CHANGE AND UNCERTAINTY, NOT APOCALYPSE:
Technological Change and Store-Based Retail

September 2020

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Acknowledgments

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Suggested Citation

Carré, Françoise and Chris Tilly. 2020. *Change and Uncertainty, Not Apocalypse: Technological Change and Store-Based Retail*. Berkeley: UC Berkeley Labor Center and Working Partnerships USA.

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Executive Summary

The retail sector, like the rest of America's economy and society, is being subjected to an enormous stress test by the coronavirus pandemic. Grocers, pharmacies, and such mass marketers as Walmart, Target, and Amazon are adjusting to shifting patterns in demand for goods, a dramatic increase in online ordering, and new social distancing guidelines in stores. Workers at these retailers have documented overcrowding and insufficient safety precautions at stores and online fulfillment warehouses. In contrast, department stores, apparel, and luxury retailers have had to close their ("nonessential") stores and endure plummeting sales as consumers focus on the basic necessities. This workforce has suffered massive furloughs and layoffs estimated to be in the millions. The economic ripple effects of the lockdowns necessitated by the pandemic already include decreased discretionary spending and economic recession. These challenges almost surely will continue to hammer retail businesses and jobs even after closing orders are lifted and consumer fears of going to crowded places abate.

The week-by-week developments in the pandemic-driven economic shutdown and gradual reopening have been gripping. At the same time, it is important to keep our eye on longer-term industry trends, including taking into account how the 2020 crisis and its aftermath are likely to intensify, blunt, or divert them. In this report, we focus on trends in technology adoption in the retail sector, looking beyond the effects of the current crisis to trace how retailers are using digital technologies in ways that alter the quality and quantity of front-line retail jobs. While we recognize the pandemic's possible impacts on the retail workplace throughout the report, the bulk of our discussion concerns longstanding trends that appear likely to continue over the next five years or longer.

Even before "coronavirus" became a household word, there was a widespread expectation that digital technology would bring big changes to store-based retail. The expectations of different observers vary considerably, however. Some predict a dark vision of a "retail apocalypse," in which e-commerce will almost entirely wipe out stores. Others describe an imminent "retail renaissance," in which technology adoption will free retail workers from repetitive drudgery to instead serve as expert guides about the merchandise, and valued, empowered implementers of a store's sales strategy. Our mission in this report is to analyze available evidence to determine how plausible either of these scenarios is, to spell out likely workforce impacts of new technologies, and to examine the choices and tradeoffs facing retailers and policymakers in an era of rapid technological change.

COVID-19 appears likely to accelerate many changes in the retail sector that already were in process. This includes the broader trends reshaping the industry—growing market share consolidation by a small number of giant corporations, and a shift from traditional department stores and mall-based apparel sellers to mass marketers. It also includes the longstanding pattern of "low-road," cost-minimizing business practices that have degraded job quality—and in the context of a pandemic, have jeopardized worker safety. The current crisis also may introduce incentives for accelerated diffusion of new digital technologies that are transforming retail work—including the shift to online sales, the spread of cashier-less checkout, increased utilization of autonomous robots, and heightened digital surveillance of both customers and workers.

The effects of COVID-19 on technological adoption in retail will not be unidirectional, however. On one hand, the need to track pathways of contagion puts a benign face on forms of workplace surveillance that might in ordinary times have faced greater resistance. On the other hand, overall sales declines will deplete or even exhaust retailers' available funds to invest in tech—and if the virus-triggered recession is long and deep, this situation will persist. The crisis likely will deepen retail enterprises' "digital divide": market leaders—especially those with a strong online presence—will be able to undertake robust investments in technology, whereas others will lag in such investments.

In this study, we focus on brick-and-mortar retailers and store-based jobs, particularly in grocery and general merchandise (which includes large discounters), though we also include some examples of apparel and home goods retailers. Our data consists mostly of interviews with key actors and experts in the retail terrain, including consultants, technologists producing and selling digital technology goods and services, retailers themselves, representatives of retail-sector unions and advocacy groups, and an academic. We also attended industry association conferences and draw to some extent on published sources, including consultant white papers, print and online media, and academic literature.

Findings

The State of the Retail Sector

The U.S. retail sector today is in some ways primed for change; in other ways, it is ill-positioned to pursue it. While retail is a heterogeneous sector, certain characterizations apply broadly. The industry as a whole is "overstored," with more retail space than needed. Profit results are mixed: margins on sales are thin, but return on investment is handsome. Retail has been a favored target of private equity companies, and asset-stripping by such companies lies behind some high-profile retail bankruptcies in recent years. Ownership in the retail sector is highly

consolidated and continuing to concentrate, with a handful of companies accounting for a large and growing share of total sales. Employment also is highly concentrated, although less extremely than sales.

1.   The employment baseline and recent changes.

The 16 million people in retail (a statistic from "normal" times preceding the pandemic) consist above all of salespersons, cashiers, stockers, and supervisors of these workers. With the exception of managers, supervisors, and health care workers, these are relatively low-paid occupations, with high turnover, low formal credential requirements, and limited presence of unions across the United States. Some broad trends in employment are discernible in the data. E-commerce is of course enjoying rapid growth in employment, but the trajectories of the different retail subsectors have diverged widely. In the years since 2011, as the economy shifted from bust to boom, grocery employment grew briskly (though it has plateaued in recent years, pre-pandemic), clothing stores have stagnated, and general merchandise has had mixed fortunes, with department stores struggling but other sections of general merchandise, such as big box sellers and dollar stores, continuing to grow. The job losses are due in part to e-commerce, but also in important part to the continuing growth in the dominance of discounters, including the big box players and dollar stores, which are growing at the expense of department stores and apparel retailers. Their leaner staffing models lead to overall drops in employment.

These changing fortunes have affected some sociodemographic groups more than others. Cashiers in grocery and salespeople in apparel and general merchandise have taken significant hits—and, of note, these jobs predominantly are held by women. The bleeding of department stores stirs concern because the general merchandise sector employs far higher percentages of women and people of color than retail as a whole, and far more than e-commerce, whose workforce is considerably whiter and more male than retail overall.

2.   Stores will survive, but will change.

Despite continuing talk of a "retail apocalypse," retail stores remain a durable way of selling, and we expect them to remain so. As of late 2019, e-commerce sales still only amounted to less than 10% of retail sales, and there were conflicting data on whether store openings or closings were more numerous that year. An April 2020 survey found that in the midst of widespread shelter-in-place policies and warnings about the dangers of person-to-person contact, 70% of Americans still were buying their groceries in stores. A set of advantages of store-based shopping contributes to the continued dominance of stores in today's worst-case scenario, and will continue to matter long after. Customers will continue to want to look at products up close, get personalized advice, and have human interactions. Retailers will continue to want

stores to communicate with customers in compelling fashion, to observe and learn about those customers (increasingly aided by new technology), and to have dispersed locations for delivery or pickup of online sales. And store-based shopping eliminates the added cost of delivery that otherwise must be shouldered by either merchants or consumers. Importantly for the retail workforce, though stores are here to stay, the mix of job activities and functions taking place within stores is changing and will continue to change—an issue at least as important as potential job destruction.

3.   Store objectives and high-level strategies.

Store-based retailers currently are dealing with coronavirus-created crises, ranging from simple survival, to meeting changed consumer demands, to ensuring safety. In the longer run, at least for the large majority of retailers that will survive these challenges, their three central objectives are going to be the same ones we found in our 2018–19 fieldwork: reserve their existing market share in face of the assault from Amazon and other e-commerce sellers, develop new revenue streams, and cut operating costs. Store-based retailers have undertaken a variety of strategies to pursue these objectives. Many of the strategies rely heavily on technological investments, and we focus on these strategies in our report.

Technology Adoption in Retail

We expect fairly quick, widespread adoption by retailers of technology solutions that fall into a relatively small number of categories and criteria:

- Continuing growth of e-commerce, especially click and collect.

- Labor-saving options already available; in particular, self-checkout systems.

- Technologies that involve light investment but a significant payoff in customer convenience or improved experience, such as mobile checkout by tablet-equipped workers.

- Micro-fulfillment centers, mini-warehouses typically carved out of the existing store footprint, that offer a quicker payoff, and at a smaller scale of online business, than large freestanding warehouse fulfillment centers.

We reject the notion that if an efficiency-enhancing technology is available, it will be adopted quickly. Industry structure, the internal social organization of the firms deciding on technology use, and external social ties and influences matter. This is all the more true in an environment of double uncertainty. First, there is short- to medium-term uncertainty about the course of the pandemic and its impacts on business shutdowns, consumer buying habits, and the

economy. Additionally, there is long-term uncertainty regarding which technologies will pay for themselves, and the tradeoffs between moving quickly versus waiting for later, more cost-effective iterations of technological solutions.

The trajectory of technology adoption and implementation will differ by retail subsector, by market segment, by company, and across specific technologies. The pace and extent of adoption also will vary based on shifts in overall economic, social, and policy environments. The accumulation of this set of uneven effects will, in turn, determine the overall deployment of new technologies in retail stores, and their qualitative and quantitative impacts on jobs and consequences for the workforce. We pay particular attention to "job content effects" that result when technology implementation alters workers' mix of tasks and the nature of work. We also distinguish between "substitution effects," which occur when machines make possible performing a job better and less expensively with fewer people; and "scale effects" that result when technology makes goods and services cheaper so consumers buy more of them. Scale effects offset substitution effects to varying degrees, sometimes leading to increasing employment in a sector.

Impacts of Technology Adoption on Store Operations and Labor

We don't organize our analysis around the set of particular technologies being implemented in stores, but rather break down the activities in stores into "bundles" of major functions and technology combinations. The four core bundles are: *inventory management* (which particularly involves stockers); *checkout* (primarily involving cashiers); *e-commerce* (the main jobs involved are the new jobs in e-commerce fulfillment); and *customer interaction* (particularly touching on salespeople). An added bundle is *worker management*, which extends across all the other functions and has impacts not just on the workers being overseen, but also on the supervisors and managers themselves. For each of these bundles, there are multiple, conflicting possible implications for the workforce: job-eliminating automation or changes in the mix of activities that make up a job—changes that are supportive and empowering for workers or shift toward more coercive, highly controlled work.

1.   Inventory Management

Technology is changing inventory management in ways that are likely to increase stocker interactions with technology, but that are less likely to reduce headcount in the near term. Perhaps the most dramatic change is the use of cameras and other sensors linked to artificial intelligence systems to instantly analyze visual images and other data. These tools can be used to verify planogram compliance, spot outages or misplaced merchandise on the shelves, flag spills,

detect and deter shoplifting, and send alerts about other such problems as freezer or cold cases where the temperature has risen. Other innovative systems include electronic pricing, automated receiving of boxes at the back of the store, and inventory systems tied to e-commerce fulfillment, as well as enhancements to the overall systems predicting inventory needs, and tracking and managing merchandise flow throughout the supply chain. Though some of these innovations are replacing, or will soon replace, front-line labor, their direct impacts are small and appear likely to remain so for a while. The larger impacts on stocker jobs will be a growing need to interact with machines, including being directed and paced by them.

2.   Checkout

Retailers seem to be gravitating toward self-checkout and decentralized checkout (by mobile employees with tablets) rather than more elaborate technologies; the COVID-19 crisis seems likely to spur the spread of "contactless" checkout. Retailers are investing in cashier-less checkout at three different levels. The first is simply increases in traditional self-checkout, in some cases with enhanced equipment. The second entails "scan and go" systems, in which shoppers use their phone or another device to scan while they are shopping, pay online, and walk out without interacting with a cashier. These first two levels do not actually automate checkout, but simply transfer the work to customers; reduced contact with cashiers, and especially the possibility of checking out with one's own phone, gain appeal when there is fear of infection. The third level is the one represented by Amazon Go and a host of competing systems: cameras and other sensors track what items a customer takes off the shelves, and automatically charge the customer when she or he leaves the store. Scalability of cashier-less checkout still appears some ways off, but the continuing spread of the first two levels is likely to translate into fewer cashier jobs, and more jobs that combine some cashiering with other duties. Another growing shift is supplementing cash register-based checkout with staff armed with tablets who can check customers out around the store—an option for years in smaller and more sales-intensive retail outlets, but now being pursued (though on hold during the pandemic) by Walmart, Target, and others for whom it is new.

3.   E-commerce

E-commerce both erodes store headcount and shifts store staffing to online order fulfillment. Growth of e-commerce has two kinds of impacts on stores. Most obviously, it displaces some store-based selling. In addition, it feeds the expansion of store-based fulfillment of online orders, both for delivery and for customer pickup. The latter trend involves a number of new technologies; one steadily diffusing use of new technology is the creation of highly automated micro-fulfillment centers located at stores. Order fulfillment creates a set of new worker roles, including picking orders, tending micro-fulfillment centers, and handing off orders to customers at curbside.

4.   Customer Interaction

*New customer interaction technologies can both replace store visits **and** make store visits more personalized by giving salespeople access to much more customer information.* Technological innovation in customer interaction is evolving in several directions with distinct implications for the workforce. As with e-commerce, one possible outcome of chatbots (artificial intelligence (AI)-enhanced automated interaction), virtual reality try-ons of clothes or furnishings, and so on may be to make store visits unnecessary. On the other hand, store-based retailers are anxious to use these contacts to drive customers to stores, or in some cases to put them in remote communication with store-based salespeople to drive additional sales. And growing capacity to store and rapidly access data about a customer's past online and store-based purchases and preferences means that store-based staff increasingly have access to "clienteling" tools that allow them to interact with customers in personalized and customized ways.

5.   Worker Management

Worker management tools are varied, and create the potential for either greater empowerment and autonomy or increased surveillance and control of workers. The leading edge of technologically driven changes in worker management consists of ever-more-sophisticated scheduling systems. These increasingly are cell phone-based, and allow store-based workers to express preferences and swap shifts without having to speak to a supervisor. Newer and less widespread are task management systems that range from simple to-do lists to software that gives detailed direction and simultaneously tracks workers' performance. Electronic communication channels can facilitate top-down communication from management to workers and even convey training, as well as potentially bottom-up and horizontal (worker-to-worker) communication. The proliferation of computer vision-equipped cameras and other sensors, including wearables and sensors that track workers' phones, bring with them the possibility of far more pervasive surveillance of workers. Finally, large-scale decision systems can automate some kinds of routine decisions, increasing efficiency but removing managerial discretion and potentially reducing the need for multiple managers or supervisors in some store-based settings. One indication of potential change on this front is Amazon's use of automated systems to make decisions about discipline and even termination of warehouse workers; the diversity of store tasks makes this less feasible in retail work so far.

What to Expect in Future Employment Changes

Prediction is always risky, generalization even more so, and the current pandemic conditions make prognostication even trickier. In projecting possible store-based workplace futures, we note that those futures are contingent on decisions by retailers, consumers, and policymakers. They also are contingent on workers' responses. All that said, some predictions seem fairly safe:

almost surely e-commerce will continue to grow, traditional department stores and apparel retailers will continue to wane (partly due to e-commerce, but also to displacement by big-box and small-box discounters), and the ranks of cashiers will be further thinned. In terms of the nature of the jobs, the default option for most retailers in recent decades has been "low-road" strategies that keep labor relatively cheap and the formal credential requirements low, while intensifying monitoring and control of the workforce along with increasing work tasks. Reports of employers' inadequate practices regarding worker safety during the pandemic underscore this longstanding pattern. That history suggests that, to the extent store-based retailers choose their technology future without new regulatory guidance, they are likely to continue to make low-road choices.

Heightened use of new digital technologies is likely to change both the nature and the number of jobs in store-based retail. The pandemic brings the possibility of speeding changes like the shift to e-commerce, but the accompanying recession also brings the possibility of slowing them down. In terms of changes in the *nature* of jobs, as we have emphasized, new technologies can facilitate both supportive and coercive changes for workers. For example, untethering cashiers from the cash register by giving them tablets can reduce the rote nature of the job, but it also can lead to increased pressures to produce under circumstances less under their control. The same is true for salespeople: instant access to background information on a particular customer can deepen their discretion on how to interact, or can be channeled in a way that is more scripted.

The content of stock clerks' jobs seems destined for more radical change than any of the other major retail job categories. Clerks increasingly will be shifted to picking stock from store shelves to assemble orders, tending micro-fulfillment centers, and handing off orders to customers at curbside. On the store floor, they also will be more frequently prompted by "alerts" to replenish stock. As with cashiers, this could make stocker jobs more varied and interesting, but in combination with new ways of tracking work, it also could result in jobs that are surveilled, closely watched, sped up, and stressed. As tech systems take on some routine management tasks and provide more information and guidance to managers, again their jobs may come to involve more discretion—or they may themselves be increasingly algorithmically managed, more closely monitored, and more tightly controlled.

Regarding the largest occupational groups in retail, will retailers primarily use technology to enhance the supportive features of jobs, or render jobs more coercive? We heard many predictions—by retail executives, tech companies, and consultants—of upgrading of the skill and pay of retail workers as they are freed up from routine tasks, and as stores shift to a more "experiential" focus for shoppers. However, for decades, the bulk of retailers have not diverged from the habit of treating labor as a short-term adjustment variable, and labor costs as a primary cost liability. Technologists have followed suit, pitching to retailers tools that tout labor and cost savings as a primary benefit.

If retailers are left alone with tech providers to decide about technology adoption without input from other stakeholders, particularly store workers and policymakers, we have difficulty envisioning a significant divergence from this longstanding approach. We expect that, at best, there will be limited departures from the status quo of retail jobs with low wages, little requirement of formal credentials, high turnover, and fluctuating hours. And we expect technology's new capabilities for surveillance and detailed direction of work to be added as an overlay in more and more retail jobs—with a boost coming from the heightened legitimacy of surveillance due to its new applications in reducing the spread of coronavirus.

As for the *number* of retail jobs, the two largest influences will be the ongoing growth of e-commerce and the newer turn toward novel applications of digital technology. E-commerce will have an important impact on the number of jobs, but a limited one. On the one hand, stores will evolve, not disappear. Most large future stores will have more workers fulfilling click-and-collect and home delivery orders, in addition to continuing to support in-person shopping and, in a more limited subset, varieties of experiential retail. On the other hand, the continuing growth of e-commerce will indeed shift more retail functions away from stores and to logistics (warehouses and delivery services), continuing recent trends. Some retail subsectors will be harder hit than others—for example, those with standardized products, portable goods, high sales volumes, and purchases that attract middle- and higher-income consumers willing to pay a premium for delivery.

In the short to medium term, the largest technology-driven job losses (relative or absolute) are likely to strike where they already have been striking: the spread of various forms of cashier-less checkout will reduce the number of cashier and salesperson jobs through a mix of automation and work-shifting onto customers. Automation will make some small, near-term incursions into the ranks of stockers, but large-scale changes are farther off, in part because the stocker job is intrinsically harder to automate (though backroom box unloading can be automated). Potentially more at risk than stocker jobs are store management and supervision positions. Store managers' jobs are not going away, but productivity-enhancing technology may thin out the ranks of secondary managers and supervisors in larger stores. We expect the biggest changes in mid-market retail: high-end retailers rely on human interaction to make sales, while the lowest-end retailers have thin staffing and low pay, so tech investments would not bring large economic benefits.

Because cashiers and salespeople are disproportionately women, job losses in retail almost surely will hit women hardest. Women of color will be especially affected by job losses because of their concentration in the vulnerable general merchandise subsector. The loss of cashier jobs, along with such associated jobs as baggers in grocery and big box stores, is of particular concern because this is the most common entry point into retail for women and young men, including those with few or no educational credentials—and a pipeline into higher-paying jobs, including supervisory ones. Reductions in stocker ranks will have an outsized impact on Black men and Latinos. Managers and supervisors disproportionately are white and male, so

job reductions in management likely would skew toward that profile as well; importantly, fewer managerial jobs translate into fewer opportunities for upward mobility from front-line work within retail. And as noted above, the growing e-commerce sector, one of the two major forces displacing store-based retail workers, is more white and male than the rest of retail (and far more so than general merchandise).

Though we see a discouraging future for retail jobs, we emphasize that the actual future of these jobs will be the outcome of a set of choices: by retailers, by customers, by policymakers, and by worker advocacy organizations and unions where they are present in the retail sector.

Key Areas of Strategy and Policy

Policies aimed at worker and consumer safety rightly have been foremost during the pandemic, but it also is important to think through bigger-picture policies appropriate for regulating retail's process of adopting new digital technologies over the long term. Policies could be aimed at minimizing the most negative scenarios for job quality, accentuating technology's supportive potential, taking the edge off job displacement, and in general creating an environment characterized by fair treatment and concern for workers' as well as managements' priorities and needs.

One key set of issues involves workers' privacy rights and ownership of data collected from and about workers, as well as AI algorithm transparency and checks on algorithm bias. Additionally, appropriate policies could curb abuses of employers' growing ability to monitor and track workers' behavior and scheduling availability, and to build decision-making systems that minimize human intervention. Policies aimed at helping displaced workers also are important. This may include support for unemployed and displaced workers as they transition to other work, as well as policies to hold large employers like retailers partly responsible for supporting the workers they displace.

Another set of broader policies could affect the retail sector's technological trajectory. Extending sales taxes to all e-commerce purchases, as some state governments are discussing, would slow, though not stop, the expansion of online sales. And the adoption of a strict standard for considering someone an independent contractor rather than an employee, as California and other states have done, could reshape (or threaten) the business model of such platform-based companies as Instacart and Shipt. It also reduces the options for retailers to hire people as independent contractors themselves for order picking and delivery, but also other store positions. Requiring all retail outlets to take cash, a step taken by New York City and other localities, complicates totally cashier-less store models like that of Amazon Go—but does not foreclose them.

Finally, it is important to ensure there are spaces for retail workers and spokespeople advocating for their interests to have a voice in the company business strategy and technology implementation, as well as in public policy decisions that will shape future retail jobs. This can take the form of unions, other types of worker associations, or advocacy organizations. The retail sector has low rates of collective bargaining coverage, but where unions are active, they have long engaged with issues of workload, compensation, and organization of the work. In unionized grocers and other retailers, collective bargaining over the implementation (possibly even the choice) of technologies would make a significant difference not only to ultimate job quality outcomes, but also to the transparency and accountability of the implementation process itself. The expansion of the scope and strength of unionization, as well as of independent organizations like United for Respect (formerly OUR Walmart), could improve possibilities for negotiation and worker input around the implementation of technologies.

In closing, it is important for retailers, policymakers, and the public to look beyond the extraordinary circumstances of the 2020 pandemic and start setting constructive guidelines for the use of the revolutionary technologies now being rolled out in the retail sector. COVID-19 has spotlighted some of the serious problems present in retail workplaces, and we should think big about policy frameworks that harness technological change to improve jobs, rather than simply eliminate and further degrade them. Multidimensional approaches (organizing, legal, consultation, or decision-sharing processes) in multiple spheres (worker rights, industry operation, taxation) are likely to be required, given the broad range of technologies being considered and the wide array of retail functions toward which they may be deployed. Worker protections require special attention because job quality and compensation have steadily eroded over decades, as the industry has been rocked by the growth of discounting and rapid consolidation. While rapid technological change risks exacerbating job quality issues and inequalities, it also provides an opportunity to restructure retail jobs in ways that are supportive of workers and their capacities.

SECTION ONE:
Introduction

The retail sector, like the rest of America's economy and society, is being subjected to an enormous stress test by the coronavirus pandemic. Even more than other economic sectors, retail and its workforce are being whipsawed in two directions at once. Grocers, pharmacies, and mass marketers such as Walmart, Target, and Amazon are adjusting to shifting patterns in demand for goods, a dramatic increase in online ordering, and new social distancing guidelines in stores. Workers at these retailers have documented overcrowded stores, insufficient social distancing and disinfection at online fulfillment warehouses, and delays in providing safety equipment. On the other hand, department stores, apparel, and luxury retailers have had to close their ("nonessential") stores and endure plummeting sales as consumers focus on the basic necessities. This workforce has suffered massive furloughs and layoffs estimated to be in the millions. The economic ripple effects of the lockdowns necessitated by the pandemic already include decreased discretionary spending and economic recession. These challenges almost surely will continue to hammer retail businesses and jobs even after closing orders are lifted and consumer fears of going to crowded places abate.

The week-by-week developments in the pandemic-driven economic shutdown and gradual reopening have been gripping. At the same time, it is important to keep our eye on longer-term industry trends, including taking into account how the 2020 crisis and its aftermath are likely to intensify, blunt, or divert them. In this report, we focus on trends in technology adoption in the retail sector, looking beyond the effects of the current crisis to trace how retailers are using digital technologies in ways that alter the quality and quantity of front-line retail jobs. While we recognize the pandemic's possible impacts on the retail workplace throughout the report, the bulk of our discussion concerns longstanding trends that appear likely to continue over the next five years or longer.

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renaissance," in which technology will free retail workers from repetitive drudgery to instead serve as expert guides about the merchandise, and valued, empowered implementers of a store's sales strategy. Our mission in this report is to analyze available evidence to determine how plausible either of these scenarios is, to spell out likely workforce impacts of new technologies, and to examine the choices and tradeoffs facing retailers and policymakers in an era of rapid technological change.

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The effects of COVID-19 on technological adoption in retail will not be unidirectional, however. On one hand, the need to track pathways of infection puts a benign face on forms of surveillance that might in ordinary times have faced greater resistance. On the other hand, overall sales declines will deplete or even exhaust retailers' available funds to invest in tech—and if the virus-triggered recession is long and deep, this situation will persist. Moreover, historical levels of unemployment have ended the labor shortage and upward pressure on wages that added urgency to retailers' efforts to shrink staffing. Retail companies already are focusing on the "low-hanging fruit" of proven technologies, and the financial crunch will redouble this focus. The crunch also will deepen retail enterprises' "digital divide": market leaders and especially, in the current circumstances, those with a strong online presence and/or a significant portion of their merchandise devoted to necessities (groceries, pharmaceuticals) will be able to undertake robust investments in technology, whereas others will lag behind.

In this report, we review that evidence and seek to answer the following set of questions:

1. What does the process of technology adoption look like in store-based retail today? What are the technologies being offered? What retail functions do they address?

2. In what ways and how quickly will digital technology change retail? What business strategies inform retailers' tech choices and speed of adoption? Which technologies already are being rolled out, and which other ones are under most active consideration?

3. What will stores of the future look like, and how will they function? Which types of stores will shrink, and which will flourish? Projecting forward, what mixes of jobs will be most common in stores? How will retailers use growing amounts of available data?

4. What are the implications of these changes for jobs? The nature of jobs? The number of jobs?

5. What possibilities are there for intervention to improve job outcomes?

In broad strokes, there are two divergent ways retail jobs could change. On the one hand, the future may bring what we call a *supportive* shift that empowers retail workers by giving them access to more information and more space for discretion. On the other hand, retail jobs may take a *coercive* turn, including work intensification and surveillance. Though our interviewees did not express an intention to move toward coercion, the potential certainly exists—and many jobs in "neighboring" sectors, such as warehousing and call centers, have followed this path. The reality almost surely will be mixed: some jobs will include more supportive features, while others become more coercive. However, we argue that retail employment practices since the 1970s suggest that coercive changes are likely to predominate, absent proactive policy intervention.

In brief, we arrive at five main conclusions. First, despite apocalyptic predictions, stores as a whole will survive, though subsectors that have been struggling will continue to do so and some merchants will shut their doors permanently. Second, however, e-commerce will continue to make gradual inroads, a process accelerated by the experience of the pandemic. Third, activities in stores will shift, particularly in the direction of store-based fulfillment of online orders and handling of order pickups and returns. Fourth, regrettably, we expect most retailers to continue to follow "low-road," low job-quality strategies; new technologies will not shift this trajectory in the direction of significant job improvements unless new public policies redirect it and alter employer incentives. Lastly, it seems likely that, unless pressed by policy action, retailers will predominantly implement technologies in ways that will make retail employment on the whole worse, above all through increased job tasks and digital surveillance, as that also will reduce store headcount, especially among cashiers.

It is important to remember that, while these outcomes may be likely, they are not inevitable. In the final section of this report, we discuss policies aimed at minimizing the most negative outcomes for workers and enhancing technology's supportive potential. The COVID-19 crisis presents an opening for rethinking policymaking in the retail sector. While attention rightly has been focused on policies aimed at protecting worker and consumer safety, we also should seize the opportunity to consider bigger-picture policies that will shape the ways the retail sector approaches technological change in the long run.

The main body of the report offers our findings and conclusions. Readers may find a glossary of retail-relevant tech terms, appended at the end of the report, helpful in fleshing out what different technologies do.

How We Conducted Our Study

The focus of this study is on brick-and-mortar retailers and store-based jobs.[1] We have narrowed the focus further to particularly examine grocery and general merchandise (which includes large discounters), the two largest subsectors within retail in terms of both sales and employment. However, we have stretched this focus to some extent, including some cases of apparel and home goods sellers, as relevant.

The core of our data consists of about 60 interviews conducted in 2018–19 with a variety of key actors and experts in the retail terrain. The categories of interviewees included (in declining order of number of interviews) consultants, technologists producing and selling digital technology goods and services, retailers themselves—mainly store-based, but also including "digital natives"—and a few others (advocates and union officials, an academic). A list of interviewees is included at the end of the report. We also attended nine industry association conferences over the same time period. The most informative conferences included the flagship retail trade shows—the National Retail Federation's Big Show and the new but rapidly growing ShopTalk annual conference—as well as a specialized one, NRFTech.

We draw to some extent on published sources, especially consultant white papers, and to a lesser extent academic literature (which on the whole has not kept up with the pace of technological change in retail). But ultimately, more important than these more infrequent but in-depth publications has been an ongoing scan (continuing into 2020) of print and online media, leaning heavily on daily and weekly news digests by the National Retail Federation, the Food Marketing Institute (now calling itself "FMI, the Food Industry Association"), Retail Dive, and the Retail Industry Leaders Association, as well as consultant newsletters and blogs.

SECTION TWO:
Profile of Today's Retail Sector and Recent Employment Trends

A Quick Overview of the State of Retail

We start by taking a step back to consider the broader retail context. The U.S. retail sector today is—and was, well before COVID-19—in some ways primed for technological change, but in other ways is ill positioned to pursue it. Start with the bad news: The industry is significantly "over-stored," with more stores and floor space than current, let alone future, consumer demand will support. U.S. retail space per capita stands at 23.5 square feet, towering above the two to five square feet per person found in Europe and China.[2] This creates a vulnerability in large sections of retail that the COVID-19 crisis exacerbated—as we write, a number of bankruptcies of venerable retailers have been announced, with more expected. However, retail's profit results are mixed. Viewed from a retail operator's perspective as the excess of revenues over expenses (net margin), retail profit margins are slim, typically 2% to 4%, a fraction of the economywide average.[3] But viewed from an investor's perspective as the return on assets or equity, profit rates are quite handsome. Food and general merchandise retail before the pandemic were earning about 18% return on equity, 1.5 times the marketwide average.[4] The market leaders exemplify this strength: For the three months ending Oct. 31, 2019, Walmart's return on equity was more than 18%, and Kroger earned a 20% return.[5] In other words, though retailers' markup is minimal, large retail businesses do make very efficient use of their assets.

Retail also is highly consolidated and continuing to concentrate, with a few companies accounting for a large and growing share of total retail sales. At the same time, the sector still has a large competitive fringe of independent "mom and pop" stores. Employment is less concentrated than sales, but still very, and increasingly, concentrated. Between 1997 and 2012 (the most recent detailed economic census data available), the eight largest firms' share of

total employment rose from 15% to 20%. Consider the largest and smallest retail enterprises, those with fewer than 10 employees, and those employing 1,000 or more workers. The smallest enterprises' share of employment fell from 13% to 10% from 1997 to 2012, while the share employed by firms with 1,000 or more employees rose from 52% to 61%.[6]

Private equity has found retail a tempting investment, and private equity firms have bought and resold quite a few large retailers. In many cases, private equity has followed opportunistic strategies, selling off real estate and other assets and leaving retailers saddled with large amounts of debt as well as costly rental obligations, and highly vulnerable to market fluctuations.[7] This was the history behind the 2018–2019 bankruptcies of Toys "R" Us, Payless, Gymboree, and Shopko.[8]

The majority of the retail workforce today receives low wages and few benefits, has limited formal credentials (though the tacit skills involved can be significant), faces fluctuating work hours, and experiences high turnover. The coronavirus pandemic has complicated this picture with temporary and permanent store closings, layoffs, and furloughs, and far more severe occupational hazards and heavy workloads, on the one hand, and wage premiums paid by a number of large retailers as a sort of "hazard pay" on the other hand—but the basic profile of job characteristics has remained similar. Three large occupational groups dominate the retail workforce: cashiers and salespersons, stock clerks, and managers and supervisors. Together these account for two-thirds of retail workers. Only a small minority of retail workers belong to unions, so collective bargaining for higher compensation and enhanced benefits is not currently an option for most.

The sector as a whole has a low and falling rate of union membership: 4% in 2019 (down from 9% in 1983). Union presence is most concentrated in grocery stores, where 14% of workers were union members in 2019, down from 31% in 1983.[9] The majority of the retail sector has reduced job quality over the long run across the last four decades: real, post-inflation wages are down relative to other sectors, benefit packages are less generous, store staffing has become leaner with resulting increases in workload, work schedules have become more fragmented and unpredictable, and promotion paths have become less accessible to those with limited education.[10] (Some of this deterioration is surely due to decreased union density: among full-time retail workers, union members earned 6% more weekly than nonunion workers in 2019.[11]) In Section Five we argue that, in addition, retailers' implementation of previous rounds of technological upgrading further worsened the typical retail job. This history augurs poorly for how retailers' deployment of new technology will affect job quality.

We already have noted the disproportionate employment share of the largest businesses; when it comes to the sizes of individual stores there is wide variation, but the average retail worker is based in a medium- to large-sized store. Thirty-five percent of retail establishments have five or fewer employees, but 34% of employees are at establishments with 100 or more, and expanding that group to those with 50 or more captures 48% of the total workforce.[12]

Retail historically has lagged in investment in technology, outside of the logistics advances pioneered by Walmart and adopted by other industry leaders since. Until Amazon launched e-commerce starting with book sales in 1995, the major recent innovations in retail were bar codes (1980s), modern logistical systems (1980s+), radio frequency ID tags (introduced in the 1990s, but adoption has been slow), and self-checkout (also originated in the 1990s, also slow to diffuse). In response to the success of Amazon and others, brick-and-mortar retailers began launching websites in the late 1990s (macys.com in 1997, walmart.com in 2000), but for years these remained limited and peripheral to the businesses. Even Walmart, despite its strong engineering base, only created a president of global e-commerce and technology in 2012, and only went on to establish a chief technology officer position in 2017. For many other large retailers, 2017—with its wave of store closings and "retail apocalypse" headlines—was the wakeup call that drove them to begin more ambitious investments in technology. So for most U.S. retailers, large-scale engagement with new digital technologies is a very novel experience.

Apocalypse...*Not:* Stores Will Survive

From media coverage of the "retail apocalypse," one might assume that predicting the future of store-based retail jobs will just consist of estimating the small number of years before these jobs disappear altogether. "More than 7,000 stores have closed in 2019!" screamed a representative headline in September 2019;[13] "These 28 retailers could go bankrupt in the next year," trumpeted another the next month.[14] However, based on our research and that of other observers, stores are here to stay for the foreseeable future, though some formats are likely to shrink more than others. As of late 2019, online retail sales by pure or principally e-commerce companies such as Amazon still were less than 10% of total retail sales. E-commerce sales by primarily brick-and-mortar retailers are reported with a longer time lag, but probably only add a few percentage points more.[15] And headlines aside, different sources offer very different estimates of store shuttering trends. Coresight Data estimated store closings exceeded openings by 2,625 in 2018 and 4,910 in 2019.[16] But IHL Group's tally conveys a more optimistic picture: openings outran closings by about 1,500 in 2018,[17] and 2,965 in 2019.[18]

IHL's analysis of closings in the first eight months of 2019 also showed that just 16 retailers accounted for nearly three-quarters of 2019 store closings, and that closings were concentrated in mall-based specialty apparel chains, especially those that took on excessive debt—debt that often was incurred as part of private equity buyouts.[19] Both companies' methodologies are proprietary, but the conflicting reports suggest that amid large-scale turbulence there is substantial uncertainty about overall trends. The coronavirus crisis-induced recession surely will lead to a spike in store closings, as the 2008 recession did before. But strikingly, an April 2020 survey found that even in the midst of widespread shelter-in-place policies and warnings about the dangers of person-to-person contact, 70% of Americans still were buying their groceries in stores—whether by choice or because of limited online options.[20]

It also is important to emphasize that employment losses or slower-than-expected employment growth in store-based retail sectors are *not* all due to e-commerce. Two other trends are quite important. First, there are shifts in sales and employment *within* store-based retail: big box discounters such as Walmart and Target, and other discount retailers including dollar stores, are growing at the expense of traditional grocery, general merchandise, and other stores—almost invariably with a leaner staffing model. Second, productivity has grown within each sub-category of retail, including among traditional retailers, leading to less headcount for any given amount of sales.

At the same time, the turmoil in the retail sector was significant before the pandemic struck. The pandemic has intensified it, making the long-run outlook more pessimistic as well. The challenges that put Toys "R" Us and Forever 21 out of business, that quickly drove J. Crew and JCPenney into bankruptcy during the pandemic, and that continue to stalk Gap, Macy's, Sears, Bed, Bath and Beyond, and others are real. And the closings that have taken place strike unevenly across the country, with small towns and rural areas most hard-hit, and mid-market suburban malls also struggling.[21] Furthermore, while online sales still represent only a small fraction of total retail revenue, that percentage is growing rapidly—a trend that seems likely to accelerate with the coronavirus pandemic, as more people buy online, many of whom are likely to continue the habit.[22] Above all, the mix of activities and functions taking place within stores is changing and will continue to change—an issue at least as important as job destruction, as we show in this report.

Bottom line, there are solid reasons for expecting stores to survive. Stores will continue to matter to customers. Consumers still will need places to look at products up close, whether "showrooming" items before buying them online, squeezing the produce, trying on apparel items that don't have a standardized fit, choosing a substitute when something is out of stock, or getting a sense of what's available that search engines can't fully provide. They need somewhere to get shopping advice more personalized and context-sensitive than a chatbot's. And speaking of the shortcomings of chatbots, shoppers, like other humans, generally enjoy social interaction, and a physical store can be a convenient place to experience that interaction.

Stores also will continue to matter for retailers. The store is a place where a retailer can interact with customers in a way that is rich and multidimensional, allowing them to upsell and build brand loyalty. Stores also are laboratories in which retail businesses can observe customers—how they react to and interact with products, what catches their eye, and so on— and new technologies, for better or worse, make it possible to observe customers much more closely than in the past. In addition, retailers increasingly are using stores as widely dispersed mini-warehouses for "forward deployment" of stock to deliver to online customers or hold for pickup. These are among the reasons that Amazon bought Whole Foods and is launching its own grocery store chain, and is building Amazon Go convenience stores, bookstores, and other physical stores across the United States.

These advantages of stores matter more in some places and types of stores than others. Stores' pluses tend to weigh more in dynamic urban centers, less in the small towns and traditional suburban malls that are most "over-stored" and have been losing retail outlets for years. We expect that apparel shops, department stores, and home goods retailers, which have borne the brunt of recent store closings, will continue to be culled in coming years, and sales of standardized goods will continue to shift online.

Still, as we heard from many a consultant, in the e-commerce era stores actually serve as an important differentiator among retailers. There is an analogy here with what has happened to local economic specialization as the economy has globalized. Some expected that as globalization makes it possible to carry out many economic activities almost anywhere in the world, geographic differentiation of production would disappear. But to the contrary, it turns out that *specialized local resources and capacities matter more than ever* in shaping a region's economic fortunes—when so much is mobile, these unique strengths make all the difference. Analogously, as more of retail can be shifted to e-commerce and the e-commerce experience becomes more standardized, *the convenience, human contact, and distinctive experiences provided by stores will continue to matter* in determining which retailers will attract loyal customers.

Store Objectives and High-Level Strategies: Reinventing Retail

 Store-based retailers currently are dealing with coronavirus-triggered crises, ranging from simple survival, to meeting changed consumer demands, to ensuring safety. In the longer run, at least for the large majority of retailers that will survive these challenges, their three central objectives are going to be the same ones we found in our 2018–19 fieldwork, and we expect their main high-level strategies toward these objectives to continue as well. Both the objectives and the strategies powerfully shape their decisions about use of new technologies.

The first objective of brick-and-mortar merchants is simply to **preserve their existing market share** in the face of the assault from Amazon and other e-commerce sellers—for many of them, a continuation of attempts to defend market share against such discounters as Walmart and the rapidly growing dollar store chains. Where possible, they seek to expand what a grocery executive calls their "share of share"—in this case, the percentage of their customers' grocery purchases that they make at this chain rather than at competitors.

A second, emergent goal is to **develop new revenue streams.** Since its origins, retail has of course relied on "front-end" revenue—income from sales to consumers. For decades, large retailers also have added "back-end" revenue, in the form of payments from vendors for prominent shelf placement (or simply more shelf space), promotions, or other steps to feature the vendors' products. Given the erosion of store-based front-end income by e-commerce,

brick-and-mortar retailers are searching for ways—call them "sideways" approaches—to use their stores to generate new sources of income.

Finally, store-based retailers seek to **cut operating costs.** This has been a perennial goal for decades, driven historically by price competition and especially the challenge posed by discounters—a challenge that is greater than ever. But there is a new urgency to this drive, due to the imperative to fund technological investments in order to fulfill customer expectations for convenience, information on demand, and systems that readily help them find products that meet their needs. The continuing and intensifying focus on cost-cutting bodes ill for use of new technologies to improve worker jobs. The technology that holds promise to reduce costs, by increasing efficiency or replacing workers, also poses the puzzle of how to pay for it—especially for large retailers with hundreds or thousands of stores, for whom rolling out technology is a very expensive proposition.

Store-based retailers have undertaken a variety of strategies to pursue these objectives. Many of the strategies rely heavily on technological investments; others do not.

Most of the strategies are directed at the first goal, shoring up market share. Four such strategies are particularly important. The first is simply to **put together an e-commerce offering that is competitive** with other alternatives—a strategy that acquired added urgency as the coronavirus compelled stores to close temporarily, and continues to place limits on the number of shoppers, either via formal limitations or customer hesitancy. Benchmarks here include a user-friendly interface and adequate—and increasing—speed and accuracy of order fulfillment. But a second, more encompassing strategy is to establish, in some of the buzzwords of the day, **an "omnichannel" presence** and achieve "seamlessness." This transcends the "multichannel" step of establishing a credible e-commerce operation: Retailers seek to integrate information and interfaces across online and physical shopping, generating a set of shopping experiences that are seamless from the customer perspective, and maintaining consistent communication with the customer across all channels.

A third step, closely related to cross-channel integration, is to **increase the intensity of engagement with potential customers,** communicating with them at every opportunity in ways that build on their past shopping behavior. The Holy Grail is a constant flow of communication with each customer, featuring customized marketing and advertising. As we shall explore in more detail later, this depends on having ways to identify and contact the customer—above all via their mobile phone—in order to stay in touch while accumulating information about their searches, purchases, which kinds of offers and outreach they respond to, and so on.

The fourth strategy is to **strengthen and further innovate distinctive roles for physical stores.** For better or worse, stores' main asset still is their convenience. Retailers seek to enhance consumers' ability to quickly get the items they need, and to use stores for pickup of online purchases so customers don't have to wait for home delivery. This quest pushes in the direction

of smaller footprints, with multiple small locations rather than a few large ones. But at the same time, store-based retailers are striving to meet multiple shopping needs at once. This strategic direction points to *larger* store footprints, adding prepared foods or services in-house or sharing store space with other businesses (such as a Starbucks) that offer these things. Additionally, some retailers are trying to build in "experiential shopping," providing experiences that are not accessible online—even as online options now can include live video interaction and virtual showcasing (e.g., "trying on" cosmetics or clothing, or virtually placing furniture in an image of one's living room). The experiences can be entertaining, educational, or community-building. Retail stores might not seem like the most likely candidates for providing these kinds of experiences, but in some ways this is an extension of stores' eternal mission to provide good customer service.

These varied roles for stores point to the need for different kinds of stores for distinct purposes, as the choice between the advantages of small and dispersed stores vs. large and comprehensive stores illustrates. It is too early to say, in the long run, to what extent single companies will roll out multiple formats and to what extent different chains will specialize in different kinds of stores. Certainly Macy's, with the addition of its Story stores, with constantly changing themes that aim to attract and entertain customers, alongside more traditional department stores, and its addition of The Market stores-within-stores to invite shoppers to explore cool new gadgets, has opted for multiple formats (at least in big cities)—but press reviews for the potential of this strategy, and similar initiatives by other retailers, remain mixed,[23] and the pandemic's body blows to department stores may end these Macy's experiments (and possibly threaten the chain's continued existence in its current classic department store form).

When it comes to new, "sideways" revenue-generation schemes, retailers currently are more at a stage of experimentation with tactics (or pilot projects) than of launching new strategies. Such retailer experiments are definitely proliferating, in a spectrum from more technologically grounded initiatives to ones that have little to do with new technology. In a technology-centered example, Kroger's Sunrise division is developing new technologies (such as "smart shelves" and in-store camera systems) for use in its several thousand grocery stores, but also marketing them to other retailers. Brick-and-mortar merchants also are selling to consumer packaged goods (CPG) companies the data on customer interaction with the companies' products, and/or the opportunity to market their products via direct in-store communication with customers—offerings that require new kinds of data-gathering. Another option is to leverage the popularity of tech products by renting store space to tech companies: for instance, Walmart and Target have rented out space to Apple Stores; Best Buy essentially rents dedicated space to Apple, Samsung, and others for displays featuring their products alone. In a potentially risky variant of this, Kohl's gets paid by rival Amazon to host customer pickups and returns of Amazon purchases at its stores. Yet another option would pivot away from technology to monetize store-based experiences and services. One longstanding example is Sur la Table's popular and profitable cooking classes; other retailers are eyeing this kind of initiative. Yet other examples include facilitating the formation of customer "communities" of shared (shopping) interests.

Cutting costs is perhaps the biggest challenge for U.S. store-based retailers. Discounters like Walmart have pioneered lean staffing and inventory models, and other retailers have aggressively followed suit for decades now—often to the point of undermining customer service, and inventory quality and availability, as well as job quality. Thus when it comes to cost-cutting, the low-hanging fruit, and even quite a bit of higher-hanging fruit, has long since been picked. New technologies do offer some opportunities to further streamline inventory management and logistics in warehouses, distribution centers, and store back rooms, and to speed replenishment and online order fulfillment. These prospects trigger interest in technologies for shelf monitoring, inventory tracking, and in-store data collection. But these and other types of tech investments entail daunting up-front costs, with the eventual cost savings hard to predict. The result is often a sort of paralysis in the face of uncertainty, or "serial piloting" of different technologies in one or a few stores without taking the plunge to scale them up. A more constructive but inherently limited approach is simply to invest in technologies where there is a documented fast payback. A classic example is expanding self-checkout, which eliminates cashiers and puts the work on customers. Other "quick payback" examples include cash-counting machines (not very high tech, but effective in replacing human labor) and Ahold Delhaize's deployment of a self-propelled robot to scan for spills, which is reported to pay for itself in liability lawsuits averted.

To some extent, the objectives we have described here—maintain or grow market share, boost revenue, cut costs—are timeless ones for store-based retailers. But even before the COVID-19 crisis, the unsettling of their traditional strategies by the rise of e-commerce has recast and intensified these objectives, and the availability of new technological tools has opened the way to innovative strategies. So this time does seem to be a moment of self-reinvention for the brick-and-mortar retail field. The particular form of the objectives, and the particular set of strategic options perceived to be in play, set the context for retailers' decisions about adoption and implementation of new technologies.

Current Status and Recent Changes in Retail Employment

Rounding out our portrait of retail is a closer look at how the numbers and mix of retail jobs have changed in recent years. In this section, we start with a look at today's baseline for the retail workforce, drawing on several data sources. We then summarize the recent patterns of employment changes in retail employment by sector, occupation, gender, and race. The trends we describe are pre-coronavirus crisis: statistics take time to become available, and in any case the extraordinary shifts occasioned by the pandemic would distract from the longer-term trends that likely will continue in play regardless of the level of snapback that occurs once COVID-19 is under control.

A Baseline Employment Snapshot

Close to 16 million people worked in retail in the United States before COVID-19 struck. As Table 2.1 shows, by far the largest occupations in the sector are salespersons (4.1 million), cashiers (3 million), stockers (1.4 million), and first-line supervisors of these and similar groups of store-based workers (1.3 million). However, three other predominantly store-based occupations numbered more than 300,000: managers, health care workers (mainly based in pharmacies), and food preparation and serving workers. With the exception of managers, supervisors, and health care workers, these are relatively low-paid occupations. The average retail business establishment only employs 15 people (though retail encompasses both very large and very small stores, so the average is not particularly informative).

TABLE 2.1
Retail's Largest Store-Based Occupations,* 2019 (wages in 2019 dollars)

	Workers	% of Total Retail Workforce	Mean Hourly Wage	Median Hourly Wage
All Retail Jobs	15,822,400	100.0%	$16.77	$13.16
Store-based retail occupations				
Management	448,540**	2.8%	$46.94	$37.54
First-Line Supervisors of Store-Based Occupations (sales, stock clerks, etc.)	1,324,650	8.4%	$22.09	NA***
Health Care****	532,310	3.4%	$32.25	$19.18
Food Prep and Serving Workers, Net of Supervisors	510,660	3.3%	$12.55	NA
Cashiers	2,967,890	18.8%	$11.72	$11.40
Salespersons and Counter Clerks	4,063,650	25.7%	$14.14	NA
Stock Clerks and Order Fillers	1,402,230	8.9%	$13.15	$12.35
Total of Store-Based Occupations	11,247,330	71.1%	$16.40	NA

Source: U.S. Bureau of Labor Statistics, 2019 OES data, www.bls.gov/oes/current/naics2_44-45.htm#00-0000.

* Table includes occupations with more than 300,000 workers, plus supervisors of store-based occupations and all managers.

** Managers are not broken down by whom they supervise, so this is the total number of managers in retail (which includes nonstore managers, such as those at warehouse facilities).

*** "NA" means median wage is not available for this category.

**** Almost all pharmacists and pharmacy aides.

Recent Employment Changes by the Numbers

Available quantitative data from the Census and the Bureau of Labor Statistics (BLS) offer two windows on recent changes in employment. One is data series on the diffusion of e-commerce; the other is a set of trends in employment data tracked in varying ways by BLS and Census surveys.

How quickly is e-commerce growing? As Table 2.2 shows, the Census Bureau reports three measures of e-commerce sales. One is e-commerce sales by retailers that mainly sell through digital channels, which we call "pure" e-commerce sales. The second is e-commerce sales by store-based retailers. Third, for some topics the Census Bureau only provides data on e-commerce in combination with mail order (catalog) retailing. Starting the clock in 2011 when the recovery from the Great Recession began in earnest and, again, taking stock before the coronavirus disruptions, pure e-commerce indeed already was rapidly growing its share of total retail sales, surging from just over 4% in 2011 to well over 9% in 2020. E-commerce sales by *store-based* retailers expanded more modestly, just reaching 1.4% in 2017. Breaking these sales down by subsector reveals very distinct trajectories. For instance, clothing sales led the way, with e-commerce accounting for nearly 4% of store-based retailers' sales in 2017 (triple the 2011 percentage), whereas online sales by store-based food and beverage merchants amounted to only 0.7% of their total receipts (but this was six times the percentage as of 2011).

It bears emphasizing that though e-commerce's growth curve is steep, digital sales still only constitute a small percentage of total retail sales. The coronavirus experience has ratcheted up e-commerce in the short run,[24] and in the long run certainly will accelerate the shift to online shopping—in part because more people have tried it for a wider range of goods, in part because cautious consumers will continue to avoid crowded stores. However, we are skeptical of projections that e-commerce growth will double or more.[25] To a large extent, the currently available low-hanging fruit already has been harvested by e-tailers, and new online buyers have been exposed to the drawbacks as well as the advantages of e-commerce. In our estimation, future large-scale expansion is likely to be driven by some combination of generational change and/or technology that dramatically reduces the cost of last-mile delivery—neither of which is on the immediate horizon.

TABLE 2.2
E-commerce Sales as a Percent of Total Retail Sales, 2011–2020

	2011	2017	February 2020
Overall Growth of E-commerce			
Pure E-commerce* as % of Total Retail Sales	4.1%	7.9%	9.6%
Pure E-commerce and E-commerce by Store-Based Retailers as % of Total Retail Sales	4.9%	9.1%	
Selected Merchandise Categories' Share of Pure E-commerce and Mail Order			
Food, Beer, Wine	2.4%	3.2%	NA
Clothing	16.7%	16.8%	NA
Furniture, Furnishings, Appliances, Electronics	21.2%	23.9%	NA
E-commerce by Store-Based Retailers as % of Their Sales, by Subsector			
Food and Beverage	0.1%	0.7%	NA
Clothing	1.2%	3.8%	NA
General Merchandise	0.0%	0.1%	NA
Total Store-Based Retail	0.8%	1.4%	NA

Sources: U.S. Census Bureau, Annual Retail Trade Survey and Advance Monthly Retail Trade and Food Services Survey. All numbers are the most recent available pre-COVID-19.

*"Pure e-commerce" refers to sales by retailers that primarily sell via e-commerce, sometimes called "pure play" e-commerce. It excludes catalog retailers, which are sometimes combined with e-commerce.

For another window on recent change in the retail sector (again, pre-coronavirus), we undertake a granular examination of employment trends. A good place to start is with the Bureau of Labor Statistics' Current Employment Statistics (CES), based on employer reports of payroll, generally considered to provide the best estimates of employment. Figure 2.1 shows employment's rate of growth for e-commerce far outstripping the job growth rate in the major store-based sectors. This data source does not allow us to break out employment due to "pure" e-commerce, only for e-commerce and catalog sales combined. Thus, it will *understate* employment growth in pure e-commerce. Sales data, which do separate out pure e-commerce from catalog sales, indicate a much steeper growth curve than shown in Figure 2.1. E-commerce sales more than doubled from 2011–17, and accounted for 89% of the sales growth in e-commerce and catalog sales combined, expanding from 57% to 72% of the combined category (not shown).

Figures 2.1 and 2.2 (Figure 2.2 just shows major retail sectors *without* e-commerce to make the trends for these sectors more visible) tell a somber story for store-based employment. Employment in retail as a whole and the grocery subsector showed respectable growth for the first several years after 2011, but both plateaued in 2016 and started to drop slightly. Clothing store employee counts slumped after only one year of growth, and general merchandise employment showed delayed, then anemic growth, followed by decline. The overall trend in general merchandise combines two disparate stories (not shown): total general merchandise employment dropped by more than 40,000 jobs, but this netted out a 439,000 job *loss* in department store employment, a 233,000 job *gain* in warehouse store and supercenter jobs, and 164,000 added jobs in "Other general merchandise," a category that includes the booming dollar store sector. Compared with the employment peak before the 2007–09 recession, employment in retail as a whole and grocery grew significantly, jobs in general merchandise slightly exceeded the earlier peak, and apparel retail jobs in 2019 stood at a discouraging 200,000 jobs fewer than their maximum in 2007 (not shown).

FIGURE 2.1
Change in Employment by Retail Subsector 2011–19 (2011 = 100)

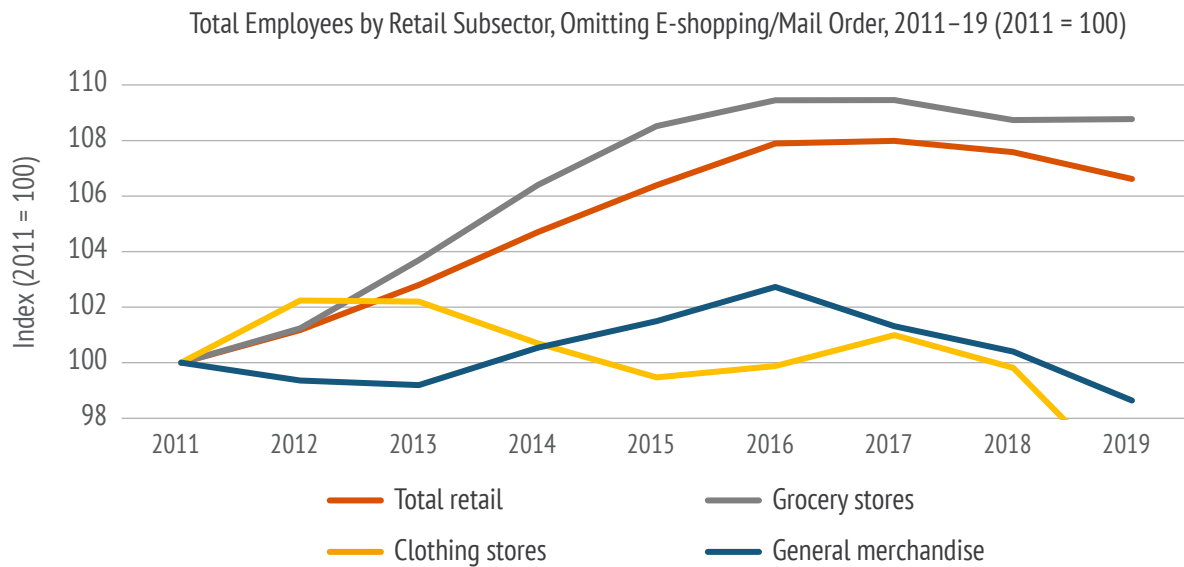Source: U.S. Bureau of Labor Statistics, Current Employment Statistics.

Total Employees by Retail Subsector 2011–19 (2011 = 100)
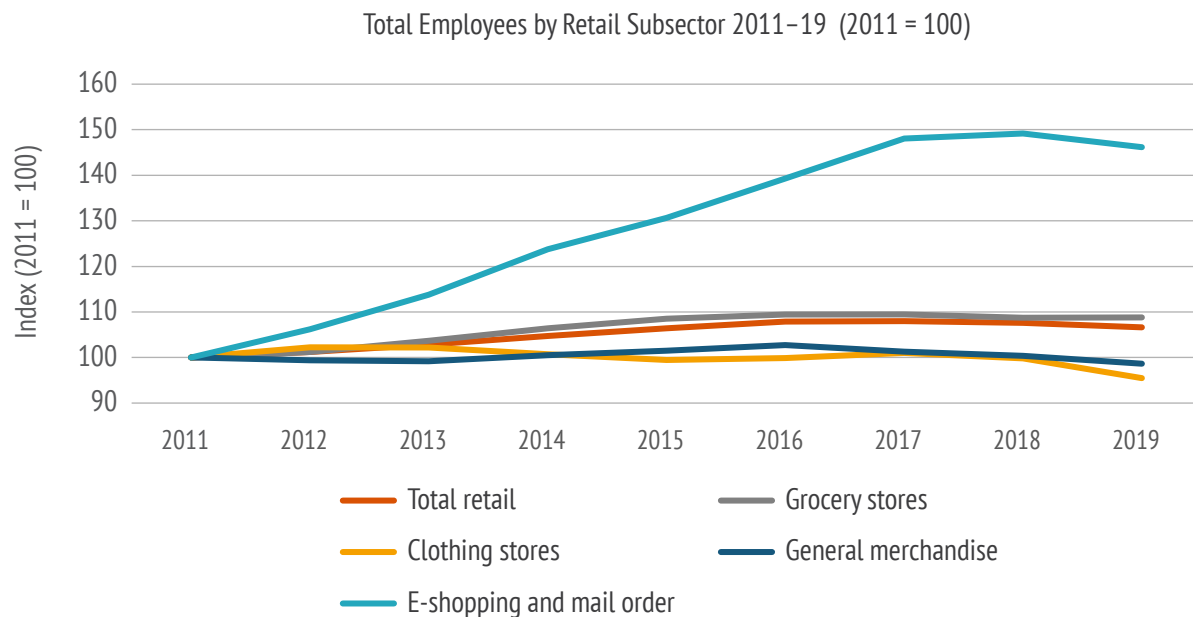
Note: E-commerce shown here not limited to "pure" e-commerce; it includes mail order (catalog) sales.

It is important to remind ourselves that stagnant or declining employment numbers in some retail subsectors are not due to e-commerce alone. Inroads by discounters, whether big boxes or dollar stores, and productivity growth (some linked to new technologies, some to old-fashioned speedup) also have contributed significantly to these trends. Sales per employee (a crude productivity measure) increased by amounts ranging from 8% in general merchandise stores to 11% in clothing stores.[26]

Moreover, the coronavirus adding to all these stresses threatens to push a significant number of department stores and apparel chains into bankruptcy. Analysts with the Cowen financial services firm put department stores' available liquidity at five to eight months in mid-April 2020,[27] and around the same time Mark Cohen, a Columbia University retail expert, predicted that "there are very few who are likely to survive."[28]

FIGURE 2.2

Change in Employment by Retail Subsector, Omitting E-shopping/Mail Order, 2011–19 (2011 = 100)

Total Employees by Retail Subsector, Omitting E-shopping/Mail Order, 2011–19 (2011 = 100)

Source: U.S. Bureau of Labor Statistics, Current Employment Statistics.

TABLE 2.3

Employment Change for Specific Occupations Within Selected Retail Subsectors, 2011–19

	Food and Beverage Stores*		Clothing Stores		General Merchandise Stores	
	Employment Change, 2011–19	2019 Index, 2011 = 100	Employment Change, 2011–19	2019 Index, 2011 = 100	Employment Change, 2011–19	2019 Index, 2011 = 100
Management	2930	106.5	13340	195.4	-2240	94.7
First-Line Supervisors of Store-Based Occupations (Sales, Stock Clerks, etc.)	56150	129.1	-5770	95.1	11700	104.9
Cashiers	-85750	91.0	17390	124.4	202680	136.1
Salespersons and Counter Clerks	-2560	98.1	-75930	90.2	-17430	98.0
Stock Clerks and Order Fillers	107140	124.5	-30100	53.2	16750	103.2
Total of These Categories	77910	104.4	-81070	92.2	211460	109.5

Source: U.S. Bureau of Labor Statistics, Occupational Employment Statistics, 2011 and 2018. Note: Changes shown in absolute numbers; index is based on setting 2011 employment levels to 100.

* Grocery stores were not available separately in 2011.

Dissecting occupational trends in food, clothing, and general merchandise stores sheds more light on these recent dynamics (Table 2.3). The story for each of these subsectors is quite distinct.

- *Grocery stores: more stock clerks, fewer cashiers.* Grocery store employment in the five largest job categories in 2019 was modestly higher than in 2011. The headcount increase of almost 80,000 primarily was driven by the addition of more than 100,000 stock clerks, who along with managers and supervisors offset a loss of 80,000 cashiers. These numbers suggest that self-scan technology has taken a toll on cashiers.

- *Clothing stores: fewer salespersons and stockers, many more managers.* Clothing stores' net loss of 81,000 jobs across the five top job categories was propelled by drops of 76,000 salespersons and 30,000 stockers. Remarkably, at the same time the number of managers grew by more than 13,000, a 95% increase from their 2011 ranks. This reflects continuing growth in the number of stores, but with much thinner staffing on average.

- *General merchandise: more cashiers and salespersons, fewer managers.* Net employment expansion was paced by more than 200,000 additional cashiers (though with a small

drop in salespersons), while the ranks of managers shrank. This marks the inverse of the clothing store trend: fewer, larger (read big box) stores with many more front-line workers per manager. General merchandise includes large discounters and warehouse stores that increasingly sell grocery items and have grown significantly, possibly accounting for the contrasts in cashier employment trends with the grocery subsector.

Finally, census data allow us to explore what employment shifts mean in gender and race terms. The Census Bureau's American Community Survey (ACS) data draw on a different survey; in order to build sample sizes adequate for fine-grained analysis, we construct our ACS sample from five years of data (2013–17), so ACS data are not completely comparable with the other data we cite. The ACS data show that the gender and racial composition of employment differs significantly across retail subsectors (Table 2.4). General merchandise's workforce includes far higher percentages of women and people of color than retail as a whole, grocery, or e-commerce plus catalog sales, though there also is notable over-representation of people of color in grocery stores over the period as well. E-commerce plus catalog, at the other extreme, tilts male, and has by far the lowest share of people of color.

  Given that general merchandise has far more diverse employment than other subsectors of retail, it is concerning that it has grown far more slowly than retail as a whole since 2011 (Figure 2.2, above). We did not conduct ACS analysis of clothing store employment, but according to the BLS's Current Employment Statistics, women make up 77% of employment in that subsector, so employment stagnation and decline in clothing stores is surely hitting women hard as well. On the other hand, e-commerce, as of now the *least* diverse of the subsectors, has been enjoying a boom in growth (Figure 2.1, above).

TABLE 2.4

Women and People of Color as Percent of Employment for Retail Subsectors

	% Women	% People of Color
All Industries	47.2%	35.9%
All Retail	49.0%	35.7%
Grocery	48.8%	37.8%
General Merchandise	59.7%	42.5%
E-shopping and Mail Order	47.9%	26.5%

Source: U.S. Census Bureau, American Community Survey, IPUMS data, 2013–17 combined sample.

Summarizing these varied statistics, a clear story emerges. E-commerce sales and employment are growing rapidly in percentage terms, but still represent small minorities of retail sales and jobs—and appear likely to retain this minority status for a considerable time to come. There is no overall "retail apocalypse" in terms of store-based sales and employment. However, a slowdown in job growth has hit retail overall as well as grocery in particular in the last few years. And there are "mini-apocalypses," or at least radical slowdowns in growth in clothing store and general merchandise employment[29]—in the latter case, relatively small overall employment losses are masking a large-scale shift away from department stores and toward big boxes. General merchandise is of particular concern, since it employs more than twice as many people as clothing stores.

Job losses, both absolute and relative, have been concentrated in a small number of job categories. In general merchandise, we find (small) job losses among managers. In the grocery sector, cashiers take the big hit. Employment losses are concentrated within retail subsectors (general merchandise, in particular department stores, and clothing) and toward occupations that tilt strongly toward being women-dominated. The struggles of general merchandise also have potential racial implications, because employment in this sector is far more racially diverse than in other parts of retail. Overall, women—in clothing, general merchandise, and grocery— are the big losers. Muddying the waters, some of the areas where jobs are created—third-party drivers for delivery, in particular—are counted in sectors other than retail, and other new jobs that still fall within retail—order pickers—are being lumped into existing occupations such as stockers.

Three parts of this complex pattern line up with accounts of the deployment of digital technologies. The first is the rapid advance of e-commerce, both in its pure-play form and via store-based retailers' limited but growing adoption of digital sales platforms (including click-and-collect modes). The second is the counterpart to e-commerce's growth, stagnating or falling employment in clothing and department stores (though part of that shrinkage is due to big box discounters seizing market share). A final trend that points to technological change is the decline in the number of grocery store cashiers, which seems likely linked to the renewed deployment of self-scan technology to cut costs (a trend likely to be fueled by pandemic-inspired demand for "contactless" checkout).

SECTION THREE:
Technology Adoption in Retail: How We Think of Potential Futures

Adoption of any technology is not an automatic consequence of its availability. It is tempting to expect that if a technology promises to increase efficiency in a retail setting, it will be implemented, and that its impacts on the workforce can be forecasted readily based on engineering parameters. But as technology researchers have been saying for decades, it's a lot more complicated than that. Organizations make decisions as social entities, not as efficiency machines. Therefore, technology availability never translates automatically into continuous, quick adoption and job outcomes. Industry structure, the internal social organization of the firms deciding on the technology, and external social ties and influences matter. This is especially true in an environment of uncertainty.

In the current rapidly changing environment, the value of investments in new technology in retail is inevitably uncertain. What will the actual efficiency payoff to an app, a device, a system be? What is the risk that a retailer will be left with huge sunk costs because a technology is rendered obsolete in a few years, or even less? What will be the trajectory of consumer demand in the aftermath of the pandemic? Without good answers to these questions, caution may seem like the best policy.

One also could argue that if organizations make less profitable decisions, they will be displaced via market competition and "survival of the fittest." If retailers are slow to make decisions, Amazon or other speedy innovators simply will push them out of the way. However, these competitive effects often are muffled, delayed, or blocked because *markets* themselves are socially constructed. The list of social factors that matter is long, and includes:

- Consumer preferences: how fast they change, how readily they can be reshaped, and the acceptance rate of new technologies.

- Investor and lender beliefs and preferences.

- Supplier configurations: digital technology providers and product suppliers (especially the big consumer packaged goods producers, which also are seeking direct-to-consumer sales and communication built on the new technologies).

- Rules of competition: how these are changing and how quickly, particularly those regulating consumer and worker protection, zoning, and antitrust.

- Union power over workplace and labor market rules.

All of these complexities mean that to assess the workplace impact of new digital technologies requires grasping the retail industry's environment and considering retail companies as social organizations.

The Retail Context for Technology Adoption

The trajectory of technology adoption and implementation will differ across specific technologies, by retail subsector, by market segment, and by company. The pace and extent of adoption also will vary based on shifts in overall economic, social, and policy environments. The accumulation of this set of uneven effects will, in turn, determine the overall deployment of new technologies in retail stores and their qualitative and quantitative impacts on jobs and consequences for the workforce.

Macroeconomic factors matter as well. The state of the business cycle and the tightness of the labor market will affect the rate of new technology adoption. As we write in 2020, until very recently the labor shortage from the long period of expansion fueled, and abundant consumer spending facilitated, investment in retail technologies, particularly automation. The renewed adoption of self-checkout machines (available for two decades) has been such a manifestation.

The COVID-19 restrictions and the recession they have triggered are likely to have a number of effects on retail's technology trajectory. Store adaptation to social distancing policies may speed both self-checkout and cashier-less checkout options in supermarkets in particular, as well as other forms of automation of some backroom functions. Retailwide, the growth of online sales will speed up the alterations in store activities we describe in the body of this report. However, the recession-driven drop in consumer demand is likely to shrink the resources dedicated to technology investments as retailers emerge from the crisis. The recession's expected downward pressures on wage increases also may render labor costs low enough, and some forms of automation correspondingly less attractive, thus slowing down the adoption of some labor-saving technologies.

Organizational Context

The retail industry as a whole does not have a strong history of technology deployment. It generally has been a laggard in technology investment inside stores (though tech investments were significant in logistics). Within chains, there is resistance to rapid technological change in stores; it is all the stronger when an organization is very large. As RetailNext CEO Alexei Agratchev put it, for established retailers with "*say…1,000, 3,000 stores, lots of store managers and regional managers have been there 10 years, they're used to a way [of] doing things, and it's hard to introduce a new way of doing things*." One common result is that technology has gotten installed, but not necessarily used. Comments such as *"the [new] tablets sit under the desks"* cropped up in our interviews, particularly among consultants with longstanding experience. An important part of this context is that stores—particularly grocery and general merchandise stores—already have experienced ongoing downward pressures on the labor hour budget for decades. Given this squeeze, operations managers may resist contemplating new practices and experimentation. Press accounts highlight tales of pilots, experiments, and implementation in a few stores, but most retailers have not yet rolled out significant tech-enabled changes across most of their stores, with the exception of dominant chains.

Available Digital Technologies and Absorptive Capacity

Characteristics of available digital technologies play a role independent of retail per se. Vendors pitch a broad array of tech-driven solutions for related functions in stores, some of which are appealing, either for labor saving or for developing a new avenue for business growth. But quite a number of these solutions are experimental; they are likely to evolve or get supplanted.

It is our sense that in the average retail chain, the growing technological capacities of equipment, software, and AI applications likely are outpacing strategy development. As store-based retail operations aim to refashion themselves to operate "omnichannel," identify their leading edge, and concurrently deploy some among the vast array of technologies offered by vendors, most are still ill-equipped and under-resourced to navigate these transformations. For example, the vastly expanded data collection capability that several of the technologies discussed in the next section provide creates opportunities but also challenges for store retail. In a poignant moment at a 2019 retail trade show, the large majority of attendees at a packed session (77%), answering a survey question about how well they understand their shoppers at a local level, chose either "No insights yet, but we're trying" (27%), "Have insights, but no one has stitched them together" (37%), or "Have insights but don't know how to apply them" (13%). Retailers with limited internal analytics capacities face difficult choices. They can rely on vendors to provide analytical reports, possibly including new key performance indicators (KPIs), but run the risk of losing information on their customer base by depending on an intermediary to make sense of the data. They may seek to build in-house analytics units, but then must compete for specialists with higher-paying industries.

Organizational Resource Constraints

Lastly, basic resource constraints complicate adoption decisions and likely slow the speed of adoption, even if it is desirable for it to be swift. Resources for technology investment are limited except in the largest retailers. Chains experiencing the largest threats to their market share have the greatest incentive to seek to increase investment, but also the thinnest available resources. Additionally, chief innovation/information officers often lack a sufficient budget for significant investments., but they are expected to deliver results quickly and rated on doing so. The profession appears to have short tenure—"the norm is three years" remarked consultant Liz Bacelar of Together Group—because of these pressures. Retailers must choose between drawing in technology officers from other industries with longer histories of technology adoption, or promoting true "home-grown" tech experts from within their ranks (limiting the pool to people who aren't as immersed in the startup world), and in all cases run the risk of losing them to more financially rewarding opportunities.

How to Think of Technologies' Potential Labor Impacts

When it does occur, technological change has been shown to have a mixture of workforce effects. "Job contents effects" result when technology implementation alters workers' mix of tasks and the nature of work. "Substitution effects" occur when machines make it possible to perform a job better and less expensively with fewer people. These can result in new technologies being implemented to replace workers, or at least some of their tasks, with machines and algorithms. "Scale effects" result when technology makes goods and services cheaper so consumers buy more of them. Scale effects offset substitution effects to varying degrees, sometimes even swamping substitution effects, leading to increasing employment in a sector.

All of these effects, as well as second-order effects like impacts on wages, depend not just on *what* technologies are deployed, but *how* they are deployed—a choice companies must make. The same technology can be used in ways that improve jobs or degrade them (for example, lighten the load or increase it), that eliminate jobs or create the need for added hiring. The actual impacts of technological change in retail will be affected by the specifics of each retail context. Though public attention has focused on quantitative substitution effects, changes in job contents potentially are much larger, and definitely more contingent on strategic choices by companies. And though the notion of scale effects heading off job losses is appealing, scale effects typically are going to be small. Consumers are not likely to purchase a lot more goods in response to small changes in retailing costs. Finally, rather than new technologies invariably

being deployed to shift an existing pool of tasks between labor and capital, many technology-driven changes, including the most dramatic changes to date, involve *new* tasks providing types of services not previously sold on the market (or at least not at current scales). This includes order-picking and delivery or for pickup (click and collect) and "experiential retailing"—creating in-store experiences that consumers value (e.g., cooking classes, customized fashion consulting). Other technology-driven changes involve shifting tasks onto consumers themselves.

Finally, most retailers are relatively early in the process of implementing digital technologies. That makes ultimate and even middle-range outcomes even more uncertain, and our predictions necessarily speculative and pointing to multiple possible directions of evolution.

SECTION FOUR:
Impacts of Technology Adoption on Store Operations and Labor

This report's approach is not to organize our analysis around particular technologies being implemented in stores, but rather to break down the activities in stores into "bundles" of major functions. We explore four core store-based functional bundles: inventory management (which particularly involves stockers), checkout (primarily involving cashiers), e-commerce (entailing jobs in e-commerce fulfillment), and customer interaction (particularly touching on salespeople). A final, cross-cutting bundle is worker management, which extends across all other functions, and impacts not just workers being overseen but also supervisors and managers. For each bundle, there are multiple, conflicting possible implications for the workforce: job-eliminating automation or changes in the mix of activities that make up a job; changes that are supportive and empowering for workers, or shift toward more coercive, highly controlled work.

All the emerging change in store-based functions is undergirded by data collection and analysis capabilities that increasingly drive change in retail functions' execution. We call attention to these processes to start with because the increased data-gathering about consumers (and, we will see, also about workers) has been facilitated by many of the new technologies. It is considered crucial to the transformation—some would say survival—of store-based retail, and is targeted for significant investment as a result. For years, retailers have collected information about inventories (using tracking systems), shopping patterns (tapping point-of-sale (POS) systems), and their workers (human resources and scheduling records). However, all the information needed for inventory management or planning may not have been gathered, nor consistently analyzed and utilized. This time, it is different. Data analysis has become a more compelling undertaking because technological tools and capabilities for data analysis are more readily available, faster, and considerably more affordable. For example, until recent improvements in computer vision, even getting an accurate picture of store traffic was a major hurdle, according to Alexei Agratchev of RetailNext, a leading tech entrepreneur.

Ever more detailed data analysis now is slated to be the primary tool for anticipating *and shaping* customer demand—tracking individual customers' preferences and identifying large-scale shopping patterns that elevate or depress demand. Data analytics-driven systems can generate recommendations for customers, and understand and answer their straightforward questions; they also can recommend retailer staffing levels, merchandise arrangements, and promotions. As we discuss below, analytics are also at the core of the effective implementation of "seamless" shopping—the integration of social media advertising and customer engagement, online and in-store shopping, all coordinated with inventory management and such follow-on functions as customer service. Data analysis can help control theft/pilfering. (Computer vision, for example, can identify areas of stores subject to frequent pilfering, or recognize individuals known to shoplift in previous instances.)

Underlying the ambition to implement "seamless" shopping, and to anticipate and shape demand, are the promises of machine learning and other features of artificial intelligence (AI) for handling numeric, text, and photo/video data (video recognition and advanced analytics). AI implementation is perceived as "helping drive sales, manage inventory, anticipate demand, and connect to the customer."[30] Importantly, going forward, store-based retailers will face significant choices about the handling of sales and customer data, about whether to hand it off for systematic analysis by specialized outside providers or build in-house capabilities for doing so. The former path may provide ready-made standardized reporting, while risking loss of control over such data (as in some third-party vendors' experience with the Amazon Marketplace). The latter path provides control of the information, but requires significant investments.

Inventory Management: Forecasting, Monitoring, and Moving Stock

Retailers' Change Goals in Inventory Management

The simplest, most frequent, and longstanding goal of retailers' management of their inventory is to reduce "shrink," that is, reduce the number of items lost through pilfering by customers or workers, and limit waste, of food items in particular. This goal has received renewed attention both because of the ongoing pressure to reduce costs (if only to free up resources for other investments), and because the availability and affordability of useful technologies has raised the possibility of greater savings.

Also an increasingly important and desirable goal is to more accurately forecast the types and volume of goods demanded. Ideally, such forecasting can provide finer adjustments for geography and for the demographic profile of potential customers (for each store), and aid in

planning special events (for example, introducing a new product). More detailed forecasting may be used to further segment the customer base incomewise, and boost profits through differentiated pricing.

Having the "right" inventory in stores and accurately knowing the merchandise's location within the store are not new aspirations for retailers. But again, the feasible level of detail, the ability to update information frequently, and to integrate sources of information with communication from central offices to stores now have increased markedly. Increasingly, it is seen as not just desirable but essential to have the right inventory on the shelf where it is needed; stock replenishment can be easier/faster and more efficient, thus avoiding missed sales opportunities.

Inventory management tools support stores' function as e-commerce fulfillment centers, whether for delivery or click and collect. In the case of grocery stores, the store is the *de facto* warehouse for fulfilling most online sales, including those brokered by digital platforms (e.g., Instacart, Shipt). Mapping the patterns of online shopping—which may be different from in-person shopping—is crucial for successfully supplying online grocery orders without generating waste due to an excess of perishable inventory. For general merchandise, the same requirements apply, but the ability to store items longer term makes the requirements less stringent.

In short, the overall goal of inventory management upgrading is to increase forecasting ability, to have a more accurate real-time picture of inventory in the store and how levels are changing, and to put these two sides together in order to reduce inventory costs while avoiding out-of-stock occurences that generate customer defections.

Key Innovations in Inventory Management

1.   Tracking goods movement, down to stock-keeping unit (SKU) level and monitoring gaps.

Tracking the movement of in-store goods, preferably in as close to real time as possible, permits the speedy identification of gaps on shelves as well as the ongoing updating of store floor inventory. Researcher and consultant Tom Moore (interviewed when at Zebra Technologies) noted that in the average store, management only knows the actual location of 55% to 60% of their inventory—a shortcoming made even more acute by e-commerce systems that assume any item in stock can be located for picking. Scott Clarke, now with Publicis Sapient, stated that at a particular luxury apparel retailer, staff spends half their time searching for items. However, new technologies promise to address this problem, and large retailers, including Walmart, Kroger, and Ahold Delhaize, are actively developing them.[31] There are multiple ways to track which goods are on shelves, and which move, when, and where. Three main types of sensors are used:

cameras, weight sensors on shelves (scales—used in combination with other sensors), and radio frequency identification (RFID) readers (in combination with RFID labels on the goods).

There is not much variation in the manner of implementation of scales and RFID readers. Regarding cameras, tech companies and retailers are exploring at least three forms of implementation: overhead cameras, shelf-mounted cameras (often as part of a "smart shelves" suite of shelf-mounted tools), and cameras located in roving robots (occasionally drones) that scan the shelves. In all cases, the cameras in question go beyond traditional surveillance cameras, with higher resolution lenses as well as computer vision software analyzing the images received. There is some debate over whether the high degree of resolution in leading camera solutions amounts to "overkill" for inventory management, and is actually designed to eventually take on more demanding functions, particularly tracking shoppers in the store.

All of these technologies can serve multiple purposes. They can determine the amount of stock on hand, spot misplaced merchandise, detect when an item has been removed and, in the case of RFID sensors and cameras, follow the item as it moves through and out of the store—tracking purchases or detecting theft. Cameras and scales at checkout can verify that a customer at self-checkout or a cashier at a check stand are scanning all items ("missed scan" technology as implemented at Walmart and Kroger).

More sophisticated and expensive forms of video data analysis enable the retailer to implement goals beyond simple goods tracking: analyzing customers' expressions and actions, and possibly customer identification for other purposes (e.g., customizing offers), and even more thorough surveillance for theft. Downward-pointing cameras on ambulatory robots can scan for spills, and indeed that is the initial application for some of these robots (such as the "Marty" robot rolled out in some Ahold-owned chain stores) as they build up the capacity to interpret shelf scans. Bossa Nova's robots, being put into use in hundreds of Walmart stores, instead are being applied immediately to inventory scanning, and the company has announced a new model with a downward-pointing camera that can be used to check produce inventory levels.[32]

Regarding backroom inventory, automation of the unloading function can replace human labor and also facilitate automated scanning of incoming store inventory. Walmart has been rolling out across some stores the implementation of automated box unloaders (already slated for more than one-third of its stores in a recent report[33]), which enables automated tracking of some categories of goods. However, we heard some reports from Walmart workers that the machines have not always proven to be up to the task and are sitting out of order in some stores' back rooms.

2.   Digitally changing prices.

Inventory management includes marking prices, and then keeping those prices up to date and implementing price changes in line with discount campaigns or other goals. Pricing—placing/updating tags on shelves—has been a frequent, labor intensive task. Digital shelf tags,[34] which centralize and automate price changes, have been uncommon in the United States but have a history of implementation in Western Europe; for example, the company Pricer's products.[35] Displays range from a simple black-and-white format conveying basic price information to color displays that can be adjusted to draw attention to sales items. The investment in automated price labeling, particularly in colors, is significant—amounting to hundreds of thousands of dollars per store—and the deployment in a large store may take a few years. Sectors and retailers seeking dynamic pricing are likely to consider centralized electronic pricing, yet also are likely to find it costly due to the large number of SKUs. With few exceptions, products have a limited color range (for example, MagaTag, PriceDropper, and SCS have labels that can only show black, yellow, and red), whereas the appeal of digital labeling would be to use the labels to attract attention to frequently changing sales campaigns; for those purposes the attractiveness of the label matters. Despite these issues, Kohl's, Kroger, and Target have started using digital labels.

3.   Micro-fulfillment centers with highly automated picking.

Micro-fulfillment centers involve a new way of handling stock, inserting a small e-commerce warehouse into the store. Although inventory is central to what they do, we include them in our discussion on e-commerce.

4.   Other tools.

In addition to all these potentially far-reaching technologies, retailers are investing in some low-tech solutions to "automate" stocking tasks. One such simple fix being used by grocery and pharmacy chains is to install "self-facing" display shelves that harness gravity and forward-tilting shelves, or that add a spring-loaded pusher behind the merchandise to keep uniformly sized items (boxes, cans, and other containers) lined up along the front of a shelf.[36] Eventually, some technology companies argue, we may see robots used to place stock on shelves. But the arrangement of store shelves, and especially of items on store shelves, is highly idiosyncratic, not least because customers touch, pick up, and scatter the merchandise. In this loosely controlled environment, robotic stocking remains a remote prospect.

Table 4.1 summarizes these trends.

TABLE 4.1

Inventory Management: Innovations and Underlying Technologies

Key Innovations	Technology/ies Involved
Improving predictive models to guide inventory inflow and optimal locations for goods within the store	• Large-scale data collection, machine learning and advanced data analytics, A-B testing
Faster tracking of incoming inventory	• Robots that unload pallets of goods • Automated scanning of product code (e.g., bar code), for example on a conveyor
Tracking goods movement, down to SKU level; monitoring gaps. At its utmost: fully automated inventory tracking. Triggering increased purchases of goods (e.g., via discounts, matching other retailers' prices) Maintaining quality and freshness of perishable goods	• Cameras with computer vision (mounted on shelves, suspended above, on roaming robots or drones) • RFID tags • Weight sensors on shelves • Automated digital price changes • Smart equipment: e.g., freezers with a digital communications alert system (cell phone message to staff)
Using stores as fulfillment centers: "warerooms" (narrow range of SKUs) for fast picking Using micro-fulfillment centers with highly automated picking (supplemented by such human activities as bagging)	• Hand-held scanners or telephone apps used by paid shoppers (often the same app as that deployed for in-store customers preparing for automated checkout) • Computer-guided picking equipment and conveyors as in offsite automated warehouses
Enhancing theft monitoring and tracking	• Again, computer vision and RFID to track suspicious movements of customers, workers, and goods

Speed of Adoption of Inventory Management Innovations

Expense is a barrier to adoption of some of these innovations. Cameras embedded in smart shelves are expensive, particularly the versions that provide accurate information about subcategories of goods, and accurately identify which product is out of stock on the shelf (and track overall store inventory). Other cameras are less expensive, but achieving adequate image resolution and computer vision capabilities still is costly, and more distant cameras may not be

able to provide the same level of detail on an item. RFID tracking implementation depends on significant investment from suppliers in printing RFID labels onto goods; RFID printing prices are falling but remain an obstacle to widespread adoption of the practice.

Roving shelf-scanning robots involve the smallest initial investment. According to a Badger Technologies engineer, in 2019 a single robot cost from $27,000 to $45,000 depending on level of functionality, plus a $12,000-per-year maintenance contract; such a machine can scan all the aisles of a typical supermarket twice a day. Competitor Bossa Nova's scanning robots (which include 15 cameras) may cost three to four times as much. In early 2020, Walmart announced it planned to deploy 1,000 Bossa Nova robots by the end of the summer.[37] Though they may be cheaper than shelf-based cameras, roving robots may not provide the same kind of ongoing real-time monitoring of stock movement and multiple applications as the other product tracking technologies. To our knowledge (as of mid-2020), no company has publicly reported how much actual difference either kind of system has made in averting stock outages.[38] Despite all the expenses, more accurate inventory management is a key priority for retailers who see it as essential for maintaining competitive position.

A major obstacle to the widespread adoption of digital labeling in the near future in the United States is that implementing full-color price labels is very expensive, and U.S. retailers rely heavily on full-color labels to advertise promotions. Expectations are that, until color displays are more readily available and affordable, retailer take-up is likely to be slow.

Likely Labor Impacts of Inventory Management Innovations

Labor and job contents impacts from technologies deployed for product tracking likely will be mixed. On the one hand, clerks' task of scanning for out-of-stocks will be reduced. Looking for gaps on shelves is difficult, repetitive, and unrewarding. Because out-of-stock occurrences result in sales losses and sometimes customer defections, the oversight and even the task itself often devolve to mid-level managers. Thus, automating the main tasks involved in stock monitoring will reduce the time spent on these activities by floor workers and their immediate supervisors. On the other hand, automated monitoring is likely to prompt more frequent restocking, tying up worker time in repeated trips to replenish stock. More generally, store workers that receive information "just in time" will have increased responsibility for replenishment, even if their main responsibility lies elsewhere. Making effective use of automated stock monitoring yields improved stock management (reduced shrink, more sales), but may not deliver reductions in labor hours.

Using roving robots typically engenders the need for maintenance and concomitant periodic interaction with store workers for training/programming adjustments of the robot's performance. Few new jobs are likely to result from these activities. Early reports from the field indicate that robot maintenance is mostly delegated to the technology provider rather than handled by training store workers.

Product tracking technologies also have implications for surveillance of workers. As noted, computer vision may deliver detailed analysis of facial features and customer behavior. It likewise may collect video information on workers. Missed scan technology that has been introduced in recent years directly monitors staffed checkouts. It thus entails enhanced worker surveillance, opening possibilities for monitoring other worker behaviors unrelated to this initial goal.

When fully implemented, digital pricing removes one task of stock clerks. In some large supermarkets, changing prices is a dedicated job. Reportedly this is a tedious, detail-focused job; one retailer reported that clerks were relieved to no longer have to carry out this task. Nevertheless, broad adoption of centralized automated labeling would eliminate labor hours in stores. As we noted above, however, widespread take-up is not likely to happen soon, particularly due to the cost obstacles.

Ironically, low-tech, self-facing shelf devices actually may have the largest impacts on headcount. Rearranging goods on shelves might be more time-consuming than checking for gaps or changing prices (currently an infrequent activity outside of grocery stores), so to the extent these technologies can displace that activity, they will take a bite out of total staffing hours. Even so, the time involved remains small relative to stockers' main activity, placing goods on the shelves.

Table 4.2, below, gives a snapshot of these patterns.

TABLE 4.2
Likely Labor Impacts of Inventory Management Changes

Replacing Labor	Change in Task Mix

• Loading/unloading dock workers partly replaced by automation
 	
• Small fraction of stock clerks' tasks automated
 	
• "Self-facing" shelves replace stocker labor
	• Increase in:
	  » Interaction with and some maintenance of robots
	  » Tending micro-fulfillment centers (replenishing stock)
	  » Systems monitoring store inventory in "real time" → increased responsibility for stockers to quickly deal with out-of-stock items or other problems
	
	• Decrease in:
	  » Manual receiving of goods
	  » Checking shelves and displays for gaps or out-of-place items

Checkout

Retailers' Change Goals in Checkout

Store-based retailers have two overriding objectives when it comes to checkout. The first is to make the process as "frictionless" as possible for customers, minimizing what the industry calls the "pain point" of waiting in line. In principle, they could achieve this by beefing up cashier staffing, but the second imperative is to reduce costs by cutting down on labor hours. Self-checkout serves both objectives—in part via automation, but in part via shifting scanning and bagging tasks to customers—and retailers are actively seeking scalable self-checkout solutions. This quest is facilitated by cell phone ubiquity and sophisticated sensors along with ever-more-powerful artificial intelligence applications (machine learning, advanced analytics) that can interpret the data the sensors generate. But at the same time, some retail companies have moved in a different direction—mobile checkout by *employees*, which takes primary aim at checkout friction rather than labor headcount.

Key Innovations in Checkout

There are three levels of technology-enhanced checkout. The first involves versions of the self-checkout systems familiar from grocery stores going back to the early 2000s. Some retailers are installing dual-purpose machines that can be run either by cashiers or self-checkout customers. Unlike the other types of automated checkout, traditional self-checkout requires intensive attention from a skilled cashier who troubleshoots, enters system override codes when the system requires, and so on. Research[39] indicates this is a stressful job—not surprisingly, since this "friction-reducing" technology is actually full of friction points for customers, and the cashier staffing it only interacts with customers when there *is* a problem. (By the same token, customer acceptance of traditional self-checkout has been far from universal.)[40] Typically self-checkout also is monitored remotely via camera, either by staff or by AI-based analytics. Some grocery chains in France have taken self-checkout to the extreme, keeping stores open with just self-checkout machines and security guards to cover nighttime and weekend hours when French law bans them from scheduling employees.[41]

A second level of high-tech checkout allows customers to scan items while they shop, and make payment via a mobile device without interacting with a cashier. The expansion of cloud-based applications in the late 2000s made checkout via mobile devices, communicating with the cloud through Wi-Fi, possible. The scanning and payment can utilize a retailer-provided device, whether hand-held or cart-mounted, or a phone-based app. Using one's own phone enables retailers to push special offers to shoppers, providing an added incentive for customers to adopt the system. One widely publicized adoption is Scan & Go at Walmart's Sam's Club,

which as of 2019 was piloting an upgrade that allows shoppers to hover the camera over items rather than needing to scan the barcode.[42] Other large implementations include Kroger's Scan, Bag, and Go, projected to reach 400 stores by the end of 2018 (we have not found any more recent updates).[43] Despite a flurry of interest and the obvious labor-saving advantages, rollout has been limited due to retail companies' worries about "shrink" (theft). For example, though Scan & Go remains available at Sam's Club where access is limited to club members, Walmart scrapped a pilot at regular Walmart stores in 2018, less than a year into the trial. One executive reportedly joked that managers started calling it the "Go" program because customers were forgoing the "Scan" step for so many items.[44] Customers were slow to adopt the technology, arguably because for them, being compelled to scan items and submit payment feels a lot like self-checkout.[45]

In the most advanced checkout solution, both item detection and payment take place automatically. Amazon Go is the highest-profile U.S. case. Customers must be logged into the Amazon app to be admitted to the store (Amazon recently filed a patent application for palm-scanning technology, a possible alternative way to verify identity,[46] and "face-pay" systems also are coming onto the market[47]), and then a combination of computer vision-enabled cameras and shelf scales track the items the client selects and charges their credit card or payment app as they leave the store (stores still are staffed with greeters/store monitors and stockers). A variety of startups offer competing versions of this technology (including Standard Cognition, Zippin, Grabango, DeepMagic, and AiFi). Current U.S. applications are convenience-store size, and given the complexities of visually tracking large numbers of individuals shopping for a wide variety of items across a large store area, scaling up to a larger store poses challenges. One industry consultant commented that Amazon Go "just shifts the line to outside the store" (referring to the limits Amazon places on the number of shoppers who can be in the store at once), and Business Week suggested in 2019 that seven years into the Amazon Go project, all Amazon had to show for it so far are 14 very expensive convenience stores in four cities.[48] Amazon and others are continuing the quest to boost the feasible scale of this approach. The major labor impact of both this fully automated model and the scan-and-go model is to completely eliminate cashiers, the largest concentration of labor in grocery and many other branches of retail—but even here there is a caveat, since Amazon Go stores recently shifted to accept cash payment as well so as not to exclude unbanked populations.[49] As of this writing, the so-called social distancing required by the COVID-19 health threat may have furthered the appeal of cashier-less checkout to some shoppers.

In an important counter-development, retailers gradually have been expanding the use of *employee*-executed mobile checkout, rather than its customer-executed counterpart. Though Apple Stores pioneered mobile employee checkout in 2006,[50] large retailers did not begin substantial installation of mobile systems—using tablet-based systems—until a few years later.[51] Apparel retailers, with stores where one-on-one customer interaction with a salesperson is the norm, led the way: as of 2013, JCPenney, Nordstrom, REI, and Urban Outfitters made major

moves into tablet-based point-of-sale (POS) systems.[52] Predicted retailer stampedes to mobile POS did not materialize,[53] but adoption has continued to advance.

Interestingly, as Walmart shut down Scan & Go in Walmart stores in 2018, it launched and then expanded "Check Out With Me," a procedure that stations associates with tablets around the store to check out customers as an alternative to the check stand;[54] Target followed suit with "Skip the Line" that same year.[55] Such systems change the nature of the job, but it is difficult to assess the impact on staffing levels. Signaling further exploration of this model blending customer interaction with checkout, as of early 2020 Walmart announced a pilot of a new, completely cashier-less version of its small-footprint Neighborhood Market store, combining Check Out With Me along with traditional self-checkout and the option of picking up online orders.[56]

In addition to these large-scale innovations, retailers are investing in smaller, less visible technologies that nibble away at checkout staffing levels. For example, retailers increasingly are using cash-counting machines rather than human counting to cash out a register at the end of a shift. For that matter, simply speeding up transaction approvals using AI tools can boost cashiers' and salespeople's "throughput," an incremental gain that can be used either to decrease customer wait times or to chip away at staffing headcount.[57]

Table 4.3 lists this set of innovations and the technologies that power them.

TABLE 4.3
Checkout: Innovations and Underlying Technologies

Key Innovations	Technology/ies Involved
Decentralized item tracking (See Table 4.1, Inventory Management)	
Customer recognition	• Wi-Fi login • Customer loyalty apps • Sensors (cell phone recognition) • Computer vision cameras (facial recognition) • Biometrics
Security monitoring	• Sensors (track phone) • Cameras (track person and items) • RFID, scales (track items)
Integrating information of the above three types	• Artificial Intelligence methods

Speed of Adoption of Checkout Innovations

Traditional self-checkout systems already are fairly broadly diffused, and a number of grocery and general merchandise chains have announced renewed plans for expansions.[58] We expect continued diffusion at an accelerated pace. Still, resistance by a large proportion of customers was expected to continue to place some limits on that spread in the near to medium term, at least until the recent COVID-19 health crisis. Interestingly, workers' reports from stores during the pandemic indicate that, paradoxically, many stores have *closed* traditional self-checkout lanes, since they are touch-screen based and not well designed to maintain distancing, particularly when a worker is called to assist customers encountering difficulties.

The likely trajectory of "scan and go" systems is similar, starting from a smaller base. Accelerants include the ubiquity of cell phone ownership along with the demonstrated feasibility of scanning while shopping using cell phones or store-provided mobile devices. Retardants include, once more, reluctance of many consumers to use these systems (for example, systems of this sort have been available at Ahold stores for many years with little take-up), as well as businesses' concerns about opportunities for theft. As installation of computer vision-equipped cameras and other surveillance systems become more widespread, presumably the latter concerns will diminish.

Though customers' hesitance to jump through the self-checkout hoops will slow the adoption of these first two checkout setups, it will not necessarily stall them indefinitely. There is a useful analogy with the rise of self-service shopping in the early to mid-20th century (rather than store clerks fetching goods stored behind the counter). Though that transition loaded new tasks on shoppers and did not immediately enjoy universal acceptance, retailers flocked to it due to cost and efficiency advantages, and later generations of shoppers accepted it as the norm.[59]

We could imagine that in 10 or 15 years, many mass marketers—at least in new stores—will include only one staffed register, akin to today's customer service desks (leaving those who insist on using that option at the mercy of the line) or none at all. Walmart's pilot store offering self-checkout and floating employees armed with tablets as the only two checkout options[60] seems a likely harbinger of a future default model that shifts most of the labor of checkout onto consumers. Of course, the unpredictability of the 2020 public health measures may push contactless options ahead of options more reliant on interaction with store staff.

What about Amazon Go and other models of cashier-less, scan-less checkout? The complexity of the technology has made these cashier-less stores very costly to build and operate, and so far has made large versions of these stores not feasible in the United States. One estimate (to be fair, by the CEO of a startup that makes a competing technology) projects that even if computation costs continue falling as they have, an Amazon Go-type system will not reach a break-even point relative to a standard cashier setup for a grocery store of standard size until after 2040.[61] The issues at stake are accurately charging the right person for the right items while detecting attempts at theft. It seems safe for now to project only slow growth of this variety of checkout.

Likely Labor Impacts of Checkout Innovations

The labor impacts of these checkout shifts are quite straightforward, as shown in Table 4.4. Conventional cashier jobs will decline in numbers at an accelerating rate as adoption speeds up. There will be more jobs for workers monitoring self-checkout, and for those checking out customers with tablets throughout large stores.

TABLE 4.4
Likely Labor Impacts of Checkout Changes

Replacing Labor	Change in Task Mix
Replacing cashiers with: • Automated systems • Persons providing technical assistance and monitoring customers • Security personnel	• Cashiers increasingly likely to cashier only part of the time, and add technical assistance or stocking duties • More generally, expansion of technical assistance and monitoring roles • New role: roaming cashiers with tablets checking out shoppers around the store

E-commerce's Impact on Stores: Stores as Fulfillment Centers

Retailers' Change Goals in E-commerce

E-commerce has become so ubiquitous among retail companies that it is regularly described by industry observers as "table stakes": retailers (at least those over a certain minimal size) must offer online sales or inexorably lose share to those who do. Or as Mike Molitor, head of e-commerce for the regional grocery chain Raley's, put it: "The CFO's saying, 'It costs more when they order online, so why are we spending money to try to shift them to a more expensive way of shopping?' But I say, 'If we don't do it, somebody else is gonna do it.'" For most store-based retailers, e-commerce investments are aimed at defending market share; for market leaders like Walmart and Target, the goal is to increase market share. The race into e-commerce continues despite its costliness: Amazon loses an average of $2.27 per next-day delivery order, according to a Morgan Stanley estimate.[62]

The exceptions to the universality of online sales tend to prove the rule. For example, Ross Dress for Less does no online sales, but this is consistent with its business model of buying a constantly changing mix of remainders and odd lots and selling them to customers who shop there in search of deep discounts available nowhere else.

Key Innovations in E-commerce

Two main technological trajectories have moved e-commerce far beyond its origins as simply an online alternative to catalog ordering by mail or phone. On the one hand, e-commerce has developed ever-more-sophisticated algorithms for search and suggestions that can benefit the customer and the vendor—but have limited implications for store-based labor. On the other hand, online sellers, with Amazon in the lead, have pushed the technological frontiers of order fulfillment and delivery. Others have examined the impact of these technological changes in warehouse work[63] and work in the delivery stream;[64] our focus is how they change work in stores.

E-commerce alters store labor in three ways, but here we will focus on just one of the three: the addition of online order fulfillment functions to stores, which significantly transforms the tasks taking place in stores. As well, of course, online sales displace in-store sales and the labor that would have carried out those sales. But this shift does not in itself alter the jobs that remain; we examine job losses in store-based retail later. In a third, backhanded impact, the continuing growth of e-commerce potentially increases the value of investments that differentiate store-based shopping from online purchases—such as "experiential retail" initiatives. However, as we discuss later, we have not observed large-scale movement toward such investments, and doubt they will be widespread.

The rapidly growing use of stores as fulfillment centers takes four forms: picking items from store shelves for delivery; picking and receiving items for store-based pickup; the (less frequent) creation of highly automated micro-fulfillment centers within store footprints that can feed both delivery and customer pickup; and processing returns. Picking items for delivery and pickup is the most visible of the four, particularly in groceries. Target reportedly fills 80% of its online orders from within stores, and a recent article describes a Brooklyn store where 80 workers are filling e-commerce orders (Target stores average 160 workers).[65]

Two cautions apply. One is that though third-party delivery platforms such as Instacart and Shipt have been particularly visible exponents of this task, third-party domination of this space seems likely to be a transitional phase. Brick-and-mortar retailers quite sensibly have become concerned about "who owns the customer" when third-party companies serve as the interface with customers. Target bought Shipt in 2018, and indications are that retailers are starting to replace Instacart with in-house pickers (though a pandemic-driven surge in Instacart use is delaying this transition). Second, for some types of goods, picking from store shelves is itself to some extent transitional. The UK grocer Tesco, which is far ahead of U.S. grocers and most U.S.

retailers in incorporating e-commerce, started with picking from existing stores. As online sales scaled up, their assessment of opportunities for greater efficiency and automation led them to shift first to "dark stores," where pickers didn't have to share the stores with customers, and then to warehouse-based fulfillment. For many kinds of dry goods, it is reasonable to expect U.S. retailers to follow this path; during the coronavirus crisis, some retailers have used closed stores as "dark stores."[66]

At least in some cases in groceries, retailers' decision to use the same technology to guide both consumers and order-picking workers around the stores has the perverse effect of deskilling in-store workers' jobs. The technology in question is hand-held devices that "read" the store's planogram (product layout) to map the most efficient route to pick a basket of goods, and guide the user along the route. To make such devices easy for customers to use to pick out their grocery list, they are "dumbed down" to provide only limited functions—barring workers from searching inventory, weighing in on purchasing decisions, and so on.

The click-and-collect or BOPIS (buy online, pick up in store) process has a somewhat different dynamic. Retailers prefer customer pickup to delivery because it is dramatically less expensive—90% less, according to Target Chief Operating Officer John Mulligan.[67] Picking up an ordered item at a store allows customers to get purchases sooner and pick them up on their own schedule. This can be particularly appealing in the case of fresh foods; in "overstored" America, the average distance from a person's home to the nearest supermarket is just more than two miles.[68] Preparing BOPIS orders is more consistently done by the retailer's own employees. The orders can go into kiosks or lockers, or be handed off at curbside. In some cases, curbside pickup builds on additional technological innovations that track the locations of customers *en route* to pick up their goods by localizing their cell phones, and that orchestrates the logistics of timely merchandise handoff.

A remarkable 92% of U.S. retailers have a BOPIS program in place, and 67% of shoppers had used it in the previous six months, according to a 2019 survey;[69] the pandemic spurred an even more remarkable 208% growth in click-and-collect usage between April 2019 and April 2020.[70] Data analytics company IRi estimates that for brick-and-mortar multicategory retailers (a grouping that combines general merchandise and grocery), click-and-collect shopping accounted for 53% of e-commerce sales in 2018, though this sorts out to two-thirds of edible categories and only one-third of nonedibles.[71] We can expect the click-and-collect share to continue to grow, since large retailers made massive investments in curbside pickup programs in 2018[72]—in one particularly dramatic example, Target ramped up from 0.6% of stores to 56% over the course of 2018—and it appears this trajectory continued in 2019, while in early 2020 large numbers of "socially isolating" consumers shifted at least temporarily to BOPIS.

Micro-fulfillment centers (MFCs) are basically mini-warehouses, equipped with the advanced robotics typical of freestanding fulfillment centers, sited in heavily populated areas, often located within closed-off areas of stores. They are stocked with the most commonly purchased

items; orders can be topped off by picking additional items in the adjacent store. MFCs are primarily being put to use in grocery, due to the importance of quick delivery or pickup for fresh or cold foods. Takeoff Technologies so far is the leading U.S. vendor of such centers, with MFCs being rolled out at Albertsons, Ahold Delhaize banners, Wakefern, and elsewhere. Though the micro-fulfillment center order-picking process, including separate ambient temperature-cold-frozen portions of an order, is highly automated, workers are needed to tend the process, including maintaining stock, bagging orders and transporting them to the staging points for delivery or pickup, troubleshooting, and so on.

Returns are a particularly large activity in general merchandise and apparel, not grocery. The shift in activities here is fairly self-explanatory: because online fulfillment generates much higher return rates than in-store purchases (three times as high according to one estimate),[73] a shift to e-commerce makes returns a larger share of workers' duties.

Table 4.5 summarizes the e-commerce innovations that are most consequential for stores.

TABLE 4.5
Innovations and Underlying Technologies for E-commerce

Key innovations	Technology/ies involved
Online search and purchase functions (affects stores by shifting these functions out of the store)	• Core internet functions (displaying, searching, taking payment) • Machine learning to enhance search and suggestion functions
Ability to quickly and efficiently pick orders from stores	• Personal-device apps to guide human pickers • Store-based automated micro-fulfillment centers
Ability to plan and execute logistics of customer pickup (also delivery)	• Algorithms with input of real-time information, enhanced by customer surveillance • BOPIS handoffs

Speed of Adoption of E-commerce

We foresee continuing steady increases in e-commerce for years to come. As one example of current trends, in groceries, Takeoff Technologies was quoted in May 2020 as claiming it was launching a micro-fulfillment center every two weeks, and expected to hit a weekly pace by the end of the year.[74] Despite anticipating ongoing growth of online sales, we are skeptical of the alarmist, "retail apocalypse" predictions of sweeping, rapid change that are currently popular. As we discuss later when considering employment impacts, we expect the growth of e-commerce will be slower than these predictions suggest, and that it likely will plateau over the long run.

Likely Labor Impacts of E-commerce

Corresponding to our measured view of the likely spread of e-commerce, we expect outright displacement of store-based workers by online sales to continue, but at a moderate pace and with uneven impacts on different parts of the retail sector.

All four forms of store-based fulfillment labor have quite significant implications for store-based labor, particularly expanding the range of tasks for sales floor workers. They add to cashiering, selling, and stocking a new set of fulfillment-related activities: picking orders, staffing micro-fulfillment centers, staging and handing off click-and-collect orders, potentially delivering orders to homes or other destinations, and handling returns. Ebbs and flows in online orders from stores and the resulting fluctuations in labor needs do not appear to be readily predictable given the existing state of technology use (data analytics, predictive algorithms). Early indications are that rollout of these functions has resulted in speedup and stress for workers; for example, a number of Reddit threads discussing Kroger's Clicklist application complain that managers never schedule enough labor for the orders coming in, so that workers have to scramble, unexpectedly add hours to their schedule at the last minute, or pick orders late and face the wrath of customers.

The curbside version of the click-and-collect process (being scaled up at Walmart, Kroger, and Target, among others) represents an interesting case of a brand-new job. In curbside pickup, a store employee hands off purchases directly to the customer in their car in the store parking lot, with the expectation that the worker will greet and interact with the customer, and in some cases actually collect payment on the spot—essentially replacing the cashier job with that of a mobile drive-through attendant.

Table 4.6 sketches out e-commerce's most probable impacts on store-based labor.

TABLE 4.6
Likely Labor Impacts of Implementing E-commerce

Replacing Labor	Change in Task Mix

Replacing store-based workers with:
 	
• Warehouse workers (offsite; onsite in micro-fulfillment centers)
• Drivers
• Third-party order pickers and deliverers (e.g., Instacart)
	• Increase in:
	  » Picking and packing orders (by own workers)
	  » Placing them in kiosks
	  » Tending micro-fulfillment centers
	  » Customer greeting and order handoff
	  » Receiving and processing returns
	  » Some delivery
	• Decrease in:
	  » Cashiering
	  » Giving customers directions
	  » In some cases, decrease in stockers' knowledge and involvement in inventory tasks (due to narrow picking algorithms)

Interaction with Customers: Customization, Convenience, Discounts

Retailers' Change Goals With Respect to Customer Interaction

Retailers aim to change nearly everything in their interactions with customers, starting with augmenting the frequency, intensity, and quality of interactions, and spanning the online interface, virtual contacts, and in-store, in-person contacts. These changes are construed as essential components of implementing "seamless," "omni-channel," or "harmonized" (the latest buzzword) retail. What retailers mean by this is to offer customers convenience, speed in meeting their needs and preferences, and customized offers of products and services as well as discounts, in ways that "feel" identical and connected regardless of the contact point with the retailer—phone, tablet, desktop computer, smart speaker, or a store visit. All of this has the ultimate basic purpose of increasing sales and expanding market share. Making these changes is deemed essential to maintaining market share, let alone increasing it.

Key Innovations in Customer Interaction

Interacting online before customers enter stores.

The purpose of online interaction is not only to tend to online sales but to drive visits to the physical stores, where sales may be augmented beyond the initial purchase that drove a customer to the website. To this end, actions include increasing the visibility of the retailer's "brand" through social media vehicles to engage with, advertise, and market to potential customers. While not a new phenomenon, enhanced social media presence has been emphasized, with some retailers adopting "online community" forums to boost customer loyalty. These approaches might build on existing customer loyalty and networking programs (e.g., Chico's refer-a-friend program). They can enable a company to tailor its messaging and product features to take account of regional or cultural differences.

For decades, retailers have had online customer interaction mechanisms to execute online sales, and basic customer service in the form of "Frequently Asked Questions" pages and, sometimes, email boxes, online chat with customer service reps, and more recently the option of Voice over Internet Protocol (VOIP) calls to a call center. Recent augmentation of these mechanisms features AI investments in far more sophisticated automated customer service agents ("chatbots"), a labor-saving option that also broadens the range of questions that can be handled and speeds up the process. A new iteration adds personal interaction with store-based salespeople. For example, "style consultants" at women's apparel retailer Chico's engage in remote FaceTime conversations with customers seeking advice, showing and talking about merchandise much as they might in a store before the customer makes an online purchase; tech startup Hero offers a platform to facilitate this kind of interaction (with a customer list that includes Nike).

To support online sales but also translate online contact into store visits and potential sales, relatively advanced machine-driven features such as "expert" shopping advisers and product recommendation systems are being developed.[75] Virtual reality and augmented reality tools to implement product trial and sizing likewise are being deployed. This option to "try on" appeals particularly to the subsectors of clothing (design, sizing, color), cosmetics (color, suitability), and home furnishings. Customers may be better informed, more apt to be convinced of a choice they already have considered, and more likely to engage with a salesperson in store; the interaction is more likely to be substantive about product, fit, and suitability.

To be rendered most effective, these online interaction strategies can be supported by detailed data collection about individual customers' online shopping patterns, often combined with aggregate information of shoppers with similar profiles. Retailers obtain individual information by getting the customer to set up an account, to join or upgrade the loyalty program, and/or download the company's shopping app—each of these increasingly include a default cell number provision. Individual customers can be tracked in stores if they are running the app.

Interacting with customers in the store.

Retailers' interaction with customers in stores takes place not only with employees but also through automated communication channels. Depending on the market segment, in-store customer interaction ranges from somewhat to highly customized. Mid- or high-intensity personalization formulas can be enhanced to provide even greater customization, while low-intensity formulas may tap technology-based tools to introduce customization not previously in play.

Software companies offer varied tech-enabled customization tools to implement "clienteling" strategies, essentially consisting of tracking customer preferences and past behavior in order to tailor product and service offerings. Clienteling entails meeting the customer's need as he or she walks in the store by identifying the customer (through cell phone recognition, Wi-Fi registration, or computer vision-enabled cameras), giving salespeople access to all this data. The relevant data includes information on products and inventory (and its location), along with a given customer's online and in-store shopping history. The clienteling strategy—when all components are deployed— aims to create the feel of a "personal shopper." For example, some stores of cosmetics retailer Sephora have salespeople meet a customer first identified through online interaction with samples of the products searched for, considered or (virtually) tried online. Startup Tulip pioneered clienteling software, selling to such high-end retailers as Coach, Chanel, Kate Spade, Tory Burch, and Michael Kors, but the function now has been replicated by numerous other providers as well as, in some cases, retailers' own in-house systems.

Less detailed customization can be delivered when potential customers, while in the store, get prompted—a message delivered via a beacon to their cell phone—with offers of special deals on items they checked online. In another example, customization of some product options is possible with dedicated software—for example, displaying room layout and color options for home decoration supplies, possibly integrating photos submitted online by the prospective customer.

This set of tech-driven innovations in customer interaction is laid out in Table 4.7.

TABLE 4.7
Customer Interaction: Innovations and Underlying Technologies

Key Innovations	Technology/ies Involved
Before store • Driving visits, changing interaction in store • Assessing preferences, facilitating choice→ Increasing likelihood of sales • Collecting personal info with online customer account, loyalty program (aim to get cell number) • Obviating need for numerous stores with online display, virtual "try-on" and product selection	• Enhanced web presence; core internet functions • Social media campaigns and "customer clubs"→ Enhancing product visibility; cultivating "relationship" • Chatbots alone or combined with in-person contact (call, FaceTime) • AI "expert advisers," product recommendation systems, virtual and augmented reality
In store • Highly customized: recognized in store, "personal shopper" feel • Get special offers (cell prompts), targeted product info • Workers with access to inventory and product info, ways to customize • Coordination among workers, with backroom and warehouse	• Phone "sniffers," Wi-Fi, retailer app with location function, cameras linked to computer vision • Information on a shopper's online activities integrated with in-store tracking (through cell phone or, at least potentially, facial recognition) • Worker tablets, cell phones and other portable devices

Speed of Adoption of Customer Interaction Innovations

Most large general merchandise retailers, many apparel sellers, and some supermarket chains have begun implementing some of these customer interaction approaches. To our knowledge, no chain has implemented the full array of complementary approaches in all, or even most, of their stores. And, beyond industry leaders, it is unclear how many retailers even have begun implementing these tools (beyond basic online customer service functions.) Most readily implementable are accessibility of inventory information and customization in interaction with the customer, as in home decoration or clothing. Integrating online and in-store customer data and its effective use to promote sales is less common and costlier. Some retail chains have made

significant headway in these two activities: in general merchandise, Nordstrom, Target, and Walmart; among grocery chains, Kroger (with its acquisition of Dunhumby, a "customer data science" company); and, in other categories, Home Depot, CVS, and Walgreens. However, the array of technology-driven options for the future is wide and might be compelling. For example, clienteling options being pitched to retailers entail a new generation of AI-powered chatbots to offer personalized advice and services, to reduce and perhaps eliminate human involvement in online chat functions.[76]

Several factors are likely to impact the speed of diffusion of novel customer interaction approaches. First, investments will be driven by the degree to which key "customer interaction" innovations are deemed to support a specific business strategy goal. Second, the cost of adding and coordinating communication technology tools continues to matter for the spread of these practices. An additional cost factor is whether worker personal devices can be used as part of the implementation (thereby reducing costs somewhat). Third, and more importantly, the high cost of implementing data collection and of carrying out the full integration of relevant data sources will have a significant impact on the features and speed of diffusion. We consequently expect that full-scale AI implementation is likely to lie only within the reach of market leaders.

Likely Labor Impacts of Customer Interaction Innovations

Replacement risk.

In-store workers' risk of replacement from these developments is indirect. If online interaction is developed extensively and used effectively to support the product choice, match process, and to maintain consumer loyalty, some retailers may see a way to *limit the number of stores* (less need for in-person connection, for display) as well as to increase the role of associates in virtual interactions, shrinking their downtime.

Outside of stores, and possibly within them, technology implementation as well as marketing jobs are likely to increase. These jobs may be outsourced, however.

Role changes.

Role changes that result from a changing mix of tasks are more likely to occur sooner. Salespeople will be asked to have intensified personal contact with customers, in store and possibly online via typed or voice communication. For most workers in large stores (with off-the-shelf self-service), this interaction will be quite a step up from tasks such as providing directions, replenishing stock, and carrying out checkout. One such example comes from some Target stores in which sales staff have gained specific knowledge about particular product areas (e.g., cosmetics, clothing) in order to provide product information, maintain and track inventory (with handheld devices in 250 stores), and interact more effectively with customers.[77] Less

elaborate approaches entail using a tablet to check inventory or to retrieve customer credit card information, for example.

To the extent retailers invest in data integration, analytics, and high levels of access for store personnel, salespersons will have more intense interaction with digital tools. The simultaneous interaction with tools and customers substantially broadens the expectations of duties for sales floor clerks.

In-person interaction in delivering customized product suggestions (choice selection but also product information) requires synthesizing information about products and the customer's pattern of purchases. It also may require assisting in problem solving (finding the "best fit"). The intent is for much of this synthesis to be AI-enabled; the reality of transforming automated suggestions into a sale still will require the salesperson not just to parrot the system's outputs, but to incorporate them into a compelling sales pitch.

In addition, and related to synthesizing product and logistical information, increased customer interaction most likely will require greater coordination skills and ability to work as part of a group. As stores implement data integration incrementally, there still will be a need for workers to exchange information or redirect customers to each other. The use of wearable devices (e.g., earphones) or cell phones facilitates communications, but the skill or experience required to act as part of a group must be learned by workers.

Finally, as noted earlier, a simple customer interaction role already in evidence in many stores is the handoff of click-and-collect orders as part of the role of stores in implementing e-commerce.

Worker privacy and role burden.

Customer interactions carried out online and with telecommunication tools are likely to be monitored closely for data collection purposes (about customer needs and satisfaction), and for quality control (worker performance). This monitoring will expand the degree to which workers are observed while performing their jobs, which also is true in the case of expanded in-store video recording (with analysis of the video potentially increasingly carried out via AI, so supervisorial time and attention to the video is no longer a limitation). In some cases the retailer is implementing aspects of this interaction via workers' personal cellular phones, further complicating the implementation of a privacy barrier between data related to job performance and personal information about the worker.

Less visibly, tools deployed to customize customer interactions have the capability to collect information about worker performance. Some of these tools, for example Tulip's, can track the number of emails or texts sent to shoppers and also track conversion rates. In effect, they may be used to track the effectiveness of a strategy, but in fact also rate individual workers and their productivity.

The cluster of tasks and expectations entailed by enhanced customer interactions being planned for are, in principle, expected to replace more routine stock replenishment and customer assistance tasks. Implementation will tell whether these routine tasks actually are eliminated (facilitated in other ways through better logistics or through automation) or will be slow to abate, in which case role burdens will increase for sales floor workers.

Table 4.8 summarizes the largest likely impacts of this set of customer interaction innovations on workers within stores.

TABLE 4.8
Likely Labor Impacts of Changes in Customer Interaction

Replacing Labor	Change in Task Mix
In-store interaction	"All about enhancement"?
• Reducing reliance on knowledgeable workers who have product experience, knowledge about frequent customers • Reducing checks of backroom stock	• Intensified personal contact (from a low starting base for most workers) • Synthesizing information about product and shopper; problem solving (finding the "best fit"); this entails more responsibility (not clear if retailers will grant more discretion) • Coordination and group communication

How Digital Technology is Changing the Way Retail Workers are Managed

Across all of these activities—managing inventory, interacting with customers, handling checkout, serving e-commerce—store-based workers must be managed. In this section we zoom in on how changing technology is altering these worker management processes.

Retailers' Change Goals in Worker Management

In applying digital technologies to the management of workers, retailers are pursuing three main goals that could be described loosely as efficiency, effectiveness, and engagement. *Efficiency*, in

turn, encompasses three separate objectives. First, employers seek to get retail workers to "work smarter" by ranking their tasks in priority order. A second target is inducing workers to "work better" and likely "harder" by tracking their work performance. A third efficiency objective is to economize on *managers'* time by freeing them up from routine supervision and communication up, down, and across the corporate hierarchy.

Three objectives likewise factor into the goal of greater *effectiveness*. One is to give workers easier access to useful information, whether that is inventory levels, product attributes, or company policies. A second, closely related objective aims at providing more accessible and effective training. Third is providing workers with feedback channels to communicate what is happening on the ground, and in particular what is working or not working—information that can help larger processes and systems operate more effectively.

Finally, as a boost to the first two goals, retail employers aspire to heighten worker *engagement*—something that can be challenging in a line of work that is often low-paid, involves contact with unpredictable and sometimes unpleasant customers, and has high labor turnover. Here again channels for feedback contribute; in addition to transmitting useful information to managers, they can make workers feel more efficacious and simply more heard. Relatedly, some retailers seek to make it easier for workers to set up a preferred schedule, since scheduling issues are the major pain point for employees in many retail settings.

This is an ambitious set of goals. How are retailers drawing on new technologies to strive for them, and what are the implications of these strategies for workers and their jobs?

Key Innovations in Workforce Management

A set of smart systems that can quickly and appropriately communicate instructions, factor in information, and in some cases actually automate some decision making—shouldering managerial functions (see Table 4.9 below)—is chief among innovations retailers are using to transform worker management. Four examples illustrate how this can work. The first advances scheduling systems. Scheduling software has been used to set staffing for more than two decades, but recent advances have improved optimization algorithms that can take into account worker preferences and changing circumstances. The reality is that it has been common for store managers to override the software's recommendations based on local knowledge; the hope is that advances will make this unnecessary. Current-generation software also has the potential to allow workers to swap shifts without managerial intervention (within certain guidelines), and to bid for shifts at multiple local stores in a chain in order to increase their weekly hours. They also can track in detail what shifts employees have opted for or rejected, information that can be used either to keep workers satisfied or to penalize them (for example, if they consistently turn down hard-to-staff shifts).

A second example, combining recruiting and scheduling functions, is a set of "on-demand staffing platforms" that draw in workers on an as-needed basis.[78] The platforms work in various ways. Some simply enable employees of a given company to get hours at multiple store branches in an area, improving the chances of getting more work hours (a chronic problem for many retail workers). Others, such as the startup Forge (now owned by Workjam), enable employee-sharing across retailers in a mall or neighborhood. And still others simply offer a pool of workers available for assignments (such as delivery of online orders), like a temp services company. The platforms correspond to multiple employment statuses—in the prevailing cases, workers are 1099 "independent" contractors like people working for Uber or TaskRabbit; in some cases, they are W-2 employees of a single retailer; and in (a few) other cases W-2 employees of the platform company.

A third smart system is task management software. In its most basic form, digital task management consists of an electronic to-do list compiled by an employee (usually a manager). More advanced systems can include directives from higher corporate levels and system-generated alerts (overly long checkout lines spotted by sensors, a spill detected by a scanning robot, an overly high thermometer reading from a refrigerated food case). Adding another level of complexity, task management software also can prioritize tasks within a list based on algorithms. It also can track how quickly someone checks off the tasks or even cross-reference the priority task with the employee's location and current activities—boosting efficiency but potentially raising worker privacy concerns. To make them more palatable, task management systems may be "gamified." For example, "At every shift, each Old Navy store employee on the sales floor is issued a 'Ticket To Win,' which the company describes as 'a contest-driven tool' to help managers and associates 'focus on how best to serve the customer and drive business results.'"[79] Tech startup Arcade specializes in producing gamified systems for motivating workers to meet objectives.[80]

To further the goals of worker engagement and process improvement, task management software can be designed not only to communicate information emanating from central offices and automated diagnostic tools, but also to take in feedback on some processes from store workers.

Task management software by its nature automates certain management tasks, such as giving direction. It has the potential to do much more. An Amazon company document about warehouse procedures states, "Amazon's system tracks the rates of each individual associate's productivity and automatically generates any warnings or terminations regarding quality of productivity without input from supervisors."[81] Similar systems also could be used in stores—and perhaps already are.

Building systems that make and communicate decisions across the company based on large pools of data, without human intervention, constitutes the potentially farthest-reaching change. To some extent this is a glorified version of what scheduling software does when it generates a

recommended staffing configuration—but it takes things to a new level. "Target can do forward, predictive analytics," a consultant told us. "They combine predictive analytics with a back-end implementation and decision system—to automatically generate and communicate the thousands of decisions that they have to make each day." Presumably these are currently small and relatively routine decisions, but over time retailers surely will push those boundaries.

Changing technology also contributes to changes in worker management via devices and processes that gather inputs from smart systems or transmit outputs from them. Consider, for example, the explosion in portable devices that can travel around the store with workers. These range from enhanced versions of the venerable scan gun, to mobile phones (whether company- or worker-owned) loaded up with apps, to wearables such as headsets or startup Modjoul's "smart belt" that detects a worker's location, body position, and type of action. These devices can (depending on the device) deliver multiple functions: communicate information (e.g., product display layout) to the worker, receive communication from the worker, track worker location, and track worker activities. In combination with cloud computing, they can miniaturize and streamline functions like scheduling (now doable via phone app) and training. For instance, retail worker training increasingly is delivered in bite-sized videos rather than lengthy modules that require sitting down with a computer. The video units, usually communicating product or sales promotion information, are designed to be viewed at one's convenience, to integrate easily into employees' work flows, and to be entertaining and thus memorable. The other side of the portable device coin is a set of fixed-location sensors, already discussed in the context of customer interaction, which can be used to monitor workers as well as consumers. On the output side, smart systems can automate recordkeeping and the generation of standardized reports.

All of these technologies either take over typical managerial functions or give managers added "eyes" around the store to track what's going on. One example of technologically enhanced surveillance is Focal Systems' computer vision-empowered cameras, which primarily are marketed to spot out-of-stock goods (and in use by regional grocer Wakefern, among others), one of the many such products covered in the inventory management discussion. But the applications listed on the website include "Detect and coach stockers that are in training or underperforming." The company website does not say that cameras are used to watch workers, but instead states that by taking a full inventory hourly, it can track stocking velocity and picking velocity for individual stockers—and claims that in case studies average pick velocities have nearly doubled after identifying, coaching, and training underperformers.[82]

TABLE 4.9

Workforce Management: Innovations and Key Technologies

Key Innovations	Technology/ies Involved
Smart systems that allow fast or even real-time optimization, more sophisticated forecasting, automation of some decision making and decision communication	• Artificial intelligence • Internet of Things (IoT) • Cloud computing
Instantaneous, customizable, multimedia communication with two-way communication possible (with/between workers)	Cell phones and other portable devices
Inexpensive, accurate monitoring, with transmission and instantaneous interpretation of transmitted data	• Sensors (cameras, sniffers, etc.) • Portable or wearable devices that serve as transponders with GPS capacity • Transmission channels: cell frequencies, Wi-Fi, infrared, RFID
More sophisticated forecasting, real-time optimization, automation of some decision making and decision communication	• Machine learning and AI • IoT
Substantially automated recordkeeping and report generation	Same as cell above
Other innovations • Further automation of screening process at hire • Enable (or require) workers to piece together shifts across store branches and even separate employers	• Virtual reality (VR); place applicants in VR scenarios • New application of existing scheduling technologies

Speed of Adoption of Workforce Management Innovations

Our findings point to active experimentation by leading retailers and some adventurous smaller retailers, but slow diffusion of managerial smart systems and their corollaries to the broad population of retail companies. One survey of retail executives found that only 22% listed "Workforce utilization and optimization" as one of "the main reasons why you may consider

using machine learning at your organization"—about half the percentage that checked off "Customer service or support recommendations."[83] Scheduling software has spread most broadly, but as of 2019 we were surprised to encounter three national retail brands (one each in grocery, apparel, and home goods), with store counts ranging from 120 to more than 1,500, that had not yet implemented scheduling software—and in some cases saw no urgency to do so.

University of Chicago Prof. Susan Lambert told us that though most scheduling software includes modules for worker shift-swapping, in many cases retailers simply don't activate those modules. Task management software has been rolled out mainly among managers, not rank-and-file workers, and mainly in a "lite" version that simply compiles tasks without prioritizing or directing action. Target was the only store-based company for which we heard about automated decision systems, though other retailers at a similar scale are likely at least investigating such systems. Given the apparently slow take-up of these systems, adoption of devices to interact with the systems seems also to be moving slowly. The cell phone is a leading candidate to be the portable worker device of choice, given its near ubiquity, but a number of retail interviewees expressed concern that if they required employees to use a phone-based app, they would be on the hook to pay for the employee's phone plan, a concern that in some cases seemed to be blocking adoption.

It's hard to get a fix on how widely new tech tools are being used to watch workers more closely. Though Focal Systems proudly touts its cameras' ability to monitor workers on its website, and we learned that Costco is using another product to track its employees' location and activities throughout the day, most retailers and tech companies are very circumspect about worker surveillance. One tech company commented that though its product can keep track of where employees are and what they're doing, "We don't sell on it, because the word 'productivity' scares the [pause] out of everybody."

Likely Labor Impacts of Changes in Workforce Management Tools and Technologies

Since adoption of the more far-reaching technologies for worker management is largely potential, likely impacts on front-line workers also are mostly potential. Such technologies could support workers and enhance job quality, or closely monitor and pressure workers and degrade job quality—or some combination of the two (see Table 4.10 below for a summary). On the one hand, new management systems could give workers ready access to useful information, including via consultation with other workers, and could increase their opportunities to communicate observations, reactions, suggestions, and preferences. The result could be more engaged workers with more ambit for exercising their judgment. For example, grocery workers could be resource people for nutrition data, recipes, or product sourcing information; apparel salespeople could have access to customers' online and offline purchase history, and could

pass along advice on fabric care, fit, and fashion. A more limited supportive shift would involve simply addressing some of the main frustrations, frictions, and irritants retail workers encounter, making their jobs more enjoyable, if not more autonomous.

On the other hand, task management could be programmed to direct workers closely—akin to the way digital technologies are used in many warehouses—and measurement systems keyed to track their performance equally closely. This direction seems likely to threaten worker privacy and generate coercive results, whether meted out through progressive discipline or through finely differentiated rewards tied to closely measured performance. Gamification of worker-directed tech tools can be a two-edged sword: it can make work more enjoyable, but it also can channel "soft" coercion. Mobile phone-based apps potentially can track workers' online and offline activities even while they are off the clock. Possibilities including observing workers' location (are they staying out late at night?) or counting their total steps per day like a FitBit, potentially raising insurance premiums for employees who don't get in enough steps—a possibility that may seem far-fetched, but was being implemented for West Virginia teachers until 2018 wildcat strikes got it discontinued.[84]

Short of such more invasive applications, simply tracking precisely how often workers have turned down shifts can allow retailers to discipline workers (possibly even triggering such discipline algorithmically), whether by offering them fewer hours or by taking disciplinary measures—something managers already do in an analog environment, but without the automated tracking that digital technology provides. And a set of predictive scheduling tools that could serve to limit "send home or cancel" practices (when workload does not warrant the worker completing their scheduled shift) could on the other hand also be deployed to schedule very short shifts scattered through the week, with deleterious effects on job quality. Moreover, beyond tools expressly designed for worker management, systems that keep track of customer behavior and shopping patterns can likewise track worker behavior.

Given that over the last few decades most retailers have refashioned front-line store jobs to increase managerial control, to concentrate detailed knowledge in a few workers per store while reducing skill requirements for most jobs, and to tap worker discretion and input in ways that heighten rather than lighten top-down control, a cynical but perhaps realistic view would suggest that in coming years most retailers will use digital technologies—as well as other work monitoring tools—more for coercion of worker behavior than support of autonomous thinking and engagement. But it is entirely possible that retail employers will implement some elements from both sides of the equation, in combinations that may prove either unstable or durable.

Not shown in Table 4.10, but worth noting, is that the largest impacts may be on managers. Tools that carry out managerial functions potentially can replace managers (not likely the store manager job, but specialized store-based managers, and higher layers of middle management) or free up managers for new—or old—tasks. Freed-up time could be dedicated to more "management by walking around" and interaction with workers (in our earlier retail research,

managers complained about the amount of time devoted to communicating messages from upper levels of management, and to generating a growing number of reports), or to new and possibly more creative activities, including building their own familiarity with tech tools. As with front-line workers, it is too early to predict with any certainty which of these potentials will get realized. However, one early signal is Walmart's January 2020 announcement that in 500 stores it is piloting a "team" store management model that reduces manager headcount and charges workers with more decision-making responsibilities, working as a team, along with raising their wages slightly.[85]

TABLE 4.10

Likely Labor Impacts of Changes in Worker Management Technologies

Supportive of Workers	Coercive of Workers

• Giving workers more resources: information, training, ability to more easily ask questions of others
  » Can increase their expertise and/or access to information and expertise
  » Can be basis for discretion
 	
• More voice: communicating observations and concerns; expressing schedule preferences
 	
• Making the job more interesting and fun (one tool for this could be gamification, though it also has coercive implications shown in the other column)
	• Surveilling workers more closely, possibly even when not at work
	
	• Controlling and guiding workers more closely (including via gamification)
	
	• Fine tuning reward and punishment systems

Further Considerations Regarding Future Technology Adoption

New Frontiers in Customer Data Gathering

We have underscored how many of the leading digital technologies sought by retailers focus on gathering data on inventory as well as shopper—and worker—behavior. Examples include roving robots, "smart shelves" combined with cashier-less checkout, online chatbots, or other technologies storing a trail of interactions. Furthermore, the greater availability and power

of data analytics systems increase their appeal to retailers seeking leverage in dealings with potential and current customers.

The appeal of these opportunities is great and has prompted exploration of other ways to collect customer data. For instance, a specific store formula has emerged whose almost exclusive function is to collect shopper information and behavior patterns for analysis. *Experimental stores*, often of the "pop-up" variety, deploy as many video recording and data collection options as feasible. They are used by brands (or occasionally by companies servicing retailers) to test alternative product designs, and to collect information on customer choice and behavior as well as responses to marketing strategies. They may enhance "direct-to-consumer" strategies of brands and strengthen their competitive position, and alter the environment in which retailers make strategic choices.

Another emerging practice may foreshadow changes in how retailers use their customer data collection capabilities, such as leveraging them for income generation. Some retailers (Target, Walmart, Kroger, Best Buy) have built upon their "first-party" data capabilities to pitch a service to brand advertisers, essentially selling the market analytics potential of the customer transaction data of their client base for targeting advertisements. In doing so, retailers join the media market alongside Facebook and Google, as well as Amazon.[86]

The workforce implications for these new retailer initiatives in gathering and using customer data are unclear. But they will be an important and growing part of the retail context in years to come.

Who Will Control the Data?

Retailers face important choices for their future as they implement digital technologies. Many of the available technologies are connected to data storage and management functions. These may reside with an external company—the technology provider or a third party—instead of, or in addition to, the retailer. Such a system favors the operators with the strongest capability for data analysis, with Amazon until now the strongest among them. For example, some vendors argue that retailers seeking to quickly implement cashier-less checkout may hand over their data to Amazon if they license the company's "Amazon Go" technology. Amazon Go's competitors contend that retailers' customer data are safer with them.[87] In this and other instances, the question of who owns, controls, and ultimately deploys data analysis to their own profit is a growing industry concern. Of the major cloud-based data management companies—Google, Facebook, Amazon, and Microsoft—only the last is not in the retail or data selling/mining business.

We expect these considerations to be a factor in the organizational choices made around both the adoption and implementation of these technologies. The overall profile of retailers'

implementation of new data gathering and crunching systems is an uneven landscape, reflecting the uneven adoption we have recounted for each of the subsystems. Market leaders have experiments and limited rollouts well underway. The vast majority of retailers, on the other hand, are either undertaking far more selective pilots, waiting to see which tools become consensus choices, or simply finding themselves shut out by the cost and management capacity requirements of currently available systems. But given the high level of concentration of retail employment in a few large companies, the concerted push by those few has an outsized footprint.

What Technologies are Likely to be Rolled Out Sooner Than Others?

As we noted at the outset, store-based retail is likely to continue to dominate sales for a long while. Amazon and other pure-play online sellers have taken a growing bite out of store-based sales, but show no indication of displacing them. Still, in response to disruption and further competitive pressures in a sector that already has been transformed by discounting models and rising firm concentration, store-based retail displays limited pockets of technology investment so far. The full integration of artificial intelligence in operations (in store, in inventory management, and in shaping demand) is still a long way off in most retail chains.

Online and omnichannel activities will continue to outgrow physical stores in the near and mid-term, but it is difficult to anticipate what *combination* of channels is most likely to prevail. As of now, we expect that customer uptake of click-and-collect orders over delivery will directly affect the survival of stores and volume of store-based retail jobs. Not surprisingly, store-based retailers, which have a large installed base of potential pickup points (namely stores), are pushing Buy Online, Pick Up in Store (BOPIS), whereas Amazon is promoting home delivery (though combined with pickup lockers and with grocery click-and-collect services in its Whole Foods stores). We, like others, expect the prevailing pattern will be click-and-collect formulas rather than delivery. But in fact, even this expectation is a sign of how quickly the terrain of options shifts: home delivery was widely discussed as the future of retail when this project started just two years ago.

While Amazon has achieved domination online, a series of physical-store stumbles make it appear unlikely that it will similarly dominate physical retailing.[88] How quickly the company adapts to the challenges of integrating online capabilities with running physical stores, and how, will surely impact store retail, but the strategies of such physical-store leaders as Walmart and Kroger may prove more consequential.

With these caveats, plus the large caveat of uncertainty about the long-term effects of the coronavirus crisis, we venture the following list of "function plus technology" combinations likely to roll out on a large scale in retail chains:

- First are those technologies that permit full implementation of click-and-collect shopping. These constitute a long list, including an easy to use website, accurate and fast inventory tracking, software and devices to assist with order picking, other equipment such as lockers or kiosks, and coordination of customer pickup.

- Labor- and cost-saving options *already at hand* will experience more widespread rollout. These can include automated systems, labor-enhancing systems, or ones that shift work onto customers. Self-checkout machines are the most visible example; as we have noted, they are depicted as "automation," but actually transfer the cashier's work to shoppers in the name of "convenience." It is less clear to what extent other emerging automation options—particularly technology-intensive ones—will prove attractive, particularly when options that entail shifting tasks onto the customer can be developed.

- Overall, technology solutions entailing a light investment in equipment but a significant payoff in facilitating shopping for customers are likely to be more readily adopted. For example, tablets enabling staff to check inventory, provide product information, and check out customers are likely to become widespread.

- In response to the threat of pure-play online food retailers in particular, automated micro-fulfillment centers (MFCs), especially for dry goods in groceries, and boxed goods more generally, already are expanding, and probably will continue to do so. Though cost constitutes a barrier, small MFCs are more affordable, quicker to set up, and have smaller break-even requirements in terms of number of online orders than large, centralized fulfillment centers (despite the fact that in the long run, centralized warehouses can achieve higher productivity). So we expect steady, if not rapid, growth.

- In contrast, technologies likely to have a longer lead time to extensive adoption and rollout include virtual interaction with products and/or staff, advanced computer vision-enabled inventory tracking and customer identification technologies.

SECTION FIVE:
What to Expect in Future Employment Changes

Armed with a sense of the factors facilitating and impeding new technology adoption, and with a relatively fine-grained scan of the technologies currently in play in retail, we can look toward the future. In assessing likely retail employment futures, we emphasize that it is risky to generalize. The impacts of technology differ, and will continue to differ, by subsector and occupation. There are sure to be racial and gender differences as well, in large part because of occupational segregation and concentration by gender and race. The pandemic brings the possibility of speeding along changes, like the shift to e-commerce, but the accompanying recession also brings the possibility of slowing them down, both because retailers will lack funds to invest in tech, and because the recession is putting an end to the labor shortage that gave urgency to efforts to reduce headcount.

We also stress that any predictions are contingent. Companies in the retail sector have a set of choices to make. To what extent will they use the power of data analysis to support workers, and to what extent to surveil and control them? As workers gain access to more information from varied sources, will they function more as well-informed experts, or more as servants attentive to shoppers' every need? Changes in job content are not likely to fall completely on one extreme or the other. Rather, they are likely to be double-edged, with workers using more advanced tools and drawing on more data, but also more closely watched and held accountable for a wider range of outcomes. Even so, given retailers' track record over the last several decades, we see the most likely prospect that, rather than being improved, jobs will be loaded down with more responsibilities and entail closer monitoring of workers' performance. The reported frequent disjuncture between stated company policies on worker safety measures amid the epidemic and actual on-the-ground practices underscores this longstanding pattern. Avoiding such negative outcomes would require significant public policy shifts—such innovative policy choices are both possible and desirable, and we review some of the possibilities in Section Six of this report.

We take up future change in two slices. First, we consider technological change's possible implications for the *nature* of retail jobs, including the mix of tasks and working conditions. Second, we turn to possible trajectories of change in the *numbers* of store-based retail jobs, overall and by category—including likely areas of relative or even absolute decline in employment as well as likely areas of growth. Throughout, our time frame is approximately the next five to 10 years. When considering future changes in retail jobs, especially quantitative ones, it is important to underscore that even if forecasts of *possible* technology-driven job losses (some of which we review below) are correct, that by no means implies all this automation actually will occur.

The Nature and Quality of Future Retail Jobs

The nature of retail jobs includes the mix of tasks involved in jobs as well as the working conditions and other job characteristics. Our discussion will cover wide-ranging potentials posed by new technologies, possible directions of change for the largest occupations, new jobs likely to grow within retail, and the actual changes that materialize in retail jobs contingent on choices by retailers, consumers, and policymakers, as well as responses by worker representative organizations.

In broad strokes, there are two divergent ways that retail jobs could change. On the one hand, the future may bring what we call a *supportive* shift that empowers retail workers by giving them access to more information and more space for discretion. We heard many predictions—by retail executives, tech companies, and consultants—of upgrading of the skill and promotion opportunities of retail workers as they are freed up from routine tasks and as stores shift to a more "experiential" focus for shoppers. On the other hand, retail jobs may take a *coercive* turn, including work intensification and surveillance. Work demands could increase due to the wider range of simultaneous activities and greater direct responsibility for "conversions" of customer inquiries into sales.[89] It may well become more coercive due to the combination of close electronic surveillance and intensive task management, and potentially even scripting for interactions with customers. Both the wider range of tasks (which theoretically could mean richer work experience) and machine-driven (prescribed by management or algorithm) organization of tasks and speed could increase the drudgery factor, and could lead to speedups, increasing stress.

Though our interviewees did not express an intention to move in this direction, the potential certainly exists—and many jobs in "neighboring" sectors, such as warehousing and call centers, have followed this path. The reality almost surely will be mixed: some jobs will include more supportive features, while others become more coercive. Some small steps toward a more "experiential" version of retail already are taking place: for example, in the months preceding the coronavirus crisis, Target launched an initiative to restructure staffing to broaden many

workers' responsibilities to include all aspects of a given department, and to shift more stockers from night shift to day shift so they can answer shopper questions—all in the name of better customer service.[90] We follow the coercive and supportive threads through the rest of this discussion.

Now consider the largest store-based occupations, starting with *sales jobs*. As the demand for cashier and salesperson labor diminishes, we expect to see more "cashier plus" and "salesperson plus" jobs. We already see this happening in various ways. As noted above, salespeople, especially in apparel, are having online interaction with potential e-commerce customers added to their portfolio of tasks. Handling curbside handoffs of merchandise to e-shoppers is a natural extension of the brief customer interactions typical of cashier jobs. Retailers such as Target and Walmart also have untethered some cashiers from cash registers, sending them to roam the aisles armed with tablets to answer product queries and check out customers.

As these jobs continue to evolve, both supportive and coercive trajectories are possible. On the supportive side, the collection of big data on customer preferences can allow salespeople to take "clienteling" (communicating with customers based on what is known about their needs and preferences) to a higher level, serving as sagacious advisers with substantial discretion. Likewise, shifting cashiers away from regimented bar code scanning and toward more varied interactions with customers could make their jobs more interesting. On the coercive side, more information and wider responsibilities could come coupled with more intense pressure to perform, exacting monitoring of that performance, and unchanged or even reduced levels of power to make decisions for oneself.

The content of *stock clerks' jobs* seems destined for more radical change than any of the other major retail job categories. Currently, stockers are responsible for organizing goods on the shelves, keeping them attractively arranged (for example, by "facing" them so there is a uniform line of items along the front of the shelf), and ensuring they are correctly priced. Store-based fulfillment creates new stock-handling roles. Clerks are likely to increasingly be shifted to picking stock from store shelves to assemble orders. As store-based and store-adjacent micro-fulfillment centers (MFCs) spread, so will jobs tending them: feeding stock into the bins, taking assembled orders out, and troubleshooting problems with the automated parts of the system. These new stocker roles could be handled by creating "stocker plus" jobs or entirely new jobs.

It appears that picking (when done in house) is starting out as a "stocker plus" duty, but most likely as it scales up it will be performed by employees dedicated to this task; MFC tending, because of the learning curve and the potential dangers of fast-moving robots and conveyors, is being performed by specially trained workers from the start. Of course, in many cases in-store picking is being carried out not by retail employees but by platform-based "independent contractors" working for companies like Instacart and Shipt. However, both interviewees and press reports[91] point to problems with reliance on third-party companies—above all, the fact that Instacart and its kin, rather than the retailer, collect data on the customers—and we expect

that at least larger retailers will move away from using third-party companies, though they may adopt the independent contractor employment model themselves. Certainly, some companies (e.g., Jyve and Hyer) are offering "job brokering" services based on an "independent" contractor model to handle these order-picking and delivery tasks as well as a broad array of other store jobs. It is unclear to us, at this point, whether core functions of stores routinely can be handled primarily with a workforce employed on a "gig" model.

On the other hand, e-retail warehouses often are staffed by temporary agencies, and it is possible retailers over time will gravitate to this model for micro-fulfillment centers as well. All these transformations of stocker jobs could, once again, follow supportive or coercive paths. Stocker jobs could become more varied and interesting, and could incorporate more customer interaction—for example, if stockers handle curbside handoffs. Because digital systems sometimes fail, retailers are likely to place a premium on the ability to troubleshoot those systems, and/or to be familiar with analog alternatives—though most likely the goal would be just to have one person with these abilities per shift per store. Automation also may reduce hazards by mechanizing some of the heaviest work, such as unloading trucks. However, even in a best-case scenario it is hard to envision substantial increases in worker discretion. And a darker future of surveilled, closely watched, sped-up, and stressed stocker jobs seems very possible.

Baseline duties for *supervisors and managers* include a high volume of relatively routine tasks (such as scheduling store staffing, implementing sales promotions, scanning reports) as well as non-routine low-stakes decisions (e.g., reviewing departments' proposed changes in merchandise order levels, choices about displays), all of which add up to affect store sales. Given the possibility of turning over many routine and some non-routine decisions and communication to algorithms, managers and to a lesser extent supervisors are likely to experience growth in both old and new kinds of non-routine tasks, including greater supervision activities (around customer interaction). This shift may involve more interaction with store staff, but seems more likely to tilt toward more interaction upward in the management chain. The supportive version of this transformation would entail freeing up managerial workers from tedious decisions, greatly expanding managers' information base via AI summaries and interpretations of data, and the potential of significantly greater discretion. The coercive branch in the road instead would involve highly automated algorithmic management of managers' tasks along with closer monitoring, diminishing opportunities for judgment rather than increasing them.

In addition to shifts in these major occupations, we would expect to see growth in a number of other job categories. For one thing, store-based fulfillment will involve much more delivery labor—whether carried out by the retailer itself, a subcontracted company, or independent contractors. Though these jobs could be shaped somewhat supportively (with more emphasis on positive interaction with the customers), they seem more likely to be tedious and subject to high pressure to accelerate deliveries. (Outside of high-end markets, the push to control delivery costs would drive job quality down.) We also can expect some increases in jobs devoted to

providing shopping "experiences" to consumers—jobs that are more likely to have a positive and even creative side. For example, more grocery and kitchen supply stores are likely to offer cooking lessons (as Sur la Table has been doing for years) or nutrition tips; more stores of all kinds may organize festive events. However, the number of added chef, nutritionist, or event organizer jobs are likely to be quite small. Conceivably, rather than new jobs per se, some culinary skill contents may be incorporated into department manager jobs, while some event coordination skills could be imparted to existing store clerks.

Also on the smaller side, but almost surely growing in number, will be tech workers, such as people skilled in running and maintaining robots, transmitters, and sensors, and the systems they are part of, and others skilled in data science and analytics. But these are likely to be based in small numbers at the regional level (system maintenance) or in centralized facilities (data science)—or, in many cases, the duties probably will be outsourced to tech providers, at least in the early years of implementing these technologies.

Regarding the largest retail occupational groups, will employers primarily use technology to enhance the supportive features of jobs, or render them more coercive? We heard many predictions—by retail executives, tech companies, and consultants—of upgrading of the skill and pay of retail workers as they are freed up from routine tasks and as stores shift to a more "experiential" focus for shoppers. However, for decades, the bulk of retailers has not diverged from the habit of treating labor as a short-term adjustment variable, and labor costs as a cost liability. This general attitude has translated to the deployment of past technologies: for instance, the technological breakthrough represented by bar codes could have been used to free up cashier time for more meaningful and unscripted interaction with customers—but instead it was used to speed up checkout, with monitoring of scan rates a key management tool at most retailers with cashier stations. Similarly, as scheduling software facilitated closely matching headcount at any time to projected demand, most retailers used this capacity to create shorter, more variable, and more unpredictable shifts.

The pandemic put grocers and other retailers that suddenly had become "essential" businesses to the test, and as of this date their choices regarding worker safety have provided further, disturbing evidence that many retailers place little value on worker engagement and empowerment. Early press coverage reported shortages of protective gear and sanitizer, insufficient access to sick leave, and widespread instances of managers—including at the largest chains—ordering workers not to wear masks or gloves because it would frighten or alienate customers.[92] Large chains since have announced a number of safety measures, but alarmingly, reports of unsafe conditions have continued, in some cases documenting that official company-level policies are not being followed at the store level.[93]

In a late April 2020 survey of essential workers in Western Massachusetts, retail workers were the group most likely to say they felt unsafe—far outstripping even health workers.[94] Workers at a variety of companies have staged repeated one-day strikes to protest safety lapses.[95] One

more positive indicator is that in California, the governor, the California Grocers Association, and the United Food and Commercial Workers union hammered out a statewide agreement on retail safety measures.[96] But this appears to be the exception that proves the rule—elsewhere, with state governments not enforcing guidelines, retailers all too often have proven lax on coronavirus safety.

Most likely, similar patterns of insufficiently considering impacts on workers and working conditions will play out with new digital technologies at work. If retailers, in consultation with tech providers, are left to decide without input from other stakeholders, we have difficulty envisioning a significant divergence from this longstanding approach of coercive measures narrowly targeting production efficiency—especially in an environment in which technologists are offering retailers numerous tools that pitch labor-saving and cost-saving benefits. We expect that, at best, there will be very limited departures from the status quo of low-wage, low-credential requirement, high-turnover, fluctuating-hours jobs in retail, and we expect technology's new capabilities for surveillance and detailed direction of work to be added as an overlay in more and more retail jobs.

High-end retailers will build in greater discretion in order for employees to provide the level of personalized, above-and-beyond service that makes them distinctive. And even at more mainstream merchants, we do expect to see some jobs with enhanced capacities, more respon-sibilities, and more intensive customer interaction, but on the whole we anticipate these will be few in number and represent a small share of the total retail workforce. Moreover, it is not clear their pay will be appreciably higher.

The Number of Retail Jobs

This discussion focuses on the role of technology in altering the future number of retail jobs. Any number of other factors, such as a recession triggered by the COVID-19 epidemic, would of course also affect jobs, but for the purposes of this report we set those aside. We restate, however, that likely job trends will depend on the choices retailers make, which will depend in turn on whether and how policymakers choose to alter the regulatory landscape.

E-commerce's Impact

The technological changes under way in retail are likely to affect store-based job counts through two channels: the growth of e-commerce and the automation of store-based processes, along with new technologies that shift work onto consumers. E-commerce will have an important impact on the number of jobs, but a limited one. On the one hand, stores will evolve, not disappear. Most relatively large future stores likely will have more workers fulfilling click-and-collect and home delivery orders, in addition to continuing to support in-person shopping

and, in a more limited subset, varieties of experiential retail. On the other hand, the continuing growth of e-commerce seems likely to shift more retail functions away from stores and to logistics (warehouses and delivery services), continuing recent trends. Some click-and-collect traffic may be directed to freestanding pickup facilities not linked to a store. Thus, overall retail employment is likely to decline, at least relative to the growth that would have been expected.

The relative or absolute declines almost surely will be greatest among salespersons and cashiers, extending recent trends. This is true because e-commerce typically replaces outright the main functions of these occupations: showing merchandise and offering information to consumers, registering their selections, and taking payment. In contrast, to the extent that the e-commerce-supporting functions of locating and moving stock for delivery take place in the store, they represent new activities for stock clerks—though of course to the extent they bypass stores altogether, they will erode store-based stock clerk jobs.

Certain retail subsectors will be particularly vulnerable to replacement of store-based labor by logistical labor. We expect the biggest losses (relative or absolute) in store-based jobs to take place in sectors and companies with one or more of the following characteristics:

- Standardized products (little tryout or comparisons involved)

- Low- to moderate-cost items (little "selling" involved, as opposed to large purchases and luxury goods)

- Portable goods that are not fragile or perishable (easy to deliver or transmit via click and collect)

- High volume sales (likely to attract the attention of cost-cutting retailers and would-be disruptors)

- Purchases not dominated by lowest-income consumers (so there is a group of consumers with disposable income, willing and able to pay the extra costs of picking and delivery)

- Based in rural areas and in older suburban malls, where retail job losses already have been concentrated

These factors line up with the hits that apparel and general merchandise already have taken. We do agree with other analysts that there will be growth in online sales of fresh food, luxury goods and some other merchandise categories that do not meet these criteria—but our assessment is that this broader expansion likely will be fairly limited in the next five to 10 years, and the prospect of a COVID-19-induced recession makes these prospects even dimmer.

Technology's Impact on Job Losses

Some high-profile studies projected very large-scale retail job losses due to technological change, even before the COVID-19 crisis. Bain & Company forecast that between 2015 and 2030, retail productivity would increase 49% (this translates to a 2.7% increase per year, far brisker than recent productivity growth, which has been sluggish).[97] A productivity bump of this size would mean that as of 2030, it would take two-thirds as many people to produce a given amount of output as in 2015. A Brookings Institution team reported an even more ominous estimate: 53% of total retail jobs, including 47% of retail salesperson jobs, will be susceptible to automation "by 2030 or in [the] next decades."[98] Even taking into account expected economic growth, McKinsey Global Institute (which generated the model underlying the Brookings predictions) forecasts the absolute number of retail jobs in 2030 to be almost 5% lower than in 2015—a dramatic reversal for a sector that has long grown in step with the economy as a whole.[99]

To put startling projections like these in context, as noted above, we must remind ourselves that not all available technologies actually will be implemented. Given the considerable barriers to rapid adoption of labor-saving technology that we have identified, we expect actual job losses over the next five to 10 years to fall far short of these predictions. At the same time, as we emphasized previously, we should not expect significant "scale effects" (increased sales triggered by technology-induced decreases in selling costs and therefore prices) to offset labor-saving technology's impact on jobs, unlike in other sectors such as manufacturing.

As with e-commerce, labor-saving technology is most likely to strike soonest and most strongly at cashier and salesperson jobs. Self-checkout, though not very popular with customers, is likely to get expanded, especially now that "dual use" cashier stations (usable for cashiering or self-checkout) are now in use. And a variety of new versions of partially or completely automated checkout are being pitched by tech companies and in some cases already are being piloted or scaled up at companies such as Amazon, Sam's Club, Kroger, Macy's, and Ahold Delhaize (which includes familiar banners such as Food Lion, Giant, and Stop&Shop). Still others are in use abroad in Europe, China, and elsewhere. All of this points to likely erosion of point-of-sale jobs. As noted, the term "automation" often gets applied to changes that consist less of automation than of a shift of labor from workers to consumers. "Automated checkout," for instance, gets used to describe truly automated systems like that of Amazon Go, but also self-checkout and "scan and go" systems that simply use new technology to transfer the cashier's tasks to shoppers. Of course, whether machines or shoppers do the work, if cashiers are no longer doing it, jobs are lost.

While cashier and sales jobs are vulnerable to these current and emerging technologies, technologies with the potential to take a major bite out of stocker jobs are farther off. To be sure, some present-day tech tools do replace stock handler labor: automated electronic price

labeling, smart shelves that additionally can in some cases detect items that are misplaced or in need of restocking, scanning robots that can spot spills or gaps in stock on the shelves, and machines to unload boxes from trucks all fit this description. But the bulk of stock clerk labor is and most likely will remain much harder to automate, precisely because—unlike state-of-the-art warehouses—the existing huge pool of stores and even the new stores currently being built are designed for humans rather than robots, and frequented by humans (customers) who are not under the business's direction.

Mid-market mass merchants are likely to be the main adopters of labor-saving tech tools. We don't expect much automation at the high end of retail because it would clash with customers' expectations for luxurious service and ambience. (One of us overheard a Tiffany's representative asking an engineer about his company's shelf-scanning robots at a trade show; she concluded, "Interesting, but I don't think it would fit with the atmosphere we're looking for in our stores.") At the low end—think dollar stores and other deep discounters—pay and benefits are extremely low and staffing is thin, so there would be little payoff to labor-saving technology. That leaves the middle of the market. And in that middle zone, it is the mass merchants that muster large enough sales volume to reap economies of scale in tech investments.

A Closer Look at Whose Jobs are Most Threatened

Where should we expect job losses—or at least slower-than-expected job growth—when we put together the effects of e-commerce and labor-saving technology? We already have signaled the likely big-picture trajectory, but here we take a more fine-grained look and also discuss the implications in terms of the gender and racial mix of the retail workforce. Recall that the main store-based occupations are salespersons, cashiers, stock clerks, managers, and supervisors. We examine these in three groups.

Salesperson and cashier jobs face the largest threat. Headcount in both categories probably will continue to be undermined by *both* e-commerce and labor-saving tools. But again, we do not expect these effects to come close to the apocalyptic predictions of major consulting companies Bain, Brookings, and McKinsey in the next decade. And e-commerce is creating new configurations of the tasks traditionally associated with cashiers and salespeople. For example, "style consultants" at women's apparel retailer Chico's now are engaging in remote FaceTime conversations with customers in addition to speaking with them in stores; curbside handoff of BOPIS purchases generates a new task and potentially a whole new job. We do not expect the growth of new roles like these to reverse the decline in cashier and sales jobs, but it will temper that decline to some degree.

Employment erosion likely will be more limited among stock clerks over the next five to 10 years. As noted, e-commerce will have mixed impacts—shifting some sales away from stores altogether, with concomitant thinning of store-based stocker ranks, but also expanding

store-based order fulfillment that will translate into redeployment rather than elimination of stocker labor. And labor-saving technology is so far just nibbling around the edges of these jobs.

Potentially more at risk than stocker jobs are store management and supervision positions. Store managers' jobs are not going away, but productivity-enhancing technology may thin out the ranks of secondary managers and supervisors in larger stores. Electronic surveillance that uses AI to interpret what cameras or other sensors are seeing makes direct human surveillance of workers and shoppers less necessary. Increasing sophistication of worker scheduling software, including allowing employees to choose their own schedules and swap shifts without managerial intervention (within specified parameters) has the potential to shrink one major management activity. AI-guided task management software that prioritizes employee tasks and tracks their completion automates another such activity.

Except for scheduling software that is longstanding, these technologies are relatively early in their development, not in use at scale, and are not likely to spread across the entire retail sector soon or perhaps ever. And the ability to reduce managerial headcount is limited by the remaining managers' and supervisors' capacity to absorb and act on the data generated by these systems—though algorithms may scold or exhort employees and even may decree disciplinary actions (as in Amazon warehouses), for now we still need humans to motivate workers and actually carry out terminations. However, the higher pay of supervisors and especially managers does make them a tempting target for downsizing, and we expect to see some (relative or even absolute) reductions in their numbers by the latter part of the coming decade.

Because cashiers and salespeople are disproportionately women, job losses in retail almost surely will hit hardest at women—many of them women of color, especially in the vulnerable general merchandise subsector. The loss of cashier jobs, along with associated jobs such as baggers in grocery and big box stores, is of particular concern, because this is the most common entry point into retail for women and young men, including those with few or no credentials— and a pipeline into higher-paying jobs, including supervisorial ones. Any reductions in stocker ranks will have an outsized impact on Black and Latino men. Managers and supervisors are disproportionately white and male, so job reductions in management likely would skew toward that profile as well; in addition, fewer managerial jobs translate into fewer opportunities for upward mobility within retail. And as noted, the growing e-commerce sector, one of the two major forces displacing store-based retail workers, is more white and male than the rest of retail (and far more so than general merchandise).

Final Thoughts on Likely Job Impacts

In short, if retail employment continues the long-run trajectory we consider most likely, we can expect to see continuing, concentrated job losses (at least in relative terms) and a persistent preponderance of low-quality jobs, most likely characterized by increased digital monitoring and supervision. This will be on top of store closings and company bankruptcies triggered by the coronavirus epidemic and the resulting recession. Diminished employment opportunities most likely will particularly hit women, who are concentrated in the cashier and salesperson jobs where recent thinning out is likely to continue. People of color could be impacted strongly in some occupations and subsectors, and in particular the stocker jobs disproportionately held by men of color are likely to become more regimented and closely surveilled.

For all of these trends, ongoing growth in the dominance of discounters has pushed, and seems likely to continue to push, in many of the same directions as technological change. Retail consolidation, and in particular the climbing market share of several giant discounters (with Walmart and Target in the lead, but also including fast-growing grocer Aldi and the dollar store chains), is likely to intensify the trends, especially since the largest companies with the deepest pockets—notably Walmart and Target—are in position to make major investments in technology rollout and reorganization of work.

Though we see this discouraging future for retail jobs as the most likely future, we emphasize that the actual future of these jobs will be the outcome of a set of choices. First and foremost, that future is shaped by retailers' choices. However, as signaled above, if all else remains equal, those choices will be severely constrained by the ubiquity both of low-price competition— Walmart's Everyday Low Prices as well as the even more cut-rate pricing of deep discounters like the dollar stores, TJ Maxx, and grocers Aldi and Lidl—and of the "convenience arms race" currently epitomized by Amazon's push for next-day and even same-day delivery.[100] Consumers' choices also will have an impact on the nature of retail jobs going forward. But though the pocket guide "Shopping for a Better World" sold briskly in the 1990s, the evidence is that most of us only are willing or even financially able to shop for a better world if it does not involve sacrifices in terms of price or convenience.

The ultimate backstop, then, is the choices we make as a society via laws, regulations, and collective bargaining. Laws setting a higher minimum wage or safeguards on worker privacy, or strong unions bargaining on these and other issues, potentially could close off options built around low job quality and coercive management, and steer retailers toward a more supportive job profile. In the concluding section of this report, we briefly review the report's findings, and then return to the choices that will make a difference for future retail jobs.

SECTION SIX:
Key Areas of Strategy and Policy

As we have emphasized throughout this report, the use of technologies has a variety of possible implications for work and workers. New technology can make jobs more supportive and empowering to workers, or more coercive and surveillance-intensive—or both in different ways. It can wipe out jobs, and also create new ones. In this final section of the report, we discuss a set of policies aimed at minimizing the most negative scenarios for job quality, accentuating technology's supportive potential, taking the edge off job displacement, and in general creating an environment characterized by fair treatment and concern for workers as well as management's rights and needs. Policies aimed at worker and consumer safety rightly have been at the forefront during the pandemic, but it also is important to think through longer-term policies appropriate for regulating retail's process of adopting new digital technologies. We first explore policies targeted directly at job quality and displacement, then turn to broader policy levers, and finally consider the prospects for strengthening processes of negotiation around these issues.

Policies Governing Individual Worker Experience and Compensation

Since the majority of retail workers are not represented by a union, they only can rely on legislated protections, and only if these are consistently enforced through more reliable mechanisms than are now available for the implementation of many other labor standards.[101] In this section, we review laws targeting individual workers in jobs, and in the next section we consider broader legislative tools.

Worker Privacy, Autonomy, and Nondiscrimination Protections

Most discussion of privacy has been focused on consumer privacy, but this debate could be leveraged to legislate protections for worker privacy that would limit technologically enabled monitoring and overly intrusive use of artificial intelligence (algorithms, computer vision). Legal safeguards to protect individual workers' privacy may be similar to those for customers.

Digital technologies that observe customer behavior (even if the customer is not identified), as well as those that identify customers, can both identify workers and keep a record of their behavior. As noted, computer vision-backed video recording on the store floor can support a systematic analysis of worker behavior (including with whom they speak). Similarly, missed scan technologies designed to observe checkout processes (monitor errors and theft) also can observe other cashier behavior. Personal cell phones, when used by workers to interact with scheduling systems, conceivably could be used to monitor behavior even during off hours. Supervisors of course have always observed workers, but these new methods permit worker monitoring to be more comprehensive and continuous, for observation data to be analyzed more systematically, and for conclusions to be drawn and even actions taken via automated processes.

Regulations that protect customer privacy in shopping settings could be extended to workers readily, offering some relief from surveillance. This would require that customer privacy laws be formulated in broad enough ways that the worker data captured at the same time as the customer data are protected in similar ways.

However, retail workers also will need protection of their rights *as workers*. It will not be sufficient to provide warnings such as "this may be recorded." For example, at a minimum there should be a ban on recording of conversations during lunch breaks and other breaks or of other private conversations on a personal cell phone. Exactly how a separation can be established between monitoring job-related performance and other behavior needs to be invented, in consultation with worker organizations, privacy protection experts, and technologists themselves. There may be ways to limit analysis of audio or video data via automated sorting mechanisms selecting job-related interactions only (e.g., with customer, with co-workers about display preparation). The European Union is far ahead of the United States in digital privacy regulation, and is planning to issue regulations on the use of artificial intelligence in 2020, so those laws may provide useful models for U.S. legislation at the federal, state, and even local levels.

Related but distinct from privacy issues is the realm of worker autonomy in personal choices regarding their relationship to work, and regarding how they balance a job with other demands (be they care responsibilities or other jobs). With most direct bearing on autonomy, scheduling apps or platforms that enable workers to check on their weekly schedule, indicate availability, and swap shifts contain information that managers in principle already have access to—

information that signals willingness to accommodate management scheduling requirements and that is already used by managers to select candidates for steadier jobs among part-timers. However, again, digital scheduling technologies capture and make available the *full* history of worker interaction with scheduling and enable a *systematic* analysis of workers' scheduling availability and willingness to alter their expectations and plans. Interactive scheduling software data collection capability may enable new management practices regarding scheduling (for example, finely gradated penalties for deviations from 24–7 availability from work, or designing shorter shifts) and further undermine workers' ability and willingness to signal their scheduling preferences.

Broader issues of algorithm bias—nominally color-blind or gender-blind algorithms that have discriminatory impacts—also arise as employers use algorithms to guide or even simply make a larger number of decisions. Case law that turns on discriminatory intent, which is the direction federal courts have been taking for decades, will do little or nothing to protect workers who are victims of this type of bias. Again, the European Union is weighing measures that would require some degree of human oversight and accountability for algorithm-driven decision-making.

The United States has a history of legislation protecting individual privacy but, as far as we know, little experience in protecting autonomy in decision-making regarding ways in which individuals relate to work, or regulating algorithm bias.

Whose Data? Emerging Issues

Technologies being implemented in stores can ever more easily collect, store, and analyze information about the behavior of individuals. The resulting data is now the property of retailers and possibly of the technology vendors that advise and often analyze this information for retailers. There may be a need for safeguards mandating how long video data that includes workers can be kept or how far up the chain within a corporation it can be transmitted, and governing who has access to it. It may be appropriate to guarantee workers the right to access any video or sound recording that is used as evidence for a disciplinary action, though this in and of itself is not sufficient without recourse processes for workers to contest such action. The retail industry, like others, has been reluctant to share information about its employment patterns beyond diversity data mandated for equal employment opportunity reporting. However, with the potential for analysis of large amounts of information on worker behavior, there also may need to be guidelines as to whether and under what circumstances such information can be mandated to be released to address legal complaints of differential treatment of population groups.

Minimum Wage Legislation and Other Mandates

For many retail workers, particularly those in part-time positions, the entry-level wage is set at the minimum wage—whether set at the federal or state level, or mandated by a local living

wage ordinance where applicable to retail. The overall wage scale for store clerks thus is directly affected by changes in the minimum wage, and minimum wage laws are important for assuring adequate earnings. A higher minimum wage does strengthen retailers' incentive to use automation to replace labor, but the weight of the evidence is that minimum wage increases typically have small and statistically insignificant effects on total employment in the region. As we write, the labor shortage of the late 2010s has evaporated, and a COVID-19-induced recession seems virtually certain to occur, which would leave the minimum wage as the main factor maintaining retail wages at a decent level.

Mandates affecting scheduling practices that are in place in several states or municipalities also may affect the ways in which new types of scheduling software are implemented. The local coalitions of advocates that have given rise to scheduling mandates (for instance, advance notice of schedule or of cancellation, reporting pay) may well become actors in bringing to public attention the limitations on worker choice imposed by some of the newer tools being implemented.

Addressing Worker Displacement

"Creative destruction" is inherent to capitalism, and economic progress will always involve declines in some jobs and growth in others. We have argued throughout that store-based retail will survive and continue to employ large numbers. However, our findings also point to the likelihood of large job losses in some parts of the sector. In the short run, we expect to see a continuation of employment losses through store closings and bankruptcies in the most vulnerable parts of the sector, especially department stores and brick-and-mortar centered apparel retailers—in part due to the growing role of e-commerce, though in large part due to competition from discounters. In the somewhat longer run, we see a likelihood of significant decreases in cashier jobs across retail subsectors with the spread of cashier-less technologies.

Two kinds of responses seem promising in softening these blows. The first is to increase broad supports for unemployed and displaced workers to help them transition to other work. Greater availability of unemployment insurance, retraining programs designed for former retail workers (including ones helping workers gain new skills at community colleges or other higher education institutions) following on the experience with the Trade Adjustment Assistance program (addressing manufacturing job losses), and a stronger health insurance safety net would be part of this package. The second response is more proactive: in the case of large retailers undertaking rapid technological change that eliminates jobs, a variety of actors can press them to take more responsibility for helping displaced workers move to new jobs, either within the company or elsewhere. Retail unions and state, local, and federal government all have levers they can use to incentivize retail enterprises to shoulder more of this responsibility. New Jersey has taken the lead by requiring employers that make mass layoffs to give workers severance pay[102]; other jurisdictions, including the federal government, would do well to follow their lead.

Policies Affecting the Industry as a Whole

Action in two additional broader policy areas—both active areas of policy debate and experimentation at the state level currently—is likely to significantly affect technology's impact on store jobs. On the one hand, the tax treatment of e-commerce may shift the competitive balance between online and in-person sales. On the other hand, struggles to define who is an employer, and what their responsibilities include, cast a broad net with implications for retail as well as a wide range of other sectors. In addition to discussing these two policy domains, we touch briefly on local requirements that all stores take cash.

The taxation of e-commerce at the point of sale long has been advocated by local economic development advocates and even policy actors of some states as a response to the threat from e-commerce, particularly pure-play companies with large numbers of warehouses and almost no stores, such as Amazon.[103] Taxation of e-commerce sales would level the playing field with store-based retail and drive up the cost of e-commerce, making it less attractive to customers and therefore to retailers. It may drive sales toward click-and-collect options instead, a trend that store-based retailers prefer, on the whole, because it avoids the costs and unpredictable complexities of deliveries (particularly for groceries), and facilitates opportunistically augmenting online sales with in-store sales. Were taxation to result in higher prices for delivered goods, more jobs are likely to remain in stores than otherwise would be the case.

California's policy approaches may prove to have an indirect effect on stores. The *Dynamex* decision ruling that many so-called independent contractor drivers are in fact employees, and the resultant implementing legislation, (California Assembly Bill 5)[104] could prove influential if other states or even the federal government pick up on this standard (some states, such as Massachusetts, already apply similar standards). These approaches directly affect the reliance on independent contractors—often called gig workers—on the part of third-party delivery companies such as Instacart, and indirectly will affect the mechanisms through which grocery companies, in particular, organize the fulfillment and delivery of online orders. If this policy tool spreads quickly, grocery chains and other retailers may find there is a benefit to directly hiring their own delivery drivers, little cost difference to the customer between the chains' delivery and that of third-party companies (as long as the order volume is of significant scale), and a particular advantage to retaining data about shopping patterns of their own customers (rather than it being appropriated by the delivery company). The extension of unemployment insurance eligibility to gig workers during the COVID-19 crisis may serve as a precedent for extending more employee protections to this workforce. However, providing limited, nonequivalent, protections to a "third category" falling between employees and independent contractors, as some have proposed, offers far less of a safety net than employee status like that conferred by California's Assembly Bill 5.

Finally, the requirement by some localities (notably New York City) that all stores take cash has more limited implications for retail workers.[105] (Discussion of similar legislation also has begun at

the federal level.[106]) The motivation is in part to prevent cashier-less retail models like Amazon Go from excluding shoppers who lack electronic means of payment. The requirement can be met with machines that accept bills and coins, so these laws do not imply that stores must be staffed by cashiers. But the laws do preserve functions that currently require human intervention (emptying cash machines, if not directly receiving money), and add complications that may marginally delay the spread of cashier-less technologies.

The Space for Negotiation

As noted, the retail sector currently has low rates of collective bargaining coverage, but where unions are active, primarily in grocery retail and especially on the East and West coasts, unions long have engaged with issues of workload, compensation, and organization of the work. In unionized grocers and other retailers, collective bargaining over the implementation (possibly even the choice) of technologies—how much input workers will get in the plan for upgrading technology, and how much feedback on how the equipment works—would make a significant difference not only to ultimate job quality outcomes but to the transparency and accountability of the implementation process itself.[107] Bargaining could help set ground rules for undertaking new technologies, address resistance, and potentially improve both job quality and efficiency, particularly if coupled with ongoing consultation on specific issues. It could come with counterparts such as progressive replacement of workers if automation of specific tasks is planned. Other important counterparts could include the inclusion of positions created by click-and-collect activities such as order pickers or "shoppers," as well as delivery workers into the bargaining unit where these jobs are being created by the retailer. Mechanisms for safeguarding worker privacy and autonomy could be taken up as issues for bargaining or grievance handling. Representation of unions and other worker organizations on boards would be a fruitful additional channel for workers' voices in company decisions.

For more retail workers to have access to negotiated implementation and input into these processes, they would need representation. There are currently no representation options outside of unions and policy advocacy organizations. The expansion of the scope and strength of unionization, as well as of new worker advocacy networks like United for Respect (formerly OUR Walmart), could improve possibilities for negotiation and worker input around the implementation of technologies. At a minimum and already, such organizations may provide ways for workers to communicate with each other that are alternatives to internal company-run apps. One such example is the "WorkIt" app created by United for Respect that serves as a tool for sharing information (about policies) as well as working experiences that preserves worker anonymity, safe from management scrutiny.[108] More recently, the group has launched a Walmart COVID-19 Tracker through which workers share information about infections and working conditions.[109]

There also have been repeated attempts by parts of Amazon's workforce to form unions, though so far the company has successfully repelled these attempts in the United States.[110] A new organizing front has opened with tech worker organizing around issues as varied as gender discrimination and harassment, and applications of technology to military and repressive uses, and this wave of activism has reached retail technology workers. For example, workers of online retailer Wayfair held a June 26, 2019, walkout over Wayfair selling furniture to migrant detention facilities.[111] It remains to be seen whether the demand for representation and input of the retail-based technology workers also would help store-based retail workers gain a voice in the use and deployment of digital technologies in their stores.

A related policy proposal well worth considering calls for states to establish worker safety and health councils, elected by all employees and contractors who work closely with the employer, for all workplaces larger than a certain size.[112] The distressingly frequent instances of retailers neglecting or even actively obstructing worker safety measures during the COVID-19 crisis underscore the importance of institutionalizing a worker voice on health and safety issues. But the value of such a channel for communication, advocacy, and discussion with management is not limited to the extraordinary circumstances of a pandemic (nor to retail jobs alone). And a representative forum for discussing workplace safety could serve as a steppingstone toward worker-management consultation and negotiation on a wider range of issues.

Turning back to our main focus on technological change, both unions and policy organizations also can play a role in highlighting the ways in which in-store workers are consulted, or not, as companies roll out new tech. Importantly, they can play a significant role in flagging where important choices are being made and, where appropriate, calling them into question. For example, they can point out that in-store workers be considered for training in equipment repair or troubleshooting, rather than the tasks being assumed, without prior consideration, to be outside the purview of store workers. (It may turn out that all such tasks will be deemed too technical, but the question is worthy of consideration.)

Quite importantly, representative organizations can call attention to gender and racial-ethnic compositional consequences of choices of technology implementation; if there are consequences of particular choices of implementation for the diversity of a chain's front-line workforce, the workers but also the chain itself stand to be alerted. We have noted the risks of differential gender and racial-ethnic impacts are real.

SECTION SEVEN:
Conclusion

In closing, it is important for retailers, policymakers, and the public to look beyond the extraordinary circumstances of the 2020 pandemic and start setting constructive guidelines for the use of the revolutionary technologies now being rolled out in the retail sector. COVID-19 has spotlighted some of the serious problems present in retail workplaces, and we should dare to think big about policy frameworks that harness technological change to improve jobs, rather than simply eliminate and further degrade them. Multidimensional approaches (organizing, legal, consultation, or decision-sharing processes) in multiple spheres (worker rights, industry operation, taxation) are likely to be required given the broad range of technologies being considered and the wide array of retail functions toward which they may be deployed. Worker protections require special attention, because job quality and compensation have eroded steadily over decades as the industry has been rocked by the growth of discounting and rapid consolidation. This erosion may go in high gear as new technologies get added to the mix. As retailers implement a large number of digital technologies, they do so in a market environment severely "disrupted" by both internet-based giants such as Amazon and retail discount giants like Walmart that aim to master the combination of online and in-store discounting. While rapid technological change risks exacerbating job quality issues and inequalities, it also provides an opportunity to restructure retail jobs in ways that are supportive of workers and their capacities.

Glossary of Relevant Technologies Used in Retail Settings

Patrick Dexter, Françoise Carré, and Chris Tilly

A/B Testing

A/B testing is a comparison of the performance of two different approaches or "treatments." Originally referring to comparisons between two different versions of a webpage or an application, A/B testing now also is used to refer to performance comparisons of physical world "treatments" such as store layouts or staffing comparisons. It also is known as split testing or bucket testing.[113]

Artificial Intelligence and Machine Learning

Artificial intelligence (AI) refers to the ability of computers to behave in ways that simulate human thinking and problem solving. There are several layers of artificial intelligence, ranging from "weak" AI to "strong" AI. In weak AI, computers are made to mimic human thinking with the goal of achieving a similar outcome to a human attempt at the same problem, with little concern for the underlying method. Weak AI is typically limited to a computer being able to perform one task (i.e., a chess game), and must have the relevant information (i.e., all the possible chess moves) fed into it manually. In strong AI, computers think nearly exactly like humans do, though a system that can do this perfectly does not yet exist. Strong AI systems involve programming by engineers that instructs them how to respond to specific situations. There is a third type of AI that lies somewhere between these two poles, which is AI that uses human thinking as a model but is aimed at problem solving rather than perfectly replicating human cognition. The prototypical example of this form of AI is IBM's Watson, which is able to detect and evaluate patterns in text in order to form conclusions.[114]

Machine learning (ML) is a subset of AI that allows systems to learn automatically without being programmed. It refers to computer programs that can learn directly from data, discern patterns, and make decisions without any human assistance, typically in order to solve one particular type of problem (such as making sense of a visual image or voice). Unlike traditional AI, in which computer programs respond to programmed rules/directions, machine learning programs learn by gathering and analyzing examples, building their ability to recognize and respond to patterns. Machine learning algorithms make guesses about the nature of the pattern being observed (for example, a visual image), compare their guesses with the correct answer, determine the degree of error, and iterate so as to minimize the amount of error. Though they are developing decision rules via trial and error rather than following programmed decision

rules, they usually require human training (for example, feedback on whether they have correctly identified an image). The algorithms used to sharpen pattern recognition are called *neural networks*. *Deep learning* is a subset of machine learning in which the neural networks have multiple layers that build from lower to higher levels of pattern recognition—continuing the image example, think of building up from a pixel, to a line, to a two-dimensional shape, to a three-dimensional shape.[115]

Augmented Reality, see Virtual Reality

Beacons

A *beacon* is a small computer that uses a signal-transmitting technology to communicate with devices via Bluetooth. Beacons can deliver personalized information to a mobile device via a third-party application installed on the device. They also (whether or not the app is turned on) can track the location and movements of a customer within a store, for example detecting whether they are lingering in a particular location. A beacon system is more secure for a user than an RFID chip because they must first opt in via an app.[116]

Cashier-less Checkout

Cashier-less checkout is an advanced form of *self-checkout*, whereby the customer's purchases are tracked automatically while they shop and they do not have to visit a checkout station or scan their items in order to purchase them. The most famous example of this is Amazon Go, in which customers use an app on their phones to identify themselves upon entering the store (allowing cameras to register a visual image of them) and then have their purchases tracked via facial recognition and computer vision, as well as shelf-located weight sensors that detect when objects are removed, while they shop. Variations include completely unstaffed stores, where shoppers access entrance by identifying themselves and can only exit with items if payment takes place. Though most current cashier-less solutions build on computer vision, some stores, such as JD.com in China, use RFID chips to track purchases.[117]

Codes for Products: SKUs, UPCs, PLUs

- *SKU* stands for stock-keeping unit. It is the number assigned to a space on a shelf by a store. They are not universal and thus have relevance only within an individual store.

- *UPC* stands for Universal Product Code. It is a number, typically 12 to 13 digits, assigned by the global standards organization (GS1 US) to a product and printed next to the barcode, assuring that all retailers with a product have the same code. There are UPCs for 12,000 varieties of fresh fruits and vegetables, but they typically are used only for packages of produce, not for loose produce.

- *PLU* stands for Price Look-Up. It is a four- or five-digit number used for loose fresh produce and is assigned universally by the International Federation for Produce Standards.[118]

Also see **QR Codes.**

Computer Vision

Computer vision is a field of *artificial intelligence/machine learning* that trains computers to interpret visual information. Computers can identify and classify individual objects (including, in some cases, faces) and respond to the information they are receiving. Computer vision usually involves digital camera inputs to allow computers to gather and process information. It can be used to monitor the inside of a store, ranging from monitoring customer traffic (*see* **Smart Shelves**) and looking for spills or gaps in on-shelf inventory (*see* **Scanning Robots**) to enabling *cashier-less checkout*, like in an Amazon Go store.[119]

Facial Recognition Technology

Facial recognition is a biometric software function and application of *computer vision* that can identify an individual person by analyzing and comparing the patterns of the person's facial contours. It is used primarily for security functions, but is being expanded to other realms as well. There are different levels of facial recognition. At the high level, the software retains all usable information about a face and seeks to match the face with a database of faces, potentially adding new information about this person and their behavior to existing data. At a lower level, the software temporarily stores distinctive information about the face in order to distinguish this person from others; for example, during a visit to a store, and then discards the information. European retailers use the lower level of facial recognition to track customers in store without violating EU privacy guidelines.[120]

Fulfillment Center

A *fulfillment center* is a facility where a company receives, processes, and fills orders to ship to customers. This is different from a *distribution center*, which distributes primarily to stores and retailers.[121] *Also see* **Micro-fulfillment Center.**

GPS

Stands for Global Positioning System. GPS is a satellite navigation system used to determine the ground position of an object.[122]

IoT (Internet of Things)

IoT stands for Internet of Things, and refers to a situation in which objects are connected to each other via the internet, and communicate with each other without human interference. For example, a thermometer in a cold or frozen merchandise case could send an alert if the temperature goes out of the allowable range; a sensor could detect and communicate with a customer's cell phone.[123]

Machine Learning, *see* **Artificial Intelligence**

Micro-fulfillment Center or Wareroom

A *micro-fulfillment center* (sometimes called a *wareroom*) is a miniature, highly automated fulfilment center, often operating in a space converted from a different function such as a sales floor or a storage room. Because of their small size, micro-fulfillment centers are much cheaper than traditional fulfillment centers, and can be located closer to customers' homes for faster delivery times.[124]

Passive Network Sniffers, *see* **Tracking Customers in Store**

Point of Sale (POS) System

A *point of sale system* originally referred to the physical place where a customer makes a payment in a store, such as a cash register. It now refers also to mobile devices on which in-store sales are transacted, and to the online locations in which e-commerce sales take place. The point of sale typically is linked to the store inventory system in order to track which products are leaving the store. In the physical retail case, the POS includes both the hardware (the device the customer uses to pay) and the software (the inventory tracking and accounting program).[125]

QR Codes

A *QR code*, which stands for "quick response code," is a visual code composed of a matrix of dots that can be read by a scanner on a mobile device, such as a dedicated QR scanner or a smartphone with a camera. A QR code is two dimensional, which provides an advantage over traditional, one-dimensional barcodes. A QR code also can be scanned from a screen, whereas a traditional barcode is read by a laser, which cannot read a code from a screen.[126]

Radio Frequency Identification (RFID)

Radio frequency identification (RFID) is a technology that stores data on a small electronic tag affixed to an item. The electronic tag also is known as an electronic label, a transponder, or a code plate. It is made of an RFID chip and antenna that transmits information. RFID chips provide an advantage over barcodes because they do not have to be viewed by a scanner in order to be read; they just need to be in proximity to a reader.[127]

Scanning Robots

Scanning robots are mobile robots that operate independently of human assistance and observe their environment. Current retail applications include monitoring stores either for spills or for out-of-stock items. Though they function without assistance, they currently require human training, through a guided machine learning process *(see* **Machine Learning***)* before they can operate effectively.[128]

Self-checkout

Self-checkout refers to a POS station operated by the customer without the presence of a cashier. They commonly are called "self-scanning checkout" or other variations on that name. Self-checkout can be carried out via a fixed or mobile POS. In the case of a fixed POS, customers scan the barcodes on their items and use a touch-screen to complete the transaction.[129] Mobile self-checkout is a system that lets shoppers scan and bag their items as they shop and check out without the assistance of a cashier, using a portable device, often their mobile phone via a mobile payment app. There also are hybrid systems—for example, scanning items while shopping but then being required to pay at a fixed kiosk.[130] *Also see* **Cashier-less Checkout.**

Smart Shelves

Electronic shelves connected both to each other and to a central computer network. They can monitor inventory for out-of-stock items as well as make price changes across stores instantaneously. They also can transmit personalized communications to a customer by detecting their cell phone. In some cases, they can observe customer actions and reactions via shelf-based cameras, or alternatively can access such observations from overhead cameras. Smart shelves can use a variety of technologies to receive data, such as price changes (hard-wiring, Wi-Fi, infrared, etc.). They also can use varied technologies to observe their environment: cameras equipped with computer vision, weight sensors, beacons, network sniffers (*see* **Tracking Customers in Store).**[131]

Task Management Software

A *task management* application presents a worker or manager with a set of tasks to be completed, and a way of checking off completed tasks as well as delivering access to training modules and monitoring completion of these. Such systems can range from an unprioritized to-do list, to a priority-ranked list, to detailed blow-by-blow instructions that may be delivered one at a time to walk a worker through their tasks. More complex systems can build in scheduling and planning functions for tasks that extend over days or months, thus extending to *project management software*, but "task management" typically refers to systems organizing more immediate tasks.[132]

Tracking Customers in Store

There are four digital methods for tracking customers within a store. The first is cameras using *computer vision* and *facial recognition*. The second is a *beacon* that detects the presence of an app on a customer's phone; this tracking is limited to customers who have opted into the app. Third is Wi-Fi; since a phone regularly pings to search for a Wi-Fi signal, the Wi-Fi system can locate the customer and distinguish them from others via the phone's Wi-Fi signature, though without determining their identity. Changes in iPhone technology mean Wi-Fi no longer can be used to track iPhone users. Finally, *passive network sniffers* are "small Wi-Fi-like devices designed

explicitly for in-store measurement. ... They track multiple bands, not just passive Wi-Fi pings, and they can deliver better positional accuracy because they can be deployed in very large numbers quite cost effectively."[133]

Transponders

A *transponder* is a radio or radar set that sends and emits radio signals for the detection, identification, and location of objects. It can be used for tracking inventory, customers, employees, or vehicles.[134]

Virtual Reality and Augmented Reality

Virtual reality (VR) is an immersive, computer-simulated environment a user experiences through his or her own senses, such as sight or sound, and in which the user's choices and actions shape the outcome.[135] *Augmented reality* (AR) is a more limited interactive visual environment that combines the functions of computer-generated imagery, sound, and text effects to change the user's perception of his or her experience. It differs from virtual reality in that it includes real-world images and sounds rather than completely replacing those perceptions with virtual ones. Thus, it combines both real and digitally created imagery to project a reality-grounded but augmented view.[136]

Wareroom, *see* **Micro-fulfillment Center**

Wearables

Wearable technology is a category of electronic devices that can be worn as accessories, embedded in clothing, implanted in the user's body, or even tattooed on the skin. The devices are hands-free gadgets with practical uses, powered by microprocessors and enhanced with the ability to send and receive data via the Internet. The rapid adoption of such devices has placed wearable technology at the forefront of the Internet of things (IoT).[137] Wearables can be used to detect the wearer's location and the nature, direction, and speed of their movement. They can be used to communicate with the wearer, in ways ranging from a buzz indicating the right (or wrong) way to move, to two-way communication through a voice-activated headset.

List of Interviews

Consultants

Liz Bacelar, Together Group, and Scott Emmons, TheCurrent Global (now with Memomi Labs) (two interviews)

Peter Burggraaff, Boston Consulting Group

Ken Cassar, Rakuten Intelligence

Scott Clarke, Cognizant Technology Solutions (now with Publicis Sapient)

Jim Dion, Dionco

Lisa Disselkamp, Deloitte Consulting LLP

Ken Fenyo, McKinsey

Tom Furphy, Consumer Equity Partners

Sucharita Kodali, Forrester

Brittain Ladd, Brittain Ladd Consulting

Zoe Leavitt, CB Insights (now with ZX Ventures)

Argentina Moise, Bleexy

Thomas Moore, Zebra Technologies (now with Motorola Solutions)

James Okamura, Okamura Consulting

Steven Pinder, Kurt Salmon/Accenture Strategy

Rick Stein, FMI - The Food Industry Association

Elley Symmes, Kantar Consulting

Zebra Technologies group interview: Bree Bergman, Scott Drobner, Kasia Fahmy, Daniella Gutierrez, Tim Kane, Thomas Moore

One anonymous consultant

List of Interviews

Technologists

Yegor Anchyshkin, Takeoff Technologies

Alexei Agratchev, RetailNext

Curt Avallone, Takeoff Technologies

Megan Berry, by REVEAL

Roger Davidson, iControl Data

Stacey Ferreira, Workjam (formerly Forge)

Adam Hatch, Workjam

Kevin Howard and Kaitlyn Kempiak, AWM Smart Shelf

Charles Jackson, Pricer AB

Steven Kramer, Workjam

Eric Mahecha, Adyen

Larry Negrich, Reflexis

Grace Paglen, Jyve Corp.

Sylvain Perrier, Mercatus Technologies

Sam Purtill, Jyve Corp.

ShiSh Shridhar, Microsoft

Sarjoun Skaff, Bossa Nova Robotics

Daniel Sokolovsky, AxleHire

Greg Tanaka, Percolata

Eric Martinez and Jen Thorson, Modjoul

Simon Turner, Myagi

Jaron Waldman, Curbside

Michael Weksel, Same Day Delivery

Retailers

Curt Avallone, formerly of Ahold (now Takeoff Technologies)

Brett Bonner, Titus Jones, and Doug Meiser, Kroger Sunrise (Brett Bonner now with Arete South LLC)

Casey Carl, formerly of Target

Paul Clarke, Ocado

Scott Emmons, formerly of Neiman Marcus

Narayan Iyengar, Albertsons Companies

Mary Jensen, Sur La Table

Chris Kung, Macy's

Mike Molitor, Raley's

Vibhu Norby, b8ta

Elpida Ormanidou, Chico's (now with Starbucks)

Shari Rossow, Best Buy

Three anonymous retail interviewees (one grocery, two apparel)

Other informants: Worker organizations, workers, and researchers

James Araby, United Food and Commercial Workers

Eddie Iny, Ryan Gerety, and Lily Wang, United for Respect

Susan Lambert, University of Chicago

John Marshall, United Food and Commercial Workers

Anonymous worker member, United for Respect

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