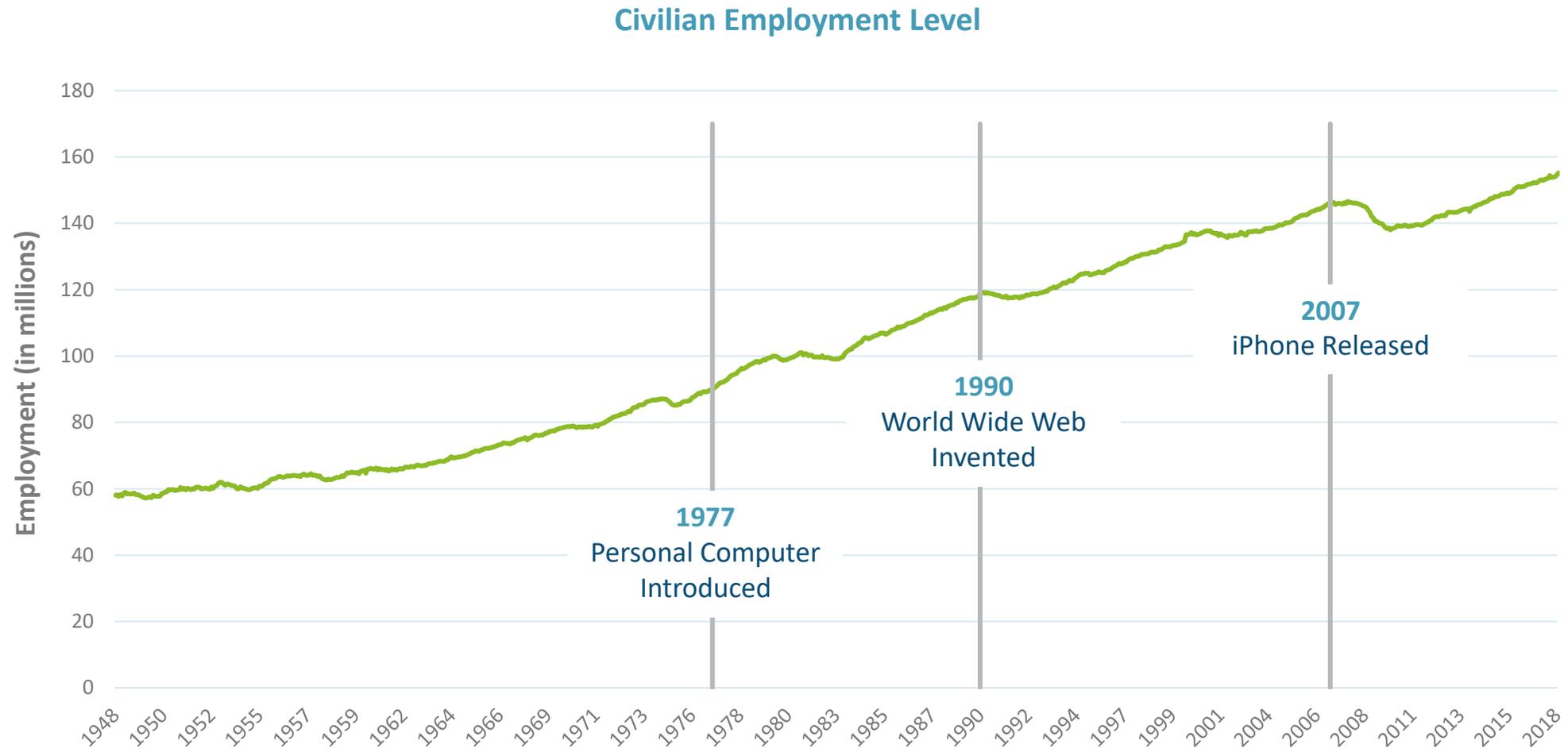




Automation and a Changing Economy

April 2020

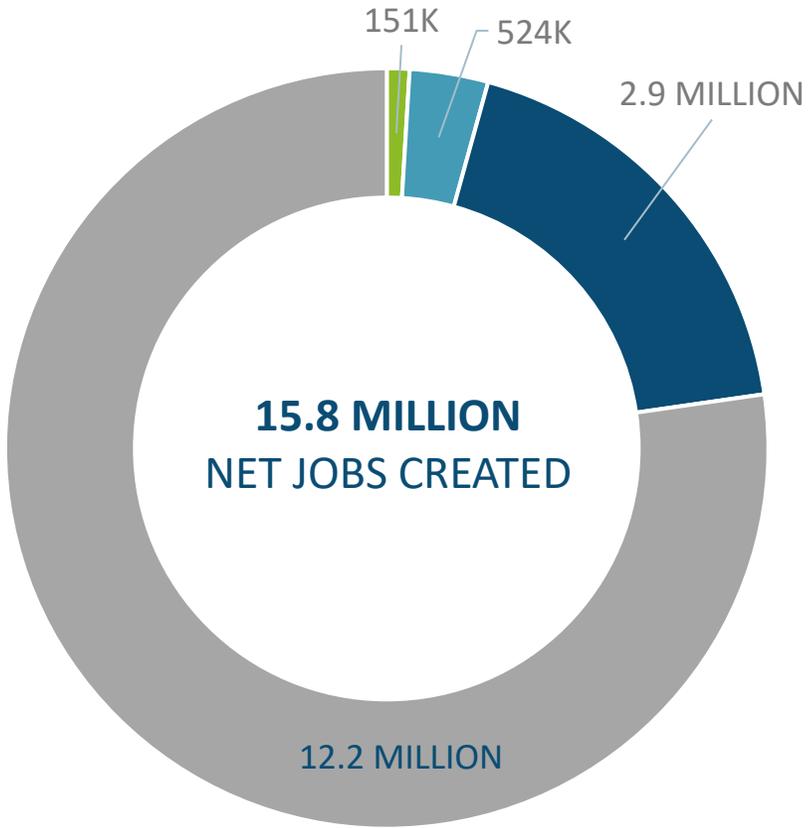
Alongside Automation, U.S. Workforce Has Grown Over Time



Source: analysis of Current Population Survey and Employment Projections data, U.S. Bureau of Labor Statistics.

Automation Has Created Jobs: Personal Computers

TOTAL US JOBS CREATED BY PERSONAL COMPUTERS



REPRESENTATIVE OCCUPATIONS (in thousands)

DIRECT (Computer equipment manufacturing, 1970–2015)

▲ Assorted managers and administrators	31
▲ Computer software developers (in-industry equipment)	27
▲ Computer scientists	18
▼ Office machine manufacturers (typewriters)	-61

INDIRECT (Computer suppliers, 1970–2015)

▲ Managers	42
▲ Semiconductor manufacturing occupations	31
▲ Semiconductor manufacturing occupations	26
▼ Typewriter indirect occupations	-79

ENABLED (Computer software and service industries, 1970–2015)

▲ Software developers (software and apps)	768
▲ Computer scientists	686
▲ Managers	416
▼ Typewriter repair	-32

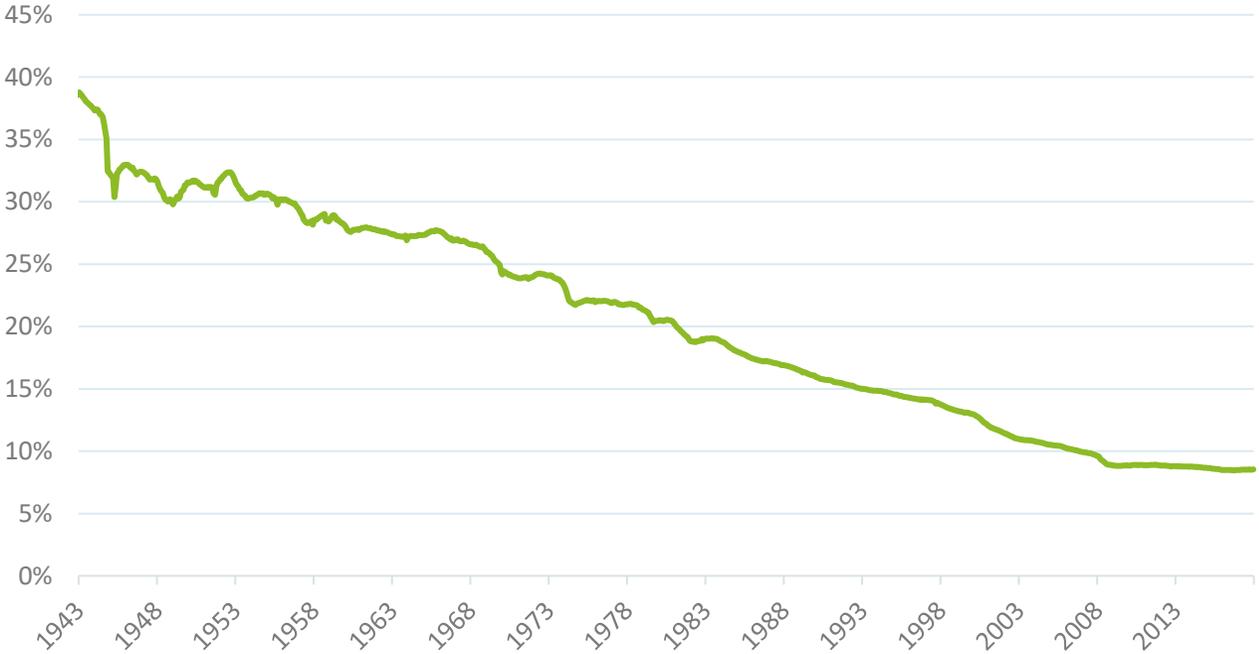
UTILIZERS (Computer-utilizing industries, 1980–2015)

▲ Customer service reps	3,205
▲ Computer scientists (not in computer industry)	1,873
▲ Stock and inventory clerks	1,517
▼ Bookkeepers and auditing clerks	-881
▼ Secretaries	-823
▼ Typists	-562

Source: IPUMS; Moody's; IMPLAN; US Bureau of Labor Statistics; FRED; McKinsey Global Institute analysis

Automation & the Manufacturing Industry

All Employees: Manufacturing/All Employees:
 Total Nonfarm Payrolls
 1943-2018



Source: U.S. Bureau of Labor Statistics. Retrieved from FRED, Federal Reserve Bank of St. Louis.

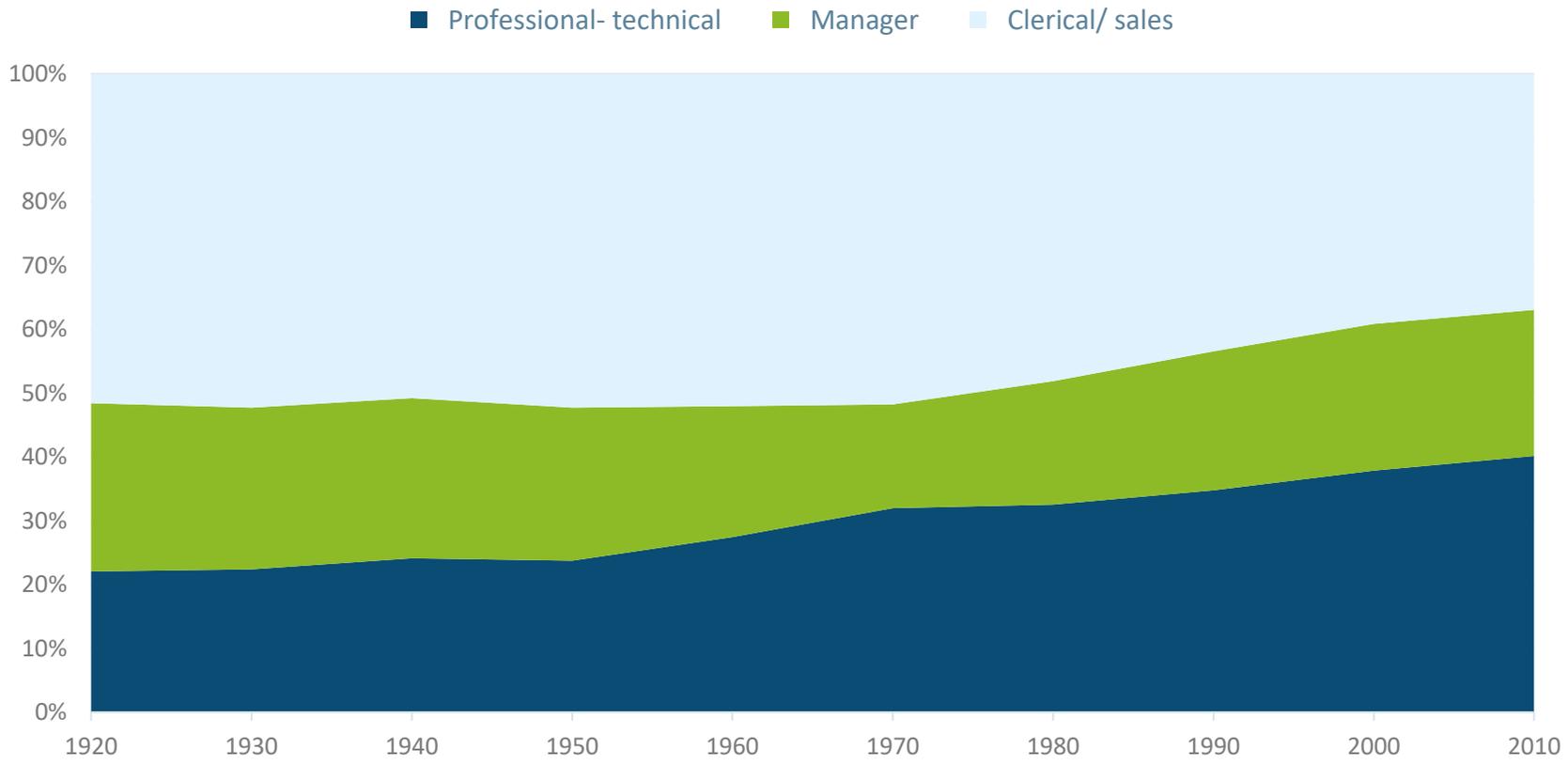
For every additional industrial robot introduced into a local labor market, on average, **6.2 workers** in that labor market lost their jobs.

These losses include both **direct factory job losses** as well as **indirect losses** elsewhere, particularly in the construction, business services, wholesale, service, and retail industries.

Source: Acemoglu and Restrepo. 2017. "Robots and Jobs." National Bureau of Economic Research. <http://www.nber.org/papers/w23285>.

Automation Has Eliminated Jobs: Routine Office Jobs Have Declined

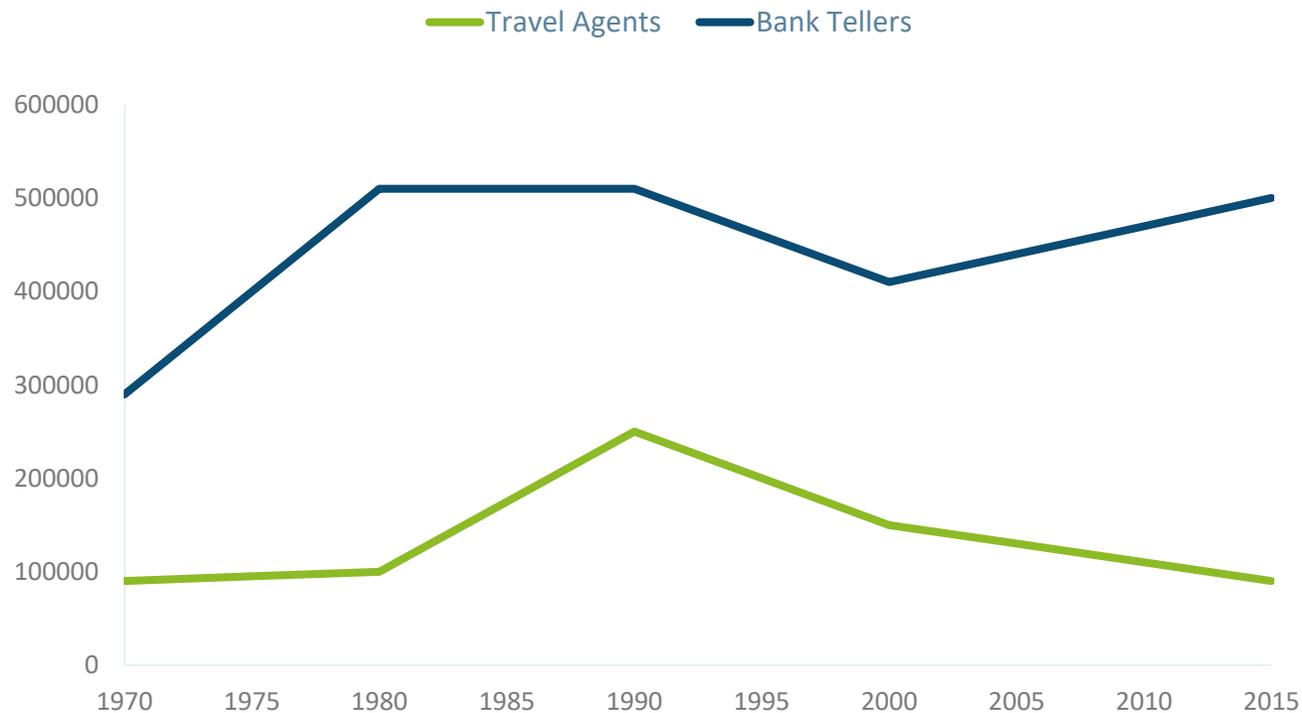
Distribution of Jobs Within White Collar Work, 1930-2010



Source: Katz and Margo. 2014. "Technical Change and the Relative Demand for Skilled Labor." In *Human Capital in History*. <https://www.nber.org/chapters/c12888.pdf>.

Automation Has Changed Jobs: Bank Tellers & Travel Agents

Bank Tellers vs. Travel Agents Over Time



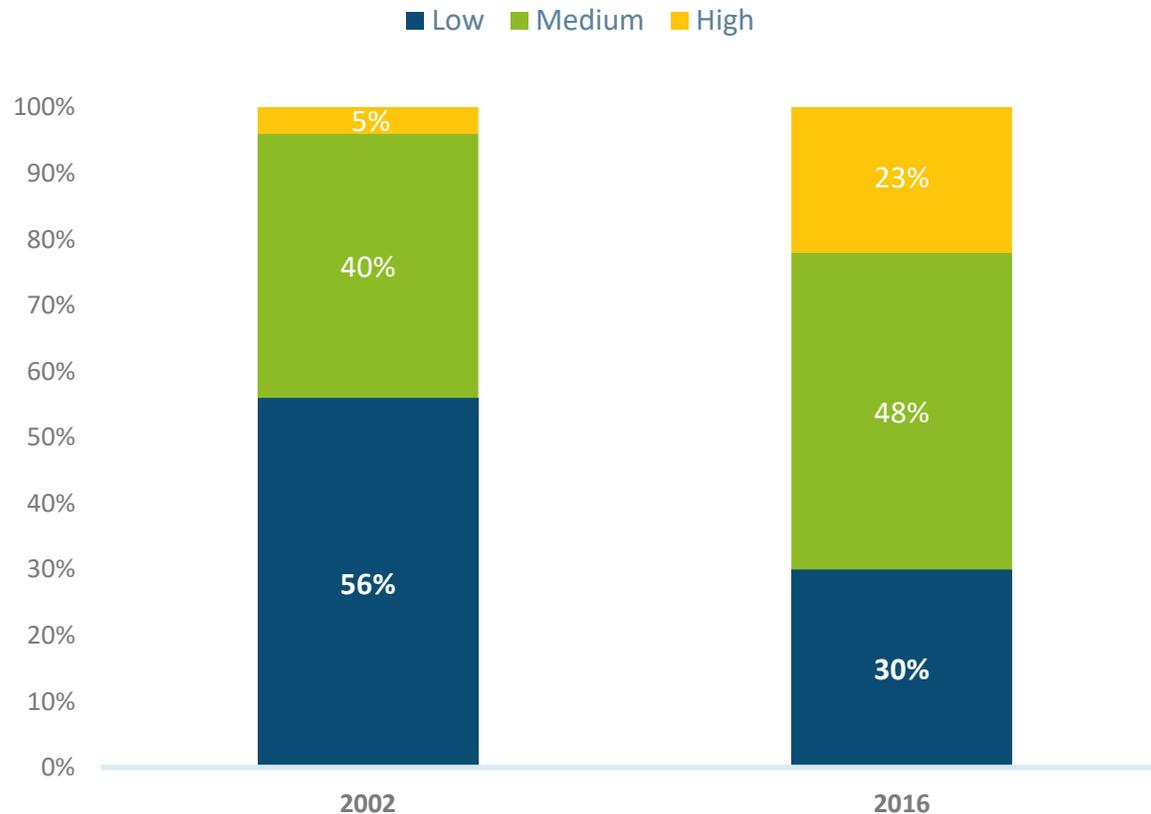
Source: U.S. Census

Despite the introduction of **400,000+** ATMs in the U.S., the number of bank tellers has increased over time

With the introduction of ATMs, the responsibilities of bank tellers have changed: **more customer-facing, new responsibilities**

Automation is Changing Skills: Increasing Digital Skills Needed

Employment by Levels of Job Digitalization



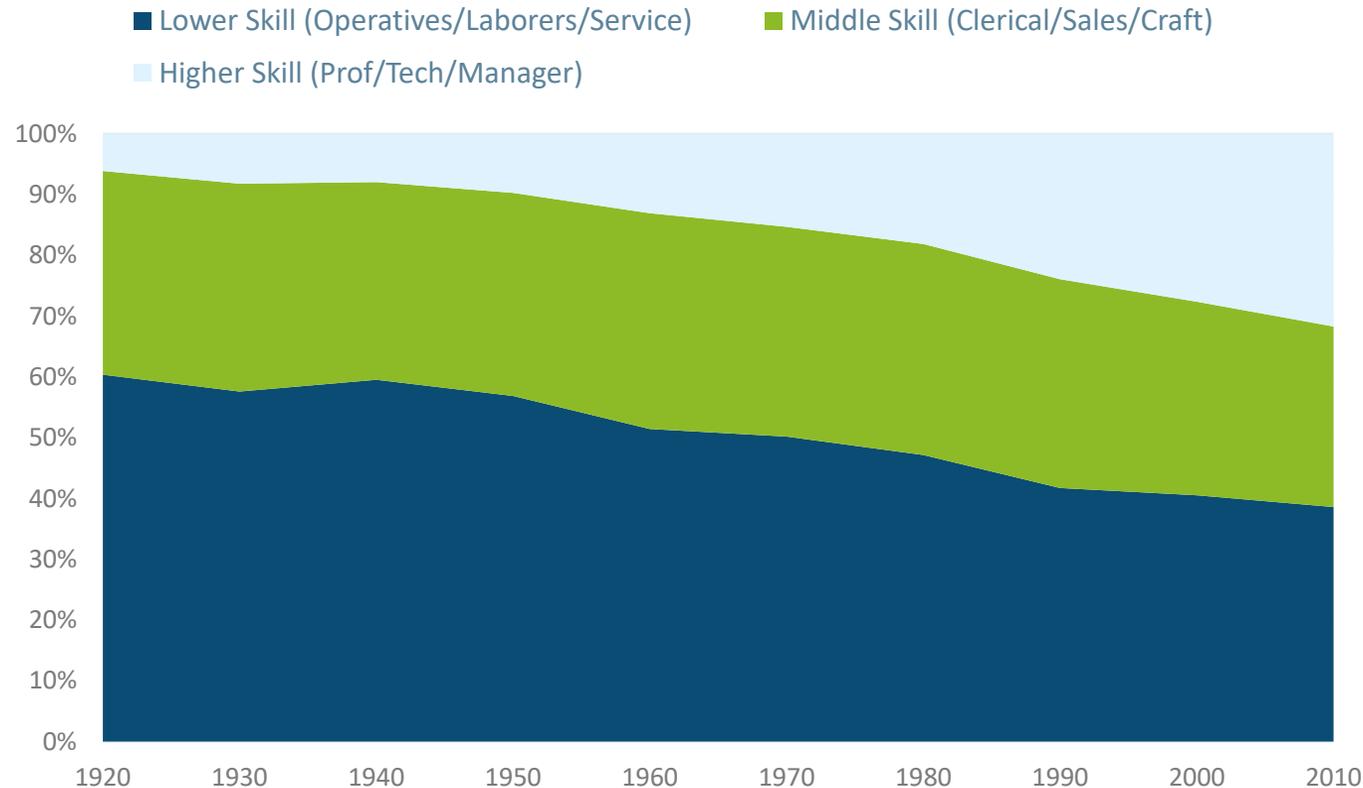
Source: Brookings Institution

Janitors: 2.2 million in the workforce, digital skills requirements have increased by **45%** over the last 10 years

Personal care aides: digital skills requirements have increased by **189%** over the last 10 years

Automation is Changing Skills: Manufacturing Industry

Manufacturing Industry Employment by Skill Levels



Source: Katz and Margo. 2014. "Technical Change and the Relative Demand for Skilled Labor." In Human Capital in History. <https://www.nber.org/chapters/c12888.pdf>.

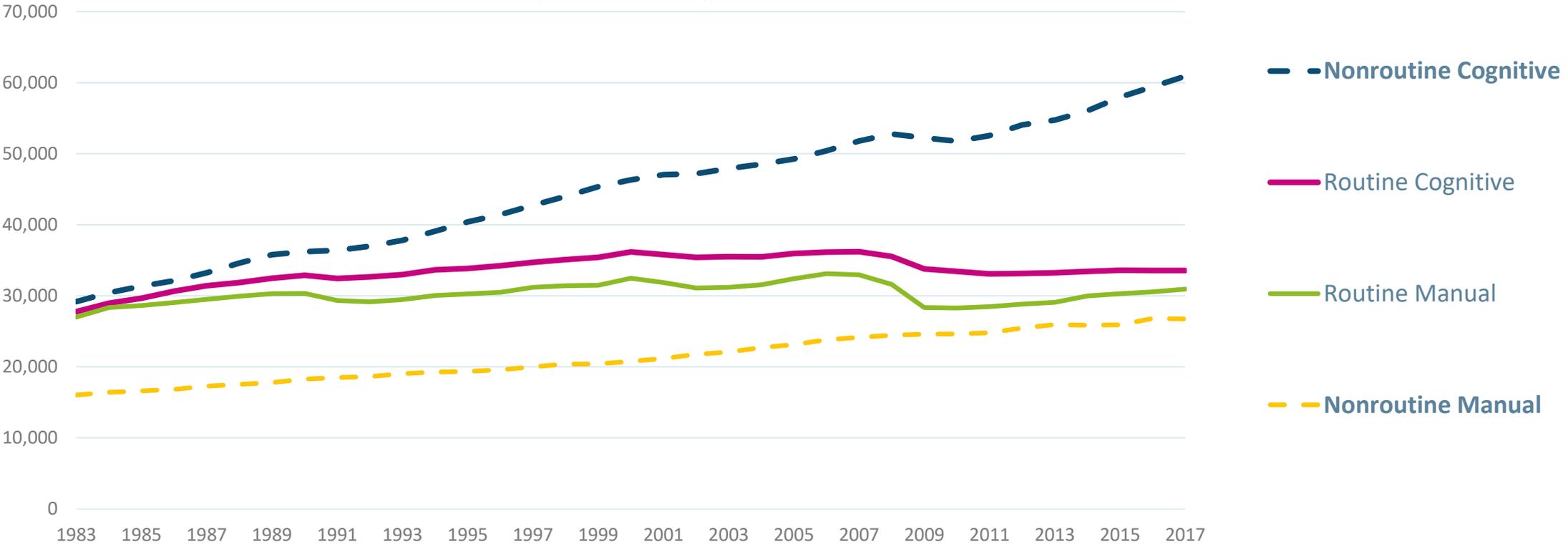
Jobs are increasingly higher-skill professional, managerial, and technical jobs

In 2019, American manufacturers were on track to employ **more college graduates** than workers with a high-school education or less.

More than **40%** of manufacturing workers have a college degree, up from **22%** in 1991.

Automation Contributing to a Divided Labor Market: Nonroutine Jobs Growing, Routine Jobs Remain Flat

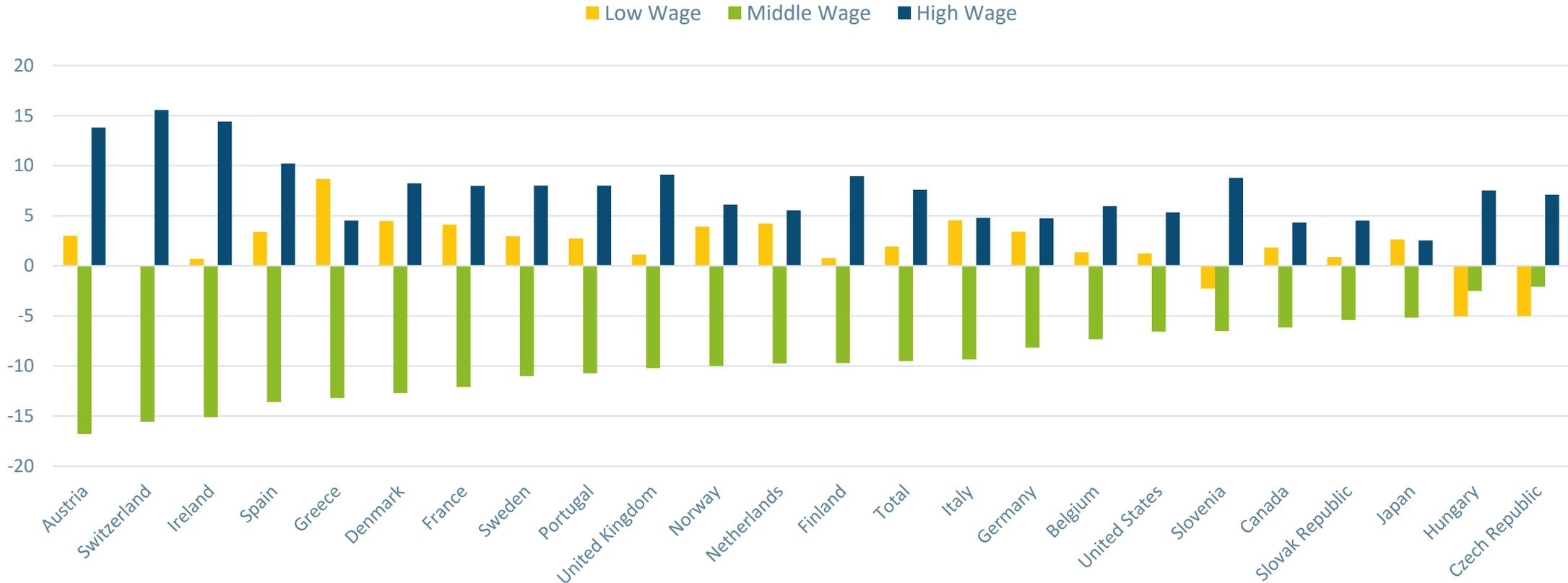
Employment Levels of Routine and Nonroutine Occupations, 1983-2017
 (in thousands)



Source: Author's analysis of Employment Level data, U.S. Bureau of Labor Statistics. Retrieved from Federal Reserve Bank of St. Louis. <https://fred.stlouisfed.org/graph/?g=43U0#0>.

Automation Contributing to a Divided Labor Market: Middle-Wage Jobs in Decline Across OECD Countries

Percent Change in Share of Total Employment, OECD Countries, 1995-2015

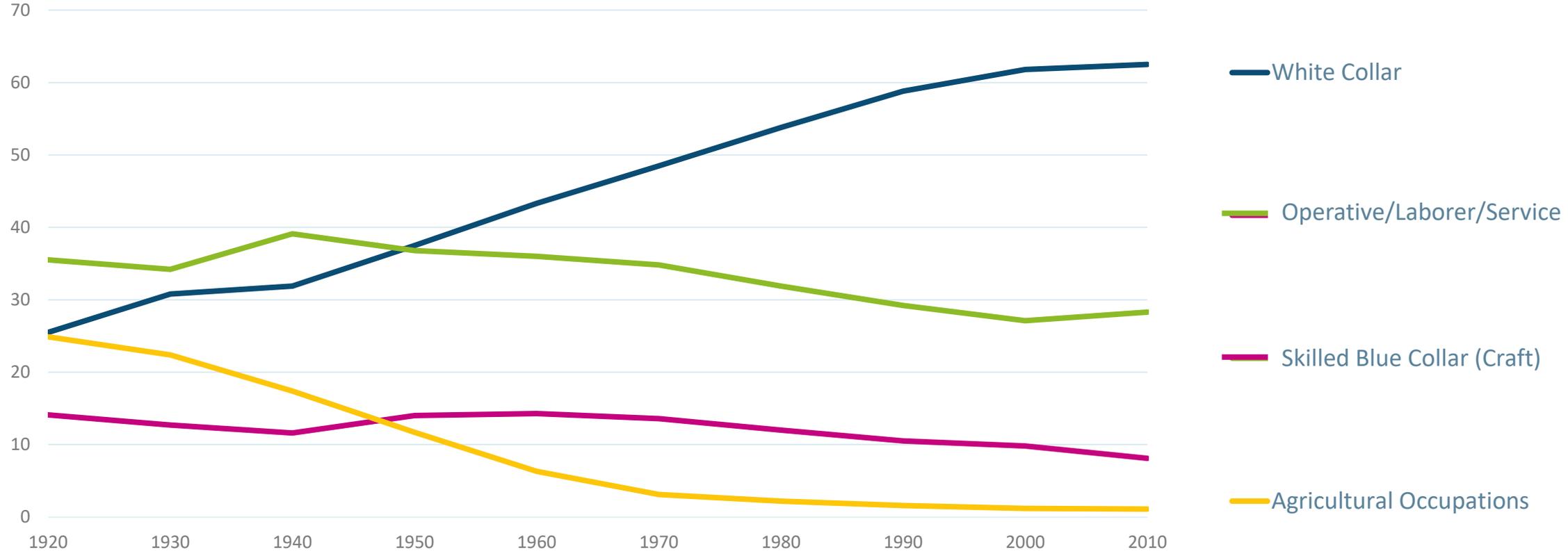


Source: OECD. 2017. "Job polarization by country." In *OECD Employment Outlook 2017*. https://www.oecd-library.org/employment/oecd-employment-outlook-2017/job-polarization-by-country_empl_outlook-2017-graph39-en.

Automation Contributing to a Divided Labor Market

Occupational Distribution of U.S. Employment, 1920-2010

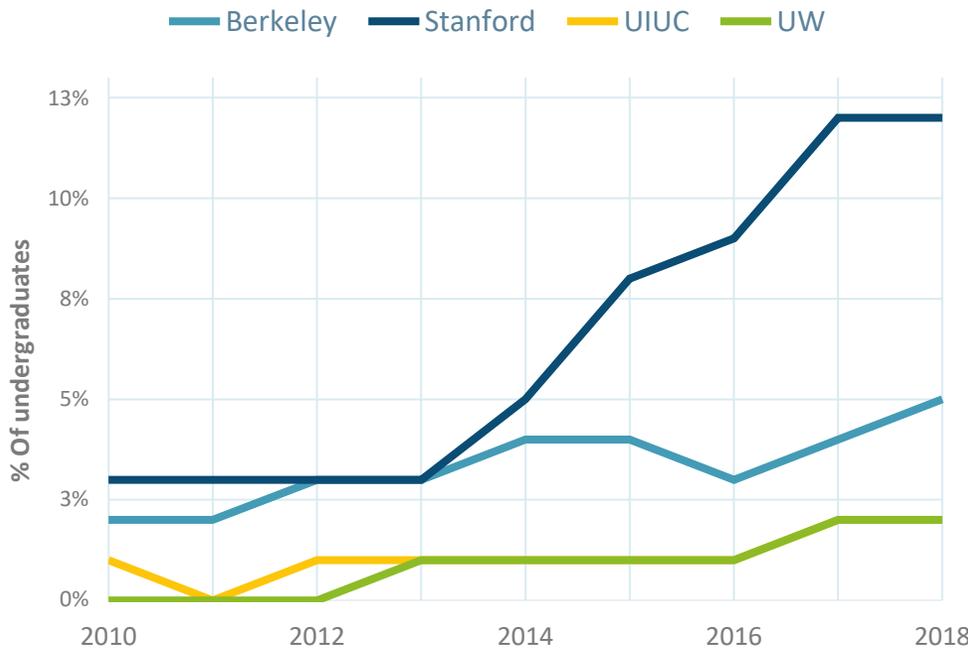
Middle- and High-Skilled White Collar Work Grew Significantly as a Share of All U.S. Jobs



Source: Katz and Margo. 2014. "Technical Change and the Relative Demand for Skilled labor." In Human Capital in History. <https://www.nber.org/chapters/c12888.pdf>.

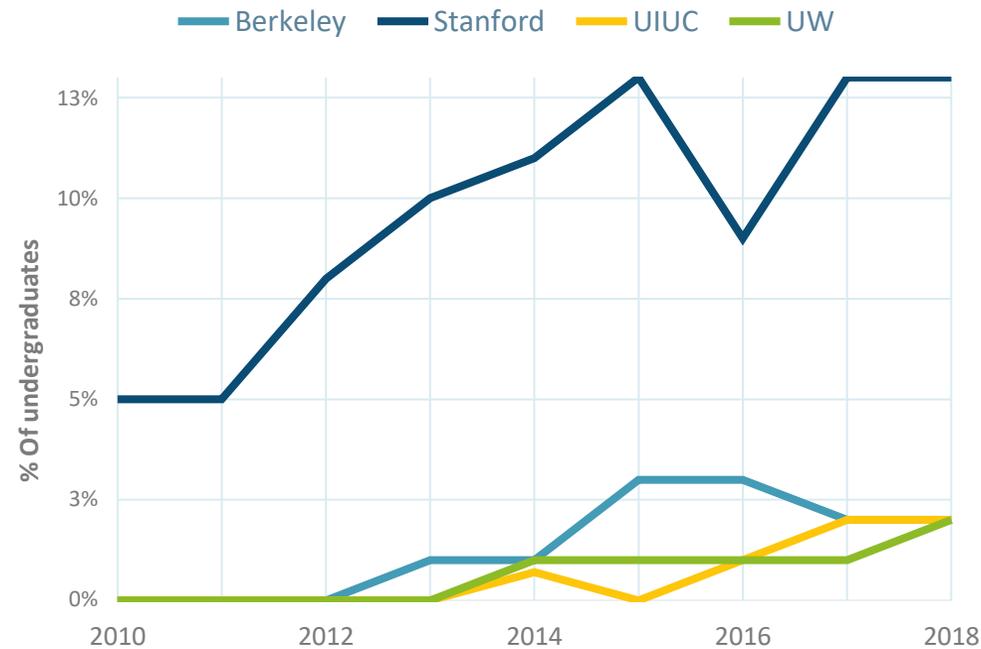
Potential for Increased Automation: Undergraduate Enrollment Trends

PERCENT OF UNDERGRADUATES
ENROLLED IN INTRO TO AI
(2010-2018)



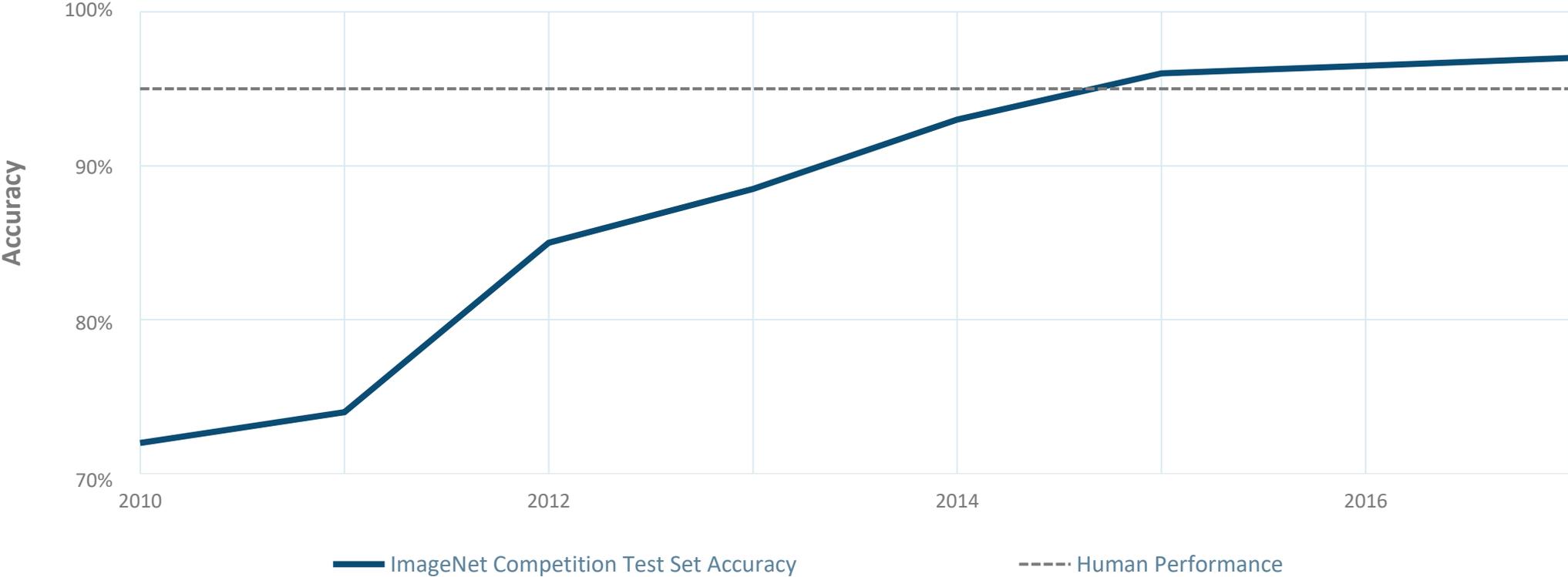
Source: AI Index, University provided data

PERCENT OF UNDERGRADUATES
ENROLLED IN INTRO TO ML
(2010-2018)



Source: AI Index, University provided data

Potential for Increased Automation: AI Image Detection Outperforming Humans



Source: ImageNet 2010-2018; see appendix, AI Index

Projections of Automation Disruption

Projections about what jobs are at risk and how many workers could become displaced:

» McKinsey Global Institute

- Up to **32 percent** of workers may need to transition to entirely different occupations by 2030 as a result of automation

» Brookings Institution

- Over the next few decades, approximately **25 percent** of U.S. employment will have experienced high exposure to automation (with greater than 70 percent of current task content at risk of substitution).

Who is Most at Risk of Automation?

» Low-wage, routine jobs

- The jobs that appear most vulnerable are those that involve **routine cognitive and manual tasks**: repetitive, predictable activities like operating machinery, preparing fast food, and collecting and processing data.

» Women

- Studies of jobs in Phoenix and Indianapolis show that **women in certain markets may be more likely than men to be employed in jobs at highest risk of automation**, such as cashier, office clerk, secretarial and administrative positions.

» People of color

- A recent study by the Joint Center for Political and Economic Studies found that **larger shares of Latino (31 percent) and African American (27 percent) workers are employed in the 30 jobs identified as being at highest risk of automation**, particularly cooking, cashiering, and food preparation, than are White (24 percent) or Asian American (20 percent) workers.

» Disabled

- A recent study by Source America shows that **workers with disabilities are, on average, more likely to be employed in jobs at high risk of automation**, such as in grounds and building maintenance, food service, retail, warehousing, and administrative work..

» Young people

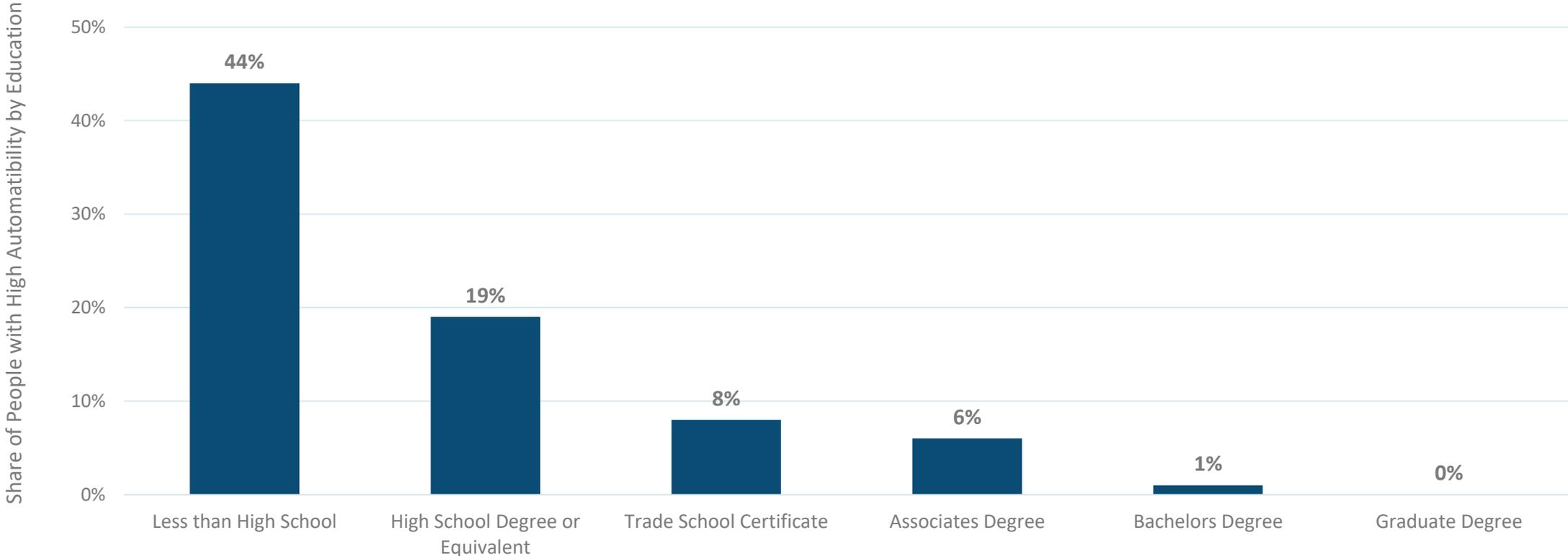
- A Brookings Institution study found that **workers between the ages of 16 and 24 face a notably high average automation exposure** due to their dramatic overrepresentation in automatable jobs, such as those in the food services..

» Rural vs. urban

- Automation risk varies across U.S. regions, states, and cities. For example, the **“American Heartland” states**, which have a longstanding and continued specialization in the manufacturing and agricultural industries, are expected to face heightened automation risk.

Who is Most at Risk of Automation?

Percent of Workers in Highly Automatable Jobs by Education Level



Calculations based on the Survey of Adult Skills (PIAAC) 2012.
Source: Arntz, Gregory, and Ulrich Zierahn. 2016. "The Risk of Automation for Jobs in OECD Countries." OECD Social, Employment and Migration Working Papers.
https://www.oecd-ilibrary.org/social-issues-migration-health/the-risk-of-automation-for-jobs-in-oecd-countries_5jlz9h56dvq7-en

Policy & Employer Response: Limited Supports for Workers

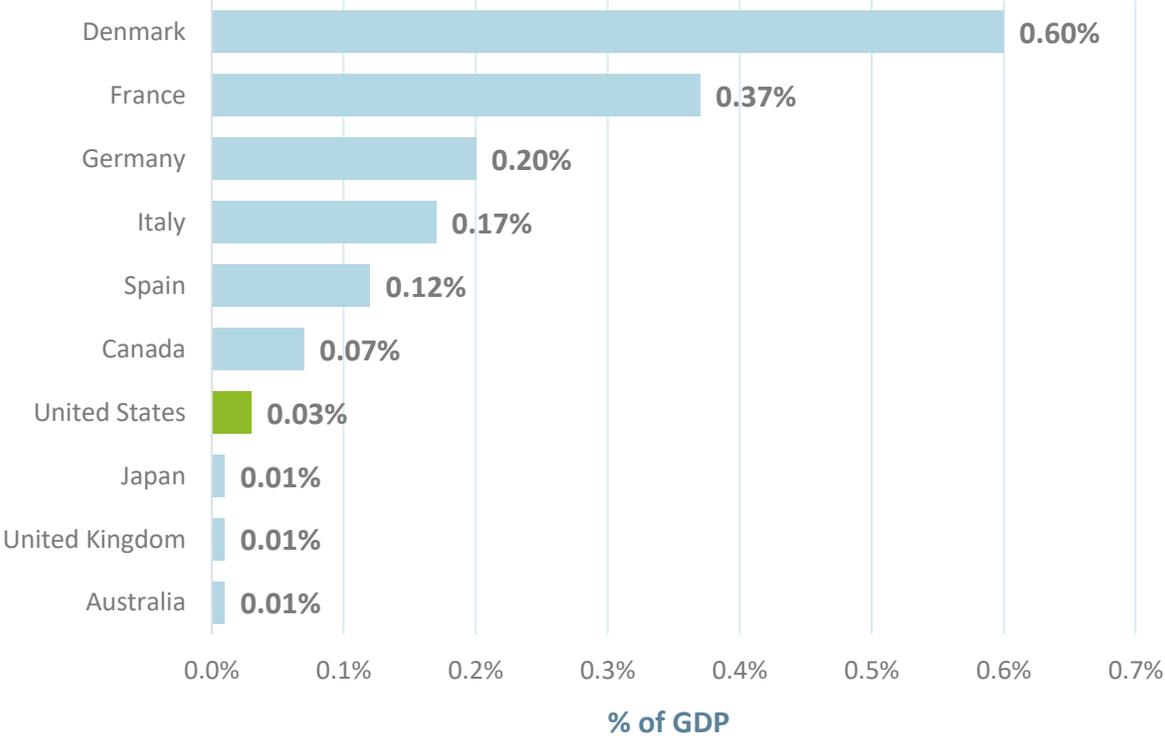
Percent of Workers Receiving Job-Related Training



Note: Fraction of workers ages 18-65 receiving training of any duration last year.

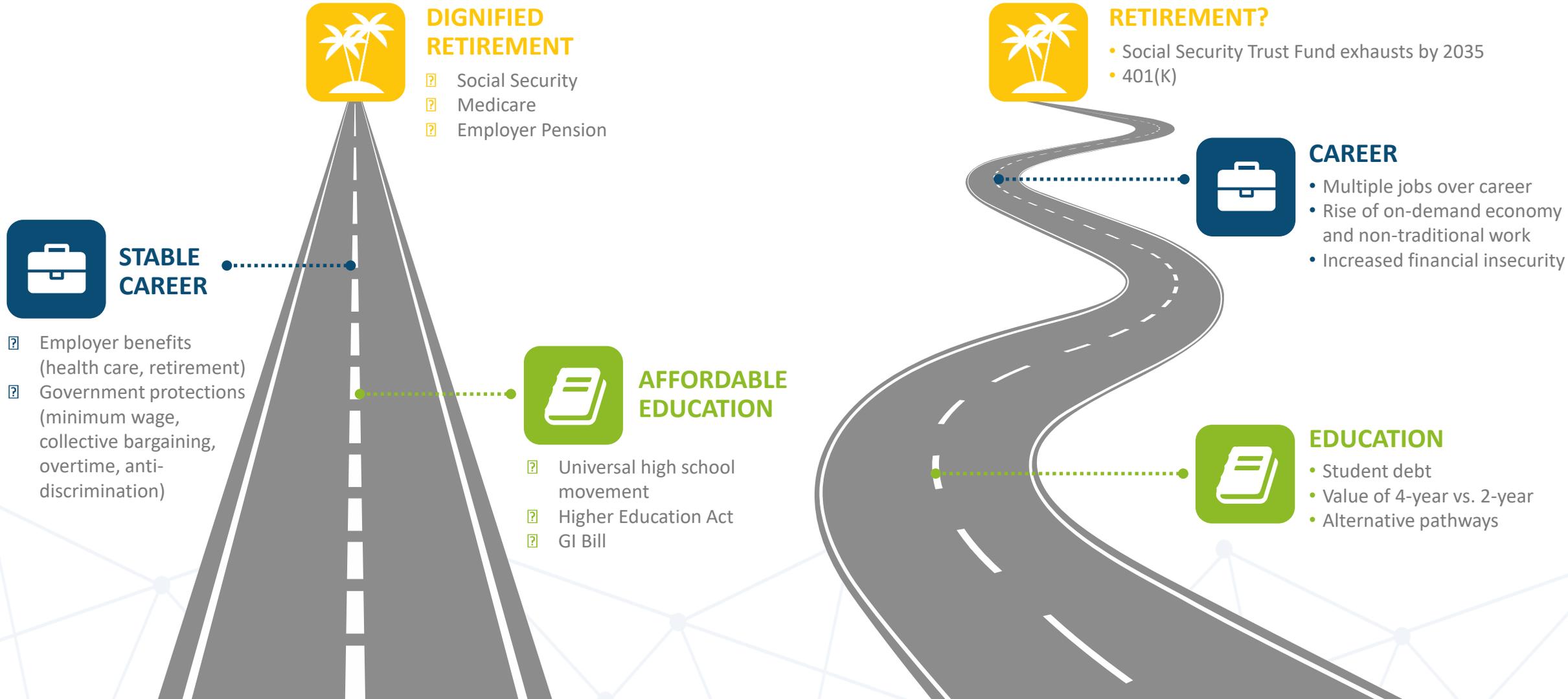
Source: Census Bureau, Survey of Income and Program Participation (Employment and Training Topical Module); CEA calculation

Total Public Spending on Worker Training, 2015



Source: McKinsey Global Institute analysis of OECD data, December 2017

Policy Development in the 20th Century



Policy Recommendations for the Future of Work

1

Encourage Employers to Lead Human-Centric Approach to Automation

- » Expand apprenticeship programs
- » Promote worker voice
- » Create Worker Training Tax Credit

2

Enable Workers to Access Skills Training, Good Jobs, and New Economic Opportunities

- » Establish lifelong learning & training accounts
- » Improve data on training outcomes
- » Promote job quality

3

Help People and Communities Recover from Displacements

- » Modernize Unemployment Insurance
- » Provide wage insurance to older workers
- » Develop place-based policies

4

Understand the Impact of Automation on the Workforce

- » Develop better data on local and regional economies
- » Create new metrics for tracking technological progress & automation
- » Improve occupational projections

Encourage Employers to Lead a Human-Centric Approach to Automation

» CHALLENGES

Automation changes workforce skill needs, yet employer investment in workforce development has declined.

Employers are making decisions about adopting automation, but may not take into account potential impacts on workers and communities.

» SOLUTIONS

» Promote employer engagement and investment through a worker training tax credit, expansion of apprenticeships, and new sector and regional workforce partnerships.

» Encourage employers to adopt a multi-stakeholder approach to automation decisions by promoting new forms of worker voice and ownership and developing proactive strategies to identify and address impacts in advance.

Enable Workers to Access Skills Training, Good Jobs, and New Economic Opportunities

» CHALLENGES

The labor market is constantly evolving, with automation contributing to changing jobs and skill needs, but supports for worker training and adult education are limited.

Many workers struggle to make ends meet, and while automation has the potential to improve job quality, it also may lead to more low-wage jobs and greater economic insecurity.

» SOLUTIONS

» Improve access to effective and affordable skills training and develop a culture and system of lifelong learning.

» Increase wage subsidies and the minimum wage, while creating more economic opportunities by improving labor market flexibility and promoting entrepreneurship.

Help People and Communities Recover from Displacements

» CHALLENGES

Workers displaced by automation face significant economic challenges.

Communities that are severely impacted by automation require targeted and comprehensive strategies to recover and transition.

» SOLUTIONS

» Strengthen supports for unemployed workers through retraining, reemployment services, and Unemployment Insurance to help displaced workers transition to new jobs and careers.

» Support local economic development and improve regional competitiveness through sector-based development strategies and investment in digital infrastructure.

Understand the Impact of Automation on the Workforce

» CHALLENGE

Policymakers, communities, workers, businesses, educators, and other stakeholders struggle to understand how automation is changing the economy because federal, state, and local data on the impact of technology on work is inadequate.

» SOLUTIONS

» Provide key stakeholders with better information on the impact of automation by collecting data on technological advancements, adoption rates, and workforce impacts.



Automation and a Changing Economy

www.aspeninstitute.org/programs/future-of-work/automation/

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April 2020