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Technological change in five industries:
Threats to jobs, wages, and working conditions

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Acknowledgments

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Introduction

Workers in the U.S. were facing many questions about their future prior to the onset of the COVID-19 pandemic, and that uncertainty has only intensified as the pandemic lingers, and employers' use of new technologies continues to evolve. Policymakers, worker advocates, and researchers are watching and evaluating which technologies employers are choosing to adopt, and what consequences these changes might have for workers' jobs. Understanding how technological changes may unfold in different industries is essential for developing effective solutions to the challenges that workers face.

From 2018 to 2020, the UC Berkeley Labor Center and Working Partnerships USA brought together a team of experts to investigate trends in several industries in the U.S. that have been focal points for these concerns: trucking, warehouses, health care, retail, and food delivery. Our team of researchers conducted multi-year studies of each industry, examining how new technologies are changing work and why, what new technologies are on the horizon, and what factors are shaping job outcomes.[1]

The intent of the industry studies was not to predict the future or to develop a broad, unified theory of technological change. Instead, the objective was to examine how and why technological change is unfolding in key industries and assess what these changes could mean for different groups of workers. While many of the important findings from these studies are industry-specific, some common themes emerge across the research. In this report, we synthesize the findings of the industry studies, and discuss what they suggest about how policymakers and industry stakeholders should approach the challenges and opportunities workers face in a changing technological landscape.

> Technology's effects on job *quality*– like wages and working conditions– should be just as big of a concern as its effects on job *quantity*.

One of the most striking findings from these studies is that technology's effects on job *quality*— like wages and working conditions—should be just as big of a concern as its effects on job *quantity*. Employers' use of automating technologies could lead to job loss for specific occupations, but this is just one of many ways that technological change threatens workers' livelihoods. Rather than replacing large numbers of workers with

robots, our researchers find that employers are using technology to change *how workers do their jobs*: how they are hired; what tasks they are asked to do, how many and how quickly, and how they are instructed to do them; and how their performance is monitored and assessed. Sometimes technology-related changes are helpful to workers—enhancing their skills or safety, for instance—but far more often they are harmful to wages and working conditions. Technological changes can also worsen existing inequities for women and people of color, who are overrepresented in the many front-line occupations that are most likely to be changed by technology.

The introduction of new technology in low-wage industries can easily lead to bad outcomes for workers, but this is not inevitable. Our studies identify important sources of variation in how technological change happens across and within industries, and multiple scenarios for future adoption. These findings suggest that how and why employers implement new technologies in the workplace is not predetermined. The choices we make now and the regulations we implement can re-shape the course of technological change and its consequences for the U.S. labor market.

The five industry studies

- DRIVERLESS? Autonomous Trucks and the Future of the American Trucker
  by Steve Viscelli (September 2018)

- The Future of Warehouse Work: Technological Change in the U.S. Logistics Industry
  by Beth Gutelius and Nik Theodore (October 2019)

- Technological Change in Health Care Delivery: Its Drivers and Consequences for Work and Workers
  by Adam Seth Litwin (June 2020)

- Change and Uncertainty, not Apocalypse: Technological Change and Store-Based Retail
  by Françoise Carré and Chris Tilly, with Chris Benner and Sarah Mason (September 2020)

- Delivering Insecurity: E-commerce and the Future of Work in Food Retail
  by Chris Benner and Sarah Mason, with Françoise Carré and Chris Tilly (December 2020)

Findings

1. Employers' use of new technologies is changing the content of workers' jobs, but is likely to have limited effects on the overall number of jobs

Each team of researchers identified various new technologies that employers are using in each industry. These ranged from relatively simple improvements in internet and communications technology and digitization of information to complex data collection and algorithmic technologies, including but not limited to autonomous machines. Across the industries we studied, our researchers found that employers' use of new technologies is altering both the content and the processes involved in people's jobs in a range of ways.

Employers' use of new technologies may cause job reductions in some specific occupations, but is not expected to lead to an overall reduction in the number of jobs in the industries studied.

Our researchers found that technology-induced job loss is a real concern for specific occupations. Most notably, nearly 294,000 long-haul truck drivers are at risk of losing their jobs in coming years due to advances in automated driving technologies.[2] Retail and grocery employers are likely to continue thinning the ranks of cashiers by shifting check-out work to customers through self-check-out stations or app-based check-out. In addition, advances in productivity tracking and managerial technology may lead to reductions in supervisors and secondary managers in larger stores.[3] In hospitals, semi-autonomous service robots could reduce the overall number of people employed as orderlies, dietary clerks, and laundry workers; COVID-19 may have jump-started this trend, as hospitals have looked for ways to limit human interactions to reduce the risk of transmission.[4]

Across industries, however, our researchers did not find that widespread technology-induced job loss was currently happening, or that it was likely to happen. In some cases, a growing

demand for services—due to changing consumer preferences (e.g., e-commerce) or changing demographics (e.g., an aging population requiring more healthcare services)—has led to a demand for more workers. In these circumstances, overall demand for certain occupations of workers is outpacing technology-induced job loss or slower job growth. Other factors contributing to worker shortages in specific industries—such as long-term wage stagnation for truck drivers—may result in labor demand for workers continuing to outpace supply, even as automation reduces the overall number of jobs.[5]

Furthermore, the pace of technology adoption is often slower than expected and uneven within industries. Despite abundant speculation about the possibility of highly-automated "dark warehouses" and a "retail apocalypse" due to the growth of e-commerce, neither of these scenarios appears probable any time soon, according to our researchers.[6] In trucking, employers are unlikely to transition from human drivers to broad reliance on automated driving technology for delivery in the near future, despite the real possibility that they will implement these changes in some form for long-haul trucking.[7]

Another reason that large-scale job displacement is unlikely in the foreseeable future is that the technology to automate certain types of tasks, such as item-picking to package e-commerce orders or delivery vehicles navigating complex urban environments, remains inadequate for employers' needs. And even where technology exists that is capable of automating certain tasks, there may be other reasons employers prefer a person to a machine in a particular role. For instance, employers may prefer a human worker to answer a customer's questions about a product in a store, or to identify an appropriate place to leave a package at someone's residence.

> Despite abundant speculation about the possibility of highly-automated "dark warehouses" and a "retail apocalypse" due to the growth of e-commerce, neither of these scenarios appears probable any time soon.

New technology can also be prohibitively expensive, especially in highly cost-sensitive industries. In warehousing, slim profit margins and cost-based competition have led to a cautious approach to new technology.[8] The growth of e-commerce has spurred experimentation with new technologies among industry leaders like Amazon, but many other firms still lag far behind in adopting even simple technologies like digital warehouse management systems.[9] Similarly, a "digital divide" exists in retail, where market leaders—especially those who have effective channels for participating in e-commerce—have the resources to invest in the latest technology, while other smaller firms do not.[10]

Employers are using technologies in ways that create new tasks and jobs, and shift the allocation of tasks across machines, workers, firms, and customers.

Understanding how new technologies are changing some workers' jobs requires an examination of the ways in which technologies affect the specific tasks the jobs involve.[11] Every occupation consists of an assemblage of tasks, which often vary across industries or employers, and can change for all kinds of reasons, including employers' adoption of new technologies.

Some tasks are easier than others to execute using technology, such as those that involve highly structured and repetitive actions. Even so, employers rarely use technologies to replace all tasks involved in a worker's job; technologies are more often used to substitute for specific tasks, leaving other aspects of the job intact but potentially transformed. For example, where employers use automated chatbots to field customer service calls, human representatives may end up fielding more complicated inquiries, while the simpler ones are resolved by machines.

Technology-enabled task reorganization can create new tasks, such as remote operation of semi-autonomous vehicles, maintenance and programming of new machinery and software, and managing and staffing order-picking and curbside pickup for retail and grocery stores. This may create new jobs, increase the demand for certain jobs, or change the scope of work involved in a job.

Rather than replacing large numbers of workers with robots, employers are using technology to change how workers do their jobs.

In some cases, technologies are used to transfer tasks between customers and workers. In a customer self-checkout system, the core tasks of a cashier—ringing up and bagging groceries—are not automated but transferred from a worker to a customer.[12] On the other hand, online ordering for groceries transfers tasks that customers would otherwise do—such as filling a cart and taking the food home—to workers.[13]

Employers may also use technologies in ways that redistribute tasks among different workers. These could be workers within a particular firm, or workers employed in other firms, or independent contractors. In some grocery stores, retrieving and packing groceries for online orders is carried out by employees of the store, but in other cases (and sometimes within the same store) these tasks are carried out by a worker employed or contracted by a third party, such as Instacart. Similarly, restaurant take-out deliveries may be completed by restaurant employees, or by workers affiliated with a third-party ordering platform like Doordash or UberEats.[14]

Employers' use of technologies may contribute to broader shifts in employment as well, across industries or market segments. The increased reliance on e-commerce for retail sales, for instance, has reduced demand for employment in stores, but increased the need for workers in warehouses and trucking. It has also shifted unpaid work by consumers in shopping and driving to paid work in order fulfillment and home delivery services.

Employers are using technologies in ways that change how job tasks are done.

In addition to the reshuffling of tasks, employers are using new technologies in ways that change the processes involved in workers' job tasks. Advances in data collection and algorithmic technologies are enabling employers to make changes to a broad array of HR and management functions, such as hiring, scheduling, task direction and pacing, monitoring, evaluation, and discipline or dismissal.[15] These changes serve specific functions; here, we describe several types of managerial objectives, offer examples of the technologies that employers are using toward those ends, and discuss how these technologies change the way workers complete their tasks.

Safety: Some employers are using technologies intended to make work safer; examples include machinery that can alleviate the need for heavy lifting and sensors that track driving conditions, vehicle operations and potential safety hazards.[16] These technologies can change the physical processes involved in workers' tasks, or give workers real time notifications to adjust their actions.

Personnel decision-making: In some cases, employers use data-gathering and analytic processing software to compile and interpret information about current or prospective employees, which human managers then take into consideration in their decisions about personnel. In other cases, employers are using algorithmic technologies to replace certain aspects of human decision-making altogether.

Information-sharing: Employers in many industries are using technologies that can facilitate communication and information-sharing, which can affect work processes in a wide variety of ways, such as changing the order in which workers complete their tasks, and giving them real-time direction and feedback. A few of the far-reaching range of examples of these types of technologies include delivery apps, customer service platforms, telehealth, and electronic health records.

Pace-setting: In several of the industries our researchers studied, employers are using technologies aimed at speeding up work processes to reduce costs. For instance, warehouses and retail stores may use digital inventory tracking systems and stocking devices to help streamline workers' movement of goods in a facility. Delivery drivers often use mapping and route-planning software intended to optimize speed and maximize their number of deliveries.

Monitoring: Employers are also using technologies to monitor and track workers' locations, activities, and the accuracy of their work. This type of tech is increasingly common in warehouses and delivery, but is also being deployed in home health care, where employers are using phone-based software to manage workers remotely by tracking their location and task-completion at clients' residences.

The managerial objectives highlighted here are not exhaustive, nor are they mutually exclusive. Employers adopt technologies and make other changes to production processes for a complex array of reasons. These changes can affect the processes involved in workers' jobs in intended and unintended ways, and can have both positive and negative effects on job quality. In the next section, we discuss the consequences of employers' use of new technologies for workers.

2. Employers in each industry are using new technologies in ways that may degrade workers' wages and working conditions and worsen existing labor market inequities

Employers can use new technologies in ways that are helpful to workers, as some of the above examples indicate. Technologies can make work safer, and reduce worker time spent on paperwork or arduous, repetitive tasks. However, in each industry, our researchers concluded that many employers are likely to use new technologies in ways that threaten workers' wages and job quality.

Employers' use of technology to reorganize work and production could lead to lower wages, deskilling, and deteriorating job quality for workers.

When employers reorganize and reshape production processes, the changes they make can have consequences for workers' wages and job quality. While the consequences aren't invariably or inevitably negative, our researchers found that technologically-induced task redistribution may result in poor outcomes for many workers.

When employers use technology to reshuffle tasks among workers within the firm, workers may see a reduction in the range or complexity of tasks involved in their work, which employers can use as justification for lower pay. In some cases, workers may actually experience a pay cut following technologically-induced reorganization of work processes; in others, an industry may experience a longer-term shift toward lower pay for certain occupations. In health care, chatbots and autonomous service robots are starting to be used in ways that reduce staffing

and decrease the complexity of workers' roles—for instance, by limiting or entirely eliminating dietary clerks' interaction with patients through the use of autonomous bots to deliver meals.[17] Warehouse employers are using technologies designed specifically to replace human decision-making functions; other technologies simplify warehouse work by breaking a job into subtasks, sometimes to the point that previously required worker skills become completely irrelevant.[18]

Employers' use of technology to redistribute tasks to workers outside of the firm also can have negative implications for workers' wages and job quality. In retail, restaurants, and grocery, employers are using technology to reallocate tasks (e.g., delivery or shopping, as discussed above) to workers employed by third-party firms or hired as independent contractors. In warehouses, employers are turning to on-demand staffing platforms to hire temporary workers through staffing agencies, in some cases via third-party logistics (3PL) management firms.[19] Regardless of the industry, workers employed by third-party firms are likely to be paid less and lack access to benefits that workers at the lead firm may have, including union representation. Workers hired as independent contractors lack access to basic employment rights and legal protections, such the right to a minimum wage, collective bargaining, and workers' compensation in case of injury.[20]

Technologically-induced reorganization of production processes has also resulted in work being shifted within industries in ways that favor lower-wage segments. In trucking, the jobs most at risk of displacement from automation are long-distance truck driving jobs, which have higher rates of pay compared to local delivery jobs; the latter increased in number as e-commerce has grown but are much harder to automate.[21]

Employers' use of technology to change work processes can lead to work speed-up accompanied by decreased autonomy and privacy for workers.

Employers are using new technologies in ways that can impinge on workers' autonomy and privacy, and that speed up and intensify their work. Amazon has been a leader in the development and adoption of technologies that increase employers' surveillance and control over workers. At Amazon warehouses, workers are closely monitored using video surveillance, and tools like GPS-enabled handheld devices and wearable tech embedded with sensors. These devices gather and record data on workers' location and activities, which are used not only for general monitoring but also as inputs into algorithms that direct workers' tasks. Besides setting the pace of work, the algorithmic systems are used to assess workers' performance and speed.[22] Workers' time spent "off-task," including time spent walking to and from a restroom or break room, is automatically recorded. If the workers aren't meeting specific productivity targets, they are penalized and may be fired.[23]

> Many employers are likely to use new technologies in ways that threaten workers' wages and job quality.

The intensive surveillance and grueling pace at Amazon warehouses have been well-documented in media accounts and have been cited as an important impetus to attempts to organize warehouse workers into unions. Workers report that the conditions in Amazon warehouses take a serious mental and physical toll, leading to exhaustion, workplace injuries, and psychological stress induced by the pressure to achieve their required productivity rates.[24]

Warehouse workers are far from the only workers who have experienced negative consequences from employers' use of new technologies that reshape work processes. Electronic visit verification (EVV), a software which allows home care workers to be managed and monitored through a smartphone by tracking their location and activities in real-time, is an increasingly common technology in home health care.[25] The use of EVV has created an environment where many workers report feeling increased stress from micromanagement, constant surveillance, and invasion of their privacy.[26]

In trucking, drivers can be exposed to an extreme amount of data collection and electronic monitoring. Employers use sensors and real-time visual data streams to track and assess everything happening inside or around the vehicle, including location, possible hazards, driving patterns (speed, acceleration, braking, etc.), and driver behavior (seatbelt use, driver fatigue, or other distractions like texting or eating). Fleet managers can use these systems to "exert control over workers by setting quantified metrics to evaluate driver performance and challenge workers' accounts of driving conditions."[27]

Major retailers frequently use algorithmic technologies as part of their processes for hiring, scheduling, and managing workers. Stores are using cameras and other sensors to track and monitor product inventory and store conditions, meaning that clerks and stockers can receive real-time alerts and direction about where and what to restock, or where to clean.[28] Delivery drivers and in-store shoppers (e.g. for Instacart) can be tracked and directed by employers and/or customers in real time via apps that monitor location and item selection.[29] These workers have reported that constant location tracking and other forms of electronic monitoring, plus algorithm-generated metrics that intensify workload and time pressure, have added to the mental and physical stress of their jobs and increased the potential for accidents and injuries.[30]

Employers are using new technologies in ways that can worsen existing labor market inequities.

The peril arising from employers' use of new technologies is not borne equally across all workers. Many of the occupations facing significant threats from technologies that displace, monitor, control, and speed up work are those in which higher concentrations of women and people of color are employed. In warehouses, people of color are overrepresented compared to the labor market at large, and women are a growing portion of the e-commerce warehouse sub-sector.[31] In retail and grocery, women are more likely than men to work in customer-facing

roles like cashier, which will continue to decline in number as employers turn to self-checkout and e-commerce.[32] Women are also overrepresented in most health care occupations (apart from the highest-paid positions like physicians and surgeons), and Black and Latino workers are concentrated in the lowest-paid jobs like home health aids, which are increasingly subjected to surveillance and monitoring technologies.[33]

Certain new technologies have biased outcomes for women, people of color, and other disadvantaged workers.[34] For example, productivity-based pay structures to incentivize speed in warehouse work creates additional challenges for workers who are not as strong or physically fit, such as older workers.[35] Additionally, algorithms used in applicant screening and hiring processes are notorious for replicating and exacerbating existing patterns of discrimination in the labor market.[36] Research also indicates that technologies like speech and facial recognition can be less accurate in identifying and communicating with women, people of color, and people whose first language is not English. This can create additional barriers for workers who must interact with these systems in their jobs.[37]

> The most serious repercussions of new technologies in the workplace will fall on those workers already facing the greatest structural challenges in the labor market.

The work of our researchers and others suggests that the most serious repercussions of new technologies in the workplace will fall on those workers already facing the greatest structural challenges in the labor market. The use of new technologies will worsen existing inequities.

3. Industry context shapes employer decision-making about new technologies, leading to variation in adoption and worker impacts

A defining feature of each of our researchers' projects was the recognition that industry context shapes technology adoption decisions. Across and within industries, our researchers observed variation in the pace of employers' uptake of new technologies, their goals with respect to technology, and the consequences of these changes for workers. The factors that had the biggest impact on technology adoption fell into five categories: regulations, worker organizations, competitive structures, industry trends, and broader societal and market trends. These factors shaped employers' understanding of how they might use new technologies in the context of their other objectives and priorities. In some cases, these factors accelerated technological adoption and in others they hindered it.

Regulations

Regulations establish the ground rules that shape competitive market strategies, distinct market segments, and the distribution of power across market actors.[38] Variation in regulation by industry or by region therefore plays a formative role in shaping employers' technology adoption decisions.

Each industry is governed by a unique set of laws and regulations that are subject to change over time at the discretion of policymakers. These changes affect the context guiding employer decision-making, and can have direct and indirect effects on technology adoption and working conditions. For example, long-term deregulation over certain aspects of the trucking industry has weakened workers' power relative to employers, and reduced job quality and working conditions for many truck drivers.[39] These changes have created distinct labor markets in trucking where workers are especially vulnerable to the invasive or exploitative effects of employers' adoption of new technologies. For instance, in local delivery and port trucking, independent contractor misclassification has proliferated and worker protections are minimal. As we have noted, local delivery tasks remain highly reliant on human workers; as a result, local delivery firms are more likely to invest in technology that monitors and controls workers rather than attempting to replace them,[40] and drivers have limited means to object.

The health care industry, on the other hand, is highly regulated. Health care involves a complex web of actors and regulations, organized around a division between the providers of care (hospitals, etc.) and the financers of care (insurance companies and the government). In recent years, the government has tried to guide the market toward payment models based on "value-based care" (VBC) rather than "fee for service" care, which increase quality and efficiency of care provision. Under VBC models, insurers contract to reimburse providers on a fixed rate (e.g. per-member-per-month), so providers internalize the risk of variable costs associated with their patient population, and thus they no longer have an incentive to maximize the number of claims submitted to insurers.

The shift toward VBC is likely to accelerate the adoption and diffusion of quality-enhancing health care technologies, such as those that facilitate patient-provider communication and increase access to preventative care.[41] Regulations advancing VBC may be a promising shift for the health care industry for many reasons, but the constraints that VBC places on health care providers' income can also pose challenges for workers' bargaining power by limiting the overall amount of resources

> Weak federal labor laws have limited the power of labor market institutions like unions to bargain for better wages and working conditions—including working conditions related to technology.

available for wages and benefits. Ensuring that workers are not penalized by the shift to VBC will require additional regulation and worker organizing.[42]

Broader regulations influence markets and technology adoption across industries. In many areas of regulation in the U.S., laws and policies favor the rights and freedoms of employers relative to workers, which creates incentives for employers to compete on labor cost cutting strategies.[43] Weak federal labor laws have limited the power of labor market institutions like unions to bargain for better wages and working conditions—including working conditions related to technology.[44]

Some states have stronger labor regulations, however, such as laws that specifically target independent contractor misclassification. Other states have laws that make it more difficult for workers to advocate for their rights and form unions. Twenty-eight states have "right to work" (RTW) laws that inhibit worker organizing. In RTW states, labor unions have less power to shape legislation or working conditions, and wages for workers tend to be lower.[45] The strength or weakness of labor regulation affects workplace technology deployment in important ways; workers' ability to fully participate in this process can be inhibited *or* enhanced depending on the law, as can their ability to organize to protect themselves from potential harms of new technologies (see next section).

> The dearth of regulation creates strong incentives for employers to use digital technologies widely, and in ways that can directly or indirectly harm workers.

The lack of regulation governing employers' uses of technology in the workplace has had a profound effect on employers' use of technology in relation to their workers. As we note in our 2021 report *Data and Algorithms at Work: The Case for Worker Technology Rights*, the dearth of regulation creates strong incentives for employers to use digital technologies widely, and in ways that can directly or indirectly harm workers. There is also no oversight of the testing and quality of new systems that developers sell, which can worsen adverse effects for workers.[46]

Recent efforts to remedy this challenge have been promising, however. In September 2021, California passed a bill targeting the grueling pace of work in Amazon warehouses by limiting companies' use of production quotas, and improving transparency around the use of algorithms in setting quotas, and several states have since passed or proposed similar legislation.[47] In April 2022, California legislators introduced A.B. 1651, The Workplace Technology Accountability Act, which would establish broad protections for workers against employers' use of monitoring and algorithmic management technologies.[48] Legislators in California and elsewhere have passed laws fighting independent contractor misclassification, granting employment protections like minimum wage, overtime, and workers' compensation to workers in trucking and app-based delivery.[49]

Worker organizations

Unions and worker organizations can affect technology adoption patterns in individual firms, and in the industries and regions where they represent significant portions of an industry's workforce.[50] Health care workers are more likely to be represented by a union than workers in many other industries in the U.S. This affords them more power in influencing employers' decisions related to technology. For example, at Kaiser Permanente, unions played an important role in facilitating the company's switch to an Electronic Health Records system, ensuring effective deployment and use of the system, and protecting employment and wages for workers affected by the new system.[51]

Unions also play an important role in certain segments of the trucking and grocery industries. The most recent contract negotiated between United Parcel Service (UPS) and the Teamsters union includes a requirement that UPS give the Teamsters six months' notice of any company plans to integrate emerging tech, such as drones, driverless vehicles, or truck platooning.[52, 53] The United Food and Commercial Workers union (UFCW), which represents grocery workers, has fought to keep the growing numbers of e-commerce and delivery jobs in-house. UFCW has challenged employer attempts to outsource these jobs to third-party app-based shopping companies that typically use non-union workers or independent contractors.[54]

Worker organizations can also affect technology adoption by attempting to create policy. Where unions do not currently exist in significant numbers, other organizations representing workers— such as United for Respect in the retail sector, the Warehouse Workers Resource Center, and Gig Workers Rising—have been leading efforts to advocate for stronger regulations of industries around technology and other job quality issues. In some cases, worker organizations have partnered or allied themselves with unions.

Competitive structures

Regulations create a unique structure of competitive and cooperative arrangements between firms in each industry. Market structures and market power shape employers' strategies for growth and survival: what problems are employers trying to solve, what technologies could address those problems, and what factors will affect an employer's decision to invest?

Weak antitrust enforcement in the U.S. has allowed ownership consolidation to proliferate in many industries, which in turn has led to a gap between large, well-resourced industry leaders that are able to invest in and experiment with cutting-edge technologies, and smaller firms that tend to lag far behind. This dynamic is especially notable in retail and warehouses.[55] Historically, employers in both industries have been slow to adopt new technologies. The rise of Amazon has reoriented the competitive terrain in both sectors, however, compelling other large employers to integrate new technologies related to e-commerce ordering and delivery into their business strategies, while smaller firms continue to take a more cautious approach.

The market dominance of a firm like Amazon means that it has an outsize influence on the competitive landscape of an industry, including on employer objectives regarding technology. Firms with the means to invest are focused on technologies that can promote speed in processing, packaging, delivery, and cost-reduction at every step of the way. Large retailers are also concerned with strategies to increase their own market share and to develop new revenue streams. For some smaller retailers, however, growing consumer expectations about low-cost, rapid online ordering and delivery options are reducing their ability to attract customers, further constricting resources available to adopt new technologies.[56]

> Unions and worker organizations can affect technology adoption patterns in individual firms, and in the industries and regions where they represent significant portions of an industry's workforce.

In industries where ownership consolidation is less extreme, employers still face similar pressures to reduce wages, speed up work, and micromanage their workers, but a wider range of strategies related to technology adoption can exist. In the grocery and trucking industries, for instance, there are major employers with unionized employees. At unionized firms, workers can exercise their collective market power to influence the effects of new technologies on their jobs, as in the examples discussed above.

In health care, the government is the dominant market actor. Although most people in the U.S. have private insurance through their employers, the U.S. government funds Medicare and Medicaid, making it the largest single buyer of insurance in the U.S. As such, it has significant leverage and buying power in the industry. Thus, when President Obama signed the 21st Century Cures Act, which required home care agencies that provide personal care services to have EVV technologies or risk losing their Medicaid claims, "the federal government essentially 'picked a winner,'" ensuring that this type of technology would proliferate across the market for home care.[57]

Industry trends

Ownership consolidation is not the only industry trend creating distinct patterns of technological change. As another important example, changes in consumer preferences also have a profound effect on patterns of technology adoption in each industry. The increase in e-commerce has reoriented employer objectives across several of the industries we studied, including retail, grocery, warehouses, and trucking. Developing effective platforms for online shopping is of course a priority for many employers, as is deploying a wide range of technologies to facilitate rapid order assembly and delivery. Similarly, growing consumer demand for prepared or semi-prepared food rather than groceries has put pressure on traditional grocery stores to

develop more options in this area. One result is that some grocery stores are partnering with subscription-based meal kit companies, which typically rely on warehouse-like facilities where workers' wages and job quality are comparatively low.[58]

In the warehouse industry, there are important differences between production processes for shipping in e-commerce facilities and traditional warehouses. Processing in traditional facilities involving bulk transfer of products is far less labor-intensive and time-sensitive compared to processing in e-commerce facilities. As a result, traditional warehouse employers may be less interested in the kind of intensive employee surveillance pioneered by Amazon, and more interested in advances in warehouse management systems and machinery to automate movement of goods around a facility.[59]

Another industry trend affecting technological adoption is outsourcing. We've already discussed outsourcing in the context of trucking, grocery, and food delivery, and the implications of these changes for workers, in particular independent contractors, who lack basic employee rights and protections on the job. There has also been an increase in recent years in firm-to-firm outsourcing in some sectors, such as retailers outsourcing warehouse services to third-party logistics companies ("3PLs"). Competition in the 3PL market is extremely price-sensitive, and contracts are often short-term, which may blunt employers' incentives to invest in specialized technology.[60]

Broader societal and market trends

The COVID-19 pandemic, long-term demographic changes, and shifts in economic conditions and labor markets all affect patterns of technological change across multiple industries, but the consequences of these trends are not uniform across or even within industries. In particular, the pandemic appears to be speeding up technology adoption in some cases but slowing it down in others. For example, grocery employers have rapidly shifted to online ordering and health care providers to telehealth options since 2020; these are both technologies that had made limited inroads prior to the pandemic. On the other hand, financial constraints in stores and restaurants caused by declines in in-store shopping and eating have limited some employers' ability to experiment or invest in any new technologies.[61]

COVID-19 has also reshaped employers' objectives and strategies related to technology. In industries where workers have been required to work onsite, such as health care, grocery stores,

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and warehouses, technologies that could help reduce disease transmission for customers or workers became a priority for some employers.[62] These included new forms of data gathering on workers' health to prevent and track outbreaks, and technologies that reduce the need for on-site workers or reduce their physical proximity to one another, such as semi-autonomous service robots and cashierless checkout.[63]

Societal and demographic trends affect industries' uptake of technology as well. Women's long-term increases in labor force participation has induced growing demand for prepared food along with online ordering of groceries and takeout. In the U.S., people are also living longer on average, which creates an interest among health care providers in technologies that can respond to the increasing demand for long-term care.[64] Additionally, an aging workforce has led to a retirement bubble in certain industries that may exacerbate ongoing labor shortages, with a prime example being trucking.

Broader trends may work in favor of or against workers in terms of technology adoption and its consequences. Labor shortages are benefiting some workers in sectors like trucking and warehousing by prompting long-overdue wage increases, but they may also accentuate employers' interest in technologies that reduce employers' reliance on workers in the long-run.[65] As discussed above, the pandemic has likely accelerated some employers' interest in labor-displacing technologies and employee surveillance technologies, but it has also reduced some employers' ability to invest in such technologies, potentially slowing the pace of change in certain industries and market segments.

Conclusions

Recent technological advances such as big data, robotics, and artificial intelligence have expanded our technological capabilities exponentially, and are poised to accelerate the pace of change in many industries. In some cases, employers will deploy new technologies in ways that reduce the number of jobs available. In other cases, they will use new technologies in ways that expand the numbers of existing jobs or create entirely new types of positions. Employers also will continue to use new technologies to reorganize production, reshuffle tasks, and change work processes. Across all the industries our researchers studied, we found that new technologies pose a significant threat to workers' wages and job quality, and equity for women, people of color, and other disadvantaged workers. Many employers are using—or exploring the use of—technologies that facilitate monitoring and control over workers' actions, speed up the pace of work, and generally devalue workers and their contributions.

The COVID-19 pandemic has injected additional uncertainty into forecasting the future of work; it serves as an important reminder that the form new technologies take and the consequences they have are not preordained. What the jobs of tomorrow will look like depends on the choices we make now to shape the course of tech development and adoption, and on the mitigable ground rules for the economy overall and for the industries in which these decisions are situated. Our studies illustrate how employers' choices about technological change occur within the context of specific industries and markets, and the regulations and institutions that guide and govern how firms function.

> The same forces that have constrained workers' ability to improve their wages and working conditions are currently on course to wield disproportionate influence over the types of technologies that are developed and the ways they are deployed in each industry.

The same forces that have constrained workers' ability to improve their wages and working conditions are currently on course to wield disproportionate influence over the types of technologies that are developed and the ways they are deployed in each industry. Through

our industry studies we have highlighted the importance of regulations to allow workers to help shape the process of technological change, and for employers to be motivated to make choices that prioritize quality-based over cost-based competition. Industry regulation and labor market institutions matter in guiding employer options and choices around technology adoption, and the resultant outcomes for workers.

In industries with some presence of unions—health care, trucking, and grocery—our researchers identified examples of workers influencing the process of new technology adoption to create better outcomes for workers. However, even in these industries, our researchers found that broader societal and economic trends are likely to continue to push employers to use new technologies in ways that increase the challenges workers face on the job. In industries like non-food retail and warehouses, where unions are less common and where large firms are able to set the terms of competition, prospects for workers to experience beneficial effects from technological change are even bleaker.

Absent an intentional shift in our current approaches to technological change, the industries our researchers studied are likely to see employers use new technologies in ways that make job quality worse and widen economic and race and gender inequality in the labor market. So how do we change our course? We know that new technologies *can* be used in ways that support workers, but how do we get there? The findings of our studies suggest that achieving better outcomes for workers will take a multifaceted approach including industry-specific institutional and regulatory changes, broader policy changes, and workplace-based organizing.

> The introduction of new technology in low-wage industries can easily lead to bad outcomes for workers, but this is not inevitable.

Endnotes

1   There is of course a substantial and growing body of theoretical and empirical literature on technological change and work, including but not limited to the question of automation. For some recent examples see Acemoglu & Restrepo (2020); Agrawal et al. (2019); Hu (2022); Jarrahi et al. (2021); Kellogg et al. (2020); Moradi & Levy (2020); Rogers (2020). For a discussion of methodological approaches to studying technology and work, see Bailey & Barley (2020).

2   Viscelli (2018).

3   Carré et al. (2020).

4   Litwin (2020).

5   *Ibid*.

6   Benner et al. (2020); Carré et al. (2020); Gutelius & Theodore (2019).

7   Viscelli (2018).

8   Gutelius and Theodore (2019), p. 6.

9   Gutelius & Theodore (2019).

10   Carré et al. (2020) p. 17.

11   For further discussion on automation and tasks, see: Acemoglu & Restrepo (2019); and Manyika et al. (2017).

12   Carré et al. (2020).

13   Benner et al. (2020).

14   *Ibid*.

15   For a deeper discussion of the ways employers can use algorithms in the workplace, see chapter 5 of Kresge (2020a).

16   Gutelius & Theodore (2019).

17   Litwin (2020).

18   Gutelius & Theodore (2019).

19   Gutelius & Theodore (2019).

20   Benner et al. (2020); Carré et al. (2020).

21   Viscelli (2018).

22   Data collection on workers often serves another function besides monitoring, task direction and pace-setting: generating data to inform the development of new tools and machines to automate certain types of tasks.

23   Hanley & Hubbard (2020).

24   Tung et al. (2021).

25   Litwin (2020).

26   Eubanks & Mateescu (2021).

27   Levy (2015).

28   Workers are also monitored as a by-product of employers' use of video monitoring to track customers as well (e.g., for shoplifting or for tracking customer shopping habits). (Carré et al. 2020).

29   Benner et al. (2020).

30   Bhuiyan (2020).

31   Gutelius & Theodore (2019).

32   Carré et al. (2020).

33   Litwin (2020).

34   Bernhardt et al. (2021); Heilweil (2020).

35   Gutelius & Theodore (2019) p. 61.

36   Bogen (2019).

37   Harwell (2019).

38   Vogel (2018).

39   Viscelli (2018), p. 7. Levy (2015) notes that certain regulations have increased in trucking: some Department of Transportation rules introduced over the past few decades have actually led to increased electronic monitoring of truckers.

40   Viscelli (2018).

41   Litwin (2020).

42   Litwin (2020) p. 37.

43   Litwin et al. (2022).

44   Additionally, although labor is relatively inexpensive, the U.S. tax code favors employer investments in capital over investments in labor in a variety of ways, which may incentivize firms to pursue labor-replacing technologies in the long run (Acemoglu et al. 2020).

45   Constant (2021).

46   Bernhardt et al. (2021).

47   Connecticut and Minnesota passed similar bills, and one was proposed in Washington as well. Both chambers of the New York State Legislature have passed the Warehouse Worker Protection Act, though it has yet to be signed by the governor. (An Act Concerning Protection of

Warehouse Workers, 2022; Concerning Warehouse Distribution Centers., 2021; HF 2774 Status in the Senate for the 92nd Legislature (2021 - 2022), 2021; Roth, 2022).

48   Kalish (2022).

49   However, companies like Uber, Lyft, and Doordash continue attempting to weaken and overturn these laws. In 2020, Uber, Lyft and Doordash spent over $200 million in California to pass Proposition 22, which invalidated the law extending employment rights to many app-based workers. An Alameda County Superior Court Judge ruled the ballot measure unconstitutional in 2021, but it remains in effect during the app companies' appeal. (Conger & Browning 2021; Lyons 2021).

50   Kresge (2020b). It's important to point out that there are ongoing debates around the extent of unions' legal right to bargain over employers' decision-making regarding technology, versus the effects of their decisions regarding technology. See Ashford & Ayers (1987); Rasband (1989).

51   Litwin (2020).

52   Platooning involves electronically linking a series of trucks. In human-human platooning, humans drive each truck, but the lead truck controls the speed and braking in the following truck(s). In human-drone platooning, the lead truck is driven by a human, and subsequent truck(s) are controlled by technology. (Viscelli, 2018).

53   Kapadia (2019).

54   Howland (2021).

55   Benner et al., (2020); Carré et al. (2020); Gutelius & Theodore (2019).

56   Carré et al. (2020).

57   Litwin (2020) pp. 75, 79.

58   Benner et al. (2020) p. 17, 61.

59   Gutelius & Theodore (2019) p. 18.

60   Gutelius & Theodore (2019) p. 49.

61   Benner et al. (2020); Carré et al. (2020); Litwin (2020).

62   Many other employers seriously neglected worker safety during COVID, for instance by supplying insufficient protective equipment or sick leave accommodations, or by not enforcing masking rules for customers.

63   Carré et al. (2020); Gutelius & Theodore (2019); Litwin (2020).

64   Litwin (2020).

65   Gutelius & Theodore (2019).

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