THE HAMILTON PROJECT

POLICY PROPOSAL 2020-11 | AUGUST 2020

Policies to Broaden Participation in the Innovation Process

Lisa D. Cook

MISSION STATEMENT

The Hamilton Project seeks to advance America's promise of opportunity, prosperity, and growth.

We believe that today's increasingly competitive global economy demands public policy ideas commensurate with the challenges of the 21st Century. The Project's economic strategy reflects a judgment that long-term prosperity is best achieved by fostering economic growth and broad participation in that growth, by enhancing individual economic security, and by embracing a role for effective government in making needed public investments.

Our strategy calls for combining public investment, a secure social safety net, and fiscal discipline. In that framework, the Project puts forward innovative proposals from leading economic thinkers — based on credible evidence and experience, not ideology or doctrine — to introduce new and effective policy options into the national debate.

The Project is named after Alexander Hamilton, the nation's first Treasury Secretary, who laid the foundation for the modern American economy. Hamilton stood for sound fiscal policy, believed that broad-based opportunity for advancement would drive American economic growth, and recognized that "prudent aids and encouragements on the part of government" are necessary to enhance and guide market forces. The guiding principles of the Project remain consistent with these views.

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AUGUST 2020

This policy proposal is a proposal from the author(s). As emphasized in The Hamilton Project's original strategy paper, the Project was designed in part to provide a forum for leading thinkers across the nation to put forward innovative and potentially important economic policy ideas that share the Project's broad goals of promoting economic growth, broad-based participation in growth, and economic security. The author(s) are invited to express their own ideas in policy papers, whether or not the Project's staff or advisory council agrees with the specific proposals. This policy paper is offered in that spirit.

BROOKINGS

Abstract

Since the 1960s, both women and underrepresented minorities have earned an increasing share of bachelor's degrees and advanced degrees in fields most associated with invention—the STEM (science, technology, engineering, and mathematics) fields. Yet, we do not observe a similar increase in patenting activity among these groups. Economists have identified multiple sources of gender and racial disparities in allocation of talent, including disparities with respect to the process of innovation. Whatever their source, gender and racial disparities exist at each stage of the innovation process—education and training, the practice of invention, and commercialization of invention—and can be costly to both productivity and the economy. The costs of misallocating talent in the economy are increasingly being identified and estimated in the economics literature. It is estimated that GDP per capita could be 0.6 percent to 4.4 percent higher with greater participation in the innovative process among women and minorities. These disparities can also lead to increased income and wealth inequality at each stage for those who would otherwise participate in the innovation economy. A range of approaches could help close these gaps, including policies aimed at further increasing the share of women and underrepresented minorities who are educators in STEM fields, bringing more people into the world of invention, and ensuring equal access to the tools and resources needed to drive innovation. The policies proposed here focus on improving data collection at the U.S. Patent and Trademark Office (USPTO) and measurement of potential innovation, making commercialization more inclusive using the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs housed at the Small Business Administration (SBA), and addressing issues related to workplace climate in the innovation economy.

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Introduction

Allowing people to pursue their talents and interests is essential to individual well-being, but it is also a crucial part of a market economy. U.S. laws and society have too often limited people from developing their potential, harming those individuals and the overall economy in the process. Policies that encourage more equal participation in the innovation economy for women and underrepresented minorities could boost growth and reduce inequality.

The costs of misallocating talent in the economy are increasingly being identified in the economics literature. Hsieh et al. (2019) analyze the gender and racial distribution for highly skilled occupations over the past 50 years. They show that the change in the occupational distribution since 1960 suggests that a substantial pool of innately talented women and African Americans in 1960 were not pursuing their comparative advantage, and that this misallocation of talent affects aggregate productivity in the economy. They find that one-quarter of growth in aggregate output from 1960 to 2010 can be explained by an improved allocation of talent. Other recent research finds that women's underrepresentation in engineering and in jobs involving development and design explains much of the patent gap between men and women, and that closing it could increase U.S. GDP per capita by 2.7 percent (Hunt et al. 2012). Using data from the National Science Foundation (NSF) Survey of Earned Doctorates, Cook and Yang (2017) estimate that GDP per capita could rise by 0.6 percent to 4.4 percent if more women and African Americans were included in the initial stages of the innovation process.

Whatever their source, gender and racial disparities exist at each stage of the innovation process—education and training, the practice of invention, and commercialization of invention—and can be costly to the economy. These disparities can also lead to increased income and wealth inequalities at each stage of the innovation process for those who would otherwise participate in the innovation economy. Reducing barriers to participation in the innovative process could affect productivity as well as both the level and the distribution of income.

Innovation, or the commercialization of invention, is both desirable and necessary in modern economies.[1] The benefits of the innovation economy, however, have not been evenly distributed. Despite numerous initiatives to train and cultivate innovators, women and African Americans continue to participate at each stage of the innovation process at lower rates than their counterparts. As a consequence, women and African Americans have not enjoyed their proportionate share of innovation's ample economic benefits.[2]

From a number of perspectives, innovation is a good thing. Economists have long recognized that the generation and implementation of ideas drives economic growth (Romer 1986).[3] Historians also have demonstrated the positive relationship between innovation, industrialization, and economic activity in studies of early American inventors and entrepreneurs and in the creation of the patent system (Khan and Sokoloff 1993; Mokyr 2005; Thomson 2009). Statisticians provide additional evidence of the innovation economy's importance to the nation: from 1960 to 2013, the number of workers in innovation jobs grew 3 percent annually, compared to 2 percent growth for the broader workforce.[4]

Since the 1960s both women and underrepresented minorities have obtained an increasing (though still not equal) share of bachelor's degrees and advanced degrees in fields most associated with invention—the STEM fields. Despite this progress, we do not observe a similar increase in patenting activity among these groups.[5] In general, women and African Americans remain underrepresented in the innovation economy. Today, both the lack of diversity in the venture capital industry and the paucity of women and African Americans who serve as executives and board members at high-tech companies receive regular attention (U.S. Equal Employment Opportunity Commission [U.S. EEOC] 2016; Wiener 2016).

This so-called innovation gap represents a lost opportunity and is a discriminatory drag on our economy. These distributional issues provide further evidence of the wide income and wealth gaps in the United States. In this paper, I propose three policies to close the innovation gap, particularly at the commercialization stage. First, I propose improving measurement of potential innovation by keeping systematic track of demographic data on inventors to document patenting and innovation among those who have been historically excluded from innovation. Second, I propose making commercialization more inclusive by enhancing the Small Business Administration's (SBA) programs focused on innovation in order to promote diversity and inclusion in these programs. Third, I propose addressing workplace climate to attract and retain women and underrepresented minorities in the places where innovation happens.

Background: Participation and the Innovation Economy

Fundamentally, economists and the public care about innovation because it is a critical factor in economic growth, wealth generation, and higher living standards. Innovation can substantially affect each component of economic growth—labor, capital, and total factor productivity; economists have used a number of approaches to measure and evaluate innovation and who is part of innovation in the economy.

Economists draw on a wide range of metrics to define and measure participation in the innovation economy. The NSF defines the innovation economy or the science and engineering (S&E) workforce in one of three ways: (1) by the part of the economy measured by workers in S&E occupations, (2) by the number of holders of S&E degrees, and (3) by the use of technical expertise on the job.[6] The NSF collects data on S&E students, graduates, and workers using a variety of surveys and sources, including the NSF Survey of Earned Doctorates and the National Center for Education Statistics Integrated Postsecondary Education Data System Completions Survey. Demographic data, such as gender, race, and ethnicity, are among the data collected. In addition to collecting data on fields of study, I have assembled NSF data on S&E doctoral degrees earned by women (1966 to 2018) and African Americans (1968 to 2019).

In addition to occupational and income metrics, we can measure the innovation gap in pink and black (i.e., the gap between women and men, and between African American and white Americans, respectively) via patent data. Data on patents, recorded and disseminated by the US Patent and Trademark Office (USPTO), are available from 1790 to the present and thus provide a relatively consistent historical metric.[7] Demographic data, such as gender, race, and ethnicity, are not explicitly recorded in patent data. However, my colleagues and I have developed sophisticated methods for inferring which historical and contemporary patents were granted to women and African Americans (Cook 2003; Cook and Kongcharoen 2010). Consistent with the time frame of available NSF education data, I focus on patent data from 1966 to 2014.

Economists measure innovation's contribution to the economy with increasing precision, and it is clear that innovation's importance is growing (Brynjolfsson and McAfee 2011; Oliner and Sichel 2000; Oliner, Sichel, and Stiroh 2007). In 2017, the NSF calculated that the innovation economy comprised roughly 7 million to 25 million workers (NSF 2020).[8] These innovation workers earn substantially more than the median income for all workers. In 2017, the median innovation worker earned $85,390, compared to $37,690 for all workers. Innovation economy jobs also are growing faster than in other sectors, and unemployment rates are lower in the innovation sector: in 2017 the unemployment rate for scientists and engineers was 2.7 percent compared to 3.1 percent for all college graduates and 4.9 percent for the United States overall (NSF 2020). Moreover, during the Great Recession (2007–09) when the U.S. workforce contracted, the innovation workforce was less affected by the overall economic contraction (NSF 2016). Amid that recession, the income gap between innovation workers and the general labor force also widened. In 2012, median innovation economy earnings were double those of other workers; by 2014 the median innovation worker was earning 2.3 times more than the general labor force (NSF 2014; NSF 2016). Thus, across a number of measures, the science-based innovation workforce provides a tremendous boost to the overall economy, with better pay and job security going to those who work in the innovation sector.

Within the innovation economy, however, both participation and salaries vary greatly by gender, race, and ethnicity. In what follows, I examine how the racial and gender gaps in the innovation economy are manifested throughout different stages of the innovation process. I provide longitudinal, quantitative evidence to outline the nature and scope of these gaps over time. I then complement this aggregate, statistical picture with historical and contemporary examples from individual female and African American innovators who were impacted by racial and gender discrimination during the innovation process. This analysis across different scales illuminates both the aggregate, macroeconomic impact and the intimate lived experience of the innovation gap in pink and black.

The Challenge: Participation Gaps throughout the Innovation Economy

An individual participates in the innovation economy by passing through three stages of the innovation process. First, innovation typically begins with formal education or training, such as an apprenticeship, in a chosen technical field, often but not exclusively in a STEM field. Second, workers in the innovation economy participate in actual invention in university or federal laboratories, corporate research facilities, government agencies, or less formal workspaces. Finally, innovation, or the commercialization of invention, occurs when an inventor sells or licenses her patent or launches a new start-up or business unit to profit directly from the development of the invention.

THE PREPARATION AND EDUCATION GAP

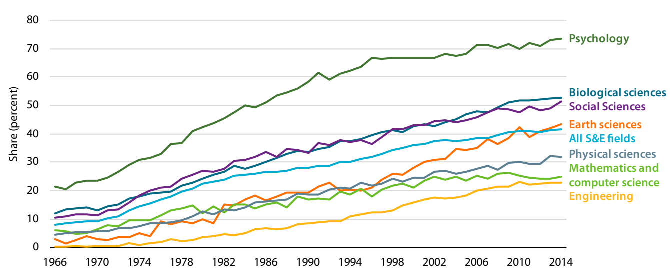
Women and African Americans have enjoyed significantly improved access to technical training over the past few decades, but a lingering education gap remains. Women and African Americans have increasingly been involved at the beginning of the innovative process—for example, by getting doctorates in the sciences and doing basic research that undergirds changes in the stock, flow, and direction of knowledge. Figures 1a and 1b report the share of women and African Americans earning doctorates in S&E fields. In 1970, only 9 percent of all doctorates in S&E fields were awarded to women. By 2014, the share going to women was nearly 42 percent. In 1970, only 1 percent of all S&E doctorates went to African Americans. By 2014, the share going to African Americans was roughly 4 percent (NSF 2017a). (For context, African Americans represent just over 13 percent of the population [U.S. Census Bureau 2019].) The trends are similar for master's and bachelor's degrees and are comparable through 2014.[9]

Increases among women and African Americans, however, have not been uniform across fields of study. Psychology starts off with the largest share of female S&E doctorate recipients in 1966 (22 percent) and finishes with the largest share in 2016 (75 percent) (NSF 2001; NSF 2017a). Apart from the field of psychology, women have traditionally received the highest share of doctoral degrees in the life sciences (over half of all degrees in biological sciences in 2016) and one of the lowest shares in engineering (24 percent in 2016). This is important because engineering is the field most closely associated with patenting. There is a large literature that examines why few women enter the field of engineering, and how and why those few leave (Seron et al. 2016). Similarly, among STEM fields, the highest share of African American doctorates was in psychology (8 percent in 2014) and the lowest was in engineering (2 percent in 2014).

African Americans have also traditionally earned the highest share of doctorates in the life sciences and the lowest share in the physical sciences. In the 2000s, apart from psychology and the social sciences, the share of doctoral degrees going to African Americans has hovered between 2 and 3 percent.

FIGURE 1A.

Share of S&E Doctorates Earned by Women, by Field, 1966–2014

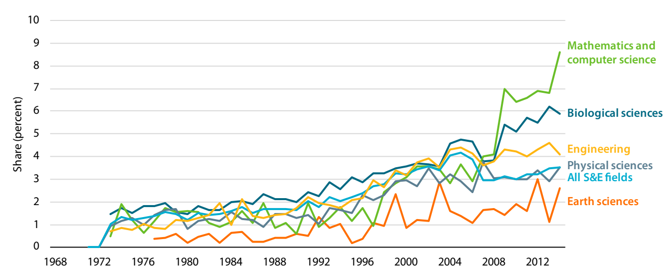


Source: National Science Foundation (NSF) 2017a; author's calculations.

Note: Earth sciences include atmospheric and ocean sciences; biological sciences include agricultural sciences.

FIGURE 1B.

Share of S&E Doctorates Earned by African Americans, by Field, 1968–2014



Source: National Science Foundation (NSF) 2017a; author's calculations

Note: Earth sciences include atmospheric and ocean sciences; biological sciences include agricultural sciences.

With respect to education and training, women and African Americans are participating in increasing numbers over time. For both groups a divide remains, however, and there is considerable heterogeneity of representation across fields. Examples of persistent barriers to women and African Americans pursuing degrees in STEM fields abound. Jennifer Selvidge, a former honors student in materials engineering at the Massachusetts Institute of Technology (MIT), captured the experiences of many women and African Americans. In her 2014 article, she reports that she was told "hundreds of times" that, as a woman, she did not deserve to be there and that metallurgy was a "man's field" (Selvidge 2014). She observed male professors attempting to publicly humiliate the small number of female professors, and she witnessed sexual harassment by teaching assistants. In addition to observing people of color being actively advised to change majors and leave the department, she was also subjected to a teaching assistant arguing that "black Americans are genetically inferior due to slavery era breeding practices" (Selvidge 2014). We will never fully realize our scientific potential and ever-higher economic growth and living standards without including more women, African Americans, and others who are being actively or passively discouraged from earning degrees in STEM fields and training for STEM careers.

THE INVENTION GAP

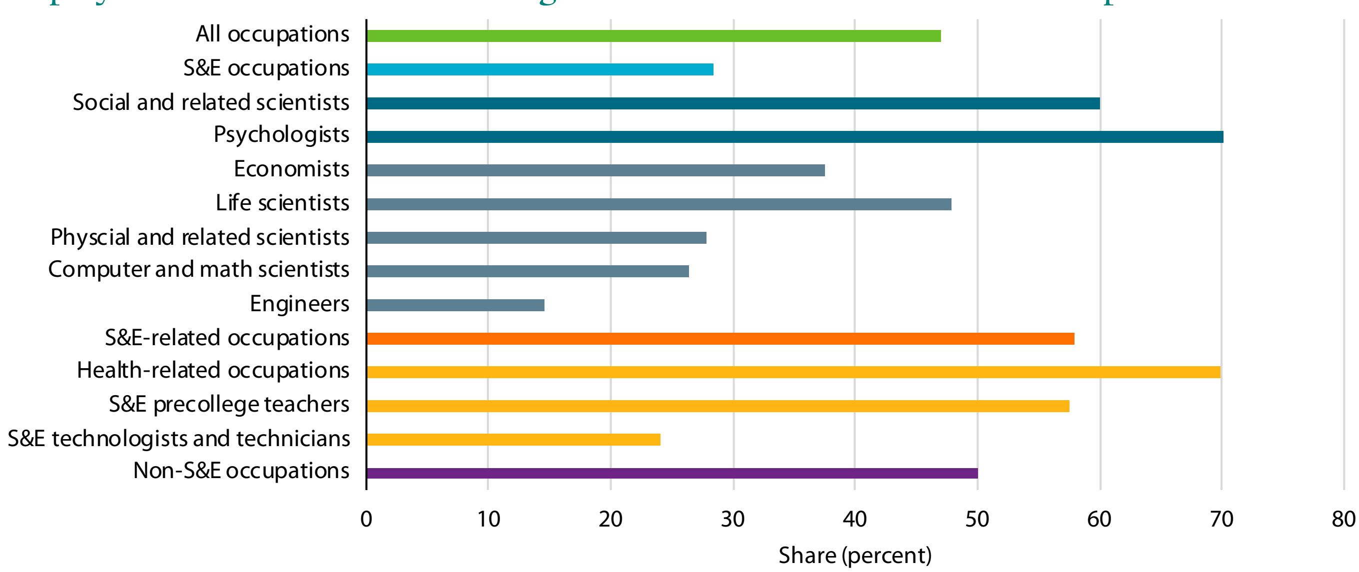
The second stage in participating in the innovation economy is to be involved in actual invention. Women and African Americans have also faced pervasive barriers to invention. For centuries, individual women and African Americans have had to battle the perception that they were mentally inferior and technically incompetent. Consequently, women and African Americans were not welcome in the white, male culture of the corporate research and development (R&D) labs. They were also barred from joining professional scientific and engineering societies until the mid-20th century, thus depriving them of the social capital and connections required to advance their careers and develop their inventions (Cook 2011; Oldenziel 1999; Sinclair 2004).

Contemporary measures of inventive activity among women and African Americans simultaneously reveal evidence of increased participation as well as lingering barriers to access. For example, women's participation in the invention stage has been increasing. Between 1993 and 2010, the share of women working in an S&E field rose from 31 percent to 37 percent. Over the same period, women in S&E occupations rose from 23 to 28 percent (NSF 2014). By 2017 women made up 29 percent of the S&E workers, and the percent of underrepresented minorities working in S&E had increased to 13 percent (NSF 2020).

Furthermore, both female and African American scientists and engineers are more likely to work in non-S&E occupations than in S&E occupations. Figures 2a and 2b report selected occupations for women and African Americans: for example, more than two-thirds of psychologists were women in 2015 (figure 2a). Women are less concentrated in the computer and mathematical sciences and engineering compared to men. In 2010, 25 percent of the workforce in computer and mathematical sciences were women, and in engineering, 13 percent were women; in 2017 these shares were 27 percent and 16 percent, respectively (NSF 2014; NSF 2017b).

FIGURE 2A.

Employed Female Scientists and Engineers as a Percent of Selected Occupations

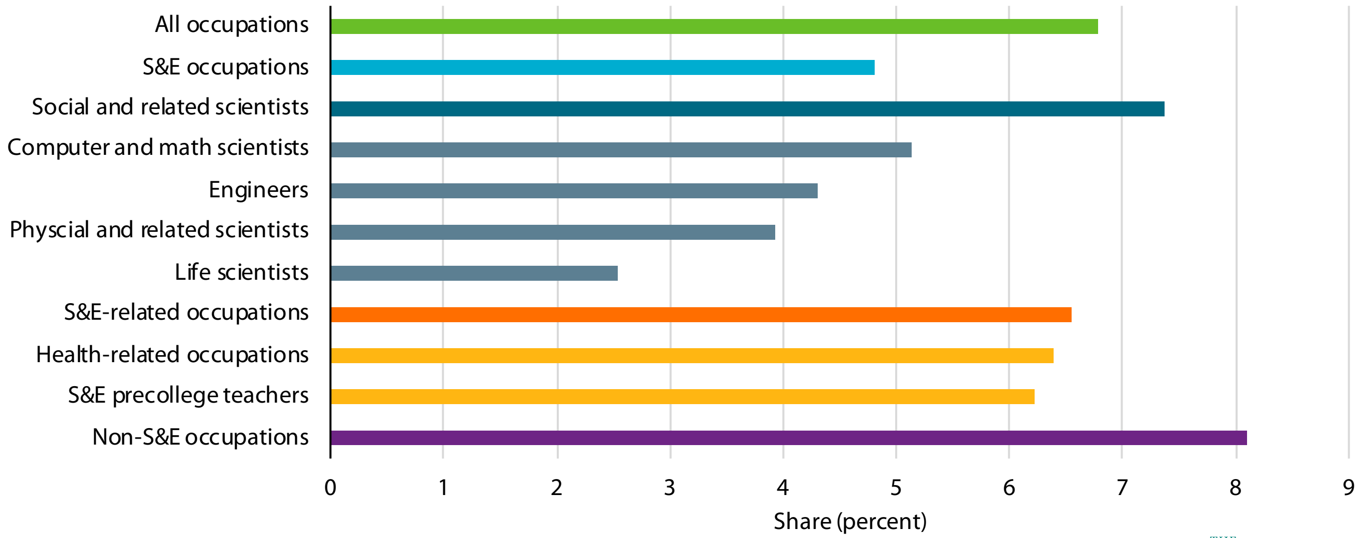


Source: National Science Foundation (NSF) 2017b; author's calculations.

Note: Data are for 2015.

FIGURE 2B.

Employed African American Scientists and Engineers as a Percent of Selected Occupations



Source: National Science Foundation (NSF) 2017b; author's calculations.
Note: Data are for 2015.

Rather than looking at the broad fields, we can more concretely examine specific occupations within a field. More than one-half the people in S&E-related occupations are women. Among them, women constitute 71 percent of workers in health-related occupations; more than one-half of S&E precollege teachers; more than one-half of technologists and technicians in the life sciences; and just one-fifth of S&E technologists and technicians.

Female scientists and engineers constitute half of scientists and engineers in non-S&E occupations. Women often start their careers working in the innovation economy but then leave for various reasons, including the need to provide child care and the lack of family-leave policies, and because of the workplace environment.[10] Such departures from the S&E economy have implications for earnings of these scientists and engineers. For one thing, women's wages will, on average, be lower outside the innovation economy relative to wages within it. Furthermore, those lower wages will exacerbate inequality that exists between the innovation and non-innovation economies.

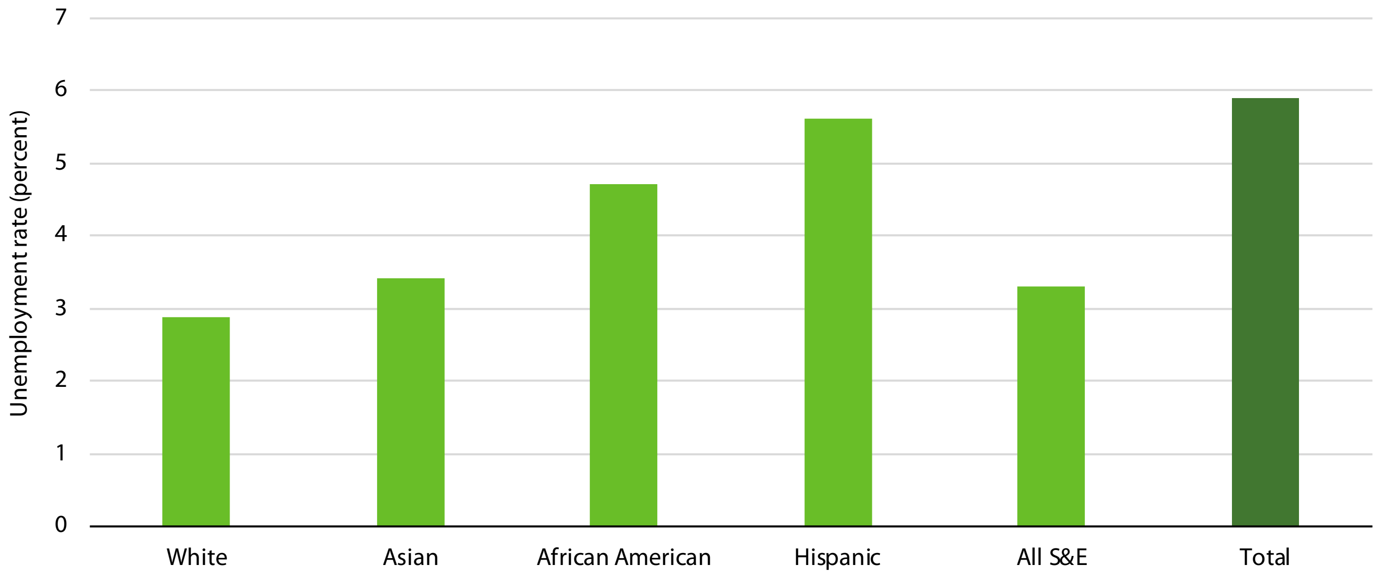
African American scientists and engineers make up just 4.8 percent of workers employed in S&E occupations. Among S&E occupations, African American scientists and engineers are more concentrated among social and related scientists and computer and math analysts than they are in other S&E occupations. Among S&E-related occupations, African American scientists and engineers, similar to the female scientists and engineers discussed above, are more concentrated in health-related occupations and in precollege teaching than in other S&E occupations. Almost twice as many African American scientists and engineers are in non-S&E occupations as are in S&E occupations.

While women and underrepresented minority scientists and engineers are growing as a share of the innovation labor force, unemployment rates vary significantly by racial and ethnic group (see figures 3 and 4). Unemployment for underrepresented minority men at just above 4 percent is higher than for white and Asian men and higher than the average for all scientists and engineers.[11] Although not illustrated below, the unemployment rate for African American women is higher than the unemployment rate overall, nearly double that of all scientists and engineers, and more than double that of white female scientists and engineers. Similar to the data on occupations, these data have implications for income inequality within the S&E economy. Unemployed scientists and engineers will likely be poorer and less able to accumulate wealth compared to their employed counterparts.

Figure 4 reports data on sectors of employment among scientists and engineers by race and ethnicity. Most scientists and engineers are employed in business or industry. For underrepresented minorities, the second and third sectors of employment are education and government. On average, government and education salaries are lower than those in business or industry, further deepening the income inequality among S&E workers. Most importantly, while many workers in government laboratories work hard at patenting, they have binding constraints relative to their private-sector peers and are less likely to commercialize their inventions. As will be discussed below, this can have even greater implications for wealth inequality.

FIGURE 3.

Unemployment Rates among Scientists and Engineers

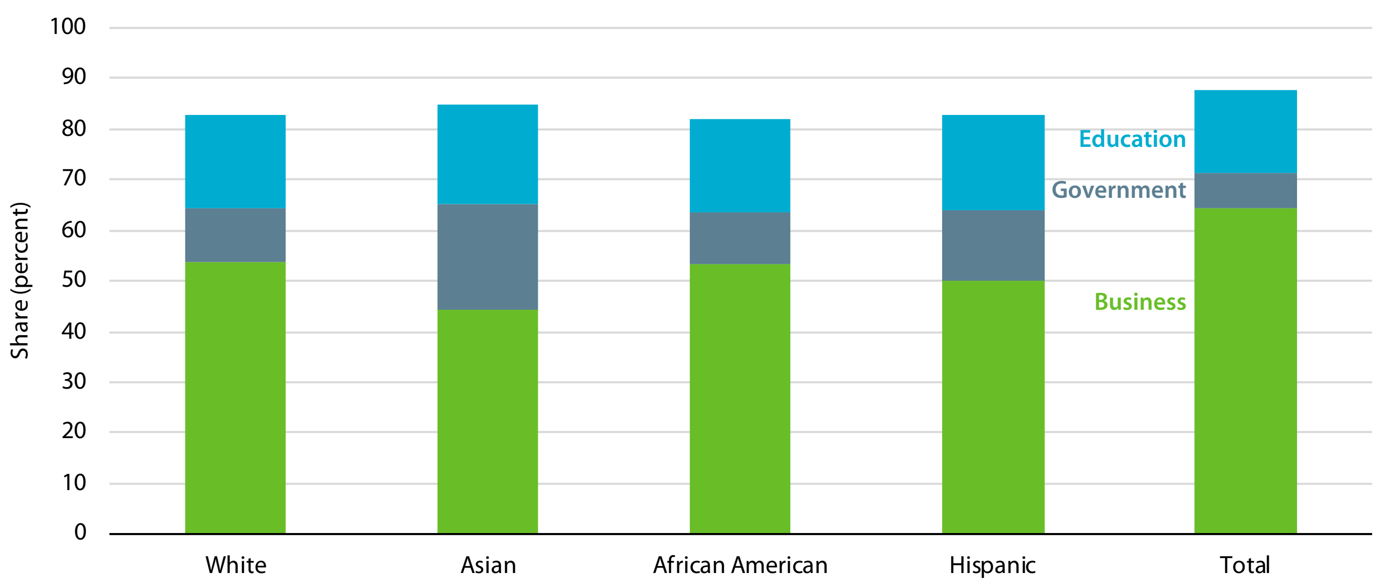


Source: National Science Foundation (NSF) 2017b; author's calculations.

Note: Data are for 2015.

FIGURE 4.

Employment Sector of Scientists and Engineers, by Race and Ethnicity



Source: National Science Foundation (NSF) 2017b; author's calculations.

Note: Data are for 2015. Bars do not sum to 100 because only selected sectors are shown. The difference between the top of the bars and 100 represents scientists and engineers that are not employed in business/industry, education, or government.

Just as incomes vary between the innovation economy and the rest of the economy, incomes also vary among those within the innovation economy. Among other things, they differ by gender and race. While the median salary for men in the innovation economy in 2010 was $80,000, it was only $53,000 for women, or 66 percent of the median male salary (NSF 2017b).[12] In 2017, the median salary for scientists and engineers was $90,000 for men, yet it was only $66,000 for women, or 73 percent of the median male salary (NSF 2019). Some of the gap is attributable to the different occupations people perform across race and gender, with more white men in S&E occupations, which tend to be higher paid. If considering only S&E occupations, the share of female-to-male median salary narrows to 81 percent and ranges from 77 percent for ages 29 and younger to 85 percent for ages 50 to 75. The share of female-to-male median salary is slightly higher in S&E-related occupations, 73 percent, and slightly lower for non-S&E occupations, 69 percent. "Mathematical scientist" is the only occupation in which the median female salary exceeds the male median salary, and the ratio of female to male median salary is 1.13 (NSF 2017b; author's calculations).

As mentioned earlier, the earnings or income gap between workers in the innovation economy and the overall economy is substantial. A worker in the innovation economy earned 63 percent more than the average American worker in 2014 (NSF 2016). To be sure, this divergence in income is consistent with and related to income inequality in the United States.

When comparing African American female scientists' and engineers' salaries to those of white women in all occupations, there is also a gap, and the share is 87 percent. There is salary parity in S&E occupations for African American and white women. Whereas the median salary for African American women in S&E-related occupations is also at parity with white women, the median salary for African American women in non-S&E occupations is 83 percent of the median salary for white women. The largest gaps within S&E occupations are among psychologists (83 percent) and computer scientists (87 percent). Among mathematical scientists, the ratio of the median salary of African American women to white women is 1.21 (NSF 2017b; author's calculations).

The gap between the median salary for African Americans and whites is not as large as it is between men and women. In 2010, the median salary for whites was $72,000, and for African Americans it was $56,000, or 78 percent of the median salary for whites.[13] In 2015, this share had moved only slightly to 79 percent. For S&E occupations, this share narrows to 92 percent. Among S&E occupations, the gap is widest among psychologists (65 percent) and physical scientists (67 percent). There is parity in engineering, and, like women, mathematical scientists' median salary for African Americans is higher than the median salary for whites, with a ratio of 1.13 (NSF 2017b; author's calculations).

In 2015, the share of median African American salary to white salary for S&E-related occupations was also 92 percent. As is the case for women, this share is lowest in non-S&E occupations, at 70 percent (NSF 2017b; author's calculations). With respect to employment and salary data, the gaps in participation that existed even seven years ago are closing. Yet gaps remain with respect to gender and race.

Legal access to the U.S. patent system offered greater, but still limited, opportunities for women and African Americans. There was no language in the original Patent Act of 1790 limiting patentees based on gender, race, age, or religion; thus, decades before emancipation and universal suffrage, women and (free) African Americans could, and did, invent and earn U.S. patents.[14] Still, women and African Americans did not have equal protection under the patent laws. While free African Americans were allowed to obtain patents, the Patent Office refused to grant patents to enslaved African Americans. Moreover, laws in many states assigned all marital property rights to husbands, and thus prohibited married women from owning or controlling patents in their own names. These draconian social norms and policies deterred many women and African Americans from even becoming inventors.[15]

Patent data provide another, albeit imperfect, means of measuring inventive activity.[16] In earlier research, my colleagues and I demonstrated that women and African Americans lag far behind other U.S. inventors with respect to patent activity. Using USPTO data from 1970 to 2006, we calculated that patent output for all U.S. inventors is 235 patents per million; for women, the number is 40 patents per million; for African Americans, it is 6 patents per million (Cook 2007; Cook 2014; Cook and Kongchareon 2010). Moreover, Bell et al. (2016) find that a propensity to patent is correlated with prior exposure to inventive activity and multigenerational income and wealth disparities. Children from high-income families who grow up around other inventors are more likely to patent, while children from low-income families with limited exposure to emerging technology are less likely to patent (Bell et al. 2016).

Taken together, these findings and others suggest a misallocation of resources that could lead to suboptimal levels and rates of economic growth that could persist across generations. For example, patent teams made up of both men and women are more productive than single-sex teams with respect to the most valuable patents. Patent teams, firms, and the economy will continue to perform at suboptimal levels without diverse teams and inclusion more generally (Cook and Kongchareon 2010).

The potential for discrimination to contribute to the invention gap was on public display in the summer and fall of 2017. A Google engineer, James Damore, wrote a memo that leaked and went viral. This memo, directed at diversity initiatives at Google, argued that women were underrepresented in technology careers because of "inherent psychological differences" between the genders (Cernovich 2017). Google dismissed Damore for "perpetuating gender stereotypes" (Bergen and Huet 2017). A few weeks later a former Google software engineer, Kelly Ellis, and two other women sued Google, alleging discrimination in both the pay and promotion of women. Coincidentally, the U.S. Department of Labor, in an ongoing investigation of Google's gender gap in salaries, reported its finding of systemic discrimination of women at Google in the spring of 2017 (Lam 2017).

Unequal salaries could depress women's interest in pursuing S&E degrees and careers, resulting in underrepresentation of women. The number of lawsuits against tech firms related to pay discrimination is increasing, which I discuss below. In addition, men who do not work on diversified teams could continue to believe negative stereotypes of women in tech. For example, Grace Hopper, having invented the COBOL language, was one of the greatest computer pioneers in the 20th century. Nonetheless, her name and contributions are still not as well known as those of her male contemporaries. Until publication of the book and release of the film *Hidden Figures,* most Americans were unaware of the significant contributions of women as human computers in the early days of computing; the individual and original contributions to NASA of the African American women in the film—Mary Jackson, Katherine Johnson, and Dorothy Vaughn; and the gender and racial disparities that have existed at the level of professional practice since NASA's inception.

THE INNOVATION GAP

The third and final stage in participating in the innovation economy is the commercialization of the invention. There is variation in different groups' participation in the development, production, and sale of an invention. Commercialization requires drawing on financial and social capital to introduce the invention into society. Historically, women and African Americans have had diminished access to these resources, and so have developed alternative strategies (Cook 2007).

The gap on the commercialization end of the spectrum was also in the public eye in 2012 when Ellen Pao sued her employer, the noted venture capital firm Kleiner Perkins Caufield and Byers, for gender bias in promotion. She argued that her performance, like that of other women and people of color, was negatively affected because the firm's partners did not sponsor her investments or include her in key decision-making and other activities of the firm. In Pao (2017), she also describes her experience as CEO of a social media technology company, Reddit, when she faced gender-related harassment and threats of violence.

Moreover, female and African Americans inventors once intentionally obscured their identities in order to counter discrimination and profit from their inventions. For example, Garrett Morgan, an African American inventor based in Cleveland at the turn of the 20th century, correctly surmised that white consumers would be skeptical of buying products from an African American inventor. So, Morgan hired white and Native American actors to portray him in order to sell his gas mask (Cook 2012). Discrimination also forced women and African Americans into bad deals or to forgo commercialization entirely. For example, in 1888 Ellen Eglin of Washington, DC sold her patented clothes wringer to a patent agent for a mere $18.00 rather than build a business around the patent. She believed that "if it was known that a negro woman patented the invention, white ladies would not buy the wringer" (Smith 1891).

Much has improved over the past century. Nonetheless, today's female and African American inventors continue to lag behind their counterparts with respect to commercialization. Contemporary inventors can generate income from an invention in at least three ways: (1) engage in entrepreneurship and start a new firm (or business unit) to develop, manufacture, and sell the invention; (2) assign (sell) the patented invention for a lump sum; and (3) license the patented invention to another manufacturer and collect royalties until the patent expires. Economists can access data on some of these approaches, but not others. Thus, I measure the innovation gap by focusing on data regarding entrepreneurship, firm ownership, patent assignments, and wealth accumulation from assets developed in the innovation economy.

Start-up data help elucidate how women and African Americans commercialize new inventions by engaging in entrepreneurship. Differential accumulation of proceeds from these entrepreneurial activities, assets, or wealth related to the innovation economy is striking. The wealth gap within and relative to the innovation economy is also related to wealth inequality in the United States. Commercialization, particularly entrepreneurship and equity ownership of tech firms, is the stage of the innovative process where the largest pecuniary gains are found. Those who own equity stakes in high-tech companies (e.g., angel and venture capital investors, founders, employees with stock options) stand to profit greatly from initial public offerings, mergers and acquisitions, stock splits, and other liquidity events.

Among the Forbes list of richest people in the world, 7 of the top 15 derive their wealth primarily from the innovation economy (Dolan 2017). The market capitalization of Amazon, Alphabet, Apple, and Microsoft is roughly $1 trillion to

$1.6 trillion, which is greater than the size of the economy (GDP) of a number of the richest countries, including Russia and Spain, and all of sub-Saharan Africa. Any recent example could demonstrate the type of large transactions that often occur. For example, the nine tech firms with initial public offerings in 2018 were valued at roughly $36 billion, and the most valuable one was valued at approximately $20 billion (Wilhelm 2017). Google recently purchased Motorola's 17,000 smartphone and wireless patents for $5.5 billion to launch Android and minimize the likelihood of infringement suits from competitors like Nokia and Apple. Patents are valuable assets, and, when sold, can bring substantial revenue to stockholders, in this case Motorola stockholders. They also provide legal protection and thus indirectly protect the equity investments of stockholders, in this case Google stockholders.

Women and African Americans are less likely to profit from the commercialization stage. This relationship is reinforced with another look at Forbes's 2020 list of the richest people in the world. Only one is a woman (Alice Walton), and none are African American. Ellen Pao's experience is instructive concerning the barriers that women face as venture capitalists and as CEOs of tech companies. Lonnie Johnson, inventor of the Super Soaker™ water gun who is African American, had to doggedly pursue Hasbro to receive the $72.9 million owed to him for his patented and trademarked invention. While his lawsuit was ultimately successful, most African American firms are small and do not have the legal and financial resources to aggressively protect their intellectual property.[17]

The innovation sector has relatively high incomes, considerable wealth, and substantial and growing political influence. If women and African Americans are disproportionately absent from the sector, however, they are deprived of their fair share of opportunity, wealth, and influence. Indeed, innovation inequality—and the resulting income and wealth inequality—fly in the face of the American ideals of equal opportunity, shared responsibility to achieve shared prosperity, and more and better technological advances to raise living standards for all.

This stage of the innovation process is also where women and underrepresented minorities are most scarce. For example, venture capital firms often seriously consider start-up proposals with patents pending. This is increasingly the case as patents become the preferred means of intellectual property rights protection. Given the gap in patent activity, it is reasonable to assume that the commercialization gap is wide from the start (Cook and Kongcharoen 2010).

In general, it is difficult to find women and African Americans among the ranks of entrepreneurs, (senior) management teams, and boards in the innovation economy. In 2014, less than 7 percent of U.S. venture capital investment was in businesses founded by women, and less than 1 percent was in businesses founded by African American women (National Venture Capital Association [NVCA] 2016). Moreover, founding teams that include a woman outperform their all-male peers by 63 percent, but female CEOs receive only 2.7 percent of all venture funding, while women of color get virtually none: 0.2 percent (Weisul 2016).

Women and African Americans are often found in legal and marketing departments but are largely missing in technical positions and among executives and boards. In 2014, *Fortune* ranked several large tech firms based on recently released demographic data. With respect to female executives, Indiegogo was ranked highest, with women constituting 43 percent of leadership roles. Cisco and Pinterest were ranked lowest, with 19 percent women in executive roles. Women constituted just 18.7 percent of directors of boards of S&P 500 firms in 2014, which was up from 16.3 percent in 2011 (Huddleston 2014). In 2015, just 11 percent of venture capitalists were women, and 2 percent were African American (NVCA 2016).

Among the reasons cited for little gender, racial, and ethnic diversity and inclusion are lack of mentors and social networks, implicit or explicit bias, and, to a lesser extent, the pipeline of potential entrepreneurs, executives, board members, and funders.[18] There is a large and growing literature that provides evidence that more-diverse teams produce better outcomes (Rock and Grant 2016). This further suggests that the homogeneity among venture capitalists might lead to suboptimal financing of projects, which is a bad outcome not only for female and African American founders and entrepreneurs, but also for the economy that depends on maximizing the arrival rate of new ideas that ultimately raise income and living standards.

Patent assignment is another simple measure of (potential) commercialization recorded in USPTO data. Patents are typically sold by independent or employee-inventors to entities such as corporations, government agencies, universities, and research institutions. In particular, as part of their employment contracts, corporate, university, and government employees who produce inventions on the job are contractually obligated to immediately assign their patents to their employers (usually for $1) once they are issued by the USPTO. The assignees (the buyers) might or might not choose to commercialize these inventions, so assignments are an admittedly imperfect proxy for commercialization.[19]

Economists have particularly good data on corporate and government patent assignments as a measure of the commercialization gap. In earlier research, I found that the likelihood of female inventors assigning a patent at issue to a public firm was 51 percent lower than men's odds; similarly, African American inventors' assignment odds were 46 percent lower than other U.S. inventors' odds (Cook and Kongchareon 2010).[20] In addition, the concentration of African American scientists and engineers in the government sector has implications for wealth accumulation and inequality. Because of historical practices prior to the Government Patent Policy Act (Bayh-Dole Act) encouraging the development of government patents, strict ethics policies, and likely risk aversion among employees of or contractors to government laboratories, commercialization is more difficult in the government sector, especially with respect to entrepreneurship, production, and ownership.[21] African Americans who begin assigning their patents to government entities, moreover, are more likely to continue to assign to government entities rather than to corporate entities, unlike their white co-inventor partners on the original government-assigned patents (Cook 2003).

Therefore, female and African American inventors are significantly less likely than their other inventor counterparts in the United States to obtain a patent and to commercialize it. The data confirm the commercialization gap: female and African American entrepreneurs are less likely to engage in entrepreneurship, to start a new firm, to receive funding for developing their ideas, and to profit from their patents. This drives a nontrivial wedge between those within the innovation economy and even more between those in the innovation economy and those external to it.

INNOVATION OUTCOMES AND INEQUALITY

Taken together, these findings from the innovation economy raise fundamental questions related to income inequality and wealth inequality. Indeed, skill-biased technological change should favor higher-skilled workers, but having these higher skills is not enough to reap the benefits predicted by economic theory. In the economics literature, evidence of both types of inequality is increasing. For example, income-tax data provides evidence that levels of income inequality are higher now than they were during the Gilded Age (Atkinson, Piketty, and Saez 2011; Piketty and Saez 2003). In just the period 1993 to 2011, real income growth was nearly 10 times higher for the top 1 percent than it was for the bottom 99 percent—57.5 percent compared to 5.8 percent (Saez 2013).

Why would economists and the public care about such distributional issues? First, with respect to well-being, individuals assess their incomes, or economic well-being, in relative rather than absolute terms. Large and sustained divergence in income can result in discontent and social unrest, which in turn could lead to lower growth rates.

Second, earners at the top might be able to increasingly influence the political process, which can also lead to social unrest. Groups of people not participating in the gains experienced in the innovation economy for prolonged periods may contribute to such divergence in income and wealth and to these undesirable outcomes.

The Proposal

How might the issue of participation or exclusion be addressed? How would one affect the innovation process at each stage or just one of the stages of innovation? And is there a role for policy?

To answer the last question first, yes. Policy can change the balance of who is able to participate in the innovation economy. This policy proposal focuses on who chooses to invent and patent and who commercializes those inventions and brings new ideas and products into the economy. Specifically, this proposal targets three areas: increasing the participation of women and underrepresented minorities (1) in the practice of invention (patenting), (2) in the federal government's flagship program for innovation (the Small Business Innovation Research [SBIR] and Small Business Technology Transfer [STTR] program), and (3) in the workplaces of the innovation economy by addressing issues related to climate.

MEASUREMENT OF POTENTIAL INNOVATION

The SUCCESS Act passed in 2018 and the companion IDEA Act, which is currently being considered, seek to measure participation by groups that are underrepresented in patenting in order to increase their participation in patenting, commercialization, and entrepreneurship. As was mentioned at the congressional hearings on the issue, both legislative proposals are based on my previous research on diversity in innovation, especially Cook and Kongchareon (2010). The IDEA Act directs USPTO to collect demographic data on USPTO applicants and to report annually on changes in the demographic composition of applicants over time.

Having an accurate picture of the composition of patentees will give policymakers guidance on where existing interventions, like USPTO's mentoring and outreach programs, might be most or least useful or effective and on where future interventions might be targeted. Based on my research on African American and women's names, my proposal is to support collecting these data directly using an external vendor, such as the Inter-university Consortium for Political and Social Research (ICPSR) or NORC at the University of Chicago, both of which will remain independent of USPTO and will de-identify the data and take other measures to ensure privacy.

Proposal Part 1: The IDEA Act should be passed by Congress. Demographic data on patentees should be collected annually by the USPTO at the time of patent application.

Congress would need to allocate additional funds for collection of these data and production of reports summarizing these data. Alternatively, these might be financed by USPTO fees.

MORE-INCLUSIVE COMMERCIALIZATION

The National Academies of Science just completed an extensive review of the premier program within the U.S. government to explicitly promote commercialization of innovation, the SBIR and STTR programs, which are housed with the SBA (National Academies of Sciences, Engineering, and Medicine 2020). While the report focused on the Department of Energy SBIR and STTR programs, the lessons and recommendations directed at the Department of Energy, the SBA, and Congress are largely applicable to any agency. The salient major recommendations relate to diversifying the applicant pool by expanding reviewer pools, optimizing matches between applicants and R&D partners, and implementing virtual mentoring programs to connect SBIR/STTR applicants to national labs. This proposal includes applying those recommendations from the report to the recruitment, application, and review processes.

Proposal Part 2: Increase the diversity of the applicant pool for flagship innovation programs by promoting increased diversity among the people who review applications for the programs.

Currently the people who serve as reviewers of applications for premier innovation programs are primarily white men, selected for their expertise that they have demonstrated by leadership, research management, and technical management positions at national labs or research universities. Women and underrepresented minorities historically hold a tiny fraction of these leadership and management positions and a tiny fraction of full professor positions at universities (National Laboratory Directors' Council 2020; National Center for Education Statistics 2019).[22] In engineering departments, for example, only 16 percent of the professors are women, 2.3 percent are African American, and 3.6 percent are Hispanic (Yoder 2016). A more-diverse reviewer pool might help to identify potential projects that reviewers have not traditionally identified as innovative in the same way that this has been executed at the National Institutes of Health. In order to reduce, or at least not increase, the service burden that underrepresented minorities often bear while serving as reviewers, all the agencies, departments, and national labs should provide incentives to people from these groups in the form of compensation, progress in metrics related to promotion, and so on.

Proposal Part 3: Increase the diversity of the applicant pool for flagship innovation programs by improving information about the pool of prospective R&D partners available, thus facilitating matches between applicants and R&D partners.

Women and underrepresented minorities are less likely to be in the same innovation, commercialization, and entrepreneurship networks than their white male counterparts. Information that would help find and connect applicants to research partners, which is often exchanged in these networks, would be critical for them to obtain for their applications to be successful. This information is likely to be more difficult for them to access through unofficial means, and making it more publicly available could disproportionately help them. For example, making historical data on research partners for previous awards public and searchable could be particularly helpful to applicants outside these networks. This would be a low-cost measure that government agencies could undertake that could have substantial impact.

Proposal Part 4: Increase the diversity of the applicant pool for premier innovation programs by introducing virtual mentoring programs to connect applicants with national labs, thus reducing the barrier caused by geographic distances.

In some cases, distances can be great between the national labs that provide R&D expertise and people from underrepresented areas of the country. As a result, potential applicants have little or no access to the connections and mentoring essential to find suitable R&D partners. These geographic distances can be a substantial barrier. A mentoring program that is virtual could be a cost-effective way to reduce such a barrier and could be designed specifically for women and underrepresented minorities. A model for this program would be the longstanding Mentor-Protégé Program, which fosters long-term business relationships between small disadvantaged firms and prime contractors.[23] The SBA, as well as various agencies, have this program. In addition, presentations, fairs, and other gatherings to promote the SBIR/STTR program could be extended to locations where there are already inventors from underrepresented minority groups, such as Atlanta and Austin.

WORKPLACE CLIMATE

Recently, and particularly following the Black Lives Matter protests in the summer of 2020, a number of developments have highlighted the problem of systemic racism and its manifestations in the innovation economy environment and workplace. First, with respect to venture capital, an important source of funding in the innovation economy, a recent CNBC study focused on the lack of African American founders of venture-backed companies, noting that only 1 percent of venture capital–funded start-ups are founded by African Americans and a mere 0.2 percent are founded by African American women. Start-ups with diverse executive teams yield a return two times greater than entirely white teams, meaning the lack of African American founders is an actual loss of potential economic growth. The CNBC report faults racial bias of nondiverse venture capital investors. Recent Bloomberg interviews with African American CEOs in Silicon Valley revealed a routine assumption that they were not in charge of their companies: there were constant challenges to their credentials, subtle and overt discrimination, and the regular suggestion that they hire a white business partner to put investors at ease (Anand and McBride 2020). Second, racial bias, rooted in systemic racism, manifests itself in other related ways in the innovation economy. The Department of Labor is suing Oracle for $400 million for pay discrimination against women and racial minorities. Google and Pinterest have similarly been sued for pay discrimination (Schwab 2020). Finally, workers from minoritized groups in the innovation economy have begun to speak more openly about their experiences that identify these firms as allowing or cultivating suboptimal or openly hostile workplaces. A number of these workers have spoken out on social media platforms.

Freada Kapor Klein, a venture capitalist and long-time advocate for diversity in technology companies, points out that while many technology companies claim they are addressing a lack of diversity in their workforce, they can do more (Harrison 2019). Among her suggestions are continued investment in diversity in hiring at all levels, retention initiatives, and making sure all employees value and prioritize a workforce that is diverse and inclusive. Recognizing unequal outcomes is the first step. Implementing policies and business plans that address these inequalities is essential for shared prosperity.[24] Separately, CNBC pledged to do its part with access to information, highlighting founders, innovators, and investors who help the business world move toward a more-diverse and more-inclusive future.

With respect to execution and accountability to change this climate that inhibits participation in the practice and commercialization of invention, there is a role for shareholders of and investors in all firms in the innovation economy, as well as the federal and state governments.

Shareholders and investors will need to set specific diversity targets and hold management accountable for those targets. One recommendation in this regard would be to expand California's Women on Boards law (which requires all publicly held corporations whose principal executive offices are located in California to have at least one woman director on their boards) nationally and extend it to include underrepresented minorities with oversight by the U.S. Securities and Exchange Commission (SEC).

Proposal Part 5: Extend California's Women on Boards law to all states and include similar targets for underrepresented racial and ethnic minorities.

Problems of workplace climate cannot be addressed substantially and systematically without counting workers at firms and organizations accurately. Firms in this sector often provide too little disaggregated data on the gender, racial, and ethnic composition of their work force. A role for the federal government would largely focus on reporting to the Department of Labor, the U.S. Equal Employment Opportunity Commission (EEOC), and, again, the SEC. While measures recently proposed by Jocelyn Frye, Senior Fellow at the Center for American Progress and former Deputy Assistant to President Obama and Director of Policy and Special Projects for First Lady Michelle Obama, are meant to combat racism and sexism in the workplace generally, they seem especially appropriate for combatting racism and sexism in the innovation economy (Frye 2019).

Proposal Part 6: Require public reporting of employer pay and promotion data by race and gender to provide greater transparency of employer pay practices (and could include detailed data on domestic and foreign composition).

Proposal Part 7: Require employer reporting of steps taken to address pay and promotion discrimination based on race, gender, ethnicity, and other factors in SEC filings, including eliminating forced arbitration in sexual harassment cases; implementing anti–African American and antisexist bias training for all levels of staff, especially leadership, managers, and supervisors; and increasing funding for enforcement to ensure compliance with equal pay protections and to undertake targeted efforts to examine the prevalence of race and gender bias in pay discrimination cases.

Questions and Concerns

1. What types of barriers could these proposals face?

Beyond funding, all three sets of proposals might encounter bureaucratic resistance. Congress will need to continually reaffirm its interest in raising living standards for all Americans by broadening participation through the implementation of all three sets of proposals.

2. Why focus on the innovation stage and not on education?

These proposals do not address the beginning of the innovation process—education and exposure to invention. Of course, greater STEM education and exposure to invention, such as Spark!Lab at the Lemelson Center for the Study of Invention and Innovation, could be encouraged. There is already a large literature on addressing the education gap in STEM, and government agencies, including the NSF, are working on the policy proposals emerging from this literature.

The racial wealth gap is most pronounced at the stage of commercialization of invention or innovation. Patented invention is often commercialized by the sale of the rights to an invention or creation of a business to manufacture and sell the invention. While entrepreneurship is a traditional path to the middle class and wealth in the United States, there is only one African American entrepreneur for every 50 white entrepreneurs. As aforementioned, African American founders receive only 1 percent of venture capital funding, and African American employees and senior managers at venture capitalist firms tech firms are largely nonexistent. Because addressing the racial wealth gap has become a policy priority among policymakers, the stages involving patenting and commercialization of the invention seem ripe for policy intervention.

Conclusion

Living standards among Americans could be higher if women and minorities participated more in the innovation process. Some of the starkest differences between these groups and their counterparts arise in the practice and commercialization of invention. The proposals put forward here would address each of these phases of the innovation process. Specifically, the proposals call for further tracking and reporting the participation of women, underrepresented minorities, and other groups in patenting; broadening participation in federal government programs that foster commercialization of invention (SBIR and STTR programs); and addressing systemic racism and other forms of discrimination in the places where commercialization of invention occurs to aid in increasing the innovation outcomes of women and minoritized groups and in raising living standards for all Americans.

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Acknowledgments

The author wishes to thank Jan Gerson for helpful comments and suggestions. All mistakes are her own.

Endnotes

1. This section of the paper draws heavily on Cook (2019).
2. To be sure, other forms of discrimination in the American innovation economy exist, including discrimination against various racial and ethnic groups, religious groups, and sexual orientations. This paper focuses exclusively on the underrepresentation of women and African Americans, however.
3. Prior to Romer, economists largely thought of innovation as an exogenous phenomenon that was generated outside of economic models. For example, see Solow (1957) and Griliches (1957).
4. This paper uses the terms "innovation economy," "innovation sector," and "science and engineering (S&E) economy," and "S&E workforce" interchangeably; and the terms "innovation jobs" and "S&E occupations" interchangeably.
5. Cook and Kongchareon (2010) includes a rich discussion of divergence in education outcomes and patenting and commercialization activity by female and African American inventors.
6. These are the three measures the NSF uses to define the S&E workforce.
7. This proposal focuses on utility (vs. design) patents, which constitute the largest category of issued patents. A utility patent is issued for any new and useful process, machine, manufacture, composition of matter, or any new and useful improvement thereof.
8. The definition varies based on the three ways NSF measures the S&E workforce: workers in S&E occupations, holders of S&E degrees, and use of S&E technical expertise on the job. In the United States in 2013, roughly 7 million college graduates were employed in S&E occupations, and roughly 25 million college graduates had a bachelor's or higher-level degree in an S&E field (NSF 2020).
9. While the focus of this section is on S&E doctorates, most commercialized inventions originate from those with bachelor's degrees and master's degrees (NSF 2001; NSF 2017a; NSF 2020).
10. A growing number of researchers are examining why women leave S&E occupations. For example, see NSF (2017b) and Pepitone (2011).
11. Underrepresented minorities include scientists and engineers who are African American, Hispanic, and American Indian or Alaska Native. While the disaggregated data are not available, the unemployment rates in the innovation economy for these groups are somewhat similar. Data on gender by race and ethnicity are reported in NSF (2017b), but the accompanying data do not allow this calculation to be made.
12. As is true for any salary data, differences will vary across occupations, age groups, race, ethnicity, and so on.
13. Salary data for 2010 are from NSF (2014) and are for full-time workers with the highest degree in an S&E field. If using the measure of S&E occupations, the median salary for men is 19 percent higher than the median salary for women. Salary data for 2015 are from NSF (2017b).
14. For example, in 1809 inventor Mary Kies was the first woman to receive a U.S. patent, for an improved method of weaving straw with silk thread to make hats. Similarly, Thomas L. Jennings was the first free person of color to receive a U.S. patent in 1821, for a dry-cleaning process. On Kies, see U.S. Patents Office (1888). On Jennings, see Sluby (2005). On the egalitarian nature of the U.S. patent system, see Khan (2005).
15. On discriminatory patent laws and policies, see Gage (1883), Baker (1902), Pursell (1981), Lubar (1991), and Sluby (2005).
16. For a variety of reasons, patent data is an imperfect proxy for measuring inventive activity. First, not all inventions are legally protected. Second, the mechanisms for legal protection vary widely, including patents, copyrights, trademarks, trade secrets, or some combination thereof. Finally, many patents are not economically viable; these include vanity patents, defensive patents (patents obtained but purposefully not developed to prevent a competitor from inventing in a complementary area), and inventions whose commercialization may be cost-prohibitive. On the methodological possibilities and limitations of using patent data, see Schmookler (1966), Griliches (1990), and Jaffe and Trajtenberg (2002).
17. See Black Enterprise's list of top 100 African American firms, which reports their size (Hill 2019).
18. For more information on gender bias, specifically implicit bias, please see Sanders and Ashcraft (2019).
19. On the appropriation of employees' patents, see Fisk (2009) and Mirowski (2011).
20. Odds are calculated relative to assignment to an individual.
21. Beyond the greater barriers to commercialization in the government sector relative to other sectors, there is also an issue of selection. Government jobs are often quite stable and government agencies have traditionally been risk averse; for example, see Gustetic (2019).
22. At the national laboratories, women comprise approximately 25 percent of senior leadership positions and 18 percent of research/technical management positions. Underrepresented minorities comprise about 8% of senior leadership positions and research/technical management positions (National Laboratory Directors' Council 2020).
23. For more information on the Mentor-Protégé Program, see Office of Small and Disadvantaged Business Utilization (2020).
24. A more comprehensive strategy to address shortcomings related to diversity and inclusion in the tech sector appear in the Klein et al. (2018).

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Highlights

Gender and racial disparities exist at each stage of the innovation process—education and training, the practice of invention, and commercialization of invention—and can be costly to the economy. This innovation gap represents a lost opportunity, a discriminatory drag on our economy. More broadly, the underrepresentation of women and African Americans in the innovation economy is a failure to deliver on the American ideals of equality and equal opportunity for all. A Hamilton Project proposal by Lisa Cook of Michigan State University offers several reforms to the U.S. innovation ecosystem that would promote a more inclusive and more dynamic innovation economy.

The Proposal

Improve data collection at the U.S. Patent and Trademark Office (USPTO) and enhance the measurement of potential innovation. To that end, Congress should pass the IDEA Act, and the USPTO should collect annual demographic data on patentees at the time of patent application.

Make commercialization more inclusive by using the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. National laboratories and research universities should also aim to increase the diversity of the applicant pool for flagship innovation programs by promoting increased diversity among application review boards; by improving access to information about the pool of prospective R&D partners available; and by introducing virtual mentoring programs to connect applicants with national labs, thus reducing the barrier caused by geographic distances.

Address issues related to workplace climate in the innovation economy. For example, the federal government should extend California's Women on Boards law to all states and include similar targets for underrepresented racial and ethnic minorities. Federal policymakers could also require employers to publicly report (e.g., in SEC filings) salary and promotion data by race, gender, ethnicity, and other factors.

Benefits

Policies that encourage more equal participation in the innovation economy will enable women and underrepresented minorities to more fully pursue their talents and interests. Reducing barriers to participation in the innovative process could also boost growth, affect aggregate productivity, and impact both the level and distribution of income. Some estimates suggest that GDP per capita could be 0.6% to 4.4% higher with greater participation in the innovative process among women and minorities.

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