

# UNIVERSITY PATENTING: IS PRIVATE LAW SERVING PUBLIC VALUES?

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## INTRODUCTION

As privatization of publicly funded university research has grown, so too has the steady undercurrent of public criticism of academic patenting from both inside and outside the academy. During debates over the Bayh–Dole Act of 1980, which standardized federal policy to allow grant recipients to patent resulting inventions,<sup>1</sup> Senator Russell Long called it “one of the most radical and far-reaching giveaways” he had seen.<sup>2</sup> In his 2003 *Universities in the Marketplace*, former Harvard president Derek Bok worried that “the lure of the marketplace” might cause universities to compromise their core values.<sup>3</sup> Jennifer Washburn’s 2005 *University, Inc.* lamented commercialization as a “foul wind [that] has blown over the campuses of our nation’s universities” since 1980 in pursuit of benefits that are “vastly overblown.”<sup>4</sup> In 2019, freshman congresswoman (and Twitter sensation) Alexandria Ocasio-Cortez used her first committee hearings to question why the public is “putting tons of money in the development of drugs that then become privatized, and then they receive no return on the investment that they have made.”<sup>5</sup>

What return does the public receive for the tax dollars spent on R&D, primarily at universities? Does privatizing this research through patent law in fact serve public values?<sup>6</sup> From this social welfare

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1. See Bayh–Dole Act, Pub. L. No. 96-517, 94 Stat. 3019 (1980) (codified as amended at 35 U.S.C. §§ 200–211).

2. Celia W. Dugger, *House Panel Votes Patent Law Change*, WASH. POST, July 25, 1980, at A9 (quoting Senator Russell Long).

3. DEREK BOK, *UNIVERSITIES IN THE MARKETPLACE: THE COMMERCIALIZATION OF HIGHER EDUCATION*, at x (2003).

4. JENNIFER WASHBURN, *UNIVERSITY, INC.: THE CORPORATE CORRUPTION OF AMERICAN HIGHER EDUCATION*, at ix, xii (2005).

5. Lisa Larrimore Ouellette, *AOC on Pharma & Public Funding*, WRITTEN DESCRIPTION (Feb. 3, 2019), <https://writtendescription.blogspot.com/2019/02/aoc-on-pharma-public-funding.html> [<https://perma.cc/NX79-E7V7>] (quoting Congresswoman Alexandria Ocasio-Cortez).

6. We take no position on the largely academic question of whether patent law is in fact “private law.” See generally Henry E. Smith, *Intellectual Property and the New Private Law*, 30 HARV. J.L. & TECH. 1 (2017) (noting that intellectual property “is more public and administrative than classic areas of private law” but that “[t]here are few things more contested in the legal academy than the nature of private law, whether it has a nature, and if it even exists at all”).

perspective, could the Bayh–Dole framework be improved? In this symposium contribution, we seek to tackle these questions, identifying the key empirical questions that must be resolved to answer them. In short, we conclude the benefits of university patenting may justify the costs where licensees need exclusivity to undertake the costs of commercialization. For the substantial portion of university patenting that is not necessary for commercialization, evidence of other plausible benefits is not yet sufficient to justify the costs. Much of the data needed to investigate these plausible benefits—and related costs—rests in the hands of universities and federal grant agencies. Unless defenders of university patenting develop this evidence, university patenting should be curtailed in ways discussed further below.

Understanding the net benefits of university patenting is crucial to setting innovation policy because universities are substantial players in the U.S. innovation ecosystem. In 2015, they conducted nearly 50% of basic research in the United States and 13% of all R&D.<sup>7</sup> Out of the nearly \$65 billion spent on R&D at U.S. universities in 2015, over half (52%) came from the federal government,<sup>8</sup> 27% came from university funds, 10% came from other nonprofits such as foundations, and 6% came from each of non-federal governments and for-profit businesses.<sup>9</sup> For research funded by the federal government, the Bayh–Dole Act was passed in 1980 to alleviate uncertainty about patent rules for grant recipients.<sup>10</sup> Under the Bayh–Dole framework, universities and other recipients of federal grants may “elect to retain title to” inventions created under those grants.<sup>11</sup> We will focus here on

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7. See NAT'L SCI. BD., SCIENCE & ENGINEERING INDICATORS 2018, at 4-20 tbl. 4-3 (2018).

8. These figures include “indirect costs” such as maintaining facilities. The overhead rate averages 52% for NIH grants, so that for every \$100,000 spent on research, the agency pays up to an additional \$52,000 to cover indirect costs. Jocelyn Kaiser, *NIH Plan to Reduce Overhead Payments Draws Fire*, SCIENCE (June 2, 2017, 3:45 PM), <https://www.sciencemag.org/news/2017/06/nih-plan-reduce-overhead-payments-draws-fire> [<https://perma.cc/8WZC-NHTS>].

9. See NAT'L SCI. BD., *supra* note 7, at 4-20 tbl. 4-3.

10. For reviews of university patenting before Bayh–Dole and the factors leading to the Act's passage, see Rebecca S. Eisenberg, *Public Research and Private Development: Patents and Technology Transfer in Government-Sponsored Research*, 82 VA. L. REV. 1663, 1671–91 (1996); Peter Lee, *Patents and the University*, 63 DUKE L.J. 1, 30–32 (2013); and Bhaven N. Sampat, *Patenting and US Academic Research in the 20th Century: The World Before and After Bayh-Dole*, 35 RES. POL'Y 772 (2006).

11. 35 U.S.C. § 202(a) (2018). Although the statute refers to a “nonprofit organization or small business firm,” *id.*, this has been extended to large businesses

university patents stemming from public funding, though many of our arguments also apply to university patents that are not Bayh–Dole patents, and to Bayh–Dole patents that are not university patents.<sup>12</sup>

Patent rights for federal grant recipients come with certain restrictions. A Bayh–Dole patent application must note “that the Government has certain rights in the invention.”<sup>13</sup> The funding agency may “require periodic reporting on the utilization” of the invention.<sup>14</sup> The agency has a free, nonexclusive license to practice the invention “for or on behalf of the United States,” and the agency may use “[m]arch-in rights” to grant additional licenses.<sup>15</sup> Agencies have used the threat of royalty-free licenses and march-in rights to attain price reductions.<sup>16</sup> If the invention is exclusively licensed, any resulting products must be “manufactured substantially in the United States” unless “domestic manufacture is not commercially feasible.”<sup>17</sup> Universities must also give a preference to small businesses and cannot assign rights without the agency’s approval.<sup>18</sup>

Why are patents and grants combined through this particular legal structure? Patents and direct federal research funding are the two most significant U.S. innovation policies for facilitating financial transfers from consumers to inventors.<sup>19</sup> Under the Bayh–Dole

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by Executive Order and regulation. *See* 37 C.F.R. § 401.1(b) (2019) (noting that the implementing regulations “appl[y] to all funding agreements with business firms regardless of size (consistent with [earlier Executive Orders])”). There are a few exceptions, including for certain contractors of the Department of Energy. 35 U.S.C. § 202(a)(iv) (2018).

12. The policy goals of Bayh–Dole seem to apply regardless of the type of grantee. And although universities are legally required to follow Bayh–Dole only for inventions stemming from federal funding, universities typically have standardized patent policies for all inventions, both for administrative simplicity and because universities—as nonprofit institutions with educational missions—often have similar policy goals to those set out in Bayh–Dole. We will thus use “university patent” and “Bayh–Dole patent” somewhat interchangeably.

13. § 202(c)(6).

14. § 202(c)(5).

15. §§ 202(c)(4)–(5), 203.

16. *See Several March-in and Royalty Free Rights Cases, Under the Bayh–Dole Act*, KNOWLEDGE ECOLOGY INT’L, <https://www.keionline.org/cl/march-in-royalty-free> [https://perma.cc/8UFU-HUU4] (last visited Jan. 20, 2020); *cf.* Ryan Whalen, Note, *The Bayh-Dole Act & Public Rights in Federally Funded Inventions: Will the Agencies Ever Go Marching In?*, 109 NW. U. L. REV. 1083, 1106 (2015) (describing the failure of agencies to formally trigger these rights).

17. *See* § 204.

18. *See* § 202(c)(7).

19. *See* Daniel J. Hemel & Lisa Larrimore Ouellette, *Beyond the Patents–Prizes Debate*, 92 TEX. L. REV. 303, 319–21 (2013) [hereinafter Hemel & Ouellette,

framework (and the similar Stevenson–Wydler framework for national laboratories),<sup>20</sup> these policy tools are used as complements, not substitutes. In prior work with Daniel Hemel, Ian Ayres, and Andrew Tutt, one of us (Ouellette) has discussed the relative benefits of patents and direct research funding,<sup>21</sup> as well as the benefits that their combination might have for ex post commercialization,<sup>22</sup> ex ante incentives,<sup>23</sup> and overall research funding levels.<sup>24</sup> This Article draws on this prior work, as well as the work of numerous other scholars who have questioned the current Bayh–Dole framework from a social welfare perspective.<sup>25</sup> In making this assessment, it is important to remember that university patents—like patents in general—impose costs, including increased deadweight loss, transaction costs, and negative changes in the practice and norms of science.<sup>26</sup> The key question is thus: Is society getting a benefit that outweighs these costs?

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*Beyond the Patents–Prizes Debate*]; Daniel J. Hemel & Lisa Larrimore Ouellette, *Innovation Policy Pluralism*, 128 YALE L.J. 544, 551–52 (2019) [hereinafter Hemel & Ouellette, *Innovation Policy Pluralism*].

20. The Stevenson–Wydler Act of 1980 allows inventions created at federal laboratories to be patented. See 15 U.S.C. § 3710(b)–(c) (2018); Adam B. Jaffe & Josh Lerner, *Reinventing Public R&D: Patent Policy and the Commercialization of National Laboratory Technologies*, 32 RAND J. ECON. 167, 170–71 (2001).

21. See generally Hemel & Ouellette, *Beyond the Patents–Prizes Debate*, *supra* note 19; Hemel & Ouellette, *Innovation Policy Pluralism*, *supra* note 19.

22. See generally Ian Ayres & Lisa Larrimore Ouellette, *A Market Test for Bayh–Dole Patents*, 102 CORNELL L. REV. 271 (2017) (proposing a “market test” approach to federally funded inventions to assess whether exclusivity is needed for commercialization).

23. See generally Lisa Larrimore Ouellette & Andrew Tutt, *How Do Patent Incentives Affect University Researchers?*, 61 INT’L REV. L. & ECON. 105883 (2020).

24. See generally Daniel J. Hemel & Lisa Larrimore Ouellette, *Bayh–Dole Beyond Borders*, 4 J.L. & BIOSCIENCES 282 (2017) [hereinafter Hemel & Ouellette, *Bayh–Dole Beyond Borders*] (explaining why Bayh–Dole may increase public spending on scientific research).

25. See, e.g., Rebecca S. Eisenberg & Robert Cook-Deegan, *Universities: The Fallen Angels of Bayh–Dole?*, 147 DAEDALUS 76, 78–79 (2018); see also Mark A. Lemley, *Are Universities Patent Trolls?*, 18 FORDHAM INTELL. PROP. MEDIA & ENT. L. J. 611, 611–12 (2008); Arti K. Rai & Rebecca S. Eisenberg, *Bayh–Dole Reform and the Progress of Biomedicine*, 66 LAW & CONTEMP. PROBS. 689, 689 (2003); Christopher J. Ryan, Jr. & Brian L. Frye, *An Empirical Study of University Patent Activity*, 7 N.Y.U. J. INTELL. PROP. & ENT. L. 51, 55 (2017).

26. See Ayres & Ouellette, *supra* note 22, at 281 (reviewing the literature on these costs); Margo A. Bagley, *Academic Discourse and Proprietary Rights: Putting Patents in Their Proper Place*, 47 B.C. L. REV. 217, 238–39 (2006); Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 136 (1999).

We begin in Part I with a brief overview of U.S. university practices in filing, licensing, and litigating patents. Part II focuses on the primary justification for university patents: that they promote ex post commercialization, either through exclusivity itself or by providing an incentive for university researchers to help develop their inventions. As we explain, evidence of this benefit is compelling for some inventions but cannot support the current scope of university patenting activity. The remainder of the Article thus considers other justifications for patents that do not seem necessary for commercialization.<sup>27</sup> Part III examines how patents affect ex ante incentives for university researchers. Part IV sets out two mechanisms by which patents might increase university research funding: increased internal university research funds and higher federal grant appropriations. Part V discusses the effect of university patents abroad, including the efficiency and distributional effects that patents in other high-income countries may have. We conclude by setting out an agenda for university patenting research: a summary of the research questions that we think must be addressed to provide a more conclusive assessment of the social impact of university patenting. We advocate for rigorous policy experiments to answer these questions, which could be run by institutional actors including universities, government funding agencies (including state and non-U.S. funders), and private research foundations in partnership with academics.

## I. WHAT DO UNIVERSITY PATENT PRACTICES LOOK LIKE TODAY?

University patenting practices vary widely. Knowledge and discussion about current university patenting practices is largely informed by the annual survey conducted by the Association of University Technology Managers (AUTM), a nonprofit organization of academic professionals from the technology transfer offices (TTOs) of more than 800 universities and other institutions.<sup>28</sup> While helpful

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27. One justification for patents in general that is not considered in this Article is the incentive to disclose new scientific knowledge. As one of us has argued in prior work, patents do serve an important disclosure function. See Lisa Larrimore Ouellette, *Who Reads Patents?*, 35 NATURE BIOTECHNOLOGY 421, 421 (2017). But this benefit cannot bear the weight of justifying the costs of the patent system. See Lisa Larrimore Ouellette, *Do Patents Disclose Useful Information?*, 25 HARV. J.L. & TECH. 531, 534–35 (2012). And the disclosure benefit of patents is far more attenuated in the university context, where inventors have strong independent justifications to publish their results in the scientific literature.

28. See *Statistics Access for Technology Transfer (STATT) Database*, ASS'N OF UNIV. TECH. MANAGERS, <https://autm.net/surveys-and-tools/databases/statt>

for illuminating general trends of AUTM members, the survey's broad categories and changes over time limit its use for answering even basic questions such as what percentage of university inventions are governed by Bayh–Dole,<sup>29</sup> what percentage are licensed exclusively,<sup>30</sup> and how practices vary by technology.

This general lack of transparency, especially with regard to the role that university patents play in the commercialization of technologies, is exacerbated by the fact that while the patents themselves are publicly available, licenses are private and not subject to FOIA requests—at least at private universities.<sup>31</sup> This makes aggregating quantitative data regarding terms and conditions more difficult. In addition, some university inventors bypass their university TTOs and patent inventions themselves, such that AUTM numbers are an underestimate of academic patenting activity and start-up formation.<sup>32</sup>

#### A. Growth in University Patenting

The Bayh–Dole Act of 1980 was not the start of university patenting; as Bhaven Sampat has explained, it simply “magnified and

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[<https://perma.cc/9GY8-76T7>] (last visited Jan. 20, 2020) [hereinafter AUTM SURVEY]. For instructions, see ASS'N OF UNIV. TECH. MANAGERS, LICENSING SURVEY: 2014 INSTRUCTIONS AND DEFINITIONS (2015) [hereinafter AUTM SURVEY INSTRUCTIONS]. On AUTM membership, see *Who We Are*, ASS'N OF UNIV. TECH. MANAGERS, <https://autm.net/about-autm/who-we-are> [<https://perma.cc/D26H-Z5P7>] (last visited Jan. 20, 2020).

29. In theory, researchers should be able to determine this statistic from public patent data because Bayh–Dole patents must include “a statement specifying that the invention was made with Government support and that the Government has certain rights in the invention.” 35 U.S.C. § 202(c)(6) (2018). In practice, many Bayh–Dole patents fail to include these statements. See Arti K. Rai & Bhaven N. Sampat, *Accountability in Patenting of Federally Funded Research*, 10 NATURE BIOTECHNOLOGY 953, 954 (2012).

30. The survey does ask for the number of exclusive and nonexclusive licenses granted, but not for how many distinct inventions those licenses cover. See AUTM SURVEY, *supra* note 28.

31. See Hannah Schwarz, *Finding and Funding the Cure*, YALE DAILY NEWS (Oct. 30, 2015, 3:48 AM), <https://yaledailynews.com/blog/2015/10/30/finding-and-funding-the-cure> [<https://perma.cc/2PQZ-RG4D>].

32. See T. Taylor Aldridge & David Audretsch, *The Bayh–Dole Act and Scientist Entrepreneurship*, 40 RES. POL'Y 1058, 1059 (2011); Christopher S. Hayter & Mary K. Feeney, *Determinants of External Patenting Behavior Among University Scientists*, 44 SCI. & PUB. POL'Y 111, 114 (2017); Gideon D. Markman, Peter T. Gianiodis & Phillip H. Phan, *Full-Time Faculty or Part-Time Entrepreneurs*, 55 IEEE TRANSACTIONS ON ENGINEERING MGMT. 29, 34 (2008).

accelerated” changes that were already occurring in America’s innovation institutions.<sup>33</sup> Similarly, Elizabeth Popp Berman has argued that Bayh–Dole cemented the turn toward academic patenting.<sup>34</sup> The solid line in Figure 1 shows the dramatic increase in U.S. university patenting over the past fifty years. According to data collected by the U.S. Patent and Trademark Office (USPTO), in 1970, U.S. universities were granted a total of 198 patents; in 2012, that number was 4,797.<sup>35</sup> From Bayh–Dole’s passage through 2012, the number of university patents issued each year grew over tenfold. However, a small number of universities are responsible for the vast majority of patenting activity. Only five individual universities—MIT, Stanford, the University of Wisconsin, the University of Texas, and Caltech—were granted more than 100 patents in 2012.<sup>36</sup>

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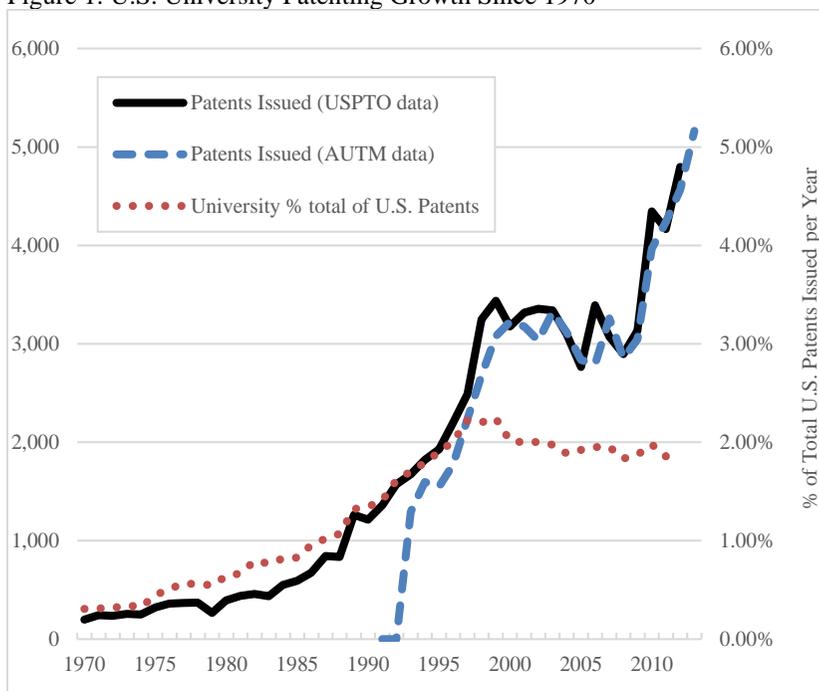
33. Sampat, *supra* note 10, at 776.

34. See ELIZABETH POPP BERMAN, CREATING THE MARKET UNIVERSITY: HOW ACADEMIC SCIENCE BECAME AN ECONOMIC ENGINE 94–118 (2012).

35. See *University Patent Count & Expenditures*, U.S. PATENT & TRADEMARK OFFICE, <https://developer.uspto.gov/visualization/university-patent-count-expenditures> [<https://perma.cc/WGJ5-NDJ7>] (last visited Jan. 20, 2020).

36. *Id.* A sixth, the University of California system, is not broken out into its constituent universities, but taken together, it had 357 patents granted in 2012, far more than the MIT, which came in second with 216 patents granted that year. *Id.* Patents originating with University of Wisconsin inventors are managed and prosecuted through the Wisconsin Alumni Research Foundation (WARF). See *History*, WIS. ALUMNI RESEARCH FOUND., <https://www.warf.org/about-us/history/history-of-warf.cmsx> [<https://perma.cc/W5LE-WQJV>] (last visited Jan. 20, 2020).

Figure 1. U.S. University Patenting Growth Since 1970



The dashed line in Figure 1 provides the same information—granted U.S. patents to U.S. universities—as self-reported by universities in the AUTM survey.<sup>37</sup> By the early 2000s, this line closely matches the USPTO data, giving us greater confidence in using the AUTM survey results for other metrics that are not available from public records.

Finally, the dotted line in Figure 1, which corresponds to the right-hand axis, shows U.S. university patents as a percentage of all patents granted by the USPTO. As this data indicates, universities became a more significant part of the overall patenting landscape between 1970 and 2000. But since the late 1990s, university patenting has mimicked the overall U.S. patenting trends, with the percentage staying relatively constant at around 2%.<sup>38</sup>

37. See AUTM SURVEY, *supra* note 28. Only six universities responded to this question in 1991 and 1992, and they each reported zero issued patents. *Id.* In 1993, 119 universities reported. *Id.*

38. See Ryan & Frye, *supra* note 25, at 64–65 (showing that universities responded strategically to changes in U.S. patent law).

The university TTO coordinates patenting and commercialization, serving as the point of contact for both university inventors and private firms interested in acquiring rights to university-owned IP. TTOs come in a variety of organizational forms, including those housed in the university itself and those that operate as affiliated nonprofits, such as WARF.<sup>39</sup> Many universities created TTOs in the wake of Bayh–Dole, and these offices have diverse and sometimes conflicting motivations, including (1) commercializing university technologies in quantifiable and public ways to demonstrate that the university is serving the public interest (with the resulting reputational benefit),<sup>40</sup> (2) serving entrepreneurial university faculty members (which may help with faculty recruitment and retention),<sup>41</sup> and (3) generating revenue.<sup>42</sup> The relative importance of different motivations differs by university, resulting in different approaches to technology transfer generally and academic patenting in particular.

In materials presented to university inventors and the public, TTOs depict innovation as a cyclical process.<sup>43</sup> Under this idealized description, university inventors generate useful knowledge in the course of their research, which they disclose to the TTO. The TTO evaluates each disclosure and decides whether to seek formal IP protection.<sup>44</sup> If it seeks formal IP protection, it markets the IP to find

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39. See *History*, *supra* note 36.

40. See, e.g., NAT'L RES. COUNCIL, MANAGING UNIVERSITY INTELLECTUAL PROPERTY IN THE PUBLIC INTEREST 29 (Stephen A. Merrill & Anne-Marie Mazza eds., 2011); Carol Mimura, *Nuanced Management of IP Rights: Shaping Industry–University Relationships to Promote Social Impact*, in WORKING WITHIN THE BOUNDARIES OF INTELLECTUAL PROPERTY 269, 270 (Rochelle Dreyfuss et al. eds., 2010).

41. See generally THE CHICAGO HANDBOOK OF UNIVERSITY TECHNOLOGY TRANSFER AND ACADEMIC ENTREPRENEURSHIP (Albert N. Link, Donald S. Siegel & Mike Wright eds., 2015) (providing suggestions for universities).

42. See *infra* Section IV.A (discussing university revenue issues).

43. See, e.g., STANFORD UNIV. OFFICE OF TECH. LICENSING, INVENTOR'S GUIDE 7 (2017); see also HARVARD OFFICE OF TECH. DEV., THE INVENTOR'S HANDBOOK 17 (2016). This simplified picture of technology transfer is discussed, and complicated, in Samantha R. Bradley, Christopher S. Hayter & Albert N. Link, *Models and Methods of University Technology Transfer*, 9 FOUND. & TRENDS ENTREPRENEURSHIP 571, 574 (2013).

44. See Kirsten Leute, *Patenting and Licensing of University-Based Genetic Inventions—A View from Experience at Stanford University's Office of Technology Licensing*, 8 COMMUNITY GENETICS 217, 218–19 (2005) (discussing what considerations go into the patenting decision). Some of the factors Leute notes include whether the invention can be licensed absent IP protection; whether a patent could be enforced in a cost-effective manner; or whether the invention is best left in the public domain. See *id.*

and select an appropriate licensee (or multiple licensees) of the technology, and then it negotiates with the licensee to reach a license agreement. The licensee commercializes the invention and pays royalties to the university. Royalties are shared according to university policy, with some distributed to the inventors personally and some funneled back into further research, beginning the innovation process anew.<sup>45</sup>

Policies on revenue sharing differ by university. Stanford University, for example, funds its Office of Technology Licensing with a 15% administrative fee, and then divides revenues evenly, providing one-third net cash royalties each to the inventor, the inventor's department, and the inventor's school.<sup>46</sup> Harvard University likewise takes a 15% administrative fee, but then gives half of the remainder to the inventor (70% as personal compensation, 30% for research) and splits the other half among the department, school, university president's office, and a Technology Development Accelerator Fund.<sup>47</sup> Under the Bayh–Dole Act, some portion of these royalties must be shared with inventors,<sup>48</sup> but there is substantial variation in these policies across universities and over time. Ouellette and Tutt have created a publicly available dataset of royalty-sharing policies for over 150 U.S. universities.<sup>49</sup>

As shown in Figure 2, between 2004 and 2013, activity at these university TTOs has been steadily increasing.<sup>50</sup> Invention disclosures rose almost 50%, which may reflect successful efforts to encourage researchers to report their inventions or unrelated changes in

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45. For summary tables of literature relevant to this idealized process, see Bradley, Hayter & Link, *supra* note 43.

46. Leute, *supra* note 44, at 220 (discussing the 15% administrative fee at Stanford); *Stanford Policies*, STANFORD UNIV. OFFICE OF TECH. LICENSING, <https://otl.stanford.edu/intellectual-property/stanford-policies> [https://perma.cc/UH8W-WYQZ] (last visited Jan. 20, 2020) (outlining Stanford's royalty sharing policy between the inventor, the inventor's department, and the institution).

47. *Statement of Policy in Regard to Intellectual Property (IP Policy)*, HARVARD OFFICE OF TECH. DEV., <https://otd.harvard.edu/faculty-inventors/resources/policies-and-procedures/statement-of-policy-in-regard-to-intellectual-property> [https://perma.cc/FE28-E4SY] (last visited Jan. 20, 2020).

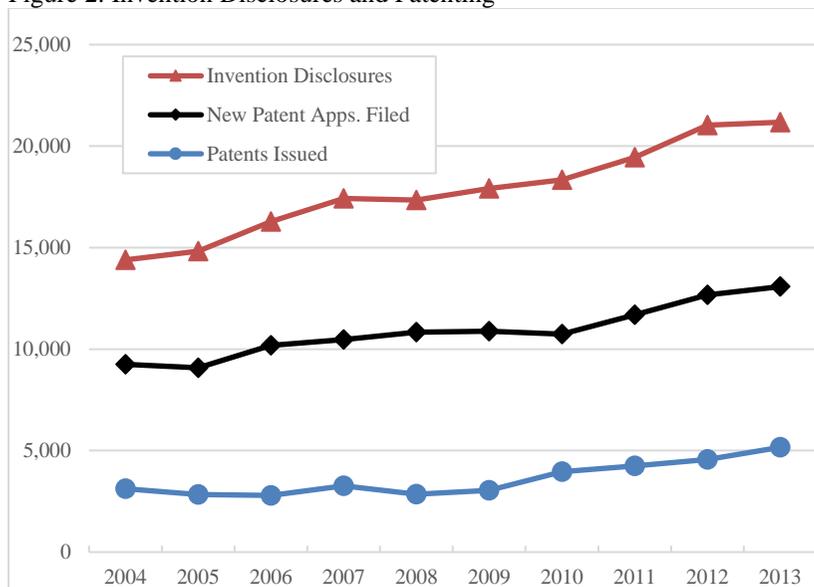
48. See Bayh–Dole Act, 35 U.S.C. § 202(c)(7)(B) (1980) (stating that a contractor is required to share royalties with the inventor).

49. Lisa Larrimore Ouellette & Andrew Tutt, *Main Page*, UNIV. PATENT DATA, [http://universitypatentdata.com/wiki/Main\\_Page](http://universitypatentdata.com/wiki/Main_Page) [https://perma.cc/GKV5-56ML] (last visited Jan. 20, 2020); see also Ouellette & Tutt, *supra* note 23 (discussing the university patent data set).

50. See AUTM SURVEY, *supra* note 28 (displaying disclosures, applications, and issued patents dated by the year of disclosure, application, and issue).

university research portfolios.<sup>51</sup> New patent applications increased more than 40%, while patents issued increased by 66%. The increased ratio of applications to issued patents may reflect more success in prosecuting patent applications before the USPTO, or it may also reflect TTOs finding more licensees and therefore abandoning fewer applications.

Figure 2. Invention Disclosures and Patenting



## B. Nonexclusive Licensing, Exclusive Licensing, Spinoffs, and Startups

Once it decides to patent a given invention, the TTO markets and possibly licenses the patent. The inventor, TTO, and licensee may agree to an exclusive license that bars the TTO from licensing the patent to any other company, or they may agree to a non-exclusive

51. 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 99, 100 (2001) (“The portfolio of university research has shifted somewhat in recent years independently of Bayh-Dole, and these changes are important factors behind the increased patenting and licensing activity. In particular, the growth in federal financial support for basic biomedical research in universities that began in the late 1960s, along with the related rise of research in biotechnology that began in the early 1970s, contributed to growth in university patents and licenses.”).

license, leaving the patent available to other licensees. According to data from AUTM, and as shown in Figure 3, exclusive licensing has been relatively constant since 2004; however, since 2008, the number of non-exclusive licenses has increased.<sup>52</sup> The number of licenses throughout this period is close to the number of issued patents, but this does not mean most patents are licensed—rather, some patents are licensed multiple times.

A simple division into exclusive and non-exclusive licensing does not capture the full range of options available to universities and companies. For example, licenses may also be restricted to specified fields, which enables TTOs to grant exclusivity to multiple licensees, each for a different application.<sup>53</sup> TTOs may also impose diligence benchmarks and other requirements to ensure licensees are taking reasonable steps toward commercialization.<sup>54</sup> The licensor often receives both an up-front payment and “continuation payments” in the form of royalties, equity, or milestone payments.<sup>55</sup>

U.S. universities generally use exclusive licenses rather than outright assignments. The Bayh–Dole Act includes “a prohibition upon the assignment of rights to a subject invention” without the funding agency’s approval,<sup>56</sup> and even for inventions not subject to Bayh–Dole requirements, university patenting policies often limit assignments.<sup>57</sup> Recent work has found that, between 2012 and 2017, U.S. universities recorded only 108 assignments of 227 patent assets in arms-length transactions.<sup>58</sup> But there may be many more

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52. See AUTM SURVEY, *supra* note 28.

53. See STANFORD UNIV. OFFICE OF TECH. LICENSING, START-UP GUIDE 6 (2016); Leute, *supra* note 44, at 219.

54. See STANFORD UNIV. OFFICE OF TECH. LICENSING, *supra* note 53, at 21; Leute, *supra* note 44, at 219.

55. See *infra* Section II.B.

56. See Bayh–Dole Act, 35 U.S.C. § 202(c)(7) (1980).

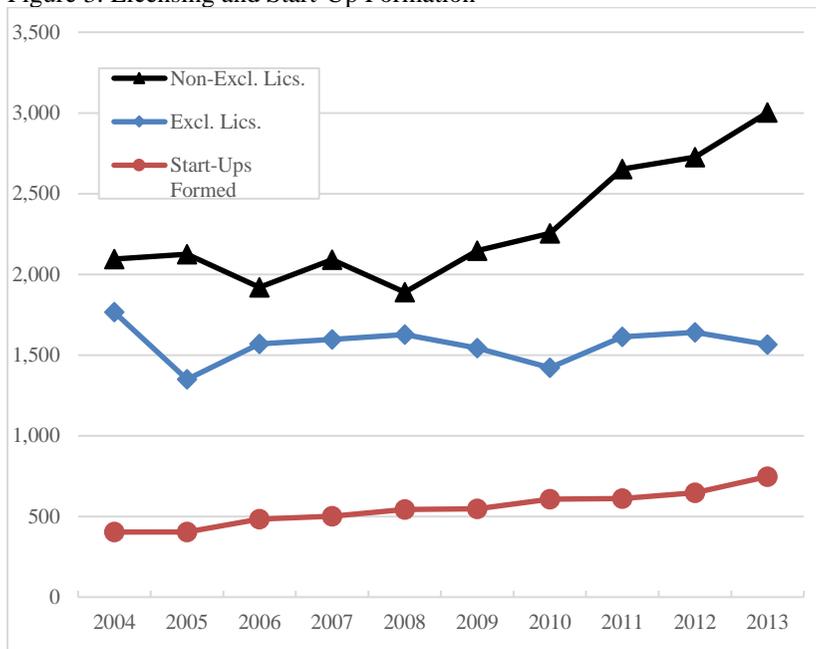
57. See, e.g., NW. UNIV., UNIVERSITY PATENT AND INVENTION POLICY 5 (Sept. 1, 2017) (“As a general policy, the University does not sell or assign patent rights.”); see also STANFORD UNIV. OFFICE OF TECH. LICENSING, *supra* note 53, at 22 (“Stanford does not assign or transfer IP rights.”).

58. Brian J. Love, Erik Oliver & Michael Costa, *US Patent Sales by Universities and Research Institutes*, in RESEARCH HANDBOOK ON INTELLECTUAL PROPERTY AND TECHNOLOGY TRANSFER 256, 267 tbl. 12.3 (Jacob H. Rooksby ed., 2020). These sales were made by universities relatively uniformly distributed across the U.S. News rankings. See *id.* at 264 fig.12.2. Another study found that 326 out of 106,075 patents granted to universities (including foreign universities) based on filing dates from 1990 to 2013 were transferred to patent-assertion entities. Stefania Fusco et al., *Monetization Strategies of University Patents Through PAEs: An Analysis of US Patent Transfers*, 2019 ISSI CONF. PROC. 1184, 1187 (2019). 59 out of 92

assignments that are not recorded at the USPTO; an analysis of patents owned by patent-assertion entity Intellectual Ventures in 2016 found 500 patents originally assigned to universities, including over 100 from the University of California, 60 from the New Jersey Institute of Technology, and 40 from Caltech.<sup>59</sup>

Some universities have shifted their licensing strategy more toward start-up formation, and this gradual trend is reflected in AUTM survey results. As illustrated in Figure 3, from 2004 to 2013, the number of reported start-ups has almost doubled, from 403 to 747. AUTM defines start-up formation based on whether the company was created “specifically to license and develop the technology being licensed.”<sup>60</sup>

Figure 3. Licensing and Start-Up Formation



universities with transfers to patent-assertion entities were foreign; the U.S. universities with the highest number of transfers were North Carolina State University (38 patents), the University of Texas System (24 patents), and Duke University (11 patents). *See id.* at 1188.

59. Yarden Katz, *Universities Have Turned over Hundreds of Patents to Patent Trolls*, MEDIUM (Oct. 13, 2016), <https://medium.com/@yardenkatz/universities-have-turned-over-hundreds-of-patents-to-patent-trolls-99d5cdec1d8a> [https://perma.cc/8YFU-SR5M].

60. AUTM SURVEY INSTRUCTIONS, *supra* note 28, at 11.

The amount of start-up formation and the extent to which TTOs actively facilitate start-ups is likely influenced by the personnel that universities attract, university policies and programs, and the availability of outside partnerships and venture funding. The interaction among these factors can vary dramatically across different universities.<sup>61</sup>

Universities appear to prefer licensing technological inventions back to their own faculty or student inventors than to others. Harvard offers to actively facilitate the inventor's decision of whether or not to create a start-up.<sup>62</sup> Even Stanford, which claims not to give "preferential treatment" to inventor-incorporated start-ups, has nonetheless "almost always" selected such start-ups and provided them with exclusivity.<sup>63</sup>

Start-up creation might form the foundation of an independent justification for university patenting if there are reasons to prefer a more fragmented technology ecosystem, independent of what technologies are actually produced.<sup>64</sup> But it is not obvious whether patenting leads to greater market concentration or fragmentation.<sup>65</sup>

### C. University Patent Assertion and Litigation

Universities are involved in the U.S. patent ecosystem not only as patent owners and licensors, but also as litigants. In 2008, Mark Lemley wrote an article titled *Are Universities Patent Trolls?*, and while he concluded that "the general answer . . . is no,"<sup>66</sup> the increasingly aggressive behavior of some universities in asserting their patent portfolios has caused a number of commentators to give them the "troll" pejorative.<sup>67</sup> For example, Boston University

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61. See Wai Fong Boh, Uzi De-Haan & Robert Strom, *University Technology Transfer Through Entrepreneurship: Faculty and Students in Spinoffs*, 41 J. TECH. TRANSFER 661, 666–67 (2015) (interviewing 130 individuals, including founders of 47 spinoffs, at eight U.S. universities to track different models for spinoff development).

62. See HARVARD OFFICE OF TECH. DEV., *supra* note 43, at 16, 26.

63. STANFORD UNIV. OFFICE OF TECH. LICENSING, *supra* note 53, at 16–17.

64. We thank Arti Rai for suggesting this point.

65. See Peter Lee, *Reconceptualizing the Role of Intellectual Property Rights in Influencing Industry Structure*, 72 VAND. L. REV. 1197, 1198 (2019); Peter Lee, *Innovation Consolidation*, 54 U.C. DAVIS L. REV. (forthcoming 2020) (on file with authors).

66. Lemley, *supra* note 25, at 612 n.1.

67. E.g., Daniel Engber, *In Pursuit of Knowledge, and Profit*, SLATE (May 7, 2014, 11:49 PM), <https://slate.com/technology/2014/05/patent-trolls-universities-sometimes-look-a-lot-like-trolls.html> [<https://perma.cc/PPJ2-QVUT>] ("Universities

successfully sued nearly thirty leading technology firms—including Amazon, Apple, Dell, HP, and Microsoft—over its NSF-funded<sup>68</sup> blue LED patent.<sup>69</sup> And Carnegie Mellon University made headlines for its \$1.5 billion award against Marvell Semiconductor, which was reduced to \$750 million in a settlement.<sup>70</sup>

These are not isolated lawsuits. One of us analyzed a random sample of 20% of all patent lawsuits filed from 2000 to 2015 and found 77 patent assertions involving a U.S. university patent plaintiff,<sup>71</sup> suggesting that there were about 25 university patent assertions per year.<sup>72</sup> The university was joined as a necessary party

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and patent trolls have some major traits in common . . . and that resemblance is growing stronger.”); see also Erin Fuchs, *Tech’s 8 Most Fearsome “Patent Trolls”*, BUS. INSIDER (Nov. 25, 2012) (including WARF in a list of the eight “Most Fearsome ‘Patent Trolls’”); John Koetsir, *Congratulations, Boston University, You’re Now a Patent Troll*, VENTUREBEAT (July 3, 2013 12:17 PM), <http://venturebeat.com/2013/07/03/congratulations-boston-university-youre-now-a-patent-troll> [https://perma.cc/M3LS-LQ5V] (calling Boston University a patent troll for its lawsuit against Apple); Joe Mullin, *Public University, Public Research—And Four Big Patent Suits*, ARSTECHNICA (Nov. 11, 2014, 9:45 AM), <http://arstechnica.com/tech-policy/2014/11/public-university-public-research-and-four-big-patent-suits> (noting increased “criticism that universities are . . . engag[ing] in litigation strategies similar to that of so-called ‘patent trolls’”).

68. See U.S. Patent No. 5,686,738 (filed Jan. 13, 1995) (claiming priority to an application filed Mar. 18, 1991); T. Lei et al., *Epitaxial Growth of Zinc Blende and Wurtzitic Gallium Nitride Thin Films on (001) Silicon*, 59 APPLIED PHYSICS LETTERS 944, 946 (1991) (noting NSF support for the invention described in the patent).

69. See Jon Brodtkin, *Patent-Waving Boston U. Wins Cash from Apple, Amazon, and Microsoft*, ARSTECHNICA (Jan. 16, 2014, 12:45 PM), <http://arstechnica.com/tech-policy/2014/01/patent-waving-boston-u-wins-cash-from-apple-amazon-and-microsoft> [https://perma.cc/GRH6-S9E5] (reporting that twenty-five defendants agreed to undisclosed licensing fees); Joel Brown, *BU Wins \$13 Million in Patent Infringement Suit*, BU TODAY (Dec. 7, 2015), <http://www.bu.edu/today/2015/bu-wins-13-million-in-patent-infringement-suit> [https://perma.cc/THH5-J7HQ] (reporting that BU won \$13 million from the remaining three defendants).

70. Joe Mullin, *Marvell Agrees to Pay Record-Breaking \$750M to University to End Patent Lawsuit*, ARSTECHNICA (Feb. 18, 2016, 2:43 PM), <https://arstechnica.com/tech-policy/2016/02/marvell-will-pay-750m-to-carnegie-mellon-university-in-massive-patent-settlement> [https://perma.cc/Z922-6CWL].

71. See Lisa Larimore Ouellette, *University Patent Plaintiffs, Presentation at Stanford Patent Assertion Entity Symposium* (May 11, 2017) (on file with authors). This figure combines related cases over the same technology, such as when a university asserts the same patent portfolio against a number of defendants in different cases; there were 115 separate lawsuits. *Id.* For details on the random sample, see generally Shawn P. Miller et al., *Who’s Suing Us? Decoding Patent Plaintiffs Since 2000 with the Stanford NPE Litigation Dataset*, 21 STAN. TECH. L. REV. 235 (2018).

72. Analysis by Tania Bubela suggests that “educational institutions file between 45 and 50 patent-related suits each year in the U.S.[.]” though Bubela

by an exclusive licensee or co-owner of the patent in 51 of those 77 assertions.<sup>73</sup> In the other 26, the university directly asserted its patents.<sup>74</sup>

The most detailed published investigation of university involvement in patent-related litigation was conducted by Jacob Rooksby. He found that in 2009 and 2010, universities were plaintiffs in 57 patent infringement lawsuits, 14 of which were filed solely by the university or by the university and its affiliated research entity.<sup>75</sup> He concluded that there was “a remarkable similarity between the litigation behavior of universities and for-profit actors.”<sup>76</sup> Based on subsequent interview and survey work with university TTO directors and chief research officers, Rooksby summarized universities’ motivations for involvement in patent litigation, as well as the barriers to greater patent assertion—including incongruity with mission, public perception as “troll-like,” and high cost.<sup>77</sup> Rooksby found most universities are reluctant to enforce their patents in litigation.<sup>78</sup>

Finally, these litigation events are just a small window into university patent assertion activity. Robin Feldman and Mark Lemley surveyed practicing companies and found that 82% of respondents said a lawsuit rarely (0–10% of the time) preceded those patent

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presumably includes foreign universities and separately counts lawsuits over the same patented technology filed against different defendants. Andrew Chung, *Schools that Sue: Why More Universities File Patent Lawsuits*, REUTERS (Sept. 15, 2015, 10:42 AM), <https://www.reuters.com/article/university-patents/schools-that-sue-why-more-universities-file-patent-lawsuits-idUSL1N11G2C820150915> [<https://perma.cc/8KUE-LJ24>].

73. See Ouellette, *supra* note 71. To sue in its own name without joining the patent owner, an exclusive licensee must possess “all substantial rights” to a patent such that it “may be deemed the effective ‘patentee.’” *Luminara Worldwide, L.L.C. v. Liown Elecs. Co.*, 814 F.3d 1343, 1349 (Fed. Cir. 2016) (quoting *Prima Tek II v. A-Roo Co.*, 222 F.3d 1372, 1377 (Fed. Cir. 2000)). There is no list of which rights constitute “all substantial rights,” but “the right to sue for infringement is critical.” *Id.* at 1350.

74. See Ouellette, *supra* note 71.

75. Jacob H. Rooksby, *University Initiation of Patent Infringement Litigation*, 10 J. MARSHALL REV. INTELL. PROP. L. 623, 650–52 (2011).

76. *Id.* at abstract.

77. See generally Jacob H. Rooksby, *Innovation and Litigation: Tensions Between Universities and Patents and How to Fix Them*, 15 YALE J.L. & TECH. 312 (2013) [hereinafter Rooksby, *Innovation and Litigation*]; Jacob H. Rooksby, *When Tigers Bare Teeth: A Qualitative Study of University Patent Enforcement*, 46 AKRON L. REV. 169 (2013). For earlier interview work, see Scott Shane & Deepak Somaya, *The Effects of Patent Litigation on University Licensing Efforts*, 63 J. ECON. BEHAV. & ORG. 739 (2007).

78. Rooksby, *Innovation and Litigation*, *supra* note 77, at 352–53.

licensing demands from universities that ultimately led to patent licenses.<sup>79</sup> They also found that the licenses negotiated in response to these unsolicited demands were rarely accompanied by technology transfer, whether measured by creation of new products or features, transfers of technical knowledge or personnel, or creation of joint ventures.<sup>80</sup>

## II. HOW DO PATENTS AFFECT EX POST COMMERCIALIZATION OF UNIVERSITY-DEVELOPED INVENTIONS?

The primary justification for patents on publicly funded inventions has been that they promote commercialization of technologies that would otherwise go unused.<sup>81</sup> The idea that Bayh–Dole patents incentivize the development of neglected inventions is reflected in the statutory text<sup>82</sup> and legislative history,<sup>83</sup> and has been noted by the Supreme Court<sup>84</sup> and the Federal Circuit.<sup>85</sup> As summarized by a Congressional Research Service report, when the Bayh–Dole Act was being considered, “it was widely argued that

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79. Robin Feldman & Mark A. Lemley, *Do Patent Licensing Demands Mean Innovation?*, 101 IOWA L. REV. 137, 154 (2015).

80. *See id.* at 161–66; *see also* Robin C. Feldman & Mark A. Lemley, *The Sound and Fury of Patent Activity*, 103 MINN. L. REV. 1793, 1836–39 (2019) (reporting similar results from a broader study).

81. Eisenberg, *supra* note 10, at 1669 (“[A]dvocates of private appropriation of the results of government-sponsored research . . . shift the focus from the initial costs of making an invention to the subsequent costs of developing an existing invention into a commercial product.”); *see, e.g.*, Chester G. Moore, *Killing the Bayh–Dole Act’s Golden Goose*, 8 TUL. J. TECH. & INTELL. PROP. 151, 155 (2006) (defending Bayh–Dole on the basis of this commercialization theory).

82. *See* 35 U.S.C. § 200 (2018) (“It is the policy and objective of the Congress to use the patent system to promote the utilization of inventions arising from federally supported research or development . . .”).

83. *See, e.g.*, H.R. REP. NO. 96-1307, pt. 1, at 3 (1980) (describing the Act as creating “a single, uniform national policy designed to cut down on bureaucracy and encourage private industry to utilize government funded inventions through the commitment of the risk capital necessary to develop such inventions to the point of commercial application”); *see also* 124 CONG. REC. 29,122 (1978) (statement of Sen. Bayh) (expressing concern about the “[h]undreds of valuable medical, energy, and other technological discoveries” that were “sitting unused”).

84. *Bd. of Trs. of Leland Stanford Jr. Univ. v. Roche Molecular Sys., Inc.*, 563 U.S. 776, 782 (2011) (quoting 35 U.S.C. § 200) (“In 1980, Congress passed the Bayh–Dole Act to ‘promote the utilization of inventions arising from federally supported research’ . . .”).

85. *In re Roche Molecular Sys., Inc.*, 516 F.3d 1003, 1008 (Fed. Cir. 2008) (“The purpose of the Bayh–Dole Act is as an incentive, not a bar, to university–industry collaboration and commercial development through licensing . . .”).

without title (or at least an exclusive license) to an invention and the protection it conveys, a company would not invest the additional, and often substantial[,] time and money necessary to commercialize a product or process for the marketplace.”<sup>86</sup>

In a 2002 paean to Bayh–Dole, *The Economist* painted a dreary picture of the world before 1980:

[I]nventions and discoveries made in American universities, teaching hospitals, national laboratories and non-profit institutions sat in warehouses gathering dust. Of the 28,000 patents that the American government owned in 1980, fewer than 5% had been licensed to industry. Although taxpayers were footing the bill for 60% of all academic research, they were getting hardly anything in return.<sup>87</sup>

But then came “the most inspired piece of legislation to be enacted in America over the past half-century”: the Bayh–Dole Act, which “unlocked all the inventions and discoveries” that had been gathering dust and turned universities into “hotbeds of innovation” that generate patents, spin-offs, jobs, and billions of dollars for the U.S. economy.<sup>88</sup> The licensors of academic patents have been estimated to contribute hundreds of billions of dollars to U.S. GDP and millions of person-years of employment from 1996 to 2015.<sup>89</sup>

This compelling picture, however, is only part of the Bayh–Dole story. As Bhaven Sampat has explained, “in most industries patents are a relatively unimportant channel” through which university research is transferred to industry.<sup>90</sup> Patent licenses may be salient and easily quantifiable, but they are not the only measure of whether the public is getting anything in return for its direct support of R&D—many technologies based on federal funding have entered the marketplace without patents, both before and after Bayh–Dole.<sup>91</sup> Indeed, the idea of using non-IP incentives (grants) to spur creation of

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86. WENDY H. SCHACHT, CONG. RESEARCH SERV., *THE BAYH–DOLE ACT: SELECTED ISSUES IN PATENT POLICY AND THE COMMERCIALIZATION OF TECHNOLOGY* 2 (2012).

87. Opinion, *Innovation’s Golden Goose*, *ECONOMIST TECH. Q.*, Dec. 14, 2002, [http://www.economist.com/science/tq/displaystory.cfm?story\\_id=1476653](http://www.economist.com/science/tq/displaystory.cfm?story_id=1476653) [<https://perma.cc/CWJ5-NBZN>]. Eisenberg, *supra* note 10, at 1702, points out serious selection effects in this data.

88. See *Innovation’s Golden Goose*, *supra* note 87.

89. BIOTECHNOLOGY INNOVATION ORG. & AUTM, *THE ECONOMIC CONTRIBUTION OF UNIVERSITY/NONPROFIT INVENTIONS IN THE UNITED STATES: 1996–2015* 3 (2017).

90. See Sampat, *supra* note 10, at 773.

91. See *id.*; see also NAT’L RES. COUNCIL, *supra* note 40, at 60 (listing mechanisms for knowledge transfer).

a new knowledge good and then choosing to allocate access to that good through IP rather than an open access regime may initially seem odd. IP creates allocative inefficiency—the deadweight loss of proprietary pricing that affects both end-users and subsequent innovators—so why would society choose to incur that cost when it is not necessary to incentivize production of the good in the first place?<sup>92</sup>

The answer depends on the specific technology at issue. There are two general mechanisms through which an IP-based allocation regime for publicly funded inventions may lead to more efficient utilization of those inventions than open access. First, as discussed in Section II.A, the knowledge good may be useful primarily as an input for production of a follow-on knowledge good that requires substantial investment. For example, knowledge that a particular compound seems effective against HIV in an *in vitro* cell line is not terribly useful until someone takes the subsequent step of determining whether the compound is safe and effective for use in humans. A patent on the initial knowledge good that covers the follow-on use is one way to incentivize the later stages of development.

Second, as discussed in Section II.B, the knowledge good may be more useful when its original creators are involved in its dissemination. For example, if the invention depends on some laboratory technique that is difficult to explain in writing and best conveyed person-to-person, a patent on the initial knowledge good may help encourage this tacit knowledge transfer.

#### A. Exclusivity as a Commercialization Incentive

When might exclusivity itself be necessary for commercialization? The clearest example is pharmaceuticals: If no one were permitted to patent a promising HIV treatment discovered by an NIH-funded researcher at Duke University, it is unlikely that any pharmaceutical firm would conduct the expensive clinical trials necessary to gain approval from the Food and Drug Administration (FDA).<sup>93</sup> Just how expensive those clinical trials are is vigorously

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92. See Hemel & Ouellette, *Innovation Policy Pluralism*, *supra* note 19, at 567 (describing how Bayh–Dole produces this “matching” between non-IP innovation incentives and IP-based allocation mechanisms).

93. Benjamin N. Roin, *Unpatentable Drugs and the Standards of Patentability*, 87 TEX. L. REV. 503, 545 (2009) (“[P]harmaceutical companies systematically screen their drug candidates to exclude the ones lacking strong patent protection . . .”).

disputed,<sup>94</sup> but they are costly enough that for-profit firms invest in drugs that are expected to have lengthy remaining patent protection once they are brought to market.<sup>95</sup> But because Duke was able to patent the novel compound (enfuvirtide, marketed as Fuzeon), it could grant an exclusive license to the pharmaceutical firm Roche, which then gave Roche enough financial incentive to bring the drug to market.<sup>96</sup>

Of course, granting exclusive patent licenses to for-profit firms and then paying the patent “shadow tax”<sup>97</sup> on resulting products is not the only way to fund drug development. Roche and other firms that commercialize university inventions also benefit significantly from nonpatent incentives such as regulatory exclusivity, tax preferences, and direct federal grants,<sup>98</sup> and these could be increased. Additionally, numerous scholars—including one of us—have questioned why the government does not directly fund more clinical trials.<sup>99</sup> But given

94. See Lisa Larrimore Ouellette, *How Many Patents Does It Take to Make a Drug?*, 17 MICH. TELECOMM. & TECH. L. REV. 299, 302, nn.10–12 (2010) [hereinafter Ouellette, *How Many Patents*] (citing figures ranging from under \$100 million to over \$1 billion). A recent study of fifty-nine new drugs approved by the FDA in 2015 and 2016 estimated a median clinical trial *direct cost* of \$19 million, ranging from less than \$5 million for three orphan drugs tested without a control to a high of almost \$350 million. Thomas J. Moore et al., *Estimated Costs of Pivotal Trials for Novel Therapeutic Agents Approved by the US Food and Drug Administration, 2015-2016*, 178 JAMA INTERNAL MED. 1451, 1451 (2018). But this direct cost does not account for the high risk of failure or the opportunity cost of the investment.

95. See Roin, *supra* note 93 (explaining that pharmaceutical companies drop drugs that lack strong patent protection from their development pipelines). See generally Eric Budish, Benjamin N. Roin & Heidi Williams, *Do Firms Underinvest in Long-Term Research? Evidence from Cancer Clinical Trials*, 105 AM. ECON. REV. 2044 (2015) (showing a distortion in R&D away from drugs with shorter effective patent life).

96. See Ouellette, *How Many Patents*, *supra* note 94, at 332 (providing the patent information for Fuzeon); see also Betsy de Parry, *Why Bipartisanship Matters*, IPWATCHDOG (Nov. 3, 2012), <http://www.ipwatchdog.com/2012/11/03/why-bipartisanship-matters/> [<https://perma.cc/2FD8-3G6X>] (“[N]early 200 . . . drugs are available today as a result of . . . a little-known bill that laid the foundation for the development of therapies that have saved—literally—millions of lives . . . . That bill became known as the Bayh–Dole Act.”).

97. See Hemel & Ouellette, *Beyond the Patents–Prizes Debate*, *supra* note 19, at 312, 371–72 (explaining that the “shadow tax” is a cost borne by consumers and taxpayers).

98. See generally Lisa Larrimore Ouellette, *Patentable Subject Matter and Nonpatent Innovation Incentives*, 5 U.C. IRVINE L. REV. 1115 (2015) [hereinafter Ouellette, *Nonpatent Innovation Incentives*] (providing an overview of these incentives).

99. Hemel & Ouellette, *Innovation Policy Pluralism*, *supra* note 19, at 570–71 (“One might think that the federal government would have an advantage over private industry in bringing new pharmaceutical products to market, given its unique

existing institutional structures and incentives, if a university were unable to patent a promising drug candidate, it seems unlikely that the drug would be developed. With the ability to use patents to transfer drugs to industry, universities are playing a significant role in the drug-development pipeline, with one study suggesting that they are responsible for about a third of the most innovative new drugs.<sup>100</sup>

Exclusivity may be important for pharmaceutical development, but it is not necessary for commercialization of all university inventions, as evidenced by the fact that over 60% of patent licenses reported by universities are nonexclusive.<sup>101</sup> To be sure, if each nonexclusively licensed invention involves a large number of licenses, the fraction of patented inventions that are nonexclusively licensed may be far smaller. And as noted by Hemel and Ouellette, “one should be cautious about inferring that all nonexclusive licenses have no commercialization value: for instance, universities might maximize profits through cartel rather than monopoly arrangements,”<sup>102</sup> though we do not know of universities that have adopted this strategy. At the very least, the prevalence of nonexclusive licenses raises questions

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ability to raise capital and especially given that the challenge of bringing a new drug to market largely involves navigating *federal* regulations . . . . [T]he public sector would [outperform] the private sector on these dimensions if the government committed itself to a more active role in development and commercialization.”)

100. See Robert Kneller, *The Importance of New Companies for Drug Discovery: Origins of a Decade of New Drugs*, 9 NATURE REVS. DRUG DISCOVERY 867, 869 tbl.1 (2010) (focusing on all drugs coming out of universities, including ones based on industry funding, and reporting that of drugs approved 1998 to 2007, including biologics, universities discovered 30% of “priority review” drugs—for “drugs that are anticipated to provide substantial benefit over currently marketed drugs”—and 31% of “scientifically novel” drugs); see also Bhaven N. Sampat & Frank R. Lichtenberg, *What Are the Respective Roles of the Public and Private Sectors in Pharmaceutical Innovation?*, 30 HEALTH AFF. 332, 334–35 (2011) (focusing on federally funded drugs and reporting that 17% of priority review drugs approved 1988 to 2005 had a patent assigned to the government or acknowledging government support).

101. See Ayres & Ouellette, *supra* note 22, at 275 n.16 (citing AUTM SURVEY, *supra* note 28); see also Eisenberg, *supra* note 10, at 1710 (“[N]onexclusive licenses do little or nothing to give licensees an advantage over their competitors and thus are unlikely to enhance the profitability of product development.”).

102. See Hemel & Ouellette, *Bayh–Dole Beyond Borders*, *supra* note 24, at 289–90; *id.* at 290 n.46 (“[I]f a licensee firm thinks a university is profit maximizing, it might accept a nonexclusive license for a percentage of its profits on the condition that the university demand the same percentage from any future licensee. A purely profit-motivated university would have an incentive to grant a second non-exclusive license only if the first firm turns out to be bad at commercializing the invention (because a fixed percentage of monopoly profits is greater than that same percentage of duopoly profits).”).

about the applicability of commercialization theory across all technology classes.<sup>103</sup>

Exclusivity does not seem to have been needed for commercialization of a number of high-profile university inventions. For example, Stanford's Cohen–Boyer patents on early recombinant DNA technology and Columbia's Axel patents on a method for inserting foreign DNA into cells were platform technologies that were foundational for the U.S. biotechnology industry.<sup>104</sup> They were widely and nonexclusively licensed, bringing in \$255 million to Stanford and \$790 million to Columbia.<sup>105</sup> We will return in Part IV to whether this revenue helps provide an additional justification for university patenting, but it seems hard to argue that these biotech techniques would not have been adopted by industry if they had not been patented.<sup>106</sup>

Another example from the biosciences may be genetic diagnostic tests, raising questions about whether the added incentive needed for pharmaceutical commercialization is applicable to overcoming lower regulatory hurdles.<sup>107</sup> A request by the Department of Health and Human Services found that for none of the ten genetic tests studied—including the breast cancer gene tests patented by Myriad Genetics—“was the test developed by the exclusive rights holder the first to market.”<sup>108</sup> Although diagnostics are increasingly

103. For similar critiques of the commercialization justification for university patents, see Suzanne Scotchmer, *Intellectual Property—When Is It the Best Incentive Mechanism for S&T Data and Information?*, in *THE ROLE OF SCIENTIFIC AND TECHNICAL DATA AND INFORMATION IN THE PUBLIC DOMAIN* 15, 18 (Julie M. Esanu & Paul F. Uhler eds., 2003); Lemley, *supra* note 25, at 624; Rai, *supra* note 26, at 120, 135; Rai & Eisenberg, *supra* note 25, at 300; Sampat, *supra* note 10, at 786. For a critique of commercialization theories as a justification of lawsuits and licensing demands from non-practicing entities, see Mark A. Lemley & Robin Feldman, *Is Patent Enforcement Efficient?*, 98 B.U. L. REV. 649, 656–57 (2018).

104. See Alessandra Colaianni & Robert Cook-Deegan, *Columbia University's Axel Patents: Technology Transfer and Implications for the Bayh–Dole Act*, 87 MILBANK Q. 683, 685–86 (2009); see also Ayres & Ouellette, *supra* note 22, at 275.

105. Colaianni & Cook-Deegan, *supra* note 104, at 684–85; see also Leute, *supra* note 44, at 221.

106. Eisenberg, *supra* note 10, at 1710 (“[I]t can hardly be argued that the patents have done anything to promote product development that would not have occurred if the patented technology had instead been placed in the public domain.”).

107. On the lower hurdles for diagnostics than therapeutics, see Ouellette, *Nonpatent Innovation Incentives*, *supra* note 98, at 1129, 1136–37.

108. See SEC’Y’S ADVISORY COMM. ON GENETICS, HEALTH, AND SOC’Y, U.S. DEP’T HEALTH & HUMAN SERVS., *GENE PATENTS AND LICENSING PRACTICES AND THEIR IMPACT ON PATIENT ACCESS TO GENETIC TESTS* 31 n.82 (2010); see also Hemel

difficult to patent,<sup>109</sup> it is not clear whether this is creating problems outside the university context,<sup>110</sup> and the case for patents is less convincing when the early stages of the research have already been funded by grants.

It is also difficult to square commercialization theory with assertion of patents in litigation against successful products that have incorporated the patented technology without a license, or with outsourcing this function to patent-assertion entities. For example, Boston University's successful patent suit against large technology companies for its patent on blue LEDs may have brought in significant income for the university,<sup>111</sup> but the widespread adoption of this technology without exclusivity indicates that exclusivity was not necessary to make blue LEDs publicly available. Rather, like the Cohen–Boyer and Axel nonexclusive licenses, this kind of litigation seems to impose a tax on users (including both end-users and subsequent innovators) that cannot be justified for its commercialization benefit.<sup>112</sup> Similarly, an analysis of university software patent lawsuits filed by 2006 found “a number of lawsuits in which university software patents have been used not for purposes of fostering commercialization, but instead to extract rents in apparent holdup litigation.”<sup>113</sup>

Ayres and Ouellette have argued that if the benefit of exclusivity for commercialization is the only compelling justification for Bayh–Dole patents, then “a nonexclusive license is *prima facie* evidence that

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& Ouellette, *Bayh–Dole Beyond Borders*, *supra* note 24, at 290–91 (noting that the breast cancer gene patent that was invalidated by *Association for Molecular Pathology v. Myriad Genetics*, 569 U.S. 576 (2013), was jointly owned by Myriad, the University of Utah, and the United States and was funded by the NIH and the National Institute of Environmental Health Sciences).

109. See, e.g., *Cleveland Clinic Found. v. True Health Diagnostics LLC*, 859 F.3d 1352, 1359 (Fed. Cir. 2017) (holding the testing processes at issue to be patent ineligible); see also Rebecca S. Eisenberg, *Diagnostics Need Not Apply*, 21 B.U. J. SCI. & TECH. L. 256, 257 (2015) (discussing the patent-ineligibility of advances in diagnostic medicine and its implications).

110. See Colleen Chien & Arti K. Rai, *An Empirical Analysis of Diagnostic Patenting Post-Mayo* (unpublished manuscript).

111. See *supra* note 69 and accompanying text.

112. For an explanation of how patents act as a “shadow tax” on patented products, see Hemel & Ouellette, *Beyond the Patents-Prizes Debate*, *supra* note 19 and accompanying text.

113. See Arti K. Rai, John R. Allison & Bhaven N. Sampat, *University Software Ownership and Litigation: A First Examination*, 87 N.C. L. REV. 1519, 1519 (2009).

the invention ought not to have been patented at all.”<sup>114</sup> More generally, federally funded inventions that are patented should be subject to a “market test”:

Before charging significant licensing fees for these inventions, these federal grant recipients would first be required to find out whether firms would be willing to commercialize the invention in exchange for a nonexclusive license with a nominal fee. If a company is willing to commit to developing the invention under a nonexclusive license, then an exclusive license—or a nonexclusive license with high fees—would be contrary to the public interest. More generally, using a formal economic model, we show that deadweight loss can be reduced through an auction that forces bidders to reveal the least amount of exclusivity needed to induce commercialization, that revenue cap bidding is more efficient than duration bidding, and that defensive bidding by firms that consume as well as produce the invention will not increase deadweight loss.<sup>115</sup>

Ayres and Ouellette did not claim that the commercialization benefit of exclusivity *is* the only compelling justification for Bayh–Dole patents. Rather, the goal was, “[b]y showing that it would not be infeasible to limit Bayh–Dole patents to those areas in which they are actually needed for commercialization, . . . to shift the burden to Bayh–Dole defenders to develop stronger theoretical and empirical accounts of why patents should be allowed in other cases.”<sup>116</sup> In other words, because commercialization theory does not justify the present scope of university patenting practices, either other theories must be developed, or the Bayh–Dole Act should be curtailed. In the remainder of this Article, we examine what evidence exists to support alternative benefits.

## B. Patent Rewards as an Incentive for Inventor Involvement and Tacit Knowledge Transfer

Even if market exclusivity itself is not necessary for commercialization, patents may still facilitate development of university inventions if they provide an incentive for university inventors to be directly involved in commercialization and if this personal involvement leads to more efficient use. This mechanism seems most important for inventions that depend heavily on tacit knowledge, or knowledge that is conveyed more easily in person than

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114. See Ayres & Ouellette, *supra* note 22, at 276.

115. *Id.* at 271–72.

116. *Id.* at 280.

in writing.<sup>117</sup> It may also be important for simply encouraging inventors to comply with the formalities of disclosing inventions and help TTOs with prosecution. However, as discussed in this Section, not all licensees need tacit knowledge transfer for successful commercialization, and patent licensing contracts are not the only mechanism for incentivizing inventor involvement. Other types of incentives may enable tacit knowledge transfer at a lower cost. Additionally, the benefits of tacit knowledge transfer must be weighed against the opportunity cost of taking inventors away from other efforts.

The Senate Judiciary Committee Report accompanying the Bayh–Dole Act noted the benefit of inventor involvement, reporting that among witnesses testifying before the committee, “[v]irtually all experts in the innovation process stress very strongly that . . . involvement by the inventor is absolutely essential [for further development], especially when the invention was made under basic research where it is invariably in the embryonic stage of development.”<sup>118</sup> In support of Bayh–Dole, witnesses explained to the committee that “when Government agencies retain title to inventions made by nonprofit organizations or small business contractors there is no incentive for the inventor to remain involved in the possible development of the patentable discovery.”<sup>119</sup>

Because codifying knowledge is costly, university inventors have a great deal of knowledge that is not captured in patents or publications. As Ajay Agrawal has explained, knowledge does not fall into binary categories of codified or tacit: much of the uncoded knowledge university inventors have may be codifiable, but at some cost.<sup>120</sup>

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117. Others define tacit knowledge as not codifiable and not contractible, as “that knowledge that requires repeated or prolonged interaction between two people to exchange.” Robert A. Lowe, *Who Develops a University Invention? The Impact of Tacit Knowledge and Licensing Policies*, 31 J. TECH. TRANSFER 415, 427 (2006). In light of later theoretical and empirical work on consulting arrangements and other knowledge transfer provisions in licensing contracts, it seems accurate to describe this knowledge as having a high cost to codify.

118. S. REP. NO. 96-480, at 22 (1979).

119. *Id.*

120. See Ajay Agrawal, *Engaging the Inventor: Exploring Licensing Strategies for University Inventions and the Role of Latent Knowledge*, 27 STRATEGIC MGMT. J. 63, 64 (2006); see also Lynne G. Zucker, Michael R. Darby & Jeff S. Armstrong, *Commercializing Knowledge: University Science, Knowledge Capture, and Firm Performance in Biotechnology*, 48 MGMT. SCI. 138, 140 (2002); James E. Bessen, *From Knowledge to Ideas: The Two Faces of Innovation* (Boston Univ. Sch. L., Working Paper No. 10-35, 2012), <https://ssrn.com/abstract=1698802> (showing

Additionally, only certain knowledge is considered patentable or publishable.<sup>121</sup> For example, failed experiments are codifiable and may be valuable for preventing redundant work but are typically not published.<sup>122</sup> While a great deal of information *could* be disclosed in a patent, the disclosure requirement does not legally require it, and codification by a patent attorney in a patent is both costly and sometimes not the most effective way to communicate.<sup>123</sup> Uncodified-but-codifiable “latent knowledge”<sup>124</sup> may also include “heuristics, rules of thumb, and other ‘tricks of the trade’” the inventor learns by trial and error;<sup>125</sup> “intuition regarding how the invention might behave under alternate circumstances;”<sup>126</sup> and background knowledge from “disparate fields” that the inventor has learned “on an as-needed basis.”<sup>127</sup> The fact that university inventions are typically “embryonic” at the time of disclosure and licensing<sup>128</sup> suggests the associated knowledge is not yet codified, and that a university patent alone will rarely convey all the inventor’s knowledge relevant to development

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communication costs are endogenous and the cost of codification can explain distribution in patenting across different firm sizes and geographic regions).

121. See Agrawal, *supra* note 120, at 64.

122. See *id.*

123. See Peter Lee, *Transcending the Tacit Dimension: Patents, Relationships, and Organizational Integration in Technology Transfer*, 100 CALIF. L. REV. 1503, 1519–20 (2012) (summarizing scholarly commentary on limitations of patent disclosures).

124. Agrawal, *supra* note 120, at 64.

125. Ashish Arora, *Licensing Tacit Knowledge: Intellectual Property Rights and the Market for Know-How*, 4 ECON. INNOVATION & NEW TECH. 41, 42 (1995).

126. Agrawal, *supra* note 120, at 64.

127. *Id.* at 65.

128. See Richard Jensen & Marie Thursby, *Proofs and Prototypes for Sale: The Licensing of University Inventions*, 91 AM. ECON. REV. 240, 243 (2001) (surveying TTO managers about their 1991–95 licensing activities); Jerry G. Thursby & Marie C. Thursby, *Are Faculty Critical? Their Role in University–Industry Licensing*, 22 CONTEMP. ECON. POL’Y, 162, 167 (2004) (surveying firms about their 1993–97 licensing activity with universities).

and commercialization.<sup>129</sup> Engaging the inventor directly is the most obvious way for a firm to capture this tacit knowledge.<sup>130</sup>

Inventor involvement with a licensee has been associated with various metrics of commercial success across technological fields,<sup>131</sup> although these studies have not isolated the causal effect of inventor involvement or whether the benefits outweigh the costs for inventors or for licensees. In mechanical engineering, electrical engineering, and computer science at MIT, Agrawal found a positive and statistically significant association between inventor engagement, measured by hours of collaboration, and both whether a product based on the licensed invention is sold and the average annual royalty payments over the duration of the license agreement.<sup>132</sup> Lynne Zucker and her coauthors found biotechnology firms that collaborate with academics, as measured by coauthorship with the firm's scientists, have more

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129. Most scholars point to the embryonic nature of disclosed inventions as evidence of *more* tacit knowledge, pointing out that knowledge is tacit when it is first produced and eventually becomes codified. See Agrawal, *supra* note 120, at 64; Zucker, *supra* note 120, at 140; Richard A. Jensen, *University–Industry Linkages in the Support of Biotechnology Discoveries*, ANN. REV. RESOURCE. ECON., 377, 380 (2016). Others, however, describe tacit knowledge as know-how that accumulates over time, which might therefore be more abundant for more fully developed technologies. See Arora, *supra* note 125, at 42. Still others suggest that the importance of tacit knowledge is greater for more complex technologies, rather than newer technologies. See Gaétan de Rassenfosse, Alfons Palangkaraya & Elizabeth Webster, *Why Do Patents Facilitate Trade in Technology? Testing the Disclosure and Appropriation Effects*, 45 RES. POL'Y 1326, 1372 (2016).

130. Agrawal points to four reasons engaging the inventor in tacit knowledge transfer is useful for commercialization: the inventor (1) can often codify non-codified knowledge with appropriate incentives; (2) has mastered the complex bodies of knowledge needed to use the invention; (3) has intuition about how the invention will behave in different circumstances; and (4) can provide knowledge on an as-needed basis rather than requiring the licensee to predict product development in advance. See Agrawal, *supra* note 120, at 65.

131. Though this effect has been documented across fields, payoffs from commercial activities and opportunity costs of time spent away from research vary across disciplines. See Wesley M. Cohen, Henry Sauerermann & Paula Stephan, *Not in the Job Description: The Commercial Activities of Academic Scientists and Engineers*, MGMT. SCI. (forthcoming 2020), <https://doi.org/10.1287/mnsc.2019.3535>. These differences affect the level of incentives necessary to induce inventor involvement under models such as in Jensen & Thursby, *supra* note 128, at 241.

132. See Agrawal, *supra* note 120, at 75. Agrawal disposes of the possibility that inventors are scaling their involvement based on likelihood of commercial success. However, Agrawal does not address firms' criteria for involving inventors and does not include a measure of tacit knowledge or otherwise prove it is the causal mechanism. See *id.* at 65.

products in development and on the market.<sup>133</sup> In interviews and case studies, university inventors, licensees, and TTOs explain that they view inventor involvement as important for development and commercialization.<sup>134</sup> Outside the university context, licenses requiring the licensor to provide technical assistance are associated with more subsequent patenting.<sup>135</sup> The effect is diminished for licensees that already have patents in the relevant subject area, for whom tacit knowledge transfer is presumably less important.<sup>136</sup>

The economics literature has framed inventor involvement as a moral hazard problem, in which incentives linked to commercialization success are necessary to ensure the inventor devotes sufficient effort to the firm.<sup>137</sup> Licensing agreements with royalties can provide such an incentive, as can licensing agreements with other “continuation payments” such as equity or milestone payments.<sup>138</sup> Inventor involvement in tacit knowledge transfer may

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133. See Lynne G. Zucker, Michael R. Darby & Jeff Armstrong, *Geographically Localized Knowledge: Spillovers or Markets?*, 36 *ECON. INQUIRY* 65, 81 (1998); Zucker, *supra* note 120, at 140 (discussing how firms that collaborate with successful academics produce more patents, with a higher citation rate per patent, than firms that do not). Neither study addresses the possibility that more promising firms are able to attract star scientists at a higher rate.

134. See Jensen & Thursby, *supra* note 128, at 243 (finding TTO managers believe 71% of licensed inventions require cooperation by the inventor for further development); Thursby & Thursby, *supra* note 128, at 170 (finding that “[f]aculty have specialized knowledge” is the most common reason firms give that faculty input is considered important for further development of a technology).

135. See Maria Isabella Leone et al., *License to Learn: An Investigation into Thin and Thick Licensing Contracts*, 46 *R&D MGMT.* 326, 332 (2016).

136. See *id.*

137. See, e.g., Emmanuel Dechenaux, Jerry Thursby & Marie Thursby, *Inventor Moral Hazard in University Licensing: The Role of Contracts*, 40 *RES. POL'Y* 94 (2011); Jensen & Thursby, *supra* note 128, at 246–47.

138. Based on a theoretical model, Richard Jensen and Marie Thursby show equity induces inventor effort more efficiently than a royalty because an equity share does not decrease the profit-maximizing output level. See Jensen & Thursby, *supra* note 128, at 246, 251–52. A survey of Harvard’s license agreements found, however, that the inclusion of equity provisions was associated with a higher rate of contract termination. See Daniel W. Elfenbein, *Contract Structure and Performance of University-Industry Technology Transfer Agreements* 19 (July 2009) (unpublished manuscript), <https://ssrn.com/abstract=1452717>. Elfenbein accounts for the possibility of endogenous matching by showing that large and small licensees use equity at similar rates. See *id.* at 24. Milestone payments create less deadweight loss than royalties and are viewed as important when faculty involvement is critical, but university license agreements commonly include royalties as well as milestone payments, perhaps because a risk-averse firm will prefer to include royalties to shield

also be induced by license agreements providing for corporate-sponsored research or consulting arrangements.<sup>139</sup> For inventions that require significant tacit knowledge transfer for commercialization, inventor-owned startups may be the most effective mechanism.<sup>140</sup> But the value of these different structures for facilitating inventor involvement has primarily been studied through theoretical modeling; empirical evidence supporting the existence of a moral hazard problem is scant and outdated.<sup>141</sup>

Additionally, although license agreements provide a tractable scaffold for tacit-knowledge-transfer arrangements, tacit knowledge transfer also occurs outside patent channels. A consulting arrangement itself may serve as a non-patent form of exclusivity.<sup>142</sup> The consulting arrangement could be exclusive by its terms, or it could be exclusive in practice, given inventors' reluctance to spend time away from academic research to transfer tacit knowledge to multiple firms. Firms relying on consulting for exclusivity, though, may be reluctant to disclose advances in publications, which runs counter to norms of open science.<sup>143</sup> Where inventions are patented, just as nonexclusive licenses are prima facie evidence that exclusivity is not necessary for

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itself from the risk the invention will be a technical success but a commercial failure. See Dechenaux, Thursby & Thursby, *supra* note 137, at 98–100.

139. For economic models, see Dechenaux, Thursby & Thursby, *supra* note 137, at 98; Jensen & Thursby, *supra* note 128, at 252; and Inés Macho-Stadler, David Pérez-Castrillo & Reinilde Veugelers, *Designing Contracts for University Spin-Offs*, 17 J. ECON. & MGMT. STRATEGY 185 (2008).

140. See Lowe, *supra* note 117, at 415–18 (developing a theoretical model of how inventor know-how might affect an inventor's decision to license an invention or create a start-up).

141. See Daniel W. Efenbein, *Publications, Patents, and the Market for University Inventions*, 63 J. ECON. BEHAV. & ORG. 688, 689 (2007) (“While it is clear that a scientist's time is a scarce input in the production function that generates both of these economically desirable outputs, the empirical research has found little evidence that commercialization activity and scientific research are substitutes in the statistical sense; rather, these outputs seem to be highly correlated even after controlling for a number of factors.”). *But see* Jensen & Thursby, *supra* note 128, at 248 (“[I]n many cases TTO managers said one of their major challenges is getting productive research faculty to disclose and continue to develop inventions beyond the proof of concept stage.”).

142. See Lee, *supra* note 123, at 1570 (describing tacit knowledge as naturally excludable); Emily Michiko Morris, *The Many Faces of Bayh–Dole*, 54 DUQ. L. REV. 81, 123 (2016); Michael R. Darby & Lynne G. Zucker, *Grilichesian Breakthroughs: Inventions of Methods of Inventing and Firm Entry in Nanotechnology* 4, 17 (Nat'l Bureau of Econ. Research, Working Paper No. 9825, 2003).

143. See generally Rebecca S. Eisenberg, *Proprietary Rights and the Norms of Science in Biotechnology Research*, 97 YALE L.J. 177 (1987) (explaining how proprietary rights are counter to scientific norms).

commercialization, licenses to more than a few firms are prima facie evidence that inventor involvement is not necessary for commercialization.

Tacit knowledge transfer can also occur without any formal incentives or agreements. Ajay Agrawal and Rebecca Henderson found that faculty members at MIT perceive informal knowledge channels (conferences, co-supervision, recruitment, and conversations) to have about as much influence on industry activities as formal channels of tacit knowledge transfer (consulting, collaborative research), and more influence than codified knowledge (publications, patents and licenses).<sup>144</sup>

There is little doubt that inventors can facilitate commercialization of their inventions, but we have not located any convincing evidence on the causal effect of patents and license agreements to induce their cooperation. Continuation payments are common, as moral hazard models predict. Even in the absence of moral hazard, though, firms may prefer to use continuation payments because the value of the invention is too uncertain at the time of licensing to use up-front payments.<sup>145</sup> The embryonic nature of university inventions is an essential premise of the tacit-knowledge-transfer justification for university patenting, but the primary evidence for the development stage of university inventions is survey data from the early 1990s.<sup>146</sup> Validation of moral hazard models with more recent data is warranted, especially in light of the fact that many TTOs reorganized in the 1990s,<sup>147</sup> and the use of different types of continuation payments fluctuated during that period.<sup>148</sup> The Internet and ease of travel have made tacit knowledge transfer faster and cheaper, while the Internet has also reduced the cost of codification for knowledge not publishable in scientific journals. These changes raise questions about whether patents and license agreements are

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144. See Ajay Agrawal & Rebecca Henderson, *Putting Patents in Context: Exploring Knowledge Transfer from MIT*, 48 MGMT. SCI. 44, 53 (2002); Wesley M. Cohen et al., *Industry and the Academy: Uneasy Partners in the Cause of Technological Advance*, in CHALLENGES TO RESEARCH UNIVERSITIES 171, 171–87 (Roger G. Noll ed., 1998).

145. See Jerry G. Thursby, Richard Jensen & Marie C. Thursby, *Objectives, Characteristics and Outcomes of University Licensing: A Survey of Major U.S. Universities*, 26 J. TECH. TRANSFER 59, 64 (2001).

146. See Jensen & Thursby, *supra* note 128, at 242.

147. See Thursby, Jensen & Thursby, *supra* note 145, at 60.

148. See Jensen & Thursby, *supra* note 128, at 246; see also Elfenbein, *supra* note 138, at 15.

necessary or cost-effective as a means of promoting tacit knowledge transfer.

### III. WHAT EX ANTE EFFECT DO PATENT INCENTIVES HAVE ON THE QUANTITY, QUALITY, OR DIRECTION OF UNIVERSITY RESEARCH?

As summarized by Mark Lemley, “[t]he standard justification for intellectual property is ex ante . . . . It is the prospect of the intellectual property right that spurs creative incentives.”<sup>149</sup> And the Bayh–Dole framework does provide incentives for university inventors. By statute, government-funded researchers must receive a percentage of patent royalties from their inventions: the Bayh–Dole Act requires that agreements between the government funding agency and a contracting university or other nonprofit include “a requirement that the contractor share royalties with the inventor.”<sup>150</sup> Inventors may also receive preference in using the patent to create a start-up.<sup>151</sup> One might thus expect this added financial incentive to increase the quality or quantity of research produced ex ante by university researchers.

Legal scholars generally have dismissed this incentive effect in the university context, arguing that the public already bears the fixed costs of grant-funded research, and that patents inefficiently force taxpayers to “pay twice” for the resulting knowledge goods.<sup>152</sup>

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149. Mark A. Lemley, *Ex Ante Versus Ex Post Justifications for Intellectual Property*, 71 U. CHI. L. REV. 129, 129 (2004).

150. 35 U.S.C. § 202(c)(7)(B) (2017). The relevant standard contract language is:

(2) The *contractor* will share royalties collected on a subject invention with the inventor, including Federal employee co-inventors (when the agency deems it appropriate) when the subject invention is assigned in accordance with 35 U.S.C. 202(e) and 37 CFR 401.10;

(3) The balance of any royalties or income earned by the *contractor* with respect to subject inventions, after payment of expenses (including payments to inventors) incidental to the administration of subject inventions, will be utilized for the support of scientific research or education

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37 C.F.R. § 401.14(k) (2018) (emphasis added). Note that the Bayh–Dole Act does not specify a *particular* royalty share for university and nonprofit researchers. In contrast, the Stevenson–Wylder Act specifies that inventors at government laboratories receive the first \$2,000 of royalties each year plus 15% of any additional royalties. 15 U.S.C. § 3710c(a)(1)(A)(i) (2018).

151. See *supra* Section I.B.

152. See, e.g., Rochelle Cooper Dreyfuss, *Collaborative Research: Conflicts on Authorship, Ownership, and Accountability*, 53 VAND. L. REV. 1161, 1194 (2000); see also Eisenberg, *supra* note 10, at 1666; cf. Bd. of Trs. of Leland Stanford Junior Univ. v. Roche Molecular Sys., Inc., 563 U.S. 776, 796 (2011) (Breyer, J., dissenting)

Moreover, university researchers have other motivations to innovate, including the desire for tenure and prestige.<sup>153</sup> The net incentive effect of Bayh–Dole patents on researchers could even be *negative* if, for example, the financial rewards reduce intrinsic motivations<sup>154</sup> or cause researchers to shift their research focus away from more socially valuable but unpatentable research.

But the potential incentive benefit of Bayh–Dole patents for researchers cannot easily be dismissed as a matter of theory. The patent incentive may help encourage researchers to stay in academia rather than shifting to industry research or to fields like finance that value quantitative skills. It may provide added incentive to produce more or better research, especially for faculty who have already satisfied the requirements for tenure. And if it causes a shift in research focus, that shift may well be *toward* more socially valuable work. Thus, rather than forcing the public to “pay twice” for the same invention, Bayh–Dole may split the bill into ex post market-set patent rewards and ex ante government-set payments. And mixing these different innovation policy instruments may help direct research toward the projects with the most social benefit by tethering part of the payment to commercial success.<sup>155</sup>

Patents are complex legal instruments, so it is worth disentangling the different influences that patents may have on academic researchers. We can identify at least three independent potential benefits that the prospect of patents may have for faculty researchers. First, and perhaps most obviously, patents can have a *financial* effect. The requirement that universities share patent royalties with inventors means that academic researchers can capture

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(arguing that there must be some compensating benefit of Bayh–Dole because otherwise, “[w]hy should the public have to pay twice for the same invention?”). For an analysis of this critique, see generally Rebecca E. Wolitz, *The Pay-Twice Critique, Government Funding, and Reasonable Pricing Clauses*, 39 J. LEGAL MED. 177 (2019).

153. See, e.g., Eisenberg, *supra* note 10, at 1668; see also Lemley, *supra* note 25, at 621; Brian J. Love, *Do University Patents Pay Off? Evidence from a Survey of University Inventors in Computer Science and Electrical Engineering*, 16 YALE J.L. & TECH. 285, 318–19 (2014); Morris, *supra* note 142, at 87–88; Rai, *supra* note 26, at 119–20.

154. See YOCHAI BENKLER, *THE WEALTH OF NETWORKS: HOW SOCIAL PRODUCTION TRANSFORMS MARKETS AND FREEDOM* 92–98 (2006) (arguing that inventors are often motivated by “social-psychological rewards” and that extrinsic financial rewards may “crowd out” intrinsic motivations).

155. See Hemel & Ouellette, *Innovation Policy Pluralism*, *supra* note 19, at 574–81, 596–99; see also Hemel & Ouellette, *Beyond the Patents–Prizes Debate*, *supra* note 19, at 303–04 (explaining why no one innovation policy is optimal in all circumstances).

a direct financial gain from patenting. Some researchers may also realize financial gain by founding university spin-offs based on their patents.

Second, patents can have a *reputational* effect. Even if patents are never licensed or enforced and thus never generate any royalties, some inventors value the stamp of government approval saying that they had a novel and nonobvious idea, as well as the corresponding ability to claim the idea as “theirs”—especially if the invention is widely adopted.<sup>156</sup> It is becoming more common for patents to be listed on a professor’s curriculum vitae and even to be considered in some tenure decisions.<sup>157</sup> It is far from clear that patents—with their associated legal costs—are the best way (or even a good way) to serve these reputational values, but it is a function patents are sometimes serving in practice.

Third, patents can have a *social impact* effect on adoption of an inventor’s technology. If patents in fact serve commercialization goals, the prospect of more widespread use of their research findings may have intrinsic benefits for faculty that enhance their ex ante incentives. Commercialization may, of course, also enhance the reputational rewards discussed above. But even if (counterfactually) university inventors could not be associated by name with their patents and received no financial benefit from them, the patents could still be used as legal instruments to promote (or perhaps inhibit) commercialization and widespread use of their technologies—which may be relevant to inventors who care about promoting the public good or the validation of their research, even without the ability to take credit for it.

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156. See Jason Rantanen & Sarah E. Jack, *Patents as Credentials*, 76 WASH. & LEE L. REV. 311, 340 (2019); see also Clark Asay, *Patent Schisms*, 104 IOWA L. REV. 45, 59–66 (2018) (explaining how these motivations may conflict with how the university uses the patents). See generally Jeanne C. Fromer, *Expressive Incentives in Intellectual Property*, 98 VA. L. REV. 1745, 1759–60 (2012) (providing a framework for considering such expressive incentives).

157. See Pierre Azoulay, Waverly Ding & Toby Stuart, *The Determinants of Faculty Patenting Behavior: Demographics or Opportunities?*, 63 J. ECON. BEHAV. & ORG. 599, 621 (2007); Ashley J. Stevens, Ginger A. Johnson & Paul R. Sanberg, *The Role of Patents and Commercialization in the Tenure and Promotion Process*, 13 TECH. & INNOVATION 241 (2011). But see Lisa Larrimore Ouellette, *Do Patents Disclose Useful Information?*, 25 HARV. J.L. & TECH. 545, 549 n.12 (2012) (surveying websites of fifty academic nanotechnology researchers and finding only one that listed patents, but arguing that patents *should* become documents that faculty are proud to list next to their publications).

As discussed in the following three Sections, the literature on how these effects impact university inventor behavior is mostly a series of null results or context-specific findings, making it difficult to draw strong conclusions about how patents affect academic research. And even if any of these three benefits did increase the quantity or quality of innovation at universities, these effects must be weighed against the potential costs of the patent incentive, such as shifting researchers' focus away from the most socially valuable projects.

#### A. Survey and Interview Evidence

One approach to understanding how much these different benefits matter to university researchers is to ask them. For example, Jason Owen-Smith and Walter Powell interviewed 68 faculty in academic year 1999–2000 at two U.S. universities—an elite private school and a large state school—about their motivations for patenting (or not).<sup>158</sup> Faculty perceptions of the benefits of patenting were similar at the two schools, and they reported a wide variety of motivations, including the desire to make money, increase their prestige, and benefit the public.<sup>159</sup> But this result does not imply that U.S. researchers are sensitive to changes in royalty share. It is unclear how many interviewees mentioned each goal or how they weighed the different benefits. And at both schools, reported incentives varied across broad research fields; in general, physical scientists took a “relational” approach of using patents to develop relationships with multiple firms and as bargaining chips for access to proprietary technology, whereas life scientists took a “proprietary” approach that focused on finding the best partner for exclusively developing a technology.<sup>160</sup> This unsurprising finding reflects the ways patents are used in different industries more broadly,<sup>161</sup> and it is worth keeping in mind that conclusions based on academics in one field may not be generalizable.

Other interview and survey work also shows that faculty researchers describe a variety of motivations for patenting, with financial incentives playing an important role only for a small fraction

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158. See generally Jason Owen-Smith & Walter W. Powell, *To Patent or Not: Faculty Decisions and Institutional Success at Technology Transfer*, 26 J. TECH. TRANSFER 99 (2001).

159. See *id.* at 105, 107.

160. See *id.* at 105–06.

161. See generally Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575 (2003).

of researchers.<sup>162</sup> For example, in 2002–2003, Catherine Renault asked faculty at 12 southeastern universities (39 interviews, 59 survey responses) to categorize their attitude on a five-point scale ranging from agreement with the traditional Mertonian ideal of free exchange of ideas (1) to support for academic capitalism (5), with roughly one-fifth of the respondents placing themselves in each category.<sup>163</sup> When asked about reasons for patenting, only those at the capitalist end of this attitude scale mentioned financial rewards—about 30% of “5”s and 10% of “4”s, reflecting only about 7% of the entire sample.<sup>164</sup> Those at the low end of the scale who patented were more likely to report pursuing that outcome because of the challenge (50% of “1”s).<sup>165</sup>

Based on 36 interviews and 734 survey responses from academics in the United Kingdom in 2006–2007, Alice Lam found that faculty report “a diversity of motivations for commercial engagement.”<sup>166</sup> Many respondents said they were motivated by “reputational and intrinsic reasons”; “financial rewards play[ed] a relatively small part.”<sup>167</sup> When asked which of seven factors has motivated them to engage in commercial activities (including but not limited to patenting), only 27% reported that increasing personal income was an “important” or “very important” motivator (“3” or “4” on a four-point scale)—the lowest rating for any factor.<sup>168</sup>

Most recently, in 2013, Brian Love analyzed survey responses from 269 faculty at the top twenty computer science and electrical

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162. We focus here on studies that tried to determine researchers’ *motivation* for patenting, but there is a related literature showing that patenting is only a small fraction of the activity of typical academics. For example, in 1999, Ajay Agrawal and Rebecca Henderson interviewed MIT mechanical and electrical engineering faculty who were inventors on at least one patent, and these faculty reported that patents were a “relatively unimportant” means of transferring information out of the university. Agrawal & Henderson, *supra* note 144, at 50. They also found that most faculty never patented, publication rates greatly surpassed patent rates, and faculty estimated that patents accounted for less than 10% of the knowledge transfer from their laboratories. *Id.* at 44.

163. See Catherine Searle Renault, *Academic Capitalism and University Incentives for Faculty Entrepreneurship*, 31 J. TECH. TRANSFER 227, 233 (2006).

164. *Id.* at 235–36.

165. *Id.*

166. Alice Lam, *What Motivates Academic Scientists To Engage in Research Commercialization: ‘Gold’, ‘Ribbon’ or ‘Puzzle’?*, 40 RES. POL’Y 1354, 1354 (2011).

167. *Id.*

168. *Id.* at 1356.

engineering departments at U.S. universities.<sup>169</sup> Only about 10% of respondents reported that the prospect of obtaining patent rights encourages them to produce more or higher quality research, and they overwhelmingly ranked patents outside the top four factors motivating their work.<sup>170</sup> Indeed, over 50% of patent holders were unaware of their university's royalty-sharing policy.<sup>171</sup>

These survey and interview results are informative about how faculty perceive their motivations, but one should be cautious before using them to inform public policy. Although people are somewhat reliable at reporting what they have done in the past, they are less accurate at explaining why they made past choices, or at predicting future choices.<sup>172</sup> Respondents may perceive a stigma against expressing an interest in financial gain, particularly in academic environments that idealize Mertonian norms.<sup>173</sup> To draw stronger conclusions, it is thus necessary to look to how people and firms actually behave under different policy regimes.

## B. Evidence from Patenting Behavior

Despite faculty scientists' general disavowal of financial motivations in the surveys canvassed above, their behavior indicates that they are, in fact, at least somewhat interested in money. For example, Paula Stephan reports that faculty "routinely move to take more lucrative-paying positions."<sup>174</sup> Also, professors generally use part of their research funds to pay their own summer salary, rather than leaving these funds for science.<sup>175</sup> But this does not mean that the

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169. Love, *supra* note 153, at 286. The respondents were highly representative of the target population with respect to observable characteristics, including being named as an inventor on at least one university patent (54% of respondents vs. 52% of targets). *Id.* at 299–300.

170. *Id.* at 315–16.

171. *Id.* at 317.

172. See Marianne Bertrand & Sendhil Mullainathan, *Do People Mean What They Say? Implications for Subjective Survey Data*, 91 AM. ECON. REV. 67, 68 (2001); John A. List, *Do Explicit Warnings Eliminate the Hypothetical Bias in Elicitation Procedures? Evidence from Field Auctions for Sportscards*, 91 AM. ECON. REV. 1498, 1504 (2001).

173. See generally ROBERT K. MERTON, *THE SOCIOLOGY OF SCIENCE* (1973) (discussing scientific norms generally); Robert K. Merton, *Priorities in Scientific Discovery: A Chapter in the Sociology of Science*, 22 AM. SOC. REV. 635, 639 (1957) (discussing historical trends in scientific disputes over priority of discovery).

174. PAULA STEPHAN, *HOW ECONOMICS SHAPES SCIENCE* 3 (2012).

175. See BURROUGHS WELLCOME FUND & HOWARD HUGHES MED. INST., *MAKING THE RIGHT MOVES: A PRACTICAL GUIDE TO SCIENTIFIC MANAGEMENT FOR*

financial incentive from *patents* matters—for most professors, the ability to maintain a steady stream of grants to pay summer salary each year is likely a more immediate financial concern than speculative patent royalties.

Moreover, as noted above, the net effect of the patent incentive may be a private gain for university researchers but a social welfare loss.<sup>176</sup> Arti Rai has described early critics of the Bayh–Dole Act who “extolled the virtues of traditional scientific norms and argued that the intrusion of property rights would thwart the success of scientific research by inhibiting further work in areas that had been removed from the communal domain.”<sup>177</sup> Here, we are focused not on the impact that *other* patents might have on scientists as *users* of knowledge goods and the debate about an “anticommons” in basic research,<sup>178</sup> rather, we are interested in the effect that the prospect of their *own* patents might have on faculty’s research, including their willingness to engage openly with other scientists. Margo Bagley has raised related concerns about patents creating incentives for academics to keep results secret or delay their disclosure.<sup>179</sup> There is some empirical support for this concern about delay,<sup>180</sup> but patents do not appear to be substituting for publications; rather, the consistent finding in the literature is that publications and academic patents are

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POSTDOCS AND NEW FACULTY 20 (2d ed. 2006); *see also* STEPHAN, *supra* note 174, at 43 (“Most academic scientists in the United States are hired on nine- to ten-month contracts. It is the grant that pays for their summer, not the institution.”).

176. *See* BENKLER, *supra* note 154 and accompanying text.

177. Rai, *supra* note 26, at 109. It is not clear, however, that these problems materialized. NAT’L. RES. COUNCIL, *supra* note 40, at 3 (“The Bayh-Dole legal framework and the practices of universities have not seriously undermined academic norms of uninhibited inquiry, open communication, or faculty advancement based on scholarly merit . . . [or] interfere[d] with other important avenues of transferring research results.”).

178. *See generally* Lisa Larrimore Ouellette, *Access to Bio-Knowledge: From Gene Patents to Biomedical Materials*, 2010 STAN. TECH. L. REV. N1 (2010) (providing an overview of this debate, including empirical studies suggesting that patents do not impede academic researchers in the ways that were predicted, but that restrictions on material transfers imposed by patent-conscious universities have made it more difficult for researchers to access materials).

179. *See* Bagley, *supra* note 26, at 217–18.

180. *See generally* Jeremy M. Grushcow, *Measuring Secrecy: A Cost of the Patent System Revealed*, 33 J. LEGAL STUD. 59 (2004) (finding a shorter lag between when work was presented at a scientific meeting and when it was published when the work was patented, suggesting that presentation was delayed until the work was complete, though it also might mean that scientists who seek patents are more efficient).

complementary, and that patenting academics may even produce more and higher-quality work.<sup>181</sup>

The patent incentive might also affect the *direction* of university research by diverting scientists from basic work to more patentable applied projects.<sup>182</sup> Of course, as noted above, academic researchers are somewhat constrained based on what projects they can receive funding for, so the direction of research may be driven more by decisions at funding agencies than by faculty choice.<sup>183</sup> The line between basic and applied work is notoriously blurry, but self-reported university survey results gathered by the NSF indicate that the share of academic research expenditures devoted to basic research *increased* from two-thirds in 1980 to three-quarters in 2009.<sup>184</sup> Similarly, Jerry Thursby and Marie Thursby's study of faculty at eight major U.S. research universities from 1983 to 1999 found that

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181. Pierre Azoulay, Waverly Ding & Toby Stuart, *The Impact of Academic Patenting on (Public) Research Output*, 57 J. INDUS. ECON. 637, 637 (2009) (finding, based on a panel dataset of 3,862 academic life scientists, that "patenting has a positive effect on the rate of publications and a weak positive effect on the quality of these publications"); Azoulay, Ding & Stuart, *supra* note 157 ("Whereas previous research emphasized that academic patenters are more accomplished on average than their non-patenting counterparts, our findings suggest that patenting behavior is also a function of scientific opportunities."); Brent Goldfarb, Gerald Marschke & Amy Smith, *Scholarship and Inventive Activity in the University: Complements or Substitutes?*, 18 ECON. INNOVATION & NEW TECH. 743, 743 (2009) (finding, based on data from electrical engineers at Stanford, "no evidence that engaging in inventive activity reduces the quantity of scientific output and some evidence that it increases its quality"); Kira R. Fabrizio & Alberto Di Minin, *Commercializing the Laboratory: Faculty Patenting and the Open Science Environment*, 37 RES. POL'Y 914, 914 (2008) ("[P]ublication and patenting are complementary, not substitute, activities for faculty members."). *But see* Gustavo Crespi et al., *The Impact of Academic Patenting on University Research and Its Transfer*, 40 RES. POL'Y 55, 56 (2011) (finding, based on survey of UK researchers, that patenting and publishing are complementary up to about ten patents, after which there is some evidence for a substitution effect in chemistry and physics).

182. Fabrizio & Di Minin, *supra* note 181, at 917 ("The possibility to license-patented research provides an incentive for researchers to focus more time on research projects with more commercial potential.").

183. Though federal funding decisions are often made by other researchers through peer review. *See, e.g., Peer Review*, NAT'L INST. OF HEALTH, <https://grants.nih.gov/grants/peer-review.htm> [<https://perma.cc/H36D-DNTX>] (last updated Dec. 11, 2018).

184. SCHACHT, *supra* note 86, at 20. It is possible, however, that respondents' views of "basic research" changed over time. *See generally* NAT'L SCI. FOUND., *Survey of Research and Development Expenditures at Universities and Colleges*, <https://www.nsf.gov/statistics/srvyrdexpenditures> [<https://perma.cc/PYW7-MT4R>] (last updated Oct. 1, 2009) (explaining information and data changes on the survey design for higher education).

scientists who filed invention disclosures with their universities' TTOs tended to have a subsequent *increase* in basic research effort.<sup>185</sup> And David Mowery and colleagues concluded in 2001 that changes in university research portfolios reflected broader trends, and that "the Bayh–Dole Act itself has had little impact on the content of academic research."<sup>186</sup> More recent evidence suggests that while patenting tends to increase the rate of publication, it "may also modestly shift the content of these publications toward questions of commercial interest."<sup>187</sup>

In sum, survey evidence suggests that financial returns are only a small part of faculty incentives to patent, although this evidence presents the usual difficulties with self-reported motivations. And efforts to study the impact of Bayh–Dole on more quantitative metrics of university research suggest that patents are not substituting for publications or causing a marked shift in research focus, although it is difficult to extricate the effect of Bayh–Dole's enactment from related trends in university research.<sup>188</sup>

### C. Effect of Variations in Financial Royalty Sharing

As noted above, the Bayh–Dole Act requires universities to share some portion of patent royalties with inventors, and there is substantial variation across universities and over time.<sup>189</sup> This source

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185. See Jerry G. Thursby & Marie C. Thursby, *Has the Bayh–Dole Act Compromised Basic Research?*, 40 RES. POL'Y 1077, 1081–83 (2011). They calculated basic research effort for faculty based on citation-weighted publications in more basic scientific journals. See *id.* As they note, these results depend on the appropriateness of their measure of basic research, and they are unable to determine whether more recently hired faculty have a different research focus. See *id.* at 1083.

186. Mowery et al., *supra* note 51, at 100; Bhaven N. Sampat, David C. Mowery & Arvids A. Ziedonis, *Changes in University Patent Quality After the Bayh–Dole Act: A Re-Examination*, 21 INT'L J. INDUS. ORG. 1371, 1388 (2003) ("Our analysis of citations to university patents before and after the Bayh–Dole Act suggests that there is no decline in the 'quality' of university patents during the 1980s."). Relatedly, another study found "no difference between labs that encourage entrepreneurship and those that do not with respect to basic research activity and the number of publications." Michael Roach, *Encouraging Entrepreneurship in University Labs: Research Activities, Research Outputs, and Early Doctorate Careers*, PLOS ONE, Feb. 8, 2017, at 1.

187. Azoulay, Ding & Stuart, *The Impact of Academic Patenting*, *supra* note 181, at 668.

188. See Mowery et al., *supra* note 51, at 99 ("The evidence suggests that Bayh–Dole was only one of several important factors behind the rise of university patenting and licensing activity.")

189. See *supra* text accompanying notes 48–49.

of variation creates an empirical opportunity to determine whether the share of patent royalties actually has an observable outcome.

The first researchers to exploit this opportunity were Saul Lach and Mark Schankerman, who collected royalty-share data from 102 U.S. university websites in 2001, which they combined with AUTM survey data from 1991 to 1999.<sup>190</sup> They found that a higher inventor's royalty share was associated with higher licensing income at the university, controlling for other factors.<sup>191</sup> This suggests that higher royalty shares caused academics to increase patent-related activity. Ouellette and Tutt, however, have determined that this result was caused by errors in coding university policies; when corrected, the association is no longer statistically significant.<sup>192</sup> Ouellette and Tutt also performed independent analyses using an expanded range of years (1991 to 2013), additional outcome variables such as the number of invention disclosures filed with TTOs each year, and panel data analyses that took advantage of policy changes over time.<sup>193</sup> None of these analyses support the claim that increasing the inventor's share of patent licensing revenue in official royalty-sharing policies causes academics to increase their patent-related activity.<sup>194</sup>

These results do not mean that financial incentives from patent royalties have no effect on university inventor behavior.<sup>195</sup> Efforts to study this effect in the European context have had mixed results, with royalty sharing increasing university patenting in Italy,<sup>196</sup> but having no impact in Portugal and Spain.<sup>197</sup> The most compelling evidence that university professors are sensitive to their patent rights comes from Hans Hvide and Ben Jones, who found that Norway's switch from full patent rights for researchers to the U.S. model, where the university holds title, led to a 50% decline in patenting rates and start-up

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190. Saul Lach & Mark Schankerman, *Royalty Sharing and Technology Licensing in Universities*, 2 J. EUR. ECON. ASSOC. 252, 253–55 (2004) [hereinafter Lach & Schankerman, *Royalty Sharing*]; see also Saul Lach & Mark Schankerman, *Incentives and Invention in Universities*, 39 RAND J. ECON. 403, 404 (2008) [hereinafter Lach & Schankerman, *Incentives and Invention*].

191. See Lach & Schankerman, *Royalty Sharing*, *supra* note 190, at 253; see also Lach & Schankerman, *Incentives and Invention*, *supra* note 190, at 427.

192. See Ouellette & Tutt, *supra* note 23.

193. See *id.*

194. See *id.*

195. See *id.*

196. See Nicola Baldini, *Do Royalties Really Foster University Patenting Activity? An Answer from Italy*, 30 TECHNOVATION 109, 114 (2010).

197. See Pere Arqué-Castells et al., *Royalty Sharing, Effort and Invention in Universities: Evidence from Portugal and Spain*, 45 RES. POL'Y 1858, 1867 (2016).

formation.<sup>198</sup> It is unclear, however, how this policy change (a change in title) compares with varying the share of inventor royalty income within a system in which the university holds title. Additionally, the faculty labor market in Norway has important differences from the United States that might cause Norwegian academics to be more sensitive to additional income sources: salaries are collective negotiations between trade unions and the state, and overall compensation is comparatively low, with a *maximum* annual salary for full professors of 1,020,000 Norwegian kroner in 2008 (around US\$140,000–200,000, depending on the historical daily exchange rate), and a median of 610,296 (around US\$84,000–122,000).<sup>199</sup>

As noted at the beginning of this Part, the literature on how different aspects of patents impact university researchers mostly consists of null results and context-specific findings, and studies of the financial impact of patent royalties are no exception. But we think there is currently no strong evidence that the prospect of patent royalties incentivizes publicly funded researchers to be more engaged in the patent system, much less to produce more or better research in the first place.

#### IV. HOW DO PATENT REVENUES AFFECT UNIVERSITY RESEARCH FUNDING FOR SCIENCE AND ENGINEERING?

A third potential benefit of university patents, in addition to providing *ex post* commercialization incentives and *ex ante* innovation incentives, is that they may help create additional funding for research and education in science and engineering. Of course, this is not why Bayh–Dole was enacted. As Rebecca Eisenberg and Robert Cook-Deegan note, this “argument was not even made” when Bayh–Dole was debated, and “even now, the revenue-for-universities

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198. See Hans K. Hvide & Benjamin F. Jones, *University Innovation and the Professor's Privilege*, 108 AM. ECON. REV. 1860, 1860–61 (2018).

199. See SVEIN KYVIK, FORSKERFORBUNDET: NORDIC INST. FOR STUDIES IN INNOVATION, RES., & EDUC., ACADEMIC SALARIES IN NORWAY 5 (2010); *U.S. Dollar to Norwegian Krone Spot Exchange Rates for 2008 from the Bank of England*, POUND STERLING LIVE, <https://www.poundsterlinglive.com/bank-of-england-spot/historical-spot-exchange-rates/usd/USD-to-NOK-2008> (last visited Mar. 3, 2020). The value of a krone has fallen over time from the 2008 maximum of five kroner per U.S. dollar to over nine kroner per dollar today, making these salaries appear even lower to U.S. audiences. See *U.S. Dollar to Norwegian Krone Spot Exchange Rates for 2020 from the Bank of England*, POUND STERLING LIVE, <https://www.poundsterlinglive.com/bank-of-england-spot/historical-spot-exchange-rates/usd/USD-to-NOK-2020> (last visited Mar. 3, 2020).

rationale is raised only *sotto voce*, if at all.”<sup>200</sup> And we think few would argue that funding research through patent revenue is the optimal solution in a world without political constraints: given the high transaction costs of the patent system, it seems highly unlikely to be more efficient than simply increasing federal grant funding.<sup>201</sup> But in an era of declining federal science funding (as a percent of GDP<sup>202</sup>), is it possible that a patent shadow tax on university-developed technologies is the most politically feasible option for increasing direct R&D expenditures?

In this Part, drawing on prior work, we explore two possible mechanisms through which Bayh–Dole patents might increase R&D funding.<sup>203</sup> Section IV.A examines how Bayh–Dole patent revenues might increase internal university research funds, and Section IV.B examines how they might lead to higher federal grant appropriations in the first place. Note that for purposes of this revenue-generating theory, it does not matter whether the funding appears on the federal budget: “If universities receive additional revenues from Bayh–Dole patents and those revenues are reinvested in research, this is functionally equivalent to a tax on Bayh–Dole patent revenues that is returned to universities for new research projects.”<sup>204</sup>

Overall, we think that, for Bayh–Dole patents not needed for commercialization, revenue generation must be considered to justify their use.<sup>205</sup> This potential benefit has been underappreciated, perhaps

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200. Eisenberg & Cook-Deegan, *supra* note 25, at 79.

201. As noted previously, even though the university patent “shadow tax” is not reflected in the federal budget, it is still very costly to consumers. *See* Hemel & Ouellette, *Beyond the Patents Prizes Debate*, *supra* note 19, at 312, 371–72. And the administrative costs of generating revenue through the patent system are significant. *See id.* at 364–66; *see also* James Bessen & Michael J. Meurer, *The Direct Costs from NPE Disputes*, 99 CORNELL L. REV. 387, 410 tbl.5 (2014) (estimating that of the direct costs to defendants in patent lawsuits brought by non-practicing entities, only approximately 20% is passed through to R&D at the non-practicing entity or to inventors).

202. *See Federal R&D as a Percent of GDP*, AM. ASS’N FOR THE ADVANCEMENT OF SCI. (2018), <https://www.aaas.org/sites/default/files/s3fs-public/RDGP%253B.jpg> [<https://perma.cc/LMU9-UD9N>].

203. *See* Ayres & Ouellette, *supra* note 22, at 291–94; Hemel & Ouellette, *Bayh–Dole Beyond Borders*, *supra* note 24, at 293–97.

204. Hemel & Ouellette, *Bayh–Dole Beyond Borders*, *supra* note 24, at 293 n.63.

205. Some commentators have argued that Bayh–Dole patents are useful even if universities *lose* money, but these arguments are premised on those patents serving commercializing benefits. *See, e.g.*, Vicki Loise & Ashley J. Stevens, *The Bayh–Dole Act Turns 30*, 2 SCI. TRANSLATIONAL MED. 52cm27, 4 (2010) (arguing that the failure

due to a reluctance of TTOs to appear to be too focused on money. But if revenue generation is to justify the current extent of university patenting, TTOs must provide data and collaborate with scholars to make the case empirically and to study related costs, such as how patent revenues might exacerbate inequalities across universities or how aggressive patent assertion might undermine universities' ability to argue for exceptional treatment within the patent ecosystem such as a broader experimental use defense.<sup>206</sup>

#### A. Direct Funding from Net Patent Revenues

Universities must reinvest Bayh–Dole revenues in science research and education. Under the statute, a grant agreement with a university or other nonprofit must include a “requirement that the balance of any royalties or income earned by the contractor with respect to subject inventions, after payment of expenses (including payments to inventors) incidental to administration of subject inventions, be utilized for the support of science research or education.”<sup>207</sup> Peter Detkin, the owner of Intellectual Ventures, has argued that this requirement allows universities “to recoup their research dollars”—and that Intellectual Ventures has helped with this function by acquiring “rights to thousands of university patents,” licensing them, and returning about “\$110 million to universities and government researchers” over a decade.<sup>208</sup>

As a rare example in which the revenue rationale is raised at more than *sotto voce*, Stanford's Office of Technology Licensing (OTL) lists this benefit as the first argument “in support of licensing university inventions”:

[W]hile the federal government has traditionally been the major sponsor of basic research conducted in universities, the current trend is to limit such funding. Universities thus are faced with the need to develop alternate

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of TTOs to generate revenue “simply verifies the institutional mission of the research enterprise: getting science into the public's hands”).

206. For example, when narrowing the experimental use defense in *Madey v. Duke University*, the Federal Circuit noted “Duke's patent and licensing policy may support its primary function as an educational institution. . . . Duke, however, like other major research institutions of higher learning, is not shy in pursuing an aggressive patent licensing program from which it derives a not insubstantial revenue stream.” 307 F.3d 1351, 1362–63 n.7 (Fed. Cir. 2002).

207. Bayh–Dole Act, 35 U.S.C. § 202(c)(7)(C) (1980); *see also* 37 C.F.R. § 401.14(a)(k)(3) (1987) (providing the standard contract language).

208. Peter Detkin, Correspondence, *Patents: Universities Are Right to Partner*, 502 NATURE 448, 448 (2013).

sources of funding or to curtail their research activities. Licensing income can be a critical source of much-needed unrestricted funding.<sup>209</sup>

In 2017, Stanford's licensing office distributed \$17.7 million to departments and schools,<sup>210</sup> which is valuable funding, although this net revenue is just one percent of Stanford's total \$1.6 billion research budget.<sup>211</sup> Another successful university technology transfer institution, WARF, provided \$81 million in research funding to the University of Wisconsin at Madison in 2017,<sup>212</sup> which is close to 7% of the total \$1.2 billion research budget.<sup>213</sup> These successful TTOs generate enough patent revenue to constitute a significant research funding source, though far from the amount needed to recoup their original research investments.

And most universities aren't Stanford. In fact, it is far from clear that the average university generates positive net revenue. The best existing source of evidence is the annual survey data from AUTM.<sup>214</sup> As Figure 4 shows, U.S. universities and nonprofit research institutes have been reporting gross licensing income in excess of their legal fees, and the gap between the numbers has grown over time,

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209. Hans Wiesendanger, *A History of OTL*, STANFORD UNIV. OFFICE OF TECH. LICENSING, <https://otl.stanford.edu/history-otl> [<https://perma.cc/3KQW-9UVD>] (last visited Jan. 20, 2020); Heidi Ledford, *Universities Struggle to Make Patents Pay*, 501 NATURE 471, 471 (2013) (“[T]he unstated aim [of university licensing] is to make money to fund more research and the technology-transfer office itself, says Melba Kurman, a former technology-transfer officer at Cornell . . .”).

210. STANFORD UNIV. OFFICE OF TECH. LICENSING, *IT TAKES A VILLAGE: ANNUAL REPORT 2017*, at 11 (2017). Stanford brought in \$45.4 million in gross royalty revenue and \$2.5 million in liquidated equity, out of which it paid \$10.4 million to inventors in personal income, \$0.9 million to other organizations for jointly-owned technologies, and \$19 million for the OTL operating budget and legal expenses. *Id.* at 11–12.

211. *Research at Stanford*, STANFORD UNIV., <https://facts.stanford.edu/research> [<https://perma.cc/RD7D-EYVX>] (last updated Feb. 15, 2019).

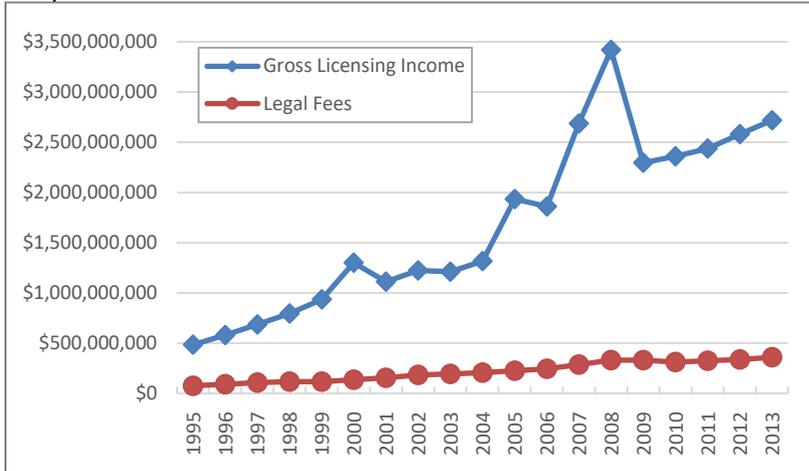
212. *Grants and Support: Current Grant*, WIS. ALUMNI RES. FOUND., <https://web.archive.org/web/20180909045327/https://www.warf.org/stewardship/grants-support/current/current-grant.cmsx> [<https://perma.cc/3HQ6-KNPF>] (last visited Jan. 20, 2020); *Frequently Asked Questions About WARF's Purpose and Functions*, WIS. ALUMNI RES. FOUND., <http://www.warf.org/about-us/faqs/facts-about-warf-purpose-and-functions.cmsx> [<https://perma.cc/G39U-VYRM>] (last visited Jan. 20, 2020) (“Since its inception [in 1925], WARF has provided \$2.3 billion in cumulative direct grants . . . adjusted for inflation.”).

213. *UW–Madison Retains Research Ranking*, UNIV. WIS.–MADISON NEWS (Nov. 20, 2018), <https://news.wisc.edu/uw-madison-retains-research-ranking> [<https://perma.cc/H243-FEHX>].

214. See AUTM SURVEY, *supra* note 28.

suggesting a positive trajectory for net revenue averaged across universities.<sup>215</sup>

Figure 4. Licensing Income and Legal Fees at U.S. Universities and Nonprofits



But the AUTM survey data is missing many of the direct financial benefits and costs of patenting for universities. On the revenue side, the survey results do not seem to include revenue from selling equity in university start-ups (such as the \$336 million Stanford made from its 2005 sale of Google stock<sup>216</sup>) or large damage awards from patent infringement lawsuits.

On the cost side, the AUTM survey data only asks about legal fees. This number has not included significant litigation expenses since 1999, and it does not include TTO operating expenses.<sup>217</sup> The AUTM survey does ask for the number of TTO employees, and Walter

215. *Id.* Over this time period, the number of reporting institutions ranged from 157 to 192. *Id.*

216. See ASSOCIATED PRESS, *Stanford Reaps Windfall from Google Stock*, L.A. TIMES (Dec. 2, 2005), <https://www.latimes.com/archives/la-xpm-2005-dec-02-fi-calbriefs2.3-story.html> [<https://perma.cc/V6QC-U2KD>].

217. See AUTM SURVEY INSTRUCTIONS, *supra* note 28, at 5 (contrasting “significant litigation expense” such as “any individual litigation expense that exceeds 5% of total” legal fees, which have been excluded since 1999 to “eliminate skews in the data,” with “minor litigation expenses” such as “the cost of an initial letter to a potential infringer written by counsel,” which should be included in the costs reported to AUTM).

Valdivia has used this figure to estimate TTO operating expenses.<sup>218</sup> He concluded that “of the 155 universities reporting to the AUTM survey, 130 did not generate enough licensing income in 2012 to cover the wages of their technology transfer staff and the legal costs for the patents they file.”<sup>219</sup> But Valdivia’s estimates relied on assumptions about average costs and did not account for the unreported revenue benefits discussed above. A 2007 survey of AUTM members found that just under half brought in more revenue than their operating costs.<sup>220</sup>

Without more transparency about all the financial benefits from university patenting (including the value of equity and litigation awards) and the costs (including TTO operating expenses and litigation expenses), it is difficult to assess the revenue-generating function of university patents. But since there seem to be many university patents that cannot be justified from a social welfare perspective except as a means of generating additional revenue for research, we hope universities will analyze and share this data.

## B. Indirect Effects on Government Funding

The prior Section focused on how patent revenues might directly increase universities’ internal research funds. But patent revenues might also increase U.S. spending on research grants through a more indirect mechanism, by causing higher congressional grant appropriations in the first place. In other words, the institutional structures that were catalyzed by securing and defending patent rents may change the public choice dynamics for other rents: greater research funding. As summarized by Hemel and Ouellette:

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218. Walter D. Valdivia, *University Start-Ups: Critical for Improving Technology Transfer*, 2013 CTR. FOR TECH. INNOVATION AT BROOKINGS 19 n.12 (estimating operating expenses by assuming a salary of \$150,000 per full-time employee specifically involved with patenting and licensing and \$100,000 for other full-time employees); see also AUTM SURVEY INSTRUCTIONS, *supra* note 28, at 9–10 (defining these employee categories).

219. Valdivia, *supra* note 218, at 9; see also Jerry G. Thursby & Marie C. Thursby, *University Licensing and the Bayh–Dole Act*, 301 SCIENCE 1052, 1052 (2003) (noting that in the 2000 AUTM survey, “half [of respondents] reported income less than \$824,000” and “[o]n average, technology transfer offices below the median had four employees, which made it likely that many spent more than they received in income”).

220. See Irene Abrams, Grace Leung & Ashley J. Stevens, *How Are U.S. Technology Transfer Offices Tasked and Motivated—Is It All About the Money?*, 17 RES. MGMT. REV. 18, 31 (2009).

Public choice theory suggests that members of Congress will support federal funding for scientific research so long as the political benefits (in particular, the benefits to well-organized interest groups) exceed the political costs (in the form of higher taxes). Interest-group support for federal research spending will be stronger when well-organized domestic constituencies stand to profit from federally funded inventions. . . . This is not to suggest that interest-group politics will produce an outcome in which public funding for scientific research exactly equals the national-welfare-maximizing amount. It is to suggest, though, that the amount of funding seems likely to be positively correlated with domestic benefits, even if the correlation is far from perfect.<sup>221</sup>

Indeed, universities have successfully lobbied for both increased research appropriations and against curtailment of their patent rights. The public and private universities with the largest R&D budgets lobby heavily during election cycles.<sup>222</sup> They lobby for a variety of benefits, including earmarks for research projects (at least prior to the congressional earmark moratorium<sup>223</sup>), science policy including higher research funding,<sup>224</sup> and favorable patent rights.<sup>225</sup> Universities were

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221. Hemel & Ouellette, *Bayh–Dole Beyond Borders*, *supra* note 24, at 295–96.

222. See Monica Vendituoli, *Top Schools for Federal R&D Grants Are Big Spenders on Lobbying, Campaign Contributions*, OPENSECRETS.ORG CTR. FOR RESPONSIVE POLITICS (June 5, 2013), <https://www.opensecrets.org/news/2013/06/federal-research-and-development-fu/> [<https://perma.cc/7U55-P5J6>] (“Six of the top 10 recipients of federal R&D money were among the top 10 university contributors to candidates, parties and outside groups in the 2012 cycle . . .”).

223. See Andrew Kreighbaum, *The Return of Earmarks*, INSIDE HIGHER ED (Jan. 12, 2018), <https://www.insidehighered.com/news/2018/01/12/talks-restoring-earmarks-promises-renewed-debate-within-higher-ed> [<https://perma.cc/R7MH-3BSY>] (describing universities’ mixed support for the 2011 earmark moratorium).

224. See Rick Cohen, *Universities Pay Plenty for Influence and Access Through Lobbying*, NONPROFIT Q. (July 5, 2014), <https://nonprofitquarterly.org/2014/07/16/universities-pay-plenty-for-influence-and-access-through-lobbying> [<https://perma.cc/3BN5-N4GM>] (noting work “document[ing] the strong correlation between universities’ lobbying and campaign expenditures and their access to federal research and development grants”); John M. de Figueiredo & Brian S. Silverman, *How Does the Government (Want to) Fund Science? Politics, Lobbying and Academic Earmarks* 8 (Nat’l Bureau of Econ. Research, Working Paper No. 13459, 2007) (noting, prior to the earmark moratorium, that “not all university lobbying is directed at obtaining earmarks[:] [a] small number of ‘elite’ universities lobby for science policy (for example, increased budgets for the National Science Foundation; or rules that will facilitate stem cell research)”).

225. See Joe Mullin, *How the Patent Trolls Won in Congress*, ARSTECHNICA (May 23, 2014, 5:08 PM), <https://arstechnica.com/tech-policy/2014/05/how-the-patent-trolls-won-in-congress> [<https://perma.cc/U2TV-9LFK>]; see also Ryan & Frye, *supra* note 25, at 65 (“[T]he way that patent policy has bent toward rewarding university patent activity through conferral of rights is a direct result of lobbying and decision-making efforts by these universities with lawmakers . . .”); Max Colice et.

ultimately able to grow their earmarks fifty-fold from 1980 (when universities started lobbying more heavily in response to funding cuts<sup>226</sup>) to 2001, with a strong return on lobbying investment.<sup>227</sup> Anecdotally, local economic benefits<sup>228</sup> and successful commercialization are a helpful part of securing state funding. Beyond their commercial benefits, Dan Burk argues that patents play a ceremonial role, and a politically relevant one, communicating universities are “earning their keep . . . and not simply sponging off the largess of the taxpayers.”<sup>229</sup>

The indirect effect described in this Section may be more economically significant than the direct revenue effect described in Section IV.A, though it is even more challenging to study empirically. It also may be sensitive to changes in public views about whether university patenting activities are making good use of research appropriations—including concerns about universities acting like “patent trolls”<sup>230</sup> or using patents in ways that cause the public to “pay twice” for patented products.<sup>231</sup> We think these concerns about how public perception of patenting behavior feeds back on other political benefits may be one of the drivers behind the shift toward a focus on start-up formation.<sup>232</sup> The narrative of economic development through start-ups built around university patents has not acquired the same negative connotations of direct patent assertion, so invoking a start-up-based narrative may lead to more funding.<sup>233</sup>

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al, *Inside Views: Micro Entity Status for Universities and AIA Rulemaking on Power of Attorney*, INTELL. PROP. WATCH (July 15, 2013), <https://www.ip-watch.org/2013/07/15/micro-entity-status-for-universities-and-aia-rulemaking-on-power-of-attorney> [<https://perma.cc/C3QT-BUPC>].

226. See Celia Bever, *The Way Things Work: University Lobbying*, CHI. MAROON (Dec. 4, 2012), <https://www.chicagomaroon.com/2012/12/04/the-way-things-work-university-lobbying/> [<https://perma.cc/BU3N-GK93>].

227. See John M. de Figueiredo & Brian S. Silverman, *Academic Earmarks and the Returns to Lobbying*, 49 J.L. & ECON. 597, 603, 616–17 (2006). Universities with representation on the House and Senate Appropriations Committees were especially successful in securing earmark funding. See *id.* at 612.

228. See Lee, *supra* note 123, at 1536 (noting how technology and economic benefits tend to flow in geographic clusters).

229. Dan L. Burk, *On the Sociology of Patenting*, 101 MINN. L. REV. 421, 446 (2016).

230. See *supra* Section I.C.

231. See *supra* notes 5, 152.

232. See *supra* note 60 and accompanying text.

233. We thank Arti Rai for this point.

## V. WHAT EFFECT DO UNIVERSITY PATENTS HAVE ABROAD?

So far, we have focused on university patenting from a U.S. perspective. But innovation institutions like grants and patents have effects that traverse national borders.<sup>234</sup> Considering Bayh–Dole in a global context raises at least two key questions: First, should other countries adopt legal regimes modeled on Bayh–Dole? And second, what effect do patents filed outside a university’s home country have on the evaluation of that country’s Bayh–Dole regime? For example, does patenting by U.S. universities in foreign countries affect the social welfare assessment of the Bayh–Dole Act—and does it matter whether we consider U.S. or global welfare? Similarly, how do patents filed in the United States and other countries by Japanese universities affect the economic assessment of Japan’s 1999 laws modeled on Bayh–Dole?<sup>235</sup>

This Part focuses on the second question, but on the first—whether other countries should adopt legal regimes modeled on Bayh–Dole—it is worth noting that many of the theoretical arguments canvassed above also apply to analogous legal regimes in other countries. For example, patents on inventions funded by the Japanese government have the same potential benefits for ex post commercialization, ex ante invention, and revenue generation as discussed in Parts II–IV. But this does not mean that empirical results from the United States on the size of these benefits (and of the corresponding costs) can be easily translated to other countries: the effects will vary based on the local context. As David Mowery and Bhaven Sampat noted in 2005, efforts to copy Bayh–Dole “are likely to have modest success at best without greater attention to the underlying structural differences among the higher education systems of these nations.”<sup>236</sup> And translating work from the U.S. context to make recommendations for developing countries is even more fraught.<sup>237</sup>

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234. See generally Daniel J. Hemel & Lisa Larrimore Ouellette, *Knowledge Goods and Nation-States*, 101 MINN. L. REV. 167 (2016) [hereinafter Hemel & Ouellette, *Knowledge Goods*].

235. See generally Toshiko Takenaka, *Technology Licensing and University Research in Japan*, 1 INT’L J. INTELL. PROP. 27 (2005).

236. David C. Mowery & Bhaven N. Sampat, *The Bayh-Dole Act of 1980 and University-Industry Technology Transfer: A Model for Other OECD Governments?*, 30 J. TECH. TRANSFER 115, 115 (2005).

237. See Anthony D. So et al., *Is Bayh–Dole Good for Developing Countries? Lessons from the US Experience*, 6 PLOS BIOLOGY 2078, 2082 (2008) (arguing that “the appropriate sets of policies to harness public sector R&D are highly context-

On the second question—the effect of university patents outside their home country—existing scholarship has primarily focused on the impact of U.S. patents on low-income countries. U.S. universities and other federal grant recipients may patent resulting inventions worldwide,<sup>238</sup> and as we examine in Section V.A, U.S. university patents have played a role in limiting access to medicines in the developing world. Some advocates have argued that universities should use these patent rights to affirmatively promote global public health.

But the Bayh–Dole debate has largely ignored the impact of U.S. university patents on consumers in other high-income countries like Japan and Germany. In collaboration with the World Intellectual Property Organization (WIPO), Hemel and Ouellette have gathered detailed empirical data demonstrating that U.S. universities file a significant number of patents in high-income countries—and relatively few patents in lower-income countries.<sup>239</sup> Section V.B reviews the argument that these patents in other high-income countries may have attractive efficiency and distributional effects.

#### A. Access to Knowledge in Low-Income Countries

Some of the most forceful critiques of university patenting behavior have focused on the role that U.S. university patents play in increasing the price of essential medicines for the global poor.<sup>240</sup> Patents' role in contributing to high pharmaceutical prices in low-income countries has been the subject of sustained criticism from academics, activists, NGOs, and international institutions.<sup>241</sup>

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specific” and that efforts to import Bayh–Dole to developing countries should reflect these differences).

238. See 37 C.F.R. § 401.14(a)–(b) (setting forth the general rule that a contractor “may retain the entire right, title, and interest throughout the world to each subject invention”).

239. See Hemel & Ouellette, *Bayh–Dole Beyond Borders*, *supra* note 24, at 301.

240. See generally Amy Kapczynski et al., *Addressing Global Health Inequities: An Open Licensing Approach for University Innovations*, 20 BERKELEY TECH. L.J. 1031 (2005); Beirne Roose-Snyder & Megan K. Doyle, *The Global Health Licensing Program: A New Model for Humanitarian Licensing at the University Level*, 35 AM. J.L. & MED. 281 (2009).

241. See Ellen ‘t Hoen, *TRIPS, Pharmaceutical Patents, and Access to Essential Medicines: A Long Way from Seattle to Doha*, 3 CHI. J. INT’L L. 27, 30, 33 (2002).

There are at least some examples of how universities can affirmatively use their patents to promote global health, such as the story of Yale and d4T:

[I]n 1990 Yale patented the use of the drug stavudine (d4T) to treat HIV and granted an exclusive license to Bristol-Myers Squibb. Under the trade name Zerit, stavudine became a key drug for treating HIV. With a cost of over \$1600 per year, however, it was inaccessible to most patients in developing countries. Médecins Sans Frontières (MSF) wanted to distribute stavudine in South Africa. An Indian manufacturer offered to supply the drug for \$40 per year, but MSF was unable to accept because Yale had patented stavudine in South Africa. With the help of Yale Law students Amy Kapczynski (now a [Yale] law professor) and Marco Simons, MSF approached Yale, which began negotiating with Bristol-Myers Squibb. After the issue was publicized in the *New York Times*, Bristol-Myers Squibb announced that it would not enforce the stavudine patent in South Africa and that it would sell Zerit in sub-Saharan Africa for \$55 per year.<sup>242</sup>

Based on this success at Yale, students formed the advocacy organization Universities Allied for Essential Medicines (UAEM) to consider “how universities can best license their innovations to promote global access.”<sup>243</sup> UAEM now has chapters at over one hundred research universities.<sup>244</sup>

A working group based at Yale and convened by UAEM then developed a proposal for a model “Equitable Access License,” which was described in a 2005 article by Amy Kapczynski, Samantha Chaifetz, Zachary Katz, and Yochai Benkler.<sup>245</sup> The proposed licensing provisions would “give third parties—for example, manufacturers of generic medicines—freedom to operate in [low- and middle-income] countries with regard to the licensed technology or any derivative products, by adapting the so-called ‘copyleft’ characteristics of some open source licenses.”<sup>246</sup>

In part because of this movement, AUTM and many of its university members have endorsed two policy statements setting out best practices for licensing in the public interest. The 2007 *Nine Points*

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242. Ouellette, *How Many Patents*, *supra* note 94, at 309.

243. *History*, UNIVS. ALLIED FOR ESSENTIAL MEDS., <https://uaem.org/who-we-are/history> [<https://perma.cc/RZ4B-26L9>] (last visited Jan. 20, 2020). The focus has expanded to also consider “how universities can best direct and measure their research to have the greatest social impact worldwide.” *Id.*

244. *See id.*

245. *See* Kapczynski et al., *supra* note 240, at 1031.

246. *Id.* at 1041; *see also* Ayres & Ouellette, *supra* note 22, at 296–97 (describing the potential benefit of “Copyleft-Style Patent Licensing”). “Copyleft” is the use of copyright to promote free distribution of a work and of any future modifications of that work.

to Consider in Licensing University Technology urges universities to “[c]onsider including provisions that address unmet needs, such as those of neglected patient populations or geographic areas, giving particular attention to improved therapeutics, diagnostics and agricultural technologies for the developing world.”<sup>247</sup> The *Nine Points* statement has over one hundred signatories.<sup>248</sup> The 2009 *Statement of Principles and Strategies for the Equitable Dissemination of Medical Technologies* gives more specific goals to prevent patents from “becom[ing] a barrier to essential health-related technologies needed by patients in developing countries,” including “not patenting in developing countries.”<sup>249</sup>

It is unclear, however, whether either of these statements has had any impact on university technology transfer practices. Neither policy statement has any transparency requirement or enforcement mechanism. And the *Statement of Principles and Strategies* does not seem to have acquired more than the original six university signatories and is no longer available on AUTM’s website. Furthermore, it is unclear how often U.S. university patents are actually an impediment to access to medicines in developing countries.<sup>250</sup>

The leading study on university patents in developing countries in the pharmaceutical context is Bhaven Sampat’s investigation of patents on drugs approved by the FDA from 1988 to 2005.<sup>251</sup> Sampat reports that 72 (7.7%) of these drugs had at least one academic patent, and that about 19% of those academic patents were filed in developing countries—those classified by the World Bank as low- or lower-middle-income countries, which includes India, Brazil, and China.<sup>252</sup> Yale’s choice to patent d4T in the developing world was thus not a special case, although Sampat does not indicate which countries

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247. CAL. INST. TECH. et al., *In the Public Interest: Nine Points to Consider in Licensing University Technology* 8 (Mar. 6, 2007).

248. See *Nine Pons [sic] to Consider in Licensing University Technology*, AUTM, <https://autm.net/about-tech-transfer/principles-and-guidelines/nine-points-to-consider-when-licensing-university> [<https://perma.cc/8LUE-9NJQ>] (last visited Jan. 20, 2020).

249. AUTM ET AL., STATEMENT OF PRINCIPLES AND STRATEGIES FOR THE EQUITABLE DISSEMINATION OF MEDICAL TECHNOLOGIES 2 (2009).

250. Kapczynski et al., *supra* note 240, at 1083 (“[T]here is no comprehensive data and no easy way to determine patent status in the majority of [low- and middle-income] countries[.]”).

251. See Bhaven Sampat, *Academic Patents and Access to Medicines in Developing Countries*, 99 AM. J. PUB. HEALTH 9, 11 (2009).

252. *Id.* at 11, 14.

patents were filed in, including whether any were low-income countries.

To help fill this empirical gap, Hemel and Ouellette worked with the WIPO Economics and Statistics Division to compile data on the number of distinct patent families filed by U.S. universities at national and regional patent offices from 2000 to 2011.<sup>253</sup> During this period, 36,943 patent families were filed by U.S. universities at the USPTO, of which over one-third (13,175 families) were filed at the European Patent Office (EPO) and close to one-quarter were filed in each of Canada (9,136 families) and Japan (8,348 families).<sup>254</sup> Hemel and Ouellette noted that “although US universities do not seek foreign patents on a *majority* of their patentable inventions, they do file *many* patent applications abroad.”<sup>255</sup> But these patents are not uniformly spread across the globe:

[P]erhaps unsurprisingly, the number of patents filed in a given foreign jurisdiction correlates strongly with the size and strength of the local economy. US universities sought 59,750 patent families in high-income economies, 9616 in upper-middle income economies, 2952 in lower-middle income economies, and only 52 in low-income economies. And almost all of the patenting outside of high-income economies is in four large upper middle-income economies—China (5675), Mexico (1765), Brazil (1128), and South Africa (523)—and one large lower middle-income economy, India (2483). No other country outside the high-income world received more than 1 per cent of USPTO filings. While these five countries have significant poverty, they also have large economies: China has the second-highest gross national income in the world, India is seventh, Brazil is eighth, Mexico is fifteenth, and South Africa is thirty-first.<sup>256</sup>

To be clear, the relatively low numbers of university patents in low- and middle-income countries does not mean that these patents are not worth consideration. As Kapczynski and coauthors argue, “the more likely a technology is to have application in a developing country, the more likely it is the economics will weigh in favor of patenting.”<sup>257</sup> And even if patents are a tiny portion of the problem with access to medicines in the developing world, “preventing even a fraction of one

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253. Hemel & Ouellette, *Bayh–Dole Beyond Borders*, *supra* note 24, at 301 (“A patent family is a group of patents—in the same or different countries—that protect a single invention. . . . Families are counted if *any* of the applicants are US universities as coded by WIPO . . .”).

254. *Id.* at 303.

255. *Id.*

256. *Id.* at 305.

257. Kapczynski et al., *supra* note 240, at 1083.

percent of deaths in low- and middle-income countries would translate into saving tens of thousands of lives every year.”<sup>258</sup>

But a full analysis of the impact of U.S. university patents abroad should consider more than their role in the poorest countries, given that universities patent far more in high-income countries. And as Hemel and Ouellette argue, “the global distributive justice concerns that come to mind when, say, patients in sub-Saharan Africa pay higher prices for a first-generation HIV treatment patented by Yale are less compelling when patients in Norway pay more for a hair loss treatment patented by the University of Central Florida.”<sup>259</sup>

### B. Cost Sharing Among High-Income Countries

The significant number of U.S. university patents filed in other high-income countries may provide an overlooked—albeit partial—justification for patents on federally funded inventions. In particular, Hemel and Ouellette argue that “[i]n addition to yielding arguably attractive distributional consequences” by having foreign consumers pay for the benefits they receive from inventions funded by U.S. taxpayers, “such patents may also increase efficiency: by allowing the [U.S.] federal government and [U.S.] firms to internalize some of the benefits that federally funded inventions bring to foreign consumers, Bayh–Dole may induce higher levels of [U.S.] public and private spending on research in the first place.”<sup>260</sup>

This argument builds on the work of innovation economist Suzanne Scotchmer, who analyzed the problem of underinvestment in R&D in a world where many knowledge goods are global public goods.<sup>261</sup> Scotchmer argued that in the absence of coordination, a country has “deficient incentives to invest, relative to what is efficient,” due to “uncompensated externalities abroad.”<sup>262</sup> In other words, if a country cannot capture any of the benefits to foreign consumers from its R&D investments, it will have little reason to

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258. *Id.* at 1114.

259. Hemel & Ouellette, *Bayh–Dole Beyond Borders*, *supra* note 24, at 284–85.

260. *Id.* at 285.

261. See generally Suzanne Scotchmer, *The Political Economy of Intellectual Property Treaties*, 20 J.L. ECON. & ORG. 415 (2004); Hemel & Ouellette, *Knowledge Goods*, *supra* note 234, at 192–201 (examining the extent to which knowledge goods are global public goods).

262. Scotchmer, *supra* note 261, at 420.

consider these benefits in its investment decisions.<sup>263</sup> This global collective action problem is to some degree addressed by IP treaties such as the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), which requires all 164 members of the World Trade Organization (except least-developed countries) to provide twenty-year patents in “all fields of technology” to inventors from other member states.<sup>264</sup> Scotchmer was concerned, however, that coordination on IP rather than on public R&D sponsorship through grants would lead to “too little public sponsorship and too much intellectual property.”<sup>265</sup>

But when coupled with Bayh–Dole regimes, the international IP system actually may help with this too-little-public-sponsorship problem. The resulting legal regime provides a mechanism for countries to internalize some foreign benefits from domestic R&D spending, at least when the results of that research are patentable.<sup>266</sup> For example, if an NIH-funded researcher at UC Berkeley invents a new drug that is patented worldwide and licensed to Pfizer, then foreign consumers will pay the patent shadow tax when this drug reaches their markets. This patent tax will be paid to Berkeley and to Pfizer—and then to the U.S. government through taxation of Pfizer’s profits. As noted above, Bayh–Dole contains an explicit preference for domestic manufacture, which would tend to keep profits within the United States.<sup>267</sup> And the specific distribution of profits, including the amount reclaimed by the U.S. government, is a political choice of domestic tax law.<sup>268</sup>

Of course, the fact that Bayh–Dole allows the United States to internalize some of the benefits in other high-income countries from its own public spending on grants does not mean that this function

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263. See *id.* Many countries invest in R&D, drawing on the international political economy literature. See Hemel & Ouellette, *Knowledge Goods*, *supra* note 234, at 201–14.

264. Agreement on Trade-Related Aspects of Intellectual Property Rights arts. 3, 27(1), 33, Apr. 15, 1994; see also *Responding to Least Developed Countries’ Special Needs in Intellectual Property*, WORLD TRADE ORG., [https://www.wto.org/english/tratop\\_e/trips\\_e/ldc\\_e.htm](https://www.wto.org/english/tratop_e/trips_e/ldc_e.htm) [https://perma.cc/G4DT-B8BF] (last updated Oct. 16, 2013).

265. Scotchmer, *supra* note 261, at 415.

266. For a more general explanation of how countries can layer non-IP innovation policies at the domestic level under IP policies internationally, see Hemel & Ouellette, *Knowledge Goods*, *supra* note 234, at 173–74 and Hemel & Ouellette, *Innovation Policy Pluralism*, *supra* note 19, at 588–92.

267. See *supra* note 17 and accompanying text.

268. See Hemel & Ouellette, *Knowledge Goods*, *supra* note 234, at 217–18.

increases the amount of direct R&D funding within the United States. As Part IV described, there are two theoretical mechanisms through which benefit-internalization might lead to higher spending: (1) more internal university research funds from Bayh–Dole revenues and (2) higher federal R&D funding in the first place. We think both of these are plausible, especially given concerns about technological free-riding by Japan at the time of Bayh–Dole’s enactment and by China today.<sup>269</sup> U.S. science funding may be more politically vulnerable if critics could push the narrative that the fruits of this research were simply providing a free benefit to other countries. But there is not yet sufficient evidence to provide strong support for either funding channel.<sup>270</sup> Rather, our goal is to highlight the overlooked global internalization theory of Bayh–Dole, and to urge universities and other parties with access to the relevant data to investigate this theory empirically.

#### CONCLUSION: AN AGENDA FOR UNIVERSITY PATENTING RESEARCH

As we have demonstrated throughout this Article, existing evidence on the benefits of patents on federally funded research cannot justify the Bayh–Dole Act’s present scope, or the current extent of U.S. university patenting more broadly. This observation is not novel: as noted in the Introduction, other prominent scholars have reached the same conclusion.<sup>271</sup> And this lack of novelty simply underscores the importance of this point.

The implication is straightforward: universities and other federal grant recipients should either limit exclusivity to only what is needed for commercialization or develop the evidence to justify greater patent rights. Universities could change their practices unilaterally, or they

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269. Bhaven N. Sampat, *The Bayh–Dole Model in Developing Countries: Reflections on the Indian Bill on Publicly Funded Intellectual Property*, INT’L CTR. FOR TRADE & SUSTAINABLE DEV. 5 (Oct. 5, 2009) (“Bayh–Dole was passed in a climate of economic crisis in the U.S., when there was fear of loss of economic and technological leadership to Japan.”); Susan Decker & Alex Tanzi, *In Tech Race with China, U.S. Universities May Lose a Vital Edge*, BLOOMBERG (Mar. 1, 2019), <https://www.bloomberg.com/news/articles/2019-03-01/in-tech-race-with-china-u-s-universities-may-lose-a-vital-edge> [<https://perma.cc/4T3K-QNJ7>].

270. See Hemel & Ouellette, *Bayh–Dole Beyond Borders*, *supra* note 24, at 293–97 (describing these two mechanisms in more detail).

271. See *supra* notes 25–26 and accompanying text.

could be pushed in this direction by either grant agencies or Congress.<sup>272</sup>

We conclude by consolidating our analysis into the key questions we think universities should tackle—in collaboration with interested scholars—to develop a better evidence base for assessing the social impact of university patenting practices:

*Ex Post Commercialization:* Does exclusivity actually aid commercialization outside the pharmaceutical industry? What fraction of university patents are exclusively licensed in different fields? When university patents are exclusively licensed, how often are there multiple interested parties, such that the university might be able to run a market-test exclusivity auction? Are there other ways to determine the extent to which exclusivity promotes commercialization for a given technology? Is there evidence that nonexclusive licenses promote commercialization in other ways, such as through tacit knowledge transfer? What metrics can be used to quantify university–industry knowledge transfer outside patent licenses? Improvements to the Interagency Edison (iEdison) system for reporting on use of federally funded inventions, coupled with broader access to iEdison for researchers, could help address some of these questions.<sup>273</sup>

*Ex Ante Incentives:* Does the ability of university researchers to gain a financial stake in their inventions spur more or different research? Do researchers care about the reputational effect of patents? How do the effects vary by field, by type of researcher, or over time? Do university patent practices affect researchers' decisions to work in academia as opposed to industry, and what is the welfare impact of this choice? How do these answers vary by field?

*Revenue and Global Internalization:* How much revenue do universities receive from patents, including sources of revenue that are not captured by the AUTM survey? How does this compare with the nearly \$65 billion in university R&D funding? What fraction of rents from university patents are captured by the university, and where do the additional profits go? Is the answer different when considering foreign sales of products based on U.S. university inventions?

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272. See Ayres & Ouellette, *supra* note 22, at 317–24 (describing the steps that could be taken by each of these institutional actors).

273. Cf. NAT'L RES. COUNCIL, *supra* note 40 (“Federal research agencies should reinvigorate the requirement that institutions reliably and consistently provide data to iEdison on the utilization of federally funded inventions, including licensing agreements and efforts to obtain such utilization. Such data should be available for analysis by qualified researchers who agree not to disclose the parties to or terms of particular agreements.”).

Some of these questions can be answered by examining existing practices and datasets, but the most important questions will require rigorous policy experiments.<sup>274</sup> It is difficult to understand the effect of university patenting based on comparisons before and after 1980 because Bayh–Dole’s enactment corresponded with numerous other changes in the U.S. innovation ecosystem, as noted above.<sup>275</sup> One approach for drawing more rigorous conclusions is to look for “natural experiments,” or variation that is close to random.<sup>276</sup> But the most convincing evidence comes from controlled field experiments in which the relevant policy variation is actually randomized. Fruitful field experiments could be run by a number of institutional actors, including not just universities and federal funding agencies, but also private research funders. For example, a foundation that funds university research could run a randomized controlled trial in which different incentives are provided to different grant recipients. In light of the economic importance of university patenting and the limited evidence base for most of the key policy questions in this area, we think it is past time for scholars to partner with these institutions to test the most promising interventions.

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274. See generally Lisa Larrimore Ouellette, *Patent Experimentalism*, 101 VA. L. REV. 65 (2015) (describing different approaches to policy experimentation in the innovation context).

275. See Sampat, *supra* note 10.

276. See, e.g., Martin Watzinger, Lukas Treber & Monika Schnitzer, *Universities and Science-Based Innovation in the Private Sector* (July 3, 2018) (unpublished manuscript) (comparing newly hired German professors with runners-up for the same position to estimate that “a new professor induces corporate science-based innovation [at local companies] with a value of up to half a million dollars per year . . . driven primarily by PhD graduates working in the private sector”).