

Race and Jobs at Risk of Being Automated in the Age of COVID-19

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Introduction

The COVID-19 pandemic has created an ongoing health and economic crisis. The contagious nature of the virus has necessitated physical distancing and led to an economic shutdown in early 2020. The resulting increases in unemployment have disproportionately impacted Black and Latino workers who are overrepresented in jobs that cannot be done remotely and in jobs considered to be frontline or essential, putting them at higher risk both of being laid off and of being exposed to the virus.

The pandemic is likely to accelerate the automation of jobs and the emergence of the network economy: a network of internet-connected people and devices, “as employers invest in technology to adapt the production process to safeguard against current and potential future pandemics” (Chernoff and Warman 2020; Carson 2020). Thus far, automation and “advancing technologies have mainly replaced the routine tasks of low-wage workers, while the incomes robots generate flow to wealthier capital owners” (Bloom and Prettner 2020). While the COVID-19 pandemic is likely to reinforce this trend in the near-term, automation will continue to have vastly different effects for various industries, educational institutions, and workers of different educational, income, and racial and ethnic backgrounds.

This analysis focuses on jobs at the highest and lowest risk of being automated, and on the acceleration of automation by the COVID-19 pandemic. We address the following questions: (1) Which occupations are most and least susceptible to automation in the next two decades? (2) How has the COVID-19 pandemic affected jobs that can be automated versus those that require in-person participation? (3) How will developments in automation affect Black and Hispanic communities and institutions? and (4) What interventions are necessary to prepare Black and Hispanic communities for jobs that are at a lower risk of being automated?

Advances in artificial intelligence and automation have contributed to achievement gaps in the workplace, with employers reporting a deficit of skilled workers to meet their needs (Danaher and Nyholm 2020; Grob-Zakhary and Hjarrand 2017). There are labor shortages in specialized sectors such that many American businesses are currently unable to find qualified workers to fill available jobs. Automation without strategic intervention will increase the skills gap, the wage gap, and economic inequality. Black and Hispanic communities will face unique challenges in labor transitions as a result of automation.

COVID-19 Is Expected to Accelerate Automation

There are three reasons why we expect the COVID-19 pandemic to accelerate the pace and scope of automation. First, recessionary periods often accelerate efficiency-enhancing changes in the economy, both as individual firms aim to reduce costs while retaining their productive capacity, and as resources are reallocated towards the most productive companies and industries (Blit 2020b). With decreased revenues, due to the pandemic and associated economic shutdown, many companies seeking to cut costs will transition from human workers to machines for automatable tasks (Nova 2020). As a result of the pandemic, many companies plan to invest more in automation than in rehiring workers in an effort to survive the recession (Joseph 2020). Furthermore, because consumers’ demand for goods and services has decreased, companies will be forced to cut costs by turning to less-expensive suppliers that use fewer workers (Williams 2020).

Second, though the Trump administration seized on the confluence of the United States–China trade war and stalled international travel to make the case to manufacturers to bring their business back to the United States to increase American jobs, a wave of factories returning to the United States has yet to occur (Swanson and Tankersley 2020). Furthermore, manufacturing no longer determines the conditions of the U.S. workforce, as fewer than one in ten Americans works in manufacturing compared to one in four in 1970. Companies that are choosing to expand U.S. manufacturing operations have factories that are heavily automated (Alden 2020).

Reshoring would increase labor demand and labor costs nationwide. Managers facing higher labor costs could be encouraged to increase automation rather than hire more American workers at higher labor costs (Feng 2020; Holzer 2019; Williams 2020). Social distancing and other health precautions have led many businesses to increase their investments in automating technologies; this is particularly true for those businesses engaged in food packaging, preparation, and service (Casey and Maciolek 2020).

Both advances in automation and the economic impact of the COVID-19 pandemic disproportionately affect Black and Latino workers. These workers are more likely to be employed in jobs that are at high risk of being automated in the next two decades and that cannot be done remotely. Of the five occupations that employ the highest number of Black and Latino workers, four have experienced the highest losses during the pandemic: retail salespersons, cashiers, cooks, and waiters and waitresses. Jobs in the clothing and accessories sector fell by 59 percent and jobs in furniture stores fell by 46 percent between February and April 2020 (Bureau of Labor Statistics [BLS] 2020c).

Automation and the Four Industrial Revolutions

Automation has been used in production and manufacturing at least since the 11th century, when workers used water wheels to power draining machines (Rothenberger 2020). The invention of the steam engine in 1698 led to the first industrial revolution, allowing production to be mechanized and driving socioeconomic change (de Pleijt, Nuvolari, and Weisdorf 2020; McGinnis 2020). The second industrial revolution involved the invention of electricity and other scientific advancements, which led to mass production. The third industrial revolution, which began in the 1950s, largely surrounded the introduction of computers and other digital technology.

The fourth and current industrial revolution entails the automation of job functions and the use of artificial intelligence (McGinnis 2020). A study by the McKinsey Global Institute (Manyika et al. 2017) estimated that accelerated automation could raise productivity growth significantly and replace half of today’s work activities by 2055.

Jobs Most and Least Susceptible to Automation

Research by McKinsey Digital (Chui, Manyika, and Miremadi 2015) suggests that “few occupations will be automated in their entirety in the near or medium term,” but that “certain activities are more likely to be automated.” One example in recent years is the redefinition of the cashier’s job with the advent of self-checkout. Hence, automation will necessitate education and training for workers whose jobs will be redefined.

While automation is taking the place of some occupations, offshoring has forced employment declines in other occupations. Employment in middle-skilled occupations (those that require specialization in routine labor tasks) has declined significantly in the United States in the past 30 years due to automation and offshoring (Mandelman 2017). Middle-skilled occupations typically consist of blue-collar manufacturing jobs associated with assembly and machine operation, and white-collar occupations that involve routine office and administrative duties such as bookkeepers, cashiers, and telephone operators (Bresnahan 1999). In both cases, these occupations focus on the execution of a daily routine that can be easily broken down into a set of smaller tasks that a computer could be programmed to complete (Mandelman 2017).

High-skill and what are often referred to as “low-skill” jobs—but are actually low-wage jobs that require optimizing time trade-offs, quality control, emotional intelligence and project skills (August 2019)—continue to be less susceptible

to automation. High-skill jobs can include highly skilled accountants and expert finance professionals who execute nonroutine cognitive tasks and thus are at less risk of automation because they generally require creativity, managerial skills, and flexibility, although this does not protect them from the risk of offshoring (Mandelman 2017). Low-wage jobs have been relatively sheltered from automation and offshoring for several reasons. Jobs in childcare and in nonmedical in-home care for the elderly require the skills needed to deal with unpredictable human behavior. Other low-wage jobs, including gardeners and construction laborers, require detailed manual handling and cannot yet be automated or sent offshore. In summary, low-wage and high-skilled jobs have a lower risk of automation relative to middle-skilled jobs.

Jobs at High Risk of Automation by Workers’ Race

Frey and Osborne (2017) used a Gaussian process classifier to examine the expected impacts of future computerization on U.S. labor market outcomes. Drawing from a workshop held at the Oxford University Engineering Sciences Department, they examined the automatability—the ability of a job task to be completed by a computer or computerized technology—of a range of tasks, associated with job descriptions for occupations and answering the question, “Can the tasks of this job be sufficiently specified, conditional on the availability of big data, to be performed by state-of-the-art computer-controlled equipment?” They ranked occupations according to their probability of computerization from lowest to highest. Frey and Osborne (2017) consider occupations with an automation probability of 70 to 99 percent at high risk. Automation probabilities are organized with a version of the Standard Occupational Classification, which has an overlapping but a slightly more detailed classification of occupations than the BLS Current Population Survey’s occupations racial data. Thus, for some subcategories of occupations we have data by automation risk, but for the larger occupational category we have data only by race. To remedy this issue, we applied the percentages by race of the larger occupational category to the subcategories. Furthermore, the BLS does not provide a racial breakdown for all occupations listed. Hence, our data set includes 220 occupations for which the BLS provides gender and race statistics and for which Frey and Osborne (2017) provide an automation risk score.

Table 1 shows the subset of the 30 jobs with the highest automation risk scores that employ the highest number of U.S. workers (more than 300,000 workers). These occupations employ 36.3 million American workers, and make up 23 percent of the white employed workforce, 24 percent of the Black employed workforce, 19 percent of the Asian employed workforce, and 30 percent of the Hispanic employed workforce. Compared to white workers, the data show that

TABLE 1.

The Subset of the 30 Jobs with the Highest Automation Risk Scores that Employ the Highest Number of U.S. Workers

	Total Number Employed	Total Percentage Employed	Percentage of White Workforce	Percentage of Black Workforce	Percentage of Asian Workforce	Percentage of Hispanic Workforce	Automation Risk Score (Percent)
Cashiers	3,164,000	2.01	1.79	2.92	2.26	2.75	97.00
Retail salespersons	3,105,000	1.97	2.00	1.99	1.36	2.09	92.00
Secretaries and administrative assistants	2,688,000	1.71	1.87	1.21	0.92	1.30	96.00
Laborers and freight, stock, and material movers	2,235,000	1.42	1.32	2.28	0.59	1.86	85.00
Construction laborers	2,051,000	1.30	1.43	0.91	0.32	3.45	88.00
Waiters and waitresses	2,038,000	1.29	1.26	1.17	1.51	1.72	94.00
Cooks	2,031,000	1.29	1.17	1.90	1.23	2.69	81.00
Accountants and auditors	1,964,000	1.25	1.24	0.86	2.30	0.63	94.00
Office clerks, general	1,355,000	0.86	0.82	0.95	1.14	1.02	96.00
Receptionists and information clerks	1,288,000	0.82	0.80	1.02	0.58	1.01	96.00
Sales representatives, wholesale and manufacturing	1,281,000	0.81	0.93	0.39	0.49	0.50	85.00
Grounds maintenance workers	1,273,000	0.81	0.89	0.54	0.11	2.00	95.00
Production workers, all other	1,141,000	0.72	0.69	0.95	0.64	1.01	92.00
Real estate brokers and sales agents	1,095,000	0.70	0.76	0.45	0.56	0.42	92.00
Food preparation workers	1,079,000	0.68	0.65	0.74	0.87	1.09	87.00
Bookkeeping, accounting, and auditing clerks	1,015,000	0.64	0.71	0.36	0.54	0.48	98.00
Miscellaneous agricultural workers	866,000	0.55	0.65	0.12	0.10	1.69	87.00
Inspectors, testers, sorters, samplers, and weighers	802,000	0.51	0.51	0.48	0.42	0.51	98.00
Taxi drivers and chauffeurs	790,000	0.50	0.36	1.20	1.01	0.67	89.00
Property, real estate, and community association managers	780,000	0.50	0.53	0.36	0.34	0.36	81.00
Insurance sales agents	595,000	0.38	0.39	0.31	0.33	0.29	92.00
Industrial truck and tractor operators	571,000	0.36	0.32	0.76	0.09	0.65	93.00
Billing and posting clerks	459,000	0.29	0.31	0.24	0.21	0.26	96.00
Paralegals and legal assistants	444,000	0.28	0.28	0.27	0.29	0.28	94.00
Couriers and messengers	402,000	0.26	0.24	0.36	0.17	0.31	94.00
Operating engineers and other construction equipment operators	375,000	0.24	0.26	0.17	0.03	0.20	95.00
Combined food preparation and serving workers, including fast food	372,000	0.24	0.21	0.38	0.20	0.27	92.00
First-line supervisors of housekeeping and janitorial workers	352,000	0.22	0.23	0.27	0.11	0.35	94.00
Dining room and cafeteria attendants and bartender helpers	338,000	0.21	0.21	0.22	0.20	0.42	91.00
Hosts and hostesses, restaurant, lounge, and coffee shop	322,000	0.20	0.20	0.14	0.13	0.21	97.00
Total/Average	36,271,000	23.02	23.03	23.91	19.05	30.50	92.02

Source: U.S. Bureau of Labor Statistics (BLS), 2020a authors' calculations; Frey and Osborne (2017).

Note: This table reflects data for a subset of the 220 occupations for which the BLS provides gender and race statistics and for which Frey and Osborne (2017) provide an automation risk score.

Black and Hispanic workers are more likely to be concentrated in occupations at high risk of being automated, whereas Asian workers are more likely to be in occupations at low risk.

Black and Hispanic workers account for 13 percent and 18 percent of the U.S. labor force (BLS 2020b) but are overrepresented in jobs with a high risk of being eliminated or significantly changed by automation. Black workers are overrepresented in 11 of the 30 jobs that employ the most Americans and are at high risk of being automated, including taxi drivers and chauffeurs (where 29.5 percent of taxi drivers and chauffeurs are Black); industrial truck and tractor operators (25.8 percent); laborers and freight, stock, and material movers (19.8 percent); food preparation and serving workers (19.6 percent); cooks (18.1 percent); cashiers (17.9 percent); couriers and messengers (17.4 percent); production workers, and others (16.1 percent); receptionists and information clerks (15.4 percent); first-line supervisors of housekeeping and janitorial workers (15 percent); and office clerks, general (13.6 percent). Hispanic workers are overrepresented in 13 occupations at high risk of being automated. In addition to the positions where Black workers are overrepresented, Hispanic workers are also overrepresented in food preparation occupations (28.1 percent) and dining room and cafeteria attendants and bartenders (34.2 percent). The positions listed are at high risk of being automated in the next 10 to 20 years; in 2019 they employed 6.4 million Black and Hispanic workers. Furthermore, Black workers tend to be employed in jobs at the lower end of the pay scale, with only half of the top 10 jobs that Black workers typically hold paying above the federal poverty guidelines for a family of four, or \$25,750 annually (Cook et al. 2019).

Jobs at Low Risk of Automation by Workers' Race

Table 2 shows the subset of 30 jobs with the lowest automation risk scores that employ the highest number of U.S. workers (more than 73,000 workers). These occupations employ 22.1 million American workers or 14.5 percent of the white employed workforce, 11.6 percent of the Black employed workforce, 15 percent of the Asian employed workforce, and 7.8 percent of the Hispanic employed workforce.

Black workers are overrepresented in just 5 of the 30 positions at low risk of being automated: preschool and kindergarten teachers (where 15.7 percent of preschool and kindergarten teachers are Black), logisticians (15.5 percent), training and development specialists (15.4 percent), education administrators (15.3 percent), and dietitians and nutritionists (15.2 percent). These five positions employ 311,985 Black workers. Hispanic workers are not overrepresented in any of the 30 positions.

Impact of COVID-19 on the U.S. Workforce

Technology, and the way it has been adopted, changed considerably in 2020 as millions of workers and students began working and learning from home to mitigate the spread of the pandemic. Brynjolfsson et al. (2020) estimate that one-third of the labor force switched from commuting to work to remote work between February and May 2020, resulting in about 50 percent of US workers working from home. Online meeting platforms like Zoom, Microsoft Teams, Slack, and Google Meet that were moderately used by individuals, businesses, and educational institutions prior to the pandemic drastically increased in popularity during the pandemic as many organizations transitioned to remote work and learning (Pega 2020). Daily users of Zoom increased from 10 million in December 2019 to 200 million in March 2020, and daily usage of Google Hangouts Meets was 25 times higher in March 2020 than it was in January 2020 (Yuan 2020; Condon 2020).

Autor and Reynolds (2020) lay out four reasons for why the COVID-19 pandemic will impact both employment and the character of cities. First, telepresence, a form of automation, will decrease the use of office space for performing tasks that many employees could accomplish elsewhere. Telepresence is “the experience of being present at a real world location remote from one’s own immediate physical environment. It attempts to allow the user to feel immersed in the remote environment and to be able, through teleoperation, to manipulate or control remote events” (Mair 1997). Although telepresence is not specifically associated with a particular automation risk score on Frey and Osborne’s (2017) scale, it is a mechanism through which many jobs can be done remotely. This has led to the second reason that Autor and Reynolds (2020) suggest for why the pandemic will impact the way we work: “Reductions in office occupancy, daily commuting trips, and business travel will lead to a decline in the economic centrality and cultural vitality of cities” (Autor and Reynolds 2020). Third, the crisis will disproportionately and negatively impact small businesses and accelerate the dominance of large firms. Finally, social distancing and stay-at-home orders encouraged firms to use automation in new ways to accomplish core tasks with less human labor.

As state and local governments around the country passed safety measures that shuttered many U.S. businesses, retail workers, specifically those who work in the clothing and accessories industries, experienced significant job losses. Retailers are moving away from large and well-staffed brick-and-mortar locations selling products replenished in bulk weekly shipments. Black and Hispanic workers account for 12.4 percent and 18.7 percent, respectively, of the 3.1 million people employed in the retail sales industry, an industry that is seeking to rapidly and efficiently overcome the brick-and-mortar/digital divide. Automation in the retail industry

TABLE 2.

The Subset of the 30 Jobs with the Lowest Automation Risk Scores that Employ the Highest Number of U.S. Workers

	Total Number Employed	Total Percentage Employed	Percentage of White Workforce	Percentage of Black Workforce	Percentage of Asian Workforce	Percentage of Hispanic Workforce	Automation Risk Score (Percent)
Elementary and middle school teachers	3,604,000	2.29	2.49	1.90	0.92	1.33	0.44
Registered nurses	3,242,000	2.06	2.01	2.07	2.91	0.84	0.90
Chief executives	1,602,000	1.02	1.16	0.34	0.91	0.36	1.50
First-line supervisors of office and admin. support	1,306,000	0.83	0.86	0.90	0.47	0.63	1.40
Marketing and sales managers	1,184,000	0.75	0.83	0.37	0.65	0.38	1.30
Physicians and surgeons	1,098,000	0.70	0.65	0.46	1.93	0.30	0.42
Other teachers and instructors	1,017,000	0.65	0.65	0.61	0.61	0.43	0.95
Secondary school teachers	1,015,000	0.64	0.72	0.38	0.33	0.32	0.78
Education administrators	958,000	0.61	0.62	0.76	0.31	0.41	1.32
First-line production supervisors, operating workers	844,000	0.54	0.55	0.53	0.31	0.52	1.60
Medical and health services managers	677,000	0.43	0.44	0.44	0.38	0.29	0.73
Computer systems analysts	663,000	0.42	0.37	0.33	1.31	0.20	0.65
Preschool and kindergarten teachers	655,000	0.42	0.41	0.53	0.33	0.35	0.74
Engineers, all other	582,000	0.37	0.34	0.16	1.17	0.21	1.40
Social and community service managers	470,000	0.30	0.31	0.30	0.15	0.18	0.67
Clergy	413,000	0.26	0.27	0.26	0.24	0.11	0.81
Mechanical engineers	351,000	0.22	0.23	0.09	0.40	0.11	1.10
Pharmacists	341,000	0.22	0.18	0.18	0.73	0.03	1.20
Human resources managers	321,000	0.20	0.20	0.18	0.22	0.12	0.55
First-line mechanics supervisors, installers, repairers	272,000	0.17	0.19	0.14	0.04	0.16	0.30
Psychologists	234,000	0.15	0.17	0.07	0.08	0.09	0.43
Securities, commodities, and financial services sales	231,000	0.15	0.16	0.06	0.17	0.10	1.60
Speech-language pathologists	180,000	0.11	0.14	0.04	0.04	0.04	0.64
Lodging managers	162,000	0.10	0.11	0.06	0.15	0.09	0.39
Logisticians	154,000	0.10	0.10	0.12	0.04	0.05	1.20
Occupational therapists	136,000	0.09	0.08	0.07	0.16	0.05	0.35
Dietitians and nutritionists	128,000	0.08	0.08	0.10	0.07	0.04	0.39
Training and development specialists	125,000	0.08	0.08	0.10	0.05	0.05	1.40
First-line supervisors of police and detectives	83,000	0.05	0.06	0.03	0	0.02	0.44
Public relations and fundraising managers	73,000	0.05	0.05	0.03	0	0	1.50
Total/Average	22,121,000	14.04	14.51	11.65	15.08	7.79	0.90

Source: U.S. Bureau of Labor Statistics (BLS), 2020a authors' calculations; Frey and Osborne (2017).

Note: This table reflects data for a subset of the 220 occupations for which the BLS provides gender and race statistics and for which Frey and Osborne (2017) provide an automation risk score.



means customers can order online and pick up in-store or have products delivered. This new model decreases retail store space requirements, inventory holding costs, and sales staff employment (Arcieri 2020).

Automation has become one way to reduce transmission and protect employees and customers from a highly contagious disease. According to a recent data brief from the Joint Center for Political and Economic Studies (Broady 2017), relative to white workers, Black workers are more than one and a half times more likely to be cashiers, cooks, food preparation and serving workers, production workers, laborers, and material movers. They are also more than three times more likely to be security guards, bus drivers, and taxi drivers or chauffeurs, all of which are jobs at high risk for automation in the future (Broady 2017). The current lack of automation in these sectors, however, may have led to fewer work-at-home options for those essential workers and an increase in their potential exposure to COVID-19.

The overrepresentation of Black and Latino workers in these sectors might have contributed to the increase in COVID-19 cases among Black and Latino populations. If this is the case, automation in the form of self-checkout, pick-up lockers, and other forms of retail automation could have decreased the health impact of COVID-19 on these workers' communities. The fear of job losses has led to protectionist measures against automation, but if these jobs were automated, workers could be upskilled to perform higher-skilled and better-paying jobs. In an industry report titled "The Future of Jobs Report," the World Economic Forum estimates that globally "75 million jobs may be displaced by a shift in the division of labour between humans and machines, while 133 million new roles may emerge that are more adapted to the new division of labour between humans, machines and algorithms" (World Economic Forum 2018). Thus, technological innovation will likely result in more job growth, but training and upskilling will be necessary to ensure workers are prepared for these new opportunities.

Strategic Adjustments

For the Black and Hispanic workforce to thrive throughout the Fourth Industrial Revolution, which as noted above is driven by increasing automation and artificial intelligence, strategic adjustments in education and workforce training will be necessary to create additional pipelines to jobs that are less susceptible to automation.

Education

A report from McKinsey & Company (Cook et al. 2019) found that fewer years of educational attainment, on average, is a contributing factor in the increased risk of job disruption from automation for Black workers. Indeed, the projected displacement risk drops significantly for both Black

and white workers who have a bachelor's degree. Hence, investments in higher education, particularly in historically Black colleges and universities (HBCUs) and minority serving institutions (MSIs), can increase educational attainment and lower displacement risk from automation. Investing in HBCUs is an efficient route to helping Black students: according to the United Negro College Fund (UNCF 2019b), HBCUs account for only 3 percent of the nation's colleges and universities but enroll 10 percent of all Black students and produce almost 20 percent of all Black graduates. HBCUs are also more affordable: according to the UNCF, "the cost of attendance at an HBCU is 28% less than attending a comparable non-HBCU" (UNCF 2019c). HBCUs produce 25 percent of Black STEM graduates, preparing them for careers in jobs that are less susceptible to automation.

In addition to investing in HBCUs and MSIs, the higher education sector should focus on retention, graduation, and placement of Black and Hispanic students. The need to equip students with the knowledge and skills necessary for the future of work with automation—including a functional understanding of technology, theory, and soft skills—can be a challenge for most educational institutions. The challenges are magnified for HBCUs and many MSIs, however, with lower endowments than predominately white institutions. Hence, increased funding for technical infrastructure at HBCUs and MSIs is critical to mitigating disparities in access to employment that is less sensitive to automation risk. In addition, initiatives to increase connections between educators and employers could create pipelines from school to employment, for students and for workers in lower-skilled occupations.

To be sure, many HBCUs have been working for years to create innovative programs and partnerships to prepare students for the future of work. Collaborations between HBCUs, MSIs, predominately white institutions, and industry leaders that were developed prior to the COVID-19 pandemic served to create pipelines for graduating students to more seamlessly enter graduate school, internships, and full-time employment with lower risk of being automated. An example is the partnership between three institutions in Kentucky: Kentucky State University, a HBCU in Frankfort; the University of Kentucky, Lexington; and Toyota Motor Manufacturing Kentucky in Georgetown. The partnership prepares students for jobs in the field of engineering. Through the five-year program, Toyota is developing a pipeline to employ students who earn engineering degrees. Students who participate in the program receive full-ride scholarships: the first three years at Kentucky State University in a pre-engineering curriculum and the last two years at the University of Kentucky. Upon successful completion of the program, students receive an undergraduate degree from Kentucky State University and an engineering degree from the University of Kentucky (Toyota Newsroom 2014). Another example is a partnership between Year Up Atlanta and Atlanta Metropolitan State College that allows students

to earn up to 21 college credits focusing on business and computer science during the first six months of the program, and then allows them to participate in a six-month internship at one of Year Up's corporate partner firms. Experiential learning opportunities like the program offered by the College of Business and Public Affairs at Alabama A&M University include a course in managerial communications to teach students soft skills and to provide them with professional development opportunities followed by an internship in cooperation with business, government, and nongovernment organizations. Throughout, the program exposes students to diversity and international perspectives (Alabama A&M University n.d.).

Organizations such as the UNCF that are dedicated to the education of Black students realize the importance of preparing students for the future of work. "The UNCF Career Pathways Initiative (CPI), funded by Lily Endowment, is a \$50 million investment over a seven-year period [beginning in 2015] that helps four-year HBCUs and PBIs [predominantly Black institutions] strengthen institutional career placement outcomes with the goal of increasing the number of graduates who immediately transition to meaningful jobs in their chosen fields" (UNCF 2016). Dillard University in New Orleans is the recipient of a UNCF Career Pathways Initiative grant called the Liberal Arts Innovation Center grant, and is using the funds to create the Center for Automation Readiness and Employment that will blend technical and social skills to develop higher-order mental skills in students that will prepare them to effectively function in and move between jobs and tasks. "Professors at Dillard will embed lessons on conflict negotiation and resolution, verbal and written communication, content creation, empathy, planning, teaching and leadership into their courses while also teaching students how to fully utilize programs necessary for data analytics" (UNCF 2019a). Talladega College is using UNCF Career Pathways Initiative Liberal Arts Innovation Center grant funds to "institute an interactive professional learning process for faculty, which will lead to increased student learning and retention. Professors will study student responses to active learning strategies during technology-enhanced lessons using a variety of techniques to include training models focusing on critical thinking, communication, and problem-solving skills" (UNCF 2019a).

Teaching and other education-related positions make up 5 of the 30 positions least threatened by automation in Table 2. Therefore, programs that prepare Black students for careers in teaching both open more pathways into automation-resilient jobs in education as well as expand the population of Black teachers supporting future students. One such program was launched by Clemson University and implemented by South Carolina's HBCUs: Call Me Mister. Call Me Mister (Clemson University n.d.) is an initiative to increase the pool of available teachers from a more diverse background. The young men who are participants in the program are selected from underserved, socioeconomically

disadvantaged and educationally at-risk communities. The scholarship helps the young men, who otherwise would not be able to afford to do so, pay for college; provides them with the necessary skills to become teachers; and allows them to become necessary role models to their future students. The Call Me Mister initiative is now active in dozens of colleges and universities nationwide.

In order to prepare students to participate in programs like the ones described, classroom strategies must be put in place to ensure that students are technically competent to learn in face-to-face environments and online learning platforms. Students of color, significantly more than their white peers, view technology—when it is available and effective—as a tool that helps them to communicate and improve their perceived learning in the classroom. This may also be related to the ability of technology to remove race from the equation during student discussions, thus placing the focus on what they are saying rather than on the race of the person saying it. Women, minorities, students with disabilities, first-generation students, students who are independent, and students who come from disadvantaged families see their personal computer devices (laptop, tablet, mobile phones) as considerably more important to their learning outcomes than do their peers. White students are significantly less likely than non-white students to think desktops, tablets, and smartphones are important to their success (Galaneck, Gierdowski, and Brooks 2018).

Workforce Training

As technological innovation continues to alter which skills are demanded from workers, investments in workforce training will be necessary to reskill people who are currently employed but whose roles are destined to change. Business executives and leaders of higher education institutions will be vitally important in establishing opportunities for vocational training, and prioritizing reskilling initiatives that stimulate a culture of curiosity and life-long learning (Tyagarajan 2019).

In particular, employer-provided training can result in benefits for both workers and companies themselves. Since firms frequently recapture the costs of training programs, either partially or fully, through productivity gains unlocked by upskilled workers, it would make sense for firms to increase their investments in training initiatives (Muro, Maxim, and Whiton 2019; Dostie 2015). Yet, many companies remain unwilling to make the investment, leading to suboptimal training investment throughout the economy (Muro, Maxim, and Whiton 2019).

Holzer (2021) suggests that, to encourage employer-paid worker training, governments should provide incentives. One way is through expanded tax credits for education and training expenses. Generally, only education expenses that improve worker skills for their current positions are deductible for firms, but education that would qualify workers for

a new type of work are not deductible (York 2019). Policy-makers should expand the scope of eligible expenses to include training that prepares workers for new positions and training that does not result in a credential but is nevertheless beneficial to the firm and the employee.

Apprenticeship programs that combine on-the-job, work-based training with classroom instruction are an important tool for preparing youths and early-career workers for jobs in various industries, but access to these programs has not been provided equitably (Zakiya 2019). In 2019, 29,542 (10 percent) of the 282,495 individuals completing a Registered Apprenticeship Program were Black, though Black Americans accounted for 13 percent of the U.S. labor force in 2019 (BLS 2020b; U.S. Department of Labor n.d.). Increasing investment in apprenticeship programs would help narrow the racial gap in postsecondary credentials, expose participants to experiential learning opportunities through structured on-the-job training, and increase workers' wages.

The United States could learn from successful workforce training programs in other countries. In particular, Singapore and Denmark have developed workforce training programs and incentives to ensure workers are able to update their skills to match the demands of the evolving workforce. The SkillsFuture Credit program is a credit that enables all eligible Singapore citizens to acquire new skills or enhance existing ones. Since 2016 the program has provided an opening credit of \$500 to citizens aged 25 and older. Citizens aged 40 to 60 receive an additional \$500 SkillsFuture Credit that can be used for skills courses, a mid-career pathways program, company training courses, and a career transition program (MySkillsFuture n.d.). In Denmark, adult vocational training programs provide an opportunity for workers to maintain and improve their vocational skills and competencies in accordance with the needs of the labor market (Ministry of Children and Education [Denmark] n.d.). The programs are typically provided by state-funded, self-governing institutions such as adult education centers, vocational education and training colleges, labor market training institutions, and higher education institutions. The programs receive a public subsidy to cover part of the cost, while the remainder is covered by employers or user fees (Eurydice 2020). Similar programs in the United States would serve to provide an affordable mechanism for workers at various skill levels to receive the training necessary for jobs that are less likely to be disrupted by automation.

Conclusion

The continued deployment of automation in the U.S. economy, our workplaces, and our everyday lives will increase economic growth, output, efficiency, and—as the COVID-19 pandemic has shown—even health and safety. In this paper, we provided data on the 60 jobs that employ the most workers in the United States and have the highest and lowest susceptibility to automation in the next 10 to 20 years, with a particular focus on Black and Hispanic workers. We then offered arguments for and examples of partnerships and methods to increase the preparation for Black and Hispanic students and workers for the future of work with automation.

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Summary

Automation allows both workers and companies to increase productivity through the use of technology. In 2020, automation—through new uses of technology—allowed millions of workers and students to work and learn from home to mitigate the spread of the pandemic. However, not everyone benefits from the effects of automation, particularly not those whose jobs are eliminated as a result of automation. In this analysis, we ask: How will the acceleration of automation, spurred by the COVID-19 pandemic, directly affect Black and Hispanic workers, communities and institutions? Using an Automation Risk Index developed by Frey and Osborne (2017), we identify the occupations and people who are most at risk of job loss due to automation. We propose increased investments in higher education and workforce training programs to create pipelines to jobs with lower risk of automation.



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