

4-19-2022

Sy-STEM-Ic Bias: An Exploration of Gender and Race Representation on University Patents

Jordana R. Goodman

Follow this and additional works at: <https://brooklynworks.brooklaw.edu/blr>



Part of the [Education Law Commons](#), [Law and Race Commons](#), and the [Science and Technology Law Commons](#)

Recommended Citation

Jordana R. Goodman, *Sy-STEM-Ic Bias: An Exploration of Gender and Race Representation on University Patents*, 87 Brook. L. Rev. 853 (2022).

Available at: <https://brooklynworks.brooklaw.edu/blr/vol87/iss3/2>

This Article is brought to you for free and open access by the Law Journals at BrooklynWorks. It has been accepted for inclusion in Brooklyn Law Review by an authorized editor of BrooklynWorks.

Sy-STEM-ic Bias

AN EXPLORATION OF GENDER AND RACE REPRESENTATION ON UNIVERSITY PATENTS

Jordana R. Goodman[†]

INTRODUCTION

Women and people of color have been systemically excluded from participation in science, technology, engineering, and math (STEM) fields in the United States for centuries.¹ This inability to participate, coupled with disparate abilities to own and control property, created STEM access gaps still evident in the United States today.²

In the twenty-first century, many praised colleges and universities for closing admissions gaps relating to higher education.³ Colleges have implemented programs “to expand [their] reach to women and minority students.”⁴ These include

[†] Jordana Goodman is Visiting Clinical Assistant Professor at the BU/MIT Technology Law Clinic at Boston University School of Law. She can be contacted at jordi@bu.edu. The author would like to thank Carmi Rothberg, Zachary Kessel, Jaimee Francis, Philip Dutko, Paul Gugliuzza, Gary Lawson, Oded Stein, Kathryn Zeiler, and Janet Freilich for their support and encouragement throughout the writing and publication process.

¹ See B.M. SOLOMON, IN THE COMPANY OF EDUCATED WOMEN: A HISTORY OF WOMEN AND HIGHER EDUCATION IN AMERICA 188 (1985) (“[W]omen students in the 1930s rarely entered fields like engineering and the hard sciences . . .”); see also Caldwell Titcomb, *Key Events in Black Higher Education*, J. BLACKS HIGHER EDUC., <https://www.jbhe.com/chronology/> [<https://perma.cc/XKJ5-48K5>] (highlighting events where Black students and faculty fight for representation in STEM and higher academia).

² See Anette I. Kahler, *Examining Exclusion in Woman-Inventor Patenting: A Comparison of Educational Trends and Patent Data in the Era of Computer Engineer Barbie*, 19 AM. U. J. GENDER, SOC. POL’Y & L. 773, 783–84 (2011); Shontavia Jackson Johnson, *The Colorblind Patent System and Black Inventors*, LANDSLIDE, Mar.-Apr. 2019, at 16, 21 (2019); *Dred Scott v. Sandford*, 60 U.S. 393, 453 (1856).

³ See, e.g., Gijsbert Stoet & David C. Geary, *Gender Differences in the Pathways to Higher Education*, 117 PROC. NAT. ACAD. SCI. U.S. 14073, 14073–76 (2020) (“In most developed nations, fewer men than women enroll in postsecondary education.”); Deirdre Fernandes, *The Majority of Harvard’s Incoming Class Is Nonwhite*, BOS. GLOBE (Aug. 2, 2017, 8:26 PM), <https://www.bostonglobe.com/metro/2017/08/02/harvard-incoming-class-majority-nonwhite/5yOoqrsQ4SePRRNfFemuQ2M/story.html> [<https://perma.cc/2CW6-FLMC>] (“The majority of students accepted into the incoming [class of 2021] freshman class at Harvard University are not white, the second year in a row [that Harvard] . . . has reached that milestone.”).

⁴ *HBS Implements New Programs to Expand Reach to Women and Minority Students*, HARV. OFF. FOR DIVERSITY, INCLUSION & BELONGING,

programs to promote diverse applicants, create an inclusive campus climate, and support programs for incoming students to address remedial educational necessities.⁵ Despite this, the gap in STEM access for women and people of color persists.

Many have published studies on the STEM success gap between white men, women, and people of color, especially Black, Hispanic, and Native American people.⁶ Issues, including low graduation rates, poor access to equal early education, sexism, and systemic racism, all contribute to the lack of diversity in both academia and industry.⁷ Recent developments, like the COVID-19 pandemic and the Black Lives Matter movement, have helped push these issues into the spotlight once again.⁸

This article examines the STEM success gap through the lens of representation in patents and provides a new success metric for racial and gender equality: an equity metric. This is the first article to quantitatively estimate the patent gap between white, male inventors, inventors of color, and female inventors at Ivy League institutions, historically Black colleges or universities

<https://dib.harvard.edu/hbs-implements-new-programs-expand-reach-women-and-minority-students> [<https://perma.cc/W86F-6LQD>].

⁵ U.S. DEP'T OF EDUC., ADVANCING DIVERSITY AND INCLUSION IN HIGHER EDUCATION: KEY DATA HIGHLIGHTS FOCUSING ON RACE AND ETHNICITY AND PROMISING PRACTICES 3 (2016), <https://www2.ed.gov/rschstat/research/pubs/advancing-diversity-inclusion.pdf> [<https://perma.cc/66PW-25NC>].

⁶ See, e.g., Am. Ass'n Cmty. Colls., *Lagging in STEM Credentials*, DATAPOINTS (2019), https://www.aacc.nche.edu/wp-content/uploads/2019/09/Data-Points-16_fixed2.pdf [<https://perma.cc/WZ92-FP3U>] (showing the distribution of STEM certificates and associate degrees by race-ethnicity in 2016-2017, highlighting that “Minority students don’t even comprise half of those who are earning STEM certificates and associate degrees.”); Cary Funk & Kim Parker, PEW RSCH. CTR., *WOMEN AND MEN IN STEM OFTEN AT ODDS OVER WORKPLACE EQUITY* 6–8 (2018), <https://www.pewresearch.org/social-trends/2018/01/09/women-and-men-in-stem-often-at-odds-over-workplace-equity/> [<https://perma.cc/ME3C-2473>] (showing that “[p]erceived inequities are especially common among women in science, technology, engineering and math jobs who work mostly with men” and discussing that Black and Hispanic people “are underrepresented in STEM occupations relative to their share in the U.S. workforce”); Sandia Nat’l Lab’s, *The Current State of STEM Education for American Indian and Alaska Native Communities*, DEP’T OF ENERGY (2021), <https://www.energy.gov/sites/prod/files/2018/02/f48/begay-stem-education.pdf> [<https://perma.cc/CB6Q-VACN>] (generally discussing that “American Indians and Alaskan Natives are not prevalent in engineering”).

⁷ Paul H. Barber et al., *Systemic Racism in Higher Education*, 369 SCI. 1440, 1441 (2020).

⁸ See Colleen Flaherty, *COVID-19: A Moment for Women in STEM?*, INSIDE HIGHER EDUC. (Mar. 10, 2021), <https://www.insidehighered.com/news/2021/03/10/covid-19-moment-women-stem> [<https://perma.cc/SAX8-DV7K>]; NAT’L ACADS. OF SCIS., ENG’G, & MED., *THE IMPACT OF COVID-19 ON THE CAREERS OF WOMEN IN ACADEMIC SCIENCES, ENGINEERING, AND MEDICINE* 6 (Eve Higginbotham & Maria Lund Dahlberg eds., 2021), <https://doi.org/10.17226/26061> (last visited Apr. 10, 2022) (“[B]udget cuts made by many colleges and universities . . . greatly affected contingent and nontenured faculty members—positions disproportionately occupied by women and People of Color. Along with these potential negative effects, the COVID-19 pandemic may be catalyzing changes that could portend a better future for women in academic STEM.”); Lilah Burke, *#ShutDownSTEM*, INSIDE HIGHER EDUC. (June 11, 2020), <https://www.insidehighered.com/news/2020/06/11/scientists-strike-black-lives-more-inclusive-academia> [<https://perma.cc/6JXX-34E8>].

(HBCUs), research institutions, and other highly ranked universities in the United States (highly ranked schools, or HRS).⁹ This article compares representation on patents to representation at the university, excluding variable systemic issues regarding access to attorneys, patent funding, and other resources to pursue intellectual property protection.

Whether universities have a representative population of faculty and students equivalent to the racial and gender demographics present in the United States is immaterial to this article. Instead, this article presents a metric to determine whether groups of individuals invent and receive credit for their inventions through patents at the same rate as their peers at universities. The research herein demonstrates that Black, Hispanic, and female professors are not named as patent inventors at the same rate as their white and male peers, even when accounting for their underrepresentation on campus. Thus, the equity metric herein demonstrates that Black, Hispanic, and female professors are not succeeding in patent inventorship at the same rate as their white and male peers.

Patent inventorship is the recognition of an inventor's contribution to the wealth-building tool of a patent application.¹⁰ This article uses patent ownership as a proxy for a wealth and value metric, showing both that a person can produce value for their employer and that their contribution to that value is recognized in the form of patent inventorship. Closing current racial and gender patent inventorship gaps would increase aggregate economic output by trillions of dollars.¹¹ According to the study herein, when accounting for representation on campus, women are up to 7 times less likely than their male peers to be named patent inventors.¹² The

⁹ I acknowledge that gender does not fall on a strict binary and race does not fall into easily distinguished categories. I selected the categories for gender and race given the population data available at the time of this article. I selected analytical methods similar or identical to research methods used by peers to identify race and gender disparities. I welcome critique of and suggestions on techniques for quantifying race and gender disparities that better account for the fluid nature of gender and race. See generally Adams Nager et al., *The Demographics of Innovation in the United States*, INFO. TECH. & INNOVATION FOUND. (2006), https://www2.itif.org/2016-demographics-of-innovation.pdf?_ga=2.48696229.260237362.1643240430-1261716487.1643240430 [<https://perma.cc/4KS9-5D2N>] (quantifying the overall race representation on patents compared to the US population); Inmaculada de Melo-Martin, *Patenting and the Gender Gap: Should Women be Encouraged to Patent More?*, 19 SCI. & ENG'G ETHICS 491 (2013) (discussing overall patent representation for women).

¹⁰ Bronwyn H. Hall et al., *The Market Value of Patents and R&D: Evidence from European Firms*, 2007 ACAD. MGMT. 1, 6 (2007).

¹¹ See Shelby R. Buckman et al., *The Economic Gains from Equity* 17 (Brookings Inst., Brookings Papers on Econ. Activity, BPEA Conference Drafts, Sept. 9, 2021) (showing that race and gender disparities in STEM cost the US economy \$0.94 trillion in 2019).

¹² According to my findings herein, male students and staff at research universities are 7.17 times more likely than their female peers to be named patent inventors. See *infra* Section III.A.

patent gap is even more striking for Black and Hispanic inventors, with white full-time STEM professors over 18 times more likely than a Black peer and about 27 times more likely than a Hispanic peer to be a named patent inventor at top research universities in the United States.¹³ Moreover, although universities are admitting more people of color and women to undergraduate programs, in some cases, the newly hired professorship class is less diverse in 2015 than in 2000.¹⁴

From this data, it is apparent that universities are either consciously or unconsciously engaging in what this article calls “restorative justice theater”—performatively pushing towards racial and gender equity but failing to quantitatively demonstrate that their efforts effectively repair previous harm. Universities should replace this theater with quantitative measures of patent inventorship—equity metrics—to demonstrate their commitment to racial and gender equity, to comply with antidiscrimination legislation, and to help other universities engage in effective programs with measurable results to close the racial and gender gaps in higher education.

To understand the implications of the racial and gender inventorship disparities pervasive across Ivy League institutions, research universities, and HBCUs in the United States, Part I shows how patent inventorship is an indicator of value recognition and how universities facilitate the patent process, highlighting the crucial roles of education, funding, and technology offices in mitigating gender and race disparities. Part II explains the techniques used in this article to gather data and calculate the results of my research. Part III provides the results of my analysis, showing that full-time male STEM professors are between 2 and 5 times more likely to be patent inventors than their female peers at HBCUs, Ivy League Schools, research institutions, and schools outside of the HBCU system with the most tenured Black faculty. White full-time STEM professors were between 2 and 27 times more likely to be named patent inventors than their Black and Hispanic peers, depending on the university entity. Finally, Part IV explores potential reasons for these disparities, as well as legal implications for the systemic

¹³ According to my findings herein, at research universities, when considering the representation of STEM staff, white STEM staff are patent inventors at a rate that is 18.8 times higher than Black STEM staff and 26.9 times higher than Hispanic STEM staff. *See infra* Section III.B.

¹⁴ According to my findings herein, at Ivy League universities, Black professors made up 4.2% of the total professor population in 2001 and 4.0% of the total STEM professor population in 2015, representing a decrease in Black professor representation of 4.77% over the fifteen-year period of the data set. Other high-ranking schools had a decrease in Black professor representation of 10.09% in the same time period. *See infra* Section III.B.

issues uncovered by this quantitative analysis, including violations of antidiscrimination laws.

I. THE IMPORTANCE OF RECOGNIZING PATENT GAPS

The US patent system was established as an early “instrument for economic development.”¹⁵ From the first State of the Union address to the Patent Act of 1790 and the Patent Act of 1793, the founding fathers recognized the importance of protecting patents for “any new and useful art, machine, manufacture or composition of matter, or any new and useful improvement [thereof].”¹⁶ Patents recognize ownership over mental creation, allowing a patent owner to exclude others from “making, using, offering for sale, or selling the invention.”¹⁷ Although this can seem monopolistic, from the establishment of the patent system, “patentees were viewed as beneficent contributors to progress, and the consistent goal of those who shaped the system was to encourage domestic ingenuity, whatever the social class of the inventor.”¹⁸ This sense of an inventor’s contribution to progress manifests in a wealth-building tool: a patent.

Recognition of patent inventorship is synonymous with recognition of that inventor’s contribution to this wealth-building tool. This value recognition in no way demonstrates that a patent is necessarily good or bad for society.¹⁹ Social costs associated with monopolies may or may not outweigh the benefits of encouraging “creation and dissemination of new works.”²⁰ Much like ownership

¹⁵ Robert P. Merges, *The Hamiltonian Origins of the U.S. Patent System, and Why They Matter Today*, 104 IOWA L. REV. 2559, 2590 (2019).

¹⁶ Patent Act of 1793, ch. 11, § 1, 1 Stat. 318, 318–23 (1793), *repealed by* Patent Act of 1836, ch. 357, § 21, 5 Stat. 117, 125; *see 10 Facts About 18th Century Patents*, MOUNT VERNON, <https://www.mountvernon.org/george-washington/the-first-president/patents/> [<https://perma.cc/4TCG-TW5D>] (“So important that part of Article 1 of the Constitution provided Congress with the power to create a method of granting patents. Washington also saw the importance of creating a patent system. On January 8, 1790, during his first State of the Union, he called on Congress to establish a system.” (footnote omitted)); *see also* 35 U.S.C. § 101.

¹⁷ 35 U.S.C. § 154(a)(1) (establishing that patent owners may also “exclude others from . . . importing the invention into the United States, and, if the invention is a process . . . exclude others from using, offering for sale or selling throughout the United States, or importing into the United States, products made by that process”); *see also Patent Process Overview: Step 1*, U.S. PAT. & TRADEMARK OFF. (May 15, 2020, 1:34 PM), <https://www.uspto.gov/patents-getting-started/patent-process-overview#step1> [<https://perma.cc/9NLQ-J98M>].

¹⁸ DAVID KLINE & DAVID KAPPOS, INTRODUCTION TO INTELLECTUAL PROPERTY 21 (OpenStax 2021) (ebook) (footnote omitted); THE MICHAELSON 20MM FOUND., THE INTANGIBLE ADVANTAGE: UNDERSTANDING INTELLECTUAL PROPERTY IN THE NEW ECONOMY 16 (OpenStax 2021) (ebook).

¹⁹ *See* Mario Biagioli, *Weighing Intellectual Property: Can We Balance the Social Costs and Benefits of Patenting*, 57 HIST. SCI. 1, 18 (2019).

²⁰ *Id.* at 1.

of a house, society will forever debate the social benefits and detriments of private ownership and exclusion.²¹ However, there is no question that patents build and recognize value.²²

The patent owner, the inventors, and society at large all recognize the value of a patent. First, the mere existence of a patent right demonstrates that the government recognizes the value of the invention therein. The government allows an owner to have a temporary monopoly in exchange for helping to establish a market for inventions.²³ This exchange prevents owners from keeping inventions a trade secret, instead enabling others to manufacture the invention either under a license from the patent owner or after the patent expires by reading the blueprint within the publicly available patent disclosure.²⁴ Society then rewards the patent owner through monetary returns based on perceived market value.²⁵ Currently, the United States allows a patent owner to prevent others from making, using, selling, or offering to sell their invention without first paying a license fee for up to a twenty-year period.²⁶

The patent owner, “the entity who has authority to file patent applications and take action in a pending application,”²⁷ demonstrates recognition of their patent’s value by investing in the application process, engaging in the licensing process, and, sometimes, by rewarding inventors for their efforts. The patent owner has the right to control patent monetization and the use (or lack thereof) of the claimed invention.²⁸ The patent owner likely paid anywhere from \$5,000 to \$16,000 or more to gain these rights, and usually paid this money with an underlying expectation to receive a return on their initial

²¹ Dan Immergluck & Geoff Smith, *The External Costs of Foreclosure: The Impact of Single-Family Mortgage Foreclosures on Property Values*, 17 HOUS. POL’Y DEBATE 57, 57 (2006).

²² Hall et al., *supra* note 10, at 6.

²³ See Daniel F. Spulber, *How Patents Provide the Foundation of the Market for Inventions* 12–13 (June 2014) (unpublished manuscript), https://wwws.law.northwestern.edu/research-faculty/clbe/events/roundtable/documents/spulber_patents_and_the_market_for_inventions.pdf [<https://perma.cc/NY7K-TBNR>].

²⁴ See Jonathan J. Darrow, Note, *The Neglected Dimension of Patent Law’s PHOSITA Standard*, 23 HARV. J.L. & TECH. 227, 248 (2009) (“Similarly, as patents expire and scientific papers are published, the increased base of knowledge that is freely available to the public justifies an expanded scope of relevant prior art.”).

²⁵ See Spulber, *supra* note 23, at 43.

²⁶ *Duration of Patent Prosecution*, JUSTIA (May 2019), <https://www.justia.com/intellectual-property/patents/duration-of-patent-protection/> [<https://perma.cc/K7HV-C83F>].

²⁷ Michael K. Henry, *Patent Ownership vs. Inventorship: Who Really Controls the Rights to a Patent?*, HENRY PAT. L. FIRM: INSIGHTS (June 14, 2018), <https://henry.law/blog/patent-ownership-vs-inventorship/> [<https://perma.cc/M7S2-Z24C>].

²⁸ Jaime Siegel, *What Is a Patent Owner to Do When They Want to Monetize Their Patents?*, IPWATCHDOG (Nov. 29, 2015), <https://www.ipwatchdog.com/2015/11/29/63459/id=63459/> [<https://perma.cc/DR3A-XN6B>].

investment.²⁹ Inventor award programs, wherein the patent owner gives money to named patent inventors,³⁰ further demonstrate value recognition in two ways. First, inventorship awards show that the owner values the patent because the owner is willing to part with more money to incentivize employees to produce more patentable inventions. Second, giving money directly to inventors, rather than simply investing money into more research or the business itself, shows that the owner recognizes the value of the inventors behind the invention.³¹

Inventors also recognize the inherent value of a patent and inventorship recognition.³² Even if the inventors do not derive monetary benefit from the patent itself or a bonus from their employer, inventors still derive benefit from being named on the patent.³³ The process of naming inventors gives each inventor credit in the form of name recognition for their intellectual property contribution.³⁴ This credit, similar to authorship of a work of literature, recognizes the inventor as a person who helped to conceive of at least one concept claimed in the final patent.³⁵ Thus, the patent memorializes that the inventors conceived of an invention found valuable to the patent owner and society at large. Inventors have fought over this memorialization for years after a patent issues, further demonstrating that they recognize the value of patent inventorship recognition.³⁶

²⁹ See *How Much Does a Patent Cost?*, THERVO, <https://thervo.com/costs/how-much-does-a-patent-cost> [<https://perma.cc/5NDY-K2L5>]; Pat. Tech. Monitoring Team, *Independent Inventors by State by Year, All Patent Types Reports, January 1977–December 2015*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/web/offices/ac/ido/oeip/taf/inv_all.htm [<https://perma.cc/W8R9-7FWW>]; Pat. Tech. Monitoring Team, *U.S. Patent Statistics Chart Calendar Years 1963–2020*, U.S. PAT. & TRADEMARK OFF. (May 2021), https://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.htm [<https://perma.cc/G47D-S8JR>].

³⁰ Betty Sosnin, *A Pat(ent) on the Back*, SOC'Y FOR HUM. RES. MGMT.: HR MAG. (Mar. 1, 2000), <https://www.shrm.org/hr-today/news/hr-magazine/pages/0300sosnin.aspx> [<https://perma.cc/L7NN-NYLS>].

³¹ See, e.g., Donal O'Connell, *Award the Investor, But How?*, INTELL. PROP. EXPERT GRP. (Sept. 29, 2015), <https://www.ipeg.com/award-the-inventor-but-how/> [<https://perma.cc/P92P-8YXD>] (“Most innovative businesses provide rewards and some form of recognition to inventors[because] . . . a good comprehensive reward and recognition program encourages and motivates innovation and creativity.”).

³² See *In re VerHoef*, 888 F.3d 1362, 1365–67 (Fed. Cir. 2018) (noting that the threshold question in determining inventorship is who conceived the invention, and that a person who “share[s] in the conception of [a] claimed invention . . . is a joint inventor” of that invention”).

³³ Patrick G. Gattari, *Determining Inventorship for US Patent Applications*, 17 INTELL. PROP. & TECH. L.J. 16, 18 (2005).

³⁴ Christopher Jon Sprigman et al., *What's a Name Worth?: Experimental Tests of the Value of Attribution in Intellectual Property*, 93 B.U. L. REV. 1389, 1391 (2013).

³⁵ See O'Connell, *supra* note 31.

³⁶ See, e.g., *Meng v. Chu*, 643 F. App'x 990, 991 (Fed. Cir. 2016) (discussing two inventors, Meng and Hor, who sought correction of inventorship on a patent in 2010 and 2008 respectively, on patents filed in the 1980s).

A. *The Value of Equity in the Patent System*

Gender and racial disparities in patent inventorship “hold back economic growth and U.S. leadership in innovation.”³⁷ The US patent system was developed as a theoretically accessible option to protect inventor ownership, not just because of low fees, but also because of its purportedly colorblind and genderblind system.³⁸ The United States has never had a federal law barring any citizen from applying for a patent and has always allowed the possibility of patent rights for citizens or residents who intended to become citizens.³⁹ Despite this supposed neutrality, female inventors and inventors of color have never reached parity with white men regarding patent inventorship in the United States.⁴⁰ Increasing diversity in patent inventorship “would unlock a wealth of innovation[and] economic growth . . . that is now untapped.”⁴¹

Society at large has created significant barriers for women and people of color to achieve the status of “patent inventor[.]” at the same rate as their male and white peers.⁴² However, in recent years, many programs have attempted to correct these barriers.⁴³ Patent owners and potential inventors play a part in the success of these programs, mainly through recognition of who contributed to the patent process.

³⁷ Holly Fechner & Matthew S. Shapanka, *Closing Diversity Gaps in Innovation: Gender, Race, and Income Disparities in Patenting and Commercialization of Inventions*, 19 TECH. & INNOVATION 727, 727 (2018).

³⁸ See B. Zorina Khan, *An Economic History of Patent Institutions*, ECON. HIST. ASS'N, <https://eh.net/encyclopedia/an-economic-history-of-patent-institutions/> [<https://perma.cc/4M7R-48NM>] (“[T]he first patent law in 1790 set the rate at the minimal sum of \$3.70 plus copy costs. . . . Rural inventors could apply for patents without significant obstacles, because applications could be submitted by mail free of postage.”); Johnson, *supra* note 2, at 16.

³⁹ Khan, *supra* note 38.

⁴⁰ Jessica Milli et al., *The Gender Patenting Gap*, INST. FOR WOMEN'S POL'Y RSCH. (July 21, 2016), <https://iwpr.org/iwpr-general/the-gender-patenting-gap/> [<https://iwpr.org/iwpr-general/the-gender-patenting-gap/>]; Fechner & Shapanka, *supra* note 37, at 728–29, 732.

⁴¹ Fechner & Shapanka, *supra* note 37, at 727.

⁴² See, e.g., Kahler, *supra* note 2, at 783–84; B. Zorina Khan, *Married Women's Property Laws and Female Commercial Activity: Evidence from United States Patent Records, 1790-1895*, 56 J. ECON. HIST. 356, 357 (1996) (describing women not having full ownership over their property); Johnson, *supra* note 2, at 16 (noting that although patent “law did not explicitly exclude certain races of inventors from participation in the patent system enslaved people . . . were not considered American citizens, and the rights and provisions of the Constitution [including the right to pursue rights to their own intellectual property] did not extend to them” (citing Shontavia Johnson, *America's Always Had Black Inventors—Even When the Patent System Explicitly Excluded Them*, CONVERSATION (Feb. 14, 2017, 9:02 PM), <https://theconversation.com/americas-always-had-black-inventors-even-when-the-patent-system-explicitly-excluded-them-72619> [<https://perma.cc/9TFH-4VY7>])).

⁴³ See, e.g., #MakeWhatsNext Patent Program, MICROSOFT, <https://www.microsoft.com/en-us/patent-program> [<https://perma.cc/7HJA-3DB5>]; Freeman A. Hrabowski III & Peter H. Henderson, *How to Actually Promote Diversity in STEM*, ATLANTIC (Nov. 29, 2019), <https://www.theatlantic.com/ideas/archive/2019/11/how-umbc-got-minority-students-stick-stem/602635/> [<https://perma.cc/XRT9-WCJP>].

For too long, systemic racism and sexism have prevented women and underrepresented minorities from receiving economic credit for their inventive contributions to society.⁴⁴ The lack of diversity plaguing STEM education and employment has cost the United States trillions of dollars over the last century.⁴⁵ The systemic underutilization of STEM degrees can no longer be ignored if the United States wants to maximize economic growth. Opportunities for inventorship recognition should therefore be viewed not only as methodologies for redressing historic barricades to patent equality, but also as methods to promote economic growth through maximizing economic participation.

B. *The Equity of Technology Transfer Offices*

The technology transfer office model offered at universities removes many of the inequities faced by individual inventors when pursuing a patent and theoretically helps to reduce economic losses from the patent diversity gap. Universities have a structured system of technology transfer offices designed to protect and manage patents and allow their researchers—students and faculty members—to continue

⁴⁴ O’Connell, *supra* note 31; *see, e.g.*, Kara W. Swanson, *Inventing While a Black Woman: Passing and the Patent Archive*, 25 STAN. TECH. L. REV. (forthcoming 2022) (manuscript at 42), <https://ssrn.com/abstract=4007539> [<https://perma.cc/HE93-XWX5>] (“Boyd’s story, another whisper out of the silence, reminds us that each marginalized inventor had to perform a risk assessment of their options, considering the constraints they faced, the opportunities available, and the costs they were willing to pay.”); *id.* (manuscript at 58) (“As a Black woman inventor, Eglin navigated a raced and gendered terrain shaped by the laws of both slavery and coverture in which all options entailed a cost.”).

⁴⁵ *See, e.g.*, DANA M. PETERSON ET AL., CLOSING THE RACIAL INEQUALITY GAPS: THE ECONOMIC COST OF BLACK INEQUALITY IN THE U.S. 3 (Citi GPS: Global Perspectives & Solutions, Sept. 2020), <https://www.etsu.edu/afam/documents/citi-economic-inequality.pdf> [<https://perma.cc/JXG8-FT8Y>] (“The analysis in the report that follows shows that if four key racial gaps for Blacks—wages, education, housing, and investment—were closed 20 years ago, \$16 trillion could have been added to the U.S. economy. And if the gaps are closed today, \$5 trillion can be added to U.S. GDP over the next five years.”); NICK NOEL ET AL., THE ECONOMIC IMPACT OF CLOSING THE RACIAL WEALTH GAP 5–6 (McKinsey & Co., Aug. 13, 2019), <https://www.mckinsey.com/industries/public-and-social-sector/our-insights/the-economic-impact-of-closing-the-racial-wealth-gap#> [<https://perma.cc/6W38-E5MJ>] (noting that the racial wealth gap’s “dampening effect on consumption and investment will cost the US economy between \$1 trillion and \$1.5 trillion between 2019 and 2028—4 to 6 percent of the projected GDP in 2028”); LISA D. COOK & JAN GERSON, THE IMPLICATIONS OF U.S. GENDER AND RACIAL DISPARITIES IN INCOME AND WEALTH INEQUALITY AT EACH STAGE OF THE INNOVATION PROCESS 1 (Wash. Ctr. for Equitable Growth, July 2019), <https://equitablegrowth.org/the-implications-of-u-s-gender-and-racial-disparities-in-income-and-wealth-inequality-at-each-stage-of-the-innovation-process/> [<https://perma.cc/7R8Q-MHWV>] (“Closing [the] gender and racial gap in the U.S. innovation process could increase U.S. Gross Domestic Product per capita by 2.7 percent.”); Buckman et al., *supra* note 11, at 16 (“Eliminating the gaps in returns earned by whites versus people of color and women versus men on measured skills, utilization, and industry-occupation allocation would have increased aggregate economic output in 2019 by 0.94 trillion 2019 dollars.”)

inventing.⁴⁶ Federal agency partnerships, in tandem with the pursuit and passage of the Bayh-Dole Act of 1980,⁴⁷ expanded university patenting and licensing in the twentieth century.⁴⁸ This had led to an expansion of technology transactions, where universities are adding \$21 billion each year to the economy through commercializing their products.⁴⁹ Although universities do not eliminate inequities regarding patent accessibility, their structure and motivations behind patent acquisition facilitate an easier patent process for university inventors than independent inventors.⁵⁰ By facilitating this process, an analysis of the relative racial and gender representative equity from university patents can help to highlight the causes of and solutions to the patent inventorship disparity that higher education is capable of addressing.

Through the help of attorneys, drafting professionals, and licensing officers, technology transfer offices can help inventors patent and commercialize their inventions, leading to an easier value recognition process for inventors and patent owners.⁵¹ Because technology transfer offices are not involved in the admissions or hiring processes at universities, analysis of patents

⁴⁶ See, e.g., *Guide to Intellectual Property as a Student at the University of California*, UNIV. OF CAL., <https://www.ucop.edu/research-policy-analysis-coordination/policies-guidance/intellectual-property/intellectual-property-as-a-student-at-the-university-of-california.html> [<https://perma.cc/9ASA-7P7N>] (guiding the students and faculty at the University of California through the patent process at their campus technology transfer office (or TTO)); *Statement of Policy in Regard to Intellectual Property (IP Policy)*, HARV. OFF. OF TECH. DEV. (June 11, 2019), <https://otd.harvard.edu/faculty-inventors/resources/policies-and-procedures/statement-of-policy-in-regard-to-intellectual-property#inventions-and-patents> [<https://perma.cc/626T-4W2C>] (guiding the students and faculty at Harvard University through the patent process at their office of technology development); *Ownership*, MIT TECH. LICENSING OFF., <https://tlo.mit.edu/learn-about-intellectual-property/ownership> [<https://perma.cc/P9HW-53ZL>] (guiding the students and faculty at MIT through the patent process at their technology licensing office). Technology transfer offices may be referred to as technology licensing offices (TLO), offices of technology development (OTD), technology transfer offices (TTO), or other acronyms, but most perform similar functions at a university. For consistency, I refer to these offices as technology transfer offices in this Article unless referring to a specific office at a university.

⁴⁷ Pub. L. No. 96-517, 94 Stat. 3015 (1980) (codified as amended at 35 U.S.C. §§ 200–212) (enabling universities to own and control the commercialization of inventions developed at their university, even if developed under federally funded research programs).

⁴⁸ 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, 119 (2005).

⁴⁹ See *id.* at 125 n.7.

⁵⁰ See Abhay Aneja et al., *Try, Try, Try Again? Differential Responses to Rejection & the Gender Innovation 4* (May 2021) (unpublished manuscript) (on file with author) (explaining that the shrinkage of gender differential with better legal representation suggests that institutional supports helps to mitigate gender disparities); see also Fechner & Shapanka, *supra* note 37, at 730 (“For women and people of color, whose access to social networks is more limited, technology transfer offices can prove especially valuable to help navigate the patenting process and grow their networks.”).

⁵¹ Fechner & Shapanka, *supra* note 37, at 730.

filed by the technology transfer office can be used to evaluate two aspects of the equity metric: (1) whether everyone at the university has an equal opportunity to obtain value through pursuing a patent, and (2) whether every peer at the university has an equal opportunity to receive credit for building that value.

One job of a technology transfer office is to educate the community it serves. Education of the university community includes educating inventors on the importance of pursuing a patent, determining what constitutes patentable material, and giving credit to inventors on a patent application.⁵² Technology transfer offices generally provide accurate, easily digestible information regarding the patent process on technology office websites.⁵³ Many also offer classes to educate students and faculty on the nuances of patenting, in the hopes that more technology is patented at the university.⁵⁴ These educational endeavors contribute to the technology transfer office's purpose to "assist and lead the successful commercialization of innovations."⁵⁵

Furthermore, the importance of inventorship credit promotes the validity of another purpose of the technology transfer office: patent commercialization. Unlike the vast majority of incorrect paper authorship instances, incorrect patent inventorship recognition comes with legal consequences.⁵⁶ If a person is not named as a joint inventor on a patent application and the patent issues, the patent may be considered invalid.⁵⁷ The technology transfer office, responsible

⁵² See, e.g., *About the Technology Transfer Office (TTO)*, CASE W. RESERVE UNIV., <https://case.edu/research/faculty-staff/technology-transfer/about-technology-transfer-office-tto> [<https://perma.cc/XNT4-NHVS>] (noting that the university's technology transfer office "seeks to educate the university faculty, staff and students and the regional community on issues such as intellectual property, standard licensing practices, and the formation of new ventures").

⁵³ See, e.g., *Protecting Intellectual Property*, HARV. OFF. OF TECH. DEV., <https://otd.harvard.edu/faculty-inventors/protecting-intellectual-property/> [<https://perma.cc/H5WD-Q35H>] (stating "OTD provides the expertise to ensure you navigate this complex process successfully").

⁵⁴ See, e.g., *Enterprise Engineering Seminar*, FINNEGAN (Apr. 3, 2013), <https://www.finnegan.com/en/insights/events/enterprise-engineering-seminar-2.html> [<https://perma.cc/YB4M-FAZ3>] (providing a patent law seminar at Cornell University for engineers).

⁵⁵ *Case Western Reserve University*, UNIV. OF HOUS. TECH MAP, <https://techmap.uh.edu/entity/case-western-reserve-university> [<https://perma.cc/D4Y6-ETRL>].

⁵⁶ *Award the Inventor, But How?*, INTELL. PROP. EXPERT GRP. (Sept. 29, 2015), <https://www.ipeg.com/award-the-inventor-but-how/> [<https://perma.cc/GVM5-NFKN>].

⁵⁷ See 35 U.S.C. § 116 (requiring that two or more people should jointly apply for a patent when those two or more people invented the disclosed invention. Furthermore, if a person is named in error, the director may permit correction of the error.); Alex Wolcott et al., *Failure to Name Joint Inventors May Bar Patentability*, SQUIRE PATON BOGGS (May 20, 2018), <https://www.iptechblog.com/2018/05/failure-to-name-joint-inventors-may-bar-patentability/> [<https://perma.cc/KE3K-9WVF>] (showing that failure to name a joint inventor or correct inventorship can be fatal to the patent).

for the commercialization of these patents, must therefore educate its community on the rules and consequences of patent inventorship recognition, and may also be motivated to actively correct inventorship.⁵⁸

Inventors' and owners' statements determine who should be named on a patent application.⁵⁹ This eventual recognition should come from a mutual understanding of the actors who contributed to the invention, with the patent application listing every person who meaningfully contributed to the patent claims.⁶⁰ Universities are legally obligated to name all inventors on their patents and the lack of recognition demonstrates either (1) that the unnamed person did not contribute to the claimed invention's conception, or (2) that the unnamed person was not recognized for their contribution to the claimed invention's conception and was not equipped to fight for their recognition.⁶¹

In addition to educating the community on patent recognition and inventorship, the technology transfer office also collects patent disclosures and decides whether the university will pursue a patent on the disclosed invention.⁶² In total, each patent application may cost between \$6,400 and

⁵⁸ See *Award the Inventor, But How?*, *supra* note 56.

⁵⁹ See Aneja et al., *supra* note 50, at 4 ("When female applicants are represented by one of the top general or IP-focused law firms, the gender differential in applicant attrition shrinks considerably.").

⁶⁰ Gattari, *supra* note 33, at 18–19.

⁶¹ The latter option may be particularly prevalent in laboratories where the professor is biased against contributions from undergraduate or graduate students. Additionally, scientists may not be familiar with the legal consequences associated with patent inventorship. I plan to do further research into the relative contribution of these two factors towards the patent inventorship results shown in this article. Further, because of this legal obligation, I hypothesize that the inventorship on university patents presents a more accurate assessment of inventorship contributions than the authorship on university papers and a less subjective recognition of value in academia than paper authorship in areas that have papers directed to primarily patentable subject matter. See generally Robert P. Crease, *Patenting Science*, PHYSICS WORLD (Apr. 24, 2014), <https://physicsworld.com/a/patenting-science/> [<https://perma.cc/YSZ3-E7PB>] (recognizing that, in certain areas of STEM, such as mathematics and theoretical physics, publishable discoveries such as algorithms and natural laws are less likely to be patent-eligible).

⁶² See, e.g., *MIT and Industry*, MASS. INST. OF TECH., <https://web.mit.edu/facts/industry.html> [<https://perma.cc/C6LN-SH5D>] (noting that MIT's Technology Licensing Office "cultivates an inclusive environment of scientific and entrepreneurial excellence, and bridges connections from MIT's research community to industry and startups by strategically evaluating, protecting, and licensing technology"). An invention disclosure is a written or oral explanation of the potential invention. Generally, in a technology transfer office setting, members in the office will evaluate disclosures to determine if the office will pursue a patent application based on the disclosure. In this way, the disclosure may remain private until a decision-maker decides to file an application. A patent will only be rewarded to an inventor who publicly discloses their invention in a patent application. Disclosure to a university entity is insufficient for patent protection because it is not a disclosure to the USPTO and, generally, it is not a public disclosure.

\$16,900 to prepare and file,⁶³ and accordingly, technology transfer offices may not be able to file applications for every disclosure. For example, in 2019, the MIT technology transfer office decided to file 439 new US patents from 789 received invention disclosures.⁶⁴

Despite the high cost, the technology transfer office provides a readily available option for funding if an inventor does not have the immediate means to pay for an application not otherwise available to the general public.⁶⁵ In exchange for using this process (either due to contractual obligations or voluntarily), the university will retain a share of any royalty generated from the patent.⁶⁶ While a study of Stanford University faculty found that there was little to no disparity between the gender of those listed on a patent disclosure and the gender of the inventors listed on the selected patent applications, more research should be done to see whether this is replicable across all university institutions.⁶⁷

Once the technology transfer office chooses a patent application, they are instrumental in selecting attorneys and knowledgeable draftsmen available to assist inventors in the patent drafting process. Unlike individual inventors, who may need to spend countless hours finding attorneys, searchers, and other professionals to help them through the patent process, most university inventors undergo a far easier process before receiving a patent.⁶⁸ This is available to every inventor from the university, leveling the traditional gender and racial barriers to legal engagement.⁶⁹

Once a patent is granted, the technology transfer office also helps inventors past a barrier in the licensing process:

⁶³ *How Much Does a Patent Cost?*, *supra* note 29 (noting that the patent search cost and provisional patent application filing is optional).

⁶⁴ *MIT and Industry*, *supra* note 62. MIT refers to its technology transfer office as the Technology Licensing Office.

⁶⁵ In some universities, students and faculty members pursue patents outside of the university's ownership. This may be more likely if the university chooses not to fund the patent process.

⁶⁶ Lisa Larrimore Ouellette & Andrew Tutt, *How Do Patent Incentives Affect University Researchers?*, *INT'L REV. L. & ECON.*, Mar. 2020: 105,883, at 1, 1.

⁶⁷ Serena Hanes et al., *Gender Analysis of Invention Disclosures and Companies Founded by Stanford University Faculty from 2000-2014*, 53 *LES NOUVELLES J. LICENSING EXECS. SOC.* 83, 84 (2018) (noting that 14 percent of disclosure events were from women and 15 percent of faculty inventors were women).

⁶⁸ *Developing Frameworks to Facilitate University-Industry Technology Transfer: A Checklist of Possible Actions*, *WORLD INTELL. PROP. ORG.*, https://www.wipo.int/export/sites/www/policy/pdf/en/ui_checklist.pdf [<https://perma.cc/8NFY-8ZB6>].

⁶⁹ Cf. Paul Gugliuzza & Rachel Rebouché, *Gender Equality in Patent Litigation*, 100 *N.C. L. REV.* (forthcoming 2022) (manuscript at 16), <https://ssrn.com/abstract=3871975> [<https://perma.cc/G3NJ-VSMG>] (suggesting that the lack of women may reinforce gendered barriers).

monetizing the invention.⁷⁰ Although universities rarely pursue patents solely for monetary economic motivations,⁷¹ licensing a product often contributes to the prestige of the patent and the inventors listed thereon. In the licensing process, patent owners (licensors) license their patents to other individuals and companies (licensees) who want to use the claimed invention.⁷² The licensor negotiates and authorizes the licensee to use the claimed invention in exchange for a monetary value known as a fee or a royalty.⁷³ This process is complicated to navigate; only about 5 percent of all granted patents are ever commercialized or licensed.⁷⁴

The licensing process is plagued by a myriad of hurdles, including finding licensees, contract fees, enforcement fees, and other logistical infrastructure. Universities have a much higher patent commercialization rate than individual inventors, with over one-third of all patents granted to the top US universities involved in monetization.⁷⁵ This is in large part due to (1) the university-provided infrastructure built to successfully commercialize the patent and (2) the royalties earned by individual professors and students for successfully commercialized inventions.⁷⁶

The university's infrastructure, education, funding, and time all help inventors through the patent process, recognizing an inventor's value while requiring little effort from the inventors after the initial disclosure. Universities assist inventors by

⁷⁰ *Startups and Licenses: Crafting a Strategy*, HARV. OFF. OF TECH. DEPT, <https://otd.harvard.edu/faculty-inventors/commercializing-technologies/> [<https://perma.cc/4E5G-FFT2>].

⁷¹ See Jon Marcus, *Think Universities Are Making Lots of Money from Inventions? Think Again*, THE HECHINGER REP. (Jan. 17, 2020), <https://hechingerreport.org/think-universities-are-making-lots-of-money-from-inventions-think-again/> [<https://perma.cc/S8YF-UPXP>].

⁷² See *Patenting an Invention*, MIT TECH LICENSING OFF., <https://tlo.mit.edu/learn-about-intellectual-property/patenting-invention> [<https://perma.cc/UW9Q-ZCM8>].

⁷³ *What Is an IP License?*, METIS PARTNERS, <https://metispartners.com/ip-basics/what-is/an-ip-licence/> [<https://perma.cc/BDC7-67VE>].

⁷⁴ Jay Walker, *The Real Patent Crisis Is Stifling Innovation*, FORBES (June 18, 2014, 8:45 AM), <https://www.forbes.com/sites/danielfisher/2014/06/18/13633/?sh=1cb1b14e6f1c> [<https://perma.cc/86TP-GK4R>].

⁷⁵ See Federico Caviggioli et al., *The Licensing and Selling of Inventions by US Universities*, TECH. FORECASTING & SOC. CHANGE 1, 13 (Oct. 2020) ("We find that 37.0% of the patents granted at the *United States Patent and Trademark Office* (USPTO) have been involved in a form of monetization.").

⁷⁶ See, e.g., *Guide to Intellectual Property as a Student at the University of California*, UNIV. OF CAL.: OFF. OF THE PRESIDENT, <https://www.ucop.edu/research-policy-analysis-coordination/policies-guidance/intellectual-property/intellectual-property-as-a-student-at-the-university-of-california-faq.html> [<https://perma.cc/G4XH-9YBX>] (providing a guide to intellectual property for students at University of California, including an explanation of basic terms, steps to own an invention, and technology transfer office infrastructure); see also Skipp Derra, *ASU Revises Royalty Policy Giving More Proceeds to Researchers*, ARIZ. STATE UNIV.: UNIV. COLLEGE (NOV. 10, 2014), <https://universitycollege.asu.edu/asu-revises-royalty-policy-giving-more-proceeds-researchers> [<https://perma.cc/XL3F-UNCU>] (giving a "greater percentage of royalties . . . directly to inventors[in order to] . . . speed the journey from lab to market and reward inventors for their time and effort").

providing the crucial infrastructure and support necessary to finance and guide the inventors through the patent process while still allowing the inventors to continue their normal work. This infrastructure eliminates many societal barriers for patent inventors, providing a useful inventorship recognition vehicle for inventors who are not independently wealthy. However, this benefit extends only to those for whom the university will effectively provide funding, support, and education.

Because the university system eliminates many patent barriers, university inventorship is a good proxy for value accessibility and recognition analysis. Furthermore, because top research universities use patents as an indicator of entrepreneurial strength, innovation, and potential impact of university research, rather than purely a source of commercial potential,⁷⁷ the pursued patent applications provide a better sense of the value of overall inventorship recognition than simply commercialization value.

II. METHODOLOGY

This article quantitatively estimates the patent gap between white, male inventors, inventors of color, and female inventors at Ivy League institutions, HBCUs, research institutions, and other HRSs in the United States from 2000 to 2015.⁷⁸ The analysis in Part III compares the racial and gender

⁷⁷ See Doug Banks, *MIT, Harvard Rank Among Top 10 in International Patent Rankings*, BOS. BUS. J. (June 10, 2019, 6:38 AM), <https://www.bizjournals.com/boston/news/2019/06/10/mit-harvard-rank-among-top-10-in-international.html> [https://perma.cc/WB69-4KL4]; Paul R. Sandberg et al., *Changing the Academic Culture: Valuing Patents and Commercialization Toward Tenure and Career Advancement*, 111 PROC. NAT'L ACAD. SCI. U.S. 6542, 6543 (2014) ("Benefits of patents and commercialization . . . extend beyond just direct revenue generation through licensing, and consist of advantages such as: increased opportunities for research funding, access to unrestricted funds for further institutional investment, sustaining high scholarship level, student success, increased prestige, public benefit, and economic development."); Federico Castillo et al., *Time of Adoption and Intensity of Technology Transfer: An Institutional Analysis of the Offices of Technology Transfer in the United States*, 43 J. TECH. TRANSFER 120, 121–22 (2016).

⁷⁸ I analyzed patent representation at institutions grouped into the following categories: Ivy League schools, research institutions, HRS, and HBCUs. The Ivy League schools analyzed were Dartmouth College, Cornell University, Brown University, University of Pennsylvania, Harvard University, Princeton University, Yale University, and Columbia University. The Research Institutions were Georgia Institute of Technology, California Institute of Technology, Massachusetts Institute of Technology, University of California, and Stanford University. I analyzed the University of California system as a whole because the patents from staff and students at University of California, Berkeley are generally assigned to the University of California system in the aggregate. HRS included Emory University, University of Michigan, University of North Carolina, Wake Forest University, Georgetown University, and Duke University. The HBCUs were Spelman College, Morehouse College, Hampton University, Howard University, Xavier University, and North Carolina Agricultural and Technical State University. There were no patents assigned to Morehouse College, so this study also used patents assigned to Morehouse School of Medicine.

representation on university patents to the representation at the university, rather than the general population of the United States. By using equity metrics explained herein, rather than representation metrics, the data measure disparities within a seemingly equalizing environment, in which every student and faculty member theoretically has equal access to university funding and legal representation to obtain patents on their intellectual property. I selected Ivy League institutions, HBCUs, research institutions, and other HRSs as four university types to estimate institutional differences and determine if any have narrowed racial and gender patent inventorship gaps.

A. *University Sample Selection*

The Ivy League schools and research institutions are well-funded institutions capable of supporting a large intellectual property and research infrastructure.⁷⁹ Although this may not occur in practice, these schools can theoretically afford to apply for an almost unlimited number of patents for their students and faculty. The laboratories may also receive funding from the institutions, potentially creating a more equitable option to pursue research than just relying on grants.⁸⁰

Moreover, in research institutions, the majority of the faculty and students focus in science and engineering research capable of producing patentable inventions,⁸¹ as opposed to

⁷⁹ See James A. Barham, *The 100 Richest Universities: Their Generosity and Commitment to Research*, THE BEST SCHOOLS (Apr. 23, 2021), <https://thebestschools.org/features/richest-universities-endowments-generosity-research/> [<https://perma.cc/FDP5-RDF7>].

⁸⁰ See Helen Shen, *Inequality Quantified: Mind the Gender Gap*, 495 NATURE 22, 24 (2013) (highlighting that “Christine Wennerås and Agnes Wold at the University of Gothenburg in Sweden found in 1997 that female applicants for postdoctoral fellowships had to score 2.5 times higher on an index of publication impact to be judged the same as men”). Though there is no guarantee that institutional funding would not also favor men, the additional option of institutional funding, especially where only professors from the same school are competing, may provide a more level playing field for funding opportunities.

⁸¹ See, e.g., *Statistics & Reports: Undergraduate Majors Count 2021-2022*, MIT REGISTRAR'S OFF., <https://registrar.mit.edu/stats-reports/majors-count> [<https://perma.cc/R5HC-U2BW>] (showing in the undergraduate majors count at MIT that, out of 4,999 majors, 3,389.5 are in the school of engineering or school of science); *Schools & Departments*, MASS. INST. OF TECH., <https://web.mit.edu/education/schools-and-departments/> [<https://perma.cc/352Y-54HR>] (listing MIT's schools including architecture and planning; engineering; humanities, arts, and social sciences; management; and science); *People*, MIT DEP'T OF ARCHITECTURE, <https://architecture.mit.edu/people> [<https://perma.cc/VZH7-L8AW>] (showing architecture has forty-nine teaching members); *Faculty*, MIT SCH. OF ENG'G, <https://engineering.mit.edu/faculty-research/faculty/> [<https://perma.cc/Z6V7-EJGD>] (showing engineering has 378 faculty members); *Faculty*, MIT SCH. OF HUMANITIES, ARTS, & SOC. SCIS., <https://shass.mit.edu/about/faculty> [<https://perma.cc/T8C6-ZBMZ>] (showing that humanities has 179 faculty); *About MIT Sloan: Facts and Figures*, MIT MGMT. SLOAN SCH., <https://mitsloan.mit.edu/about/facts-and-figures> [<https://perma.cc/R92B-9BRD>] (noting that management has 116 faculty members in fiscal year 2019); *School of Science: Overview*, MIT SCH. OF SCI., <http://catalog.mit.edu/schools/science/> [<https://perma.cc/A3M6-62J7>] (noting that science has 275 faculty members).

research in social sciences, which is less likely to produce patentable inventions.⁸² In liberal arts colleges, comparing the inventorship population to the general population may not be sufficient to determine STEM disparities because the general population would not reflect the population most likely to produce a patentable invention. For example, if most female professors were in a nonpatenting department at the university, such as women's studies, then comparing the overall female professor population to the representation of female patent inventors would result in an improper quantification of relative representation in STEM. In research institutions, the vast majority of the campus population pursue studies that promote patentable inventions, reducing the research disparity.⁸³ Additionally, research institutions value and actively pursue patents to highlight the novelty and inventiveness of their research.⁸⁴

I selected HBCUs to test whether campus representation correlates to success in STEM, using the proxy of the number of patents achieved. HBCUs have a large population representation of people of color who are historically underrepresented in STEM⁸⁵—from students to full-time professors—which provided an increase in sample size for potential Black inventors. The HBCUs also included Spelman College, a liberal arts college for women, which provided a school with a larger relative representation of female students and professors. Additionally, most of the selected HBCUs are in the southern United States, providing a geographical contrast to the Ivy League institutions of the northeast United States.

I selected schools outside of the HBCU system with a high percentage of tenured Black faculty to determine how increasing representation of underrepresented minorities in positions of power on campus impacted the diversity of patent inventorship. According to sociology professor Adia Harvey Wingfield at Washington University in St. Louis, “minority

⁸² See *Patent Technology Centers Management*, U.S. PAT. & TECH. OFF., <https://www.uspto.gov/patents/contact-patents/patent-technology-centers-management> [<https://perma.cc/XY95-8DNS>] (noting that patentable technologies usually stem from biotechnology, chemistry, computer architecture, mechanical engineering, and other STEM fields).

⁸³ See, e.g., *Statistics & Reports: Undergraduate Majors Count 2021-2022*, *supra* note 81 (showing that there are more students and faculty in high-patenting departments, like engineering and science disciplines, than in nonpatenting departments, like humanities and social sciences).

⁸⁴ See *supra* note 77 and accompanying text; see also Joe Hadzima, *The Importance of Patents, It Pays to Know the Rules*, MASS. INST. OF TECH., <http://web.mit.edu/e-club/hadzima/the-importance-of-patents.html> [<https://perma.cc/UL8K-JZL8>].

⁸⁵ See *supra* notes 1–2 and accompanying text; see also LISA M. FREHILL ET AL., *EFFECTIVE STRATEGIES TO DIVERSIFY STEM FACULTY* 5–10 (2006), <https://bit.ly/3JziMu> [<https://perma.cc/7WK5-Y4T9>].

faculty remain underrepresented in the most secure, highest-paying and most influential tenured and upper-administrative positions—those that have the potential for changing institutional norms and cultures.”⁸⁶ Data from these colleges demonstrate whether increasing the percentage of underrepresented minorities within tenured faculty begins to create racial equity among inventors on patents.

B. *Patent and Inventor Sample*

I compared the demographic data from these universities to the race and gender of identified patent inventors from each university between 2000 and 2015.⁸⁷ I collected a subset of 30 patents granted to each institution from fall of 2000 until spring of 2015.⁸⁸ I randomly selected these subsets after downloading the entire patent data set from each school.⁸⁹ I identified individuals by race and gender through a plurality of known, standard techniques used to identify an individual’s socially perceived race and gender and verified this determination through known techniques used to identify an individual’s self-identified race and gender.⁹⁰

⁸⁶ Adia Harvey Wingfield, *More Faculty of Color Can and Should Be in the Top Ranks of Universities*, INSIDE HIGHER EDUC. (Sept. 9, 2016, 3:00 AM), <https://www.insidehighered.com/advice/2016/09/09/more-faculty-color-can-and-should-be-top-ranks-universities-essay> [<https://perma.cc/2S37-B3A2>].

⁸⁷ I gathered race, gender, and employment demographics from twenty-five separate universities and colleges within the United States using IPEDS. *Integrated Postsecondary Education Data System*, NAT’L CTR. FOR EDUC. STATS., <https://nces.ed.gov/ipeds/> [<https://perma.cc/8X2Q-3YAR>]. From 2000 to 2015, IPEDS altered its data collection questionnaire, as is evidenced when collecting data from IPEDS. IPEDS altered its demographic collection methodology from total number of individuals at a school to whole-number percent of individuals at the school relative to the entire population in 2011. To account for this change, I multiplied the percent demographic reported by the total number of people reported in the employment category to estimate the total number of people within that body at the institution. For example, if the total undergraduate population was 10,000 students and 20% of them were white students, the number “2,000 white students” was used in the demographic calculation.

⁸⁸ If schools had fewer than 50 patents, I collected and analyzed the entire sample. With approximately 3.2 inventors per patent, this 30-patent sample roughly equated to a random selection of 100 patent inventors. Because there was no school in my sample set with a Black, Hispanic, or female STEM professor representation of under 3%, I determined this 30-patent sample with roughly 100 inventors would result in a good round-percent estimate of the inventor representation at the school. I selected the sample patent data pool with a random number generator, see *Random Number Generator*, CALCULATOR.NET, <https://www.calculator.net/random-number-generator.html> (last visited Apr. 10, 2022) (used to randomly select patents assigned to the university from 2000 to 2015).

⁸⁹ *Community Home Page*, PATENTSVIEW, <https://patentsview.org/> [<https://perma.cc/H998-ENR2>]. Each patent assigned to the university was counted and analyzed separately, regardless of whether they originated from the same patent family.

⁹⁰ See Kellee White et al., *Socially-Assigned Race and Health: A Scoping Review with Global Implications for Population Health Equity*, INT’L J. EQUITY HEALTH 1, 4 (Feb. 10, 2020) (showing a method to identify a person’s socially assigned race by having an interviewer

Specifically, I collected a sample of 719 patents comprising 2,294 inventors, with 1,836 unique inventors in the set, and searched publicly available websites and videos, including LinkedIn, ResearchGate, YouTube, and school websites, to find photographs and other information about each listed inventor.⁹¹ I then used this information to assign a socially perceived race and gender to each inventor.⁹² I cross-referenced this determination with publicly available databases identifying a person's race and gender by their first and last names. To determine the accuracy of this assessment, I sent 1,434 inventors a follow up email, asking the inventor to identify their socially perceived racial and gender identity, as well as their self-identified racial and gender identity.⁹³ The inquiry, in full, required each individual to first identify their race and gender using the race and gender categories presented on the Integrated Postsecondary Education Data System (IPEDS) data. The inquiry also allowed individuals to use their own words to identify their race and gender. I recorded the responses from inventors and compared the responses to the initially assigned identity to determine the error rate of the initial socially perceived race and gender identifications.⁹⁴ I also corrected any misidentified gender or race based on the inventor responses.

classify "participants' race/ethnicity or skin tone"); Eric C. Wong et al., *Using Name Lists to Infer Asian Racial/Ethnic Subgroups in the Healthcare Setting*, 48 MED. CARE 540, 540–46 (2010) (showing a method of identifying a person's self-identified race using a surname); Laurie Elam-Evans et al., *Using 'Socially-Assigned Race' to Probe White Advantages in Health Status*, 18 ETHNICITY & DISEASE 496, 497 (2008) (asking individuals to identify how other people classify the individual). I chose not to use other common methods of race and gender identification, such as comparisons to voter records and census data because these are not ideal tools to define the race of an individual. See, e.g., Kevin Fiscella & Allen M. Fremont, *Use of Geocoding and Surname Analysis to Estimate Race and Ethnicity*, 41 HEALTH SERVS. RSCH. 1482, 1484–87 (2006) (discussing use of Census data for geocoding and surname analysis in race and ethnicity identification and noting that "[t]he validity of geocoding to infer race depends on its purpose. It is not sufficiently accurate to infer individual race"). I identified a person's gender through a combination of name and pronoun identifiers available on a work or personal website when available.

⁹¹ Other information included if the person spoke another language and if the person had attended school in another country. This is a small dataset compared to the number of patents assigned to these universities. All numerical conclusions should be considered rough estimations. I welcome collaborators to expand the dataset.

⁹² See *infra* Section II.F for further explanation regarding socially perceived race and gender assignment.

⁹³ This number comprises 78.1% of all unique inventors in the sample. Forty-nine inventors of the remaining 402 inventors in the sample set (12.2%) are deceased, mentally incapacitated, or incarcerated. We received 173 responses as of June 15, 2021, which is a 12.1% response rate. This is an acceptable survey response rate for a blindly emailed survey. See Adrienne Keller, *What Is an Acceptable Survey Response Rate*, NAT'L SOC. NORMS CTR. AT MICH. STATE UNIV. (Nov. 12, 2014), <https://socialnorms.org/what-is-an-acceptable-survey-response-rate/> [<https://perma.cc/KL5Z-847V>] ("In addition, various studies described their response rate as "acceptable" at 10%, 54%, and 65%.")

⁹⁴ I did not email or attempt to contact any inventor known to be deceased or incarcerated as of June 15, 2021.

C. *Variable Classification*

When assigning socially perceived racial and gender identity, I used the categories and definitions available on the IPEDS website, with few exceptions.⁹⁵ The IPEDS website includes two categories of “one or more races” and “nonresident alien.”⁹⁶ I did not use nonresident alien as a socially perceived race because a person’s citizenship status is not an indicator of race. Additionally, IPEDS added the category of “two or more races” in 2008 for staff and in 2010 for students,⁹⁷ and because this was not present for the entire fifteen-year range of this study, anyone identifying as two or more races in the IPEDS demographic survey was added to the “unknown” category.⁹⁸ If a person’s socially perceived race presented as “two or more races” and one was white, I identified the person as their nonwhite race. For example, if a person’s socially perceived race was Native American and white, I identified the person as Native American.

I chose to label certain people identifying as “two or more races” by a perceived categorization as a person of color both as a statistical necessity and as a white privilege⁹⁹ acknowledgement. As will be shown by the data in Part III, there were very few inventors of color who were not Asian on any patents assigned to universities outside of the HBCUs. Assigning these underrepresented inventors of color as “two or more races” renders the data unusable because, in some cases, there would be a statistically insignificant number of inventors remaining to calculate a racial disparity. Additionally, a person perceived as “not completely white” in the United States may

⁹⁵ See *Definitions for New Race and Ethnicity Categories*, INTEGRATED POSTSECONDARY EDUC. DATA SYS., <https://nces.ed.gov/ipeds/report-your-data/race-ethnicity-definitions> [<https://perma.cc/HV8W-7G8M>]. Although the category of Hispanic/Latino is defined as “[a] person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race,” see *id.*, it appeared from the collected data that the schools were not collecting Hispanic/Latino data separately from race data, in that, by including Hispanic/Latino data as a race category, the total surveyed populations added up to 100%. If the Hispanic/Latino data set was not included as a race category, the total surveyed populations, including unknown populations, added up to less than 100%. For this reason, I included Hispanic as an exclusive race/ethnic category for the purposes of this study.

⁹⁶ *Id.*

⁹⁷ *Use the Data*, INTEGRATED POSTSECONDARY EDUC. DATA SYS., <https://nces.ed.gov/ipeds/datacenter/CDS.aspx> [<https://perma.cc/Z3BT-N8NW>].

⁹⁸ See *Definitions for New Race and Ethnicity Categories*, *supra* note 95.

⁹⁹ See generally Erika Blacksher & Sean A. Valles, *White Privilege, White Poverty: Reckoning with Class and Race in America*, 51 HASTINGS CTR. REP. (SPECIAL REP.) S51, S51–S57 (2021) (“White privilege refers to the economic, political, cultural, and psychological advantages of Whiteness.”).

experience a diminution of the privileges associated with being white, even if they may self-identify as white.¹⁰⁰

D. *Statistical Analysis*

My initial research compared the racial and gender representation of inventors in the patent sample to four groups of people at each university as bases for my equity metric set. These four groups included: (1) total population of students and staff, (2) total full-time staff, (3) graduate research assistants and full-time STEM professors, and (4) full-time STEM professors.¹⁰¹ The collected data compare the racial and gender demographics of each of these university employment categories to the estimated racial and gender representation of the inventors on the patents assigned to each university.¹⁰² The analysis herein details a determination of the existence of a full-time STEM professor representation gap.¹⁰³

I explored three different models to demonstrate relative race and gender representation on patents. These three models include a disparity index model, a disparity ratio using “white” as a race basis and “male” as a gender basis, and a patent aggregation disparity ratio, which are standard calculations to determine disparities in race and gender.¹⁰⁴ Each of these models is explained below.

¹⁰⁰ Haydn Wall, *Becoming White: Religion and the Construction of Race* 18 (Apr. 27, 2018) (Senior Capstone Project, Vassar College), <https://bit.ly/3O4lfOy> [<https://perma.cc/CJS8-BQF5>] (discussing new immigrants who “occupied a position where they could be legally white, yet still face[d] questions about their racial character rendering them not completely white”).

¹⁰¹ “Staff” comprised “Total full-time faculty” for 2001–2007, “Total full-time instruction/research/public service” for 2008–2010, and “All full-time instructional staff” for 2011–2015. Each of these represented similar demographics according to a phone call with IPEDS data department on June 16, 2021. STEM professors are limited to only full-time computer, science, engineering, and research professors at universities.

¹⁰² Although the teaching categories could be broken down into STEM and not STEM, the data collected from IPEDS presented no means of breaking the STEM category down to individual subject matter to determine total population in, for example, biology instead of mathematics.

¹⁰³ I will provide a full assessment with all employment categories upon request. Statistically significant gaps were present for all employment groups. Because full-time STEM professors likely had the greatest access to patent resources at the university, the analysis in this article concentrates on their representation gaps. I will provide a full analysis of the student representation gap in a future article.

¹⁰⁴ See *RD 8 through 13: Disparity Ratio (DR)*, ROM REPS., https://secureapp.dhs.state.ia.us/PublicROMReports/report_help/default.htm#!Documents/rd8through13disparityratiodr.htm [<https://perma.cc/LF6N-DG4X>] (calculating the disparity ratio); *Racial Disparities and Disproportionality Index*, THE CORP. FOR SUPPORTIVE HOUS., <https://www.csh.org/supportive-housing-101/data/> [<https://perma.cc/WQL7-L92X>] (describing the aggregate disparity ratio). See generally *RD 2 through 7: Disproportionality Index (DI)*, ROM REPS., https://secureapp.dhs.state.ia.us/PublicROMReports/report_help/default.htm#!

I calculated the disparity index (D_i) as a ratio of percentages within a sample. The disparity index model is as follows:

$$D_i = \frac{P_i}{P_d}$$

P_i is the percent of inventors of a certain race or gender demographic at a university. P_d is the percent representation of the same race or gender demographic at the same university in a certain employment category. For example, if Native American inventors comprised 10% of the total number of inventors on patents from Yale University, and the IPEDS data showed that Native American staff comprised 30% of the total staff at Yale University, then the disparity index for Native American Staff at Yale University would be $10\%/30\% = 0.33$ (approximately). This measure controls for the disparity in size between inventors on the patent sample and the population at universities from 2000 to 2015.

The disparity index can be used to show intragroup comparisons. For instance, using the example above, the percentage of Native American patent inventors would be 0.33 times the percentage of Native American staff at Yale University. Any number under 1 would indicate an underrepresentation of inventors relative to their demographic representation at the university. The lower the index, the larger the disparity.

I then calculated a disparity ratio (D_r) using a race and gender population as a basis set. The disparity ratio model is as follows:

$$D_r = \frac{D_{i(\text{base})}}{D_{i(\text{demographic})}}$$

I calculated the disparity ratio by dividing the base disparity index ($D_{i(\text{base})}$) by each demographic's disparity index $D_{i(\text{demographic})}$. For example, if the D_i for white staff at Yale University was 1 and the D_i for Native American staff at Yale University was 0.33, as calculated above, the disparity ratio would be $1/0.33$, or 3.03. This means that, when considering the representation of staff, white staff would be patent inventors at a rate that is 3.03 times higher than Native American staff at Yale University.

The disparity ratio can only be used to compare two groups at a time. To show underrepresentation of one group compared to an average peer group in the entire sample set, rather than a

simple comparison between two groups, I calculated the patent aggregation disparity ratio ($D_{r(Ag)}$) by averaging the disparity indices across a demographic category (i.e., race or gender) ($D_{i(Av)}$) and then dividing this average by the demographic's disparity index ($D_{i(demographic)}$). A model for the $D_{r(Ag)}$ is as follows:

$$D_{r(Ag)} = \frac{D_{i(Av)}}{D_{i(demographic)}}$$

$D_{i(Av)}$ is calculated for gender according to the following calculation:

$$D_{i(Av)} = \frac{D_{i(women)} + D_{i(men)}}{2}$$

$D_{i(women)}$ is the disparity index for women in a certain employment category and $D_{i(men)}$ is the disparity index for men in the same employment category. $D_{i(Av)}$ is calculated for race as follows:

$$D_{i(Av)} = \frac{D_{i(Wh)} + D_{i(BL)} + D_{i(Hi)} + D_{i(As)} + D_{i(Na)} + D_{i(U)}}{6}$$

$D_{i(Wh)}$, $D_{i(BL)}$, $D_{i(Hi)}$, $D_{i(As)}$, $D_{i(Na)}$, and $D_{i(U)}$ are the disparity indexes for people who are white, Black, Hispanic/Latino, Asian or Pacific Islander, Native American, and of unknown race, respectively, in a certain employment category. For example, if the sample patent data for a school had a disparity index for men on staff of 1 and a disparity index for women on staff of 0.33, then the aggregate disparity index is $(1+0.33)/2 = 0.665$. The aggregate disparity ratio for women on staff would be calculated as $0.665/0.33 = 2.01$. This example shows that likelihood of the average person on staff being named as an inventor on a patent is 2.01 times higher than the likelihood that a woman is named as a patent inventor.¹⁰⁵

I ran each of these three models on both a per-school and per-university entity set basis. To convert the disparity index or disparity ratio from a per-school analysis to a per-university entity set ($D_{(UES)}$), I weighted the results by the percentage of patents produced by the school relative to other schools in the university entity set as follows:

$$D_{(UES)} = D_{S1} * W_{S1} + D_{S2} * W_{S2} + D_{S3} * W_{S3} + \dots$$

¹⁰⁵ As noted in footnote 9, I acknowledge that gender does not fall on a strict binary. The calculation of the aggregate disparity ratio for gender when analyzing binary data includes “2” in the denominator for the two-gender identification categories present in my sample. When more than two gender identification categories are present in a sample, the denominator should be adjusted accordingly.

D_s is the disparity index or ratio calculated for the individual school (S1, S2, etc.). W_s is the patent weight of each school. For example, if S1 had 500 patents, S2 had 300 patents, and S3 had 200 patents assigned to them between 2000 and 2015, W_{S1} would be $500/(500+300+200) = 0.5$, W_{S2} would be $300/(500+300+200) = 0.3$, and W_{S3} would be $200/(500+300+200) = 0.2$. For example, to obtain the D_{UES} for HRS, I multiplied each HRS's disparity index by the patent weight of that school's W_s . I then summed each weighted disparity index in the set to obtain the expected value of the set. This accounts for the weight of the patent pools from each school.

I further calculated the Chi-square values to determine whether (1) the gender distribution on university patents is different than the gender distribution at the university at every employment level and (2) the race distribution on university patents is different than the race distribution at the university at every employment level.¹⁰⁶

E. Assumptions and Limitations

The notion that this comparison indicates a quantitative race or gender disparity between the demographics present at the university and the demographics present on the patents relies on several assumptions.

First, I assumed that every inventor at the university assigned their invention to the university and that each named inventor in my sample was associated with the university.¹⁰⁷ If a greater number of inventors of color and women assigned their

¹⁰⁶ See generally Adam Hayes, *Chi-Square Statistic*, INVESTOPEDIA (Sept. 20, 2021), <https://www.investopedia.com/terms/c/chi-square-statistic.asp> [<https://perma.cc/8L67-KFYN>] (“A chi-square (χ^2) statistic is a test that measures how a model compares to actual observed data. . . . The chi-square statistic compares the size of any discrepancies between the expected results and the actual results, given the size of the sample and the number of variables in the relationship.”). The Chi-square test for race-based analysis in this article used the three categories of white, Asian, and other instead of two due to the significantly disproportioned representation of Hispanic and Black inventors both in patent representation and on campus, as compared to their white and Asian peers. I recognize that, especially within the Asian STEM community, “[m]odel minority stereotype masks disparities in [the] STEM pipeline among Asian American students.” Marcene Robinson, *Filipino, Vietnamese and Thai Students Are ‘Invisible’ Victims of Inequality in STEM Fields*, UNIV. AT BUFFALO NEWS CTR. (Sept. 14, 2021), <http://www.buffalo.edu/news/releases/2021/09/010.html> [<https://perma.cc/W6HB-DEUC>]. The term Asian American includes “more than 20 different ethnic subgroups” and many datasets, including IPEDS and my currently collected dataset cannot contribute to the study of underrepresented groups within the Asian STEM community. *Id.* I welcome insight into datasets and methods to address this concern and simultaneously recognize “that Asian Americans are overrepresented in STEM fields relative to other nonwhite groups.” *Id.* (quoting Lois Weis, PhD, Distinguished Professor of Educational Leadership and Policy, State University of New York).

¹⁰⁷ I selected all patents in the set from patents assigned to the university.

invention exclusively to a company outside of their institution or failed to assign their invention at all, the results would incorrectly show that women and inventors of color are not being named on patents equitably. Moreover, if inventors unassociated with the university but named on the patent were more Asian, white, and/or male than the average population of STEM professors in the university, the results would also incorrectly estimate the racial and gender patent gap.¹⁰⁸

While both assumptions may prove false, there is no indication that this would significantly impact the results of my assessment. I did not find that people identifying as a particular gender or race would favor assigning their invention to an outside company instead of the university. I also did not find that the demographics of inventors who self-fund and self-patent their invention, rather than go through the university technology transfer office, deviate from demographic representation at the university. Moreover, I found no indication that inventors unassociated with the university were any less diverse than STEM professors at universities. Therefore, there is some reason to believe that the assumption is satisfied. If the assumption proves false, the estimates herein may be misleading.

Next, I assumed there was no outside influence driving a certain demographic of inventors towards or away from patenting their inventions. Outside funding opportunities, for example, could influence an individual's decision to pursue a patent. If a company is paying for research and expects to receive a patent in exchange for their funding, the researcher may decide to pursue a patent more enthusiastically than if they were funding their own research. If an outside influence significantly contributed to this patent disparity, the comparison might need to take those funding resources into account when classifying "peers" within a research space.

Male and white professors are often better funded than their female and Black peers. First-time female principal investigators have a median grant size of \$126,615—about 24% less than the average first-time male principal investigator's median grant of \$165,721.¹⁰⁹ The funding rate for white scientists is approximately 1.7 times higher than for Black

¹⁰⁸ Many patents in the initial data set were collaborative efforts assigned both to the university and an outside industrial institution. This indicates that some of the patent inventors were not necessarily affiliated with the university.

¹⁰⁹ Brian Uzzi et al., *How Big Is the Gender Gap in Science Research Funding?*, KELLOGG SCH. OF MGMT. AT NW. UNIV. (May 2, 2019), <https://insight.kellogg.northwestern.edu/article/how-big-is-the-gender-gap-in-science-research-funding> [<https://perma.cc/D4EP-LHU2>].

scientists.¹¹⁰ Professors with industry funding who collaborate with industry colleagues are more likely to patent than those without industry funding.¹¹¹

The intertwined nature of funding, race, and gender is a potential mechanism for the gender and racial inventorship gaps estimated herein. My research could not account for the source of laboratory funding, industry collaboration, or the overall wealth of laboratories producing patentable inventions. I will discuss patent budgetary concern differences as a solution mechanism in Part IV.

Third, I assumed that all STEM professors of varying race and gender were equally distributed over the types of work that motivate the pursuit of patents. This was a necessary assumption because IPEDS reported the STEM professor population only in aggregate, not broken down by specific subject area. Some technology areas are less likely to produce a large quantity of patents.¹¹² Some aspects of STEM, like theoretical physics and mathematics, focus on discovering laws of nature or algorithms, and as such, do not often produce patentable results.¹¹³ If most underrepresented inventors happened to work in STEM fields that do not produce as large a quantity of patents, the results would be skewed.

For example, the top five fields of technology for patent applications in 2019 were computer technology, digital communication, medical technology, electrical machinery, and semiconductors.¹¹⁴ It is unclear whether these fields are more dominated by white, Asian, and male professors than their female, Black, and Hispanic peers when compared to other departments at the university. According to my study, women comprised approximately 25% of the total STEM professor population at MIT from 2000 to 2015. In 2020, women constituted 12.4% of the

¹¹⁰ Travis A. Hoppe et al., *Topic Choice Contributes to the Lower Rate of NIH Awards to African-American/Black Scientists*, SCI. ADVANCES 1 (Oct. 9, 2019), <https://www.science.org/doi/10.1126/sciadv.aaw7238> [<https://perma.cc/E7Y4-54VS>].

¹¹¹ Magnus Gulbrandsen & Jens-Christian Smeby, *Industry Funding and University Professors' Research Performance*, 34 RSCH. POL'Y 932, 947–48 (2005).

¹¹² See generally NAT'L SCI. BD., NSB-2018-1, SCIENCE AND ENGINEERING INDICATORS 2018, at 8-1, 8-19 tbl.8-1 (2018), <https://www.nsf.gov/statistics/2018/nsb20181/report> [<https://perma.cc/LS65-25DW>] (showing that more patents are produced in pharmaceuticals than food chemistry).

¹¹³ See Elizabeth D. Lauzon, Annotation, *Patentability Under 35 U.S.C.A. § 101 Which Excludes Laws of Nature, Physical Phenomena, and Abstract Ideas*, 5 A.L.R. FED. 3d § 4 (2021) (showing that “[a]n application of a law of nature or mathematical formula to a known structure or process may well be deserving of patent protection” but “the method of solving a mathematical equation may not be the subject of patent protection”).

¹¹⁴ Erin Duffin, *Number of Patent Applications, by Fields of Technology U.S. 2019*, STATISTA (Jan. 29, 2021), <https://www.statista.com/statistics/256734/percentage-of-patent-applications-in-the-us-by-fields-of-technology/> [<https://perma.cc/44VQ-8Z8U>].

computer science department.¹¹⁵ However, female faculty comprised approximately 20% (33/166) of the electrical engineering department at MIT, 27% (12/44) of the chemistry department at MIT, and 30% (10/33) of the medical engineering and science faculty at MIT.¹¹⁶ More research is required to determine if women and underrepresented people of color are researching in less-patentable fields, thus skewing the need to patent their ideas.

This also impacts the validity of comparing the HBCU data to data from other university entity sets. I was unable to analyze the inventorship of every patent produced from 2000 to 2015 for the HRSs, Ivy League schools, and research institutions due to the sheer size of the patent set. However, the HBCU dataset represents the entire patent set at those universities because the number of patents at each of the HBCUs was relatively small, with under fifty patents per institution. Although the STEM professors at the HBCUs may have still had an equal opportunity to produce and patent their ideas, it seems very likely that they did not have an opportunity equal to their peers at research universities, Ivy League schools, or other HRSs. In this way, the inventorship analysis for HRSs, Ivy League schools, and research institutions provides an estimate and support for the existence of gender and racial patent gaps, but does not provide final definitive numbers regarding the magnitude of the gap. Any calculations of these gaps and disparity ratios should be considered estimations.

Finally, all results herein do not point to any causation behind the calculated gender and racial patent gaps. Rather, the results only suggest the existence of the gender and racial patent gaps and prompt action for further studies.

F. *Validity of Race and Gender Perception Methodologies*

The complexities of race and gender identification do not jeopardize my research on gender and racial representation on university patents. My research demonstrates a high correlation between socially perceived and self-identified race and gender within my sample set. Although there may be many different methods to identify individuals by race and gender, they are all

¹¹⁵ Kiana Go, *Analyzing the Gender Disparity Among Higher Academia in Computer Science / Engineering*, TOWARD DATA SCI. fig.1 (May 22, 2020), <https://towardsdatascience.com/analyzing-the-gender-disparity-among-higher-academia-in-computer-science-engineering-2d8ceefa76e> [<https://perma.cc/LMT7-W3ML>].

¹¹⁶ See *Faculty*, MIT EECS, <https://www.eecs.mit.edu/role/faculty-ee/> [<https://perma.cc/N4CG-6NRN>]; *Chemistry*, MIT DEPT OF CHEMISTRY, <https://chemistry.mit.edu/faculty/> [<https://perma.cc/SS5P-77PE>]; *Faculty*, MIT INST. MED. ENG'G & SCI, <https://imes.mit.edu/people/faculty/> [<https://perma.cc/2H8B-D3YP>].

ultimately influenced by social perception.¹¹⁷ Therefore, socially perceived identification methods should be used to determine demographic representation on university patents, especially when assessing the socially perceived value of individual inventors within a university.

Race is “a construct in which group membership is based on phenotypical attributes and rooted in a common descent but is also structured by malleable social rules”—both social perception and physical attributes can alter a person’s race identification.¹¹⁸ Although US society primarily operates with an inherent construction of binary gender,¹¹⁹ the same malleable social rules and self-identification assessments applying to a person’s race can equally apply to gender.

Race and gender identification rely on two separate and intertwined aspects: self-identification and socially perceived identification.¹²⁰ Self-identification, as it will be used in this article, refers to how a person identifies themselves. Socially perceived identification refers to how society identifies the person.¹²¹ In this article, my methods compare a sample set comprising primarily self-identified race and gender (reported population at a university publicly available in the IPEDS database) to a sample set comprising primarily socially perceived race and gender (individually identified patent inventors by race and gender through photographs and name databases by a gender and racially diverse group of identifiers).¹²² Although these are certainly different assessment methods, the high correlation between self-identified and socially perceived race and gender reported in my sample set, in addition to the heavy social influences behind self-identification assessments, validates this comparison.

¹¹⁷ See *supra* notes 90 and accompanying text.

¹¹⁸ Lauren Davenport, *The Fluidity of Racial Classifications*, 23 ANN. REV. POL. SCI. 221, 222 (2019) (citing STEPHEN CORNELL & DOUGLAS HARTMANN, *ETHNICITY AND RACE: MAKING IDENTITIES IN A CHANGING WORLD* (2d ed. 2007)).

¹¹⁹ See Ashleigh Rushton et al., *Beyond Binary: (Re)Defining “Gender” for 21st Century Disaster Risk Reduction Research, Policy, and Practice*, INT. J. ENV’T RSCH. PUB. & HEALTH 3–4 (Oct. 18, 2019), <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6843806/pdf/ijerph-16-03984.pdf> [<https://perma.cc/6CJQ-6LMQ>].

¹²⁰ White et al., *supra* note 90, at 1 (showing that race involves both self-identified race and ethnicity, as well as other multidimensional measures, such as “socially-assigned race,” which is “the perception of one’s race by others, that may serve as the basis for differential or unfair treatment”).

¹²¹ *Id.*

¹²² *About IPEDS*, NAT’L CTR. FOR EDUC. STATS., <https://nces.ed.gov/ipeds/about-ipeds> [<https://perma.cc/Y24U-GXCP>]. The US Department of Education’s National Center for Education Statistics (NCEES) collects annual surveys of every college, university, technical, and vocational institution participating in federal student financial aid programs. IPEDS aggregates the results of these surveys and makes the results publicly available for inspection and analysis.

When identifying inventors by race and gender, I emailed 78.1% of my sample and asked them to identify their socially perceived and self-identified race and gender.¹²³ I assessed two hypotheses through the responses: (1) that the identification methods used in this article were accurate enough to compare the resulting identification to the reported IPEDS population data, and (2) that self-identified race and gender strongly correlated to socially perceived race and gender. Ninety-two percent of the responses matched my initial assessment of their race and 100% of the responses matched my initial assessment of their gender.¹²⁴ Additionally, the self-identified race of my sample set did strongly correlate to their socially perceived race and gender, with 96.7% of responses having socially perceived race identical to their self-identified race and 100% of responses having socially perceived gender identical to their self-identified gender.

This strong correlation suggests that self-identified race as collected in the US census¹²⁵ and beyond is heavily influenced by socially perceived cultural norms. Thus, they cannot be considered solely a measure of self-identification. This overlap between self-identification and socially perceived identification demonstrates that the two demographic sets, one collected from a person's self-identified perspective and one collected primarily from an outside observer's perspective, are not so different as to be considered separate entities. In fact, the strong correlation shown in the emailed survey suggests that these are simply two methods that yield very similar race and gender demographic results. This may have led to different results if my initial observational assessment had been able to account for a person's accent or their identified country of origin. There may have been a higher correlation for my particular sample because my socially perceived phenotypic identification relies primarily on a person's photograph or other visual depiction, along with their resume, and their last name.¹²⁶

This concentration on socially perceived identification, rather than self-identification, is not meant to invalidate a person's

¹²³ I emailed all inventors whose contact information was publicly available, except those who were deceased, incarcerated, or publicly identified as mentally incapacitated. *See supra* note 94.

¹²⁴ The race and gender demographics of respondents may differ from nonrespondents. *See, e.g.,* Sabina B. Gessell et al., *Test of a Web and Paper Employee Satisfaction Survey: Comparison of Respondents and Non-Respondents*, 2 INT'L J. INTERNET SCI. 45, 51 (comparing characteristics of respondents and nonrespondents in a survey). This may impact the accuracy assessment of my gender and racial identification methods.

¹²⁵ *See* U.S. CONST. art. I, § 2 ("The actual Enumeration shall be made . . . within every subsequent Term of ten Years, in such Manner as they shall by Law direct.")

¹²⁶ Kimberly Barsamian Kahn et al., *The Effects of Perceived Phenotypic Racial Stereotypicality and Social Identity Threat on Racial Minorities' Attitudes About Police*, 157 J. SOC. PSYCH. 416, 428 (2017).

identity, but rather to acknowledge the realities behind value perception in society.¹²⁷ Socially perceived phenotypic identification plays a role in how people interact with others in society, influencing an entity's unconscious biases regarding value assessment of an individual. This can be a negative interaction, resulting in hate crimes against individuals phenotypically identified as a particular group—even when that person would not personally identify as part of that group.¹²⁸ This social perception can also meaningfully impact everyday relationships, including work relationships, mentorships, friendships, and even a sense of belonging, position, and perception of value in society. The social perception of individual inventors at universities, therefore, may influence whether potential future inventors will perceive themselves as trailblazers or simply followers in a mentor's footsteps.¹²⁹

Because of this evaluation, as well as the nature of the data available to me, I used socially perceived race and gender as the primary bases for my analysis. This better correlates to potential value assessments from school administrators and peers, who influence whether a person is named on a patent. Additionally, the survey results suggest that any deviation between self-identified race and gender and socially perceived race and gender is negligible.

III. RESEARCH FINDINGS

The findings below highlight results regarding the two principal demographic focuses—race and gender. The data herein suggests a pattern of systemic racial and gender

¹²⁷ Society's perception of race is ever-changing and may require performative aspects as well as genetic aspects to allow a person to claim identification as a certain race. *See, e.g., Status and Trends in the Education of Racial and Ethnic Groups 2018*, NAT'L CTR. FOR EDUC. STATS., <https://nces.ed.gov/programs/raceindicators/guide.asp> [<https://perma.cc/ET6S-PV8C>]. For example, a person who identifies as "American Indian or Alaska Native" is "[a] person having origins in any of the original peoples of North and South America (including Central America) and maintaining tribal affiliation or community attachment." *Id.* (emphasis added). The requirement of maintaining affiliation or attachment is not required for any other category. *Id.* For example, a person who identifies as "Native Hawaiian or Other Pacific Islander" is "[a] person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands." *Id.*

¹²⁸ *See* Press Release, Am. Psych. Ass'n, Black Boys Viewed as Older, Less Innocent than Whites, Research Finds (Mar. 6, 2014), <https://www.apa.org/news/press/releases/2014/03/black-boys-older> [<https://perma.cc/6GYR-BY8A>]; Moni Basu, *15 Years After 9/11, Sikhs Still Victims of Anti-Muslim Hate Crimes*, CNN (Sept. 15, 2016, 11:22 AM), <https://www.cnn.com/2016/09/15/us/sikh-hate-crime-victims/index.html> [<https://perma.cc/M6FY-RZX2>] (describing how Sikhs are victims of crimes targeting Muslim people); *see also* SoraNews24, *Japanese Musician Beaten up in New York for Being 'Chinese,'* JAPAN TODAY (Oct. 9, 2020, 6:00 AM), <https://japantoday.com/category/crime/japanese-musician-violently-attacked-in-new-york-for-being-chinese> [<https://perma.cc/6KBJ-GRXD>] (describing a Japanese musician attacked "for being 'Chinese'").

¹²⁹ I plan to explore the influence of inventorship portfolios of senior faculty members on graduate and undergraduate students in future research.

underrepresentation for Hispanic, Black, and female inventors, and highlight the magnitude of the gender and race gaps.¹³⁰ This problem is not only pervasive among Ivy League institutions and research institutions, but also extends to HBCUs. Although I will provide hypotheses on reasons for these disparities in Part IV, further research is required to answer the questions raised by this dataset.

The following analysis provides summaries of the equity metric results from each university entity set—Ivy League institutions, HBCUs, research institutions, and HRSs outside of the HBCU system with the most tenured Black faculty. These have been weighted according to the number of patents produced by the school from 2000 to 2015. I provide some commentary about individual schools within this set, but I do not discuss the results at every university.¹³¹

The Chi-square statistics support the conclusions that (1) the gender distribution on university patents is different than the gender distribution at the university at every employment level, and (2) the race distribution on university patents is different than the race distribution at the university at every employment level.¹³² In other words, I find that Black, Hispanic, and female full-time STEM professors are not named on university patents at the same rate as their white and male peers, even when accounting for their smaller representation. Differences are significant at the 0.01 level.

The disparity between the racial and gender representation on patents compared to the entire student and faculty population is staggering. At the average Ivy League institution, when considering the percentage of representation on campus, I estimate that male staff and students are 5.43 times more likely to be named patent inventors than their female peers. White staff and students are approximately 24.33 times more likely than their Black peers and 57.68 times more likely than their Hispanic peers to be named patent inventors.¹³³

¹³⁰ The IPEDS data refers to Hispanic and Latino people as “Hispanic” and Black and African American people as “Black.” For brevity purposes only, I use the term “Hispanic” from this footnote forward to refer to both Hispanic and Latino representation and “Black” to refer to both Black and African American representation. I acknowledge these chosen phrases do not effectively capture the population identifying only as the not-chosen word.

¹³¹ Statistics regarding individual schools are available upon request. The full dataset is also available upon request.

¹³² See *supra* note 106 for an explanation of the Chi-square statistic.

¹³³ I used the race and gender categories from IPEDS to categorize individuals in my sample. See *Definitions for New Race and Ethnicity Categories*, *supra* note 95. Per IPEDS categorization, there was no way to determine the multi-racial identity of a person identifying as “two or more races.” Therefore, for this study, if a person identified as two or more races, I identified the person as their nonwhite race in accordance with the categories presented in the IPEDS surveys. For example, if a person identified as

Given the multitude of factors associated with disparities across entire school populations, the calculations below compare the gender and racial representation on patents to the demographic representation within only the full-time STEM faculty. The gender and racial patent gaps were still evident across every university set, even when only accounting for the population of full-time STEM professors. This shows that, even when using one of the most stringent employment-based equity metrics, Black, Hispanic, and female professors do not achieve equitable patent inventorship recognition when compared to their white, Asian, and male colleagues. Overall, the estimated race patent disparities demonstrate that white and Asian full-time STEM professors are more likely to be named patent inventors than their Black and Hispanic peers.

As will be discussed further in Part IV, universities and researchers can use this equity metric data to determine whether mentorship, outreach, tenure-track, and funding programs implemented to close racial and gender gaps are effective or simply restorative justice theater. For instance, this research shows that, although increasing representation of one demographic may help lessen the size of the gender and racial gaps, simply hiring or admitting more people of a certain race or gender does not erase the gap. Black, Hispanic, and female faculty and students are not equitably represented on patents. With estimated underrepresentation gaps of over 2600%, universities should strongly pursue programs for practical academic equity, rather than false promises of equal opportunity.

A. *Gender Representation*

It is not surprising that women are named on patents less frequently than their male peers.¹³⁴ However, the quantified frequency and the consistency of this frequency across every university entity set in this study is striking. Out of the 25 schools analyzed for this article, only 1 showed an overrepresentation of women on patents when compared to the campus demographic population: Spelman College.

The following is a chart of the calculated estimated gender disparities in the four university entity sets—Ivy League institutions (Ivy), HBCUs, research institutions (Tech), and HRSs

both white and Asian, I identified them as Asian. See *supra* Section II.C for more detail on the methodology for variable classifications.

¹³⁴ Clara Guibourg & Nassos Stylianou, *Why Are So Few Women Inventors Named on Patents?*, BBC NEWS (Oct. 2, 2019), <https://www.bbc.com/news/technology-49843990> [<https://perma.cc/KW8N-7REK>].

outside of the HBCU system with the most tenured Black faculty. I present the disparities in three different ways: the disparity index (D_i), the disparity ratio (D_r) using white as the race basis and male as the gender basis, and the patent aggregation disparity ratio ($D_{r(Ag)}$).¹³⁵ I calculated each of these disparities for the four employment categories of the four university entity sets: total full-time instructional staff and students, total full-time instructional staff, the total graduate researchers and full-time STEM staff, and only full-time STEM staff.¹³⁶ In the interest of space, **Table 1** shows the disparity index, disparity ratio, and patent aggregation disparity ratio only for full-time STEM staff, as well as the overall-determined percentage of representation of STEM staff and patent inventors in my sample.

Table 1. *Percentage STEM staff, percentage of patent inventors, disparity index, disparity ratio, and patent aggregation disparity ratio for full-time STEM staff at Ivy League institutions (Ivy), HBCUs, research institutions (Tech), and HRSs outside of the HBCU system with the most tenured Black faculty, calculated from 2000 to 2015.*

Disparity Analysis	Ivy Women	Ivy Men	HRS Women	HRS Men	HBCU Women	HBCU Men	Tech Women	Tech Men
STEM Staff (%)	39.3%	60.7%	50.1%	49.9%	39.4%	60.6%	38.0%	62.0%
Patent Inventors (%)	14.4%	84.3%	17.5%	79.1%	20.1%	78.3%	12.3%	87.3%
D_i to STEM Staff	0.366	1.390	0.350	1.585	0.510	1.292	0.324	1.409
D_r to STEM Staff	3.794	1.000	4.529	1.000	2.532	1.000	4.341	1.000
$D_{r(Ag)}$ to STEM Staff	2.397	0.632	2.764	0.664	1.766	0.697	2.671	0.615

At Ivy League institutions, research institutions, and other HRSs, women are underrepresented across all categories of inventorship. The percentage of female patent inventors is 0.366 times the percentage of female full-time STEM professors in Ivy League institutions. The percentage of male patent inventors is 1.39 times the percentage of male full-time STEM professors in Ivy League schools. The same pattern continues with HBCUs, research institutions, and other HRSs in the United States—the percentage

¹³⁵ The Chi-square value is lower than every test statistic in this sample and supports my rejection of the null hypothesis that the gender distribution of patent holders is equal to the gender distribution at the university for every employment category at the 0.01 level.

¹³⁶ The term “staff” includes only instructors, lecturers, and professors working full time at the university.

of female patent inventors is lower and the percentage of male inventors is higher than the percentage of their representation as full-time STEM professors at the schools. Although these numbers cannot be directly compared in their relative disparity indices, this shows that women are underrepresented on patents relative to their population on campus and men are overrepresented on patents relative to their population on campus.

I used a disparity ratio to determine whether female inventors were underrepresented compared to their male counterparts when accounting for their relative populations at the university. In Ivy League schools, when accounting for representation on campus, male full-time STEM professors are 3.79 times more likely to be patent inventors than their female peers. In these institutions, male STEM professors comprise 60.1% of the population of STEM professors. However, male inventors comprise a far greater percent of the population of inventors on the given sample, with 643 out of 763 male-identified inventors in the Ivy League school sample, or 84.3%. Female professors are relatively underrepresented, comprising 39.3% of the STEM professor population at Ivy League institutions, but only 14.4% of the total inventors identified in the sample. To achieve equity with their male counterparts, female inventors would need to have been named approximately 39 times out of 100 inventors, rather than the current rate of 14.4 times out of every 100.

In the aggregate, the average full-time STEM professor is 2.40 times more likely to be named as an inventor on a patent than a female peer at an Ivy League school. If there was inventor equity among female and male STEM professors, this number would be 1. This shows that a female full-time STEM professor is significantly less likely than an average peer to be a named patent inventor while employed at a university.

Comparatively, women are more poorly represented at research universities than at Ivy League institutions in the United States. In research institutions, when accounting for representation on campus, male full-time STEM are 4.34 times more likely to be patent inventors than their female peers. In the aggregate, the average full-time STEM professor is 2.67 times more likely to be named as an inventor on a patent than a female full-time STEM professor. In research institutions, women represent 38% of the STEM faculty, similar to their representation at Ivy League institutions. However, female representation on patents is lower, with women making up only 12.3% of patent inventors on research university patents. To achieve equity with their male counterparts in these research universities, women would need to be named as

patent inventors approximately three times more frequently than they are currently being named.

Unlike all other university entities in this data set, the HBCU calculation is not a rough estimate with a small sample. I analyzed the demographics of every inventor on every patent assigned to the HBCUs in my sample from 2000 to 2015. In total there were 399 inventors on 153 patents from the HBCUs in my sample. Although the gender patent gap still exists at HBCUs, it is less than the gaps at Ivy League schools, research institutions, and other HRSs in the United States as estimated herein. In the aggregate, the average full-time STEM professor is 1.77 times more likely to be named as an inventor on a patent than a female peer at an HBCU.

This gender representation gap was pervasive across almost every institution in my sample. Out of the 25 institutions analyzed in this data set, 24 of them had an underrepresented female population of inventors across every employment demographic—from student to full-time STEM professor. Spelman College was the only school out of the 25 schools to have an overrepresentation of female patent inventors relative to the campus population of full-time computer science, science, and engineering professors.¹³⁷ Spelman College, a historically Black liberal arts college for women, produced a total of 7 patents from 2000 to 2015, and only had 1 inventor named on 6 of those 7 patents. Therefore, data relating to Spelman College should not be taken as a sign that Spelman College is providing means to better represent women, but rather that Spelman College likely does not actively pursue patent prosecution.

Regardless of whether the gender demographics of the school were limited to only graduate students and faculty, only faculty, only STEM faculty, or were open to the entire school population, women were still underrepresented at every level. The data show that male full-time STEM professors are anywhere from 2 to 5 times more likely than their female peers to be named patent inventors. This was consistent in the calculated representation at each individual school and the calculated representation at the university entity sets, demonstrating that this issue is shared by universities across the United States.

B. Race Representation

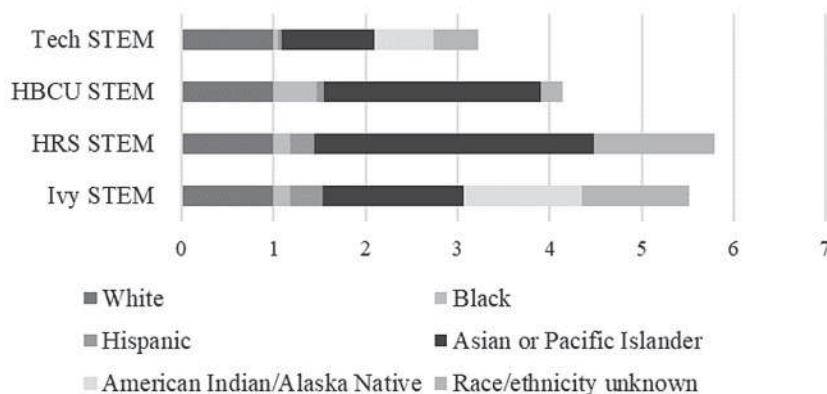
In the United States, the patent output for Black people is 6 patents per million people, compared to 40 patents per million

¹³⁷ Spelman College had only one inventor listed on six of its seven patents. I identified this inventor as female.

women and 235 patents per million in the United States overall.¹³⁸ The extent of this disparity pervades universities and colleges, even when accounting for employment level and education level.

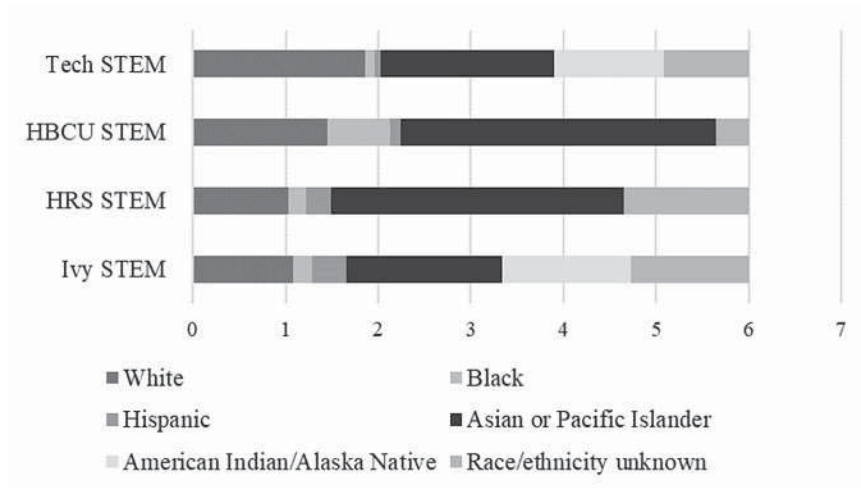
The following are two bar charts of the calculated race disparities in the four university entity sets—Ivy League institutions, HBCUs, research institutions, and HRSs outside of the HBCU system with the most tenured Black faculty based on the data collected for this study. **Figure 1** shows the inverse disparity ratio (ID_r) ($1/D_r$) using white as the race basis, with the racial demographic as the numerator to show the underrepresentation as a fractional representation compared to the white inventorship representation. **Figure 2** shows the inverse patent aggregation disparity ratio ($ID_{r(Ag)}$) ($1/D_{r(Ag)}$), showing underrepresentation as a fractional representation compared to the average inventorship representation across the university set. I calculated each of these disparities for the four employment categories of the four university entity sets.¹³⁹ In the interest of space and clarity, the charts only reflect the calculated disparity ratios for full-time STEM staff.

Figure 1. *Inverse patent white disparity ratio.*



¹³⁸ Lisa D. Cook, *Policies to Broaden Participation in the Innovation Process* 10 (Brookings Inst., The Hamilton Project, Aug. 2020), https://www.hamiltonproject.org/assets/files/Cook_PP_LO_8.13.pdf [<https://perma.cc/J7DV-8DTR>].

¹³⁹ The Chi-square test for race-based analysis used the three categories of white, Asian, and other instead of two, due to the significantly disproportionate representation of Hispanic and Black inventors both in patent representation and on campus, as compared to their white and Asian peers. The Chi-square value for this test is lower than every test statistic in this sample and supports my rejection of the null hypothesis that the race distribution of patent holders is equal to the race distribution at the university for every employment category at the 0.01 level.

Figure 2. *Inverse patent aggregate disparity ratio.*

I used a sample of approximately 30 patents from each school for the following data analysis.¹⁴⁰ With an average of 3.2 inventors per patent, I analyzed the race of an average of 96 inventors per school. In many of these samples, I did not find a single Black or Hispanic inventor. This does not mean that the universities do not have any patents with a Black or Hispanic inventor, but rather that I did not find a single Black or Hispanic inventor in my sample. I suspect that the representation of Black and Hispanic inventors is most likely low in those schools and that the percentage of Black and Hispanic people in proportion to the entire university population is also small, but further research is necessary to confirm this suspicion. Due to this result, I was unable to calculate the underrepresentation of Black inventors and Hispanic inventors at several universities in my dataset.

The race disparities, as shown above, are larger and more widespread than the gender disparities. Black inventors are underrepresented inventors across all employment categories. This gap persists even when excluding any non-full-time STEM professors.

In Ivy League schools, when accounting for representation on campus, white full-time STEM professors are 5.45 times more likely to be patent inventors than their Black peers and 2.90 times more likely to be patent inventors than their Hispanic peers. In the average Ivy League school, white full-time STEM faculty comprise about 63.5% of the total faculty

¹⁴⁰ If schools had a total of under fifty patents, I analyzed the entire set.

population. Black STEM professors make up 5.4% and Hispanic professors make up 6.4% of the total STEM faculty population.¹⁴¹ Out of the 763 inventors on the 236 patents on the Ivy League sample, I would have needed to find approximately 41 Black inventors, 49 Hispanic inventors, and 484 white inventors for the patent inventor population to match the demographic population of the STEM professors.

Instead, I only found 9 Black inventors and 16 Hispanic inventors in the entire 763 inventor sample. In other words, although Black professors constitute 5.4% of the total STEM faculty population, they only comprised 1.1% of all inventors in my sample. Similarly, although Hispanic professors comprise 6.4% of the total STEM faculty population, they made up only 2.4% of all inventors in my sample. In the aggregate, the average full-time STEM professor is 5.01 times more likely to be named as a patent inventor than a Black full-time STEM professor and 2.66 times more likely to be named as a patent inventor than a Hispanic full-time STEM professor.

Research institutions have the largest race inventor gaps in my data set. In research institutions, when accounting for representation on campus, white full-time STEM professors are approximately 18.78 times more likely to be patent inventors than their Black peers and 26.90 times more likely to be patent inventors than their Hispanic peers. In the average research institution, white full-time STEM faculty comprise about 53.3% of the total faculty population. Black STEM professors make up 3.3% and Hispanic professors make up 9.5% of the total STEM faculty population. Out of the 496 inventors on the 150 patents in the research university sample, I would have needed to find about 16 Black inventors, 47 Hispanic inventors, and 264 white inventors for the patent inventor population to match the demographic population of the STEM professors.

Instead, I only found 2 Black inventors and 4 Hispanic inventors in the entire 496 inventor sample. In other words, although Black professors comprise 3.3% of the total STEM faculty population, they only comprised 0.2% of all inventors in my sample. Similarly, although Hispanic professors comprise 9.5% of the total STEM faculty population, they made up only 0.4% of all inventors in my sample. In the aggregate, the average full-time STEM professor is 10.09 times more likely to be a

¹⁴¹ The IPEDS data do not allow for a person to be both “Hispanic” and “white,” without being in an ambiguous “two or more races” category. *Collecting Race and Ethnicity Data from Students and Staff Using the New Categories*, IPEDS, <https://nces.ed.gov/ipeds/use-the-data> (last visited Apr. 10, 2022).

named patent inventor than a Black full-STEM professor and 14.45 times more likely to be a named patent inventor than a Hispanic full-time STEM professor.

Doubling the relative percentage of Black STEM professors did impact the patent gap, but not significantly. At HRSs like Georgetown University and Emory University, Black STEM professors made up over 7% of all STEM faculty. On average, Black inventors comprised 1.11% of the patent inventor population on my sample set, representing an aggregate disparity ratio to STEM staff of 5.34. In the aggregate, the average full-time STEM professor at an HRS is 5.34 times more likely to be a named patent inventor than a Black full-time STEM professor.

The patent gap continued to close when the Black STEM professor population increased to an even higher representation ratio at HBCUs. In HBCUs, when accounting for representation on campus, the average full-time STEM professor is 1.48 times as likely as a Black STEM professor to be named on a patent. When compared to just their white peers, white STEM professors are 2.15 times more likely to be patent inventors than their Black peers. In the average HBCU, white full-time STEM faculty comprise about 16.3% of the total STEM faculty population. Black STEM professors make up 62.9% of the total STEM faculty population. Out of the 399 inventors on the 153 HBCU-assigned patents, I would have needed to find about 250 Black inventors to match the demographic population of the STEM professors. However, I only found 135. In other words, although Black professors comprise 62.9% of the total STEM faculty population, they only comprised 39.8% of all inventors in my sample.

As noted above, the HBCU data set represents an analysis of the entire patent set at those universities, rather than a sample set. Moreover, out of the entire university set for HBCUs, there were only 121 unique inventors of the 399 inventors named on the assigned patents, meaning several inventors were represented on multiple patents in the set. Comparatively, in the university set for Ivy League institutions, there were 683 unique inventors out of 763 named inventors. This might be more of an indicator of patent application interest within STEM professors at HBCUs than an indicator of value recognition, given that it seems the HBCU sample represents a few prolific patent applicants at HBCUs.¹⁴² Nonetheless, this

¹⁴² For example, Leyte L. Winfield was the sole inventor of six of the seven patents from Spelman college granted from 2000 through 2015.

data set still shows that white inventors receive patents for their inventions at a higher rate than Black inventors at HBCUs when accounting for their relative representation on campus as STEM professors.

Regardless of whether the race demographics of the school were limited to only graduate students and faculty, only faculty, only STEM faculty, or were open to the entire school population, Black and Hispanic inventors were still underrepresented at every level. Native American and Alaskan Native inventors were so underrepresented that it was impossible to calculate an underrepresentation estimate, even when aggregating the schools by university sets.

Moreover, these underrepresentation gaps did not always close when the analysis was limited to groups more likely to be involved in the patent process. Although some initially speculated that the reason for underrepresentation on patents at some universities was caused by a majority of Black and Hispanic professors not being involved in STEM, the data demonstrate that this is false. When only comparing the patent inventorship population to the demographic representation of full-time STEM professors, Black and Hispanic professors are still much less likely to be named inventors than their peers.

As an aside, I calculated the percentage change in representation from 2000 to 2015 to determine whether the inequities of patent representation could be attributed to a late increase in Black and Hispanic staff representation at universities.¹⁴³ Although the student body of most institutions has become progressively more racially diverse, the staff diversity has not always increased at the same rate. At Ivy League universities, Black professors made up 4.2% of the total professor population in 2001 and 4.0% of the total STEM professor population in 2015, representing a decrease of 4.77% over the fifteen-year period of the data set. A similar trend can be seen for HRSs and HBCUs. In research universities, the Black professor population increased from 18.9% in 2001 to 25.3% in 2015. An increase in Black representation could indicate that the patent gap is smaller than this sample indicates, given that there is a greater group of potential Black inventors present at the end of the sample set timeline. A stable or decreasing Black representation could indicate a more accurate or underestimation of the race patent gap.

I also calculated the percentage change in representation of STEM staff over the three-year time range from 2012 to 2015.¹⁴⁴ At

¹⁴³ This percent change is based on relative population change, not raw numerical changes.

¹⁴⁴ Schools only began to report STEM staff representation in 2012.

Ivy League universities, Black STEM professors made up 5.70% of the total STEM professor population in 2012 and 5.45% of the total STEM professor population in 2015, representing a decrease of 4.25% over the three-year period of the data set. The Black STEM professor population increased in HRSs by 1.21% and in HBCUs by 8.25%. In research universities, the Black STEM professor population increased from 3.04% in 2012 to 3.23% in 2015.

Moreover, I also recalculated the results for patent representation based on unique inventors in the sample, rather than overall inventorship representation per patent. This eliminated the possibility of prolific inventors skewing the demographic patent inventorship representation.¹⁴⁵ However, eliminating inventors named on multiple patents in the sample did not significantly impact the results.¹⁴⁶

Even if the calculations were repeated at the lowest representation of Black STEM professors and/or the lowest representation of Black professors (whichever is lower), Black patent inventors would still be significantly underrepresented.

IV. THE IMPLICATIONS OF SYSTEMIC DISCRIMINATION AND PROPOSED REASONS FOR DISPARITIES

This research identifies clear disparities in both racial and gender patent inventorship representation. Through university programming, legal education, and social support, the gaps in representation could begin to close. This Part explores potential reasons behind the disparities discussed above, including tenure publication expectations, existing cultural frameworks that could influence how certain groups of professors view the legal system, and the differing burdens of faculty mentorship. This Part also encourages universities to use quantitative equity metrics, such as patent representation based on campus population, to demonstrate the effectiveness of their university programming to correct systemic discrimination issues.

Although this research cannot precisely quantify the exact gender and racial disparity in higher education, all signs point to substantial and pervasive barriers to inventorship recognition for female inventors, Black inventors, and Hispanic inventors across Ivy League universities, research institutions, other HRSs, and

¹⁴⁵ For example, if three inventors were named on every patent at a university, the gender and race of those three inventors would heavily influence the calculated inventorship representation rates at those universities.

¹⁴⁶ There were 496 inventors in my sample for research institutions, with 485 unique inventors. The elimination of these eleven duplicative entries for multiple patents did not significantly impact the final disparity calculations.

even HBCUs in the United States. This research demonstrates that these barriers exist, and not just at individual schools, but across university systems. Universities and the government cannot ignore this pervasive and demonstrated pattern of discrimination.

When coupled with the hiring trends across these institutions, the pattern becomes especially disturbing. Although there is an increase in Black and Hispanic faculty at almost every institution, the diversity representation among faculty does not match the diversity representation among students. What is even more troubling is that, in some institutions, the staff diversity population is either decreasing or increasing at a rate far lower than the increase in student diversity.¹⁴⁷

Increasing racial and gender representation on campus may reduce, but not eliminate, systemic racism and sexism manifesting in patent inventorship recognition. Although universities, almost without exception, increased diversity in at least their student populations from 2000 to 2015,¹⁴⁸ the patent diversity representation differs greatly from the diversity of the campus population. This research shows that admissions and hiring statistics do not mirror the ability to participate and succeed in programs on college campuses, at least in the field of patent inventorship.

Even when accounting for the lack of diversity at some college campuses, there is still a substantial racial and gender underrepresentation in patent inventorship. The methodologies used in this article to demonstrate this underrepresentation provide an estimation of this gap. However, the quantitative estimate using the equity metrics can only be used to show the current trend of patent representation on campus. It cannot explain the reasons behind these gaps.

Below, I have provided several theories that could explain why the racial and gender underrepresentation on patents at universities is so substantial and pervasive—even within a seemingly equalizing environment where inventors have the same access to patent, legal, and research resources at universities, and even when using equity metrics instead of general representative calculations. These theories include an examination of social burdens, publication risks, and how the patent system operates at universities. The reasons are not inclusive of all potential explanations for the patent gap, and more research must be done to quantify the extent to which these factors affect an inventor's

¹⁴⁷ For example, Columbia University's Black student population fell 13.48% from 2001 through 2015 and their Black staff population fell 30.85% within the same time period.

¹⁴⁸ See *supra* notes 3–5 and accompanying text; note 147.

ability to successfully patent his or her invention at a university, if at all. Due to the nature of this article, the theories will focus on potential explanations for the vast gender and racial patent gap among full-time STEM professors at universities. I will investigate racial and gender representation gaps for undergraduate and graduate science students in further research.

A. *Burdens as a Professor*

A university professor typically has about five to six years from their date of hire to become a full-time tenured professor.¹⁴⁹ During this time, the tenure-track professor must develop a track record based on research, teaching, and service, while balancing any personal trials and tribulations, to be promoted to a tenured professor.¹⁵⁰ Although professors can choose to prove their excellence in a myriad of ways, the “great equalizer” of the twenty-four hour day is likely not equally utilized by professors of different races and genders. This unbalanced utilization is based both on societal constraints and university expectations.¹⁵¹ Professors do not equally balance mentorship, acts of service, and research. Increased participation in general acts of service could detract from participation in research and lead to a patent inventorship gap. This research participation gap likely contributes to the observable patent gap. I plan to quantify how much increased participation in acts of service decreases patent productivity in future research, for which this article lays a foundation.

I think of these university expectations, most likely influenced by societal expectations, as economic poker chips. When entering a university, each faculty member has a certain amount of economic poker chips to gamble with in the hopes of receiving tenure status. If all opportunities were equal, each faculty member would receive the same amount of credit for each tenure-track eligible task they complete. Additionally, each faculty member would be able to spend the same amount of time on equally distributed tasks as faculty of their same status. Every gamble with these poker chips—shown as a chance to distinguish yourself from your colleagues—would be outside the control of each individual professor but would result in a race- and gender-blind success rate only dependent on the talent and inventiveness of the professor. For example, each faculty

¹⁴⁹ See Laura Bonetta, *Moving up the Academic Ladder*, SCIENCE (Feb. 11, 2011), <https://www.sciencemag.org/features/2011/02/moving-academic-ladder> [https://perma.cc/TL3V-ZWQW].

¹⁵⁰ *Id.*

¹⁵¹ See *Keeping Mommy on the Tenure Track*, FEMINISTS FOR LIFE, <https://www.feministsforlife.org/keeping-mommy-on-the-tenure-track/> [https://perma.cc/MF5K-JZ3V].

member would mentor at the same rate, attempt to publish at the same rate, serve on committees at the same rate, be requested to take notes at meetings at the same rate, and spend the same amount of time at the institution.

In practice, this is not true.¹⁵² Female professors spend more hours of service per week than their male peers even when controlling for rank, race, and discipline.¹⁵³ This includes both internal mentorship and external professional association service acts.¹⁵⁴ Black, Asian, and Hispanic professors also have an increased mentorship burden, “particularly around issues of race and racism on campuses,” when compared to their white peers.¹⁵⁵ Furthermore, diversity and inclusion work disproportionately burdens faculty of color and female faculty.¹⁵⁶

Participation in these activities is not only necessary for universities to succeed in education, but it is also likely to “have an impact on productivity in other areas of faculty effort such as research and teaching, and these latter activities can lead directly to salary differentials and overall success in academia.”¹⁵⁷ Acts of service that may negatively impact Black, Hispanic, and female professors’ research trajectories are apparent both in one-on-one mentorship requirements and group leadership requirements.

Students at a university seek out a mentor to help them through their academic careers. Every student on a university campus deserves a mentor and, without women and faculty of color agreeing to the mentorship opportunity, some students may not have a mentor or may struggle more in school.¹⁵⁸ Students select mentors who not only understand their academic goals, but also their personal history. Mentor-mentee relationships are often forged between those “who are of the same gender” and who share “background characteristics, such

¹⁵² Kimberly A. Griffin & Richard J. Reddick, *Surveillance and Sacrifice: Gender Differences in the Mentoring Patterns of Black Professors at Predominantly White Research Universities*, 48 AM. EDUC. RSCH. J. 1032, 1044–49 (2011).

¹⁵³ Cassandra M. Guarino & Victor M.H. Borden, *Faculty Service Loads and Gender: Are Women Taking Care of the Academic Family?*, 58 RSCH. HIGHER EDUC. 672, 674 (2017).

¹⁵⁴ *Id.*

¹⁵⁵ Zawadi Rucks-Ahidiana, *The Inequities of the Tenure-Track System*, INSIDE HIGHER EDUC. (June 7, 2019), <https://www.insidehighered.com/advice/2019/06/07/nonwhite-faculty-face-significant-disadvantages-tenure-track-opinion> [<https://perma.cc/3E6G-2UHL>].

¹⁵⁶ See Colleen Flaherty, *Undue Burden*, INSIDE HIGHER EDUC. (June 4, 2019), <https://www.insidehighered.com/news/2019/06/04/whos-doing-heavy-lifting-terms-diversity-and-inclusion-work> [<https://perma.cc/A6GT-DS3R>].

¹⁵⁷ Guarino & Borden, *supra* note 153, at 690.

¹⁵⁸ I cannot ascertain if this is because women or faculty of color are more likely to agree to a mentorship opportunity than their white, male peers or if this is because white, male faculty are more likely to turn down a mentorship opportunity than their female or faculty of color peers.

as race, ethnicity, religion, and social class.”¹⁵⁹ However, a study of over one thousand STEM undergraduate and graduate students found that, although students whose gender or race matched the gender or race of their professor or “mirror mentor” felt that they received more help, this match did not affect academic outcomes.¹⁶⁰

If universities selected a mentor for their students, rather than allowing students to select their own mentors, certain groups of mentors may be less burdened. This is especially true in situations where the overburdened mentor is a woman or a person of color because of the disparate representation of students and faculty within these race and gender categories.¹⁶¹ Moreover, schools could track faculty mentorship hours and choose to assign more students to relatively underburdened mentors in the following academic year. Schools could also provide additional mentorship training to faculty members so that mixed-gender or mixed-race mentorship relationships can be more emotionally and academically fruitful. Balancing this burden would reduce the mentorship time-tax of currently overburdened faculty members, allowing them more flexibility to concentrate on their research.

Universities must balance the mentorship burden not only for one-on-one mentors, but also for group mentor requirements. White and male professors must learn to shoulder the extra burden of social support programs meant to promote more women and people of color in STEM fields. Although creating bonds between students and faculty of color can help strengthen a feeling of belonging within a field often perceived as exclusive, programs like diversity retreats and Girls in STEM conferences¹⁶² may be overburdening faculty of color and female faculty. If only Black, Hispanic, and female mentors attend these programs, or even if these mentors spend more time on these mentorship programs than their white and male peers, they will be at a time disadvantage when it comes to producing research.

¹⁵⁹ Joi-Lynn Mondisa, *Mentoring Minorities: Examining Mentoring from a Race and Gender Lens* 1, 4 (2014 Am. Soc’y for Eng’g Educ. (ASEE) Annual Conference & Exposition, Conf. Paper, June 15–18, 2014), <https://peer.asee.org/mentoring-minorities-examining-mentoring-from-a-race-and-gender-lens> [<https://perma.cc/5XRX-6VLB>].

¹⁶⁰ Stacy Blake-Beard et al., *Matching by Race and Gender in Mentoring Relationships: Keeping our Eyes on the Prize*, 67 J. SOC. ISSUES 622, 643 (2011).

¹⁶¹ For example, according to my study, Hispanic faculty comprise about 5% of the total staff at the average research university. Hispanic students comprise about 19% of the student body at the average research university. Conversely, male faculty comprise over 63% of the total staff at the average research university, but male students comprise only 49% of the student body.

¹⁶² Kathy Svitil, *Diversity Retreat*, CALTECH (June 11, 2015), <https://www.caltech.edu/about/news/diversity-retreat-caltech-47009> [<https://perma.cc/8F5L-TPG7>]; *Girls in STEM Conference*, GIRLSTART, <https://girlstart.org/our-programs/girls-in-stem-conference/> [<https://perma.cc/AS52-AAY3>].

The question is not whether participation in these mentorship and committee opportunities should count more towards the tenure process because credit towards tenure will not increase named inventorship on patents. Further research must be done to determine whether equalizing the service load would help to reduce the patent gap.

B. *Funding and Seniority*

As mentioned in Part II, disparities in funding may impact the ability of certain professors to be named patent inventors. The racial and gender gaps in STEM funding are well known and well quantified.¹⁶³ Funding may impact research discoveries and longevity at a certain institution, both of which may contribute to the patent gaps established in this article.

Without funding, a person cannot be expected to invent something capable of patenting, and certainly not at the same rate as someone who has funding. Although money does not necessarily beget an intellectual idea, patents require more than the recitation of an idea. “[A]ny process, machine, manufacture, or composition of matter that is not a law of nature, natural phenomena, or abstract idea has the potential to be patentable,” but only if it can be reduced to enough detail to teach “a person of ordinary skill in the art how to make and use the invention.”¹⁶⁴ Lack of funding might make it difficult to conduct enough experiments such that the resulting teachings within the patent will be sufficient for a person of ordinary skill in the art to follow. Additionally, although most universities will pay for the majority of the patent process, this is not always the case. If a university requires professors to fund their own patents, it is possible that poorer labs would choose to forego pursuing the patent process out of budgetary concerns.¹⁶⁵

Out of the 124 patents granted to Harvard University in 2015, 12.9% listed at least one other university as an assignee and 16.9% of patents listed at least one other company or nonprofit in addition to Harvard University. Contrastingly, out of the 44 patents filed from 2000 to 2015 and assigned to Howard University, 2 (4.5%) listed one other company and only 1 (2.3%) listed another university.

¹⁶³ Uzzi et al., *supra* note 109; Shraddha Chakradhar, *Not Only Who but What: NIH Funding Disparity Between Black and White Scientists Partly Driven by Research Topic*, STAT NEWS (Oct. 10, 2019), <https://www.statnews.com/2019/10/10/nih-grants-funding-racial-disparity-research-topic/> [<https://perma.cc/U89X-CATJ>].

¹⁶⁴ Jordana R. Goodman, *Patenting Frankenstein’s Monster: Exploring the Patentability of Artificial Organ Systems and Methodologies*, 15 NW. J. TECH. & INTELL. PROP. 35, 41 (2017).

¹⁶⁵ Gulbrandsen & Smeby, *supra* note 111 (showing that industry funding increases patent applications).

This could indicate that funding from external sources, or shared by different universities, lead to more patents and may impact the gender and racial disparity gaps.

Additionally, although most universities have a technology transfer office or equivalent department,¹⁶⁶ the process of accessing this department and receiving funding and support for the patent process may be different across different professors in the university. For example, if a university receives ninety applications to potentially pursue patents in a given year and only accepts fifty for funding, the process of narrowing down which applications to fund may not be race or gender neutral. University-held competitions may use outside judges who may come with racial and gender biases, affecting which inventions receive funding.¹⁶⁷ Universities may also fund certain departments more than others. If those departments have more white and more male professors than other science departments, this may also exacerbate the patent gap.

Well-funded laboratories may feel more secure in their endeavors and, thus, more likely to engage in the multi-year patent process within the university.¹⁶⁸ As has been shown in other studies, “[p]atents are positively correlated with academic position” such that full professors patent more than assistant professors.¹⁶⁹ It has also been suggested that “patents require a certain level of seniority or experience more than the other types [of commercial endeavors].”¹⁷⁰ This study could not account for the age or seniority status of the professors within the total university population sample set or for the set of inventors named on patents.

However, older professors (especially female professors) may not pursue patents on equal footing with their male peers.¹⁷¹

¹⁶⁶ See *supra* Section I.B.

¹⁶⁷ See, e.g., *Patenting an Invention*, *supra* note 72 (noting that technology officers in MIT’s technology licensing office may engage inventors, “literature search specialists,” and patent attorneys in patentability assessments of submissions).

¹⁶⁸ To determine if this is likely, I propose calculating the likelihood of a professor being named on multiple patents. In my sample, there were not many inventors named multiple times on patents outside of the HBCU system. Increasing the sample size would likely impact this result.

¹⁶⁹ Gulbrandsen & Smeby, *supra* note 111, at 950.

¹⁷⁰ ANDREA BONACCORSI & CINZIA DARAIO, UNIVERSITIES AND STRATEGIC KNOWLEDGE CREATION: SPECIALIZATION AND PERFORMANCE IN EUROPE 132 (2007) (citing Aldo Geuna & Lionel Nesta, *University Patenting and its Effects on Academic Research* 1–42 (Sci. & Tech. Pol’y Rsch. Elec., Working Paper No. 99, 2003)).

¹⁷¹ It is possible that, instead of pursuing patents, older professors may be pursuing publications. Although there is still a gender gap for both authorship publications and patent inventorship, the gender gap is larger in patent inventorship than authorship. Cf. Matthew R.E. Symonds et al., *Gender Differences in Publication Output: Towards an Unbiased Metric of Research Performance*, PLOS ONE 1 (Dec. 27, 2006), <https://doi.org/10.1371/journal.pone.0000127> [<https://perma.cc/5QSL-ZC2S>] (showing, in general, that “[t]here is a clear difference between men and women in science with regard to the quantity of their research output” (including on patents)).

According to a 2006 study, the gender gap for patenting was over twice as high for people who received their PhDs from 1967 to 1975 than from 1986 to 1995.¹⁷² This may indicate that younger women are pursuing patents at higher rates than their predecessors.

I also propose that the funding gap between male and female professors does not significantly contribute to the patent gap, given that “female patenting is proportionally more likely to occur in academic institutions than in corporate or government environments.”¹⁷³ Because corporate and government environments generally fund projects, rather than individual people, I hypothesize that, if funding was a significant source of the gender patent gap, there would be a larger gap in academia than in industry. More research is needed to determine whether funding and seniority demonstrably impact patenting rates at universities.

C. *Patent Interest and Expectations*

Yet another factor contributing to patent inventorship gaps may be the attitude towards patents and the patent application process. A professor’s relative interest in pursuing the patent process in addition to publications and their expectations of the patent process all impact whether a person will pursue a patent application. Racism and sexism underlying these attitudes, both perceived and realized, could disparately affect certain groups of professors and contribute to the patent gap. The impact of overall confidence in academia will be discussed in Section IV.D below.

To succeed in academia, a faculty member is beholden to the aphorism “publish or perish.”¹⁷⁴ Many research universities in the United States set forth a basic outline of accomplishments for tenure-track faculty to reach full-time tenure status.¹⁷⁵ These publications can include both papers in traditional science journals and patents. However, if an author publishes a paper before applying for a patent, they may be ineligible to apply for a patent.¹⁷⁶ Additionally, if a person delays publishing a paper

¹⁷² Waverly W. Ding et al., *Gender Differences in Patenting in the Academic Life Sciences*, 313 SCI. 665, 667 (2006).

¹⁷³ Cassidy R. Sugimoto et al., *The Academic Advantage: Gender Disparities in Patenting*, PLOS ONE 1 (May 27, 2015), <https://doi.org/10.1371/journal.pone.0128000> [<https://perma.cc/GC4C-SV6D>].

¹⁷⁴ Daniele Fanelli, *Do Pressures to Publish Increase Scientists’ Bias? An Empirical Support from US States Data*, PLOS ONE 1 (Apr. 21, 2010), <https://doi.org/10.1371/journal.pone.0010271> [<https://perma.cc/Y3G5-YDK6>].

¹⁷⁵ See, e.g., *Tenure Process*, MIT POL’YS (Dec. 15, 2020), <https://policies.mit.edu/policies-procedures/30-faculty-appointment-promotion-and-tenure-guidelines/32-tenure-process> [<https://perma.cc/T33F-WXE6>].

¹⁷⁶ *Patent Process Overview*, U.S. PAT. & TRADEMARK OFF., <https://www.uspto.gov/patents/basics/patent-process-overview> [<https://perma.cc/P46L-HAQ5>] (noting that an

because they are pursuing a patent, they may get “scooped” by another researcher.¹⁷⁷ Finally, the overall underlying attitude towards patenting, especially the sense that patents “violate [the] norms of openness and communalism in science,” may disparately impact Black, Hispanic, and female researchers and may contribute to the patent gap.¹⁷⁸

This study relies on the assumption that all science, engineering, computer, and research professors had an equal opportunity to produce and patent their ideas. As mentioned above, women are underrepresented in some patent-intensive fields, which means they work in fields less likely to generate patents.¹⁷⁹ However, a person’s interest in pursuing the patent process does not only depend on their field of study. Motivations to engage in the patent process and perceptions about prestige in academia may be even more important factors in pursuing a patent.¹⁸⁰

If a person does not see the benefit of applying for a patent, they may choose to forgo their application opportunity and the recognition that comes alongside the patent inventorship. This lack of benefit recognition may be different across professors and students of differing gender and race. If a person does not recognize the government as a positive influence able to help their lives and career, that person may be less likely to engage with the government to seek protection of their intellectual property rights and may avoid using the government as a means to perpetuate their goals. Additionally, if a scientist views patents as a means for violating “the norms of open science” and closing “a large domain” by allowing “private property rights” to encroach that domain, they may be less likely to pursue a patent in addition to their paper.¹⁸¹ Without uniform university education regarding the benefits (and detriments) of patent applications, professors may use differing background knowledge to make these decisions, contributing to the racial and gender patent inventorship gap.

inventor “cannot get a patent if [their] invention has already been publicly disclosed.” This includes a paper publication.)

¹⁷⁷ See *How to Deal with Being “Scooped”: The Vast Majority of Science is a Process of Derivative, Incremental Advance*, LONDON SCH. OF ECON.: IMPACT BLOG (Apr. 19, 2016), <https://blogs.lse.ac.uk/impactofsocialsciences/2016/04/19/so-youve-been-scooped/> [<https://perma.cc/E654-88X7>] (explaining being scooped as when a researcher is “on the verge of submitting that amazing paper describing a new and exciting finding, or a hot new method” and another researcher publishes before them. This results in the other researcher getting “all the credit” and the scooped researcher being “seen as some lame copycat.”).

¹⁷⁸ Gulbrandsen & Smeby, *supra* note 111, at 934.

¹⁷⁹ Jennifer Hunt et al., *Why Don’t Women Patent?* 10 (Nat’l Bureau of Econ. Rsch., Working Paper No. 17888, 2012).

¹⁸⁰ Cf. Gugliuzza & Rebouché, *supra* note 69, at 15–16 (showing that gendered conceptions of discovery have propagated gender inequality).

¹⁸¹ Richard R. Nelson, *Observations on the Post-Bayh-Dole Rise of Patenting American Universities*, 26 J. TECH. TRANSFER 13, 18 (2001).

Industry and federal funding, and the inability to operate their laboratories without this funding, may also persuade some laboratories to pursue more patents than others.¹⁸² Ideally, royalties and licensing deals from patents could be used to create funding within a laboratory space without relying on grants.¹⁸³ In practice, higher royalty sharing does not lead to more university licensing income and thus may not practically impact innovation at the university.¹⁸⁴ However, if perception of these rewards associated with patenting are different across gender and race, the rewards will contribute to the patent gap, even if they do not increase overall revenue or innovation at a university.

A scientist's overall expectations of the patent process will also impact their likelihood of engaging with the patent process. A baseline unfamiliarity with the patent process, coupled with a lack of educational outreach from the technology transfer office, may slow patent applications down to the point where the inventor decides not to file at all. This may rest on a few incorrect assumptions: (1) that a person's publishable research is not patentable, and (2) that the gender and race of a patent applicant influences the likelihood of success in the patent process.

The notion that a person's publishable research is not patentable is demonstrably false. Approximately 80% of research articles that receive at least one citation produce at least one patent.¹⁸⁵ Certainly, research that applies scientific discoveries or mathematical formulas is more likely to produce a patentable invention than research related to pure theory or algorithm work.¹⁸⁶ Overall, however, this correlation between patentable inventions and research papers indicates that almost all academic researchers should at least consider approaching their technology offices in tandem with publication. This high correlation also suggests that patent inventorship representation should roughly mirror publication authorship representation. However, the research herein indicates that the patent gap is more significant than the publication gap. On average, women comprise 21.9% of authors on

¹⁸² Brittany Flaherty, *Federal Funded Research Drives Nearly One-Third of U.S. Patents, Report Finds*, STAT NEWS (June 20, 2019), <https://www.statnews.com/2019/06/20/federal-finding-research-patents/> [<https://perma.cc/3BCX-P4SR>].

¹⁸³ Gulbrandsen & Smeby, *supra* note 111, at 934.

¹⁸⁴ Ouellette & Tutt, *supra* note 66, at 2–3.

¹⁸⁵ Morgan Ramberg, *The Surprisingly Short Journey from Ivory Tower to Patent Office*, KELLOGG SCH. OF MGMT. AT NW. UNIV., <https://insight.kellogg.northwestern.edu/article/connection-between-science-and-patents> [<https://perma.cc/A3QZ-S8PR>].

¹⁸⁶ See U.S. PAT. & TRADEMARK OFF., MPEP § 2106 (9th ed., Rev. 10.2019, June 2020) (“*Diamond v. Diehr* explained that while an abstract idea, law of nature, or mathematical formula could not be patented, ‘an application of a law of nature or mathematical formula to a known structure or process may well be deserving of patent protection.’” (quoting *Bilski v. Kappos*, 561 U.S. 593, 611 (2010))).

academic papers.¹⁸⁷ Moreover, when accounting for representation on campus, Black and Hispanic authors may publish around the same rate as their white peers.¹⁸⁸

This indicates that a large contributor to the patent gap is not necessarily an ability to conduct research, but rather the equity of a patent education. “Mere exposure to other inventors” and living in “‘innovation-intensive’ areas” reduces both gender and racial patent gaps.¹⁸⁹ Although assistance programs for entrepreneurs without this background can help to close the gap, universities cannot assume that all incoming faculty have a similar education baseline with respect to patenting. This is associated both with the ability to discern what is patentable, as well as a basic understanding of the patent process. For example, if a professor believes pursuing a patent would be a time-consuming process and potentially detract from their research, they may be less likely to pursue a patent application.¹⁹⁰ Therefore, a significant portion of the quantified patent gap may be due to a gender and racial disparity in patent education across academia.

Inequities in the patent application process—both perceived and realized—may also contribute to the racial and gender gap. Once a person successfully applies for a patent, the United States Patent and Trademark Office (USPTO) system regarding patent application evaluation is fairly race and gender blind.¹⁹¹ The USPTO does not require inventors to disclose their race or gender, nor is it likely that the USPTO examiners will ever interact directly with those inventors during the patent process. This inability to ascertain the race or gender of the inventor creates a patent evaluation environment free from significant gender and racial biases.¹⁹² Even though the USPTO is mostly gender and racially blind, with female inventors having only an 8.2% lower likelihood of having their patent granted than male inventors, the perception of a potential race or gender discrimination may deter certain inventors from beginning the process.¹⁹³

¹⁸⁷ Jevin D. West et al., *The Role of Gender in Scholarly Authorship*, PLOS ONE 1 (July 22, 2013), <https://doi.org/10.1371/journal.pone.0066212> [<https://perma.cc/2FRP-PTJ9>]. In comparison, women comprise approximately 38%–51% of STEM professors at the universities analyzed in this article.

¹⁸⁸ Judy Jackson, *The Story Is Not in the Numbers: Academic Socialization and Diversifying the Faculty*, 16 NWSA J. 172, 177 (2004).

¹⁸⁹ Fechner & Shapanka, *supra* note 37, at 730–31.

¹⁹⁰ Gulbrandsen & Smeby, *supra* note 111, at 947 (showing that patenting does not detract from publications).

¹⁹¹ Jaclyn Alcantara, Comment, *The Impact of Implicit Bias on Female Patent Applicants in an Age of Increasingly Vague Patent Standards*, 88 UMKCL. REV. 161, 170 (2018).

¹⁹² It is possible that the interaction between the attorney and the inventor during the patent process will be affected by race and gender biases.

¹⁹³ Kyle Jensen et al., *Gender Differences in Obtaining and Maintaining Patent Rights*, 36 NATURE BIOTECHNOLOGY 307, 309 (2018).

D. *External Society*

The pursuit of higher education—and pursuing markers of success in higher education—can be daunting. For many, at least some of the financial, geographical, linguistic, socioeconomic, cultural, racial, and gender barriers can prevent people from pursuing higher education at all. Even when people impacted by these barriers enter the upper echelons of academia, the barriers may increase “imposter phenomenon”¹⁹⁴ and can negatively impact a person’s confidence when pursuing a patent. This confidence gap stems from a feeling of “being the only-one”¹⁹⁵—therefore, it is important to consider a person’s journey to achieve full professor status in STEM in order to understand potential contributions to and ramifications of this confidence gap.¹⁹⁶

The racial and gender gaps surrounding higher education in the United States have certainly improved since the years of Harvard College’s establishment in 1636.¹⁹⁷ In the seventeenth century, with very few exceptions, only a privileged white man could hope to obtain a college degree in the United States.¹⁹⁸ Numerous scholars, including Catherine Brewer, Yung Wing, and Alexander Lucius Twilight, broke down educational barriers and forged a path to allow scholars to study at universities, regardless of race or gender.¹⁹⁹

The diversity gaps in college admissions still present today increase at each level of higher education—where the gaps are smaller in college, and increase in graduate school, and in faculty hiring practices at universities.²⁰⁰ College graduation rates

¹⁹⁴ Devasmita Chakraverty, *The Impostor Phenomenon Among Black Doctoral and Postdoctoral Scholars in STEM*, 15 INT’L J. DOCTORAL STUD. 433, 443–44 (2020).

¹⁹⁵ *Id.* at 442.

¹⁹⁶ See generally Naomi Oreskes, *Racism and Sexism in Science Haven’t Disappeared*, SCI. AM. (Oct. 1, 2020), <https://www.scientificamerican.com/article/racism-and-sexism-in-science-havent-disappeared/> (last visited Jan. 29, 2022) (“The history of science is rife with well-documented cases of misogyny, prejudice and bias. For centuries biologists promoted false theories of female inferiority, and scientific institutions typically barred women’s participation. . . . Racial bias has been at least as pernicious as gender bias . . .”).

¹⁹⁷ Genevieve Carlton, *A History of Women in Higher Education*, BESTCOLLEGES (Mar. 15, 2021), <https://www.bestcolleges.com/blog/history-women-higher-education/> [https://perma.cc/BY75-NZ5P].

¹⁹⁸ *Id.*

¹⁹⁹ See *Catherine Brewer Benson*, WESLEYAN COLL., <https://www.wesleyancollege.edu/academics/Commencement/catherine-brewer-benson.cfm> [https://perma.cc/V9FL-QLLM]; *Yung Wing*, YALE MACMILLAN CTR.: COUNCIL ON EAST ASIAN STUD., <https://ceas.yale.edu/yung-wing> [https://perma.cc/7QJA-8FCF]; Kari J. Winter, *Alexander Twilight (1795-1857)*, BLACKPAST (Jan. 17, 2007), <https://www.blackpast.org/african-american-history/twilight-alexander-1795-1857/> [https://perma.cc/95PG-Z2FX].

²⁰⁰ See CJ Libassi, *The Neglected College Race Gap: Racial Disparities Among College Completers*, CTR. FOR AM. PROGRESS 1, 1 (May 23, 2018), <https://cdn.americanprogress.org/>

are not on par with admission rates.²⁰¹ Black students and Hispanic students are less likely to complete their degrees than their white and Asian peers.²⁰²

In 2019, white students earned 59.1% of all undergraduate degrees earned in the United States.²⁰³ Comparatively, Black students earned 9.8% and Hispanic students earned 14.2% of all undergraduate degrees in that same year.²⁰⁴ From 2015 to 2016, Black and Hispanic students represented 15.2% and 19.8% of the undergraduate enrollment population, respectively.²⁰⁵ Although the rate of Black and Hispanic people earning advanced degrees has increased, the gap between Black and Hispanic people and their white peers still permeates and expands in higher education. In the 2018–2019 school year, white people earned 57.3% of all doctoral degrees earned in the United States.²⁰⁶ Comparatively, Black people earned 8.1% and Hispanic people earned 7.5% of all doctoral degrees earned in the United States.²⁰⁷ Faculty in 2018–2019 had an even larger gap, with white professors comprising approximately 80% of all professors in the United States and Black and Hispanic professors comprising 4% and 3% of the total professor population, respectively.²⁰⁸

When broken down by gender, the gap in undergraduate degrees is similar. In the 2018–2019 academic year, women

content/uploads/2018/05/22135501/CollegeCompletions-Brief1.pdf [https://perma.cc/5PMS-VAYH]; *Examining the Racial Gap in Graduate School Enrollments in the United States*, J. BLACKS HIGHER EDUC. (Oct. 14, 2019), https://www.jbhe.com/2019/10/examining-the-racial-gap-in-graduate-school-enrollments-in-the-united-states/ [https://perma.cc/EEY8-UCEM]; Emma Whitford, *Who Holds Professional Positions in Higher Ed, and Who Gets Paid?*, INSIDE HIGHER EDUC. (May 6, 2020), https://www.insidehighered.com/news/2020/05/06/report-details-gaps-women-and-minority-professionals-higher-ed [https://perma.cc/2LV3-W7WR].

²⁰¹ See Emily Tate, *Graduation Rates and Race*, INSIDE HIGHER EDUC. (Apr. 26, 2017), https://www.insidehighered.com/news/2017/04/26/college-completion-rates-vary-race-and-ethnicity-report-finds [https://perma.cc/D92R-HLBN].

²⁰² See DOUG SHAPIRO ET AL., NAT'L STUDENT CLEARINGHOUSE RSCH. CTR., SIGNATURE 12 SUPPLEMENT: COMPLETING COLLEGE: A NATIONAL VIEW OF STUDENT ATTAINMENT RATES BY RACE AND ETHNICITY—FALL 2010 COHORT, at 9–10 (2017), https://nscresearchcenter.org/wp-content/uploads/Signature12-RaceEthnicity.pdf [https://perma.cc/84PE-VF3W] (showing that 63.2% of Asian students complete their degrees in six years, compared to 62% of white students, 45.8% of Hispanic students, and 38% of Black students).

²⁰³ See Erin Duffin, *Bachelor's Degrees Earned in the United States by Ethnic Group 2018/19*, STATISTA (Feb. 23, 2021), https://www.statista.com/statistics/185302/number-of-bachelors-degrees-by-ethnic-group/ [https://perma.cc/5T8M-4WMY].

²⁰⁴ See *id.*

²⁰⁵ See LORELLE L. ESPINOSA ET AL., AM. COUNCIL ON EDUC., RACE AND ETHNICITY IN HIGHER EDUCATION: A STATUS REPORT 45 (2019), https://1xfsu31b52d33idlp13twtos-wpengine.netdna-ssl.com/wp-content/uploads/2019/02/Race-and-Ethnicity-in-Higher-Education.pdf [https://perma.cc/4X7L-H8SW].

²⁰⁶ *Id.*

²⁰⁷ *Id.*

²⁰⁸ BILL HUSSAR ET AL., NAT'L CTR. FOR EDUC. STATS., U.S. DEPT OF EDUC., NCES 2020-144, THE CONDITION OF EDUCATION 2020, at 150–51 (2020), https://nces.ed.gov/pubs2020/2020144.pdf [https://perma.cc/M8FY-82QR].

earned 57.4% of all undergraduate degrees earned in the United States, compared to the 42.6% earned by men.²⁰⁹ When reviewing graduate degrees, the gap shrinks. In the same year, women earned 54.3% of all doctoral degrees earned in the United States, compared to the 45.7% earned by men.²¹⁰ Although more women graduated with undergraduate and graduate degrees than their male peers, women only comprised approximately 33% of all full-time tenured professors in the United States in the 2018–2019 school year.²¹¹

The idea of climbing the metaphorical academic ladder can be formidable,²¹² especially for female, Black, and Hispanic students. Seeing peers whom they physically resemble withdraw from the academic ladder may reinforce a negative internalized message to students of color.²¹³ Women may also see the gap between doctoral representation and faculty representation as an insurmountable jump. Many women, even in 2021, are the first female full-time professors in their department.²¹⁴ These messages may subliminally tell female, Black, and Hispanic professors that their presence is not valued as much as white or Asian male presence, leading to potential imposter syndrome and lack of confidence in their scientific contributions.

As noted by several groups attempting to close the gaps for women and faculty of color, each educational rung has its own unique set of challenges that exacerbates gender and racial disparities.²¹⁵ These disparities may contribute both to presence on campus and the likelihood of pursuing a patent once at a

²⁰⁹ See Duffin, *supra* note 203.

²¹⁰ *Id.*

²¹¹ See HUSSAR ET AL., *supra* note 208, at 151.

²¹² Dolores E. Battle et al., *Climbing the Academic Ladder*, ASHA LEADER 1 (Aug. 3, 2004), <https://doi.org/10.1044/leader.FTR1.09142004.1> [<https://perma.cc/28FP-NQYA>].

²¹³ Ebony O. McGee & Lydia Bentley, *The Troubled Success of Black Women in STEM*, 35 COGNITION & INSTRUCTION 265, 267 (2017) (“A host of historical and contemporary practices have negatively affected Black students in STEM, including lack of a critical mass of STEM faculty of color; unwelcoming institutional climates, which often trigger psychological responses such as impostor syndrome . . . a lack of role models or mentors; and high numbers of Black peers dropping out of college STEM fields.”); see also Barbara T. Bowman et al., *Addressing the African American Achievement Gap: Three Leading Educators Issue a Call to Action*, 73 YOUNG CHILD. 14, 18, 20–21 (2018) (explaining that “children internalize their teachers’ evaluations of their potential, thus lowering their own (and often their parents’) expectations for achievement”).

²¹⁴ Kimberly A. Hamlin, *Why Are There so Few Women Full Professors?*, CHRON. HIGHER EDUC. (Mar. 30, 2021), <https://www.chronicle.com/article/why-we-need-more-women-full-professors> [<https://perma.cc/VS2G-NT5H>].

²¹⁵ Rebecca Sananes, *A Fight for Faculty of Color at Dartmouth and Beyond*, N.H. PUB. RADIO (May 24, 2016, 5:00 AM), <https://www.nhpr.org/post/fight-faculty-color-dartmouth-and-beyond> [<https://perma.cc/NN4F-NVSL>]; Yuliya K., *MIT’s Fight Against Gender Discrimination in STEM*, MIT ADMISSIONS (Jan. 6, 2017), <https://mitadmissions.org/blogs/entry/mits-fight-against-gender-discrimination-in-stem/> [<https://perma.cc/KD3F-FAJF>].

university. I hypothesize that these challenges can not only exacerbate imposter syndrome and lack of confidence, but can also contribute to lower patenting rates because female, Black, and Hispanic professors have internalized a sense of being undervalued and struggle to assert their unique ideas in the collaborative space of patent pursuit.²¹⁶ This Section will address four main reasons for both underrepresentation generally and patent underrepresentation permeating the academic ladder: adverse childhood experiences, historic cultural experiences at university, poverty, and elitism.²¹⁷

Children who encounter an adverse childhood experience (ACE) are significantly more likely to carry these negative experiences with them throughout their lives.²¹⁸ The mental and physical consequences of ACEs, “ranging from abuse and neglect to living with an adult with a mental illness,” are a public health issue.²¹⁹ “Children of different races and ethnicities do not experience ACEs equally[, with] . . . 61 percent of [B]lack non-Hispanic children . . . experienc[ing] at least one ACE, compared with 40 percent of white non-Hispanic children.”²²⁰ These psychological traumas can result in increased propensity for “alcoholism, drug abuse, depression, suicide, poor physical health, and obesity” in addition to a general correlation with “lower educational attainment.”²²¹ Without strong mental health advocates, trauma associated with ACEs undoubtedly contributes to underrepresentation gaps in academia.²²² Furthermore, if mentors of color and female mentors are encountering these traumas in their mentees at a higher rate than their white and male peers, this could contribute to more time spent mentoring and less time spent researching.

²¹⁶ This is in addition to caregiving responsibilities and other unequal balances outside of universities. See, e.g., Gugliuzza & Rebouché, *supra* note 69, at 57 (explaining that “[w]omen (and especially women of color) already pay what has been called an ‘inclusion tax’: ‘time, money, and mental and emotional energy’ they expend ‘to gain entry to and acceptance [in] traditionally white and male institutional spaces’” (quoting Tsedale M. Melaku, *Why Women and People of Color Still Hear “You Don’t Look Like a Lawyer,”* HARV. BUS. REV. (Aug. 7, 2019), <https://hbr.org/2019/08/why-women-and-people-of-color-in-law-still-hear-you-dont-look-like-a-lawyer> [<https://perma.cc/Z5BX-QMVA>])).

²¹⁷ Mary V. Alfred et al., *Advancing Women of Color in STEM: An Imperative for U.S. Global Competitiveness*, ADVANCES IN DEVELOPING HUM. RES. 114, 122 (2019).

²¹⁸ Vanessa Sacks & David Murphey, *The Prevalence of Adverse Childhood Experiences, Nationally, by State, and by Race or Ethnicity*, CHILDTRENDS (Feb. 12, 2018), <https://www.childtrends.org/publications/prevalence-adverse-childhood-experiences-nationally-state-race-ethnicity> [<https://perma.cc/3BDJ-VS52>] (showing that, because of this structure, Black children are far more likely to encounter ACEs. Adults with several ACEs are more likely to face mental and physical health issues later in life than their peers with fewer or no ACEs).

²¹⁹ *Id.*

²²⁰ *Id.*

²²¹ *Id.*

²²² *Id.*

Furthermore, cultural experiences at university, especially for people of color and women, are often violent, sexist, and racist. Although many have fought to overcome these policies, the fact that university administrators have prevented Black students from graduating, expelled Black students after a white mob attacked them, and have expressly allowed police officers to open fire on students cannot be erased.²²³ Almost one in four women experienced unwanted sexual contact on campus in 2015.²²⁴ Not only may the knowledge of historical violence dissuade a student from pursuing higher education, but the knowledge that this violence has not been eradicated may impact sentiments of inclusion and value when on campus.

Poverty is yet another cultural barrier that exists before the college application process, affecting a student's likelihood of academic success. Poverty is not an isolated individual trait, but rather a collective struggle.²²⁵ Poverty translates to increased imposter syndrome, feelings of guilt and responsibility for those who enter higher education, and a different perspective regarding choices of majors and careers in college.²²⁶

This ties into a fourth cultural barrier for both women and underrepresented minorities in college: elitism. Elitism, and specifically white scholastic elitism, declares an "assumption of white educational and cultural supremacy."²²⁷ Internalizing these assumptions by subliminally believing that, for example, works by Black writers or female writers are unscholarly when compared to works by white male writers, may impact a person's entire academic trajectory.²²⁸ This can lead to self-doubt, poor mentorship decisions, and lack of assertiveness, "affecting the awarding of salaries, tenure, and promotions" throughout an academic career.²²⁹ If a person feels less confident in asserting ownership of their idea in a group, they could be less likely to contribute their ideas in that group setting. Further, because of this lack of assertiveness, these groups may be

²²³ Mariah Bohanon, *African American History: A Look Back at Early Student Activism*, INSIGHT INTO DIVERSITY (Dec. 19, 2019), <https://www.insightintodiversity.com/african-american-history-a-look-back-at-early-student-activism/> [https://perma.cc/7CSJ-FNWD].

²²⁴ CAMPUS TECH. ASSISTANCE & RES. PROJECT, ADDRESSING GENDER-BASED VIOLENCE ON COLLEGE CAMPUSES: GUIDE TO A COMPREHENSIVE MODEL 7, <http://changingourcampus.org/documents/FINAL-GBV-Comprehensive-Model-22117.pdf> [https://perma.cc/QPU7-2QDK].

²²⁵ Madeline St. Amour, *What Happens Before College Matters*, INSIDE HIGHER EDUC. (Oct. 20, 2020), <https://www.insidehighered.com/news/2020/10/20/black-students-need-changes-policies-and-structures-beyond-higher-education> [https://perma.cc/3XXG-3AF9].

²²⁶ *Id.*

²²⁷ Talmadge Anderson, *Black Encounter of Racism and Elitism in White Academe: A Critique of the System*, 18 J. BLACK STUD. 259, 268 (1988).

²²⁸ *Id.*

²²⁹ *Id.* at 269.

vulnerable to others' taking credit for their ideas. Therefore, any contribution to lack of assertiveness may lead to lower patent inventorship rates.

E. Solutions

Further research is necessary to determine how—if at all—any of these proposed reasons affect the patent gap. This article encourages universities to begin to track publication and patent inventorship rates by race and gender as a proxy to measure the efficacy of their antiracist and gender-neutrality programming in closing the evident patent gaps. By doing this research and displaying results, universities can take ownership for the results (or lack thereof) of their current actions and programs instead of hiding behind admission statistics alone. Universities can also use their results to promote collaboration between universities to reduce both representation gaps and equity gaps.

Before attempting to resort to antidiscrimination lawsuits prohibiting discrimination based on race, color, national origin, or gender to resolve the gap, it is important to recognize that universities are trying to increase representation of Black, Hispanic, and female participants in STEM.²³⁰ Faculty and students have fought within higher institutions to close the gender and ethnicity gaps in faculty hiring and the tenure process.²³¹ The National Science Foundation recently discussed methodologies to ensure that the “national STEM faculty

²³⁰ 42 U.S.C. § 1981 (prohibiting discrimination on the basis of race); 20 U.S.C. § 1681 (prohibiting discrimination on the basis of sex); *Diversity & Inclusion*, MIT LEADERS FOR GLOB. OPERATION, <https://lgo.mit.edu/lgo-student-life/diversity-inclusion/> [<https://perma.cc/U3BJ-3PEW>] (recognizing “MIT’s commitment to create a respectful learning environment” and “increase the representation of Black, African American, Hispanic, Latinx, Native American, Native Hawaiian, Alaska Native, and Pacific Islander students in global business and engineering education, and to ensure that all LGO program applicants, students, and graduates are provided an equal opportunity to succeed”); ANNEILA A. SARGENT, COMM. ON THE STATUS OF WOMEN FAC. AT CALTECH, FINAL REPORT 2 (2001) (noting that Caltech’s Faculty Board created the Committee on the Status of Women Faculty at Caltech “to examine issues of gender inequity and related concerns for professorial faculty at the institute”); *About Us*, CALTECH SOC’Y OF WOMEN ENG’RS, <https://swe.caltech.edu/about-us> [<https://perma.cc/WUZ9-CC95>] (highlighting the Caltech chapter of the Society of Women Engineers, which “aims to provide a support network to Caltech women” and “perform outreach activities for local girls . . . [to] increase interest in STEM among women”).

²³¹ See Flaherty, *supra* note 231; Pearl Stewart & Cmmadmin, *Achieving Diversity in STEM Faculty Requires Systemic Change*, *Says Report*, DIVERSE: ISSUES IN HIGHER EDUC. (Jul. 14, 2020), <https://diverseeducation.com/article/183117/> [<https://perma.cc/EZN6-VQBP>]; Alfred et al., *supra* note 217, at 126 (“The incorporation of women at all levels of an organization demonstrates structural changes in hiring, recruitment, and promotion within the corporation.”).

[reflects] the demographics of the students they are educating.”²³² University of Massachusetts Boston implemented a system to hire diverse scholars, resulting in “eight African Americans, four Latinx scholars, three Asian Americans, two Native Americans, and” three female professors in STEM out of twenty-three hires in 2020.²³³ Despite these efforts, Alena Allen, Tommy J. Curry, Dena Simmons, and many other faculty of color have recently left positions due to systemic racism plaguing their institutions.²³⁴

If universities are truly committed to this representation, they must use metrics not only to show that the population of certain groups at the university increased, but also that the groups are able to equitably participate in programs at their university.²³⁵ Relying on tokenism to prove commitment to change cannot result in sustainable equity because tokenism “leads to devaluing of ability” of that token member.²³⁶ Quantitatively demonstrating advantage gaps within an institution, rather than demonstrating presence at that institution, can reduce the reliance on tokenism.

Currently, schools are neither obligated nor volunteering to publish inventorship statistics by race and gender. Such a publication would allow researchers to quantify, rather than estimate, the current racial and gender patent gaps at universities. To show increased commitment to gender and racial equity in STEM, schools should publish the racial and gender representation on their patents, rather than hide behind a celebrated increase in diverse faculty hires or a new program partnership.²³⁷ Barring all universities voluntarily disclosing their patent participation rates, scholars should consider petitioning legislators to mandate these disclosures in the same

²³² JESSICA BENNETT ET AL., ASSOC. OF PUB. & LAND-GRANT UNIVS., STRENGTHENING PATHWAYS TO FACULTY CAREERS IN STEM: RECOMMENDATIONS FOR SYSTEMIC CHANGE TO SUPPORT UNDERREPRESENTED GROUPS 7 (2020), <https://www.aplu.org/library/strengthening-pathways-to-faculty-careers-in-stem-recommendations-for-systemic-change-to-support-underrepresented-groups/File> [<https://perma.cc/6S8Q-D8L8>].

²³³ Katherine Newman, *Incentivizing Faculty Diversity*, INSIDE HIGHER EDUC. (Jan. 20, 2020), <https://www.insidehighered.com/views/2020/01/20/how-one-university-has-diversified-its-faculty-opinion> [<https://perma.cc/M3G7-JM6J>].

²³⁴ See Flaherty, *supra* note 231.

²³⁵ Gugliuzza & Rebouché, *supra* note 69, at 7 (noting that “add diversity and stir” approaches have significant limits “when it comes to changing behavior in the place . . . where sexist and racist norms are, consciously or not, deeply embedded”).

²³⁶ Pamela Holland Obiomon et al., *Advancement of Women of Color in Science, Technology, Engineering, and Math (STEM) Disciplines* (Fac. Res. Network, Advancing Women and the Underrepresented in the Academy, A National Symposium, Nov. 16–17, 2007), <https://bit.ly/3uihooW> [<https://perma.cc/EF2W-34ZK>].

²³⁷ See Juan Silezar, *Harvard Partners in National Alliance to Diversify STEM Postdocs and Faculty*, HARV. GAZETTE (Jan. 6, 2021), <https://news.harvard.edu/gazette/story/2021/01/harvard-a-partner-in-national-effort-to-diversify-stem-and-academia/> [<https://perma.cc/Q5FA-NUXD>].

way the law currently mandates reporting of hiring, admissions, and salary statistics.

Disclosure of patent inventorship statistics may serve as a proxy for demonstrating active participation in STEM and valuation of faculty at that university, providing a foil to schools attempting to hire a diverse group of faculty and then not affording them equal access to university resources. This access gap is likely not intentional but is evident in the quantified data, nonetheless. Expanding mandatory reporting to include quantified demographics for participation in federally-sponsored programs and research—rather than simply mandating reporting of hiring and salary statistics—can help to track the current racial and gender participation gaps existing at the university and the overall trend of this gap. That is, the tracking can show whether schools are actively closing racial and gender gaps at the university.

Forcing universities to confront racial and gender gaps after hiring may prompt universities to pursue further action in resolving the evident systemic gender and racial inequities demonstrated both qualitatively and quantitatively.²³⁸ Universities may cease broadcasting their restorative justice theater by showing, *quantitatively*, that their programs are closing gender and racial gaps at universities both during the admissions process and during their time on campus.²³⁹ Mandating reporting of racial and gender parity through data, rather than qualitative assertions, helps to ensure that the university is attempting to comply with federal law prohibiting discrimination on the basis of race and gender.

This mandate could either be applied through legislation or social pressure.²⁴⁰ Although litigation is often used as “a [t]ool

²³⁸ See Katherine Riley et al., *Race and Gender Differences in How Sense of Belonging Influences Decisions to Major in STEM*, 5 INT'L J. STEM EDUC. 1, 10 (2018).

²³⁹ Aditi Das, *From the Margins to the Mainstream? A Comparative Case Study of Restorative Justice Implementation and Integration Within Public Schools 220* (Aug. 2017) (Ph.D. dissertation, University of Chicago) (on file with the School of Social Service Administration, University of Chicago) (citing GERRY JOHNSTONE, *RESTORATIVE JUSTICE: IDEAS, VALUES, DEBATES* (Routledge 2d ed. 2002) (2001)).

²⁴⁰ Legislation rarely becomes law without at least some degree of social pressure. Legislation requiring schools to collect and disclose demographic inventorship data in the same way they collect and disclose population data may help to reduce the racial and gender inventorship gaps. See *FAQs—Race and Ethnicity Collection and Reporting*, CAL. DEPT OF EDUC. (Feb. 9, 2021), <https://www.cde.ca.gov/ds/dc/es/refaq.asp> [<https://perma.cc/R5BA-RKUK>] (showing that schools are required to report race and ethnicity data for accountability reports). Reporting this data will make analytics easier and allow tracking of university progress in patent inventorship representation. I also caution that celebrating this reporting without verification may lead to “tokenism,” where inventors are improperly added to patents to bolster inventorship optics. I do not

[f]or [s]ocial [c]hange,” the lack of systemic discrimination caselaw in this area suggests social pressure may be a more effective tool to close the patent gaps through quantitative analysis and reporting.²⁴¹ Universities may be initially resistant to displaying their racial and gender patent inventorship data, but by showing that Ivy League schools, research institutions, other HRSs, and even HBCUs may have inequitable representation based on their campus populations, these universities may feel less abashed by their own results. Social pressure could encourage the universities to disseminate more data regarding patent inventorship by labeling the current data primarily as a baseline for improvement, rather than a source of shame for the university.

Universities, sociologists, economists, and other social scientists and statisticians could apply the collected data to determine which programs at universities are effectively combatting racial and gender discrimination. Researchers and activists could use this data in tandem with the studies already published by the USPTO, the Patent Diversity Project, and bills, such as the IDEA Act to catalyze quantifiable change in patent representation in the United States.²⁴² Legally, universities receiving federal financial assistance are required to timely and accurately complete all IPEDS surveys, which help provide evidentiary support for any claims of discrimination regarding admissions, hiring practices, and salaries at those universities.²⁴³ Reporting this information on IPEDS surveys could help researchers better understand these results and determine reasons for the currently quantified gender and racial gaps.

wish to expand on potential legislation other than reporting requirements until my qualitative analysis about reasons for the racial and gender patent gaps is complete.

²⁴¹ Beth Van Schaack, *With All Deliberate Speed: Civil Human Rights Litigation as a Tool for Social Change*, 57 VAND. L. REV. 2305, 2305, 2341 (2004).

²⁴² *Progress and Potential: 2020 Update on U.S. Women Inventor-Patentees*, U.S. PAT. & TRADEMARK OFF. (Sept. 4, 2020), <https://www.uspto.gov/ip-policy/economic-research/publications/reports/progress-potential> [<https://perma.cc/M8EL-L98X>]; Erin Meyer & Na Hye Kim, *Patent Diversity Project: Addressing Racial and Gender Disparities in the U.S. Patent System*, JD SUPRA (Mar. 23, 2021), <https://www.jdsupra.com/legalnews/patent-diversity-project-addressing-2070099/> [<https://perma.cc/V28X-6YAU>]; Tamara Fraizer, *What a Great IDEA! Collecting Data on the Diversity of Patent Inventors*, NAT'L L. REV. (Mar. 12, 2021), <https://www.natlawreview.com/article/what-great-idea-collecting-data-diversity-patent-inventors> [<https://perma.cc/9H9Q-RDFY>] (noting that the Inventor Diversity for Economic Advancement Act of 2021 (IDEA Act) empowers the USPTO to collect demographic data on patent applicants).

²⁴³ *Statutory Requirements for Reporting IPEDS Data*, NAT'L CTR. FOR EDUC. STATS., <https://surveys.nces.ed.gov/ipeds/public/statutory-requirement> [<https://perma.cc/BB72-P8CG>] (“The completion of all IPEDS surveys, in a timely and accurate manner, is mandatory for all institutions that participate in or are applicants for participation in any Federal financial assistance program authorized by Title IV of the Higher Education Act (HEA) of 1965, as amended.”); see also Complaint at ¶ 24, *United States v. Yale Univ.*, No. 3:20-cv-01534 (D. Conn. Oct. 8, 2020).

Data regarding patent representation are only one source of potentially useful quantitative data. Universities could also track mentorship burdens, committee requirements, and other nonresearch activities not only as a potential tenure option, but also as a source of rebalancing burdens detracting from a professor's research schedule. Universities and social scientists could also track the data over time, using the produced data to highlight universities creating a more equitable mentorship and service-oriented environment while still allowing their faculty to access resources equitably. Social pressure could also lead other relevant entities, such as scientific publication entities, to track their authorship data to promote diversity.²⁴⁴ Tracking this data and highlighting successful projects to reduce the racial and gender equity gaps can lead to a more supportive and productive academic STEM community.

CONCLUSION

Universities can no longer use restorative justice theater as a substitute for measurable, quantitative change. Black, Hispanic, and female faculty and students are not equitably represented on patents and simply hiring more faculty of color or more female faculty will not fully close the representation gap. Male full-time STEM professors are over 4 times more likely to be patent inventors than their female peers in research universities. White STEM professors are anywhere from 18 to 27 times more likely to be named on a patent than their Black and Hispanic peers at research universities. Although increasing Black representation helps to lessen the size of the race gap, the act of hiring or admitting more Black people did not come close to erasing the gap—even at HBCUs. Universities must take swift and efficient action to close these gaps and should quantify the effectiveness of those efforts to help others implement the best solutions.

Early education, industry hiring, and socioeconomic barriers all contribute to the gender and racial patent gaps evident in this study. This does not mean universities can shift blame onto these other contributing institutions. By quantifying the racial and gender patent gaps through a weighted comparison of university demographics and inventorship demographics on patents assigned to the university, the data

²⁴⁴ Katherine J. Wu, *Scientific Journals Commit to Diversity but Lack the Data*, N.Y. TIMES (Nov. 2, 2020), <https://www.nytimes.com/2020/10/30/science/diversity-science-journals.html> [<https://perma.cc/QC69-5WRX>].

demonstrate that universities do not create an environment where students and faculty inventors can expect to succeed on their merits alone. Universities have the means and political clout to close these gaps, if, and only if, they combine their resources with quantifiable data to show that their methods are effective. If universities refuse to voluntarily record and publish this data, either external social pressure or legislative action should be used to hold universities accountable for the unequal environment shrouded by promises of reform. With the current estimations of underrepresentation gaps, universities should use equity metrics to quantify the successes in their programs for practical academic equity.