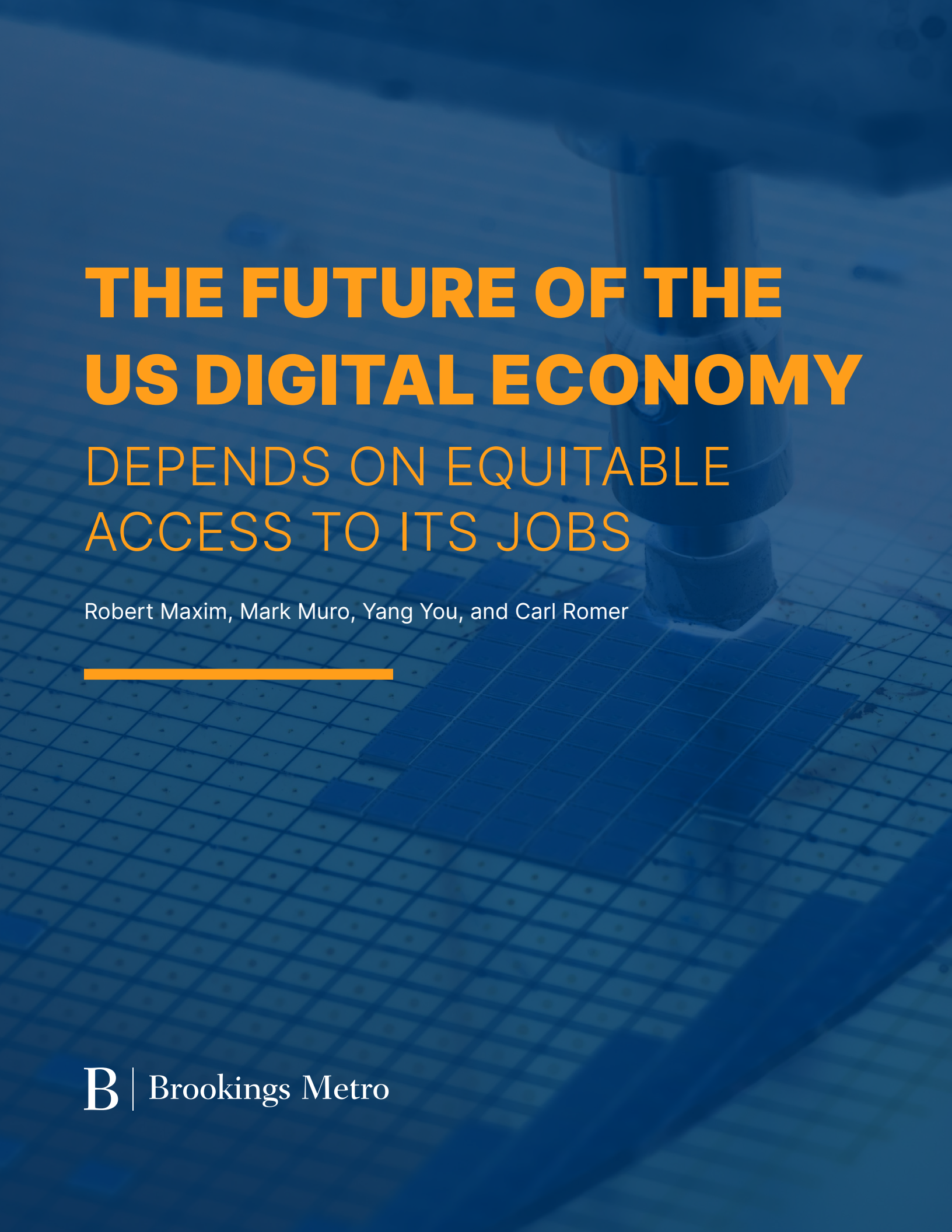

THE FUTURE OF THE US DIGITAL ECONOMY

DEPENDS ON EQUITABLE ACCESS TO ITS JOBS

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Brookings Metro

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Executive summary

Over the past several years, emerging technologies such as generative artificial intelligence (AI) have dominated headlines, while industrial strategies centered on technologies such as semiconductors have become central to U.S. economic policymaking. Meanwhile, a growing stream of scholarship has shown that certain groups—including women and many workers of color—remain underrepresented in technology-oriented fields, despite the importance of diverse workforces for firm, industry, and national competitiveness.

At the same time, there has been a concerted legal and policy effort to roll back initiatives aimed at reducing disparities across race and gender—an effort that President-elect Donald Trump endorsed during his 2024 re-election bid. However, this new analysis finds that far from being unnecessary overreach, proactive policies aimed at reducing disparities by race and gender are still needed to support the well-being of the digital economy.

This report contributes to the literature on inclusion in digital technologies by exploring which workers have access to "highly digital" jobs—namely, those that make the most intensive use of digital technologies.

To that end, this analysis focuses on a subgroup of highly digital occupations: computer, engineering, and management, or "CEM," occupations.

These occupations are defined as highly digital occupations in three occupation groups: 1) computer and mathematical; 2) architecture and engineering; and 3) management.

This report calls out these occupations specifically because of the distinct roles that they play in the digital economy. Workers in computer and engineering occupations build many of the technologies that underpin the digital economy, and play a key role in creating emerging technologies such as new AI applications. Workers in management occupations oversee the development and deployment of these and other products in their companies, and also shape the direction of firm demographics through hiring and promotion decisions.

In short, CEM occupations play a central role in enabling the future direction of the digital economy. However, they remain highly unequal by gender, race, and place, and the nation has made little progress over time in remedying these inequalities.

This analysis comes at a critical time. In recent years, federal policymakers have begun working to reverse demographic and geographic economic divides through a set of historic investments contained in major federal laws. Yet for all of that, emerging political and legal efforts seek to eliminate policies aimed at supporting the progress of historically underrepresented racial groups, and

the election of Donald Trump is likely to accelerate the rollback of such policies on the federal level. This means that just as new initiatives move to address demographic and geographic divides, the emerging federal policy landscape threatens to block efforts to help workers find opportunity in highly digital workplaces.

These crosscurrents could prevent workers from accessing the best-paying, most technology-oriented occupations. In this regard, this report provides six key data-oriented findings about CEM jobs, and identifies three important barriers to improving demographic and geographic inclusion in CEM work. From there, it proposes a series of robust state and local policy recommendations to build out the pathways to such opportunity, as well as needed federal supports.

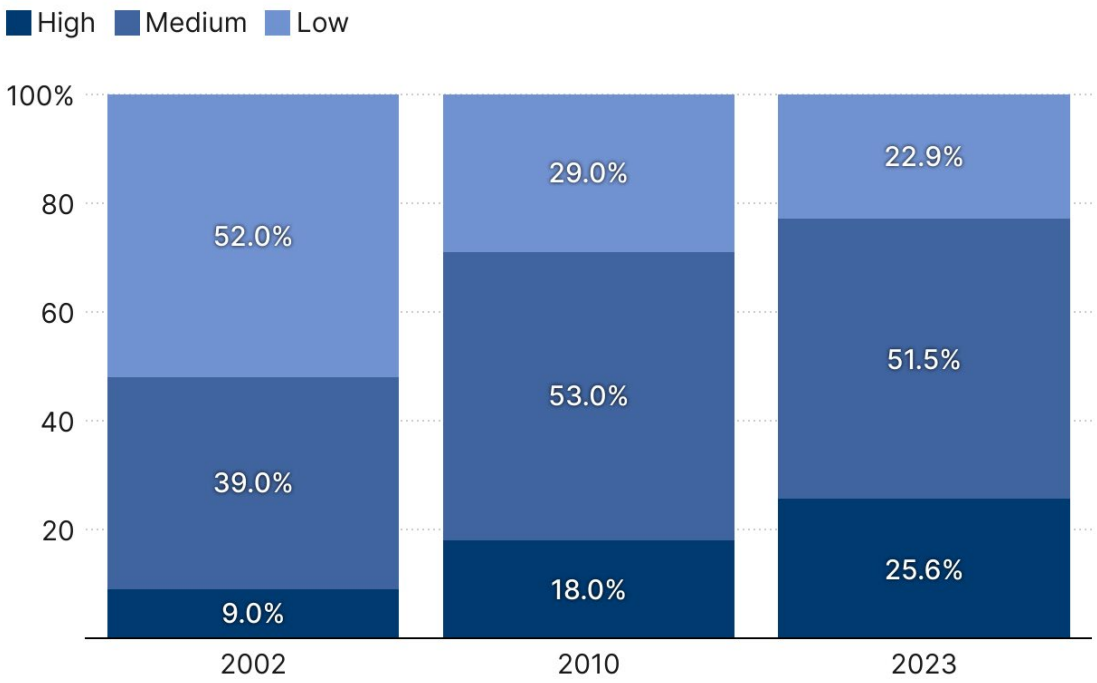
The report's findings are as follows:

FINDING #1: HIGHLY DIGITAL OCCUPATIONS ACCOUNT FOR MORE THAN ONE-QUARTER OF ALL US JOBS, AND CAN BE FOUND IN NEARLY EVERY OCCUPATIONAL GROUP

The continued diffusion of digital technologies has meant that today, more occupations are classified as "highly digital" than in years past. At the same time, highly digital jobs have grown at a faster rate than other occupations in the economy. In 2023, 26% of the U.S. workforce was employed in a highly digital job, up from 18% in 2010 and just 9% in 2002.

Highly digital employment growth at a glance

2002 to 2023

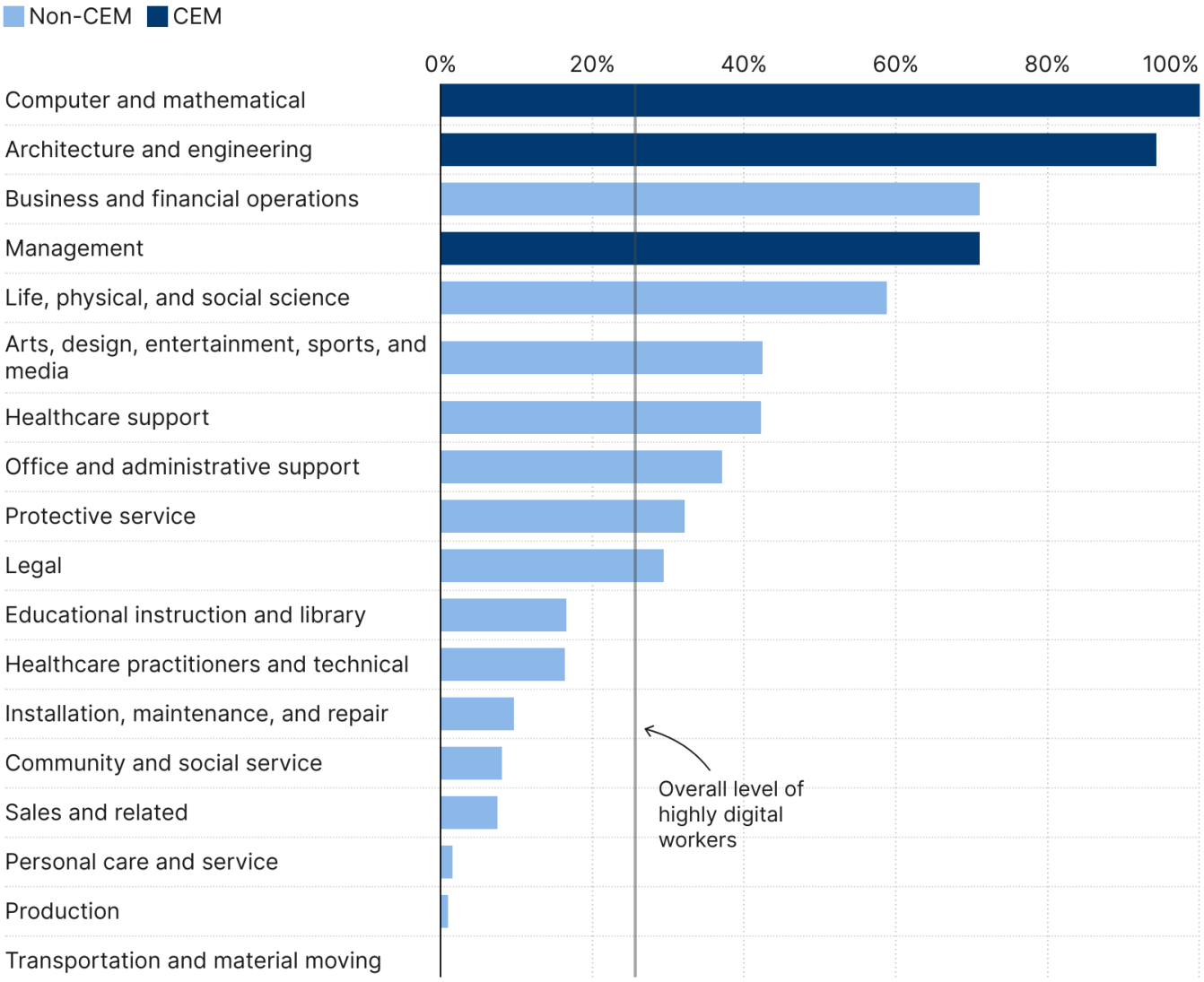


SOURCE: Brookings analysis of Lightcast data
NOTE: Calculation based on unrounded numbers. Occupations without a digital score are excluded from the calculation.

While highly digital jobs permeate many occupation groups (and all three CEM occupational groups have higher-than-average shares of highly digital jobs), computer and engineering jobs occupy the top two spots.

Share of highly digital employment by occupational group

2023



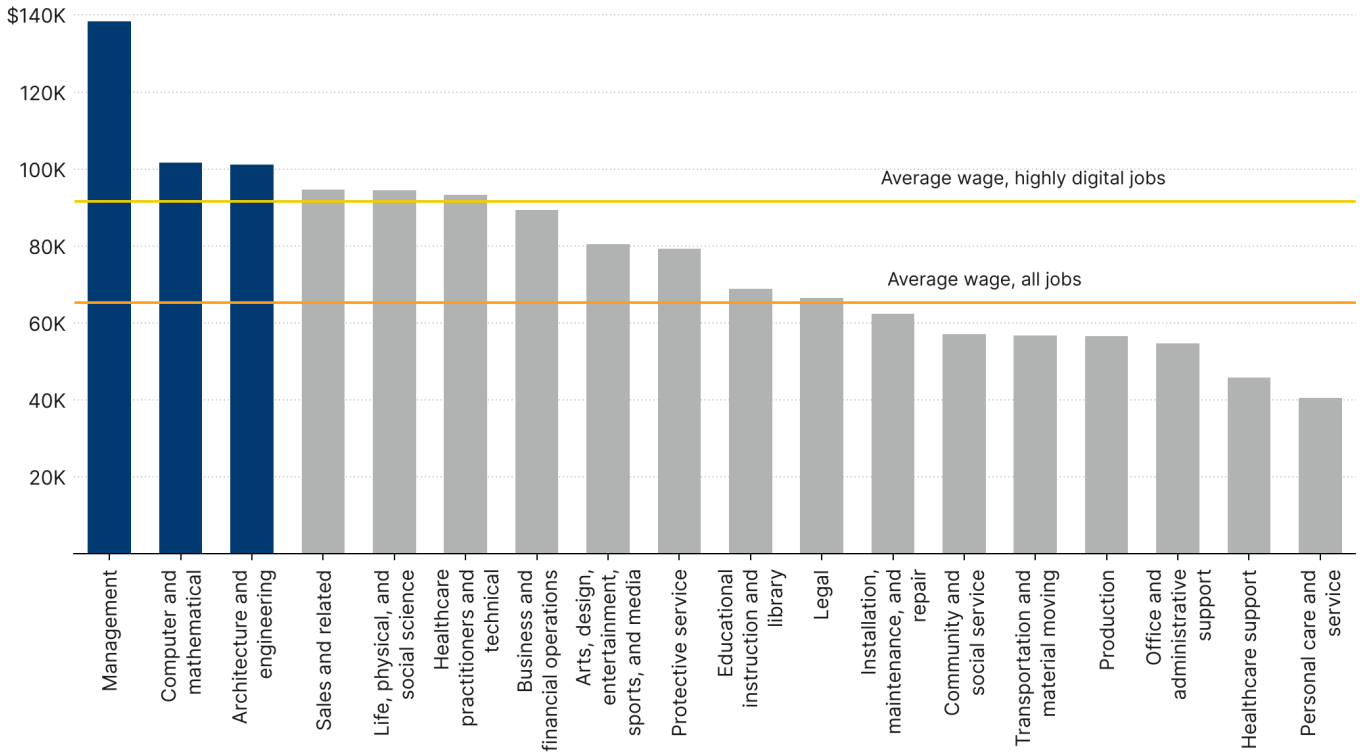
SOURCE: Brookings analysis of Lightcast data
NOTE: Occupational groups that have no highly digital workers are excluded.

FINDING #2: CEM JOBS ANCHOR HIGHLY DIGITAL WORK IN THE US, AND PROVIDE A SIGNIFICANT PAY PREMIUM

CEM jobs account for a significant source of good-paying jobs. At the occupational-group level, workers in highly digital management occupations made the most on average ($138,000), followed by computer and mathematical occupations ($102,000) and architecture and engineering occupations ($101,000). By contrast, highly digital occupations in non-CEM occupation groups paid an average of $73,000, compared to the average national wage of $65,000.

Average wage of highly digital occupations in each occupational group

2023



SOURCE: Brookings analysis of BLS and Lightcast data
NOTE: Occupational groups that have no highly digital workers are excluded.

FINDING #3: CEM JOBS HAVE GROWN FASTER THAN OTHER JOBS IN THE ECONOMY, DRIVEN BY SIGNIFICANT GROWTH IN MANAGEMENT OCCUPATIONS

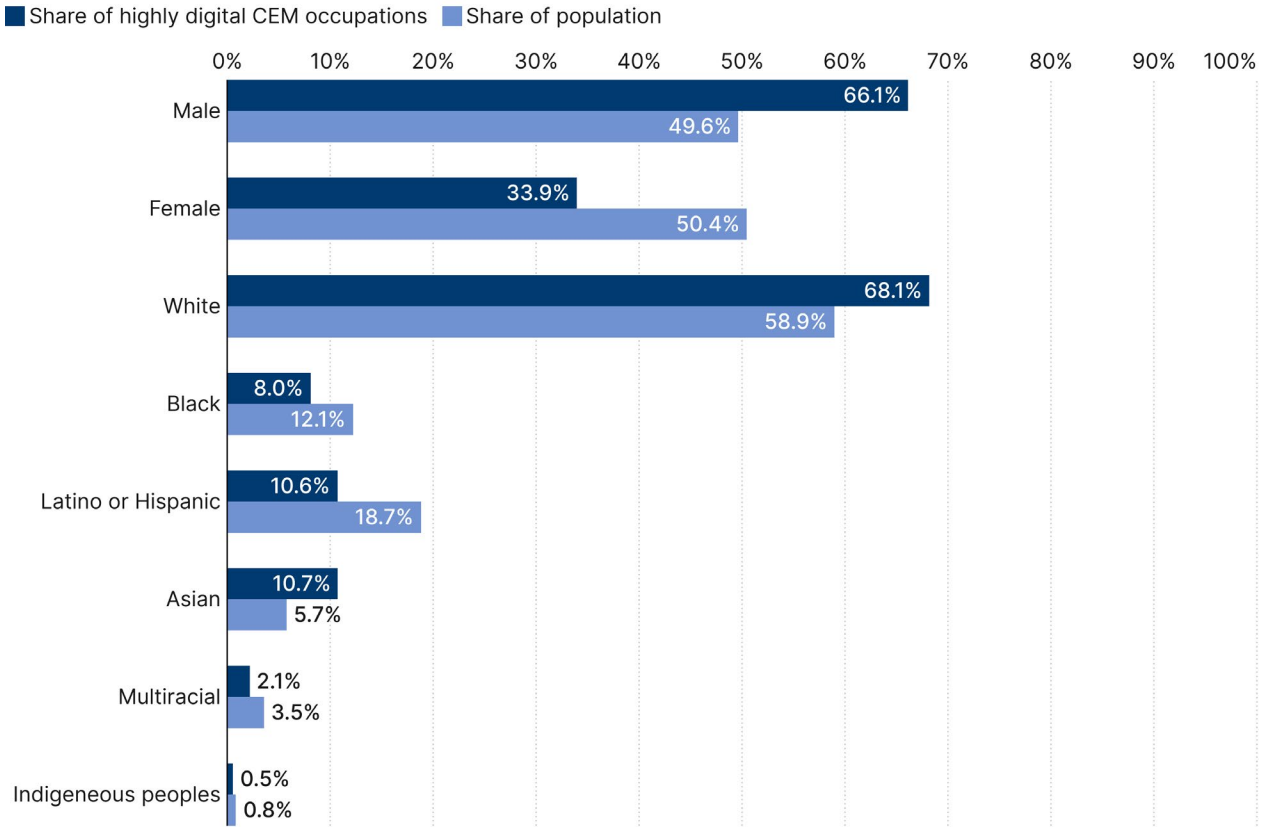
From 2020, the trough of the COVID-19 economic crisis, to 2023, management jobs grew by 33.7%—over three times faster than the 9.1% growth rate for the labor market as a whole. Computer and mathematical jobs grew by 5.6% during that time (a slower rate than that of the entire labor market), while architecture and engineering jobs grew by only 1.8%—significantly less than the economy as a whole during the first three years of the pandemic recovery. However, these recovery numbers obscure the fact that CEM jobs were also more resilient during the pandemic recession, with CEM jobs shrinking at less than one-third the rate of the labor market as a whole from 2019 to 2020.

FINDING #4: WOMEN, AS WELL AS BLACK, LATINO OR HISPANIC, AND INDIGENOUS WORKERS, ARE SIGNIFICANTLY UNDERREPRESENTED IN CEM JOBS

Women, as well as Black, Latino or Hispanic, and Indigenous workers, all remain underrepresented in CEM jobs. Moreover, there has been limited and uneven progress over time in expanding the share of highly digital jobs held by underrepresented racial and ethnic groups, with Black and Indigenous workers in particular seeing few gains in their overall share of CEM jobs.

Share of workers in highly digital CEM occupations compared to that group's share of the population as a whole

2023

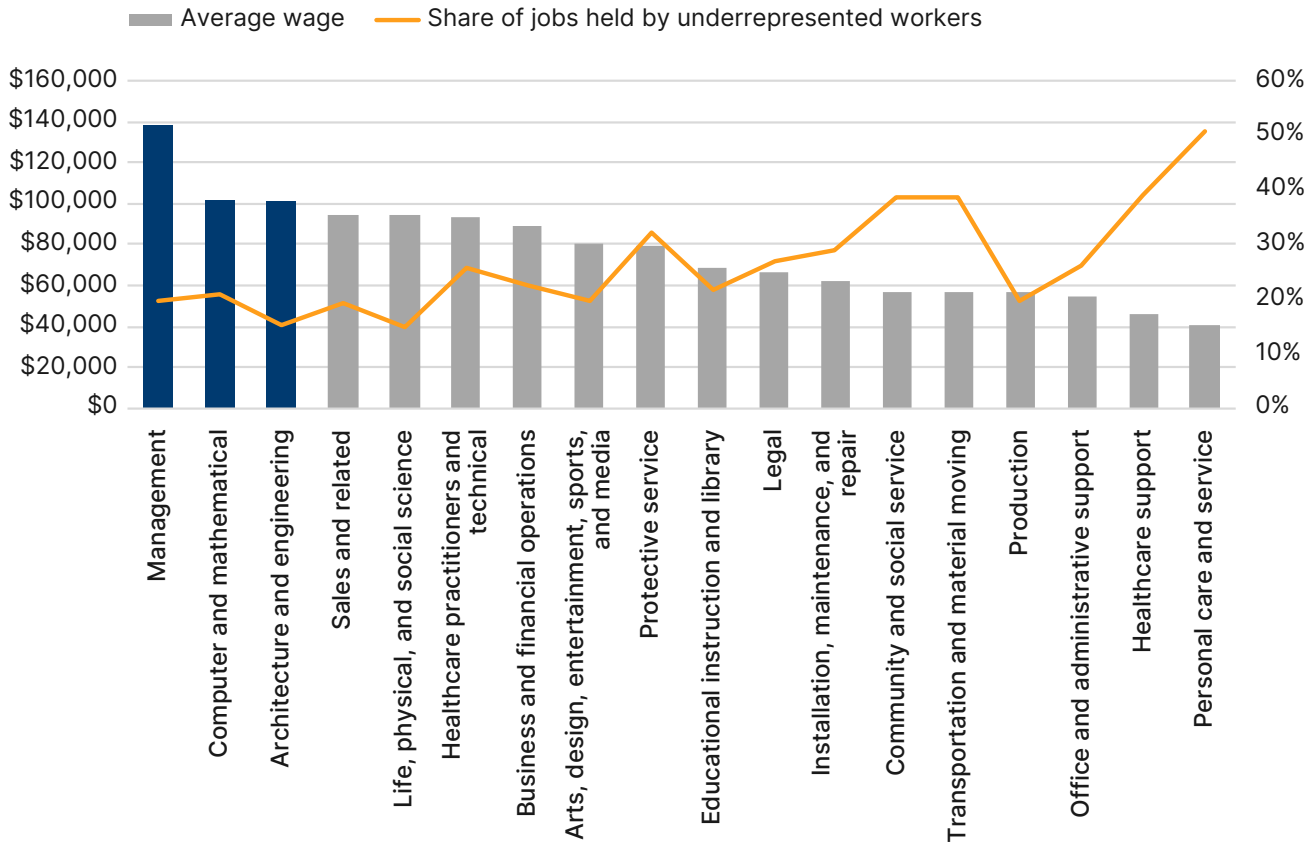


SOURCE: Brookings analysis of ACS and Lightcast data
NOTE: American Indian, Alaska Native, Native Hawaiian, and Other Pacific Islander groups are included in the Indigenous peoples group.

Likewise, highly digital roles in the best-paying occupational groups see lower levels of representation for workers of color and women than roles in lower-paying occupational groups.

Underrepresented workers are overconcentrated in lower-paying highly digital jobs

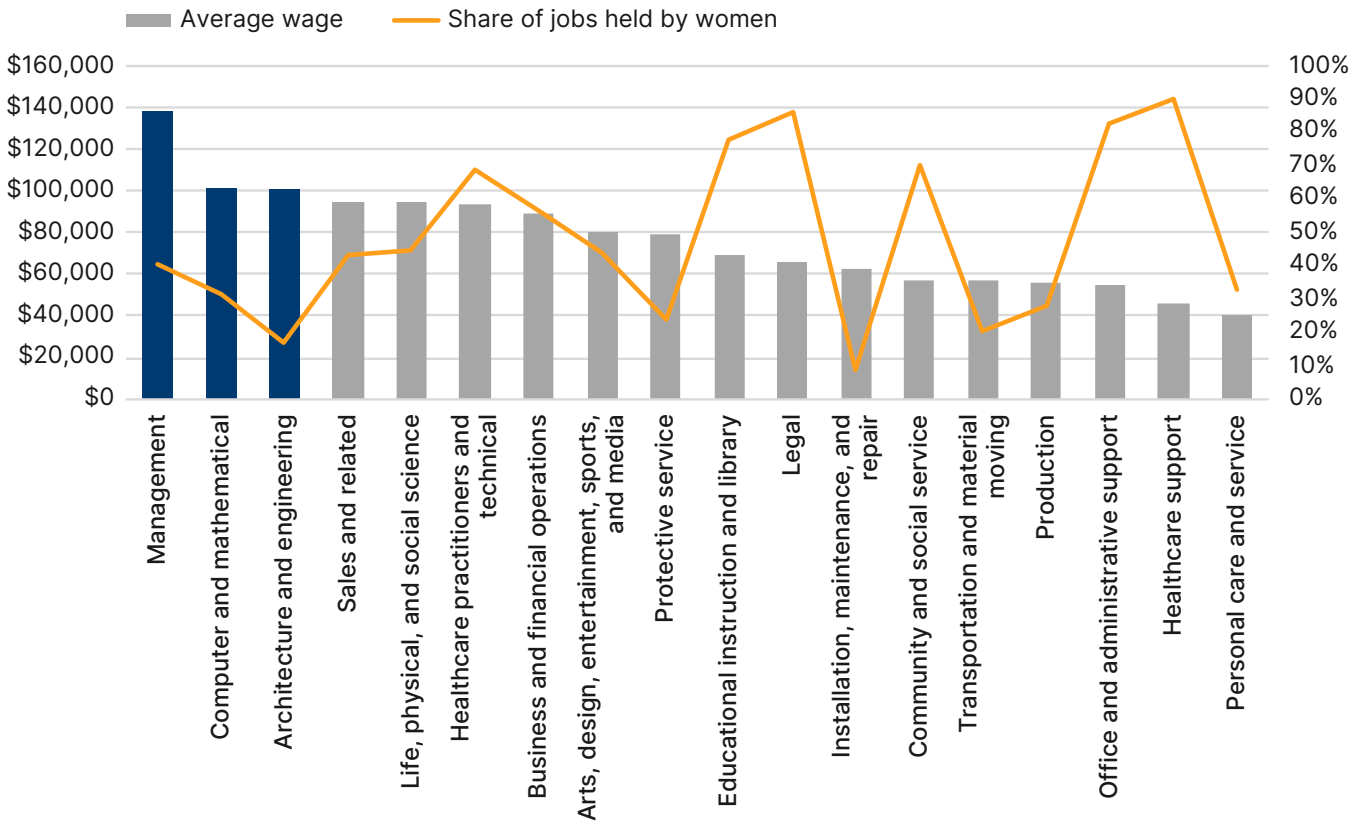
Share of underrepresented workers in highly digital jobs and average wages by occupational group, 2023



SOURCE: Brookings analysis of Lightcast data

Women are overconcentrated in some lower-paying highly digital jobs

Share of women in highly digital jobs and average wages by occupational group, 2023



SOURCE: Brookings analysis of Lightcast data

FINDING #5: MOST EMPLOYERS REQUIRE BACHELOR'S DEGREES FOR CEM JOBS, MAKING HIGHER EDUCATION A CRUCIAL BARRIER TO ENTRY

Educational demands represent a serious hurdle to the inclusivity of CEM work. In 2023, just 12.6% of CEM jobs (about 1.7 million total) did not require a bachelor's degree to access, and Census Bureau data shows that there are very few pathways to computer and engineering jobs without a STEM degree. The relatively few opportunities for workers without a bachelor's degree in CEM occupations illustrates a need to broaden access to and success within four-year education—particularly four-year STEM education—to more students, while continuing to develop novel pathways into CEM occupations for those without a degree.

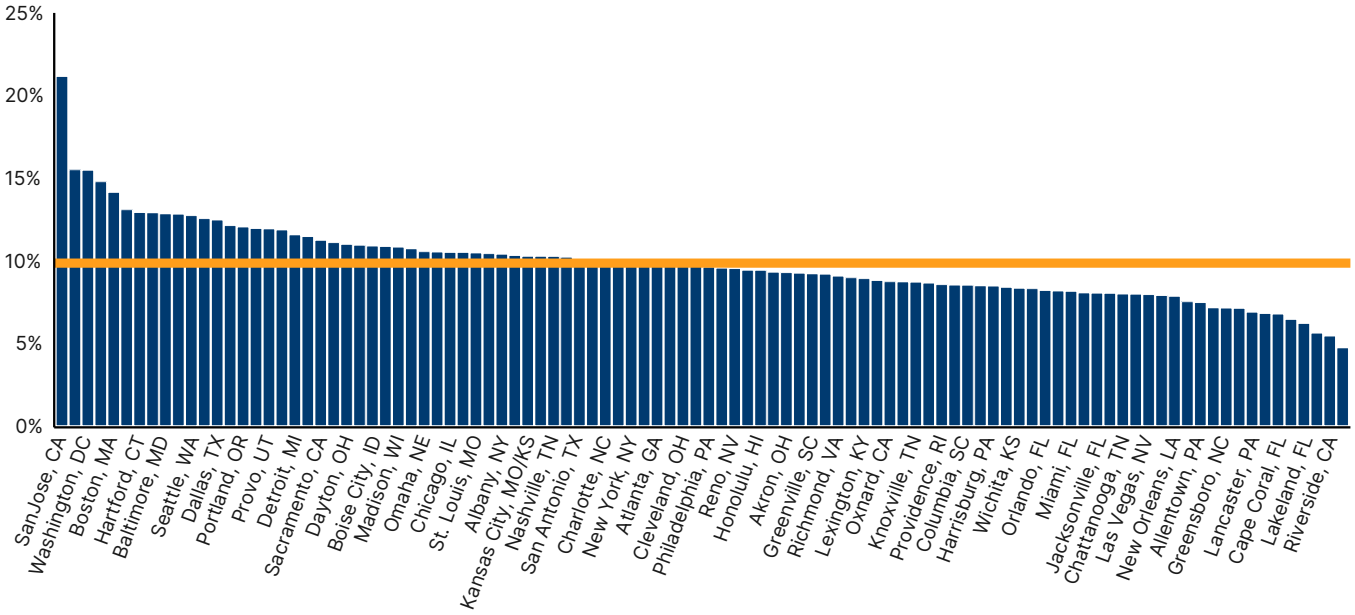
FINDING #6: CEM JOBS ARE UNEVENLY DISTRIBUTED BY PLACE, LIMITING THEIR ACCESSIBILITY

Technology-intensive occupations and industries tend to agglomerate—or "cluster"—in relatively few places. CEM jobs are central to this dynamic.

This concentration of CEM jobs results in substantial variance in the supply of these occupations across states and the 100 largest metro areas. Only 30 metro areas account for just over 50% of the nation's CEM jobs.

Share of employment in CEM occupations in selected metro areas

2023



SOURCE: Brookings analysis of Lightcast data

Meanwhile, on the demographic side, while there is some variation in access to CEM jobs by place, female, Black, Latino or Hispanic, and Indigenous workers remain underrepresented in these positions across the country. Indeed, there isn't a single metropolitan area in the United States where underrepresented workers hold CEM jobs at a rate equal to their share of the population.

POLICY RESPONSES TO UNDERREPRESENTATION IN CEM WORK

Given the growing importance of CEM work for promoting economic opportunity and technological equity, reducing the stark divides between different groups' ability to access these jobs has become crucial.

However, significant educational, bias, and place-based issues continue to reinforce unequal access to highly digital work. Specifically, this analysis identifies three important barriers to creating a more inclusive digital economy:

- Underrepresented individuals face greater barriers to digital skill development, limiting their access to CEM jobs.
- STEM education challenges and biases create obstacles to underrepresented individuals accessing CEM jobs.
- Many communities have too few CEM jobs.

To overcome these barriers, this analysis recommends policy action along three major themes:

- Make digital skill development opportunities more equitable by:
  - Creating more equitable digital education for students and young people
  - Increasing skill development opportunities for more workers
- Broaden access to STEM education, CEM career paths, and entrepreneurship by:
  - Reducing obstacles to STEM completions among underrepresented students
  - Reforming hiring practices for CEM jobs and promoting career advancement for underrepresented workers
  - Diversifying firm ownership and entrepreneurship in CEM-heavy industries
- Create a robust supply of inclusive CEM jobs in more places by:
  - Building inclusive pathways into CEM jobs in places that have a significant share of such occupations
  - Growing the supply of CEM jobs in places currently lacking them

Only through sustained investment over time and an enthusiastic embrace of new approaches by all stakeholders—including those in the private sector as well as state, local, and federal actors—will the nation be able to build a stronger, more equitable, and ultimately more competitive digital economy.

Introduction

Over the past several years, emerging technologies such as generative artificial intelligence (AI) have dominated headlines, while industrial strategies centered on technologies such as semiconductors have become central to U.S. economic policymaking.

Brookings has tracked the growth of this "digitalization" since 2017.[1] Yet while previous reports monitored the spread of digital technologies throughout the labor market, they paid less attention to its demographics.

At the same time a growing stream of scholarship has shown that certain groups, including women and many workers of color, remain underrepresented in technology-oriented fields, despite the importance of diverse workforces for firm, industry, and national competitiveness.[2]

Given that, this new analysis contributes to the literature on inclusion in digital technologies by asking: Which workers have access to the best-paying, most digitally oriented jobs in the U.S., and which do not? To do so, the report explores "highly digital" jobs—namely, those that make the most intensive use of digital technologies, with an emphasis on a subset of highly digital work called computer, engineering, and management (CEM) occupations, which most closely underpin the digital economy. These occupations are defined as highly digital occupations in three occupation groups: 1) computer and mathematical; 2) architecture and engineering; and 3) management. This report calls out these occupations specifically because of the distinct roles they play in the digital economy.

Computer and engineering jobs are central to the creation and dissemination of the products and processes that enable the digital economy. In this regard, these occupations aren't just highly digital themselves—they also create the technologies that make other occupations highly digital.

Management occupations, meanwhile, oversee the development and deployment of products and processes in their companies. Managers also help shape the direction of hiring and worker advancement for firms and industries. Among other things, management occupations play a unique role in determining the demographics of highly digital occupations: who has access to the opportunities these jobs provide, and who doesn't.

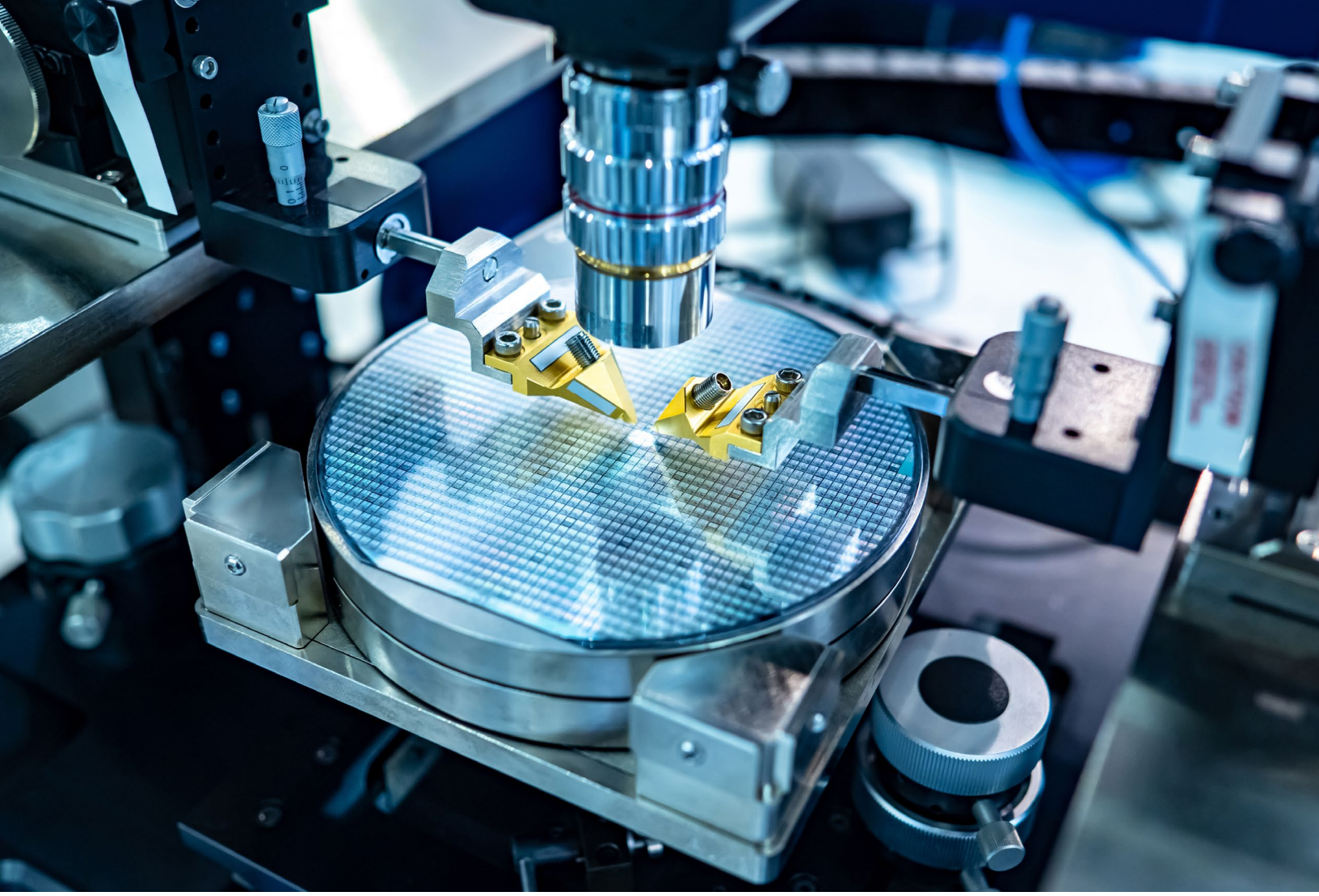
Overall, this report finds that women as well as Black, Latino or Hispanic, and Indigenous workers all remain significantly underrepresented in CEM occupations.

What's more, these inequalities exist not only across different demographic groups, but also across places—a legacy of decades of economic divergence in the United States. Today, many communities across the U.S. maintain a relatively threadbare supply of highly digital jobs, while a handful of large metro areas have concentrated the most significant share of highly digital work. This is a problem given that many workers and places benefit significantly from access to these digitally intensive occupations.

This analysis comes at a critical time. In recent years, federal policymakers have begun working to reverse demographic and geographic economic divides through a set of historic investments contained in major laws such as the American Rescue Plan Act, Infrastructure Investment and Jobs Act, CHIPS and Science Act, and Inflation Reduction Act. The hope is that these investments will spark high-quality opportunities for underrepresented workers by better connecting them with skill development and career pathways—often in digitally oriented fields.

Yet with the re-election of Donald Trump, these investments in economic opportunity and inclusion are now at risk. Trump expressed his support for dismantling such efforts to reduce inequalities in his 2024 campaign, and his election is likely to both accelerate the rollback of such policies on the federal level as well as turbocharge legal efforts that are seeking to eliminate policies aimed at supporting the progress of historically underrepresented racial groups.[3] This means that just as new initiatives have moved to address demographic and geographic divides, others seek to block efforts to help workers find opportunity in CEM or other highly digital workplaces.

These crosscurrents could prevent workers from accessing the best-paying, most technology-oriented occupations. However, this new analysis finds that far from being unnecessary overreach, proactive policies aimed at reducing disparities by race and gender are still needed to support the well-being of the digital economy. In this regard, the report provides a data-oriented demonstration that many groups remain underserved in the U.S. economy, and suggests a number of ways to build out the pathways to such opportunity.



Background: What is ‘digitalization’ and why does it matter?

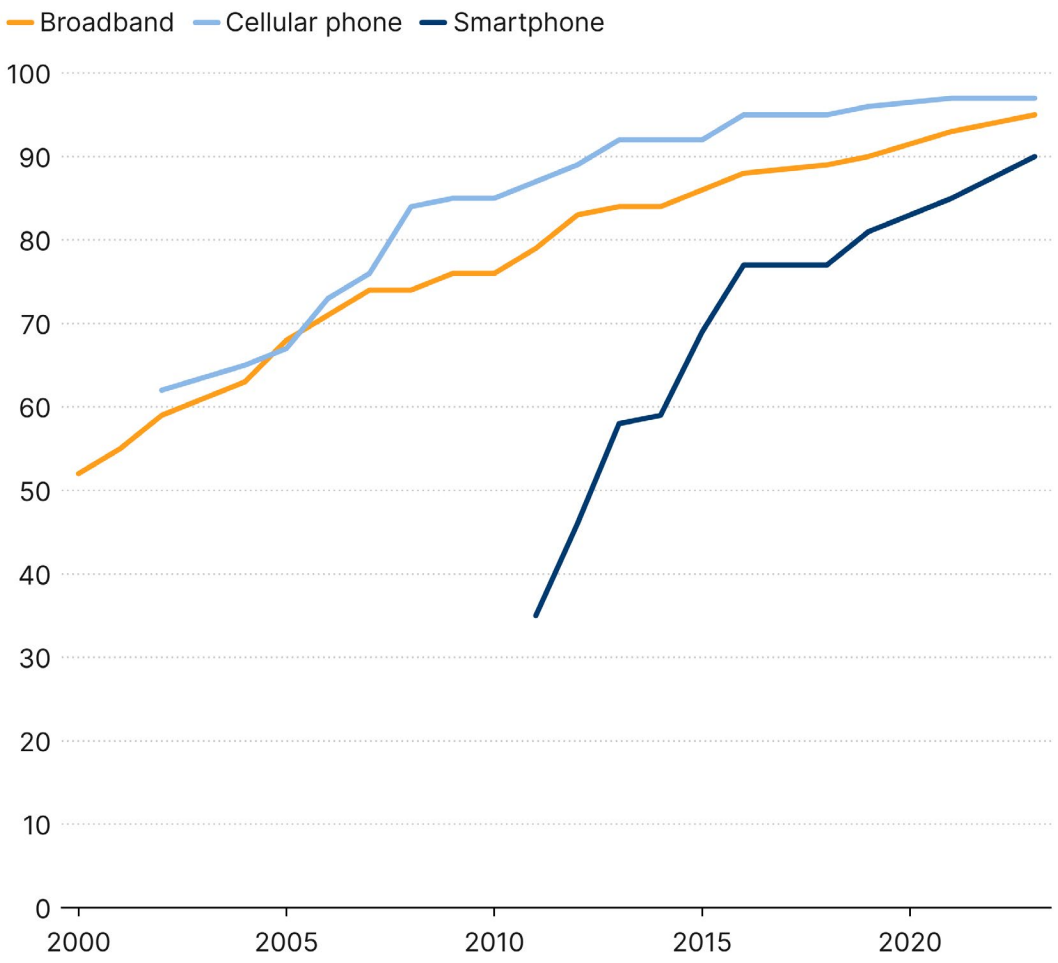
Research firm Gartner defines “digitalization” as the process of employing digital technologies and information to transform business operations. Digitalization can be seen in the diffusion of computers and computer technologies into both business and consumer products and processes.

Digital technologies encompass hardware such as personal computers and smartphones; software such as customer relationship management (CRM) platforms; networked Internet of Things (IoT) devices; emerging technologies such as generative AI; and more.

FIGURE 1

Global penetration of broadband, cellular phones, and smartphones

2000 to 2023



SOURCE: Pew Research Center

As previous Brookings work on digitalization discusses in more detail, digital technologies affect workers and the economy through multiple channels.[4]

First, as digital technologies continue to diffuse throughout the economy, most occupations continue to grow more digital. So, adeptness with digital technologies is relevant for all workers, and that relevance will continue to grow in the future for searching for, accessing, and performing work.

Secondly, ensuring more workers from different backgrounds have access to jobs that make use of digital technologies matters because digitalization can be a crucial source of prosperity. As this analysis will show, digitalization correlates with worker pay. This is in part because digital technologies improve worker productivity, which, while linked less closely to worker pay than in previous eras, still correlates with individual well-being. To that end, jobs that make more extensive use of digital technologies are disproportionately

good-paying jobs. Digital technologies can also provide critical quality-of-life improvements for workers, such as by enabling remote or hybrid work.

Finally, digitalization is central to competitiveness for firms, industries, regions, and the nation. Just as digital technology adoption is an important source of productivity enhancement for individual workers, it also is for U.S. firms, allowing them to compete not just with domestic competitors but globally.

Studies have shown digital technologies can provide an array of positive benefits for firms, ranging from greater patenting to higher valuations on innovation investments in equity markets. Such technologies also promote industry-level breakthroughs and efficiencies, and digitally intensive industries have higher growth rates overall than less digitally intensive industries. Similar effects are seen on a regional level, as regions that have higher concentrations of digital work also have higher rates of economic growth. These advancements help build regional clusters, which beget further growth for communities and their residents.

Finally, just as digital technologies help firms compete globally, so too do they bolster U.S. competitiveness and overall economic growth. These benefits may include the creation of new occupations that didn't previously exist, which can generate new economic opportunities for workers.

Approach

To study the inclusivity of digital work in the U.S., this report analyzes both the nation's extent of digitalization and the degree of demographic inclusion within the jobs that make the most use of digital technologies.

Brookings Metro studied the diffusion of digital technologies into the U.S. workplace in two previous reports: "Digitalization and the American Workforce," published in 2017, and "As the digitalization of work expands, place-based solutions can bridge the gaps," published in 2023. In those studies, Brookings examined the scope and depth of digital adoption for all occupations, and classified every job in the economy into one of three categories: low digital, medium digital, or high digital.

To do that, Brookings used the Department of Labor's O*NET database—which provides comprehensive information about every occupation in the U.S. economy—to identify two variables that reflect the frequency and depth of use of computers in work: 1) knowledge of computers and electronics; and 2) interaction with computers. Brookings then scored every occupation on a scale of zero to 100 based on the level of expertise needed in each variable and the importance of both variables to the particular occupation.

Consistent with previous analyses, in this report Brookings Metro defines "highly digital" jobs as occupations that have a digitalization score of 60 or higher based on the above methodology. This analysis focuses on which population groups tend to work in these highly digital jobs, and which don't.

The main strength of this methodology is that it leverages a rich source of direct survey data to provide specific, comparable, task-level information for 705 occupations as they change over time. However, this approach also has several shortcomings. One is that because O*NET is a national dataset, it does not allow for exact comparison in how the level of digitalization of individual occupations may vary by place.[5] Another, outlined in more detail in the box below, is that the multiyear nature of O*NET surveys can lead to significant year-over-year variance in an individual job's digital score. However, despite these limitations, O*NET remains the most comprehensive source of data for occupational tasks and skills. For a more detailed methodology on the construction of digitalization scores for occupations, industries, groups, and places, please refer to the 2017 report "Digitalization and the American Workforce."

The data on workers by occupation comes from Lightcast, a proprietary data collection and analysis firm specializing in labor market data. We use Lightcast's 2023 data, which represents, as of the time of writing, Q1 2023 to Q3 2023.

The importance of computer, engineering, and management occupations

Central to this analysis is a sub-group of occupations that this report refers to as "computer, engineering, and management occupations," or "CEM occupations." These occupations are defined as highly digital occupations in three occupation groups: computer and mathematical; architecture and engineering; and management. This report calls out these occupations specifically because of the distinct roles they play in the digital economy.

As mentioned above, computer and engineering jobs are central to the creation and dissemination of the products and processes that enable the digital economy. In this regard, these occupations aren't just highly digital themselves—they also create the technologies that make other occupations highly digital.

Workers in management occupations, meanwhile, oversee the development and deployment of firms' products and processes. Managers also help shape the direction of hiring and advancement for workers within their companies. Among other things, management occupations play a unique role in determining the demographics of highly digital occupations: who has access to the opportunities these jobs provide, and who doesn't. In short, CEM occupations pay a central role in enabling the future direction of the digital economy.

BOX 1

Understanding O*NET data and its limitations on measuring highly digital CEM work

This report uses several key sources of data. Most significant among them is occupational skills data from O*NET (the federal government's database of job characteristics) and employment data from Lightcast (a private sector database on the labor market).

Because regional and demographic data is only available on the annual level though Lightcast, this report uses 2023 Lightcast data, the most recent year available. To maintain consistency with the Lightcast data, this report also uses 2023 O*NET data.

To construct its O*NET database, the Department of Labor surveys workers about the knowledge, skills, and abilities they use in their occupations. While this approach allows for the creation of the largest and most comprehensive source of occupational characteristics, it also presents several limitations.

First, because the surveys are multiyear surveys, it means that at times there can be some occupations that are missing from the dataset entirely. For example, software developers—one of the largest computer occupations, with 1.5 million workers—was until 2017 classified as two separate occupations by the Bureau of Labor Statistics (BLS): "software developers, applications" and "software developers, systems software." After the BLS combined them into a single software developer occupation in 2018, O*NET began conducting its survey of the knowledge, skills, and abilities used in the new, combined occupation, with data scheduled to be released in 2025. That means for the purposes of this analysis, there is not data available to create a digital score for software developers, despite both former software developer occupations having digital scores above 90, which would classify them as highly digital jobs.

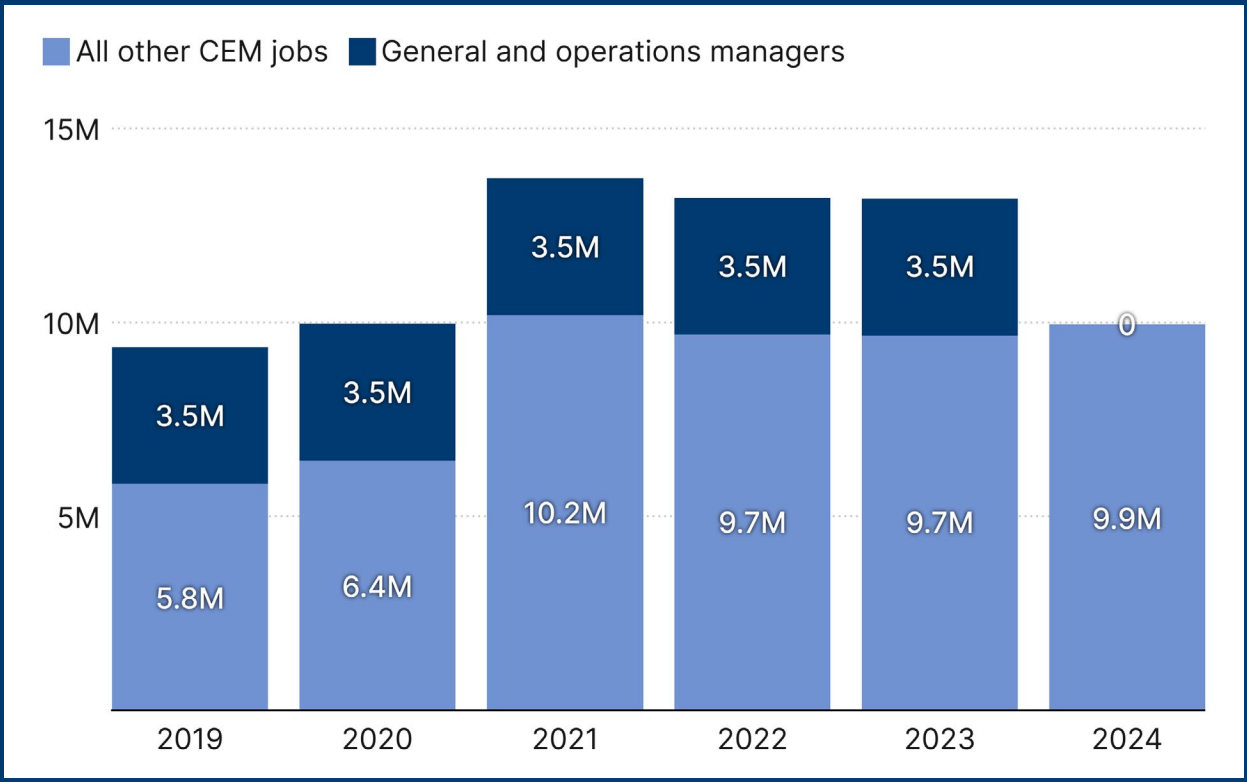
The multiyear survey structure can also lead to significant digital score swings in a single release. For example, in O*NET's most recent 2024 data release, several occupations saw changes to their digital scores. One of the largest highly digital CEM occupations—general and operations managers—saw its digital score drop from 61 to 57, meaning it is no longer classified as a highly digital job. Meanwhile, chief executives saw their scores increase from 49 to 65, turning them into highly digital jobs when they previously were not.

While general and operations managers are the only highly digital CEM occupation that went from being a highly digital job to a medium-digital job in the 2024 data, its size means that if this analysis were to be replicated in the future with 2024 O*NET and Lightcast data, the overall number of highly digital CEM jobs would likely be smaller than this current analysis, and the share of management jobs that are highly digital lower. Figure 2 below illustrates how the topline number of highly digital CEM jobs in 2023 would vary using digital scores from different years. For example, if 2019 digital scores were applied to the 2023 labor force, as shown in the 2019 column in Figure 2 below, it would result in only 9.3 million jobs nationwide being classified as highly digital CEM occupations.

BOX 1 CONTINUED

FIGURE 2

How the number of highly digital CEM jobs would change using different O*NET data release years and constant 2023 labor market data



SOURCE: Brookings analysis of Lightcast and O*NET data
NOTE: Occupational groups that have no highly digital CEM workers are excluded. Job counts are created by applying different years' digital scores to constant 2023 labor market data.

Because occupations' digital scores vary by year based on survey results—and the overall trend is toward more jobs becoming highly digital over time—it's likely that general and operations managers will again become a highly digital job in future O*NET surveys. However, beginning in the 2024 data, it will be classified as a medium-digital job for the foreseeable future.

Regardless of these limitations, the core takeaway of this analysis remains true despite changes to individual occupations: that CEM jobs remain central to the digital economy but highly unequal across demographic groups and place.

Trends

Using 2023 digitalization scores and demographic statistics, this report delineates the characteristics of "highly digital" work in the U.S. Within this high-level context, the report then dives deep into the characteristics of CEM work, which are the occupations that most clearly define the digital economy, including access to those jobs across demographic groups and place.

The data yields six significant findings, outlined in this section.

FINDING #1: HIGHLY DIGITAL OCCUPATIONS ACCOUNT FOR MORE THAN ONE-QUARTER OF ALL US JOBS, AND CAN BE FOUND IN NEARLY EVERY OCCUPATIONAL GROUP

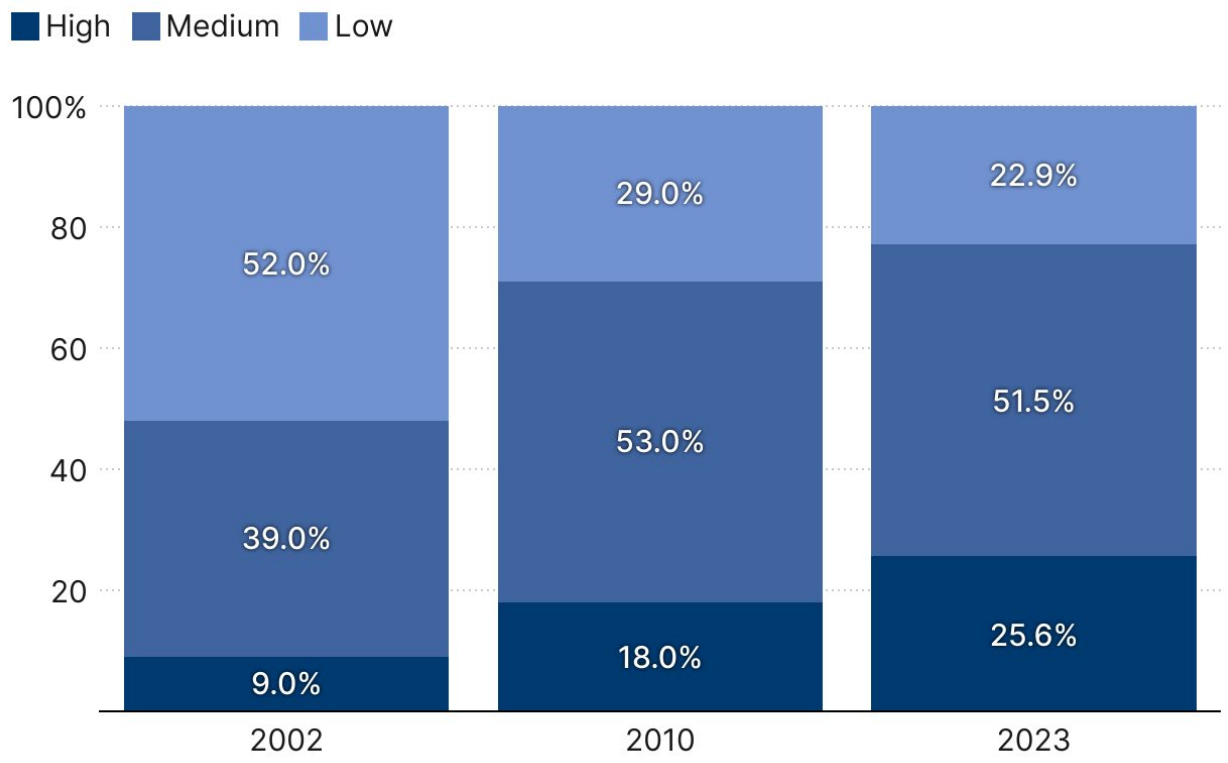
Highly digital work matters because it is a large, diverse, and growing segment of the labor market. In 2023, 34 million jobs in the U.S. qualified as highly digital—over one-quarter of the total workforce. As such, these jobs provide a substantial source of opportunity for Americans.

Moreover, the share of jobs classified as highly digital continues to grow over time. The diffusion of digital technologies has meant that more occupations are classified as highly digital today than in years past. At the same time, highly digital jobs have grown at a faster rate than other occupations in the economy. In 2023, 26% of the U.S. workforce was employed in a highly digital job—up from 18% in 2010 and just 9% in 2002.

FIGURE 3

Highly digital employment growth at a glance

2002 to 2023



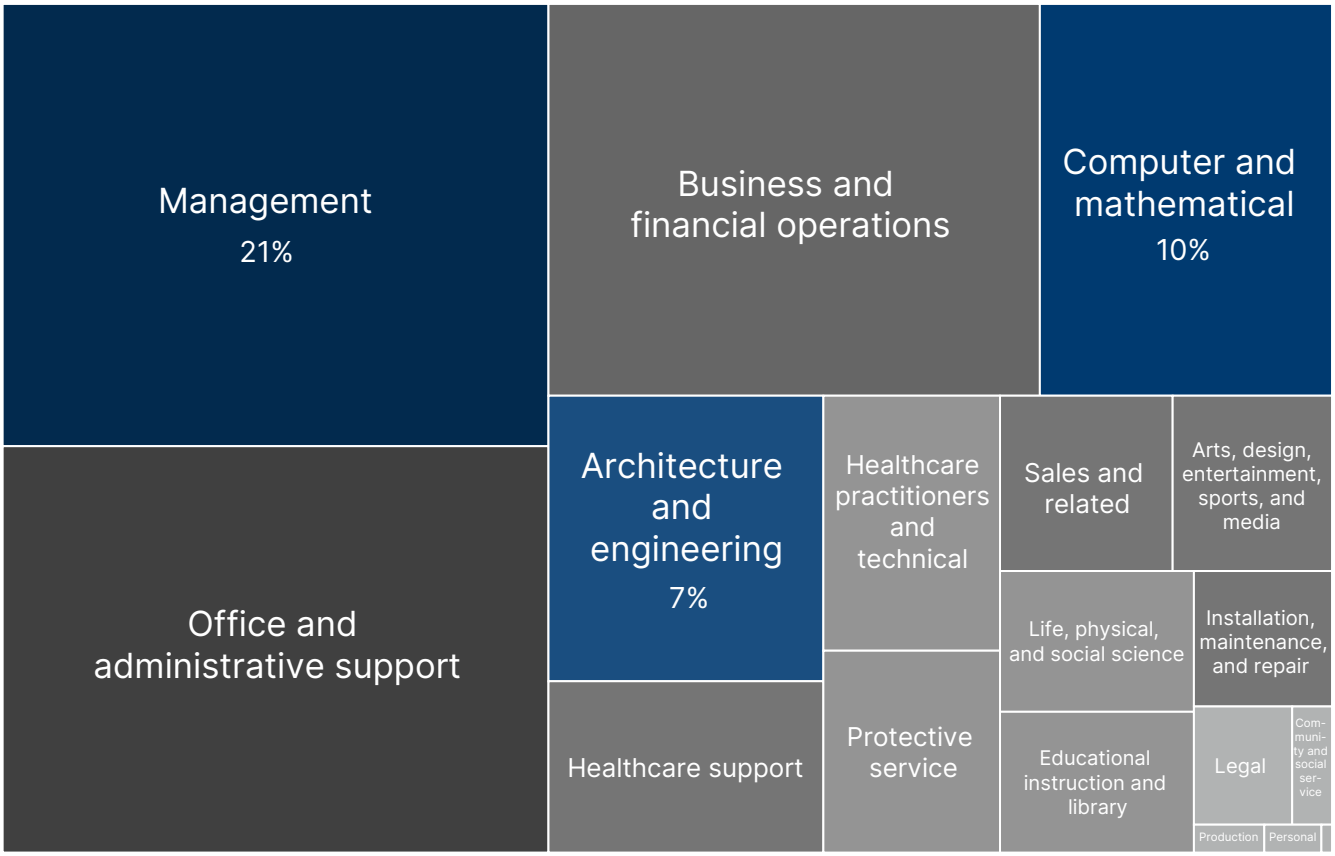
SOURCE: Brookings analysis of Lightcast data
NOTE: Calculation based on unrounded numbers. Occupations without a digital score are excluded from the calculation.

Moreover, far from affecting just a narrow segment of tech jobs with little bearing on the broader economy, digital technologies are pervading nearly every job in the economy. As such, highly digital work exists in many seemingly disparate occupational groups and encompasses hundreds of occupations. In total, 18 of the 22 major civilian occupational groups contain at least one highly digital occupation in 2023.

FIGURE 4

Share of all highly digital jobs contained in each occupation group

2023



SOURCE: Brookings analysis of Lightcast data
NOTE: Occupational groups lacking highly digital occupations are excluded from the figure. Occupational groups with a higher share of national highly digital jobs are shown in darker colors.

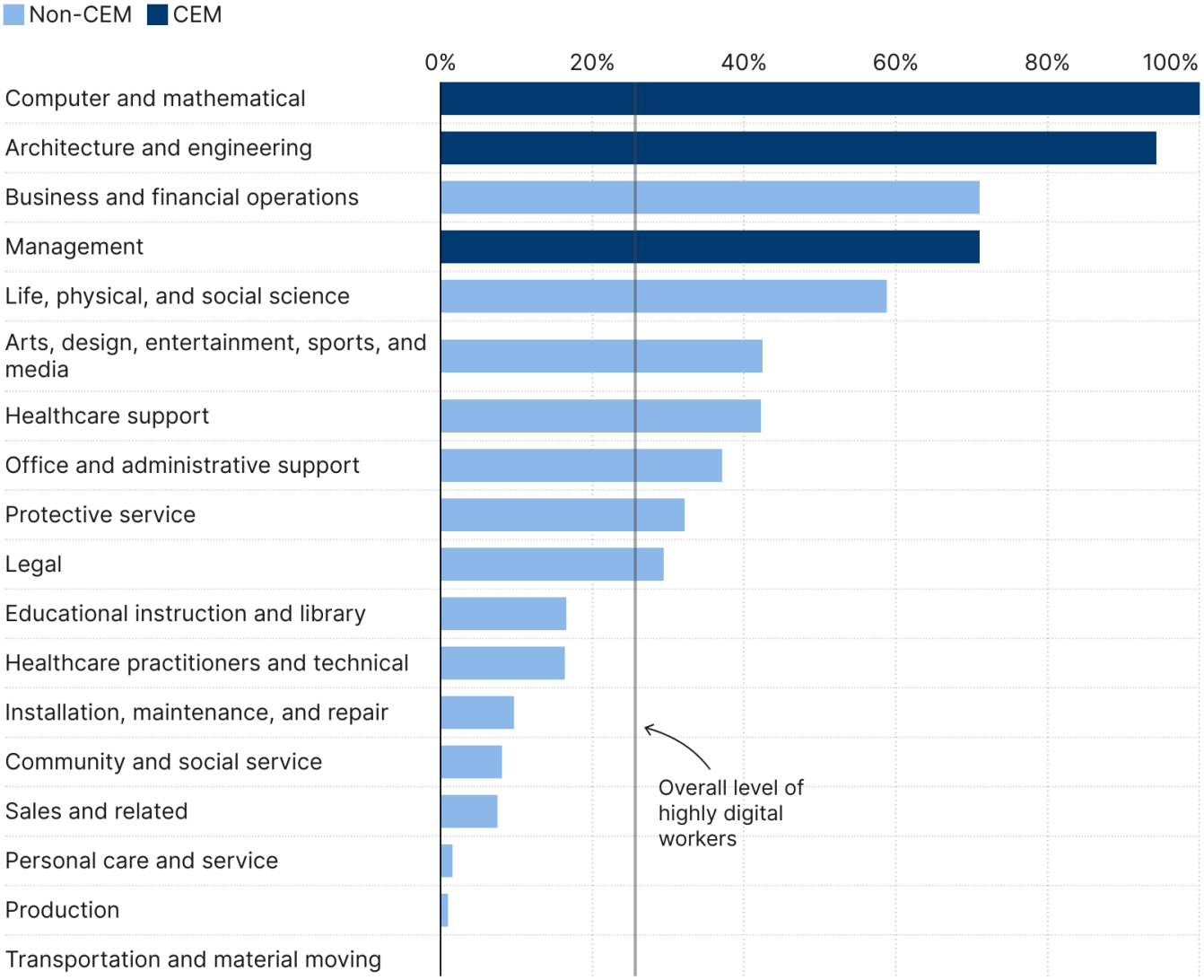
But while highly digital jobs permeate many occupational groups, the most significant sources come from knowledge and administrative work, including office and administrative support, business and financial operations, and education. Meanwhile, CEM jobs accounted for over 13 million highly digital jobs in 2023 (roughly 39% of the total), with management as well as computer and mathematical jobs accounting for two of the largest highly digital occupational groups.

Occupational groups again vary when it comes to the share of highly digital jobs within them. Most notably, CEM jobs again play a dominant role. For example, every occupation within the computer and mathematical occupational group boasted a digital score of 60 or higher in 2023, classifying them all as highly digital. Likewise, over 90% of the jobs within the architecture and engineering occupational group and 70% of the management occupational group were classified as highly digital in 2023. Two other occupational groups (business and financial operations; life, physical, and social science) have over half of workers employed in highly digital occupations.

FIGURE 5

Share of highly digital employment by occupational group

2023



SOURCE: Brookings analysis of Lightcast data
NOTE: Occupational groups that have no highly digital workers are excluded. Occupations without a digital score are excluded from the calculation.

In contrast, occupational groups where workers complete more physical tasks contained few or no highly digital jobs. Three occupational groups—personal care; production; and transportation and material moving—each accounted for less than 0.5% of the nation's total highly digital employment in 2023, with less than 2% of the employment in each those groups being highly digital. Meanwhile, four occupational groups didn't register any highly digital occupations in 2023: food preparation; farming, fishing, and forestry; construction and extraction; and building and grounds cleaning.

FINDING #2: CEM JOBS ANCHOR HIGHLY DIGITAL WORK IN THE US, AND PROVIDE A SIGNIFICANT PAY PREMIUM

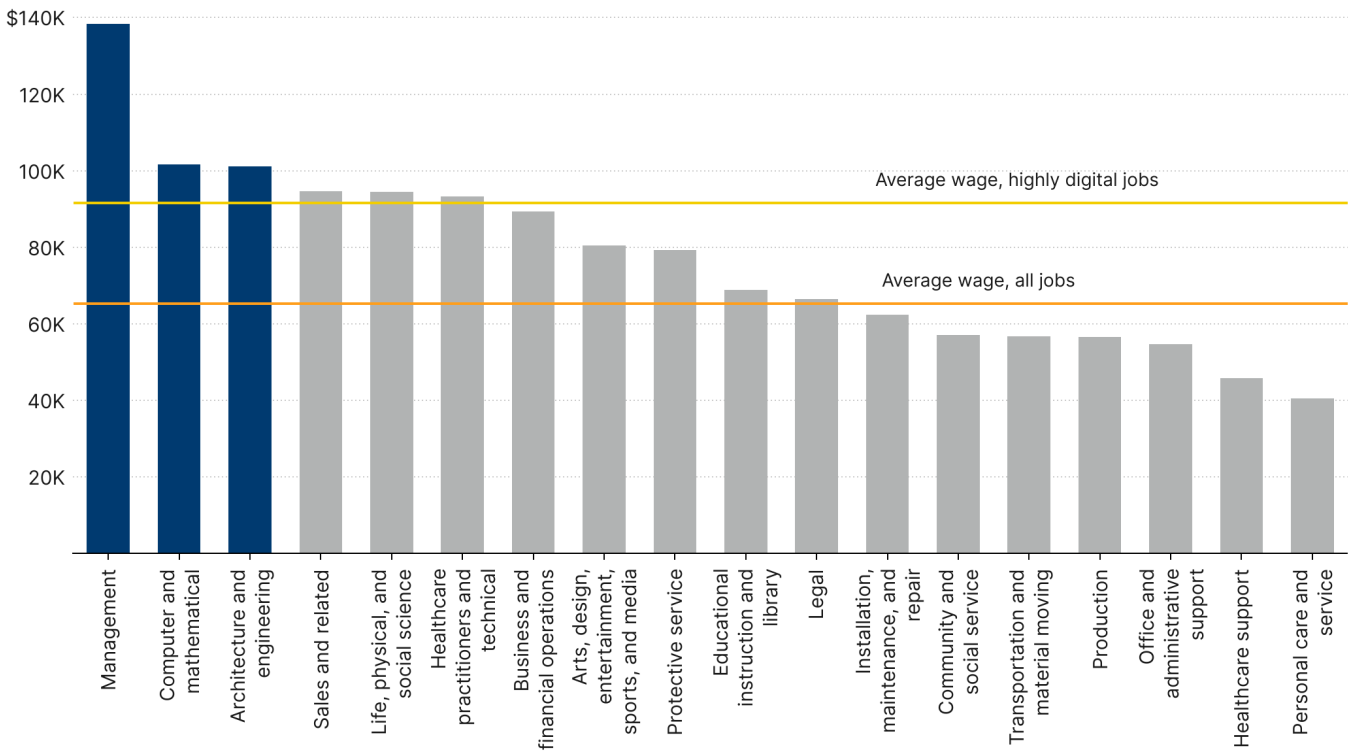
Notwithstanding the disparate nature of highly digital work, technology- and knowledge-intensive occupational groups such as computer and mathematical roles, engineering positions, and management work anchor U.S. digital employment and deliver a large share of its benefits for workers.

CEM jobs account for the most significant source of good-paying highly digital jobs. At the occupational-group level, workers in highly digital management occupations made the most on average ($138,000) in 2023, followed by computer and mathematical occupations ($102,000) and architecture and engineering occupations ($101,000). By contrast, highly digital occupations in all other non-CEM occupational groups paid an average of $73,000, while the average wage nationwide was $65,000.

FIGURE 6

Average wage of highly digital occupations in each occupational group

2023

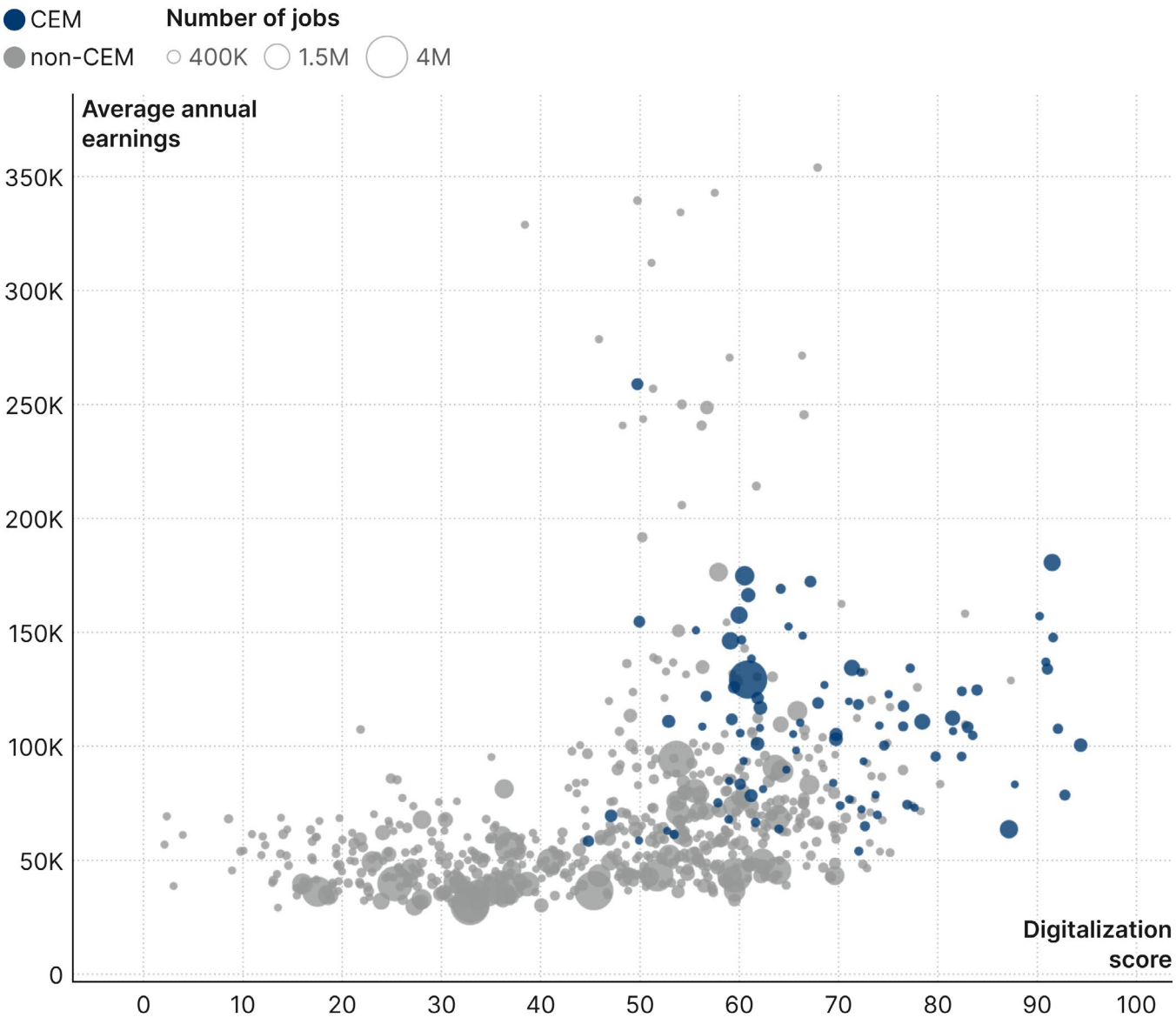


SOURCE: Brookings analysis of BLS and Lightcast data
NOTE: Occupational groups that have no highly digital workers are excluded.

FIGURE 7

Average wage by digitalization score for highly digital occupations

2023



SOURCE: Brookings analysis of BLS and Lightcast data

FINDING #3: CEM JOBS HAVE GROWN FASTER THAN OTHER JOBS IN THE ECONOMY, DRIVEN BY SIGNIFICANT GROWTH IN MANAGEMENT OCCUPATIONS

In recent years, highly digital work has grown faster than other segments of the labor market, helping to fuel the economic recovery from the COVID-19 pandemic. This growth has been driven in significant part by substantial increases in both computer and management jobs (with engineering jobs growing slower than the other two components of CEM work).

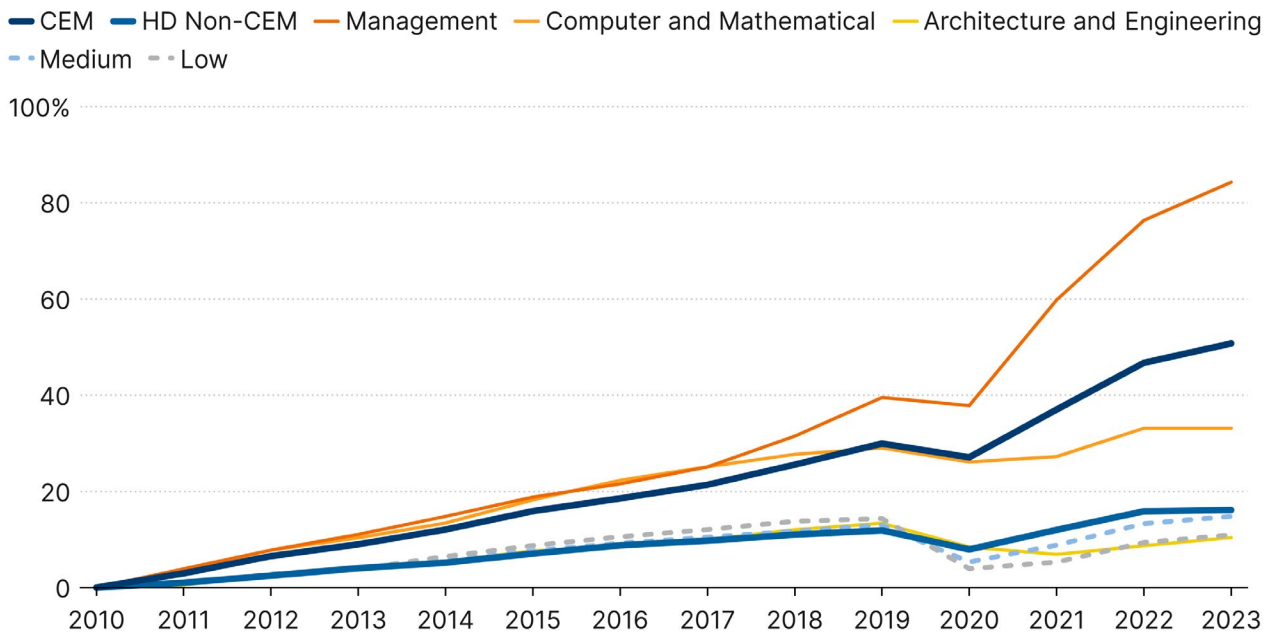
The analysis tracks the growth over time for the 209 occupations that met the threshold for highly digital work in 2023. Using this approach, it's possible to show how highly digital jobs are faring over time compared to less digital jobs.

CEM jobs overall grew at a substantially faster rate than both other highly digital jobs and the rest of the economy during the decade preceding the pandemic. However, since 2020, the story has been more mixed. From the trough of the COVID-19 crisis in 2020 through 2023, management jobs grew 33.7%—three times faster than the 9.1% growth of the labor market as a whole. Computer and mathematical jobs grew 5.6% during that time (a slower rate than that of the entire labor market), while architecture and engineering jobs grew only 1.8% (a significantly slower rate than that of the economy as a whole during the first three years of the pandemic recovery). However, these recovery numbers obscure the fact that CEM jobs were also more resilient during the pandemic recession, with CEM jobs shrinking at less than one-third the rate of the labor market as a whole from 2019 to 2020. By 2023, CEM jobs had erased their pandemic-era losses and reached employment levels nearly 16% higher than their 2019 levels, whereas all other jobs were 0.7% above their pre-pandemic 2019 levels.

FIGURE 8

Change in highly digital CEM employment and other employment

2010 to 2023



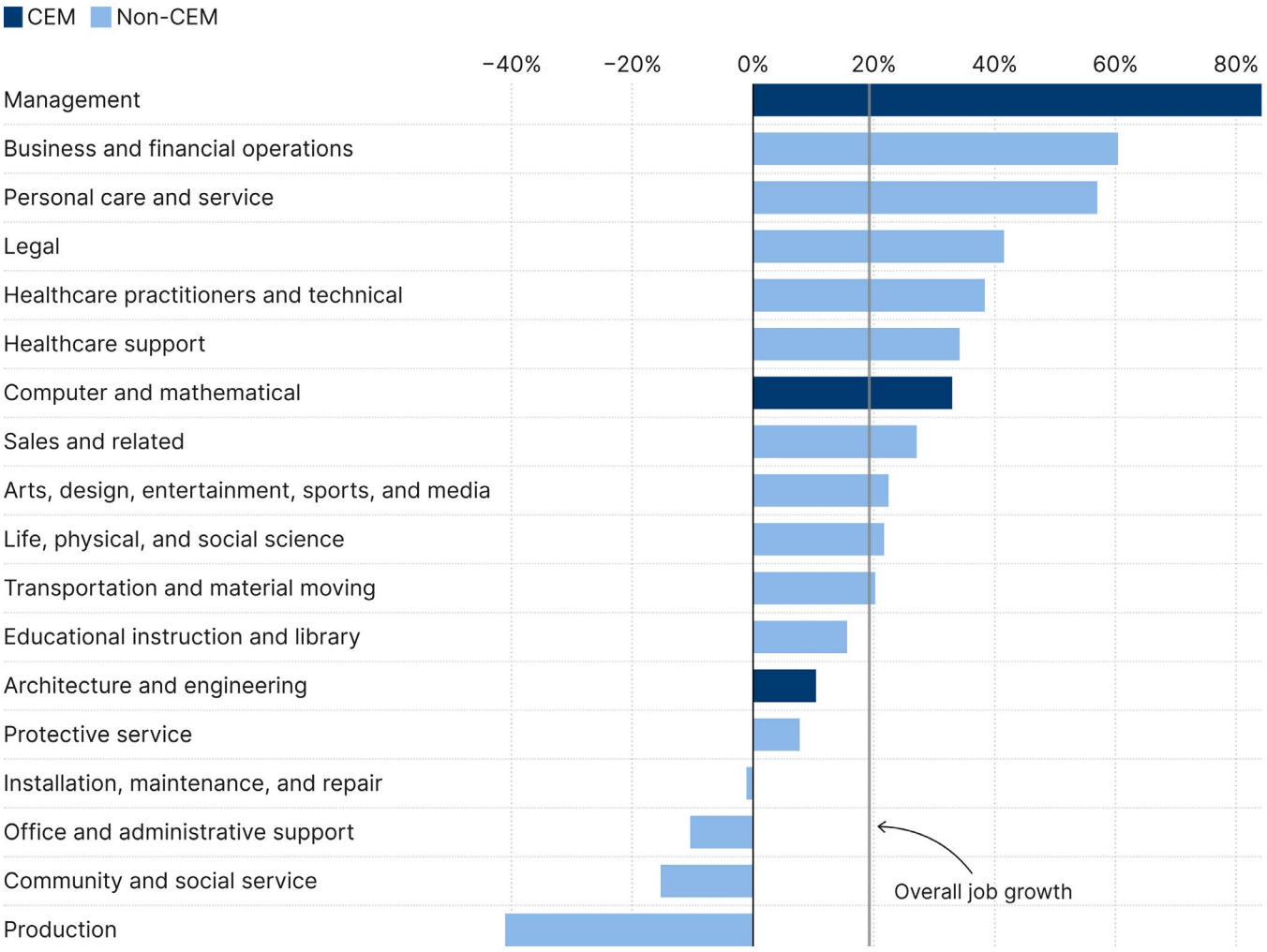
SOURCE: Brookings analysis of Lightcast data
NOTE: Calculation based on unrounded numbers. Occupations without a digital score are excluded from the calculation.

Looking at labor market data beginning with the last economic expansion in the 2010s shows that CEM jobs contributed significantly to that expansion as well. By again using a constant set of 209 occupations, it's possible to show that the management occupational group saw some of the fastest growth between 2010 and 2023, growing at 84.2% during that time—over five times the rate of the labor market as a whole. Highly digital occupations in computer and mathematical occupations (33.1% growth) also saw substantial employment gains during this period, while architecture and engineering jobs grew at a 10.3% rate—again slower than the rest of the labor market (16.8%).

FIGURE 9

Change in highly digital employment by occupational group

2010 to 2023



SOURCE: Brookings analysis of Lightcast data
NOTE: Calculation based on unrounded numbers. Occupations without a digital score are excluded from the calculation.

FINDING #4: WOMEN, AS WELL AS BLACK, LATINO OR HISPANIC, AND INDIGENOUS WORKERS, ARE SIGNIFICANTLY UNDERREPRESENTED IN CEM JOBS

Because of the attractive growth, pay, and opportunity available in CEM jobs, these roles have the potential to be an important source of good wages and wealth-building for Americans who have historically been marginalized in the labor force. Moreover, the benefits of a diverse workforce don't simply extend to workers; significant evidence has shown that diverse workforces lead to improved firm performance and better investment decisionmaking.[6] As such, effectively engaging individuals from diverse backgrounds is essential for firm, industry, and ultimately national competitiveness.[7]

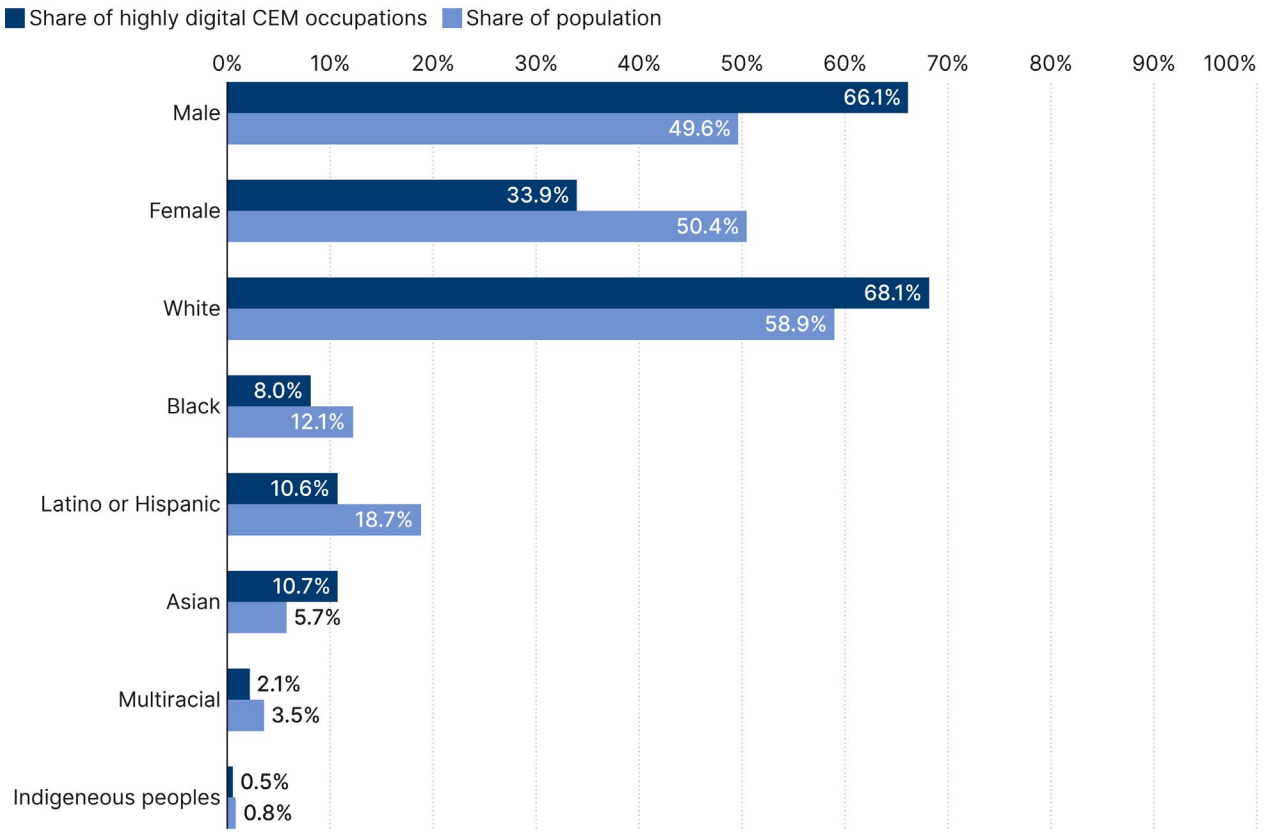
Unfortunately, measures of basic inclusion reveal that access to CEM work remains highly uneven across demographic lines.

Women, as well as Black, Latino or Hispanic, and Indigenous workers, remain underrepresented in CEM jobs relative to their share of the population (for the purposes of this analysis, Indigenous peoples are defined as individuals who are classified as American Indian or Alaska Native as well as Native Hawaiian or Other Pacific Islander; see endnote for further detail).[8] As such, this report refers to Black, Latino or Hispanic, and Indigenous workers collectively as "underrepresented workers of color."[9]

FIGURE 10

Share of workers in highly digital CEM occupations compared to that group's share of the population as a whole

2023



SOURCE: Brookings analysis of Lightcast data
NOTE: Calculation based on unrounded numbers. Occupations without a digital score are excluded from the calculation.

The patterns are stark. While Black workers accounted for over 12% of the U.S. population in 2023, they held only 8% of CEM occupations. Latino or Hispanic workers were even more underrepresented: They accounted for nearly 19% of the U.S. population, but held less than 11% of CEM jobs. Similarly, Indigenous people, constituting of 0.8% of the U.S. population under the definition used in this analysis, held less than 0.5% CEM occupations.

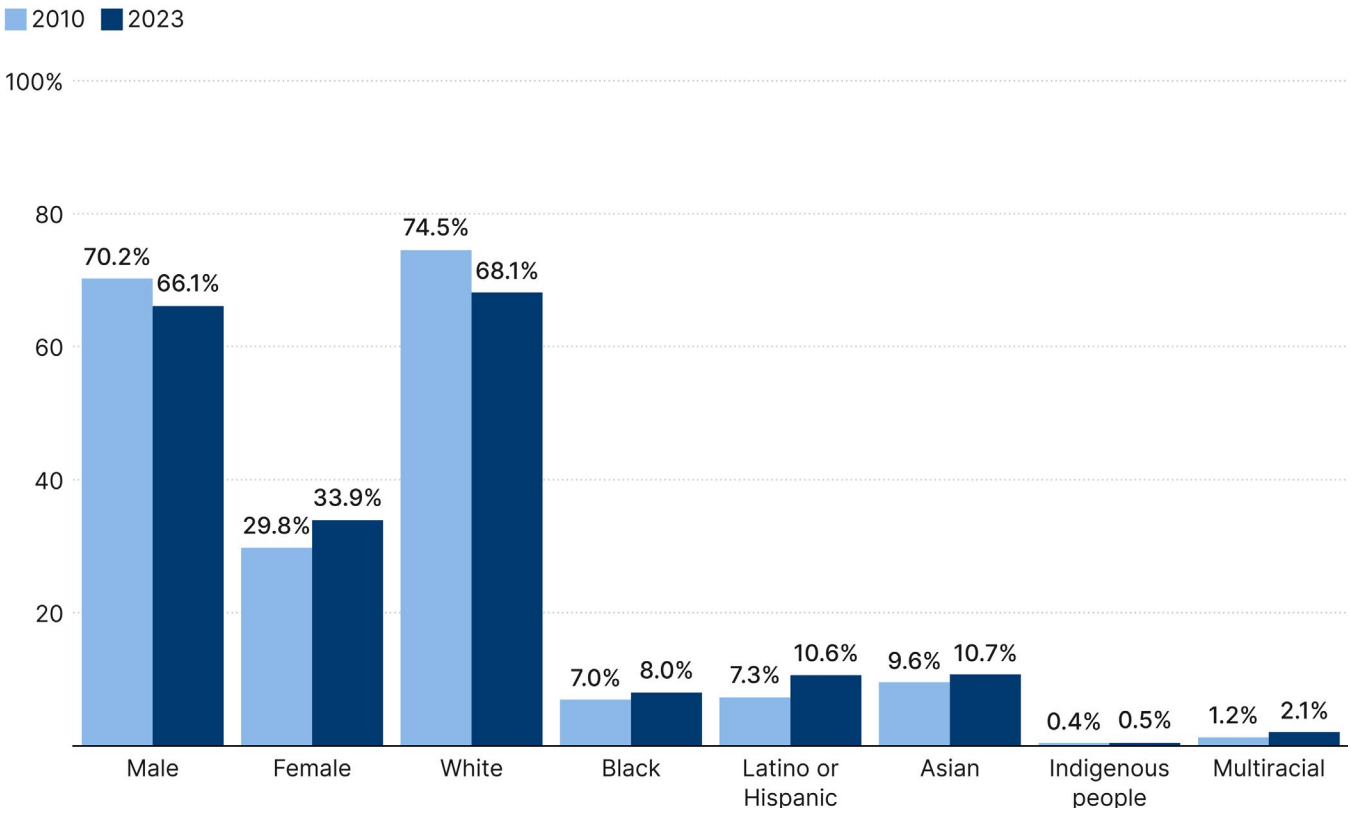
On the other hand, non-Hispanic white and Asian American workers are overrepresented in CEM occupations. Non-Hispanic white Americans held more than two out of every three CEM occupations in 2023—greater than their 59% population share. At the same time, Asian American workers accounted for 10.7% of CEM occupations, compared to under 6% the U.S. population.

Holding the set of occupations constant, as done in Finding #1, allows for demographic comparisons over time. Figure 11 compares the demographics of CEM occupations over time to show how demographic trends have changed within those occupations.

FIGURE 11

Change in highly digital CEM job share across different demographic groups

2010 versus 2023



SOURCE: Brookings analysis of Census Bureau data, IPUMS USA 1-year ACS microdata, and Lightcast data
NOTE: American Indian, Alaska Native, Native Hawaiian, and Other Pacific Islander are included in the Indigenous peoples group. Calculation based on unrounded numbers. Percentages may not sum to 100% due to rounding.

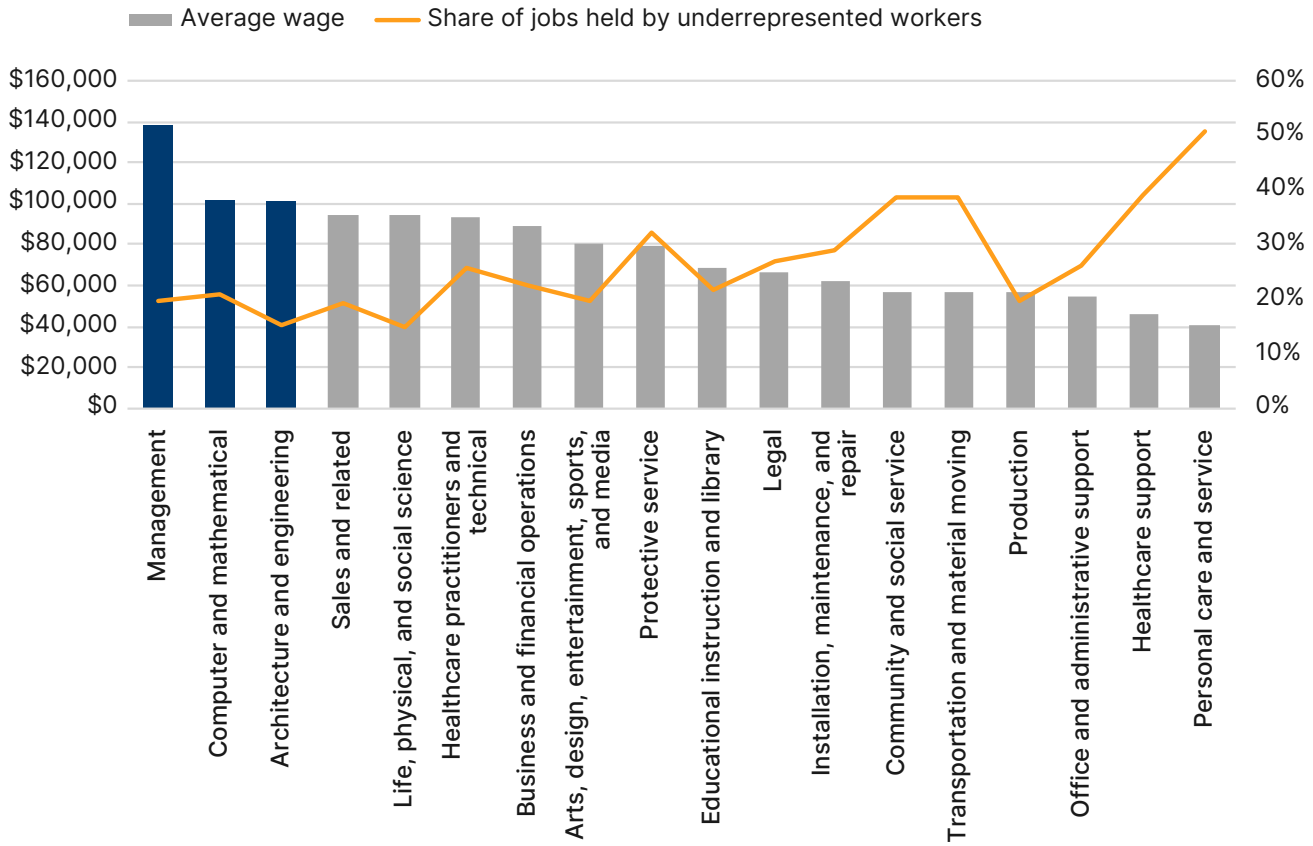
As Figure 11 shows, there has been limited and uneven progress over time in expanding the share of CEM jobs held by underrepresented racial and ethnic groups. Between 2010 and 2023, Black and Indigenous workers saw just a 1.1 and less than 0.1 percentage point increase, respectively, in their share of CEM jobs. On the other hand, Latino or Hispanic workers saw a 3.3 percentage point increase in the share of CEM jobs that they held—good for a nearly 50% increase in share. The Latino or Hispanic population grew from 16.3% to 18.8% of the total U.S. population during that time (a 1.4% percentage point increase), meaning that less than half of the increase for Latino or Hispanic workers in highly digital work resulted from population growth alone. In other words, Latino or Hispanic workers appear to be making real gains in their share of CEM jobs, though they remain underrepresented.

Comparing CEM jobs against other highly digital jobs underscores the depth of the inclusion challenge in these occupations. As shown in Figure 12, highly digital roles in the best-paying occupational groups see lower levels of representation for underrepresented workers of color than those in lower-paying occupational groups. Less than 20% of workers in high-paying CEM occupational groups belong to an underrepresented racial or ethnic group, compared to those demographic groups' 32% share of the total U.S. population. On the other hand, underrepresented workers are slightly overrepresented in lower-paying highly digital community and social service and health care support occupations, accounting for 38.9% of workers in those occupations.

FIGURE 12

Underrepresented workers are overconcentrated in lower-paying highly digital jobs

Share of underrepresented workers in highly digital jobs and average wages by occupational group, 2023



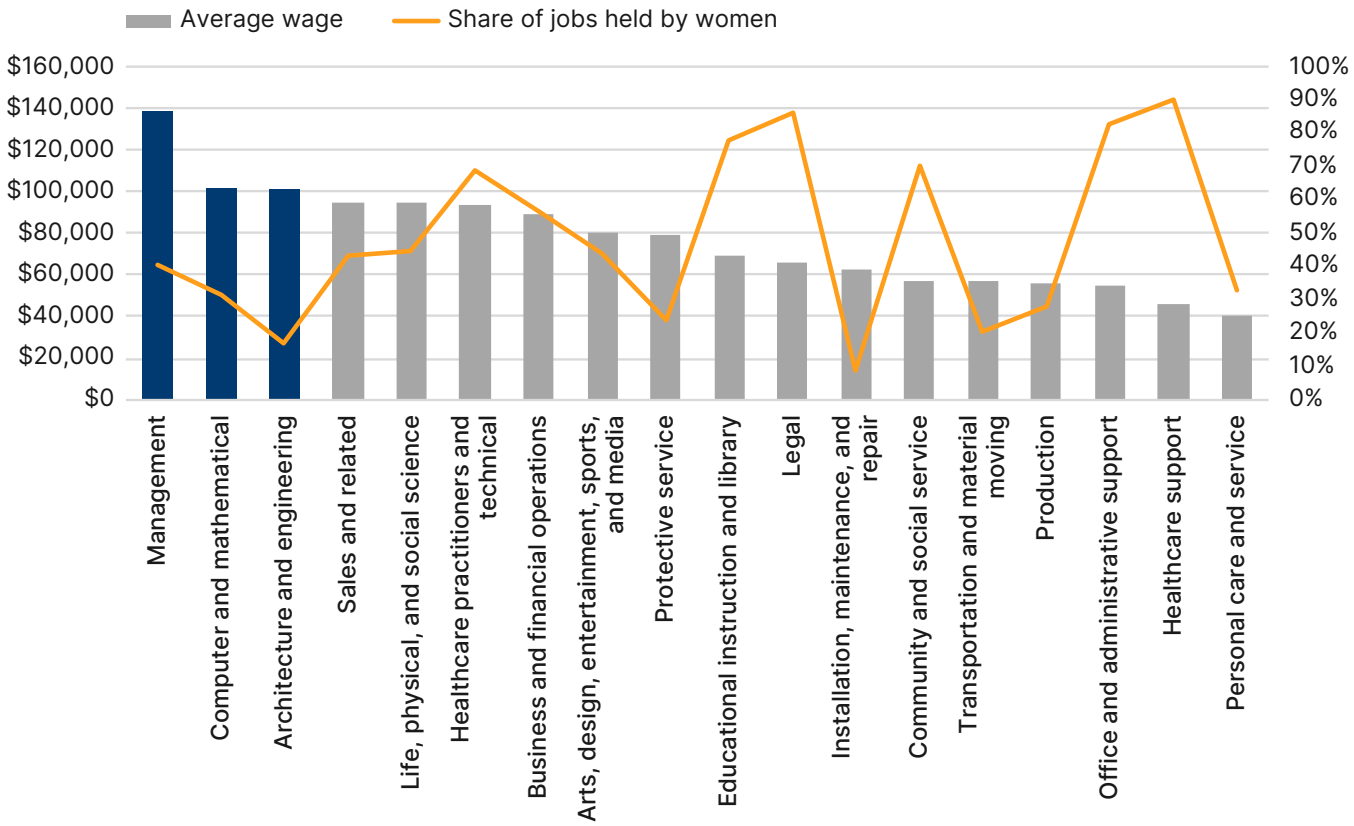
SOURCE: Brookings analysis of Lightcast data

Women likewise face pay disparities in tech jobs, receiving lower wages for the same occupations than men, and they remain underrepresented in the best-paying CEM occupations.[10] Women are also underrepresented across all CEM jobs, accounting for just 33.9% of employment in those three occupational groups. On the other hand, women are significantly overrepresented in four of the five occupational groups with the lowest pay for highly digital work.

FIGURE 13

Women are overconcentrated in some lower-paying highly digital jobs

Share of women in highly digital jobs and average wages by occupational group, 2023



SOURCE: Brookings analysis of Lightcast data

Overall, CEM jobs have potential to provide access to some of the best-paying work in the U.S. economy. However, ongoing inequality along gender, racial, and ethnic lines in access to CEM work remains a significant challenge.

FINDING #5: MOST EMPLOYERS REQUIRE A BACHELOR'S DEGREE FOR CEM JOBS, MAKING HIGHER EDUCATION A CRUCIAL BARRIER TO ENTRY

Given that CEM occupations can be a source of good-paying work, it bears examining how accessible these jobs are for workers of different educational levels. As it happens, educational demands represent a serious hurdle to the inclusivity of CEM work. Just 12.6% of CEM jobs—or about 1.7 million total jobs—could be accessed without a four-year degree in 2023, and Census Bureau data shows that there are very few pathways to computer and engineering jobs in particular without a STEM degree.[11]

The small portion of CEM occupations accessible to workers without a bachelor's degree include computer user support specialists (679,000 jobs) and computer network support specialists (155,000

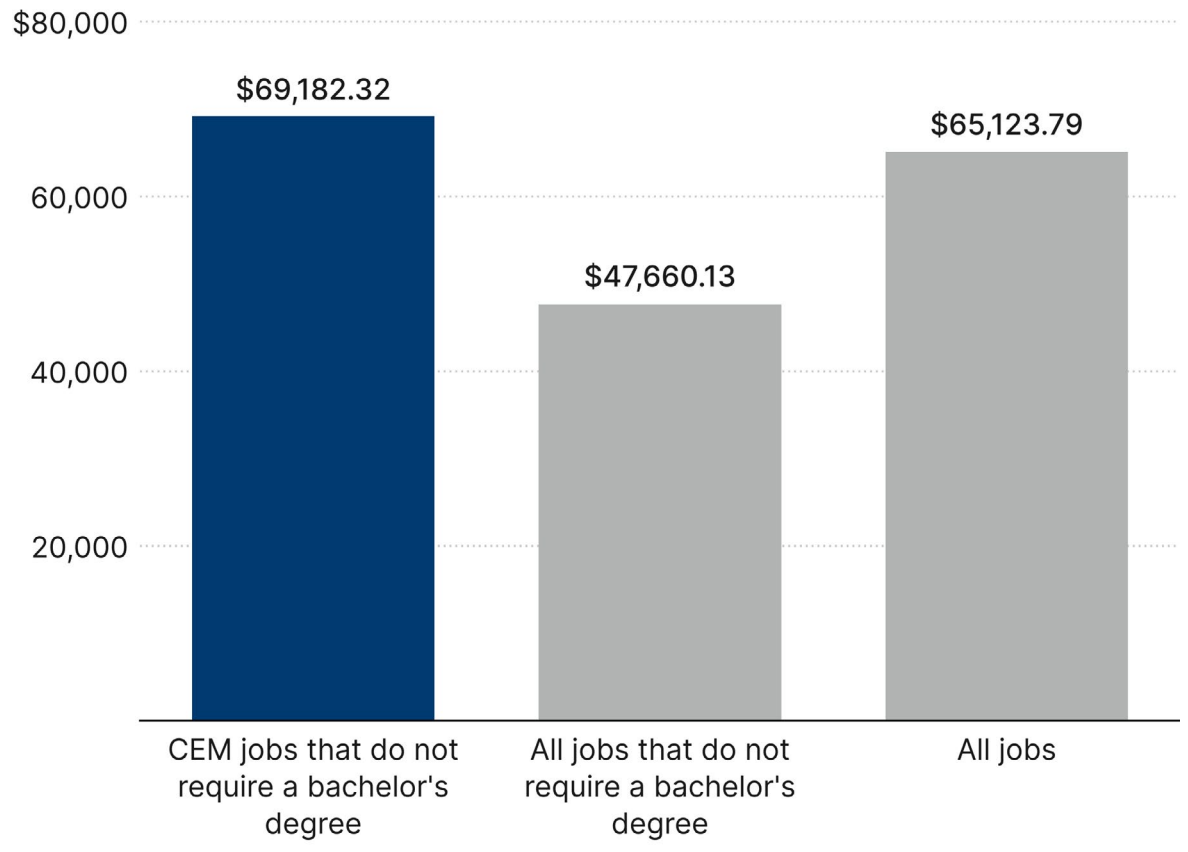
jobs); management jobs such as property, real estate, and community association managers (281,000 jobs); and engineering jobs such as electrical and electronic engineering technologists and technicians (97,000) and electrical and electronics drafters (21,000 jobs).

These jobs matter because they're a source of good-paying work for workers without a degree. In 2023, the nation's 1.7 million CEM jobs that didn't require a degree paid an average of $69,200. That figure represented a premium of more than $20,000 over the national average salary for jobs that don't require a bachelor's degree.

FIGURE 14

Highly digital CEM jobs pay better than other jobs for workers without a bachelor's degree

Average wages by selected occupational groups, 2023



SOURCE: Brookings analysis of BLS and Lightcast data
NOTE: Calculation based on unrounded numbers.

However, despite these successes, the relatively few opportunities for workers without a bachelor's degree in CEM occupations illustrates a need to broaden access to and success within four-year education—and in particular, four-year STEM education—to more students, while continuing to develop novel pathways into CEM work for those without a degree.

FINDING #6: CEM JOBS ARE UNEVENLY DISTRIBUTED BY PLACE, LIMITING THEIR ACCESSIBILITY

Technology-intensive occupations and industries tend to agglomerate—or "cluster"—in relatively few places. CEM jobs are central to this dynamic.

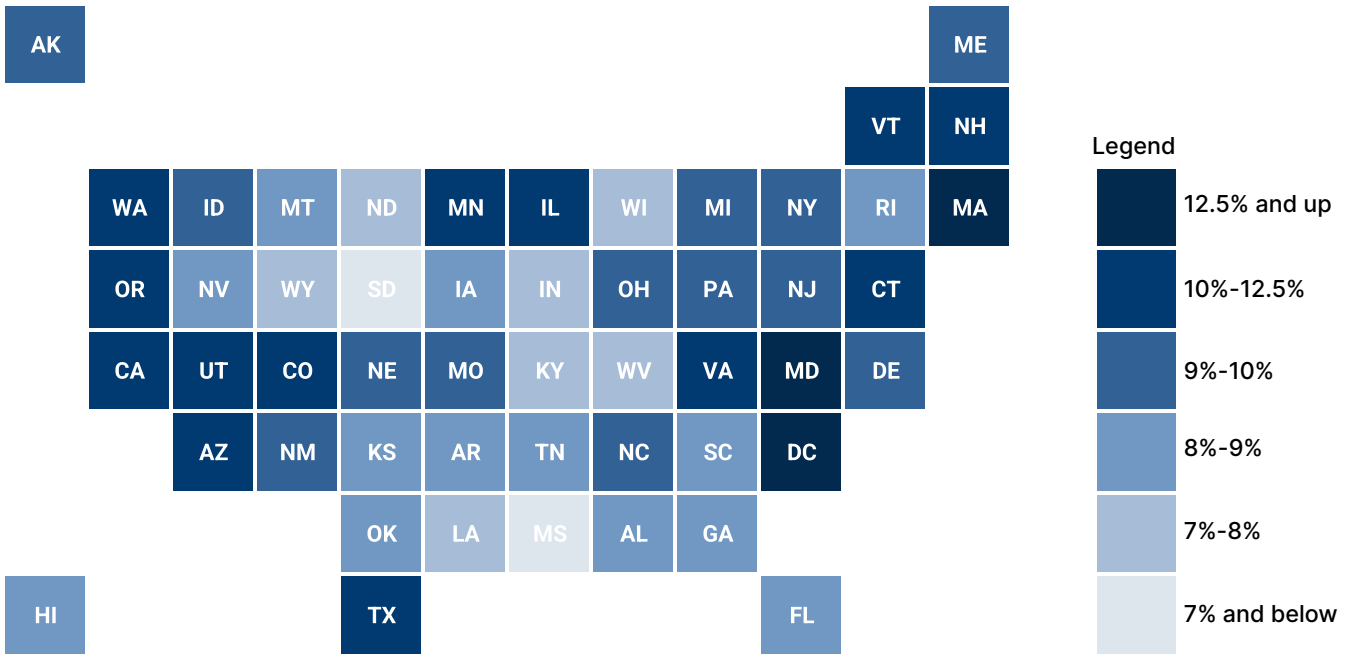
Specifically, these spatial patterns—and associated access challenges for some workers—mean that there are fewer opportunities for many people living outside of the largest CEM clusters to access this important source of high-paying work. This is another access problem for millions of workers across the country—including millions of underrepresented workers.

To start, states exhibit significant variations in the density of their highly digital employment opportunities.

MAP 1

Share of highly digital CEM jobs by state

2023



SOURCE: Brookings analysis of Lightcast data
NOTE: Occupations without a score are excluded from the calculation. Calculation based on unrounded numbers.

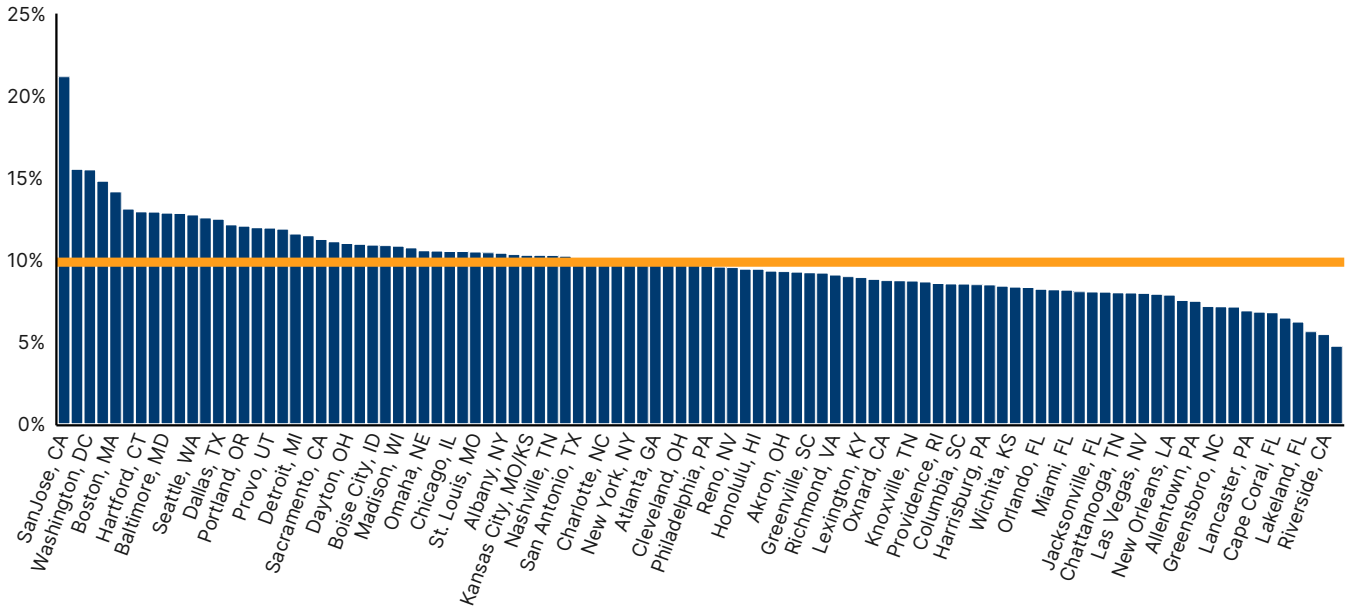
The densest population of CEM work takes place in and around the nation's capital, as well parts of New England. Both regions have substantial technology and management clusters and a large higher education presence. Over 17% of jobs in Washington, D.C. are CEM jobs. Outside of the District itself, the share of CEM jobs varies significantly across states. Maryland leads with 13.8% of jobs qualifying as CEM jobs, followed by Massachusetts at 13.4%. Beyond those regions, Utah, Colorado, and Texas possess significant shares of CEM jobs, powered by tech clusters in Salt Lake City, Boulder, and Austin, among other cities.

On the other hand, South Dakota has the lowest share of CEM work, at just 5.9% of the state's jobs; its economy is driven by production, transportation and material moving, food preparation, and personal care and service occupations that are not highly digital.

Meanwhile, the tendency of CEM occupations—particularly computer and engineering jobs—to cluster more densely in specific urban places can be seen in the distribution of these occupations across the 100 largest U.S. metropolitan areas, as shown in Figure 15.

FIGURE 15

Share of employment in highly digital CEM occupations in selected metro areas
2023



SOURCE: Brookings analysis of Lightcast data

This concentration of CEM jobs results in substantial variance by place in the supply of these occupations across the 100 largest metro areas. San Jose, Calif. leads the charts for each of the categories, with 8.4% of its jobs in highly digital management occupations, 7.2% in highly digital computer and mathematical occupations, and 5.6% of its jobs in highly digital engineering occupations.

For management jobs, the second-highest-concentration large metro area (Bridgeport, Conn., with 8.4% of its jobs in management) is nearly three times more concentrated in such roles than the lowest-concentration large metro area for management jobs (Stockton, Calif., at 3%). For engineering roles, Detroit is second behind San Jose, with 3.9% of its jobs in engineering occupations, and has a concentration nearly six times higher than Winter Haven, Fla., which ranks last, at 0.8%. And for computer occupations, the spatial divide is even wider: These occupations comprise 6% of the jobs in Washington, D.C. (the top metro area behind San Jose), but just 0.9% in last-place Stockton—a seven-to-one ratio.

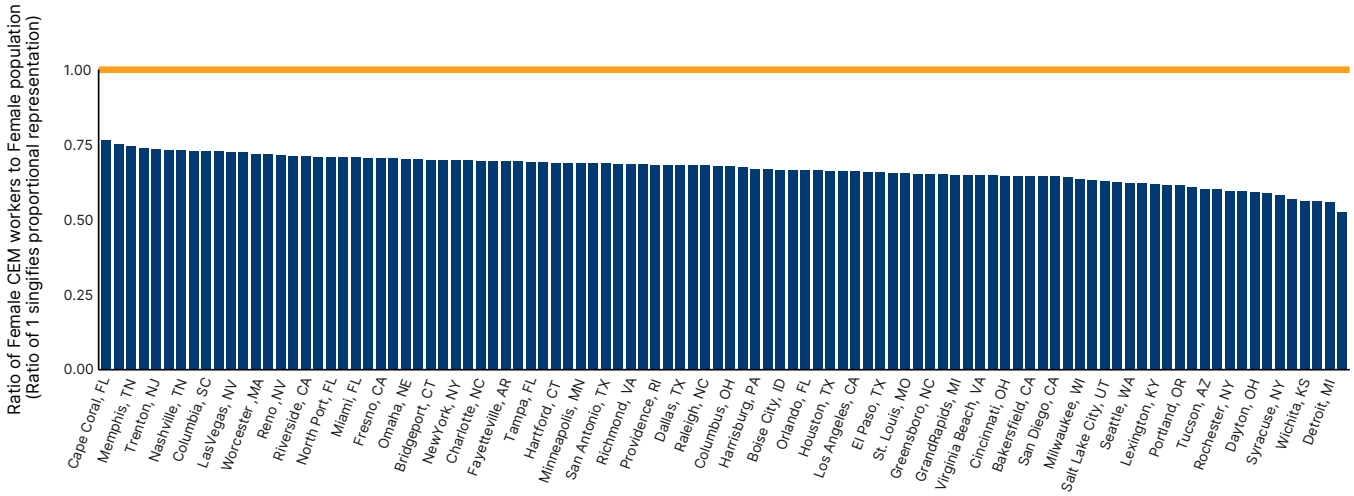
Just 30 metro areas account for over 50% of the nation's CEM jobs. In sum, the spatial dynamics of highly digital work—especially in the CEM realm—ensure that access to the best-paying highly digital jobs varies significantly across places.

On the demographic side, while there is some variation in access to CEM jobs by place, women, as well as Black, Latino or Hispanic, and Indigenous workers, remain underrepresented in these positions across the country. Indeed, there isn't a single metropolitan area in the United States where women or underrepresented workers hold CEM jobs at a rate equal to their share of the population.

FIGURE 16

Female workers are underrepresented in highly digital CEM jobs across the nation's 100 largest metro areas

2023

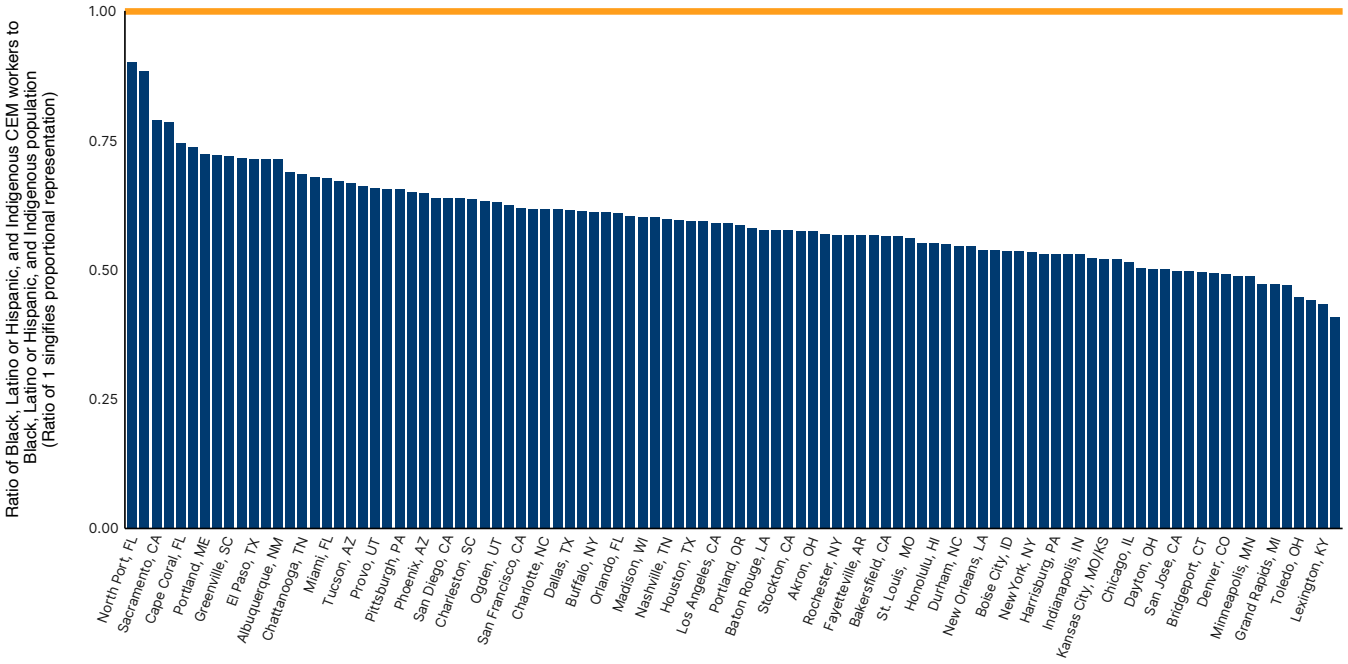


SOURCE: Brookings analysis of Lightcast data

FIGURE 17

Black, Latino or Hispanic, and Indigenous workers are underrepresented in highly digital CEM jobs across the nation's 100 largest metro areas

2023



SOURCE: Brookings analysis of Lightcast data

These trends illustrate clear inequalities in access to CEM jobs for women and underrepresented workers of color. What comes next is an analysis briefly exploring the factors contributing to some of these trends, followed by an array of policy suggestions to begin rectifying these disparities.

Policy responses to underrepresentation in CEM work

As discussed in the preceding section, CEM occupations have the strongest influence on the technologies that underpin the digital economy as well as the demographics of firms that create technology products. But despite their importance, they remain among the most segregated occupations in the labor market. Given the growing importance of CEM work for promoting economic opportunity and technological equity, reducing the stark divides between different groups' ability to access these jobs has become crucial.

However, significant educational, bias, and place-based issues continue to reinforce unequal access to highly digital work. Specifically, this analysis identifies three important barriers to creating a more inclusive digital economy:

- Underrepresented individuals face greater barriers to digital skill development, limiting their access to CEM jobs.
- STEM education challenges and biases create obstacles to underrepresented individuals in accessing CEM jobs.
- Many communities have too few CEM jobs.

Overcoming these barriers will require policy action along three major themes:

- Make digital skill development opportunities more equitable.
- Broaden access to STEM education, CEM career paths, and entrepreneurship.
- Create a robust supply of inclusive CEM jobs in more places.

Recognizing that federal policy action to reduce disparities by race and gender in CEM work is unlikely in the coming few years, this policy section first proposes state and local actions that can be taken, followed by complementary federal supports that would better enable these state and local actions.

MAKE DIGITAL SKILL DEVELOPMENT OPPORTUNITIES MORE EQUITABLE

Digital skills are a necessity for succeeding in highly digital work, and therefore a key determinant of access to highly digital jobs. But access to digital skills is not distributed equally. Many workers—especially workers of color, less educated workers, and rural workers—are given fewer opportunities or resources to acquire digital skills, systematically disadvantaging those groups and creating barriers to opportunity for millions of workers.

Skill inequities begin early in life and reflect multiple influences.[12] Because race and socioeconomic status are closely intertwined in the United States, Black, Latino or Hispanic, and Native American children are more likely to attend schools that are under-resourced.[13] With fewer financial resources, the technology offerings at schools serving low-income students often fall short of what those students need in order to successfully develop foundational digital skills.[14] Under-resourced schools are less likely to offer the full range of math, science, and computing courses generally seen as prerequisites to studying fields that lead to CEM work. For example, only about one-third of public schools with high-minority populations offer calculus, compared to over 50% of schools with low-minority populations.[15] Just 34% of Black students attend a school offering computer science (CS) courses.[16] Meanwhile, about half of high schools nationwide still don't offer foundational CS courses—again disproportionately affecting schools serving Black, Latino or Hispanic, and Native American students.[17]

Nor is inequality limited to just school resources or income levels. Learning cultures in digitally oriented fields such as STEM can be unfriendly to girls and students of color. Courses that rely on rote memorization and ignore the problem-solving aspects of STEM often fail to link subject matter with students' prior knowledge, connect topics to real-world uses, or cover the contributions of women and people of color to the sciences and mathematics. As such, they may not resonate as well as courses that do make those connections, which can lead girls and students of color away from STEM pathways.[18]

Students from underrepresented groups also face hostility and outright prejudice, which can slow their learning journey. For example, in interviews, Black elementary school students report being exposed at an early age to incorrect stereotypes about their STEM abilities.[19] Similar stereotypes surround the relationship between girls and technology-related fields.[20] Environmental cues, such as unbalanced racial and gender representation in classrooms, can reinforce these dynamics. Individuals' awareness that their behavior might be viewed through the lens of stereotypes—known as "stereotype threat"—has been shown to harm student trajectories.[21]

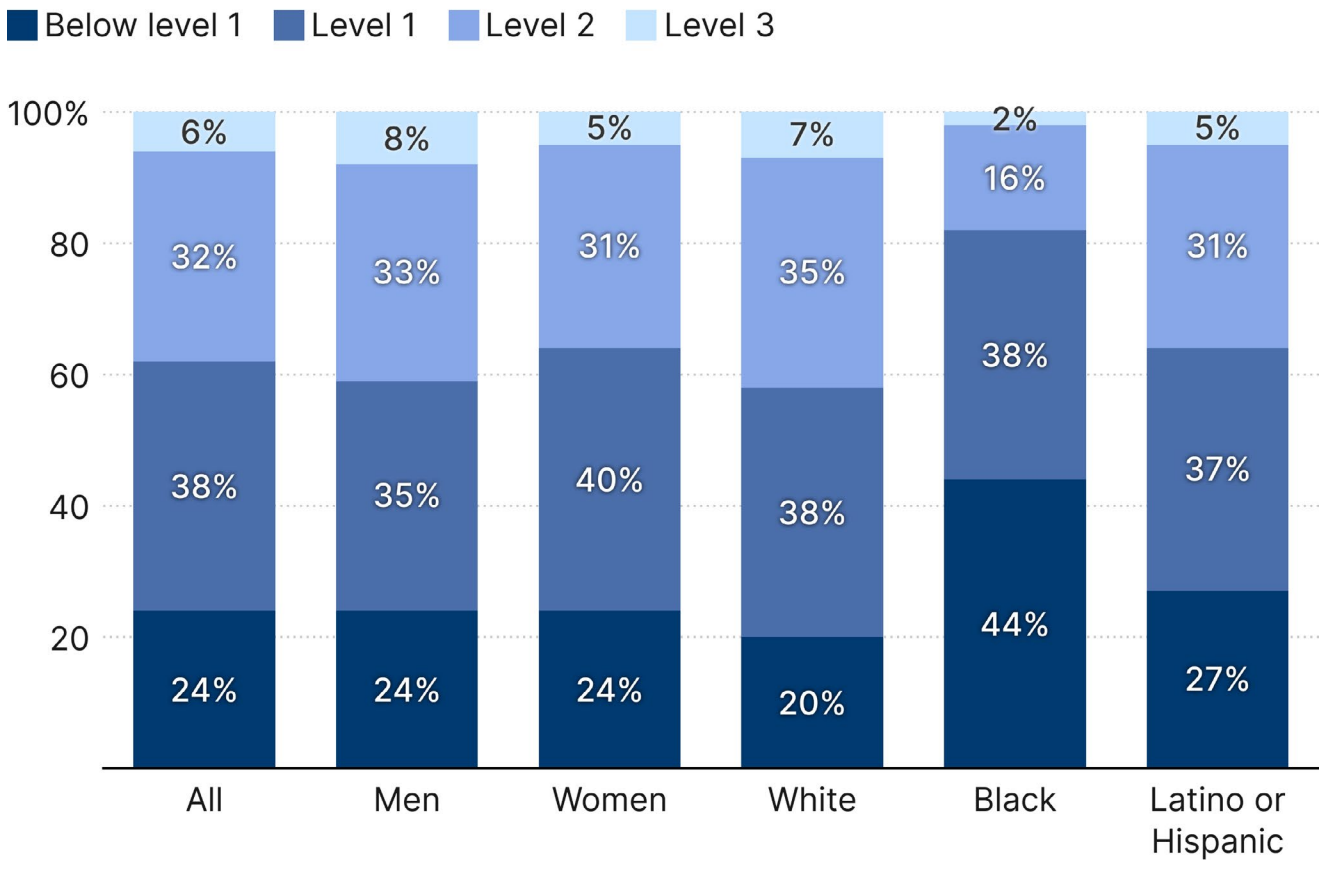
These obstacles to digital skill development that children from underrepresented groups face compound on one another and contribute to individuals from those groups registering lower levels of digital skills. Data from the Organisation for Economic Co-operation and Development's Survey of Adult Skills (officially known as the Programme for the International Assessment of Adult Competencies, or PIAAC), allows comparison of digital skills across groups.[22] The National Center for Education Statistics defines Level 2 or above on the PIAAC as indicating proficiency in digital problem-solving.[23]

In this data, Black and Latino or Hispanic workers show lower levels of digital proficiency, reflecting the relatively greater barriers to digital skill development for individuals in those groups. Just 18% of Black workers and 36% of Latino or Hispanic workers scored at a Level 2 or above, compared to 42% of white workers. While the divides across gender were less stark, still just 36% of women scored at Level 2 or above, compared to 41% of men

FIGURE 18

Share of US adults at selected levels of proficiency on PIAAC digital problem solving

2017



SOURCE: Brookings analysis of National Center for Education Statistics data
NOTE: Data for Indigenous people and Asian Americans is not available because reporting standards were not met. Detail may not sum to totals because of rounding.

Inequities in access to digital skills prevail across other demographic lines as well. Research has shown that individuals with lower levels of education are also less likely to have high levels of digital skills, and that rural U.S. residents have lower levels of digital skills than urban or suburban residents, among other demographic inequalities.[24]

Meanwhile, researchers Ian Hecker, Shayne Spaulding, and Daniel Kuehn at the Urban Institute show that device access is one of the biggest barriers to developing digital skills, with many skill development offerings now themselves being online.[25] The same groups that face other hurdles to highly digital work also face the most severe impediments to device and broadband access.[26] In this regard, the lack of digital infrastructure and lack of digital skills feed off one another as barriers to highly digital work.

POLICY ACTIONS

Given the national presence of highly digital work and the consistent inequalities in access to it (particularly along gender, racial, and ethnic lines), it's critical that policymakers act to broaden access to good-paying highly digital work for more people. Doing so will require policy steps across two important themes:

- Create more equitable digital education for students and young people.
- Increase skill development opportunities for more workers.

Create more equitable digital education for students and young people

Ensuring that all workers have access to the digital skills they need to participate in highly digital work must begin early in life. Early exposure to digital skills not only prepares individuals for highly digital work as soon as they enter the workforce, but also makes them more capable of adopting new digital technologies throughout their lives.

As mentioned throughout this analysis, students who attend schools with fewer resources for digital skill development have fewer opportunities to access highly digital work. And while the federal government must do more to provide incentives for states and localities, state and local actors have the most power to rectify these inequalities.

To that end, states should **promote more equal funding across school districts.** More equitable primary and secondary school funding is a necessary condition for making STEM and digitally focused education more equitable. Studies have shown that schools with more financial resources—particularly those serving low-income students—create more opportunities for students to acquire digital and STEM skills.[27]

Beyond general funding increases, state leaders should **provide more resources that support digital skills development.** For example, states can fund school districts to recruit qualified STEM (and other) educators for under-resourced schools and schools with high proportions of underrepresented students, as well as to train STEM educators from communities underrepresented in STEM. States could also provide funding for schools serving high proportions of low-income and underrepresented students to purchase computer equipment.

States should also leverage best practices in digital skill development to help broaden access to digital skills among students. For example, more states should **adopt Code.org's policies for CS education and fund school districts to implement them.** These principles include requiring all students take a CS course, making CS a graduation requirement, providing funding to ensure CS offerings are available at every school, and providing professional development to ensure teachers are prepared to teach CS.[28] Here too, funding is critical for schools serving underrepresented populations in order to ensure these policies don't become another barrier to graduation.

To help underrepresented students feel more comfortable with digitally oriented education, states and local school districts can **develop culturally sensitive pedagogies around STEM and CS.** When students from underrepresented groups can't see themselves reflected in their schoolwork, it lowers interest in those fields. These efforts aim to bring cultural characteristics of students into the classroom, which has been shown to increase student interest and success in STEM fields.[29] States can enable these efforts with funding and by rolling back misguided restrictions on culturally sensitive teaching.[30] For its part, the federal government has a specific responsibility to support education for Native American students as part of its trust and treaty responsibilities to tribes. As such, it should take particular care to support culturally sensitive STEM and CS learning in schools run by tribes and the Bureau of Indian Education.

BOX 2

The Wind River Elementary Computer Science Collaborative brings Indigenous knowledge to computer science learning

Culturally sensitive teaching in STEM education plays a vital role in inspiring students from underrepresented communities to pursue highly digital careers. To address the current gap in culturally relevant pedagogy, the Wind River Elementary Computer Science Collaborative brought together researchers, educators, and Indigenous community members to develop and implement a CS curriculum for Indigenous students.[31]

The Wind River Reservation in Wyoming is the fifth-largest American Indian reservation in the United States, and home to two federally recognized tribes: the Northern Arapaho and Eastern Shoshone.[32] In 2019, three school districts on the Wind River Reservation formed a researcher-practitioner partnership with the American Institutes for Research, the Wyoming Department of Education, and BootUp Professional Development to develop a culturally relevant CS curriculum for grades three through five.[33] Funded by the NSF's Computer Science for All initiative, the Collaborative integrates Indigenous knowledge and incorporates the Wyoming Indian Education for All social studies standards into elementary CS lessons, embedding cultural content into coding projects.[34]

To understand the cultural values and community priorities of the two tribes, the Collaborative conducted strengths-based assessments with teachers, parents, and community stakeholders, including elders from the Eastern Shoshone and Northern Arapaho nations.[35] The Collaborative adopted Scratch and ScratchJr—coding platforms designed as educational tools—for their storytelling emphasis to support the district's language revitalization efforts.[36] Characters in Scratch and ScratchJr projects can be programmed by students to speak Shoshone or Arapaho and narrate stories about Indigenous traditions, which supports Indigenous students in not only developing programming skills but also in deepening connections to their heritage and identity.[37]

Culturally sensitive teaching addresses the legacy of cultural erasure within Indigenous communities, where traditional knowledge and languages have been historically suppressed. By centering STEM education around cultural perspectives, programs like the Wind River Collaborative empower students to envision themselves in STEM professions. The Collaborative highlights the value of partnerships between federal grant programs and tribal leadership to dismantle systemic barriers to the tech ecosystem and cultivate equitable access to CS education for underrepresented communities.

Finally, states and school districts should expand and sustain "off-peak" accelerated and compensatory programs. These programs, which scholars Ebony McGee and Francis Pearman have studied, help young people interested in STEM fields over the summer and outside of school hours.[38] Along with after-school STEM education more broadly, these programs can create more student pathways into CEM careers. However, access to these programs is unequal along the same lines as other aspects of education.[39] To that end, states should provide funding to expand these types of programs to more students from groups underrepresented in highly digital careers.

BOX 3

Off-peak and after-school programs help underrepresented students access essential skills for digital and CEM careers, but need sustained funding

Several regional and national STEM education programs offer prime examples on creating pathways for diverse students into digital and STEM careers, and serve as the types of programs that policymakers should look toward supporting and scaling through increased investment.

On the national level, AI4ALL is transforming the pipeline of AI practitioners. As a nonprofit organization established in 2015, it has partnered with 16 colleges to expose high school and college students from marginalized groups to the AI field through summer programs.[40] In 2021, its programs served nearly 6,000 students, 64% of whom identified as female and more than 87% as students of color.[41] Since the pandemic, AI4ALL has shifted its programming to help college-age students to attain their first internships in AI companies.[42]

Another organization that has been at the forefront of promoting equity in STEM is Techbridge Girls. Since 2000, Techbridge Girls has been creating culturally relevant extracurricular environments for girls of color in STEM learning.[43] Between 2021 and 2022, it served 115 out-of-school-time programs across 28 states, with 51% of the students identifying as Black and 84% as female.[44] Its mission is to reach 1 million girls by 2030.[45]

Along with national organizations, regional STEM education programs are equally important. Founded in 2015, Code Girls United is a nonprofit in Montana that provides free after-school programs to rural and Native American girls from low-income areas. As of 2022, they've launched 38 programs across the state to teach fourth through 12th grade students the fundamentals of computer science and app development.[46] Similarly, Science Club for Girls is a nonprofit established in 1994 that serves K-12 girls in the Greater Boston area. In 2023, more than 600 youth in the region participated in their after-school program focused on evolutionary biology and data analysis.[47]

These programs highlight the impact that out-of-school learning brings to students interested in STEM and digital careers. Unfortunately, many of these programs have experienced funding cuts and significant disruptions to programming since the COVID-19 pandemic.[48] As such, there is a critical need for the federal government, states, and cities to better fund these programs—not only to sustain existing opportunities for underrepresented students, but also to scale these programs to reach students in more communities across the country.

While state and local policy action will be central to generating more inclusive digital skill development for individuals underrepresented in CEM occupations, federal policy can help enable these efforts. To that end federal policymakers could explore the following steps.

To start, Congress should **establish a federal Digital Skills in School Program** for schools serving students underrepresented in highly digital work. This program would establish dedicated federal funding to ensure all students have access to sufficient digital skill development. Funds could be used for activities such as developing new digital skills curricula and hiring qualified technology teachers.[49] While all schools could be eligible, funding should be prioritized for schools that are serving students underrepresented in highly digital fields, to provide them with the same digital skill development opportunities as other students.

To complement this, Congress should **increase funding for career and technical education (CTE) with an eye toward digital career pathways.** Career-oriented learning models such as career academies, early college high schools, or dual enrollment in community college all have potential as tools for expanding delivery of digital skills to more students.[50] Likewise, many states have already developed at-scale CTE models, such as Washington's Career Connect Washington strategy.[51] Federal policymakers should provide grants to states to expand their CTE curricula to further emphasize digital skills and highly digital career opportunities.

For its part, the Department of Education should **create federal digital skill development guides** to assist schools and districts in developing the capacity and infrastructure they need to expand access to digital skills. The Department of Education has previously published documents such as the "Teacher Digital Learning Guide" aimed at supporting teachers' implementation of digital learning.[52] Future guides could explore related digitally focused topics in learning by compiling cutting-edge research and best practices that schools can implement, published on a single, easy-to-access public site.[53]

Finally, the White House could coordinate a government-wide effort to **determine what existing federal assets can be leveraged to enhance digital skill development.** For example, the Department of Energy could utilize their National Laboratories to expand outreach to underrepresented groups and increase their interest in highly digital fields. This is already happening in some places. In Illinois, Argonne National Laboratory's annual Science Careers in Search of Women conference aims to connect female high school students with STEM research opportunities, female STEM professionals, and one another.[54] Meanwhile, the National Science Foundation (NSF) runs programs such as Experiential Learning for Emerging and Novel Technologies (ExLENT), which prepares individuals from underrepresented communities for careers in emerging technologies through hands-on experiences.[55]

Increase skill development opportunities for more workers

Congress passed one of the most significant pieces of federal legislation aimed at digital skill development and access in history with the $2.8 billion Digital Equity Act (DEA) of 2021, which was part of the larger Infrastructure Investment and Jobs Act (IIJA). Digital skill development is at the center of the DEA. One of the law's core goals is to promote access to digital literacy, which is defined as "the ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills."[56]

Extremely broad in its policy reach, the DEA aims to ensure that all individuals in the U.S. have access to a broadband internet connection, internet-enabled devices, digital literacy, technical support, and basic awareness of measures to ensure online privacy and cybersecurity.[57] To do so, the DEA creates three new grant programs to support

states and communities. The first two programs are formula grant programs aimed at supporting states in developing statewide digital equity efforts: a $60 million State Digital Equity Planning Grant to fund states putting together digital equity plans, and a $1.4 billion State Digital Equity Capacity Grant to implement those plans. In addition, the act contains a $1.3 billion Digital Equity Competitive Grant for cities, regions, state agencies, tribes, and other entities.

The federal government awarded its DEA planning grants to states in late 2022, after which states had one year to assemble their plans and post them for public comment. At the time of publication, every state plus Washington, D.C. and Puerto Rico had completed their digital equity plans and posted them for public comment.[58] Also at the time of publication, states and territories had submitted their applications for DEA capacity grant funding, and the federal government had begun awarding capacity grants to states. However, the application window for tribes was still open, and no competitive grants had yet been awarded.

To take advantage of historic federal funding, states should prepare to deliver on the DEA funding that will soon be flowing to them. As of the start of 2024, each state and territory had begun doing so by establishing a state digital equity office and publishing a digital equity plan for public comment.[59] However, most state digital equity plans only cover the five-year DEA period.

Therefore, states should **set a long-term strategy for digital equity,** and begin identifying funding resources to ensure a seamless transition if federal DEA funding isn't extended beyond 2028. Some states are taking early steps to bolster NTIA investments. For example, Maine launched a $15 million Digital Equity Fund to double the amount of funding it has available to implement its DEA strategies.[60]

States should also **provide support to entities applying for DEA competitive grants.** This could include matching funding to winning grantees or state-level support for entities that don't win competitive federal funding. Doing so would further enhance the impact of federal awards and help ensure communities that don't win federal funding can still implement their plans.

Moving forward, states and communities will lead much of the digital skill efforts supported by the DEA by implementing their digital equity plans. However, the federal government still has several important roles to play.

First, the National Telecommunications and Information Administration (NTIA), which is administering the DEA, should **expedite the implementation of the Digital Equity Competitive Grant awards.** At the time of publication, the application period for states and territories for the Digital Equity Capacity Grant Program had closed, but the application window for tribes is still open until February 7, 2025. The application period for the Digital Equity Competitive Grant has likewise closed. Now that it has received most applications, the NTIA should prioritize awarding these grants as quickly as possible.

To ensure equity is truly achieved, it's important to put capital directly into the hands of covered populations; it's not enough to simply have covered populations as "part" of a broader effort. The NTIA should therefore take care to **prioritize providing competitive grant funding to applicants led, owned, or managed by covered populations.** Examples of such applicants would include tribal governments, HBCUs, tribal colleges and universities, or nonprofits led by and serving covered populations, among others.

For its part, Congress can take steps to further enhance the effectiveness of the Digital Equity Act. First, **Congress should authorize the DEA until 2031 and provide an additional five years of funding.** The DEA is ambitious in scope, aiming to end digital inequities across the entire nation. Doing so will require more than five years of investment. Acting early to extend the program will give states additional runway to plan beyond their current five-year digital equity plans.

Finally, Congress should **pass a Digital Equity Act for tribes and territories.** As written, the NTIA is required to set aside 5% of its funding for planning and capacity grants for tribes, and 1% of its funding for territories other than Puerto Rico. However, that set-aside is likely not enough to fully meet the funding needs for tribes and territories.[61] Indeed, tribes and territories are set to receive significantly lower allocations than states, despite having higher capacity and technical assistance needs, less developed digital infrastructure, and substantial physical barriers, including in many cases relative remoteness compared to the rest of the U.S.—all of which would suggest a need for more planning and implementation funds, not fewer.

While the DEA is the most substantial federal investment ever made into closing demographic divides in digital work and life, it alone won't fix all of the inequalities in highly digital work. States, cities, tribes, and higher education institutions can therefore take steps to support digital skill development.

First, these entities can **expand digital skill development opportunities** such as tech-oriented apprenticeships and earn-and-learn programs, particularly for individuals without a four-year degree. Some regions are already doing so. In California's Central Valley, Bakersfield College is leveraging state money to create tech apprenticeships that cover four CEM occupations: software developers, digital marketers, data analysts, and help desk technicians.[62] Based on BLS data, three of these four jobs typically require a bachelor's degree for entry, meaning this program, if successful, has potential to unlock new highly digital career paths for workers without a degree.

As a complementary effort, regions can assemble consortiums of schools and training organizations in partnership with firms to **establish common "credentials" to signal to employers that workers have key digital skills.** An example of this type of effort is the Capital CoLAB Digital Technology Credential in the Washington, D.C. region, which offers students in non-technology majors the opportunity to earn a generalist digital tech credential.[63] At some institutions, students can receive a notation on their transcript that they completed the credential program.[64] This model could be replicated in other regions to allow workers to signal to employers that they have developed proficiency in various digital skills, regardless of their field of study.

For their part, states can play an important role as funders and conveners, particularly in the absence of federal action. States should create state-level funding streams to encourage the development of regional digital skill development efforts, as well as establish statewide communities of practice to connect regional actors in different parts of the state and facilitate sharing of best practices around digital skill development. For example, Pennsylvania's Digital Literacy and Workforce Development Grant program provides funds to regional actors to support digital literacy development for workers.[65]

In addition to the Digital Equity Act, the IIJA contained other transformative digital investments. One is the $42.5 billion Broadband Equity, Access, and Deployment (BEAD) Program, the single largest federal investment in broadband in history. Moving forward, the NTIA is charged with making grants to states and territories to increase access to affordable broadband internet and prioritizing communities of color, low-income areas, and rural areas—communities that align closely with those underrepresented in CEM work.

Congress could also make additional investments into developing digital skills and career paths for workers who have been historically underrepresented in highly digital work.

To start, Congress should **provide funding to establish and scale up digital skill development organizations owned by, operated by, and in support of historically underrepresented groups.** While many skill-development-focused federal programs exist, most don't provide funding at scale directly to underrepresented groups. Some federal

programs, such as the Economic Development Administration's (EDA) Good Jobs Challenge, have done so, but more investment is needed given the scope of digital work in the U.S. Examples of this type of funding could include dedicated support for digital apprenticeships or other digital skill development programs at HBCUs and tribal colleges; digital skill development programs on tribal land; or nonprofit digital skill development programs led by and in service of groups underrepresented in highly digital occupations. This type of funding—which puts money directly into the hands of underrepresented communities—can help ensure that any training or skill development efforts are culturally relevant and run by organizations that have dedicated relationships with the communities being served.

Next, Congress should **provide funding to scale up digital apprenticeship programs at community colleges and other higher education institutions,** particularly those with a dedicated history of serving workers from underrepresented groups. While apprenticeships are a well-known pathway for developing skills and credentials without a four-year degree, historically it has rarely been used to support access to highly digital work. However, that trend is slowly starting to change, with a small number of states and institutions broadening apprenticeship access to include highly digital jobs such as IT help desk and cybersecurity positions. The federal government could supercharge this effort by providing robust, dedicated funding to states and higher education institutions to develop and implement promising apprenticeship models that place workers debt-free into good-paying highly digital CEM jobs.

To complement this effort, the White House should **establish a Digital Apprenticeship Task Force** to eliminate unnecessary cross-agency and cross-funding-stream barriers to expanding apprenticeships into more highly digital fields. Within this effort, the federal government should establish a single "front door" for states and institutions looking to expand highly digital apprenticeships through steps such as identifying existing resources for funding highly digital apprenticeships; providing technical assistance for scaling up highly digital apprenticeships; and supporting efforts to develop robust employer and industry partnerships across states and regions. Such an effort could follow the template of the Biden administration's previous Apprenticeship Ambassador Initiative.[66]

However, another digitally oriented IIJA program has recently seen its funding expire. The $14.2 billion Affordable Connectivity Program (ACP) was the largest federal investment into broadband affordability in history, subsidizing broadband access for 23 million American households.[67] But without additional funding from Congress, the program ran out of money in April 2024.[68] As a result, the ACP stopped accepting new households in February 2024, and officially ended in June 2024.

Given the recent expiration of this now-critical program, Congress should **permanently authorize the Affordable Connectivity Program with long-term funding.** In addition, Congress should periodically allow households to access additional device subsidies. For example, Congress could allow households to receive a device subsidy of up to $100 every four years, rather than having it be a one-time benefit. As technology continues to improve, households will need to continue to upgrade their devices, and Congress should support them in doing so.

BROADEN ACCESS TO STEM EDUCATION, CEM CAREER PATHS, AND ENTREPRENEURSHIP

Educational demands represent a serious hurdle to the inclusivity of CEM work. Just 12.6% of CEM jobs could be accessed without a four-year degree in 2023, and Census Bureau data shows that there are very few pathways to computer and engineering jobs without a STEM degree.[69]

However, the challenges that individuals from underrepresented groups face in elementary and secondary education sharpen in higher education,

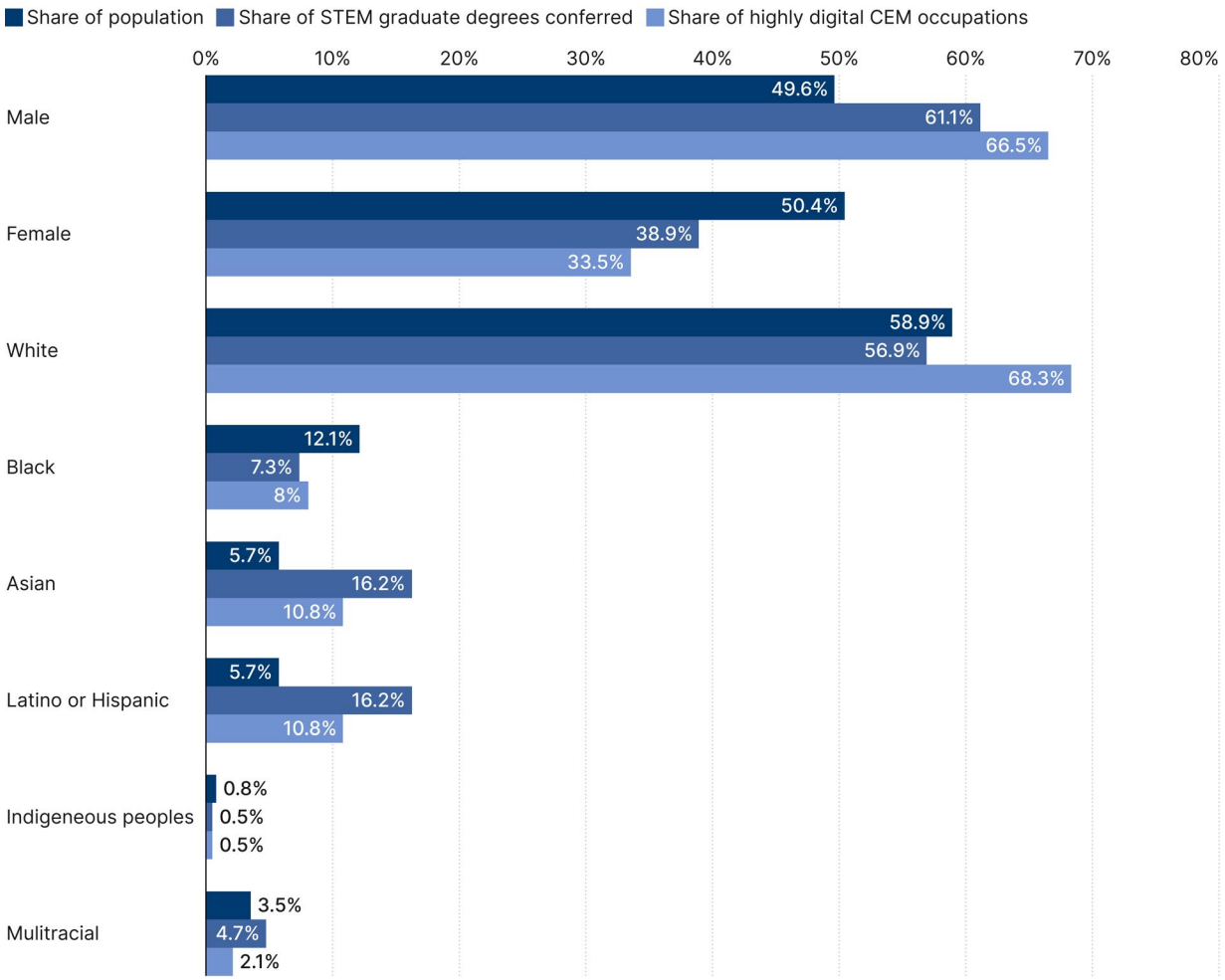
leading to a significant number of STEM students from underrepresented groups choosing to drop out of STEM programs.[70] A recent study found that nearly two-thirds (65%) of men completed their STEM degree, compared to less than half of women (48%).[71] Similar divides exist across race and ethnicity. While a majority (58%) of white STEM students complete their degree, just 43% of Latino or Hispanic students and 34% of Black students do so.[72]

Yet educational disparities alone do not fully explain the continued severity in underrepresentation of women and certain minorities in tech occupations. As shown in Figure 19, while Black, Latino or Hispanic, and Indigenous students remain underrepresented in STEM higher education, they are at times even more underrepresented in CEM jobs.

FIGURE 19

Women, Black, Latino or Hispanic, and Indigenous individuals are underrepresented in STEM degrees and within highly digital CEM jobs

2022



SOURCE: Brookings analysis of Census Bureau, IPUMS USA 1-year ACS microdata, IPEDS, and Lightcast data
NOTE: American Indian, Alaska Native, Native Hawaiian, and Other Pacific Islander are included in the Indigenous peoples group. Calculation based on unrounded numbers. Percentages may not sum to 100% due to rounding. Race/ethnicity unknown and nonresident alien were excluded from the calculation.

Latino or Hispanic workers hold CEM jobs at a rate nearly 30% lower than their share of STEM degrees. Meanwhile, while Black and Indigenous workers held CEM occupations at a rate slightly higher than their share of STEM degrees in 2022, that trend isn't due to significant gains in employment share in recent years. Prior to 2022, Black and Indigenous workers were also more underrepresented in highly digital CEM employment than in STEM higher education. However, in 2022, both groups had declines in the share of STEM degrees they received, reducing their STEM degree share relative to their share of CEM employment.

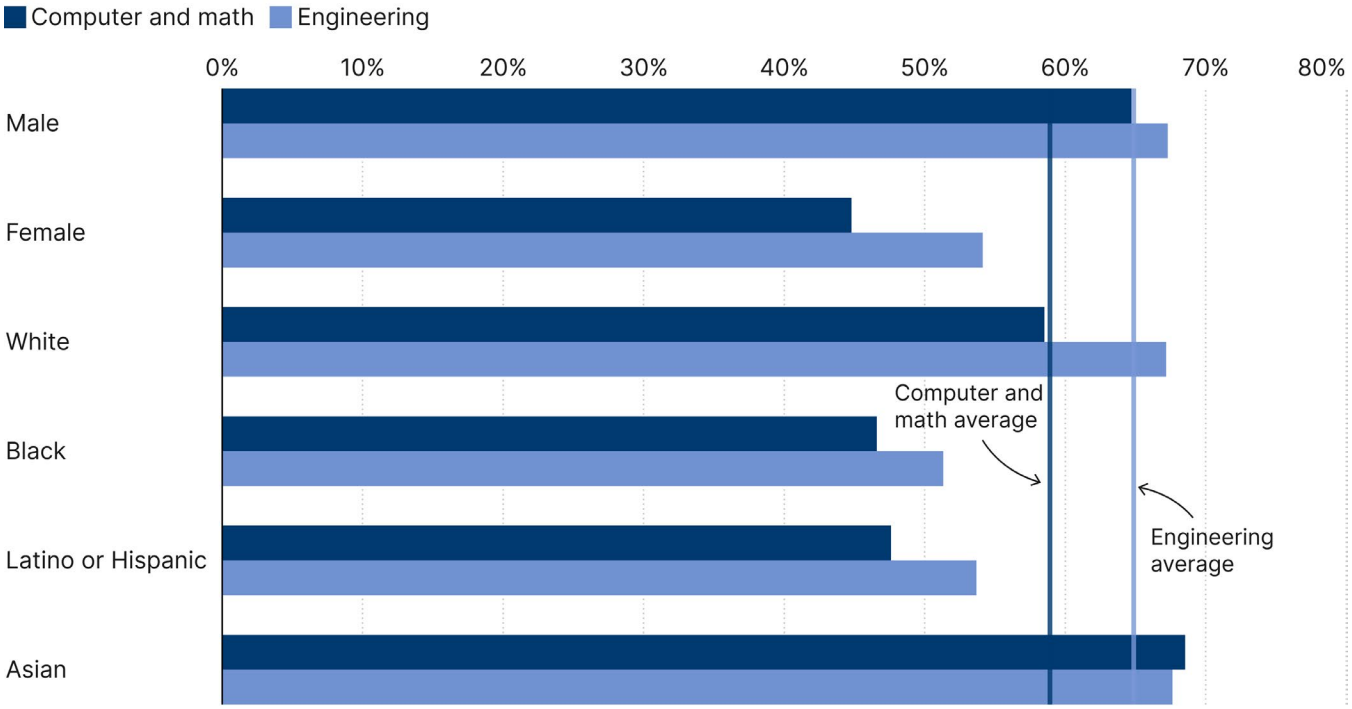
This underrepresentation is perpetuated by a variety of factors. To start, companies often recruit for highly digital computer and engineering occupations from a narrow network of elite schools.[73] But even when candidates from marginalized groups attend the "right" universities, they often maintain separate networks, which can harm their jobs prospects.[74] In addition to exclusion from hiring networks, individuals from underrepresented groups must contend with implicit biases that put them at a disadvantage in the recruiting process.[75]

These factors contribute to women and underrepresented workers of color choosing to apply to computer and engineering jobs at lower rates than their white and Asian American male peers. As Figure 20 shows, female, Black, and Latino or Hispanic workers who majored in computer and engineering fields choose to go into CEM jobs at lower rates than male, white, and Asian American workers.[76]

FIGURE 20

Share of graduates in computer and engineering that pursue careers in highly digital CEM fields by gender and race

2019



SOURCE: Brookings analysis of Census Bureau data

Once hired into CEM occupations, women and workers of color are more likely to experience unfairness on the job. A significant body of research shows that women and underrepresented minority workers face significant discrimination at work, particularly in fields that track closely with CEM jobs.[77] Other issues common in CEM occupations disproportionately affect women and underrepresented workers of color, including tokenism, burnout from "firefighting" work styles, and unequal treatment on promotions and compensation. Such issues contribute to them leaving these jobs at higher rates than white and Asian American men.[78]

It bears noting that while the nation retains the ability to enforce non-discrimination laws in employment, it has struggled to do so. While the federal government has limits on how it can influence private sector hiring, one area where it has clear jurisdiction involves federal contractors and other organizations receiving federal funds. The federal government enforces policy in this space through two agencies: the Equal Employment Opportunity Commission (EEOC) and the Department of Labor's Office of Federal Contract Compliance Programs (OFCCP). Given that numerous firms in CEM-oriented fields receive federal funds, non-discrimination enforcement by these agencies can be an important lever for inclusion.[79]

However, the federal government faces a variety of challenges in enforcing federal policy even on just firms receiving federal funding. For example, the OFCCP typically only investigates 2% of federal contractors for potential violations in any given year due to constraints on staffing and agency resources.[80] Moreover, the office's main enforcement mechanism is "debarment," or forbidding a company from receiving future government contracts, which is perceived as so extreme that it is rarely used.[81]

Finally, the gender and racial gaps in entrepreneurship are even starker than those in employment, meaning entrepreneurship in CEM-related fields fails to offer as many opportunities to underrepresented groups. Data from the Kapor Center indicates that less than 2% of founders receiving seed and Series A funding were Black, Latino or Hispanic, or Native American, while just 17% of founders receiving venture funding were women.[82] This matters, because while only 1% of businesses in the U.S. receive venture financing, more than 60% of initial public offerings (IPOs) involve venture financing.[83] In this regard, capital access plays a significant role in determining which businesses grow large enough to become industry leaders—and employ large numbers of workers in highly digital occupations. When firms owned by women and people of color are shut out of capital access systems, it perpetuates exclusion—particularly because those firms tend to hire more workers from groups underrepresented in CEM jobs.[84]

Recent judicial decisions may further hamstring agencies tasked with enforcing non-discrimination. In the 2023 case Students for Fair Admissions v. Harvard, the Supreme Court ruled that race-conscious admissions policies in higher education were unconstitutional.[85] While that ruling applied only to higher education, some organizations and elected officials are now working to expand it to prohibit race-conscious policy in areas such as employment and capital access.[86] For example, a lawsuit forced the Small Business Administration's 8(a) program—which supports socially and economically disadvantaged small business owners—to temporarily halt accepting new applications in late 2023 as the agency reworked it application to more narrowly tailor the program. Even after refining its application, the agency continues to face litigation.[87] As such, the Supreme Court ruling has the potential to create a chilling effect on federal, state, and local efforts to bolster equity in CEM employment.

POLICY ACTIONS

Given the critical role that education and hiring biases play in preventing underrepresented groups from accessing CEM jobs, policymakers should take proactive steps to grow pathways into CEM work—and firm leadership—for more people.

State, local, and federal policymakers, as well as privatesector firms, should act across three critical themes:

- Reduce obstacles to STEM completions among underrepresented students.
- Reform hiring practices for CEM jobs and promote career advancement for underrepresented workers.
- Diversify firm ownership and entrepreneurship in CEM-heavy industries.

Reduce obstacles to STEM completions among underrepresented students

One of the most significant barriers for underrepresented workers in accessing CEM jobs is that many workers have been shut out of the necessary educational pathways. With nearly 90% of CEM jobs requiring a four-year degree (typically a STEM degree), it is critical that federal policymakers work to make STEM education more inclusive.

At the same time, it's important to acknowledge that in the wake of federal court rulings limiting race-conscious policies in higher education and business development, federal policymakers are operating in an environment where race-conscious policy is under heightened scrutiny. What follows, then, is a set of policy options that policymakers can pursue to bolster inclusion in access to STEM higher education, while recognizing that federal courts and policymakers may look at race-conscious policymaking skeptically for the foreseeable future.

Because higher education is largely a state- and locally funded endeavor, states and localities must also take significant steps to support more STEM completions by students from underrepresented groups.

To start, states must **eliminate funding disparities for institutions of higher education that serve students from underrepresented groups.** Institutions such as HBCUs and regional public universities (RPUs) educate most STEM students from underrepresented groups. However, these institutions are underfunded through state funding formulas and states' failure to meet statutory funding requirements.[88] Ensuring equal funding for the institutions that support the greatest number of underrepresented students is necessary for promoting CEM equity.

In addition to creating more pathways for students to access STEM education, states should establish funds to **help institutions develop and recruit faculty from underrepresented groups** to access tenure-track faculty positions in STEM fields. Evidence shows that having faculty who better reflect the student body can help underrepresented students in STEM fields, both by creating more mentorship opportunities and by helping students see themselves as able to fit in STEM spaces.[89] To ensure compliance with federal law, states can use a definition of "underrepresented" that extends beyond just race and gender, such as the socially and economically disadvantaged individuals (SEDI) definition used by multiple federal programs.[90] Several states have faculty recruitment efforts that, while not focused on underrepresented faculty specifically, can still serve as models, such as Georgia's Eminent Scholars program and Pennsylvania's former Keystone Innovation Starter Kit.[91]

From there, states have a critical role to play in fixing the often-broken pathways between two-year institutions and four-year colleges and universities. States and institutions should therefore **expand pathways from two-year institutions and tribal colleges to four-year institutions** to leverage the success those institutions have at supporting students. This should include strengthening partnerships between institutions to minimize the paperwork and financial requirements needed to transfer, and maximizing compatibility between courses. One way to do so is by expanding formal institutional affiliations between two-year and four-year institutions.

BOX 4

Wichita State University's Shocker Pathway is a national model for student transfers in STEM-relevant fields

While the U.S. continues to grapple with how to strengthen connections between two-year and four-year institutions, several states and regions have begun rolling out new models to promote these types of cross-institutional transfers. One example is Wichita State University's Shocker Pathway.

Wichita State University (WSU) has a unique agreement with the WSU Campus of Applied Sciences and Technology (WSU Tech) that allows students to seamlessly transition from a two-year institution to a four-year degree.[92] WSU Tech was originally founded as Wichita Area Technical College, and in 2018, the two-year technical college entered into an affiliation agreement with WSU and became WSU Tech.[93] This affiliation has allowed the two separate, degree-granting institutions to develop a new level of partnership to support students across the region.[94]

Starting in 2018, the two schools developed the Shocker Pathway, which provides a pathway for students to start their associate degree at WSU Tech and finish it at WSU.[95] Students at WSU Tech can receive up to 50 general education credits that count toward a degree at WSU.[96] They can then complete their last 15 credits at WSU for an associate degree and continue on at WSU for a bachelor's degree if they choose.[97]

The Shocker Pathway creates stronger linkages between the region's higher education and workforce development systems. Because WSU Tech is an open-access technical college, it is embedded in the region's workforce development activities. For its part, WSU maintains close research and experiential learning relationships with industry in the region.[98] The Shocker Pathway further strengthens WSU's connection to workforce development by allowing it to consistently enroll WSU Tech students, and elevates WSU Tech's role in higher education by giving students of all backgrounds a clear way to pursue a two- or four-year degree. Affiliations such as the Shocker Pathway create a web of entry points for workforce development, which fosters inclusion and growth in CEM jobs.

Finally, states and institutions should explore ways to **expand wraparound services and student supports for students from nontraditional backgrounds.** These supports should include traditional wraparound services such as child care and transportation, but also ones such as emotional and psychological support for students with barriers to completing STEM education, including underrepresented students, first-generation students, parents and caregivers, and others.

Next, there are a variety of steps that can be take either at the state or federal level to bolster the digital resources at higher education institutions that serve students underrepresented in CEM work

Both states and Congress could **create new funding streams for broad-access four-year institutions to build robust STEM education programs** on par with better-funded "elite" public and private universities. Past research by Brookings and others has shown that broad-access universities, including RPUs, serve a disproportionate share of racial and ethnic groups that are underrepresented in CEM work. However, these institutions also receive substantially fewer resources from state legislatures and the federal government.[99] Given that, both states and the federal government have a role to play in ensuring the institutions serving the most diverse classes of students are as well resourced as more selective, but typically less diverse, institutions.

Two-year community colleges are another class of institution that serves a disproportionate share of underrepresented students.[100] Apropos these institutions, states and Congress could **establish new funding streams for two-year colleges, including community colleges and two-year tribal colleges, to invest in the cutting-edge technology** needed to prepare students for the global economy. This can help these institutions—which are relatively resource-constrained compared to selective four-year institutions—establish the infrastructure needed to support more students in accessing CEM fields. Policymakers could use existing efforts as a template, such as the National Artificial Intelligence Research Resource (NIARR) Pilot program, an NSF program providing access to advanced computing, datasets, models, software, training, and user support to U.S.-based researchers and educators.[101] However, given existing programs' primary focus on four-year institutions, these efforts will have to be adapted (and funded) for the two-year institution context.

It's important that students not just have access to STEM degrees, but also have programs that are designed to help them to persevere. To help with this, states and Congress could **establish new funding streams for schools to develop culturally sensitive pedagogies in STEM and digital education,** which can attract and retain more historically underrepresented students in STEM fields. These grants could be open to all institutions interested in establishing more diverse and culturally responsive STEM degree programs, and would be aimed at helping underrepresented students feel more connected to STEM education.

Additionally, there are a set of policies that either lay within the core mission of the federal government, or are investments that the federal government could make to complement and enable state and local action.

As a complementary federal policy to support institutions serving students underrepresented in highly digital work, Congress should **equalize funding for 1890 (historically Black) and 1994 (tribal) land grant institutions relative to 1862 land grant institutions.** Within the land grant system, there are three classes of institutions. First, 1862 institutions are the original land grant schools, and today are often (though not always) predominantly white institutions. Second, 1890 institutions are public historically Black college and universities (HBCUs) that were established primarily in the South when racial segregation in education was legal. Finally, 1994 institutions are tribal colleges and universities (TCUs) that are run by Native American tribes and primarily enroll Native American students. As a result of this history, 1890 and 1994 land grant institutions

serve a disproportionate number of Black and Native American students. For example, while 1890 institutions graduate just 0.6% of all STEM majors, they graduate 5% of all Black STEM majors—an overrepresentation of 833%. Likewise, while 1994 institutions graduate only 0.02% of all STEM majors, they graduate 4.5% of all Native American STEM majors—an overrepresentation of 22,500%, even though most TCUs are only two-year institutions. However, despite the critical role these institutions play for Black and Native students, they receive less overall per-student income than their 1862 peers, as well as less funding from the federal government.[102] Congress should ensure that federal funding across the three classes of institutions is at parity.

Congress should also **provide funding to enhance pathways from two-year to four-year institutions,** which will help more students from underrepresented groups access the credentials needed to enter CEM work. While many community colleges work with four-year institutions to create pathways for students, these efforts can be inconsistent, with varying levels of success across different places. In addition to new funding, the Department of Education can complement this effort by continuing to publish best-practice guidelines, as it did with its September 2020 report, "Strategies for Increasing Diversity and Opportunity in Higher Education," as well as establishing communities of practice to allow institutions to share successful models with one another, building off its November 2023 convening of higher education leaders focused on improving student transfers to complete four-year college degrees.[103]

Finally, as an avenue to support Native American students in particular, Congress should **establish a new funding stream for tribal colleges and universities to expand their programmatic offerings to include more digitally oriented degree programs and credentials.** This policy matters for two reasons. First, TCUs don't receive state funding, as they are tribally controlled and not part of states' public education systems. As with K-12 education, supporting TCUs is a component of the federal government's trust and treaty responsibilities to tribes. Second, TCUs often offer a relatively limited number of majors, typically focused on areas of need for the tribe. Providing support to expand the number of digital and STEM degree offerings will help more Native American graduates of these institutions access CEM jobs.[104] The Department of Education could also establish a community of practice focused on digitally oriented and STEM education at TCUs, perhaps in partnership with the American Indian Higher Education Consortium, the association of TCUs.

Reform hiring practices and promote career advancement

While more accessible STEM education is important to providing individuals with pathways to highly digital careers, evidence outlined in this report has shown that even qualified individuals with STEM degrees can have trouble accessing and staying in CEM jobs. That underscores that underrepresentation in highly digital work isn't just a skills or credentials problem, but rather one that is driven by biases in hiring and career advancement in CEM occupations themselves. Both policies and private sector action are needed to broaden the number of individuals from underrepresented groups that work in CEM jobs, and to take steps to support their careers once in those jobs. What follows is a series of steps that private sector actors can take to broaden pathways to CEM careers, with recommendations for supportive federal and state policies, and followed by several enforcement actions that the federal government and states can take to create a more even playing field.

Given that the private sector dictates hiring decisions, companies themselves must play a central role in eliminating bias in hiring. To start, firms should **expand recruitment channels to include universities with a greater share of underrepresented students.** Currently, many firms hiring for CEM jobs recruit only from a narrow set of "elite" institutions. By doing so, firms continue to replicate the biases that are already present

in those institutions and their STEM programs. From there, firms can work to **eliminate bias in job descriptions and interviews** through steps such as broadening qualification requirements and leveraging skills-based hiring techniques to encourage more diverse candidates.[105]

Firms can also work to **help incumbent staff from underrepresented groups move into CEM jobs.** To do so, companies can create skill development and advancement programs to enable career paths into CEM jobs. One example is T-Mobile's efforts to move customer-facing employees into product and technology occupations using six-month rotations.[106]

As mentioned earlier, many underrepresented workers, and women in particular, find themselves leaving CEM jobs because of workstyles and hours that don't align well with personal responsibilities, particularly when they become caregivers. To better encourage retention and advancement, firms should **promote flexibility for workers,** including remote and hybrid work and flexible work hours.[107]

These private sector efforts can be complemented and supported by policy. To start, state and federal agencies can **adopt skills-based hiring for CEM jobs in government.** For its part, the federal government has already begun doing so. In April 2024, the federal government's Office of Personnel Management (OPM) released a Skills-Based Hiring Guidance and Competency Model for Artificial Intelligence Work to guide the adoption of skills-based hiring for AI-related jobs in federal agencies.[108] Later that month, OPM announced it would design a framework to transition all federal IT jobs, known as "the 2210 series," to skills-based hiring principles and practices.[109] This change will affect nearly 100,000 current federal jobs. Moreover, the federal government announced it would begin leveraging its federal contracting power to encourage skills-based hiring in the private sector. As a first step, the Department of Energy announced it would begin using skills-based hiring provisions in its IT and cyber contracts.[110]

This federal leadership has two important effects. First, it will provide a template to help private sector actors voluntarily adopt skills-based hiring in their own technology-oriented positions. Second, the contractor provisions could be a strong mechanism to encourage firms contracting with the federal government to adopt skills-based hiring. Because many employers that hire a significant number of CEM workers are federal contractors, this has the potential to be a powerful resource.

As next steps, more federal agencies should follow the lead of the Department of Energy and require that contractors adopt skills-based hiring provisions for IT, cyber, and other CEM-relevant occupations. In addition, states, cities, and government agencies at other levels should follow the lead of the federal government and require skills-based hiring provisions for IT, cyber, and other CEM jobs for firms receiving public contracts.

Another step to broadening pathways to CEM occupations is by growing the accessibility of internships in relevant fields. Both states and Congress could **establish a federal paid internship grant program for CEM careers** in the Department of Education. One model for this type of program was proposed by Economic Policy Institute researchers Kathryn Anne Edwards and Alexander Hertel-Fernandez in their report, "Paving the Way through Paid Internships: A Proposal to Expand Educational and Economic Opportunities for Low-Income College Students."[111] To support broader access to highly digital work, such a program could provide grants to broad-access institutions and institutions serving students historically underrepresented in CEM occupations to fund paid student internships in universities and STEM-oriented nonprofit organizations. In the absence of federal action, states, cities, and regions can explore implementing similar programs.

States and localities should also explore how they can use their procurement power to promote greater equity. For example, states and municipalities should **require contractors to conduct pay equity audits and compensation analyses** to ensure that underrepresented workers are receiving equal pay. Doing so can

help mitigate the pay differentials that women and underrepresented workers face in CEM jobs.[112] Such policies can mirror similar efforts currently taking place on the federal level.[113] States can help here by better funding state procurement offices to fully enforce affirmative action laws.

States and regions can complement these efforts by creating public-private-philanthropic initiatives to **highlight employers that hire and promote women and individuals from underinvested groups.**

Finally, states should **enact more robust federal standards and enforcement resources for harassment- and bias-free workplaces.** While federal policies already exist to guard against such behavior, there remain substantial reports of ongoing harassment and bias along lines of gender, race, and ethnicity in many industries that hire large numbers of CEM workers. As such, there is a clear need for stronger standards around harassment and bias. Fortunately, there are several recent templates for states, including recent legislation passed by California and Vermont.[114] These actions can be complemented by federal standards enacted by Congress and enforced by the Equal Employment Opportunity Commission (EEOC).

One area where the federal government could support state and local efforts, if it chooses to do so, is around enforcement. Congress should **broaden the set of tools that the Office of Federal Contract Compliance Programs (OFCCP) has available to sanction firms that violate affirmative action laws,** to allow for more flexibility and reactivity. While many CEM workers work at companies that are federal contractors, the OFCCP is hamstrung in its ability to regulate those firms by underfunding and clumsy enforcement powers. Increasing funding to the OFCCP could help it raise the share of federal contractors that it investigates, which is currently just 2% annually.[115] Next, Congress could revise the "establishment level" policy that currently allows OFCCP to investigate just a single establishment a company controls, and instead empower it to investigate entire companies for nondiscrimination. Finally, Congress could update the OFCCP's available enforcement tools to include penalties such as public notices, fines, contract claw backs, and other intermediate steps before full debarment (i.e., ineligibility for future contracts), to increase enforcement flexibility.

Another agency that has significant ability to ensure that underrepresented workers aren't discriminated against within CEM work is the EEOC. The EEOC should take several steps to reduce discrimination in CEM work. First, it should **establish a task force to provide technical assistance to firms looking to scale up their hiring of underinvested groups in CEM jobs.** This task force could publish a "best practices" report to help guide private sector CEM employers looking to improve their practices around hiring and supporting employees from underrepresented groups.[116] This task force could be a natural extension of the EEOC's previous work on the high-tech industry, including its extensive documentation of the lack of diversity in the high tech workforce.[117] Recommendations could be based on the EEOC's expertise in private sector non-discrimination.

However, given the substantial evidence of inequality—and potential discrimination—in hiring among CEM jobs, any sharing of best practices should be coupled with investigatory action into CEM employers. The EEOC should explore the potential to **initiate a systemic investigation into employers with significant disparities in CEM occupations** under their authority granted by Title VII of the Civil Rights Act of 1964. Doing so could help uncover unlawful hiring and promotional practices that are contributing to the substantial underrepresentation of women and minority workers in CEM occupations.

Diversify firm ownership and entrepreneurship in CEM-heavy industries

It will also be critical to diversify firm ownership to expand inclusion in CEM work. As mentioned earlier, firms with diverse owners—whether that is by gender, race, ethnicity, or other characteristics—tend to hire other workers from diverse backgrounds.

One way to do so would be for states to pass laws mirroring a recently introduced Massachusetts bill to **clarify that investors who are investing in an underinvested class are protected by law**. Recent lawsuits and court decisions risk dampening the already scarce investment into underrepresented groups, which could exacerbate significant inequalities. The Massachusetts bill, titled "An Act relative to fair investment practices," would seek to directly remedy this inequality. To do so, it first reaffirms that it is unlawful to discriminate on the basis of a protected characteristic, including gender and race, in investing. It then takes the additional step to clarify that it is not unlawful to designate funds solely for historically disadvantaged members of protected classes.[118] In doing so, it creates greater legal certainty for investors.

From there, states should take legislative and executive action to **designate underinvested communities as a protected class.** Doing so would reaffirm that protected classes are not arbitrary, but rather based on both historic and present discrimination.

As with other policy actions, federal policymakers in Congress and the White House could enact federal versions of these policies to ensure equal coverage across the entire nation.

BOX 5

Fearless Fund faces legal challenges in supporting underrepresented entrepreneurs in CEM-relevant fields

The experience of the Atlanta-based Fearless Fund is an example of the growing need for policy clarity around race-conscious private sector action, as well as an illustration of how recent court decisions will make promoting equity in entrepreneurship more difficult.

Established in 2019, Fearless Fund is a venture capital firm founded by Black women that invests in women of color.[119] Fearless Fund addresses the barriers that exist in venture capital funding for businesses led by women of color. As mentioned above, Black female founders have historically received less than 1% of the total venture capital (VC) funding in the U.S.

In February 2021, Fearless Fund created a new program called the Fearless Strivers Grant Contest, which provided $20,000 grants to Black-women-owned businesses. Since launching the fund, the firm invested nearly $27 million in some 40 businesses led by women of color and awarded another $3.7 million in grants.[120] Collectively, these businesses employ about 540 people, up from 250 at the time of investment.[121]

In August 2023, the American Alliance For Equal Rights (AAER), a legal nonprofit that aims to eliminate race-conscious policies in the U.S. public and private sector, brought a lawsuit against the Strivers Grant.[122] The AAER, which was founded by the anti-affirmative-action activist who led the campaign against race-conscious admissions programs in higher education, contends that Fearless Fund's grant program is race-exclusive, violating the Civil Rights Act of 1866, which prohibits racial discrimination in contracts.[123] Fearless Fund amended the grant program to be available to all women of color; however, in June 2024 a federal appeals court suspended the program and ruled against Fearless Fund. In September of that year, Fearless Fund settled the case, closed the Strivers Grant program, launched a loan fund partnership with Accion, and focused their efforts on continuing their venture fund investments.[124]

The lawsuit against Fearless Fund represents a broader challenge to corporate and startup diversity, inclusion, and equity initiatives—an effort that has intensified since the Supreme Court overturned affirmative action in college admissions. This legal conflict is viewed as a test case with far-reaching implications for diversity initiatives in the business sector. It signals the need for clearer legal parameters around race-conscious programs aimed at supporting businesses led by underrepresented entrepreneurs.

To complement these policies, states, regions, and cities can also take steps to affirmatively get capital into the hands of companies owned by underrepresented entrepreneurs. Many communities already fund incubators and accelerators run by and focused on historically underinvested groups. One example is the Pittsburgh region's support for Ascender, a nonprofit organization that provides free community programming, business mentorship and coaching, incubation, and co-working aimed at entrepreneurs from underrepresented groups.[125]

States can also **establish new funding streams for incubators and accelerators owned by historically underinvested groups.** One model to use is the federal Indian Business Incubators Program, which provides grants of up to $300,000 to Native American-owned business incubators that serve entrepreneurs in American Indian and Alaska Native communities.[126] As mentioned previously, policymakers can leverage a broad definition of "underinvested," such as SEDI, to ensure compliance with recent federal court decisions. For its part, Congress could establish equivalent federal programs. Congress should also reauthorize the existing federal Indian Business Incubators Program with funding to provide larger grants to more places, and make it an annual program.

To complement these policies, states should also explore establishing funds to **support equity investors led by individuals from historically underinvested groups,** in line with federal law. Evidence shows that investors from underrepresented backgrounds are more likely to invest in companies led by individuals from underrepresented backgrounds.[127] Given that, one of the best ways to expand investment for underrepresented entrepreneurs is by expanding the capital available to underrepresented investors. One example of how states can enact such a program is the Diverse Leaders Venture Program established by Pennsylvania as part of its State Small Business Credit Initiative (SSBCI). This $17 million program invests in venture funds led by socially and economically disadvantaged individuals (SEDI) such as underrepresented racial and ethnic groups, women, and rural investors.[128]

Additionally, states and cities can **fund intermediaries and backbone organizations for entrepreneurs from underinvested communities.** As with incubators and accelerators, there are already good examples of these types of organizations across the country that would benefit from additional funding to allow them to scale and provide even greater supports. Examples of existing organizations include Digitalundivided, a nonprofit organization that provides access to capital, mentorship, and community to Black and Latino or Hispanic women founders in the tech industry; and Pow Wow Pitch, a grassroots community focused on supporting Indigenous entrepreneurs across the U.S.[129]

In addition to their role in educating students, colleges and universities also play an important role in supporting entrepreneurship and firm development, including as investors. Given that dual role, states and Congress should **establish dedicated funding streams to enhance entrepreneurship and commercialization programs at institutions serving underrepresented students,** including regional public universities, HBCUs, TCUs, other minority-serving institutions, and other broad-access institutions. This program could be modeled on existing law, particularly the EDA's Tech Hubs program in the 2022 CHIPS and Science Act, which requires the secretary of commerce to ensure geographic and demographic diversity in the designation of regional technology hubs.[130]

CREATE A ROBUST SUPPLY OF INCLUSIVE CEM JOBS IN MORE PLACES

Place intersects with CEM jobs across two dimensions. First, women and many workers of color remain underrepresented in CEM work regardless of place, with no metro areas in the U.S. having achieved parity in CEM work. Given that, the above policy recommendations to increase workers' overall digital skills and create more pathways into CEM jobs must be a primary focus for bolstering equity in this type of work.

At the same time, the significant variation in the supply of CEM jobs across different places (outlined in Finding #6), creates additional barriers to underrepresented workers accessing these jobs if they're situated in a community without a significant presence of CEM work.

For example, the Memphis, Tenn. metro area—which has a disproportionate share of middle-class Black families—has nearly 556,000 jobs, of which about 30,000 (or 5.4%) are CEM jobs.[131] Bringing this share up to the national average of 9.1% would mean creating over 20,500 new CEM jobs. Of the metro area's 30,000 CEM jobs, about 40% are held by women while about 28% are held by underrepresented people of color. As such, creating 20,500 new CEM jobs would potentially mean 7,500 new CEM jobs for women and 5,600 new CEM jobs for underrepresented people of color. There's still room to grow though, as women and underrepresented people of color make up 52% and 53.3%, respectively, of the metro area's population—meaning complementing these efforts with policies to increase demographic parity in CEM work would further increase these numbers.

Given that, it's essential to respond to the underrepresentation challenge by not only increasing the supply of underrepresented workers in CEM jobs, but also by increasing the supply of CEM jobs themselves, with a focus on places with fewer of these occupations. What follows is a set of policy recommendations to do so.

POLICY ACTIONS

While underrepresentation in CEM jobs is a national challenge affecting every metro area in the U.S., different metropolitan areas have significantly varied supplies of CEM jobs. As such, policy responses to respond to underrepresentation in CEM work will necessarily be different by place. Places with a large supply of existing CEM jobs will need to focus on making that supply more accessible, while places with a relative scarcity of CEM jobs will need to focus on building their supply in an inclusive way.

Along those lines, federal and state governments should take proactive policy steps to:

- Build inclusive pathways into CEM jobs in places that have a significant share of such occupations.
- Grow the supply of CEM jobs in places currently lacking them.

Build inclusive pathways into CEM jobs in places that have a significant share of such occupations

Metro areas such as the Bay Area in California, Boston, or the Research Triangle in North Carolina already have above-average shares of CEM employment. In many regards, these places are the "winners" of the modern digital economy. However, what is now clear is that within those places, not every individual has the same opportunity to access these highly paid, economically significant occupations. Moreover, a growing body of evidence illustrates that these inequalities aren't just local issues of concern, but rather have significant national competitiveness implications.[132] As such, there is a strong imperative for policy action.

To respond, states should enact **Digital Workforce Challenge Grant programs to develop inclusive regional digital workforce systems.** These programs could be modeled on the federal Good Jobs Challenge the EDA enacted through funding in the 2021 American Rescue Plan Act. The Good Jobs Challenge invested $500 million into 32 industry-led partnerships that are developing innovative approaches to inclusive workforce development. The Good Jobs Challenge encouraged the development of workforce training systems that supported multiple industries simultaneously. While the technology industry is the largest single source of employment for CEM workers, CEM jobs—and highly digital jobs more broadly—are found across a variety of industries. As such, the Good Jobs Challenge's cross-cutting, multi-industry model can serve as a template for this effort. Of course, these efforts would be complemented and amplified by federal action, so Congress should consider enacting an equivalent federal program.

BOX 6

A federal precedent for supporting the digital workforce: The EDA's Good Jobs Challenge

The idea of a federal challenge grant to support regional digital workforce development is not new. The federal Good Jobs Challenge, set forth by the EDA in 2022, serves as a commendable model for connecting historically underserved communities to digital skills and highly digital job opportunities spanning various industries.[133]

The Good Jobs Challenge is a $500 million place-based initiative to promote regional workforce development.[134] Created through the American Rescue Plan Act's $3 billion economic recovery fund for the EDA, it awarded grants to 32 partnerships to provide in-demand job opportunities and work-and-learn training to support workers and employers across multiple industries.[135] In particular, the challenge grant targeted underserved communities to address systemic barriers to employment and foster a more inclusive and diverse economy.

One notable awardee is the WTIA Workforce Institute, also known as Apprenti. Apprenti helped 11 regions across the country develop their local technology workforces by cultivating diverse tech talent pools through an apprenticeship model.[136] To date, 92% of its apprentices come from underrepresented communities and 88% are retained by employers in high-paying cloud computing jobs post-apprenticeship.[137] Over the three-year grant term, Apprenti aims to place 2,000 apprentices in high-demand cloud computing roles. The success of this program set a precedent for equitable workforce training systems to promote highly digital jobs across different industries.

Other awardees adopted a similar emphasis on highly digital occupations across multiple sectors. The Connecticut Office of Workforce Strategy is forging regional sector partnerships to develop talent pipelines in industries including IT and health care, with an emphasis on upskilling individuals from traditionally underserved communities.[138] Nevadaworks, Northern Nevada's workforce board, is connecting workers from rural and Indigenous communities with quality, in-demand IT jobs and supporting more equitable and cross-cutting career pathways.[139]

These partnerships demonstrate the transformative potential of building industry-driven and worker-centered pipelines to highly digital jobs. The success of the federal Good Jobs Challenge and its cross-industry approach not only showcases the viability of a sector-based workforce development system, but also provides a clear blueprint for future investments toward an inclusive digital workforce through a multi-industry model.

To support these efforts, governors should leverage their administrative and convening power to **encourage large employers of CEM talent to expand their hiring to more underrepresented groups.** A federal precedent for this effort could be the 2022 Talent Pipeline Challenge, which focused on securing voluntary, tangible commitments from employers, education and training providers, states, philanthropic organizations, as well as local, tribal, and territorial governments for building a more equitable infrastructure workforce.[140]

Beyond that, state governments and regional actors in CEM hubs should leverage their convening powers to **secure local commitments to hire more individuals from underrepresented communities.** This can include bringing together firms, chambers of commerce and other business intermediaries, higher education institutions, K-12 schools, community organizations, and others to facilitate dialogue, spin off skill development programs, and strengthen recruiting pipelines. Examples of this include Business Equity for Indy's People Community of Practice and Workforce Pilot programs. A partnership between the Indianapolis Chamber of Commerce, Central Indiana Corporate Partnership, and the Indianapolis Urban League, these programs are using evidence-based strategies to help Indiana companies such Cummins, Eli Lilly, and Salesforce address disparities within their workforces.[141]

Grow the supply of CEM jobs in places currently lacking them

Finally, states and the federal government can and should do more to spread CEM jobs to places that have too few of them. Of note, as with its investments in digital infrastructure such as broadband, Congress has already passed a law to do just that. The bipartisan Tech Hubs program in the 2022 CHIPS and Science Act aims to grow tech-based innovation in metro areas that have too few technology jobs. The program lays out a set of key technology focus areas, ranging from AI and machine learning to biotechnology and advanced materials science, which will be important drivers in the future growth of CEM jobs.[142] By supporting these innovation-based ecosystems in more places, the Tech Hubs program will help alleviate place-based inequalities in CEM work.

However, while Congress passed this program with significant bipartisan majorities, it has not yet passed full appropriations for it. As such, the program is at risk of falling short of its goal to broaden access to technology-focused work in more places. While Congress authorized the Tech Hubs program at $10 billion over five years, thus far, only $500 million (or 5%) of total program funding has been appropriated to the EDA to implement it—an appropriation sufficient to support just five or so hubs at the modest size of $40 million to $70 million.

As such, one of the best ways to broaden access to CEM jobs to more places would simply be to **preserve and fully fund the Tech Hubs program** with its $10 billion, five-year authorization. The EDA has already selected a cohort of 31 Tech Hubs designees, of which at least 20 encompass metro areas with an underrepresentation of CEM jobs. Fully funding this program is the most straightforward, critical step that Congress can take to create a more spatially equitable distribution of CEM jobs for places currently lacking them. Beyond just fully funding existing commitments, Congress needs to also consider additional investment beyond this initial $10 billion down-payment. Brookings' original tech hubs proposal recommended a 10-year, $100 billion investment—funding that is 10 times larger than current authorizations, and 200 times larger than current appropriations.[143]

States, meanwhile, can **enact state-level innovation hubs programs** to support ongoing federal investments and grow the industries that sustain CEM jobs in places that don't currently have them. One example of this type of effort is the Accelerate California Inclusive Hubs (iHub2) program, which designated 12 Accelerate CA Hubs across the state. These hubs aim to expedite the startup and growth of tech and science-

based firms in the underserved regions through ecosystem support, technical assistance, and inclusive innovation programming aimed at diverse founders, including women and underrepresented people of color.[144]

More broadly, a growing number of states and regions across the U.S. are exploring place-based economic development policies, including Indiana's Regional Economic Acceleration and Development Initiative (READI), California's Community Economic Resilience Fund (CERF), the Virginia Growth and Opportunity (GO Virginia) initiative, and the recently announced Pennsylvania Regional Challenge.[145] While these programs don't always have a specific focus on CEM work, they help foster the development of advanced industries and other sectors with significant shares of highly digital jobs.

To complement large place-based investments, states and the federal government can make complementary investments targeted toward local assets that the drive the expansion of CEM employment. As one example, Congress could **provide dedicated support to regional public universities** to expand the supply of technology-enabled research and occupations in the regions they serve.[146] These four-year, public, non-R1 institutions have a presence in hundreds of communities across nearly every state, and recent federal investments—such as the EDA's Build Back Better Regional Challenge investment into Wichita State University to grow and diversify South Kansas' aerospace cluster—show the potential of these institutions for transformative, technology-oriented regional development.[147]

Finally, to ensure regions are making progress over time, they should **set clear, public, and actionable goals and metrics for developing inclusive digital economies.** One strong example of a region tracking metrics around inclusive growth is St. Louis, Mo.'s STL 2030 Progress tool. Assembled in conjunction with the region's STL 2030 Jobs Plan, which laid out specific goals around economic inclusion, the tool tracks progress toward those goals in a straightforward, publicly accessible way. While not explicitly digitally focused, STL 2030 Progress' metrics measure a variety of related indicators, such as the number of quality jobs in the metro area, access to quality jobs for underrepresented workers, and firm creations by underrepresented entrepreneurs. Regions could take a similar approach to measure progress on metrics relevant to inclusive CEM ecosystems.

Spirit Aerosystems building, Wichita State University | Photo credit: Kit Leong / Shutterstock

Conclusion

The emergence of new digital technologies with potentially transformative impacts for the labor market—and society writ large—underscores the critical importance of investments that generate a more equitable digital labor force. Doing so provides opportunities not only for broader employment access and labor market resilience for groups that have been historically marginalized in the digital labor force, but it also creates new opportunities for wealth development in communities that have historically been excluded from technology-based economic opportunities. Crucially, these benefits also help the nation as a whole in the form of greater overall prosperity and stronger national competitiveness.

However, as this analysis has shown, CEM jobs, which make up the core of the digital and technology labor force, remain highly segregated by race and by place, with minimal improvement over time. At this moment of substantial technological innovation, then, these new technologies risk further exacerbating existing labor market inequalities absent new and robust policy interventions.

Moreover, needed interventions have been made more difficult by an emerging federal policy and legal environment that has grown hostile to efforts designed to mitigate economic inequality across demographic lines, particularly around issues of race.

In response, what it not needed is a wholesale retreat from efforts to create a more equitable digital economy. Instead, creative new policy efforts are necessary to invest directly into communities that have previously been shut out of the economic benefits of the digital economy—whether those are historically underinvested metropolitan areas or demographic groups that have had less access to this work. Only through sustained investment over time and an enthusiastic embrace of new approaches by all stakeholders—including those in the private sector as well as state, local, and federal actors—will the nation be able to build a stronger, more equitable, and ultimately more competitive digital economy.

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ENDNOTES

1 See Mark Muro and others, "Digitalization and the American workforce" (Washington: Brookings Institution, 2017); and Mark Muro and Sifan Liu, "As the digitalization of work expands, place-based solutions can bridge the gaps" (Washington: Brookings Institution, 2023).

2 See, for example, the work of Vanderbilt Professor Ebony Omotola McGee, including her book *Black, Brown, Bruised: How Racialized STEM Education Stifles Innovation* (Cambridge, Mass.: Harvard University Press, 2020), among others cited throughout this report.

3 Adam Liptak, "Supreme Court Rejects Affirmative Action Programs at Harvard and U.N.C.," *The New York Times*, June 29, 2023; and Julian Mark and Taylor Telford, "Federal judge orders minority-business agency opened to all races," *Washington Post*, March 6, 2024. See also: Svante Myrick, "Our imaginary racial equity is destroying the tools that can achieve it," *The Hill*, March 18, 2024.

4 This section draws from material included in Muro and others, "Digitalization and the American workforce." For a full list of citations, see that report.

5 For example, the tasks involved in being a general or operations manager in Silicon Valley may differ than those of a general or operations manager in Stockton, Calif. As such, the occupation may meet the threshold of highly digital work in one metro area, but not another. Because O*NET occupational data is reported as aggregated national data and is not available as microdata that provides information at the level of individual respondents, it's not possible to calculate how digitalization scores for individual occupations vary by place.

6 See Sundiatu Dixon-Fyle and others, "Diversity matters even more: The case for holistic impact" (New York: McKinsey & Company, 2023); Ron Carucci, "One More Time: Why Diversity Leads To Better Team Performance," Forbes, January 24, 2024; Sundiatu Dixon-Fyle and others, "Diversity wins: How inclusion matters" (New York: McKinsey & Company, 2020); and Paul Gompers and Silpa Kovvali, "The Other Diversity Dividend," *Harvard Business Review*, July – August 2018; among others.

7 McGee, *Black, Brown, Bruised*.

8 For the purposes of this analysis, American Indian, Alaska Native, Native Hawaiian, and Other Pacific Islander individuals are classified as Indigenous peoples. The authors recognize that these groups are each distinct populations with their own history, cultural backgrounds, and relationships to the United States. However, given the way that occupational and educational data is aggregated in the United States, each of these groups on their own would register as less than 1% of the total CEM workforce, making meaningful comparisons of these populations difficult. Because American Indians and Alaska Natives, as well as Native Hawaiians and Other Pacific Islanders, are disproportionately multiracial and multiethnic, a majority of individuals from these groups are classified as two or more races in many federal data sets, artificially shrinking samples sizes for their populations. (For additional context on why the authors could not effectively disaggregate multiracial workers, see the following endnote.) Because of these factors, the authors decided to combine these populations into a single "Indigenous peoples" classification. This decision is in line with other scholars, who have noted that American Indians, Alaska Natives, and Native

Hawaiians are all considered Indigenous populations in what is today the United States; see, for example: Carolyn A. Liebler, "On the Boundaries of Race: Identification of Mixed-heritage Children in the United States, 1960 to 2010," *Sociology of Race and Ethnicity*, 2 (4) (2016): 548-568; and Matthew Gregg, H Trostle, and Carolyn A. Leibler, "New 2020 Census Rules Make It Harder to Navigate Native American Data" (Minneapolis: Federal Reserve Bank of Minneapolis, 2023). As these scholars note, American Indians, Alaska Natives, and Native Hawaiians are generally considered Indigenous peoples (or alternatively, Native Americans) in the United States. While some Other Pacific Islanders are Indigenous to the United States (e.g. Chamorro people in Guam and the Northern Mariana Islands, and Samoan people in American Samoa), those from sovereign Pacific island nations are not. However, because some federal occupational and educational data does not disaggregate Native Hawaiian and Indigenous Pacific Islanders from Other Pacific Islanders, the authors necessarily included all of them in the broader Indigenous peoples category for the purposes of this analysis.

9 While multiracial workers also hold highly digital jobs at a lower rate than their share of the population, for this report they are not considered "underrepresented workers of color." This is due in part to how certain datasets aggregate workers identifying as two or more races. For example, education data contained in the Integrated Postsecondary Education Data System (IPEDS) does not allow users to ascertain the racial identity of individuals identifying as two or more races. As such, for comparability reasons, this analysis necessarily needed to include multiracial individuals as a separate category, which consists of a mixture of individuals from both underrepresented and overrepresented racial groups. For more detailed discussions of the demographic identities of multiracial Americans, see Nicholas Jones and others, "Improved Race and Ethnicity Measures Reveal U.S. Population Is Much More Multiracial: 2020 Census Illuminates Racial and Ethnic Composition of the Country," *America Counts*, August 12, 2021; and Kim Parker and others, "Multiracial in America: Proud, Diverse and Growing in Numbers" (Washington: Pew Research Center, 2015). For a more detailed discussion on the history of white ancestry for multiracial Americans, see Chandra D.L. Waring, "Appearance, Parentage, and Paradox: The White Privilege of Bi/Multiracial Americans with White Ancestry," *Sociology of Race and Ethnicity*, 9 (1) (2023): 56-71.

10 For more on pay differentials for women and workers of color in tech-related jobs, see Chapter 5, "How diverse are tech talent markets?" in Colin Yasukochi and others, "Scoring Tech Talent 2023: Slowdown in Tech Company Hiring Creates Talent Opportunities for Other Industries" (Dallas: CBRE, 2023).

11 11% figure: Brookings analysis of data from BLS and Lightcast. For a discussion on the educational credentials needed to access computer and engineering occupations, see Jennifer Cheeseman Day and Anthony Martinez, "STEM Majors Earned More Than Other STEM Workers," *America Counts: Stories Behind the Numbers*, June 2, 2021: "STEM jobs include computer occupations, mathematicians and statisticians, engineers, life scientists, and physical and social scientists. About half of the STEM jobs were in computer occupations and another 29% in engineering in 2019…The path to STEM jobs for non-STEM majors was narrow. Only a few STEM-related majors (7%) and non-STEM majors (6%) ultimately ended up in STEM occupations."

12 For example, the RAND Corporation finds that "despite rapid growth in society's use of digital technology, many children in low-income families in the United States are not able to access and use technology in the same ways as their more advantaged peers. This means they have fewer opportunities to learn, explore, and communicate digitally, and fewer chances to develop the workforce skills they will need to succeed in later life";

and that "Without technology literacy upon entry into kindergarten, students may begin to fall behind in the classroom, as standards for K–12 education in the United States place considerable importance on ICT"; see Lindsay Daugherty and others, "Using Early Childhood Education to Bridge the Digital Divide" (Santa Monica, Calif.: RAND Corporation, 2014). These skills divides often manifest along racial lines. For example, the Urban Institute finds that "A significant share of all youth in the US (23 percent) have no or limited independent digital skills. Black youth (48 percent) are three times as likely as white youth (16 percent) to have no or limited independent digital skills, and Hispanic youth (31 percent) are nearly twice as likely as white youth to have no or limited independent digital skills"; see Ian Hecker and Amanda Briggs, "Overlooked and Under-Connected: Exploring Disparities in Digital Skill Levels Among Older Youth of Color in the US" (Washington: Urban Institute, 2021).

13 For example, 72% of Black students attend a high-poverty school, compared to just 31% of white students; and 60% of Black students attend a high-poverty school with a high share of students of color, compared to just 8% of white students. On the other hand, while nearly a quarter of white students attend a school where most of their peers are white and not poor, only 3% of Black students attend such a school. See Emma García, "Schools are still segregated, and black children are paying a price" (Washington: Economic Policy Institute, 2020). In general, school districts with the most students of color receive 15% less state and local funding than the whitest school districts, see Amadou Diallo, "School districts are going into debt to keep up with technology," *The Hechinger Report*, April 22, 2019.

14 For example, schools serving low-income students of color cannot spend as much on hiring qualified science and technology teachers, purchasing equipment, or running the types of relevant extracurricular activities in fields such as robotics or web design that lead young people into digitally oriented fields; see Allison Scott and others, "The Leaky Tech Pipeline: A Comprehensive Framework for Understanding and Addressing the Lack of Diversity across the Tech Ecosystem" (Oakland, Calif.: Kapor Center for Social Impact, 2018). In some cases, students in under-resourced schools may contend with outdated technology and computer equipment that does not work or has so much security paraphernalia (such as physical locks) that it rarely gets used; see Ebony O. McGee and F. Alvin Pearman, II, "Risk and Protective Factors in Mathematically Talented Black Male Students: Snapshots From Kindergarten Through Eighth Grade," *Urban Education*, 49 (4) (2014): 363-393.

15 Office for Civil Rights, "A First Look: Students' Access to Educational Opportunities in U.S. Public Schools" (Washington: Department of Education, 2023).

16 Scott and others, "The Leaky Tech Pipeline." Unsurprisingly, then, low-income students of color are significantly less likely to have access to relevant Advanced Placement courses such as AP Computer Science. This explains why just 20% of students taking the AP Computer Science Principles exam were Latino or Hispanic, and only 7% were Black—well below both of those groups' share of the high school student population; see Tamara Pearson, "Why the most lucrative tech careers are still out of reach for so many US students," *Quartz*, December 21, 2020. And access to these classes alone is not a sufficient indicator of whether students are fully accessing and benefitting from the material. For example, while the AP Computer Science Principles pass rate averages 80% for white and Asian American students, it is only 51% for Black and Latino or Hispanic students; see Scott and others, "The Leaky Tech Pipeline."

17 Sean Roberts and others, "2022 State of Computer Science Education: Understanding our National Imperative" (Seattle: Code.org, CSTA, and ECEP Alliance, 2022).

18 Javeria Salman, "Just 3% of scientists and

engineers are Black or Latina women. Here's what teachers are doing about it." *The Hechinger Report*, November 19, 2020; and Christy M. Byrd, "Does Culturally Relevant Teaching Work? An Examination From Student Perspectives," SAGE Open, 6 (3) (2016).

19 For example, in interviews with Black elementary school students, they report being exposed at an early age to stereotypes that they "can't do math," "are lazy," and "are unintelligent," among many others. See McGee and Pearman, "Risk and Protective Factors in Mathematically Talented Black Male Students." Similar stereotypes exist around the relationship between girls and tech-related fields. For example, evidence shows that because stereotypes about intellect across genders tend to (wrongly) associate innate brilliance less with women and more with men, it can discourage women from pursuing STEM fields. See Tiffany A. Ito and Erin McPherson, "Factors Influencing High School Students' Interest in pSTEM," *Frontiers in Psychology* (9) (2018): Article 1535.

20 For example, the association of success in STEM fields with innate brilliance (as opposed to hard work) that tends to be (wrongly) associated with men can dissuade girls and women from pursuing STEM fields; see Ito and Erin McPherson, "Factors Influencing High School Students' Interest in pSTEM."

21 Ebony McGee, ""Black Genius, Asian Fail": The Detriment of Stereotype Lift and Stereotype Threat in High-Achieving Asian and Black STEM Students," *AERA Open*, 4 (4) (2018): 1-16.

22 The PIAAC assesses the "cognitive skills required in the information age" by measuring workers' ability to use technology to solve a set of problems and accomplish complex tasks. The survey then classifies workers into four levels, ranging from level 1 (indicating they can use widely available technology applications such as email or a web browser) to Level 3 (indicating they can use both generic and more specific technology applications to complete tasks requiring significant amounts of integration and inferential reasoning). See OECD, "Problem Solving in Technology-Rich Environments," https://www.oecd.org/skills/piaac/Problem%20Solving%20in%20TRE%20Sample%20Items.pdf. See also Steven Ezell, "Assessing the State of Digital Skills in the U.S. Economy" (Washington: Information Technology and Innovation Foundation, 2021); Ian Hecker and Pamela Loprest, "Foundational Digital Skills for Career Progress" (Washington: Urban Institute, 2019); and Ian Hecker, Shayne Spaulding, and Daniel Kuehn, "Digital Skills and Older Workers" (Washington: Urban Institute, 2021).

23 National Center for Education Statistics, "Highlights of the 2017 U.S. PIAAC Results Web Report" (Washington: Department of Education, 2019).

24 See Hecker and Loprest, "Foundational Digital Skills for Career Progress"; and Hecker, Spaulding, and Kuehn, "Digital Skills and Older Workers."

25 Hecker, Spaulding, and Kuehn, "Digital Skills and Older Workers."

26 Device affordability remains a disproportionate challenge for low-income households and communities of color. On this front, Pew finds that just 59% of households with incomes less than $30,000 have access to a desktop or laptop computer, compared to 92% of households with incomes above $100,000. Pew similarly finds that 80% of white households have access to a desktop or laptop, while just 69% of Black households and 67% of Latino or Hispanic households do; see Sara Atske and Andrew Perrin, "Home broadband adoption, computer ownership vary by race, ethnicity in the U.S." (Washington: Pew Research Center, 2021). Meanwhile, Brookings scholars have shown that states and neighborhoods with the lowest median incomes, the highest share of rural residents, and the highest share of communities of color also have the lowest broadband adoption rates; see Adie Tomer, Lara Fishbane, Angela Siefer, and Bill Callahan, "Digital prosperity: How broadband can deliver health and equity

to all communities" (Washington: Brookings Institution, 2020).

27 See, for example, McGee and Pearman, "Risk and Protective Factors in Mathematically Talented Black Male Students;" Nick Pandolfo, "As some schools plunge into technology, poor schools are left behind," *The Hechinger Report*, January 24, 2012; and Change the Equation, "Ending the Double Disadvantage: Ensuring STEM Opportunities in Our Poorest Schools" (Washington, 2017). For a more general discussion on the impact of financial resources on childhood skill development, see Matt Barnum, "Does money matter for schools? Why one researcher says the question is 'essentially settled'," *Chalkbeat*, December 17, 2018. Evidence also shows that court-ordered state education financing reforms, such as the one currently underway in Pennsylvania, lead to significant improvements school funding and student outcomes; see Christopher A. Candelaria and Kenneth A. Shores, "Court-Ordered Finance Reforms in the Adequacy Era: Heterogeneous Causal Effects and Sensitivity," *Education Finance and Policy*, 14 (1) (2019): 1-30.

28 Code.org Advocacy Coalition, Computer Science Teachers Association, and Expanding Computing Education Pathways Alliance, "2023 State of Computer Science Education" (2023).

29 See, for example, McGee and Pearman, "Risk and Protective Factors in Mathematically Talented Black Male Students;" and Frieda McAlear, Tiffany Smith, and Kathy DeerInWater, "State of Diversity: The Native Tech Ecosystem" (Oakland: Kapor Center, 2023).

30 Michele L. Aronson and others, "The Very Foundation of Good Citizenship: The Legal and Pedagogical Case For Culturally Responsive and Racially Inclusive Public Education for All Students" (Washington: National Education Association and the Law Firm Antiracism Alliance, 2022).

31 Kathryn M. Rich, Jill Bowdon, Marissa Spang, "Implementing Culturally Responsive Coding Projects with Indigenous Communities," In Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 2, 1355–1355. Toronto ON Canada: ACM, https://dl.acm.org/doi/abs/10.1145/3545947.3576299 (accessed January 30, 2024).

32 Joseph Wilson and others, "Wind River Elementary Computer Science Collaborative: Connecting Computer Science and Indigenous Identities and Knowledges on the Wind River Reservation," *Journal of Computer Science Integration*, 6 (1) (2023): 5.

33 Ibid.

34 U.S. National Science Foundation, "Integrating Computer Science into the Elementary Curriculum in Culturally Relevant Ways: A Researcher-Practitioner-Partnership in Native-American Serving Districts in Wyoming," https://www.nsf.gov/awardsearch/showAward?AWD_ID=1923375 (accessed January 30, 2024).

35 Wilson and others, "Wind River Elementary Computer Science Collaborative: Connecting Computer Science and Indigenous Identities."

36 Ibid.

37 Interview with AIR staff, Katie Rich and Marissa Sprang, January 31, 2024.

38 McGee and Pearman, "Risk and Protective Factors in Mathematically Talented Black Male Students."

39 Afterschool Alliance, "STEM Learning in Afterschool on the Rise, But Barriers and Inequities Exist" (Washington, 2021).

40 "Our Story," AI4ALL, https://ai-4-all.org/about/our-story/ (accessed January 31, 2024).

41 AI4LL, "AI4ALL's work in 2021," (San Francisco, 2021), https://ai-4-all.org/wp-content/uploads/2022/09/AI4ALL-Impact-Report.pdf.

42 AI4ALL, "Our Story," https://ai-4-all.org/about/our-story/ (accessed January 31, 2024).

43 "Home - Techbridge Girls," https://www.techbridgegirls.org/ (accessed January 31, 2024)

44 Techbridge Girls, "Techbridge Girls Impact Report 2021-2022 Program Year," (Oakland, Calif., 2022).

45 "Home - Techbridge Girls," https://www.

techbridgegirls.org/ (accessed January 31, 2024). In 2022, they were part of the White House Office of Science and Technology Policy's announcement of a slate of bold actions that advance the Biden-Harris administration's STEMM Equity and Excellence priorities: https://www.whitehouse.gov/ostp/news-updates/2022/12/12/fact-sheet-biden-harris-administration-announces-bold-multi-sector-actions-to-eliminate-systemic-barriers-in-stemm/.

46 "Home, Code Girls United," Code Girls United, https://codegirlsunited.org/ (accessed January 31, 2024).

47 Science Club for Girls, "Fall 2023 Science Clubs: A Look Back in Time with Evolutionary Biology, Archaeology, and Data Analysis," January 19, 2024.

48 Amadou Diallo, "After-School Programs Have Either Been Abandoned or Overworked during the Pandemic," *PBS NewsHour*, April 20, 2021.

49 Schools could qualify for the program in a variety of ways, including: 1) serving a high proportion of low-income students, potentially measured by levels of free or reduced-price lunch; 2) serving a large proportion of students from groups underrepresented in highly digital work; 3) being designated as a rural school; and 4) Bureau of Indian Education-funded schools; among others.

50 See Robert Schwartz and Kerry McKittrick, "From Margins to Mainstream: Bringing Career-Connected Learning to Scale," *American Educator*, forthcoming.

51 See https://careerconnectwa.org/ (accessed February 22, 2024); see also Schwartz and McKittrick, "From Margins to Mainstream."

52 Office of Educational Technology, "Teacher Digital Learning Guide" (Washington: Department of Education, 2021).

53 Examples of topics of focus could include recruiting and training educators from underrepresented communities and professional development resources to create culturally responsive curricula in digitally relevant fields such as CS. Additionally, the Department could create a guide outlining existing sources of funding that schools can leverage to implement these efforts—not only at the federal level, but also from states philanthropic sources.

54 Argonne National Laboratory, Science Careers in Search of Women, https://www.anl.gov/science-careers-in-search-of-women.

55 National Science Foundation (NSF) Experiential Learning for Emerging and Novel Technologies (ExLENT), https://new.nsf.gov/funding/opportunities/experiential-learning-emerging-novel-technologies.

56 National Telecommunications and Information Administration, "Digital Equity Guide for the States: How to Prepare for Success in Your State" (Washington, 2022).

57 The act defines "digital equity" as the condition in which individuals and communities have the IT capacity needed for full participation in society and the economy. In particular, the DEA aims for what it calls "covered populations" and "covered households," which include many workers who have historically faced barriers to digital inclusion. Covered populations include aging individuals, individuals with a language barrier, veterans, individuals who are part of a racial or ethnic minority groups, and individuals in rural areas, among others. Covered households are defined as those whose income is not more than 150% of the federal poverty line. See: National Telecommunications and Information Administration, "Digital Equity Guide for the States."

58 See: https://broadbandusa.ntia.doc.gov/public-notice-posting-state-and-territory-bead-and-digital-equity-plansproposals, accessed December 8, 2023.

59 See: https://broadbandusa.ntia.doc.gov/public-notice-posting-state-and-territory-bead-and-digital-equity-plansproposals, accessed January 5, 2024.

60 Maine Connectivity Authority, "Maine's Vision of Digital Equity" (Portland, Maine, 2023).

61 With regard to tribes, the NTIA acknowledges as much, noting in its Notice of Funding Opportunity (NOFO) that "due to the large

number of Indian Tribes, Alaska Native entities, and Native Hawaiian organizations, and the likely resource constraints among many of these entities, NTIA will continue to offer funds in future NOFOs to tribal entities that have yet to receive Digital Equity Planning Grants and to develop digital equity plans." Under current funding amounts, the NTIA aims to provide tribes with between $50,000 and $150,000 for planning grants. But with a set aside of just $15 million in funding per year for tribes, that wouldn't be enough to fund all 574 federally recognized tribes at that level—let alone fund significant implementation grants for all of them. The NTIA likewise provided $150,000 in planning grants to each territory other than Puerto Rico. In comparison, Washington, D.C., which had a smaller planning grant allocation than every state, received over $463,000 in planning grants, and Delaware, the state with the lowest planning grant allocation, received over $516,000 in planning grant funding. See: National Telecommunications and Information Administration, "Notice of Funding Opportunity: State Digital Equity Planning Grant Program" (Washington, 2022).

62 See Paul Fain, "Turnkey Apprenticeships," *The Job*, November 9, 2023; and Bakersfield College, "Bakersfield College & OpenClassrooms Combine Forces to Launch a New Innovative Tech Apprenticeship Program," April 26, 2023.

63 Nick Anderson, "Businesses and universities team up on a new digital technology credential," *Washington Post*, May 19, 2019.

64 See, for example, *https://gwp.umbc.edu/digitialtechcred/* (accessed January 5, 2024): "By completing PRAC112/The Digital Tech Credential as a UMBC student, you will receive a transcript notation as well as a badge that can be displayed on your resume or LinkedIn page."

65 Pennsylvania Department of Labor & Industry, "Shapiro Administration Announces Grant Funding To Enhance Digital-Literacy Programs, Helping Workers To Navigate Job Search Process," August 17, 2023.

66 The White House, "FACT SHEET: Biden-Harris Administration Launches the Apprenticeship Ambassador Initiative to Create Equitable, Debt-Free Pathways to High-Paying Jobs" (Washington, 2022).

67 https://www.fcc.gov/affordable-connectivity-program-consumer-faq (accessed February 23, 2024)

68 https://www.fcc.gov/sites/default/files/ACP_Wind-down_Fact_Sheet_Final.pdf (accessed February 23, 2024).

69 11% figure: Brookings analysis of data from BLS and Lightcast. For a discussion on the educational credentials needed to access computer and engineering occupations, see Jennifer Cheeseman Day and Anthony Martinez, "STEM Majors Earned More Than Other STEM Workers," *America Counts: Stories Behind the Numbers*, June 2, 2021: "STEM jobs include computer occupations, mathematicians and statisticians, engineers, life scientists, and physical and social scientists. About half of the STEM jobs were in computer occupations and another 29% in engineering in 2019…The path to STEM jobs for non-STEM majors was narrow. Only a few STEM-related majors (7%) and non-STEM majors (6%) ultimately ended up in STEM occupations."

70 The demeaning stereotypes and hostility mentioned previously often reappear in higher education, but are made worse because there are frequently small numbers of women or students of color in STEM courses or departments. For example, Vanderbilt University Professor of Education, Diversity and STEM Education Ebony McGee documents a variety of troubling examples in her book *Black, Brown, Bruised: How Racialized STEM Education Stifles Innovation*, ranging from instructors treating individuals from underrepresented groups like they're invisible to only talking about their "potential" (as opposed to their actual ability). See McGee, *Black, Brown, Bruised*. Women in STEM higher education programs also experience high rates of harassment, including sexual harassment. Beyond stereotypes and

harassment, underrepresented students face other barriers, ranging from a lack of STEM career opportunities related to social justice, activism, or other areas of social and cultural interest for underrepresented students, to a small number and revolving door of faculty from underrepresented groups. For more, see McGee, *Black, Brown, Bruised*.

71 Amanda J. Koch and others, "Why women STEM majors are less likely than men to persist in completing a STEM degree: More than the individual," *Personality and Individual Differences*, 190 (2022).

72 Melba Newsome, "Even as colleges pledge to improve, share of engineering and math graduates who are Black declines," Hechinger Report, April 12, 2021, citing: Catherine Riegle-Crumb, Barbara King, and Yasmiyn Irizarry, "Does STEM Stand Out? Examining Racial/Ethnic Gaps in Persistence Across Postsecondary Fields," *Educational Researcher*, 48 (3) (2019): 133–144.

73 Scott and others, "The Leaky Tech Pipeline;" see also Cindy Brown Barnes and others, "Diversity in the Technology Sector: Federal Agencies Could Improve Oversight of Equal Employment Opportunity Requirements" (Washington: Government Accountability Office, 2017).

74 Students from underrepresented groups frequently maintain separate networks in response to the racial, gender, or other forms of stereotypes that they must contend with in STEM education. These factors harm these students because many companies hiring for CEM occupations tend to rely on networks and personal relationships to grant access; see, for example, Dean and Bhuiyan, "Why are Black and Latino people still kept out of the tech industry?"; and Quoctrung Bui and Claire Cain Miller, "Why Tech Degrees Are Not Putting More Blacks and Hispanics Into Tech Jobs," *The New York Times*, February 25, 2016. In other cases, firms may hire from pools of past interns, which women, students of color, and students who grew up in low-income households often have correspondingly less access to in STEM fields. See, for example, Katie N. Smith, "Undergraduate Participation in Paid and Unpaid Internships by Income Level," *Journal of Student Financial Aid*, 52 (2) (2023): Article 4: "STEM graduates had the lowest rate of participation in unpaid internships and the highest rate of participation in paid internships…Rivera (2015) also found that elite companies limit their candidate pools to students from highly selective institutions and, when reviewing application materials, search for indicators of socioeconomic status to screen for 'fit.'…students with marginalized identities are participating in paid internships at lower rates and may have less access to these opportunities. Results related to major category further support this dynamic, STEM graduates (predominantly white and men) have far greater access to paid internships…"

75 These biases are often not malicious, but rather function as mental shortcuts. However, in CEM occupations, where white and Asian American men are overrepresented, these types of biases often disadvantage women and underrepresented people of color. In other cases, firms may rely on interview processes and tactics that can disadvantage underrepresented candidates. For example, many companies rely on programming interviews when hiring for tech occupations. These types of interviews often involve logic puzzles or obscure software concepts that are covered in computer science degree programs. Not only do these interviews do relatively little to predict work performance, but they also put underrepresented candidates at a disadvantage, as they prioritize narrow knowledge sets that are taught within specific schools and programs. In some cases, they have even helped create a coding interview prep industry, akin to standardized test prep, that benefits privileged candidates who are able to pay. These interviews, then, can have similar effects to when firms draw on personal networks to identify potential candidates—attending a certain program or having a certain level of privilege becomes,

in effect, a ticket to success in getting hired. In other instances, interviewers may treat candidates aggressively in interviews, trying to "weed out" candidates. This can include interviewers making candidates feel bad for the number of questions they asked, treating candidates coldly, or using "gotcha" interview questions. Finally, some employers include more qualifications than are necessary in job descriptions, making job descriptions more of an aspirational post than an accurate representation of skill needs. When this happens, it tends to disproportionately affect qualified women and candidates of color, who are less likely than white men to apply to positions where they don't meet every criteria. For more information, see Tammy Xu, "The Deck Is Stacked Against Black Women in Tech," *Built In*, August 31, 2020.

76 These findings are backed up by survey evidence, see Pew Research Center found that 72% of Black respondents and 43% of Latino or Hispanic respondents felt that racial discrimination was a major reason for Black and Latino or Hispanic underrepresentation in STEM jobs. By contrast, just 27% of white respondents and 28% of Asian American respondents felt the same; see Cary Funk and Kim Parker, "Blacks in STEM jobs are especially concerned about diversity and discrimination in the workplace" (Washington: Pew Research Center, 2018). Literature and survey evidence finds that when job fields are perceived as hostile to underrepresented groups, or when groups don't appear well represented in them, candidates from those groups become less interested in those jobs. For example, University of Connecticut Professor of Sociology Maya Beasley has found that many Black STEM candidates opt to pursue work in the business or nonprofit sectors because they have heard negative reports about the culture in tech; see Bui and Miller, "Why Tech Degrees Are Not Putting More Blacks and Hispanics Into Tech Jobs," citing Maya A. Beasley, *Opting Out: Losing the Potential of America's Young Black Elite* (Chicago: The University of Chicago Press, 2011); see also Scott and others, "The Leaky Tech Pipeline." Women face similar challenges. As Stanford researchers Alison Wynn, and Shelley J. Correll have noted, when companies present a culture where women don't appear well represented, it causes women who may otherwise be interested in pursuing a career with the firm to lose interest; see Lori Nishiura Mackenzie, Alison Wynn, and Shelley J. Correll, "If Women Don't Apply to Your Company, This Is Probably Why," *Harvard Business Review*, October 17, 2019, citing Alison Wynn and Shelley J. Correll, "Puncturing the pipeline: Do technology companies alienate women in recruiting sessions?" Social *Studies of Science*, 48 (1) (2018): 149-164; see also Xu, "The Deck Is Stacked Against Black Women in Tech."

77 For example, over 60% of Black workers in STEM occupations report having experienced racial discrimination, and nearly three-quarters of women report experiencing gender discrimination at work, see Funk and Parker, "Blacks in STEM jobs are especially concerned about diversity and discrimination in the workplace;" and Cary Funk and Kim Parker, "Women and Men in STEM Often at Odds Over Workplace Equity" (Washington: Pew Research Center, 2018). Other studies show that Latino or Hispanic workers report being treated unfairly because of their race at nearly four times the rate of white workers, and Black workers at nearly five times as often, see Hina B. Shah, "Radical Reconstruction: (Re) Embracing Affirmative Action in Private Employment," *University of Baltimore Law Review*, 48 (2) (2019): 203-269.

78 Research shows that by the time they reach their mid- to late-thirties, many workers from underrepresented groups see their careers in tech stall. Some make lateral moves into non-tech occupations, while others leave the industry entirely. See: Sylvia Ann Hewlett and others, "The Athena Factor: Reversing the Brain Drain in Science, Engineering, and Technology" (Cambridge, Mass.: Harvard Business Review, 2008); see also Erin Carson,

"Half of young women will leave their tech job by age 35, study finds," *CNET*, September 29, 2020, citing Barbara Harvey and others, "Resetting Tech Culture: 5 strategies to keep women in tech" (New York: Accenture and Girls Who Code, 2020); and Ebony Omotola McGee, "Interrogating Structural Racism in STEM Higher Education," *Educational Researcher*, 49 (9) (2020): 633–644. For a review of issues related to tokenism facing women and workers of color in computer, engineering, and management jobs, see: Joan Williams, Katherine Williams Phillips, and Erika V. Hall, "Double Jeopardy? Gender Bias Against Women of Color in Science" (San Francisco: UC Hastings Center for WorkLife Law, 2014); see also Sidney Fussell, "Black Tech Employees Rebel Against 'Diversity Theater'," *Wired*, March 8, 2021. For a discussion about how working styles in computer, engineering, and management occupations harm women and workers of color, see: U.S. Equal Employment Opportunity Commission, "Diversity in High Tech;" Scott and others, "The Leaky Tech Pipeline;" and Williams, Williams Phillips, and Hall, "Double Jeopardy." For more on issues affecting women and workers of color when it comes to performance reviews, pay, and promotions, see: Scott and others, "The Leaky Tech Pipeline;" see also The Adecco Group, "Women of Color Suffer the Biggest Pay Gap in Technology, Hired Report Shows," May 27, 2021; and Rani Molla, "Black women in tech make 90 cents for every dollar a white man makes," *Recode*, May 19, 2021; both citing Hired, "2021 Impact Report: Wage Inequality in the Workplace" (New York, 2021).

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83 Siri Chilazi, "Advancing Gender Equality in Venture Capital: What the Evidence Says About the Current State of the Industry and How to Promote More Gender Diversity, Equality, and Inclusion" (Cambridge, Mass.: Harvard Kennedy School Women and Public Policy Program, 2019).

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85 Supreme Court of the United States, *Students for Fair Admissions, Inc. v. President and Fellows of Harvard College* (2023).

86 For example, elected officials in several states have indicated that they may interpret it to restrict firm hiring practices and DEI efforts, see Jathon Sapsford, "Republican Attorneys General Warn Top U.S. Businesses over 'Discrimination'," *Wall Street Journal*, July 14, 2023; and Taylor Telford, "2024 might be do-or-die for corporate diversity efforts. Here's why." *Washington Post*, December 27, 2023.

87 See Julian Mark, "SBA program upended in wake of Supreme Court affirmative action ruling," *Washington Post*, September 7, 2023;

and Cheryl Winokur Munk, "The next big post-affirmative action legal ruling to drop targets billions in small business contracts," *CNBC*, October 25, 2023.

88 For example, previous Brookings research finds that regional public universities receive on average just one-fifth the amount of per-student funding as public flagship and R1 institutions, see Maxim and Muro, "Restoring regional public universities for recovery in the Great Lakes." Meanwhile, in 2023, the federal government found that 16 states had underfunded their HBCUs by a total of $13 billion between 1987 and 2020, see Katherine Knott, "States Underfunded Historically Black Land Grants by $13 Billion Over 3 Decades," *Inside Higher Ed*, September 20, 2023. And the Congressional Research Service has found that many states did not provide HBCUs with full matching funds for the land grant program, underfunding institutions by $15.5 million in FY2019 and $21.5 million in FY2020, see Eleni G. Bickell, "The U.S. Land-Grant University System: Overview and Role in Agricultural Research" (Washington: Congressional Research Service, 2022).

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102 Moreover, in most years, Congress fails to meet even its statutorily obligated level of funding for 1890 and 1994 institutions, see: Eleni G. Bickell, "The U.S. Land-Grant University System: Overview and Role in Agricultural Research" (Washington, Congressional Research Service, 2022); see also: Sara Partridge, "The 2023 Farm Bill Must Address Inequities in the Land-Grant

University System" (Washington: Center for American Progress, 2023).

103 Department of Education, "Strategies for Increasing Diversity and Opportunity in Higher Education" (Washington, 2023). For more information on the convening held to discuss improving transfer pathways, see Department of Education, "Biden-Harris Administration Convenes Higher Education Leaders to Improve Student Transfer to Increase Completion of College Degrees," https://www.ed.gov/news/press-releases/biden-harris-administration-convenes-higher-education-leaders-improve-student-transfer-increase-completion-college-degrees.

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105 See Tara Sophia Mohr, "Why Women Don't Apply for Jobs Unless They're 100% Qualified," *Harvard Business Review*, August 25, 2014; and Liz Alton, "What's Working Today to Attract and Retain Women in Technology," Connected, March 23, 2021. See also Becca Carnahan & Christopher Moore, "Actively Addressing Unconscious Bias in Recruiting, *Harvard Business School – Insights & Advice*, June 16, 2023. For more on skills-based hiring, see Opportunity@Work, STARs: Skilled Through Alternative Routes, https://opportunityatwork.org/stars/, accessed February 28, 2024.

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108 Kiran A. Ahjua, "Skills-Based Hiring Guidance and Competency Model for Artificial Intelligence Work" (Washington: Office of Personnel Management, 2024).

109 The White House, "Press Release: National Cyber Director Encourages Adoption of Skill-Based Hiring to Connect Americans to Good-Paying Cyber Jobs" (Washington, 2024).

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111 Kathryn Anne Edwards and Alexander Hertel-Fernandez, "Paving the Way through Paid Internships: A Proposal to Expand Educational and Economic Opportunities for Low-Income College Students" (Washington: Economic Policy Institute and Demos, 2010).

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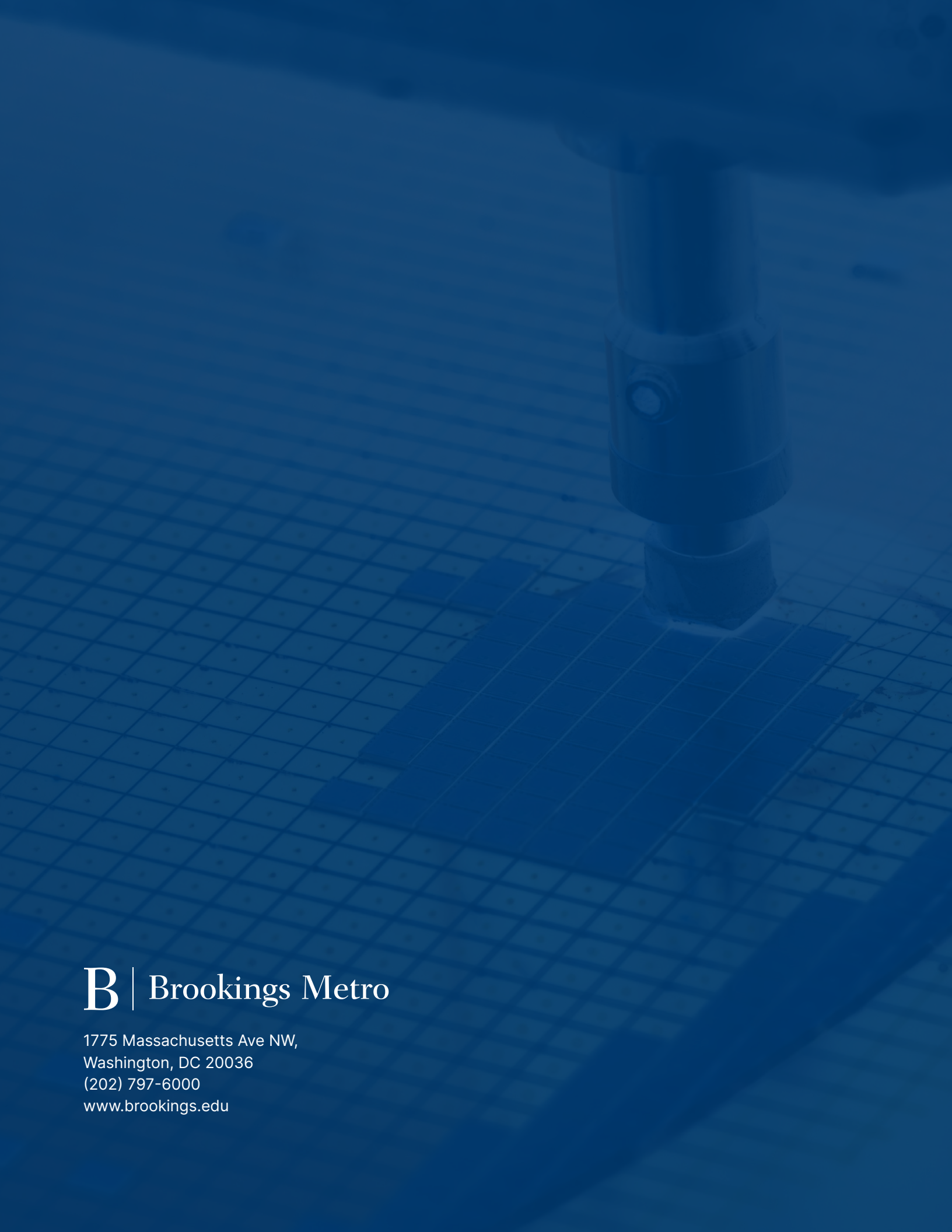

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