

HUMAN CAPITAL, AUTOMATION, AND ARTIFICIAL INTELLIGENCE

POST-COVID-19 INTEGRATION

/ **KRISTEN BROADY** FEDERAL RESERVE BANK OF CHICAGO

Increased reliance on artificial intelligence (AI) is reshaping the U.S. workforce, creating both opportunities and challenges for human capital. Industry 5.0, also known as the Fifth Industrial Revolution, is the latest development in industrialization. Driven by advancements in AI, Industry 5.0 takes a human-centric approach focused on human-machine collaborations: Various manufacturing processes are handled by automation, providing humans more opportunities to focus on delivering improved products and services to end users.³⁴³

While AI can enhance productivity and efficiency, it also raises concerns about job displacement, education and skill requirements for various occupations, and the ever-evolving role of human workers. This chapter examines the impact of automation and AI on workers, employers, consumers, and the broader economy before, during, and after the COVID-19 pandemic.

From dusk to dawn landscape lighting, to kitchen gadgets like blenders and coffee makers with automatic time settings, to smart home systems, automation has been well integrated into our everyday lives in ways that we often take for granted. We encounter AI involving systems that learn and evolve in the form of streaming services like Netflix, Amazon Prime, and Hulu that recommend content to match our interests. Online shopping platforms like Amazon, Wayfair, and

343 TWI Ltd., “What Is Industry 5.0? Top 5 Things You Need to Know,” FAQ, December 2022.

Temu suggest products based on algorithms that analyze our purchase and search histories. Our social media accounts on platforms including Threads, Facebook, Instagram, and X recommend accounts we might be interested in following, while Pinterest recommends images that we are likely to find appealing and can even tell us which of our boards each image is most aligned with. Each of these automated gadgets and AI platforms have various impacts on human interactions and on the demand for labor.

Even as AI is employed to complete more and more tasks, human capital — the skills, knowledge, and creativity of workers — remains vital. However, as the utilization of automation and AI accelerates, the nature of work is shifting. Routine, repetitive tasks are being automated, while jobs requiring human interaction, problem solving, critical thinking, and emotional intelligence are still in demand.

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Rather than replacing workers entirely, research suggests that AI will continue to augment human capabilities, making hybrid human-machine collaborations more common. However, this new way of work will require an emphasis on education, training, and adaptability. As a greater premium is placed on the emotional intelligence of human work, particularly in the service industry, a key goal is adapting workforce training so as to reinforce workers' interpersonal skills in coordination with the use of these new tools.

Prior to the COVID-19 pandemic, Americans gave varying levels of thought to how automation and AI impacted our lives. Since 2020, these technologies have become front and center in our everyday consciousness, particularly for workers in sectors or industries for which labor can be substituted by AI.

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Educational technology companies experienced significant growth in hiring and investment in the months following the World Health Organization's COVID-19 pandemic declaration on March 11, 2020. By that time, more than 1 million students had been impacted by school

closures as educational institutions switched from in-person instruction to online learning with increased reliance on learning management systems. With education being such a key factor in human capital development, the shift to online learning during the beginning of the pandemic will have ramifications for this generation of scholars as they continue their education and enter the world of work. Already, research suggests that pass rates on standardized test scores for the 2020–21 school year “declined compared to prior years and that these declines were larger in school districts with less in-person instruction.”³⁴⁴ How this will impact the labor market remains to be seen.

As students became immersed in virtual learning, businesses made adjustments including shifting some workers to telework. Medical and mental health visits transitioned to telehealth. And retail purchases that had previously been made at brick-and-mortar establishments with the assistance of salespeople and cashiers shifted to algorithm-assisted search processes for items that would be purchased online and delivered to the buyer’s residence.

When we emerged from mandatory lockdowns and business closures, we were faced with self-checkout machines in many retail establishments where cashiers previously greeted us and scanned our items. Our customer service issues are increasingly being addressed by online chatbots or automated telephone answering services. AI-powered language models, from organizations including OpenAI, Google, Amazon, and Microsoft, are now available to synthesize vast amounts of data; generate text, music, and art; and develop ad campaigns, among other tasks. Indeed, consumers have been and will continue to be impacted by technological advancements.

But the effect of these technologies is even more acute for workers, particularly those employed in occupations like cashiers that are based on tasks that can now be completed by computers and/or machines.

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344 Clare Halloran, Rebecca Jack, James C. Okun, and Emily Oster, “Pandemic Schooling Mode and Student Test Scores: Evidence from U.S. States” (Working Paper w29497, National Bureau of Economic Research, November 2021).

IMPACT ON ESSENTIAL WORKERS

WHO HAD TO WORK IN PERSON?

Essential workers — including health care workers, law enforcement officers, firefighters, grocery store employees, delivery drivers, warehouse workers, and public transit operators — continued working in person during the pandemic. Many of these jobs increased workers' exposure to COVID-19, leading to increased stress and requests for higher wages. Retail workers in particular faced inconsistent work schedules due to business closures, labor shortages, and shifting consumer demand.

In 2019, approximately 77% of the 3.6 million workers employed as cashiers in the U.S. worked in the following five industries: food and beverage stores, general merchandise stores, gas stations, restaurants, and health and personal care stores.³⁴⁵ These workers' contributions were vital to the core functions of the economy and society, ensuring that Americans were able to purchase groceries and other necessary items, particularly at the onset of the pandemic.³⁴⁶

The COVID-19 pandemic significantly altered consumer behavior. As states and municipalities instituted orders for nonessential businesses to close, e-commerce sales surged, increasing 42.6% between 2019 and 2020. By 2022, e-commerce sales had increased by 77% or \$373 million since 2019.³⁴⁷ During this three-year period, the number of retail sales jobs decreased by 677,910, and the number of cashiers fell by 300,590.³⁴⁸ As demand for delivery services increased, many laid-off workers turned to gig work with companies such as Uber, Instacart, and DoorDash, which embraced contract and freelance labor to stay flexible during a period of economic uncertainty.

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As brick-and-mortar stores were closing between March and April 2020, Amazon — the world's largest retailer — hired 175,000 people in its fulfillment and delivery network in response to increased consumer

345 U.S. Bureau of Labor Statistics, "Occupational Employment and Wages, May 2019: 41-2011 Cashiers," July 6, 2020.

346 Francine D. Blau, Josefine Koebe, and Pamela A. Meyerhofer, "Essential and Frontline Workers in the COVID-19 Crisis," *Econofact* 6 (2020): 16.

347 U.S. Census Bureau, "Annual Retail Trade Survey (ARTS)," 2024, <https://www.census.gov/programs-surveys/arts.html>.

348 U.S. Bureau of Labor Statistics, "Occupational Employment and Wage Statistics (OEWS) Tables May 2022

demand.³⁴⁹ The company reported \$108.5 billion in sales during the first three quarters of 2021, up 44% from 2020, and a profit of \$8.1 billion, an increase of 220% from the prior year.³⁵⁰

As COVID-19 vaccines became widely available, case numbers decreased, and nonessential businesses reopened, many retailers turned to self-checkout technology as they struggled to hire in-person staff and provide shoppers with the option of contactless checkout. Shipments of self-checkout machines increased 25% in 2020.³⁵¹ In 2021, consumers used self-checkout for 30% of retail transactions, nearly doubling the percentage since 2018.³⁵²

However, the rapid increase in the use of self-checkout machines was not without disadvantages. Self-checkout lanes led to higher rates of shrink or loss from theft or customer error. Loss prevention teams found it more difficult to monitor the checkout process, leading to higher financial losses. Many customers struggled with scanner errors, price mismatches, or technical glitches. Self-checkout lines often move slower than traditional cashier lines as customers are not as familiar with product scanning codes and have less experience with the checkout process than cashiers. Less tech-savvy customers, who found the machines difficult to use, may have required assistance, leading to longer wait times.

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Recognizing these and other issues with self-checkout machines, retailers like Walmart, Target, Dollar General, Costco, and some regional grocery stores decided to reverse course and bring back more cashiers to reduce reliance on self-checkout. For some companies, the savings from automation did not outweigh the cost of theft and scanning errors. While some consumers appreciated contactless checkout, others expressed frustration with self-checkout and preferred human interaction with cashiers, who could often process transactions faster and more efficiently than self-checkout users.

349 Amazon News, "Amazon Has Hired 175,000 Additional People," June 4, 2020, <https://www.aboutamazon.com/news/company-news/amazon-has-hired-175-000-additional-people>.

350 Karen Weise, "Amazon's Profit Soars 220 Percent as Pandemic Drives Shopping Online," *New York Times*, May 12, 2021, <https://www.nytimes.com/2021/04/29/technology/amazons-profits-triple.html>.

351 Suman Bhattacharyya, "How Retailers Can Improve Self-Checkout," *Wall Street Journal*, November 21, 2021, <https://www.wsj.com/articles/how-improve-self-checkout-service-11637337407>.

352 Doug Baker, "Why Self-Checkout Is Here to Stay," *The Food Industry Association*, February 13, 2024, <https://www.fmi.org/blog/view/fmi-blog/2024/02/13/why-self-checkout-is-here-to-stay>.

In fact, retailers found that for many customers, the personal service at checkout improved the overall shopping experience — increasing the likelihood of return customers and additional sales. This finding points to a broader truth about the age of AI: Automating certain tasks places an increased premium on human-led tasks, which tend to require “soft skills” driven by emotional intelligence. Training programs may need to adapt to hone soft skills alongside more technical ones.

A March 2024 fact sheet from Target announced that the company was making chainwide updates to the checkout experience including limiting self-checkout express lanes to 10 or fewer items, opening more traditional lanes staffed by cashiers, and providing store leaders with the flexibility to make adjustments to self-checkout hours to coincide with periods of higher and lower consumer demand.³⁵³ In May 2024, Dollar General CEO Todd Vasos said that the company planned to remove self-checkout kiosks from the majority of its stores in an effort to reduce shrinkage and drive increased customer engagement.³⁵⁴

TELEWORK AND OFFICE SPACE UTILIZATION

The pandemic fundamentally changed the way we work — dramatically increasing the percentage of remote workers, altering job structures, and decreasing the demand for commercial office space — accelerating trends that might otherwise have taken decades to develop.

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WHO TELEWORKED?

Many companies shifted to remote work out of necessity, proving that jobs previously considered “in office” could be done remotely. While the majority of U.S. workers continued to work in person, the number of people who primarily worked remotely tripled from 5.7%

353 “How Target Is Enhancing the Checkout Experience,” fact sheet, Target.com, March 14, 2024, <https://corporate.target.com/press/fact-sheet/2024/03/checkout-improvements>.

354 Nate Delesline III, “Dollar General to Eliminate ‘Vast Majority’ of Self-Checkout, Reduce New Store Openings,” Retail Dive, May 31, 2024, <https://www.retaildive.com/news/dollar-general-eliminate-self-checkout-shrink/717520/>.

(approximately 9 million people) to 17.9% (27.6 million people) between 2019 and 2021.³⁵⁵ The percentage of people who teleworked fell slightly in 2022 as social distancing regulations were lifted but remained higher in 2022 than in 2019 in all industries except agriculture, forestry, fishing, and hunting.³⁵⁶ Figure 1 shows the increase in the percentage of remote work participation for 21 industries from smallest to largest between 2019 and 2022. In four industries — professional, scientific, and technical services; information; finance and insurance; and management of companies and enterprises — remote work increased by over 20 percentage points between 2019 and 2022. Hybrid models have been normalized in many industries, providing workers with more flexibility while maintaining opportunities for in-person collaboration. Increased development and adoption of AI platforms reduced reliance on in-office presence for certain job tasks.

Differences in telework percentages also existed between workers based on income, age, and level of education. Higher-income workers — who generally worked in offices at desk jobs before the pandemic — were significantly more likely to work remotely compared with lower-wage workers, who tended to work in trades that could not be done remotely (such as construction). Among households with an annual income of \$200,000 or more in 2020, 73.1% worked remotely because of the pandemic, compared to only 12.7% of households earning less than \$25,000.³⁵⁷ Younger workers, those between 16 to 24 years old, were less likely to telework than those over the age of 24. Among workers 25 years and older, those with an advanced degree were most likely to work remotely.

Increases in remote work contributed to decreases in office space utilization and unit capital, energy, material, and services costs growth across industries.³⁵⁸ Many companies downsized office footprints during the height of the pandemic and adopted hybrid work models and shared desk models upon reopening. Data from Moody's showed that the office space vacancy rate increased from 16.3% in 2016 to 17.8% in 2020 and 18.7% in 2022.³⁵⁹ As businesses implemented return to work plans, some were met with pushback from workers who had become well-adjusted to working from home. Many organizations are still

355 U.S. Census Bureau, "The Number of People Primarily Working from Home Tripled between 2019 and 2021," Press Release Number: CB22-155, September 15, 2022, <https://www.census.gov/newsroom/press-releases/2022/people-working-from-home.html>.

356 Sabrina Wulff Pabilonia and Jill Janocha Redmond, "The Rise in Remote Work since the Pandemic and Its Impact on Productivity," *Beyond the Numbers: Productivity* 13, no. 8 (October 2024), U.S. Bureau of Labor Statistics, https://www.bls.gov/opub/btn/volume-13/remote-work-productivity.htm#_edn12.

357 U.S. Census Bureau, "Household Pulse Survey," 2020.

358 Pabilonia and Redmond, "The Rise in Remote Work."

359 Victor Calanog, Todd Metcalfe, and Kevin Fagan, "The Commercial Real Estate Outlook," Moody's Quarterly Analysis, February 16, 2023, <https://www.moodyscore.com/insights/research/q42022-commercial-real-estate-outlook/>.

working to fine-tune the balance between productivity and employee well-being.

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GENERATIVE AI AND THE FUTURE OF WORK

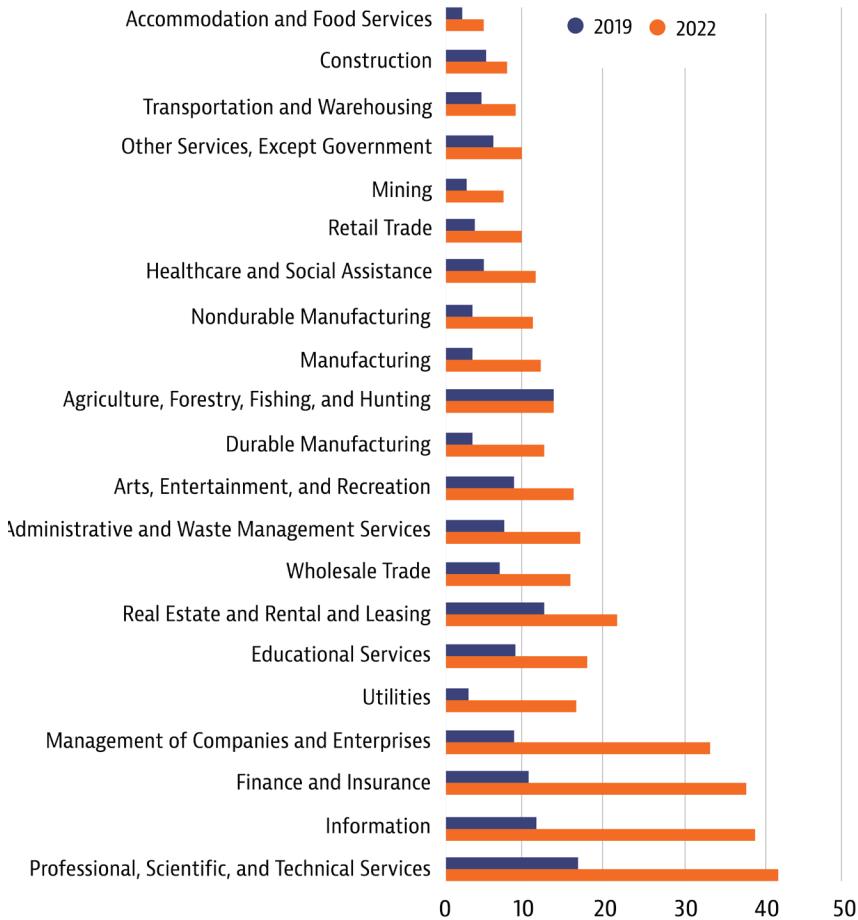
Industry 5.0 is expected to transform organizational processes and workforce expectations. Emotional intelligence skills involving leadership, adaptability, public relations, and problem solving will become more valuable as automation and AI increasingly perform routine, repetitive tasks. The pandemic changed how Americans work and redefined expectations around work among workers and employers. Increased adoption of generative AI chatbots like ChatGPT, Microsoft Copilot, and Jasper have new implications for jobs that were once thought to be out of technology's reach.

- While personalized learning powered by AI is enhancing certain student outcomes, these systems cannot replace human educators. Teachers, professors, and learning support staff provide mentorship and emotional support, and teach students creativity and critical thinking in addition to the educational areas they focus on.
- AI-driven robotics are automating repetitive manufacturing and logistics tasks, reducing the need for manual labor while increasing the demand for technicians and AI specialists.
- AI-powered diagnostics, robot-enabled surgery, and administrative automation are improving efficiency in health care while allowing human doctors and nurses to focus on patient care.
- In the finance and banking sector, AI-powered systems are allowing humans to focus on more complex decision making and customer relationship management³⁶⁰ because they have the capability to process vast amounts of data faster and more accurately than humans or legacy software while also reducing the margin of error, identifying normal and fraudulent customer behavior.
- Even as AI-driven self-checkouts, virtual assistants, and inventory management systems are reshaping the retail environment, human workers are still essential for problem solving, personalized service, and new product development.

360 Infosys BPM Analytics, "AI in the Banking Sector: How Fraud Detection with AI Is Making Banking Safer," n.d., <https://www.infosysbpm.com/blogs/bpm-analytics/fraud-detection-with-ai-in-banking-sector.html>.

/ FIGURE 1 /

**PERCENTAGE OF REMOTE WORKERS BY MAJOR INDUSTRY GROUP,
RANKED FROM SMALLEST TO LARGEST, 2019 AND 2022**



Source: Pablonia and Redmond, "The Rise in Remote Work."



Emotional intelligence skills involving leadership, adaptability, public relations, and problem solving will become more valuable as automation and AI increasingly perform routine, repetitive tasks.

Other long-term implications will include:

- **Increased opportunities for hybrid work:** Even industries that required in-office presence before the pandemic are offering flexible work arrangements.

- **Commercial real estate adjustments:** Some office buildings have been repurposed into housing or mixed-use developments.
- **Continued adoption of automation and AI:** Employers are increasingly turning to technology to reduce dependence on human workers while maintaining or increasing productivity.
- **Adjustments to worker leverage:** Employees now expect higher wages, better benefits, and flexibility, influencing labor policies and union movements.

Ongoing advances in technology will demand education, training, skill shifts, and adaptability as new job roles are created in fields like AI ethics, cybersecurity, and data science. Additional roles will also be created in caregiving, mental health, and social work, particularly as the population ages.

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Preparation for increased AI integration has necessitated shifts at all levels of education. Introducing coding and other programming activities to elementary students helps them learn problem solving and computational thinking skills.³⁶¹ To this end, in September 2024, Governor Gavin Newsome signed Assembly Bill 2876, which required California’s Instructional Quality Commission to incorporate “artificial intelligence (AI) literacy content into the mathematics, science, and history-social science curriculum frameworks,” for use in the core curriculum for all K-12 students in California starting in the 2025–26 school year.³⁶²

All of these trends have implications for workforce training. To meet the growing demand for AI expertise in the job market, many colleges and universities have developed and expanded courses and degree programs that integrate AI. On the flip side, AI-driven changes to the nature of work should lead training programs to increasingly focus on the aspects of work that require human emotional intelligence.

Kristen Broady is a Senior Economist, Economic Advisor, and Director of the Economic Mobility Project, an initiative of the Federal Reserve Bank of Chicago that provides evidence-based research on factors that affect economic mobility.

361 Alexander Slagg, “Teaching the Principles of Computer Science Early in K-12 Schools,” EdTech Magazine, June 23, 2022, <https://edtechmagazine.com/k12/article/2022/06/teaching-principles-computer-science-early-k-12-schools-perfcon>.

362 California Assembly Bill 2876, 2023–2024 Session, amended March 11, 2024, https://aedn.assembly.ca.gov/system/files/2024-04/ab-2876_0.pdf.