost of research would be a fair and equitable proposal, but that such a scheme

however, deny that patenting upstream technology causes any problem at all.[142] This debate is fueled in part by seemingly conflicting results from two studies, one from 1998 and one from 2003, that came to considerably different conclusions concerning whether patents on upstream research frustrated research attempts further downstream.[143] Charles McManis and Sucheol Noh, however, strongly criticize both studies, suggesting that the studies used unreliable methods to measure the level of harm to subsequent research.[144]

VI. ADDITIONAL TECHNOLOGY TRANSFER METHODS

One of the current weaknesses of university TTOs is that some offices may treat exclusive licensing of patents as being the cornerstone of technology transfer.[145] In fact, there are several technology transfer methods, apart from patents, some of which might be more effective for commercialization than patenting in certain situations.[146] One of the issues that TTOs regularly face is that faculty researchers may not always disclose their research to the TTO. Instead, these faculty members might use

might provide "greater benefit to large companies rather than small ones"). *See generally* Xavier Becerra, Talking Points, The Genomic Research and Accessibility Act (H.R. 977) (n.d.), *available at* http://becerra.house.gov/NR/rdonlyres/556A7E45-4762-42EC-807C-7248F70E8787/0/TalkingPoints.pdf (last visited Mar. 19, 2009) (listing harmful effects on downstream research caused by patenting of genes); Dreyfuss, *supra* note 46, at 464 (referring to TTOs as "the academic equivalent of [universities'] football teams" and explaining that profit margins give TTOs incentives to seek patent protection for all university inventions, including upstream developments).

142. *See* RIVETTE & KLINE, *supra* note 117, at 22–25 (stating that granting patent rights to knowledge assets does not stifle innovation and is in fact a very effective way of "promoting innovation, knowledge sharing, and economic growth"); Holman, *supra* note 129, at 330 (noting that material transfer agreements are more likely to impede research than patents on upstream developments); *see also* McManis & Noh, *supra* note 4, at 24 (citing studies showing that few researchers had experienced delays caused by patents, but that a considerable portion of researchers had experienced delays due to material transfer agreements).

143. McManis & Noh, *supra* note 4, at 31–32.

144. *Id.*

145. *See, e.g.*, Dueker, *supra* note 9, at 497. *But see* ASS'N UNIV. TECH. MANAGERS, AUTM U.S. LICENSING ACTIVITY SURVEY: FY 2006, at 32 (2007) [hereinafter AUTM SURVEY], *available at* http://www.autm.net/AM/Template.cfm?Section=FY_2006_Licensing_Activity_Survey&Template=/CM/ContentDisplay.cfm&ContentID=1804 (showing that, as of fiscal year 2006, 61% of the licenses executed by U.S. universities were nonexclusive licenses).

146. *See* MOWERY ET AL., *supra* note 8, at 190. Another reason why TTOs should consider alternatives to patenting stems from sociological considerations, since at least one empirical study notes that universities with higher prestige have licensed more of their research findings than less prestigious universities. Wesley David Sine, Scott Shane & Dante Di Gregorio, *The Halo Effect and Technology Licensing: The Influence of Institutional Prestige on the Licensing of University Inventions*, 49 MGMT. SCI. 478, 494–95 (2003). Wesley David Sine and his colleagues conclude that technology transfer is facilitated by the prestige of the university, and not merely by the quality of the technology being developed. *Id.* at 495.

informal technology transfer methods on their own.[147] Interactions with directors of TTOs led Richard Jensen, Jerry Thursby, and Marie Thursby to the conclusion that higher-quality faculty members are actually more likely not to disclose their findings to the TTO at all.[148] Three informal technology transfer methods include working directly with industry personnel to commercialize technology, coauthoring publications with industry personnel, and serving as paid consultants to private firms.[149] Albert Link, Donald Siegel, and Barry Bozeman explored the participation of faculty researchers in informal technology transfer.[150] Their results indicated that male, tenured faculty members who spend a lot of time on grant-related research are more likely to engage in all three of the above methods of informal technology transfer.[151] The authors suggest that the TTOs of universities should reach out to accomplished faculty members and encourage them to use formal technology transfer methods, perhaps by changing the incentive structures.[152] An empirical study by Siegel, David Waldman, and Link suggests that promotion and tenure policies, as well as a university's policy for distributing royalties and equity, are important factors in determining whether faculty members will disclose their inventions.[153]

A. *Nonpatent Methods: Informal Interactions, Publishing, and Start-Ups*

In addition to patenting, technology transfer occurs in many different ways, including sponsored research, publication in research journals, the creation of start-up companies, and relationships (professional or informal) between inventors and industry representatives.[154] This essay includes

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147. Albert N. Link, Donald S. Siegel & Barry Bozeman, *An Empirical Analysis of the Propensity of Academics to Engage in Informal University Technology Transfer*, 16 INDUS. & CORP. CHANGE 641, 642 (2007).

148. Richard A. Jensen, Jerry G. Thursby & Marie C. Thursby, *Disclosure and Licensing of University Inventions: 'The Best We Can Do with the S**t We Get to Work With,'* 21 INT'L J. INDUS. ORG. 1271, 1272 (2003); *see also* Stuart D. Allen, Albert N. Link, & Dan T. Rosenbaum, *Entrepreneurship and Human Capital: Evidence of Patenting Activity from the Academic Sector*, 31 ENTREPRENEURSHIP THEORY & PRAC. 937, 943–48 (2007) (examining the results of an empirical study that found that tenured, older, white, or Asian male faculty members were more likely to seek patents, but not necessarily through the university TTO). The inclination of faculty members toward more entrepreneurial activities may be related to the extent to which a university department emphasizes entrepreneurial activities. Martin Kenney & W. Richard Goe, *The Role of Social Embeddedness in Professorial Entrepreneurship: A Comparison of Electrical Engineering and Computer Science at UC Berkeley and Stanford*, 33 RES. POL'Y 691, 704 (2004).

149. Link et al., *supra* note 147, at 647.

150. *See generally id.*

151. *Id.* at 651.

152. *Id.* at 652–53.

153. Donald S. Siegel, David Waldman & Albert Link, *Assessing the Impact of Organizational Practices on the Relative Productivity of University Technology Transfer Offices: An Exploratory Study*, 32 RES. POL'Y 27, 44–45 (2003).

154. *See* MOWERY ET AL., *supra* note 8, at 33; de Larena, *supra* note 44, at 1413–14 (noting that "the inventor is typically the best link to potential licensees," so TTOs should focus on forming relationships and not just promoting licenses); Powell & Owen-Smith,

start-up companies in the technology transfer category even though start-up firms may be supported by a corresponding patent application because start-up firms are often founded and run by the faculty inventor or postdoctoral associates. Thus, the start-up firm performs much of the initial development to make the technology more economically desirable to companies that ultimately may market the technology as a new product.[155] Additionally, start-up firms may obtain a license for patented technology through alternative means, other than by paying royalties and licensing fees—such as by providing the university with an equity interest in the start-up firm.[156] Not only are start-up firms an effective method of commercializing technology, but supporting start-up firms also furthers one of the central purposes of the Bayh-Dole Act by giving preference to small businesses when seeking to develop federally funded inventions.[157]

Since start-up companies serve an important role in the commercialization of university research results, it might be expected that a considerable amount of university technology licensing would be to start-up firms. However, the most recent data from the AUTM indicate that only approximately 15% of the licenses executed in fiscal year 2006 were to start-up firms.[158] This observation is entirely consistent with the data and empirical analysis presented in Part III and the Appendix. It also leads to a question of how involvement in start-up firms may be increased. Dante Di Gregorio and Scott Shane conducted an empirical study concerning start-up companies and found that two university policies were correlated with increased start-up formation: paying to inventors a lower share of royalties

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supra note 34, at 258 (noting that patents may not be the best way of handling intellectual property in cutting edge fields and suggesting research parks and the acceptance of equity in start-up companies as better alternatives); Strandburg, *supra* note 86, at 114–16; Litan et al., *supra* note 7, at 8–9; Capart & Sandelin, *supra* note 61 (urging TTOs to focus on a variety of methods of technology transfer apart from patenting, "including business development, coaching, incubator facilities, seed capital funds, science parks, etc."); *see also* RIVETTE & KLINE, *supra* note 117, at 36 (quoting Henry Garrana, Vice President of Legal and Intellectual Property for Dell, as saying that a successful IP program requires that the holder "focus on the things that you do that bring real value to the market").

155. *See* Litan et al., *supra* note 7, at 9–10 (describing university "spin-offs" as small firms that emerge as a result of attempts to commercialize an early stage of university invention). Litan and his colleagues acknowledge that only 3376 of these spin-off companies were created between 1980 and 2000, but that these spin-offs are disproportionately high-performing companies—68% of the spin-offs created during that period were still operational in 2001, and 8% of spin-off companies eventually went public. Eight percent is a much higher percentage than that for U.S. enterprises generally. *Id.*

156. *See* GAO, TECH TRANSFER, *supra* note 38, at 13 (expressing concerns, however, that relationships with start-up companies might interfere with the university's mission by creating conflicts of interest by shifting the focus to making money instead of research); de Larena, *supra* note 44, at 1416. *See generally* Maryann Feldman et al., *Equity and the Technology Transfer Strategies of American Research Universities*, 48 MGMT. SCI. 105 (2002) (using empirical methods to examine the increasing acceptance of equity in lieu of licensing fees by university TTOs).

157. Gulbrandsen, *supra* note 15, at 1154 (also noting that in many situations, start-up companies may be the only way to commercialize an invention).

158. AUTM SURVEY, *supra* note 145, at 31.

and allowing the university to accept equity from a firm in lieu of traditional reimbursement for the costs of licensing and patenting.[159]

Even in an area as patent-heavy as pharmaceuticals, university researchers who form start-up firms may have difficulty securing funding from venture capitalists because of the uncertainty in the drug development area.[160] The difficulty of commercializing early-stage pharmaceutical developments led to the formation of PharmaSTART in 2003, which states as one of its objectives the intention "to facilitate development and translation of drug[s] from within Universities and Medical Centers into industry."[161]

When it comes to taking more active roles in the commercialization process with start-up firms, TTOs generally have a few models that they can adopt. Some may take a hands-off approach, others may take a more hands-on approach, and still others may take an "in-up-to-the-elbows" approach.[162] Depending on the approach taken, a university TTO that wishes to increase start-up formation may face a seemingly paradoxical trade-off, since at least one empirical study has found that start-up formation is more common at universities that provide a low share of royalties to inventors.[163] However, another empirical study has found that there is a generally held belief that faculty are not adequately rewarded for participating in technology transfer activities, and, thus, faculty may be less likely to disclose their inventions in the absence of higher royalty rates.[164]

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159. Dante Di Gregorio & Scott Shane, *Why Do Some Universities Generate More Start-Ups than Others?*, 32 RES. POL'Y 209, 222 (2003). One other factor found to correlate positively with the creation of start-up firms was the university's level of academic prestige. *Id.* However, university TTOs potentially have more of an ability to control the two policy factors cited above—inventors receiving less royalties and universities' acceptance of equity.

160. Andrew Pollack, *Three Universities Join Researcher to Develop Drugs*, N.Y. TIMES, July 31, 2003, at C1 (providing information on the formation of PharmaSTART through the collaboration of Stanford University, the University of California at San Diego, the University of California at San Francisco, and SRI International, a nonprofit research institute).

161. *Id.*; PharmaSTART, http://www.pharmastart.org/ (last visited Mar. 24, 2009). PharmaSTART's website now lists the University of California, Berkeley and the Institute for Quantitative Biomedical Research among its participating institutions, in addition to SRI International, Stanford University, University of California, San Diego, and University of California, San Francisco.

162. Almut von Biedermann, U.S. Excellence in New Venture Creation: What Technology Transfer Means in the Early 21st Century 3–4 (2004) (unpublished manuscript), *available at* http://www.publicforuminstitute.org/nde/sources/New%20Venture%20Creation%20-%2021Century%20Tech%20Transfer_A.vB1204.pdf. In a hands-off model, the licensing professionals view the formation of the start-up as just another licensing deal. In a hands-on model, the licensing professionals would help form the business plan for the start-up and possibly also help secure funding. A licensing office following an "in-up-to the-elbows" approach would play a more entrepreneurial role, writing the business plan, recruiting management, and securing funding for the start-up from an early stage. The latter model is the model used at Yale University, and it has been very successful at that institution. *Id.*

163. Di Gregorio & Shane, *supra* note 159, at 213.

164. Siegel et al., *supra* note 153, at 42–43.

The stage at which the TTO gets involved could have an impact on the TTO's success. For instance, Jensen and his colleagues found that the higher-quality faculty tended to disclose more inventions at the proof of concept stage, but that "universities with greater net income have a smaller proportion of disclosures licensed in the proof of concept stage," perhaps due to TTOs discouraging the disclosure of early-stage inventions.[165] Recently, some universities have adopted another method of assisting in the commercialization of early-stage developments: establishment of proof of concept centers.[166] Proof of concept centers are designed to facilitate "the spillover and commercialization of university research," providing funding for early stage developments that might be too upstream to receive financial backing from angel investors and venture capitalists.[167]

Proof of concept centers are a developing system, but many of the alternative methods for technology transfer have been used in universities for many decades. For instance, industries have provided support for university research through sponsored research for a long time.[168] The popular colloquialism "publish or perish" captures the long-standing importance of publication within academia as a method of promoting the open sharing of scientific data.[169] Examination of the options shows that instead of defaulting to the pursuit of patents, university TTOs may better serve the purpose of commercialization of university inventions if the TTOs focus equally on engaging in other methods of technology transfer.

B. *Exclusive or Nonexclusive Licenses*

Even when a patent is pursued, there are a variety of ways that TTOs can approach patenting and licensing to optimize commercialization of inventions. As explored in Part V.B, this decision is greatly influenced by

165. Jensen et al., *supra* note 148, at 1273–74.

166. Christine A. Gulbranson & David B. Audretsch, Proof of Concept Centers: Accelerating the Commercialization of University Innovation 4 (Jan. 2008) (unpublished manuscript), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1090575.

167. *Id.*; *see also* Litan et al., *supra* note 7, at 9–10 (noting that universities may need to play a larger role in nurturing early-stage start-ups due to venture capitalists' preference toward funding technology that is closer to commercialization).

168. *See* Maryann Feldman & Pierre Desrochers, *Research Universities and Local Economic Development: Lessons from the History of the Johns Hopkins University*, 10 INDUSTRY & INNOVATION 5 (2003) (noting that medical research at Johns Hopkins University was predominantly privately funded until the government became more active in university research following World War II).

169. *See* Bagley, *supra* note 43, at 218 (referring to the communal norms that promote the importance of publishing in order to promote the open sharing of scientific data); *see also* Eisenberg, *supra* note 102, at 1364 (listing the freedom to publish as being one of the core freedoms in the idea of "academic freedom"). Publishing, however, can have a negative impact on future attempts at patenting if the publication occurs long enough before the patent application such that it qualifies as prior art. *See In re* Klopfenstein, 380 F.3d 1345, 1352 (Fed. Cir. 2004) (finding that slides accompanying a poster presentation at a conference amounted to a "printed publication" of the research findings for purpose of prior art); *see also* de Larena, *supra* note 44, at 1401 (noting that faculty members are sometimes pressured to file provisional patent applications prior to publication of research results).

the area of study. In some disciplines, licensing a patent exclusively may yield optimal results; in others, nonexclusive licensing would prove most effective; still others may best be commercialized by not patenting at all and relying on any number of the above discussed methods of technology transfer to commercialize the development.[170]

Nonexclusive licensing may be desirable when the technology at issue is an upstream development or a ground-breaking innovation in a particular area since, in those circumstances, the greatest benefit will likely be found by licensing the technology to many developers.[171] An exclusive license, on the other hand, may be the best choice when the technology at issue is something that would require a large investment to develop its marketable potential.[172] Under such conditions, an exclusive license would assure the investors that they could devote time and money to development without having to worry that a free-riding competitor could swoop in at the last minute and take their market share before they could recoup their significant research and development investment through sales.[173] One area where exclusive licensing may be the most effective means of commercializing a development is in pharmaceuticals, where it can take over a decade and cost in the hundreds of millions of dollars to develop a final product.[174] Exclusive licenses do not necessarily result in higher

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170. *See* MOWERY ET AL., *supra* note 8, at 176–78 (reviewing an analysis of case studies that indicated that patenting is not necessary to obtain value from research tools and is not likely to help with electronics); Lemley, *supra* note 19, at 612 (noting additional possible limits on exclusivity, such as field-specific exclusivity, exclusivity for a limited term, and exclusivity that only applies to commercial sales); *see also id.* at 627 (suggesting that exclusive patents would not be appropriate in nanotechnology due to the many industries where the same nanotechnology products may be used); Powell & Owen-Smith, *supra* note 34, at 260 (listing three motivations underlying university licensing of research results: a desire to increase research in an area with limited commercial value, where broad licensing is desirable; a focus on entrepreneurial motivations that would lead to exclusive licenses being granted to a start-up company; and use of the discoveries as magnets to draw more industry-sponsored research). *But see* Dueker, *supra* note 9, at 497 (concluding that "nonexclusive licenses are viable only when inventions are revolutionary or broadly-enabling"); Strandburg, *supra* note 86, at 112–13 (suggesting that exclusive patent rights play a positive role in the commercialization of the results of curiosity-driven research).

171. *See* Mireles, *supra* note 96, at 536 (suggesting that universities should choose to grant exclusive licenses only when an exclusive license is "necessary to secure funding for commercialization"). *But see* Dueker, *supra* note 9, at 497 (referring to nonexclusive licenses as the exception, viable only with inventions that are pioneering or broadly enabling).

172. *See* Mireles, *supra* note 96, at 536.

173. Aaron Miller, *Repairing the Bayh-Dole Act: A Proposal for Restoring Non-Profit Access to University Science*, 2005 B.C. INTELL. PROP. & TECH. F. 093001, http://www.bc.edu/bc_org/avp/law/st_org/iptf/articles/index.html.

174. CONGRESSIONAL BUDGET OFFICE, *supra* note 131, at 19–21; U.S. Food & Drug Admin., New Drug Development Timeline (n.d.), *available at* http://www.fda.gov/fdac/graphics/newdrugspecial/drugchart.pdf; Simone A. Rose, *On Purple Pills, Stem Cells, and Other Market Failures: A Case for a Limited Compulsory Licensing Scheme for Patent Property*, 48 HOW. L.J. 579, 601 (2005) (estimating that it costs between $100 and $500 million to develop and market a single drug); Robert F. Service, *Surviving the Blockbuster Syndrome*, 303 SCIENCE 1796 (2004) (noting that clinical research alone during the development of a new biopharmaceutical product now takes approximately seventy-five

revenues, as evidenced by a case study of patenting activity at Columbia University, Stanford University, and the University of California. The study revealed that the patents that accounted for the largest shares of the licensing revenues at their respective institutions were licensed widely on a nonexclusive basis.[175]

Even if the most effective means of commercializing is to grant an exclusive license, TTOs must still decide what type of exclusive license to grant. A purely exclusive license would exclude potential developers in all fields from licensing the patented item. A field-exclusive license, on the other hand, would not prevent entities in other fields from obtaining a license. A field-exclusive license might be most effective in an area like nanotechnology, where the building blocks of the discipline may be used in research and development across many different fields.[176] There are several other variations on exclusive licensing that have been used over the years, such as exclusivity that does not bar potential developers from developing the technology for use in developing countries, or license agreements that provide a specific time frame for exclusivity.[177]

C. *Royalty-Free Licensing*

One of the considerations in licensing a patent is the amount of royalties that will be charged. A typical model would reserve the first cut of royalties to the university as compensation for the costs of patenting, with later royalty amounts being distributed between the inventor, the TTO, and other departments of the university.[178] Some scholars have examined the

months); PhRMA, Innovation, http://www.phrma.org/innovation/ (last visited Mar. 24, 2009) (explaining that obtaining approval for a new drug takes an average of fifteen years of research and development and costs more than $800 million).

175. David C. Mowery et al., *The Growth of Patenting and Licensing by U.S. Universities: An Assessment of the Effects of the Bayh-Dole Act of 1980*, 30 RES. POL'Y 100, 115 (2001). Most of the licenses executed by the universities in this study were exclusive licenses, but the highest licensing revenue came from the Cohen-Boyer patents (licensed nonexclusively by Stanford and University of California) and Richard Axel's cotransformation patent (licensed nonexclusively by Columbia University). MOWERY ET AL., *supra* note 8, at 155–58; Mowery et al., *supra*, at 115.

176. *See* Lemley, *supra* note 31, at 623–24.

177. *See* Lemley, *supra* note 19, at 612 (listing the options of field-specific exclusivity, exclusivity for limited terms, or exclusivity that is limited to commercial sales); *see also* Amy Kapczynski et al., *Addressing Global Health Inequities: An Open Licensing Approach for University Innovations*, 20 BERKELEY TECH. L.J. 1031, 1075–76 (2005) (providing examples of universities that have made specific licensing choices in the interest of increasing the availability of treatments for neglected diseases in low- to middle-income countries).

178. *See* OFFICE OF TECH. TRANSFER, UNIV. OF CAL. OFFICE OF THE PRESIDENT, UC TECHNOLOGY TRANSFER ANNUAL REPORT 2007, at 10, 12 (2007), *available at* http://www.ucop.edu/ott/genresources/documents/OTTRptFY07.pdf (listing the different components of royalties and licensing fees at the University of California, which reported $97.6 million in revenue from license fees and royalties in fiscal year 2007); Liebeskind, *supra* note 7. *See generally* Stanford University Office of Technology Licensing, Exclusive Agreement 4 (n.d.) (unpublished sample agreement), *available at* http://otl.stanford.edu/industry/resources/exclusive.pdf (providing the format of the contract segments pertaining to

possibilities of royalty-free licenses,[179] but the current body of research does not indicate that many scholars have considered the possibility of compensation through alternatives to monetary royalties, except in the context of accepting equity in lieu of money for university-based start-up companies.[180]

Commonly, royalty-free licenses are addressed in scholarly literature within the context of antitrust remedies.[181] If a patent holder behaves highly anticompetitively, the enforcement agency may evaluate the situation and determine that the negative effects of this behavior could be cured by forcing the patent holder to grant royalty-free licenses to anyone who requests such a license.[182] In practice, however, compulsory licenses with reasonable royalties are typically viewed as more appropriate as antitrust remedies than compulsory royalty-free licenses.[183]

Scholars who have examined the nonpunitive potential for royalty-free licenses (as they concern universities) have typically done so in the context of granting such licenses to universities, often while examining the possibility of an invigorated experimental use defense in patent law, or

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royalties); Wisconsin Alumni Research Foundation, Standard Non-exclusive License Agreement 2–3 (n.d.) (unpublished sample agreement), *available at* http://www.warf.org/uploads/media/20031002132027680_Std_non_exclusive_license_agrmt.pdf (providing the format of the contract segments pertaining to consideration, including license fees and royalties).

179. *See* Dreyfuss, *supra* note 46, at 470 (urging the creation of an invigorated experimental use defense similar to fair use in copyright law in order to protect university researchers from patent infringement suits). *But see* Lorelei Ritchie de Larena, *What Copyright Teaches Patent Law About "Fair Use" and Why Universities Are Ignoring the Lesson*, 84 OR. L. REV. 779, 814 (2005) (suggesting that reasonable royalties may be better for a fair use equivalent in patent law instead of royalty-free licenses); Garde, *supra* note 6, at 271–72 (suggesting "licenses of right" for patented research tools instead of royalty-free licenses); Jensen & Thursby, *supra* note 62, at 249–50 (presenting a theorem that royalties increase the effort expended by inventors and thus implying that a royalty-free scenario would result in less effort by an inventor than if the inventor were receiving royalties).

180. *See* GAO, TECH TRANSFER, *supra* note 38; de Larena, *supra* note 44, at 1416 (noting that some university TTOs may accept equity in lieu of cash for licensing); Capart & Sandelin, *supra* note 61 (describing Stanford's policy of handling industry-sponsored research results by first offering the sponsor a nonexclusive royalty-free license, with royalties being required if exclusivity is desired).

181. HERBERT HOVENKAMP ET AL., IP AND ANTITRUST: AN ANALYSIS OF ANTITRUST PRINCIPLES APPLIED TO INTELLECTUAL PROPERTY LAW § 6.5(c) (2003); Barnett, *supra* note 37, at 1034 (noting that the FTC has recently applied a remedy of compulsory licensing as an approval condition for some biopharmaceutical mergers); Joseph A. Yosick, *Compulsory Patent Licensing for Efficient Use of Inventions*, 2001 U. ILL. L. REV. 1275, 1277; *see also* Shamnad Basheer, *Block Me Not: How "Essential" Are Patented Genes?*, 2005 U. ILL. J.L. TECH. & POL'Y 55, 76 (examining (inconclusively) the possibility of invoking the essential facilities doctrine as a means of preventing abuse of a dominant position by a patent holder).

182. Lawrence Schlam, *Compulsory Royalty Free Licensing as an Antitrust Remedy for Patent Fraud: Law, Policy and the Patent-Antitrust Interface Revisited*, 7 CORNELL J.L. & PUB. POL'Y 467, 470 (1998) (suggesting that compulsory, royalty-free licensing would be an appropriate remedy where patentees misused patent rights in restraint of trade).

183. *See generally* Hartford-Empire Co. v. United States, 323 U.S. 386, 415 (1945) (amending the district court's order of royalty-free licenses as a remedy to a grant of compulsory licenses with reasonable royalties).

suggesting a doctrine similar to the fair use defense in copyright law.[184] Some critics assert that royalty-free licenses are not consistent with the goals of patent law or the Bayh-Dole Act, and, thus, that royalty-free licenses should not be granted to universities.[185] These critics might, for example, agree with the idea that while the Bayh-Dole Act was not passed to raise revenue for universities, neither was it passed to help universities avoid expenses. Some critics of the idea of granting royalty-free licenses to universities have suggested, as an alternative, compulsory licenses with reasonable royalties.[186]

Examining patenting by universities carries with it an examination of royalties. When a patent is licensed exclusively, the licensee usually will pay costs that include the cost of patenting.[187] Royalties typically serve to compensate the patentee for the cost of development.[188] The first question that becomes apparent is why universities should require royalties at all if the scientists obtain funds from the government and from industry partners for the purpose of conducting research. The receipt of royalties by universities in exchange for patent licenses could be viewed as paying the universities twice for the same research—once ex ante and once ex post. Accordingly, it could be argued that it is in fact more consistent with patent law and the Bayh-Dole Act for universities to grant royalty-free licenses to the patents of its scientists' inventions.

The literature generally has not addressed royalty-free licenses in the context of using alternative methods of exchange in place of money royalties, but an example of such royalty-free licensing can be seen by

184. Dreyfuss, *supra* note 46, at 470; *see also* Pulsinelli, *supra* note 39, at 459 (suggesting a compulsory, royalty-free license to universities for patented inventions produced using government funds); Rose, *supra* note 174, at 617–18 (suggesting a royalty-free, fair use-like statute that would be limited to use in scenarios involving a national emergency or a health crisis, with some circumstances where royalty-based fair use would be appropriate as well).

185. Garde, *supra* note 6, at 276 (suggesting that compulsory royalty-free licenses are not consistent with the goals of patent law).

186. *See* de Larena, *supra* note 179, at 814 (suggesting that a fair use equivalent in patent law would likely work best if it included payment of royalties); Garde, *supra* note 6, at 279–81 (proposing that universities should have a "license of right" to use inventions developed using NIH funds to ensure continued access to patented research tools); Thai, *supra* note 81, at 391 (advocating allowing universities compulsory licenses with reach-through royalties for research tools, where reach-through royalties could be adapted to a university setting by basing the royalties on licensing revenue); *see also* Pulsinelli, *supra* note 39, at 451–53 (suggesting that firms could bundle necessary reagents together into a kit and then sell those kits with the royalty fees included in the price of the kit, allowing patentees "to recover costs from researchers without needing to sue or license them individually").

187. *See, e.g.*, The University of Iowa Research Foundation, FAQ, http://research.uiowa.edu/uirf/pages/universal/faq.html#faq_3 (last visited Mar. 24, 2009) (noting that when a technology is licensed from a patent held by the University of Iowa, the licensing agreement may include "an initial licensing fee, reimbursement of patenting costs, developmental and time-based milestone payments, and royalties based on sales of products related to the licensed technology").

188. Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991, 2044 (2007) (stating the importance of ensuring that patent royalties and orders granting reasonable royalties focus on compensation of patent holders).

examining start-up companies that grant equity in lieu of paying licensing fees or royalties.[189] In the context of start-up firms, for example, commercialization is accomplished by allowing the firm to use the patented research result and develop a marketable product. However, the start-up firm may not have the capital available to pay the considerable licensing fees and royalties, so the university might receive compensation for the efforts of its researchers through receipt of equity in the start-up firm.[190] Another possibility that has been touched on briefly is the possible use of "patent pools" in lieu of charging traditional royalties, where patents would be pooled together and made available for licensing by subscribers (quite possibly for lower rates than the licensees would otherwise have paid in the absence of membership in the pool).[191] One recent example of this sort of activity, though it is not referred to as a patent pool, is the Engineering Portfolio of Inventions for Commercialization (EPIC) program of the Stanford OTL.[192]

Royalty-free licenses may be viewed as curbing unjust enrichment by universities, but they also can be viewed as a means by which industry becomes unjustly enriched. Some critics may be concerned about whether a royalty-free license granted by a university on a government-funded invention would effectively constitute a handout from the government.

In fact, a royalty-free license is not a handout because university technology transfer agreements that involve royalty-free licenses typically involve cross-licensing, general research funding, or some other form of mutual exchange.[193] In short, despite some university TTOs' hesitancy to grant royalty-free licenses, such licenses can be an effective way to bring necessary resources to the university and to transfer innovation from universities to industry, and this option should be explored in much greater frequency in the future.

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189. *See* de Larena, *supra* note 44, at 1416.

190. *See* Feldman et al., *supra* note 156, at 106.

191. *See* Michael S. Mireles, *An Examination of Patents, Licensing, Research Tools, and the Tragedy of the Anticommons in Biotechnology Innovation*, 38 U. MICH. J.L REFORM 141, 230–31 (2004) (suggesting the creation of patent pools in the biotechnology sector); Pulsinelli, *supra* note 39, at 459 (suggesting that universities should have access to all government-funded inventions in a scenario that Gary Pulsinelli says would resemble a patent pool).

192. Industry representatives who subscribe to the Engineering Portfolio of Inventions for Commercialization (EPIC) program and who wish to license any of the technologies included in the portfolio can obtain a nonexclusive license for a technology by paying a one-time fee. Stanford University Office of Technology Licensing, EPIC Summary, http://stanfordtech.stanford.edu/4DCGI/epicsummary (last visited Mar. 24, 2009); *see also* J. Strother Moore, Model Language for Patent and Licensing Agreements for Industrially Sponsored University Research in Information Technology 5 (June 25, 2003) (unpublished manuscript), *available at* http://www.cs.utexas.edu/users/moore/publications/ip-memo-3.pdf (providing general information concerning the EPIC program and other computer science and engineering specific concerns about licensing of intellectual property).

193. *See, e.g.*, Mark A. Lemley, *Intellectual Property Rights and Standard-Setting Organizations*, 90 CAL. L. REV. 1889, 1949 (2002) ("Traditional IP licenses grant the right to use the IP in exchange for a royalty payment. But in many industries IP owners regularly cross-license huge stacks of patents on a royalty free basis.").

CONCLUSION

The evidence is overwhelming. University tech transfer activities continue to be predominantly patent-centric and revenue driven with a single-minded focus on licensing income and reimbursement for legal expenses. University technology transfer activities do not extend far beyond this narrow focus and entrepreneurship and commercialization activities and/or transferring innovation through other means do not figure prominently. In fact, university TTOs are simply not engaged in a broad range of activities that might successfully result in the transfer of university-originated innovation to many different sectors in society.

This essay urges universities to readily embrace alternative technology transfer methods—such as open collaborations, free participant use agreements, increased focus on commercialization activities, and royalty-free licensing—that would result in university innovations being adopted and disseminated throughout society. In order to embrace this comprehensive approach to transferring innovation, university TTOs need to substantively broaden their business models and restructure themselves within the university hierarchy so that the structural incentives that are implemented are compatible with a broader vision of technology transfer.

APPENDIX: FIGURES AND TABLES

This Appendix includes Figures 1–4 and Tables 1–12. Figure 1 shows the frequency histogram of the Performance Index for all years. Figure 2 illustrates the boxplot of the Performance Index in each year and all years, while Figure 3 illustrates the same for the top 20 universities. Figure 4 depicts the 20 universities with the largest average Performance Indexes over eight years.

Table 1 includes the summary of descriptive statistics of the independent and dependent variables for all years. Table 2 shows the descriptive statistics of the Performance Index for each year and all years. Table 9 shows the same for the top 20 universities.

Tables 3–8 and 10–12 include, respectively, linear regression summaries for the dependant variables "Performance Index"; "Performance Index," after removing the top and bottom 5% of performers for each year; "Licensing Income," in millions; "Running Royalties," in millions; "Reimbursed Legal Fees," in ten thousands; "Number of Start-Ups"; "U.S. Patents Issued"; "Total Patent Applications"; and "New Patent Applications." Tables 3–8 and 10–12 list the independent variables chosen by the stepwise model selection.

Multiple linear regressions and the stepwise model selection by Mallows' Cp criterion were performed to build up the best model for the dependent and independent variables shown in Table 1 for each year and also for all years.

The Mallows' Cp criterion is often used as a stopping rule for various forms of stepwise model selection. In multiple linear regressions, when too many predictor variables whose coefficients must be estimated have been included in a regression model, it is said to be an "over-fit." The C_P statistic can be used as a criterion to select a best reduced model to solve such problems. If P predictor variables are selected from a set of $K > P$, then C_P is defined as

$$Cp = \frac{RSSp}{\hat{\sigma}^2} + 2p - N$$

where RSS_P is the residual sum of squares for the model with P predictor variables; $\hat{\sigma}^2$ is the residual mean square after regression on the complete set of K predictor variables; N is the sample size; and

$$RSSp = \sum_{i=1}^{N} (Yi - \hat{Y}i)^2$$

in which $\hat{Y}i$ is the predicted value of the i'th observation of Y from the P predictor variables. Yi is the observed value of i'th observation of Y.

Figure 1: The Frequency Histogram of the Performance Index

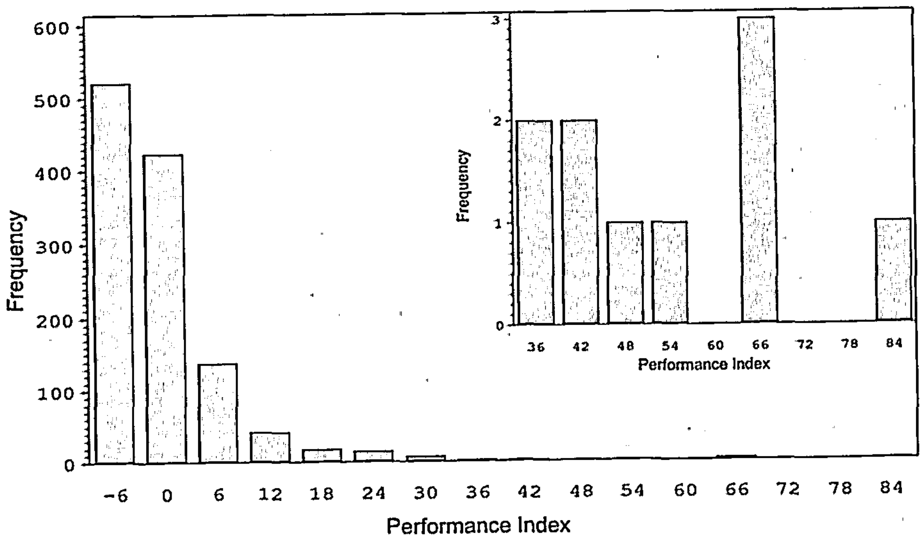
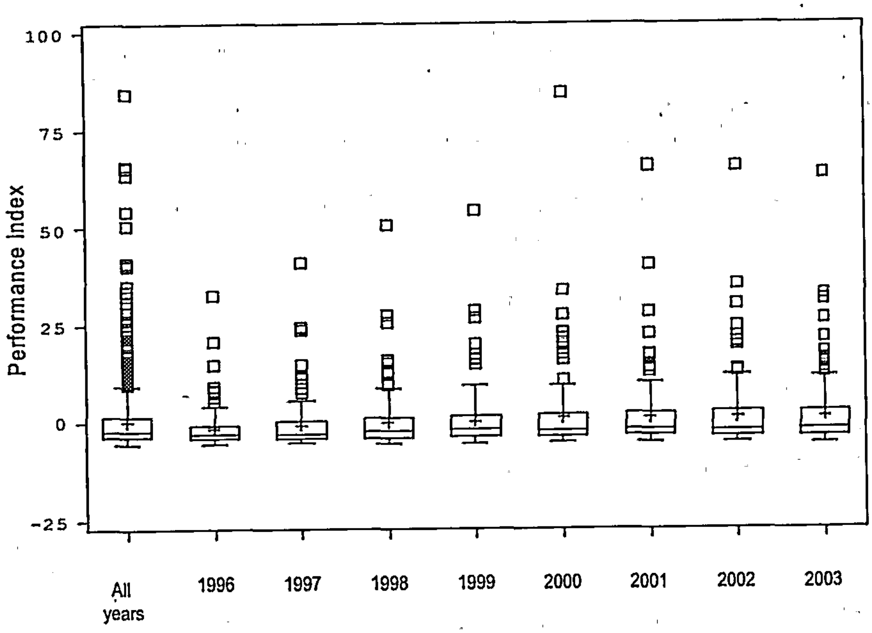
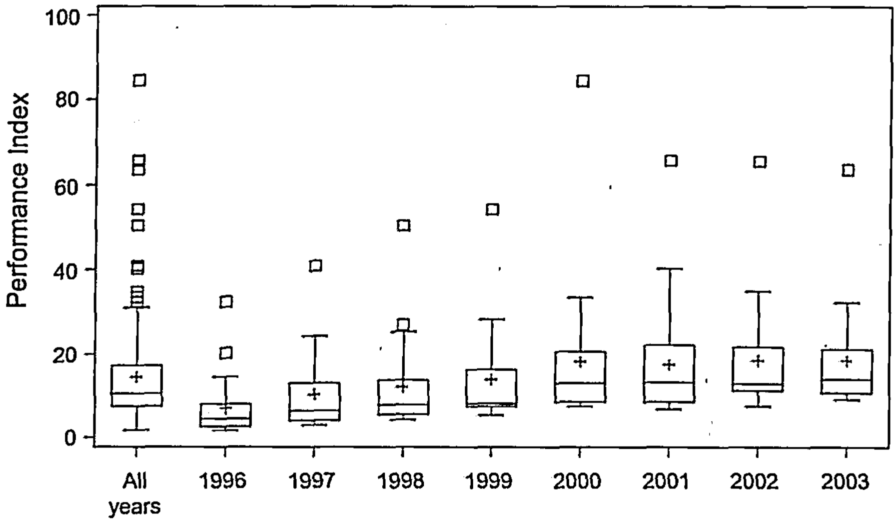


Figure 2: Boxplot of the Performance Index in Each Year and All Years



Note: The symbol " + " in the box represents the mean; the symbol "—" shows the median; the top of the box provides the 75th percentile; and the bottom of box gives the 25th percentile.

Figure 3: Boxplot of the 20 Universities with Top Performance Indexes in Each Year and All Years



Note: The symbol "+" in the box represents the mean; the symbol "—" shows the median; the top of the box provides the 75th percentile; and the bottom of box gives the 25th percentile.

Figure 4: The 20 Universities with the Largest Average Performance Indexes over Eight Years

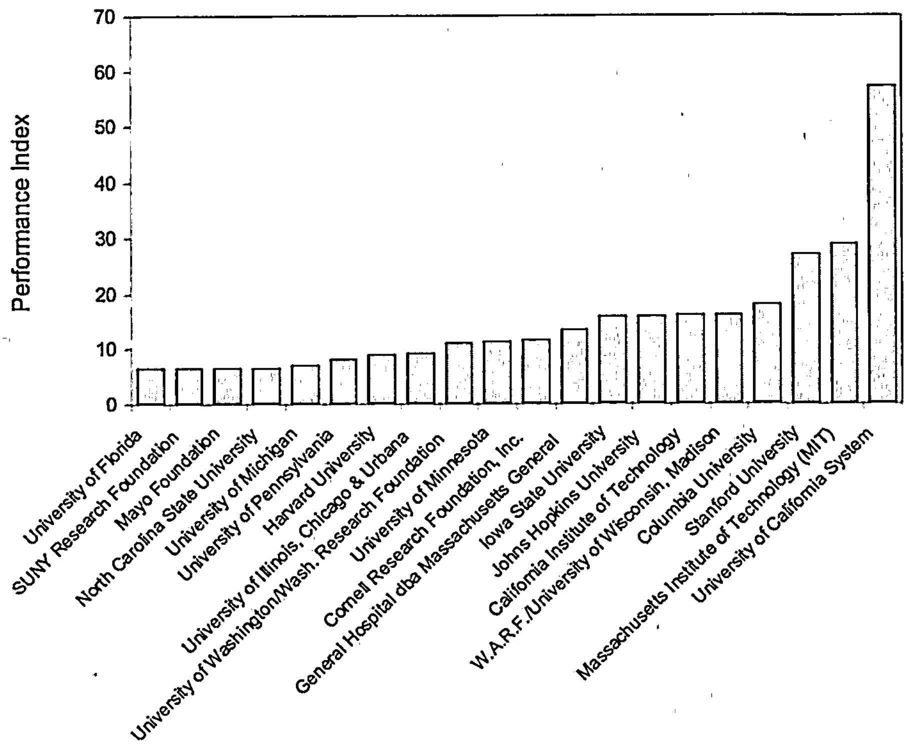


Table 1: Summary of Descriptive Statistics of Independent and Dependent Variables for All Years

Independent and Dependent Variables	N	Mean	Standard Deviation	Min.	Median	Max.
Licensing FTE (licfte)	1343	3	5	0	2	73
Other FTE (othfte)	1340	3	6	0	2	82
Research Expenditures (totexp in millions)	1331	170	220	0.062	100	2600
Expended Legal Fees (explgf in ten thousands)	1317	84	170	0	35	2200
Invention Disclosures (invdis)	1355	71	97	0	40	1027
Total Patent Applications (tptapp)	1340	53	82	0	27	884
New Patent Applications (nptapp)	1339	33	49	0	17	490
U.S. Patents Issued (usptis)	1348	19	29	0	10	324
Age of Office (age)	1266	13	11	0	11	78
Licensing Income (lirecd in millions)	1353	5.8	16	0	0.89	270
Running Royalties (lirunr in millions)	1301	4.3	13	0	0.37	160
Reimbursed Legal Fees (reimlg in ten thousands)	1294	36	92	0	10	1400
Number of Start-Ups (strtup)	1331	2	3	0	1	31

Table 2: Descriptive Statistics of the Performance Index for Each Year and All Years

Year	Performance Index					
	Mean	Median	Max.	Min.	Q1	Q3
All Years	0.18	-2.55	84.59	-5.51	-4.12	1.42
1996	-1.69	-3.37	32.53	-5.47	-4.45	-0.74
1997	-0.86	-3.06	41.07	-5.27	-4.45	0.09
1998	-0.19	-2.44	50.57	-5.46	-4.22	1.00
1999	0.01	-2.21	54.33	-5.44	-4.12	1.39
2000	0.80	-2.45	84.59	-5.30	-4.03	1.54
2001	0.94	-2.08	65.82	-5.24	-3.69	1.91
2002	0.93	-2.49	65.63	-5.43	-4.04	2.41
2003	1.14	-2.08	63.76	-5.51	-3.81	2.52

Note: Q1 is the 25th percentile, and Q3 is the 75th percentile.

Table 3: Linear Regression Summary of Dependent Variable Performance Index

Independent Variables	All Years	1996	1997	1998
Licensing FTE (licfte)	* 4.99865 ** 0.49141 *** 0.0001 ††	3.18916 0.79051 0.0001 ††	5.91571 1.04342 0.0001 ††	6.68538 0.95224 0.0001 ††
Other FTE (othfte)	2.63798 0.40927 0.0001 ††	2.24844 0.81102 0.0067 ††	1.91130 0.92573 0.0416 †	
Research Expenditures (totexp in millions)	-0.60823 0.28874 0.0354 †			
Invention Disclosures (invdis)			-2.71059 0.96448 0.0060 ††	
New Patent Applications (nptapp)	1.34231 0.30371 0.0001 ††		2.26690 0.73994 0.0028 ††	2.78870 0.55175 0.0001 ††
U.S. Patents Issued (usptis)	1.59611 0.30053 0.0001 ††	1.72167 0.47052 0.0004 ††	1.79896 0.54643 0.0014 ††	
Root MSE	4.92114	2.81581	3.36923	4.20164
Adjusted R-Square	0.6691	0.7258	0.7600	0.6843

Independent Variables	1999	2000	2001	2002	2003
Licensing FTE (licfte)	6.47222 1.19898 0.0001 ††	7.92799 1.57768 0.0001 ††	6.03781 1.61865 0.0003 ††	7.45727 1.53049 0.0001 ††	6.04430 1.46349 0.0001 ††
Other FTE (othfte)	2.22689 0.96437 0.0227 †	4.78146 1.20051 0.0001 ††	3.17035 1.10849 0.0051 ††	2.62144 1.23237 0.0356 †	2.59629 1.05676 0.0156 †
Research Expenditures (totexp in millions)					
Invention Disclosures (invdis)					
New Patent Applications (nptapp)	1.87793 0.55437 0.0010 ††		2.27772 0.83039 0.0071 ††		
U.S. Patents Issued (usptis)				1.74784 0.77065 0.0252 †	2.34199 0.75771 0.0025 ††
Root MSE	4.28687	6.57932	5.66428	5.44301	5.20768
Adjusted R-Square	0.6992	0.5914	0.6545	0.6725	0.6965

Note: For the regression fitting, all the independent variables are in log scale.
* is the coefficient of LS estimate; ** is the standard error; *** is the p-value of t-statistics to test whether the coefficient is zero.
†† is significant at the 0.01 level; † is significant at the 0.05 level.

Table 4: Linear Regression Summary of Dependent Variable Performance Index After Removing Top and Bottom 5% of Performers in Each Year

Independent Variables	All Years	1996	1997	1998
Licensing FTE (licfte)	* 1.14654 ** 0.23086 *** 0.0001 ††	1.23388 0.34473 0.0006 ††	1.15922 0.49253 0.0208 †	
Other FTE (othfte)	1.48909 0.18425 0.0001 ††		1.03446 0.41268 0.0140 †	1.63848 0.43392 0.0003 ††
Research Expenditures (totexp in millions)				
Invention Disclosures (invdis)	0.60762 0.16516 0.0002 ††	0.85002 0.26847 0.0002 ††		
Total Patent Applications (tptapp)	0.61482 0.22992 0.0076 ††			1.31129 0.53474 0.0159 †
New Patent Applications (nptapp)	0.64506 0.22090 0.0036 ††	1.11667 0.27944 0.0001 ††	1.41352 0.27668 0.0001 ††	1.21366 0.55098 0.0299 †
U.S. Patents Issued (usptis)	0.83282 0.13317 0.0001 ††	0.68223 0.24464 0.0065 ††	0.84378 0.24038 0.0007 ††	
Age of Office (age)				
Root MSE	2.19775	1.22926	1.49773	1.80665
Adjusted R-Square	0.7598	0.7986	0.7928	0.7668

Independent Variables	1999	2000	2001	2002	2003
Licensing FTE (licfte)	1.74037 0.64663 0.0082 ††				2.40254 0.64516 0.0003 ††
Other FTE (othfte)	1.26940 0.47138 0.0082 ††	2.24773 0.50305 0.0001 ††	2.29325 0.47824 0.0001 ††	1.56898 0.53993 0.0044 ††	2.01773 0.46163 0.0001 ††
Research Expenditures (totexp in millions)		0.92970 0.42417 0.0304 †			
Invention Disclosures (invdis)		1.19552 0.43805 0.0074 ††		1.34554 0.50767 0.0091 ††	
Total Patent Applications (tptapp)			1.84820 0.39787 0.0001 ††	2.00735 0.46950 0.0001 ††	
New Patent Applications (nptapp)	2.26128 0.26387 0.0001 ††				
U.S. Patents Issued (usptis)		1.13000 0.44742 0.0129 †	1.00227 0.41417 0.0172 †		1.95367 0.31603 0.0001 ††
Age of Office (age)	0.70263 0.33966 0.0409 †				
Root MSE	2.04420	2.41998	2.39442	2.52393	2.57622
Adjusted R-Square	0.7624	0.7542	0.7630	0.7389	0.7509

Note: For the regression fitting, all the independent variables are in log scale.
* is the coefficient of LS estimate; ** is the standard error; *** is the p-value of t-statistics to test whether the coefficient is zero.
†† is significant at the 0.01 level; † is significant at the 0.05 level.

Table 5: Linear Regression Summary of Dependent Variable Licensing Income (in Millions)

Independent Variables	All Years	1996	1997	1998
Licensing FTE (licfte)	* 0.61174 ** 0.14296 *** 0.0001 ††			
Research Expenditures (totexp in millions)	0.65396 0.08747 0.0001 ††	0.39051 0.19148 0.0440 †	0.49067 0.18337 0.0086 ††	1.20817 0.21502 0.0001 ††
Expended Legal Fees (explgf in ten thousands)	0.32839 0.05956 0.0001 ††	0.47937 0.15746 0.0029 ††	0.65037 0.13230 0.0001 ††	0.39816 0.15265 0.0103 †
Invention Disclosures (invdis)				
New Patent Applications (nptapp)	-0.29168 0.09225 0.0016 ††			
U.S. Patents Issued (usptis)	0.53662 0.09580 0.0001 ††	0.523 0.23081 0.0256 †	0.38303 0.18052 0.0361 †	
Age of Office (age)	0.30406 0.09067 0.0008 ††			0.54885 0.26311 0.0391 †
Root MSE	1.54984	1.23192	1.21081	1.78524
Adjusted R-Square	0.5564	0.5185	0.6360	0.5386

Independent Variables	1999	2000	2001	2002	2003
Licensing FTE (licfte)	0.95998 0.45927 0.0387 †		1.00870 0.33803 0.0035 ††	0.98803 0.33229 0.0036 ††	
Research Expenditures (totexp in millions)	1.17122 0.25379 0.0001 ††	0.86388 0.23193 0.0003 ††	0.38362 0.18562 0.0410 †		
Expended Legal Fees (explgf in ten thousands)			0.53343 0.09952 0.0001 ††	0.84011 0.14776 0.0001 ††	0.82199 0.18016 0.0001 ††
Invention Disclosures (invdis)					1.61004 0.33511 0.0001 ††
New Patent Applications (nptapp)					-0.96368 0.32064 0.0032 ††
U.S. Patents Issued (usptis)		1.04603 0.22340 0.0001 ††			
Age of Office (age)	0.69856 0.31371 0.0278 †		0.50939 0.24187 0.0374 †		
Root MSE	1.92216	1.60899	1.32045	1.3168	1.6057
Adjusted R-Square	0.4870	0.5704	0.6532	0.5995	0.5648

Note: For the regression fitting, all the independent variables are in log scale.
* is the coefficient of LS estimate; ** is the standard error; *** is the p-value of t-statistics to test whether the coefficient is zero.
†† is significant at the 0.01 level; † is significant at the 0.05 level.

Table 6: Linear Regression Summary of Dependent Variable Running Royalties (in Millions)

Independent Variables	All Years	1996	1997	1998
Licensing FTE (licfte)	* 0.77655 ** 0.23687 *** 0.0011 ††			
Research Expenditures (totexp in millions)	0.97708 0.14309 0.0001 ††		1.01795 0.39774 0.0119 †	1.44039 0.23142 0.0001 ††
Expended Legal Fees (explgf in ten thousands)	0.22786 0.09737 0.0195 †			
Invention Disclosures (invdis)				
New Patent Applications (nptapp)	-0.67113 0.15211 0.0001 ††			
U.S. Patents Issued (usptis)	0.80850 0.15717 0.0001 ††	2.04432 0.24202 0.0001 ††	0.86916 0.37259 0.0216 †	
Age of Office (age)	0.51854 0.14860 0.0005 ††			1.08821 0.32274 0.001 ††
Root MSE	2.52521	2.17041	2.73149	2.26138
Adjusted R-Square	0.3937	0.4082	0.3018	0.4355

Independent Variables	1999	2000	2001	2002	2003
Licensing FTE (licfte)			1.99555 0.65169 0.0027 ††		
Research Expenditures (totexp in millions)	1.76563 0.30924 0.0001 ††	1.69651 0.31179 0.0001 ††	1.06196 0.37515 0.0055 ††	0.68217 0.24249 0.0058 ††	
Expended Legal Fees (explgf in ten thousands)				0.87719 0.18413 0.0001 ††	0.92823 0.22298 0.0001 ††
Invention Disclosures (invdis)					2.20129 0.41475 0.0001 ††
New Patent Applications (nptapp)					-1.46892 0.39683 0.0003 ††
U.S. Patents Issued (usptis)					
Age of Office (age)	1.11881 0.49147 0.0246 †	1.34357 0.53764 0.0138 †			
Root MSE	3.04003	3.10303	2.77305	1.89148	1.98740
Adjusted R-Square	0.3408	0.3292	0.3618	0.4490	0.5393

Note: For the regression fitting, all the independent variables are in log scale.
* is the coefficient of LS estimate; ** is the standard error; *** is the p-value of t-statistics to test whether the coefficient is zero.
†† is significant at the 0.01 level; † is significant at the 0.05 level.

Table 7: Linear Regression Summary of Dependent Variable Reimbursed Legal Fees (in Ten Thousands)

Independent Variables	All Years	1996	1997	1998
Other FTE (othfte)	* 0.46441 ** 0.19573 *** 0.0179 †			
Expended Legal Fees (explgf in ten thousands)	1.18336 0.10149 0.0001 ††	1.96071 0.24390 0.0001 ††	1.56971 0.32564 0.0001 ††	1.48784 0.22834 0.0001 ††
Total Patent Applications (tptapp)	1.03678 0.28237 0.0003 ††			
New Patent Applications (nptapp)	-0.81806 0.26848 0.0024 ††			
U.S. Patents Issued (usptis)			0.99433 0.40971 0.0169 †	
Age of Office (age)	0.65117 0.16070 0.0001 ††			1.37059 0.44895 0.0028 ††
Root MSE	2.77577	3.02582	3.12917	3.15658
Adjusted R-Square	0.4516	0.3841	0.4734	0.4340

Independent Variables	1999	2000	2001	2002	2003
Other FTE (othfte)			1.05319 0.33773 0.0023 ††		
Expended Legal Fees (explgf in ten thousands)	0.96474 0.19307 0.0001 ††	1.83252 0.21508 0.0001 ††	0.96116 0.16203 0.0001 ††	1.59385 0.15656 0.0001 ††	1.79641 0.16668 0.0001 ††
Total Patent Applications (tptapp)					
New Patent Applications (nptapp)					
U.S. Patents Issued (usptis)	1.14086 0.30893 0.0003 ††				
Age of Office (age)					
Root MSE	2.79703	2.98526	2.38493	2.26974	2.44715
Adjusted R-Square	0.4556	0.3623	0.4517	0.4652	0.4939

Note: For the regression fitting, all the independent variables are in log scale.
* is the coefficient of LS estimate; ** is the standard error; *** is the p-value of t-statistics to test whether the coefficient is zero.
†† is significant at the 0.01 level; † is significant at the 0.05 level.

Table 8: Linear Regression Summary of Dependent Variable Number of Start-Ups

Independent Variables	All Years	1996	1997	1998
Other FTE (othfte)	* -0.1253 ** 0.0542 *** 0.0208 †			
Research Expenditures (totexp in millions)	0.1440 0.0547 0.0085 ††			
Expended Legal Fees (explgf in ten thousands)			-0.2497 0.1228 0.0421 †	
Invention Disclosures (invdis)	0.6002 0.0685 0.0001 ††			0.6090 0.1844 0.0010 ††
Total Patent Applications (tptapp)	0.1700 0.0823 0.0390 †			0.7238 0.2617 0.0057 ††
Age of Office (age)	0.2091 0.0442 0.0001 ††	0.3916 0.1484 0.0083 ††	0.2688 0.1218 0.0274 †	
Deviance Test Goodness of Fit	1.5445	1.7669	1.4193	1.3621

Independent Variables	1999	2000	2001	2002	2003
Other FTE (othfte)	-0.4711 0.1637 0.0040 ††				
Research Expenditures (totexp in millions)					0.6501 0.1905 0.0006 ††
Expended Legal Fees (explgf in ten thousands)					
Invention Disclosures (invdis)			0.8460 0.1792 0.0001 ††	0.8833 0.1964 0.0001 ††	0.9761 0.2168 0.0001 ††
Total Patent Applications (tptapp)					
Age of Office (age)	0.3248 0.1302 0.0126 †	0.4662 0.1157 0.0001 ††			
Deviance Test Goodness of Fit	1.3664	1.5681	1.8170	1.5113	1.5467

Note: By the Poisson model with log link function, all the independent variables are in log scale.
* is the coefficient of LS estimate; ** is the standard error; *** is the p-value of t-statistics to test whether the coefficient is zero.
†† is significant at the 0.01 level; † is significant at the 0.05 level.
The deviance testing goodness of fit is smaller than 2, which suggests that the models are adequate.

Table 9: Descriptive Statistics of Performance Indexes for Each Year and All Years for the Top 20 Universities

Year	Performance Index					
	Mean	Median	Max.	Min.	Q1	Q3
All Years	14.64	10.71	84.59	1.83	7.53	17.37
1996	7.19	4.55	32.53	1.83	2.81	8.08
1997	10.47	6.56	41.07	3.10	4.12	13.24
1998	12.35	8.01	50.57	4.43	5.66	13.88
1999	14.12	8.31	54.33	5.53	7.68	16.39
2000	18.32	13.16	84.59	7.65	8.67	20.61
2001	17.62	13.27	65.82	6.92	8.60	22.35
2002	18.53	12.97	65.63	7.54	11.35	21.73
2003	18.50	14.16	63.76	9.15	10.89	21.30

Note: Q1 is the 25th percentile, and Q3 is the 75th percentile.

Table 10: Linear Regression Summary of Dependent Variable U.S. Patents Issued

Independent Variables	All Years		1996	1997	1998
Other FTE (othfte)	* 0.13445 ** 0.03448 *** 0.0001 ††			0.39901 0.11733 0.0009 ††	
Research Expenditures (totexp in millions)	0.12985 0.02673 0.0001 ††		0.15918 0.06629 0.0178 †		0.18262 0.06321 0.0045 ††
Expended Legal Fees (explgf in ten thousands)	0.26513 0.02395 0.0001 ††		0.25613 0.05414 0.0001 ††		0.37857 0.06120 0.0001 ††
Invention Disclosures (invdis)	0.14916 0.03333 0.0001 ††		0.19105 0.08528 0.0268 †		
Total Patent Applications (tptapp)	0.23071 0.03316 0.0001 ††			0.56080 0.07358 0.0001 ††	0.36307 0.07399 0.0001 ††
New Patent Applications (nptapp)			0.25262 0.08906 0.0053 ††		
Age of Office (age)	0.06642 0.02515 0.0084 ††				
Root MSE	0.51380		0.46831	0.62829	0.48224
Adjusted R-Square	0.7782		0.7576	0.6566	0.8120
Independent Variables	**1999**	**2000**	**2001**	**2002**	**2003**
Other FTE (othfte)	0.19433 0.08102 0.0177 †	0.20447 0.07746 0.0092 ††		0.22125 0.09058 0.0157 †	
Research Expenditures (totexp in millions)	0.12818 0.06204 0.0406 †		0.27039 0.06234 0.0001 ††	0.20860 0.06551 0.0018 ††	0.15159 0.06901 0.0295 †
Expended Legal Fees (explgf in ten thousands)	0.22467 0.05413 0.0001 ††	0.31353 0.05781 0.0001 ††	0.28159 0.06543 0.0001 ††	0.37115 0.06323 0.0001 ††	0.36240 0.06252 0.0001 ††
Invention Disclosures (invdis)		0.22480 0.07710 0.0041 ††			0.24355 0.09483 0.0111 †
Total Patent Applications (tptapp)	0.35377 0.06707 0.0001 ††	0.22215 0.08225 0.0077 ††	0.26361 0.07456 0.0005 ††		0.19766 0.09164 0.0325 †
New Patent Applications (nptapp)				0.20492 0.06957 0.0037 ††	
Age of Office (age)	0.17815 0.05634 0.0019 ††		0.15166 0.06867 0.0288 †		
Root MSE	0.42389	0.43026	0.45756	0.53213	0.51513
Adjusted R-Square	0.8455	0.8374	0.8106	0.7831	0.8128

Note: For the regression fitting, all the independent variables are in log scale.
* is the coefficient of LS estimate; ** is the standard error; *** is the p-value of t-statistics to test whether the coefficient is zero.
†† is significant at the 0.01 level; † is significant at the 0.05 level.

Table 11: Linear Regression Summary of Dependent Variable Total Patent Applications

Independent Variables	All Years		1996	1997	1998
Other FTE (othfte)	* 0.04798 ** 0.02052 *** 0.0196 †				
Expended Legal Fees (explgf in ten thousands)	0.14188 0.01432 0.0001 ††		0.15463 0.03063 0.0001 ††	0.08558 0.03458 0.0146 †	
Invention Disclosures (invdis)	0.14696 0.01886 0.0001 ††			0.13007 0.04852 0.0083 ††	0.18986 0.04537 0.0001 ††
New Patent Applications (nptapp)	0.66518 0.01874 0.0001 ††		0.85127 0.03990 0.0001 ††	0.72270 0.05457 0.0001 ††	0.70827 0.05576 0.0001 ††
U.S. Patents Issued (usptis)	0.07208 0.01716 0.0001 ††			0.10402 0.03979 0.01 †	0.14662 0.04360 0.001 ††
Age of Office (age)					0.10024 0.04074 0.0152 †
Root MSE	0.30852		0.27816	0.29326	0.29276
Adjusted R-Square	0.9291		0.9243	0.9333	0.9348
Independent Variables	**1999**	**2000**	**2001**	**2002**	**2003**
Other FTE (othfte)					
Expended Legal Fees (explgf in ten thousands)		0.19497 0.03836 0.0001 ††	0.23601 0.03850 0.0001 ††	0.23645 0.03556 0.0001 ††	0.19011 0.03204 0.0001 ††
Invention Disclosures (invdis)	0.21693 0.05356 0.0001 ††	0.24870 0.05507 0.0001 ††	0.26925 0.05433 0.0001 ††	0.20223 0.05302 0.0002 ††	0.16252 0.04986 0.0014 ††
New Patent Applications (nptapp)	0.65915 0.05352 0.0001 ††	0.57957 0.05399 0.0001 ††	0.52189 0.05574 0.0001 ††	0.58816 0.04946 0.0001 ††	0.69916 0.04754 0.0001 ††
U.S. Patents Issued (usptis)	0.21122 0.04826 0.0001 ††				
Age of Office (age)					
Root MSE	0.30314	0.32561	0.32067	0.31304	0.29225
Adjusted R-Square	0.9338	0.9179	0.9186	0.9285	0.9401

Note: For the regression fitting, all the independent variables are in log scale.
* is the coefficient of LS estimate; ** is the standard error; *** is the p-value of t-statistics to test whether the coefficient is zero.
†† is significant at the 0.01 level; † is significant at the 0.05 level.

Table 12: Linear Regression Summary of Dependent Variable New Patent Applications

Independent Variables	All Years		1996	1997	1998
Expended Legal Fees (explgf in ten thousands)					
Invention Disclosures (invdis)	* 0.14302 ** 0.01919 *** 0.0001 ††		0.13565 0.04555 0.0035 ††	0.12796 0.05022 0.0120 †	
Total Patent Applications (tptapp)	0.77216 0.01801 0.0001 ††		0.79376 0.04434 0.0001 ††	0.81226 0.04870 0.0001 ††	0.87377 0.02308 0.0001 ††
Root MSE	0.33373		0.27910	0.30673	0.31092
Adjusted R-Square	0.9058		0.9152	0.9210	0.9121
Independent Variables	**1999**	**2000**	**2001**	**2002**	**2003**
Expended Legal Fees (explgf in ten thousands)					-0.08410 0.03780 0.0275 †
Invention Disclosures (invdis)	0.11840 0.05803 0.0431 †	0.18023 0.06406 0.0056 ††	0.19842 0.06615 0.0032 ††	0.18203 0.06218 0.0039 ††	0.17915 0.05401 0.0011 ††
Total Patent Applications (tptapp)	0.77687 0.0546 0.0001 ††	0.73962 0.0619 0.0001 ††	0.69603 0.06459 0.0001 ††	0.75281 0.05716 0.0001 ††	0.82218 0.05590 0.0001 ††
Root MSE	0.32771	0.37154	0.37547	0.36763	0.31692
Adjusted R-Square	0.9090	0.8833	0.8726	0.8926	0.9201

Note: For the regression fitting, all the independent variables are in log scale.
* is the coefficient of LS estimate; ** is the standard error; *** is the p-value of t-statistics to test whether the coefficient is zero.
†† is significant at the 0.01 level; † is significant at the 0.05 level.