Internet Sectoral Overview

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Artificial Intelligence and Work

The Work of the Future: Shaping Technology and Institutions[1]

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Technological change has been reshaping human life and work for centuries. The mechanization that began with the Industrial Revolution enabled dramatic improvements in human health, well-being, and quality of life. At the same time, economic and social disruptions often accompanied those changes, with painful and lasting results for workers, their families, and communities. Along the way, valuable skills, industries, and ways of life were lost. Ultimately new and unforeseen occupations, industries, and amenities took their place. But the benefits of these upheavals often took decades to arrive. And the eventual beneficiaries were not necessarily those who bore the initial costs.

The world now stands on the cusp of a technological revolution in artificial intelligence and robotics that may prove as transformative for economic growth and human potential as were electrification, mass production, and electronic telecommunications in their eras. New and emerging technologies will raise aggregate economic output and boost the wealth of nations. Will these developments enable people to attain higher living standards, better working conditions, greater economic security, and improved health and longevity? The answers to these questions are not predetermined. They depend upon the institutions, investments, and policies that we deploy to harness the opportunities and confront the challenges posed by this new era.

How can we move beyond unhelpful prognostications about the supposed end of work and toward insights that will enable policymakers, businesses, and people to better navigate the disruptions that are coming and underway? What lessons should we take from previous epochs of rapid technological change? How is it different this time?

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[1] This is an edited version of the Fall 2019 Report 'The Work of the Future: Shaping Technology and Institutions', published by the Massachusetts Institute of Technology (MIT) and the MIT Work of the Future initiative. To read the original report, please visit: https://workofthefuture.mit.edu/wp-content/uploads/2020/08/WorkoftheFuture_Report_Shaping_Technology_and_Institutions.pdf

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(...) innumerable expert reports and news articles offer alarming forecasts about what share of current jobs may be "affected" by new technologies such as AI and robotics. While such forecasts grab headlines, they provide limited actionable information.

The paradox of the present

In 2018, the Pew Research Center found that between 65 and 90 percent of those surveyed in advanced economies believe that robots and computers will probably or definitely take over many jobs now done by humans.[5]

The possibility that machines may eliminate jobs is not bad news if these technologies deliver higher living standards. But the Pew survey makes clear that people do not expect to benefit: most people believe that automation will greatly exacerbate inequality between rich and poor while making jobs harder to find. Less than one third of those surveyed believe that new, better-paying jobs will emerge.

Why, after a decade of rising employment, are people pessimistic about job prospects? One possibility is that the avalanche of alarmist "end of work" newspaper articles, books, and expert reports have overwhelmed the facts. Alternatively, public pessimism may reflect the hard-learned lessons of recent history. People may worry that the introduction of new technologies with human-like capabilities will generate enormous wealth for a minority while diminishing opportunity, upward mobility, and shared prosperity for the rest of us.

Economic history confirms that this sentiment is neither ill-informed nor misguided. There is ample reason for concern about whether technological advances will improve or erode employment and earnings prospects for the bulk of the workforce.[6] New and emerging technologies *will* raise aggregate economic output and boost the wealth of nations. Accordingly, they offer the *potential* for people to realize higher living standards, better working conditions, greater economic security, and improved health and longevity. But whether nations and their populations realize this potential depends on the institutions of governance, societal investment, education, law, and public and private leadership to transform aggregate wealth into greater shared prosperity instead of rising inequality.

Technology and work: A fraught history

In today's conversation, innumerable expert reports and news articles offer alarming forecasts about what share of current jobs may be "affected" by new technologies such as AI and robotics.[7] While such forecasts grab headlines, they provide limited actionable information. All jobs will be affected, directly or indirectly, by these technologies.

The question that concerns us is: What do these job changes imply for employment prospects, earnings, and career trajectories of workers with different skills and resources? And: How do we manage this process to improve work opportunities broadly?

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[5] Richard Wike and Bruce Stokes. "In Advanced and Emerging Economies Alike, Worries About Job Automation." Pew Research Center's Global Attitudes Project, September 13, 2018 https://www.pewresearch.org/global/2018/09/13/in-advanced-and-emerging-economies-alike-worries-about-job-automation/

[6] The consequences of technological change are almost always outside the control of the people most affected by them. New technologies are typically developed by industry, government, and academia. Workers whose skills are variously complemented or substituted by these technologies typically have no hand in their design, no voice in whether they are adopted by their employers, and no ownership stake that would potentially offset their employment losses with capital gains.

[7] See most prominently Carl Benedikt Frey and Michael A. Osborne, "The Future of Employment: How Susceptible Are Jobs to Computerisation?," *Technological Forecasting and Social Change* 114 (2016): 254–280, https://doi.org/10.1016/j.techfore.2016.08.019

To move beyond a simplistic focus on counting potentially affected jobs, a useful starting point is to look closely at the distinct mechanisms through which automation changes human work. This process operates through three distinct but related channels: substitution, complementarity, and new task creation. Of these three, only the first (substitution) is generally recognized in popular discussions—which we believe leads to undue pessimism.

Automation at its most basic level serves to *substitute* for workers in performing a subset of work tasks, often those that involve physically demanding, repetitive, and rote activities, e.g., equipping ditch diggers with mechanical excavators. This process raises productivity and generally leaves workers with safer and more interesting jobs. But displacement is not innocuous. When industrial textile machinery displaced rural spinners, lace workers, and handloom weavers in 19th century England, the shift was a boon to productivity and consumers but a serious and enduring hardship for rural textile workers.

Substitution is less than half the story, however (and indeed machines rarely substitute for human workers one-for-one). Frequently, automation *complements* the cognitive and creative capabilities of workers. Architects using Computer Aided Design (CAD) software, for instance, can design more complex buildings faster than they can with paper drawing. Machinery raises the value of human expertise in developing and guiding complex production processes and provides tools that enable people to turn their ideas into products and services.[8] Automation magnifies the power of ideas by shortening the distance from conception to realization. Over time, automation has profoundly shifted the comparative advantage of human labor from the physical to the cognitive domain, and this has gradually but inexorably raised the formal reasoning demands and educational requirements of most jobs.[9]

If work were static, this would be the end of the story. But new technologies often enable or require new tasks that demand human expertise, judgment, and creativity.[10] In the 19th century, for example, advances in metalworking and the spread of electrification created new demand for telegraph workers, managers, and electrical engineers. In the 20th century, even as agricultural machinery was displacing farm workers, changes wrought by mechanization and rising incomes generated new employment in factories, offices, medicine, and finance. In the 21st century, as computers and software have displaced workers performing repetitive tasks, they have simultaneously created new opportunities in novel, cognitively intensive work such as designing, programming, and maintaining sophisticated machines, analyzing data, and many others.

Is this time different?

In prior eras, mechanization and automation eliminated much undesirable work, while creating substantial new and more desirable work, and simultaneously raising productivity and enabling higher living standards. Does the current era of digital technologies possess these same virtues—or is it different

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[8] David H Autor, Frank Levy, and Richard J Murnane, "The Skill Content of Recent Technological Change: An Empirical Exploration," *The Quarterly Journal of Economics* 118, no. 4 (2003): 1279–1333.

[9] Claudia Goldin and Lawrence F Katz, *The Race Between Education and Technology* (Cambridge, Mass.: Belknap, 2008).

[10] Daron Acemoglu and Pascual Restrepo, "Automation and New Tasks: How Technology Displaces and Reinstates Labor," *Journal of Economic Perspectives* 33, no. 2 (May 2019): 3–30, https://doi.org/10.1257/jep.33.2.3

(...) the digital era has catalyzed labor market polarization—that is the simultaneous growth of high-education, high-wage and low-education, low-wage jobs at the expense of middle-skill jobs.

this time?[11] In our assessment, the current era is different in two respects: employment polarization and 'so-so' technologies.

EMPLOYMENT POLARIZATION

A first distinction between past and present is in how digital technologies reshape the division of labor between people and machines.

The era of mass production created vast new earnings opportunities for blue-collar workers in factories and businesses, while simultaneously opening new vistas for skilled workers in white-collar work and the professions. As did earlier waves of automation, the current era of digitalization also complements highly-educated workers possessing expertise, judgment, and creativity. But in contrast to earlier eras, digital automation tends to displace *middle-skill* workers performing routine codifiable tasks, such as sales; office and administrative support; and production, craft and repair occupations.

Ironically, digitalization has had the smallest impact on the tasks of workers in low-paid manual and service jobs. Those positions demand physical dexterity, visual recognition, face-to-face communications, and situational adaptability. Such abilities remain largely out of reach of current hardware and software but are readily accomplished by adults with moderate levels of education.[12] As middle-skill occupations have declined, manual and service occupations have become an increasingly central job category for those with high school or lower education.

Thus, unlike the era of equitable growth that preceded it, the digital era has catalyzed labor market polarization—that is the simultaneous growth of high-education, high-wage and low-education, low-wage jobs at the expense of middle-skill jobs. This lopsided growth has concentrated labor market rewards among the most skilled and highly-educated workers while devaluing much of the non-specialized work that remains.

'SO-SO' TECHNOLOGIES

A second key difference between the era of digitalization and earlier eras is that digitalization has not delivered the same gains in productivity. How can we square these sluggish productivity numbers with the disruptive labor impacts of these same innovations? It feels counterintuitive that so many kinds of workers— cashiers, fast food cooks, machine operators, legal secretaries, and administrative assistants among them—should be losing their jobs to disruptive technologies, without those same job cuts spurring measurable gains in productivity.[13]

To understand this paradox, we return to our discussion of the mechanisms by which automation changes human work—specifically, to the effects of substitution and complementarity. When a new technology automates a set of tasks previously done by workers, it *substitutes* machinery for people. This process raises aggregate productivity to the extent that the machinery is cheaper, faster, or better at the tasks than the workers who previously performed them. Examples abound: automated turnpike tolls substitute for toll collectors, there-

[11] We use the term digital technologies to denote the vast set of technologies made possible by symbolic processing, including computers, mobile telephony, the Internet, global positioning systems, artificial intelligence, robotics, and many others.

[12] Autor, D. H. (2015, Agosto). Why are there still so many jobs? The history and future of workplace automation. *Journal of Economic Perspectives*, *29*(3), 3–30. https://doi.org/10.1257/jep.29.3.3

[13] https://www.bls.gov/emp/tables/occupations-largest-job-declines.htm

by speeding traffic and reducing pollution; computerized typesetting software substitutes for physical typesetters, enabling faster, cheaper print layout; tax preparation software substitutes for trained tax accountants, enabling consumers to cheaply files taxes from their personal computers.

Substitution of machines for workers creates winners and losers. The gains typically flow to firms via higher profits and to customers via lower prices. The costs, however, are typically borne by displaced workers, their families, and their communities, as well as by the public, through the social benefit programs that workers rely upon when they lose jobs.

But automation may also complement workers. New technologies often *augment* workers' productivity in their current job tasks rather than displace workers from those tasks. Examples include power tools that equip construction workers to accomplish more in less time; computer aided design (CAD) software that allows architects to rapidly explore design options without painstaking drafting; and medical imaging tools that boost the speed and accuracy with which medical experts diagnose patients.

As with labor-substituting technologies, these labor-complementary technologies also raise productivity. In contrast to labor-substituting technologies, however, complementary technologies tend to increase earnings because they render workers more effective in their existing job tasks. They also frequently change the nature of the work and enable new capabilities. Because productivity gains often spur lower prices, improved quality, or greater convenience, employment of workers performing these tasks may rise.

Most workplace technologies do both: substitute for one set of tasks while simultaneously complementing others. Power tools displace manual laborers but complement workers who can skillfully wield them; CAD software substitutes for draftspersons but complements architects; imaging tools substitute for technicians but complement experts.

While most new technologies offer a mix of substitution and complementarity, the mix differs greatly across technologies and across organizations, as do the productivity impacts. And herein lies a little acknowledged economic reality: *not all innovations that raise productivity displace workers, and not all innovations that displace workers substantially raise productivity*.

Consider the introduction of electric lighting in the late nineteenth century. Electric lighting allowed industrial plants to operate in shifts around-the-clock, reduced employee exposure to oil smoke and fire risk, and allowed workers to perform precision tasks with greater speed and fidelity. Electric lighting was accordingly strongly labor-complementing, raising worker productivity and spurring new job creation (e.g., night shifts). While some workers in the gas lighting sector were adversely affected, the ratio of broadly distributed productivity benefits to modest labor displacement was favorable.

Now consider two other recent, commonplace digital technologies: computerized telephone agents deployed by airlines and hotels, and self-checkout kiosks offered by large retailers. Both technologies perform tasks previously done by workers. Yet neither improves the quality of the product or service: computerized telephone agents stumble over all but the most rudimentary queries; self-service kiosks merely shift checkout tasks from practiced cashiers to amateur customers. Firms deploy these technologies because they deliver sufficient labor cost savings to justify the attendant increases in customer frustration, not because they make their services better.

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Economists Daron Acemoglu and Pascual Restrepo label these latter cases 'so-so' technologies.[14] They disrupt employment and displace workers without generating much of a boost in productivity. Computerized telephone agents and self-checkout kiosks likely do raise productivity by some amount, or firms would presumably stick with human workers. But the ratio of worker displacement to productivity growth for these so-so technologies is arguably less favorable than for labor-complementing innovations such as electric lighting.

Workplaces of the future: Automation, Robotics, and Artificial Intelligence

How are widely-reported advances in AI, machine learning (ML), robotics, and autonomous vehicles currently being applied and what are the implications for the future of work? How much substitution, how much complementarity, and how much new task creation do we expect to see?

THE ROBOTS ARE COMING, BUT SLOWLY

As cultural icons, robots tap into long-standing fears and mythologies of artificial life, from Mary Shelley's *Frankenstein* to modern science fiction villains. Robots in practice are more prosaic: computer-enabled variants of mechanical sequencers, manipulators, and mobile platforms, enabled by increasingly powerful perception and software systems. While robots have been employed for decades in extreme environments (such as warfare and spaceflight), large-scale industrial applications have made the greatest impact in manufacturing (where the automotive and electronics industries were early adopters) and, increasingly, automation of the supply chain (distribution, warehousing, logistics) across multiple industries. Today, robots are finding their way into a host of new environments, from food service to surgery, as the promise of AI-enabled software broadens their reach and flexibility.

INDUSTRIAL ROBOTS

Industries such as automobile manufacturing and electronics incorporated robotics in the late 20th century. Recent evidence indicates that industrial robots have displaced production workers and had negative impacts on earnings and overall employment in the local labor markets where large manufacturing plants are based.[15] These effects are economically, socially, and politically consequential, but their economy-wide impacts are modest so far since most industrial robotics is concentrated in a few industry sectors.

Robots integrate cognition, perception, and actuation, and hence are inherently more complex to deploy than conventional software systems. Accordingly, they do not proliferate at the same rapid rates we are used to seeing for software-only products like apps or web-based services. Robots remain expensive, relatively inflexible, and challenging to integrate into work environments.

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[14] Daron Acemoglu and Pascual Restrepo, "Automation and New Tasks: How Technology Displaces and Reinstates Labor, "*Journal of Economic Perspectives* 33, no. 2 (May 2019): 3–30, https://doi.org/10.1257/jep.33.2.3

[15] Daron Acemoglu and Pascual Restrepo, "Robots and Jobs: Evidence from US Labor Markets," *Journal of Political Economy, forthcoming*, https://doi.org/10.3386/w23285; Asha Bharadwaj and Maximiliano A. Dvorkin, " The Rise of Automation: How Robots May Impact the U.S. Labor Market" Federal Reserve Bank of St. Louis, 2nd quarter, 2019. https://www.stlouisfed.org/publications/regional-economist/second-quarter-2019/rise-automation-robots

These hurdles are falling, but gradually. Precise manipulation has been making great strides, but human-like flexibility remains out of reach. Similarly, autonomous navigation for mobile robots works well in structured environments but has trouble in dynamic or unstructured areas. Larger robots, or those operating as vehicles or heavy machinery, are dangerous to people, so safety requirements further moderate the pace of change.

COLLABORATIVE ROBOTS AND AUGMENTED INTELLIGENCE

Not all robots displace workers, and major efforts are underway, particularly with collaborative robots, to enhance their complementarity with people. Compared to traditional robots, collaborative robots are less expensive, easier to program, and safer to work alongside. While collaborative robots are a small fraction of the total robotics industry, they do represent the vanguard of a new wave of "*augmented intelligence*," wherein AI and related technologies assist human workers to make them more productive—enhancing the complementary nature of new forms of automation.

BEYOND THE FACTORY FLOOR

Commercial robots, as they gain flexibility, will assume a larger set of tasks in warehouses, hospitals, and retail stores. Robots will perform more tasks outside of factories that will substitute for mundane human tasks such as stocking, transporting, and cleaning, as well as awkward physical tasks that require picking, harvesting, stooping, or crouching (as in arenas like agriculture). As we heard from several companies, advances in robotics can displace relatively low-paid human tasks and may boost the productivity of workers by freeing their attention to focus on higher value-added work.[16]

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING: DEEP STRENGTHS, NARROW CAPABILITIES

While AI is a component of robotics, it has broader reach in its software-only forms. The current state of AI is similar to, though more uncertain than, the current state of robotics. Artificial general intelligence, the idea of a truly artificial human-like brain, remains a topic of deep research interest but an aspirational goal that experts agree is far in the future. Some, including Task Force advisor Professor Rodney Brooks, argue that the traditional "Turing test" for artificial intelligence should be updated. The new standard for artificial general intelligence should be work tasks such as those required of a home health aide—including physical aid of a fragile human, observations of their behavior, and communications with family and doctors.[17] New understandings of work may even drive us to redefine the quest for artificial general intelligence.

With forms of AI that are here today, firms are experimenting with new technologies and with ways to redesign their workflows, task allocation, and job design to best adopt new technologies to in- crease productivity. But the pace of adoption appears uneven across industries as well as firm sizes.

Most contemporary AI successes involve forms of machine learning (ML) systems, in applications where large data sets are available. These basic tech-

Robots remain expensive, relatively inflexible, and challenging to integrate into work environments.

[16] Recent research by MIT Professor Julie Shah has shown how robots can help nurses make critical time-sensitive decisions on an obstetrics ward. See Matthew Gombolay, Xi Jessie-Yang, et,al, "Robotic Assistance in Coordination of Patient Care," *International Journal of Robotics Research*, June 22, 2018

[17] Mindell, David. n.d. "Are Home Health Aides The New Turing Test For AI?" *Forbes*. Accessed August 30, 2019. https://www.forbes.com/sites/davidmindell/2019/01/03/are-home-health-aids-the-new-turing-test-for-ai/

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niques have been around for a long time, but in the past decade new computing hardware, software, and large-scale data have made ML notably more powerful.

ML applications include image classification, face recognition, and machine translation. They are familiar to consumers in applications like Amazon Alexa, real-time sports analytics, face recognition on social media, and customer recommendation engines. An equivalent array of applications is finding its footing in business, including document analysis, customer service, and data forecasting. The barriers to deploying these technologies are rapidly coming down, as cloud-based AI services make algorithms once available only to highly skilled, well-resourced companies available to small and even individual enterprises.

These applications are already replacing tasks and aspects of existing jobs: for example, workers labeling data, paralegals doing document discovery in law firms, or production workers performing quality inspection on factory lines.[18] We also see cases where AI and ML tools are deployed to make existing employees more effective, by aiding call center responses, for example, or speeding document retrieval and summary. Some applications in engineering involve using AI to search physical models and design spaces to propose alternatives to human designers—enabling people to come up with entirely novel designs. In short, AI and ML systems have deep implications for the workplace, as the tools on which we have come to rely become more intelligent and widespread.

ML differs from previous waves of automation in that it applies to high- as well as low-education jobs, and has the promise of learning as it works. Still, ML applies at the task level (ideally to tasks with easily measurable results) and does not fully automate particular occupations in any case of which we are aware, though all occupations have some exposure. As one example, ML interpretation of x-ray images, while an important part of a radiologist's work, affects but one of dozens of tasks performed by a professional radiologist. That effect may in turn complement other tasks that radiologists perform such as conducting physical examinations and developing treatment plans.

LEARNING TO USE MACHINE LEARNING

To make use of the strengths and limitations of ML, organization will need to redesign workflow and rethink the division of tasks between workers and machines, akin to what occurred as Amazon deployed robotics in its warehouses. The resulting changes in work design will alter the nature of many jobs, in some cases profoundly. But the implications for specific skill groups are as yet uncertain and will in part depend on managerial and organizational choices, not on technologies alone. We should nevertheless expect to see declining demand for some broad occupational task categories that are most suitable for ML applications. These include back office and phone support operations, transcription and translation services, customer service, credit monitoring activities, and many financial management activities.[19]

ML systems still face challenges with respect to robustness and explicability. The industries that use ML are slowly learning that the data used to train ML systems must be as unbiased and trusted as the systems themselves need to be—crucial challenges in an era of hacking and cyber-warfare. Additionally, ML

[18] Brynjolfsson, Erik, and Tom Mitchell. 2017. "What Can Machine Learning Do? Workforce Implications." *Science* 358 (6370): 1530–1534. https://doi.org/10.1126/science.aap8062

[19] Brynjolfsson, Erik, and Tom Mitchell. 2017. "What Can Machine Learning Do? Workforce Implications." *Science* 358 (6370): 1530–1534. https://doi.org/10.1126/science.aap8062

systems tend to be “black boxes” that offer no insight into how they make their decisions. Explainability, however, is essential for systems that must be robust to failure, interact with humans, and aid in significant decisions with legal or life-critical implications.

While it seems unlikely that AI has greatly impacted the labor market so far—beyond spurring increased demand for computer and data scientists—we have no definitive evidence on this topic to date. AI is being applied to a range of tasks in white collar work and is predicted to have greater displacement effects on higher skill professional and technical workers than earlier waves of automation.[20] Proven measures of those effects, however, are still in development.

Interview I

Aiha Nguyen
Program Director of the Labor Futures Initiative at Data & Society.

Internet Sectoral Overview (I.S.O.)_ How is AI currently changing practices in the workplace? More specifically, how is AI being used for algorithmic management? Please provide examples.

Aiha Nguyen (A.N.)_ There are many instances in which AI and automated decision-making systems are being used in employment. Generally, data centric technologies have many purposes and based on what employers or users of technologies want to accomplish, can be applied in nearly any industry. Monitoring tools may serve purposes such as protecting assets and trade secrets, controlling costs, enforcing protocols, increasing work efficiency, or guarding against legal liability.

New technologies that couple monitoring tools with granular data collection are used widely by employers to manage large workforces. Work activity data such as rate of work, transactions and even tone of voice can be used to rapidly change workflows, detect deviant behavior, evaluate performance and automate tasks. In the warehousing industry, algorithmic management systems can set the rate of work for employees and also provide real-time feedback. Retailers, including supermarkets, often use predictive scheduling technology which collect information from a variety of sources including the weather and customer foot traffic to help set schedules that match predicted customer traffic. Labor platforms like Uber and DoorDash rely on algorithms that can process location information, traffic, and driving patterns to match drivers with passengers and dynamically set prices.

I.S.O._ What are the main legal and ethical implications of the adoption of new technological tools and techniques in the workplace?

A.N._ Much of the discussion about AI and data-centric technologies have centered around the potential abuse of data collected on users of technology. However, there are fewer protections for individuals at work, where people have much less power to opt out of using technologies. These protec-

[20] Webb, Michael. “The Impact of Artificial Intelligence on the Labor Market.” Stanford University Working Paper, July 2019.

As one example, ML interpretation of x-ray images, while an important part of a radiologist's work, affects but one of dozens of tasks performed by a professional radiologist.

tions and laws vary from country to country. In the United States, there is no comprehensive data protection law and in general, employers have wide discretion to surveill workers, set productivity outcomes, and determine the parameters of the work environment.

Data-driven tools rely on data collection of workers, and could deprive them of privacy because this data may not be willingly or knowingly provided. In particular, tools that collect biometric data have generated a lot of debate about how much information employers should be allowed to ask of workers. For example, employees may be asked to use applications that help them do their job, like restocking items at a store, but require that employees turn on cameras, microphones and location tracking in order to function. Often these tracking systems don't automatically turn off. Some employers have mandated use of health and fitness trackers as part of company health plans. Some of this information is protected but not all of it.

With Covid-19 gripping the world, many employers are implementing contact tracing in workplaces, creating new ethical and legal concerns around how much employers should know about the whereabouts and health of employees.

More recently, a new legal battle is brewing over the misclassification of employees. Misclassification, the treatment of employees as independent contractors in order to skirt labor protections threatens to undermine good job standards. Misclassification suggests that employees working on labor platforms and governed by algorithms have discretion and are not controlled by employers. In some countries, independent contractors cannot access basic protections and benefits such as minimum wage, overtime, health insurance, paid sick time, and workers compensation. Unfortunately, this argument can be applied to nearly every worker as algorithmic management systems are in use in almost every form of employment.

I.S.O._ What are the main challenges raised by increased collection of data on workers and the workplace?

A.N._ Broadly, we are concerned about the ability of such systems to perpetuate social inequalities that already exist. There is already a wealth of research demonstrating the prevalence of algorithmic bias in AI systems. The same can be said for use of AI and automated decision-making systems in employment that include bias but also perpetuate inequality generally.

"Automated decision-making systems can lead to work intensification while also creating greater instability and insecurity for employees."

Automated decision-making systems can lead to work intensification while also creating greater instability and insecurity for employees. In industries like warehousing and logistics, algorithms fueled by worker data and employer demands for high output are leading to work speedups. As explained earlier data can be used to identify wrong doing by employees in order to correct and regiment behavior but also to discipline and terminate. Data alone are imprecise measures, incorrectly identifying behaviors as abnormal or failing to take into account real-world context. However, employees might be disciplined based solely on metrics. Scheduling technology has made workers' lives more unstable because it allows for rapid and last-minute changes, often to reduce labor costs. By building schedules to only suit the needs of companies, employees end up carrying the burden because schedules become more irregular and erratic. For other employees, data collection and automated decision making can create insecurity because algorithms are obscured from view. Employees may be assigned shifts, discipline, pay, or any other number of factors based on an opaque algorithm.

There are many challenges raised by increased collection of data on workers and in the workplace. Chief among these is the loss of autonomy that comes with a right to privacy. When we talk about autonomy however, this includes both how employees go about accomplishing their work but it can include autonomy over other aspects of their life outside of the workplace. As mentioned earlier, scheduling technology can make workers jobs more erratic and unstable. The consequence for retail employees is that they cannot plan for parts of their life outside of work including education and childcare.

I.S.O._ What measures should be taken to leverage the benefits of new technologies while protecting the labor force? What is the role of transparency and accountability in this context?

A.N._ If the first question reflects the current debate, then the entire debate needs to change. Protecting the labor force shouldn't be a secondary goal but part of understanding whether a technology is beneficial or not. Rather than calculating simply the benefits and dealing downsides afterwards, a better evaluation of a technology should consider both the advantages and disadvantages before it can be deemed beneficial. Right now, major corporations and employers are the owners of such technologies and use it to reduce labor costs or shift costs of operations. Transparency and accountability place workers at the disadvantaged position of having to demand that their concerns be considered after a new technology has already been introduced. Rather, providing employees, and possibly other stakeholders like community members, with a seat at the table to determine the design, implementation, and benefits of such systems need to occur first.

"Protecting the labor force shouldn't be a secondary goal but part of understanding whether a technology is beneficial or not."

Article II

The pandemic, technology, and work at the crossroads

By Glauco Arbix[21] and Alvaro A. Comin[22]

The expansion, depth, and severity of the pandemic led governments and institutions around the world to look for ways to adapt to new realities, which began to emerge as the health crisis evolved, unfolded and disseminated in the economy, in politics and in all dimensions of society.

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The impacts caused by the COVID-19 pandemic manifested strongly in the global scenario of 2020, when a set of new technologies gave shape to a powerful cycle of innovations, supported by the advance of digital techniques, by an enormous volume of available data, by automation and system integrators, as well as the sophistication of computers and algorithms. The highlight in this new world, which is still in the making, can be attributed to Artificial Intelligence (AI) technologies, which not only prove capable of affecting economic and social reality, but also modify the more subtle mechanisms that generate new knowledge and underpin advances in science and technology. Therefore, AI is increasingly consolidated as a constellation of general purpose technologies, given its ability to change and emulate the innovation processes themselves.

The reach of this new technological cycle was felt even before the measures of social distancing and economic downturn resulting from the pandemic, which led to a loss of dynamism in business activity and a dramatic reduction in the fiscal capacity of the states. The economic activity and basically all dimensions of social life were already going through profound changes caused by the dissemination of AI, cloud computing, Big Data, biotechnology and nanotechnology, robotics and 3D printing.

All of this offered potential to transform education, life in cities, communication systems, public security and energy generation, thus opening up new opportunities for the sustainable development of economies and for the improvement of the quality of life of entire populations.

The problem is that these technologies are not always geared towards generating shared and fair prosperity. To begin with, there is a gap between the few countries that develop these new technologies and the vast majority of nations on the planet. Even within this select group, few companies and universities are able to substantially master this new cycle and push the frontiers of knowledge. When technologies are not able to benefit everyone, the results almost invariably point to income concentration. They also increase the gap between developed and developing countries, raise inequalities, not to mention the imbalances in ethics, privacy, human rights and democracy.

The fact is that the pandemic has brought more uncertainties across the globe and has particularly affected areas related to employment and work activities. Millions of people who were already pressured by automation became even more fragile with changes in the workday, in the hiring systems, in the lowering of compensation and, of course, by the layoffs. The situation, which was bad for the most fragile, became worse, because it dragged new contingents to the terrain of vulnerability in all countries. The risk is that the allegedly transitory conditions become permanent. Research by the Organisation for Economic Co-operation and Development (OECD) carried out with its member countries found that 43% of the interviewed companies plan to reduce the number of employees with the use of new technologies and 41% will make more intensive use of outsourcing processes; and most companies expect to equalize human and machine hours in 2025 (OECD, 2020).

Brazil was experiencing similar dilemmas even before the crisis was triggered by the coronavirus. Not only because the difficulties in catching up with advanced innovations were noticeable, but also the labor market rarely ceased to be dysfunctional and unbalanced, with more than 40% of workers immersed in informality and with a chronic difficulty in generating quality jobs.

With the pandemic, there were major changes in the employment system and work processes, which posed new challenges for society, particularly those

related to the urgent need to qualify professionals with new profiles and to requalify those who began to be displaced by the crisis and by the new demands resulting from the rapid advance of digital technologies. In this context, the labor market started to see an accelerated rise of unemployment, with legal and regulatory changes, which affected compensation systems, working hours, hiring, pensions, retirement and social protection. These changes merged with the presence of new work relations, such as those generated by digital platforms (e.g. Uber, iFood, Rappi and others) and the still incipient growth in demand for cognitive skills related to the analysis and resolution of complex problems, as well as for workers with behavioral profiles linked to tolerance for multidisciplinary activities. Companies that are more intensive in communication and automation technologies, in several industries of the economy, started to show difficulties in hiring skilled labor.[23]

The economic contraction, job cuts, and changes in hiring systems have lowered the living conditions of millions of workers. In fact, many initiatives related to labor reforms began to be implemented in 2017 and converged with many measures taken during the pandemic, always in the direction of flexible contracts and the possibility of reducing and redistributing work hours.

It is true that, when facing COVID-19, the Brazilian federal government and state governments created emergency programs[24] aiming at preserving jobs and income. However, more than 15 million flexibility agreements for work contracts were signed by August 2020 (Prates & Barbosa, 2020). According to "Pesquisa Pulso Empresa", a survey carried out by the Brazilian Institute of Geography and Statistics (IBGE, by its acronym in Portuguese) which assesses the impact of COVID-19 on companies, the pandemic was responsible for 39.4% of the 1.3 million temporary or permanent suspensions of work contracts in the first half of June. And, for the first time in the IBGE historical series, April 2020 registered a sharp drop in employment, when the unemployed and inactive population represented more than 50% of the total workforce (Prates & Barbosa, 2020).

Despite the protection policies, many legal and regulatory innovations tend to stay over time, mainly because some of them respond to the preventive health logic (e.g. social distancing), others contribute to work efficiency (cost reduction) and others remain due to the advantages they offer, such as reduced commuting time and pollution.

New platforms, new logics

The disseminated use of technologies that incorporate AI affects the labor market in several ways.[25] Rideshare and food delivery platforms, such as Uber and iFood,

Rideshare and food delivery platforms, such as Uber and iFood, which use algorithms to bring together drivers/motorcyclists and passengers/consumers, generate new types of work relationships for which there are still no well-established regulatory principles.

[23] Research sponsored by the Brazilian Association of Information Technology and Communication Companies (Brasscom) revealed an imbalance between the number of job openings and the shortage of candidates for the areas of information technology (IT) and computing, which can lead to a large part of the 290 thousand jobs being unfulfilled from 2019 to 2024, if there are no adequate policies and programs to overcome the current situation (Brasscom, 2020).

[24] In April 2020, President Jair Bolsonaro signed Law 13,982/2020 that determined the granting of an emergency relief of R$ 600.00 (about US$ 100) per capita to vulnerable groups during the pandemic. The benefit amount dropped after three months to R$ 300.00. Its continuity is still under debate in the government and in Congress. Several Brazilian states and municipalities have also approved their own programs, albeit in different amounts than the Federal government program.

[25] It is important to note that there is no reliable data regarding the impact of new technologies on job creation. The available studies are partial, not conclusive, and offer totally inconsistent results, which range from a global unemployment tragedy to the multiplication of jobs. Many of these researches deal with automation processes and they often tend to attribute their results to Artificial Intelligence, as if automation and AI could be equated, but they cannot.

In addition to work relationships, new technologies affect the qualifications and professional attributes demanded by the market.

which use algorithms to bring together drivers/motorcyclists and passengers/consumers, generate new types of work relationships for which there are still no well-established regulatory principles. These platforms define themselves as solely intermediaries for exchanges between consumers and service providers, characterizing drivers as self-employed professionals, thus exempting themselves from any employment responsibility. However, this definition is far from being consensual, and disputes over its regulation are just beginning. In the recent US election, California voters decided that Uber drivers are not employees of the company, but self-employed professionals. In London, where the license for this service was suspended in 2018 due to failure in identifying drivers, the decision on the labor issue is in the hands of Justice. Following the same rationale, several other types of services, from building maintenance (plumbers, electricians, etc.) to school tutoring can be found on specific platforms, operating in the same regulatory void. For society to decide on these issues, it is crucial that comprehensive and reliable public information systems are in place and, therefore, it is necessary to update traditional sources, such as job and unemployment surveys, and to create new ways of collecting and disseminating data.

This "platform economy" – as these services have been called – is also starting to change the mechanisms of intermediation between supply and demand for work. Platforms such as LinkedIn and UpWork use systems based on algorithms to match professionals and jobs, based on the qualifications required by the companies. Intermediation by algorithms, as a rule, broadens the range of options of agents and reduces the selection costs, but it also involves the risk of reproducing and amplifying well-known discriminatory biases against specific groups of workers, such as women, black people or immigrants. Once machine learning systems, for example, learn from past data that certain professions have been historically practiced predominantly by men, the system may favor men when distributing job offers, reducing the chances that more women will practice this profession. Thus, past inequalities are reiterated and projected into the future.

In addition to work relationships, new technologies affect the qualifications and professional attributes demanded by the market. Automation and AI tend to replace routine and predictable activities, which affects manual labor opportunities, but it also increasingly affects "white collar" occupations which are typical of higher education professionals. Qualifications linked to advanced programming, AI, Big Data, cloud computing and digital marketing are today among the most demanded by the market, while traditional professions such as accountants, business managers, and auditors are increasingly low. Similarly, the growth of online retail, which has been greatly reinforced by the pandemic, eliminates jobs linked to direct service to consumers, such as salespeople and cashiers, while the demand for logistics and transportation services is increased.

In view of these multiple shifts in modalities of work relations, types of occupations, and areas of activity, triggered by technological innovations, much has been debated about the future of work. The fear that machines will steal human jobs and produce mass unemployment is at the heart of this debate.

For now, this discussion is somewhat speculative, and empirical studies are very much concentrated in the North American reality, where these trends are more advanced and primary data sources are more abundant. Of course, there is no consensus in this debate. For example, technology expert Martin Ford (2015) draws a future of job collapse, while economist David Autor (2015) ensures that technologies create new jobs and make up for those they destroy.

In the latter case, there is an exception – the profile of new jobs will most likely be polarized, with a relatively small number of highly qualified and compensated occupations, concentrated in industries such as information technology (IT) and finance, versus a large volume of low qualified and compensated occupations, in industries such as retail and personal services. However, regardless of the conclusion of this debate, it is a fact that the United States is not a parameter for countries like Brazil, where the penetration of these new technologies is much slower and uneven.

Even if the most optimistic scenarios prevail and new jobs are created in sufficient quantity, the profile of workers whose professions will become obsolete does not necessarily fit the qualifications required by the new occupations, which constitutes one of the greatest challenges for specialists and public policymakers.

In Brazil, where the workforce has relatively low formal education and the quality of education is insufficient, the investments required for the requalification of workers shall be even greater and the results may be slower. In addition, the speed of innovations makes it increasingly difficult to predict, beyond the short term, the nature of the qualifications that will be required in the future. Higher education professionals, who already perform functions that require some familiarity with information and communication technologies (ICT), need less professional retraining and their chances of future relocation, maintaining the same levels of compensation and professional status, are much bigger. For workers with intermediate or little schooling, in particular older people, the difficulties will be much greater and the chances that they will face a drop in income and precarious working conditions are significant.

It is worth mentioning that diverse technological resources started to be developed and used by companies and institutions as a way of adapting to the new realities of communication, production, recruitment, hiring and training that began to take shape. In countries that have infrastructure resources, teleworking has enabled companies to continue their operations. For example, due to social distancing, about 75 million of the population in North America have started to work from home.[26] In Brazil, on the other hand, working from home or remotely was restricted to only the high income population. According to PNAD COVID19, a National Household Sample Survey carried out by the Brazilian Institute of Geography and Statistics (IBGE), the percentage of people working from home (May 2020) did not exceed 10.3% of the employed population (IBGE, 2020). Infrastructure deficiencies, high levels of informality, lack of Internet access and digital knowledge and skills were the main reasons for the low adaptability of the Brazilian market and its interaction with new modalities provided by technology.[27]

Even if the most optimistic scenarios prevail and new jobs are created in sufficient quantity, the profile of workers whose professions will become obsolete does not necessarily fit the qualifications required by the new occupations, which constitutes one of the greatest challenges for specialists and public policymakers.

Looking for alternatives

The combination of the effects of the pandemic with new technologies can change the dynamics for employment and work processes worldwide, including

[26] 42% of Americans started working remotely, from their homes, according to a survey by Nicholas Bloom (2020), from the Stanford Institute for Economic Policy Research. Available on: https://siepr.stanford.edu/research/publications/how-working-home-works-out

[27] For more information, see the research coordinated by Rogério Barbosa, Ian Prates, Fábio Senne, Leonardo Lins and Thiago Meireles in Bulletin 16 of the Solidary Research Network, of July 17, 2020. Available on: https://redepesquisasolidaria.org/boletins/

Even in highly qualified professions, digitalization trends in service delivery, which have been going on for years, were accelerated during the pandemic with consequences that may become permanent.

to compensate for the drop in the level of occupation, since the aggregate volume of hours worked was strongly impacted, with a sharp reduction in productive capacity. This change poses advantages and disadvantages.

Several researchers point out the benefits of teleworking and its positive impact on productivity, by reducing stress and improving performance.[28] However, teleworking also carries potential negative effects on the mental and emotional health of those who work remotely, such as loneliness, worry, and guilt. In addition, in families with children and/or adults who require special care, but do not have any support, the conciliation of household tasks with work can prove to be unattainable, with long-term negative impacts on both the well-being of the families and their professional careers, especially for women.

COVID-19 has driven many large companies, governments, and institutions (such as in the finance and education industries) to operate remotely, without offices, using platforms such as Zoom, Microsoft Teams, and Google Meet. In general, this adaptation was possible in environments with more resources and with specific characteristics in their work processes. In other industries, which lack infrastructure and require physical presence to obtain results, working from home was hampered by the lack of access to basic technologies and equipment (WiFi, computer, broadband, smartphone and others). The hotel, food, storage and retail industries had to redesign their work, including the creation of new activities and businesses.

This diversity had an impact on income, which, in general, benefited more qualified workers, who were able to use the virtual modalities. The new dynamics of the labor market show that growth in some areas (such as e-commerce) is happening at the expense of others (such as street commerce).

Even in highly qualified professions, digitalization trends in service delivery, which have been going on for years, were accelerated during the pandemic with consequences that may become permanent. This is the case of distance learning, that has had increasing offers in Brazil for more than 20 years and has undergone a sudden boost due to social isolation, facilitating, for example, the dismissal of more than 1,600 university professors from private educational institutions in the city of São Paulo, between April and September 2020.[29] This trend, associated with flexibilities in labor legislation and regulatory changes in education (such as the recent expansion from 20% to 40% of activities offered remotely in classroom learning, and the encouragement of the creation of graduate programs in a distance learning format)[30] indicate a scenario of precariousness both in the working conditions of educators and in teaching.

When the topic is income, the pandemic caused an enormous increase in inequalities, aggravating the situation that was already bad for the poorest, for women, and for black people. The effort now is to prevent the most fragile people from becoming even more vulnerable and the gap between the more and less educated from becoming even greater.

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[28] For further reference on remote work, see research by Jonathan I. Dingel and Brent Neiman (2020), from the National Bureau of Economic Research. Available on: https://www.nber.org/papers/w26948

[29] Learn more: https://g1.globo.com/sp/sao-paulo/noticia/2020/09/02/faculdades-particulares-de-sp-lotam-salas-virtuais-com-ate-180-alunos-e-demitem-mais-de-1600-professores-durante-pandemia.ghtml

[30] Ordinance 2,117 of the Brazilian Ministry of Education, of December 6, 2019. Learn more: https://www.in.gov.br/en/web/dou/-/portaria-n-2.117-de-6-de-dezembro-de-2019-232670913

Given these multiple variables and paths that technological changes can follow, it is essential that the Brazilian society be heard in order to define a strategy for the adoption and development of new technologies. The country cannot take the risk of looking only at the (few) leading companies and ignoring the necessary evolution of the others. In the labor market, the same dilemma calls for a resolution with different attitudes, both for highly qualified workers and for those who are at great risk of being left on the margins of society, without jobs and opportunities. Therefore, the challenge is to leverage new technologies (due to their potential impact on productivity, social benefits, and generation of well-paid jobs) and, at the same time, double the efforts to help millions of workers to reposition themselves in the job market. This is difficult, we are all aware, but this is necessary for a country that intends to be democratic and seeks to raise its level of civilization.

The Brazilian society and especially the government cannot remain passive in the face of these different logics that, left to their own devices, can reproduce and increase social inequalities. Proactivity is essential both to separate emergency from permanence, as well as to prepare and support those who need to make changes in their qualifications and work activities.

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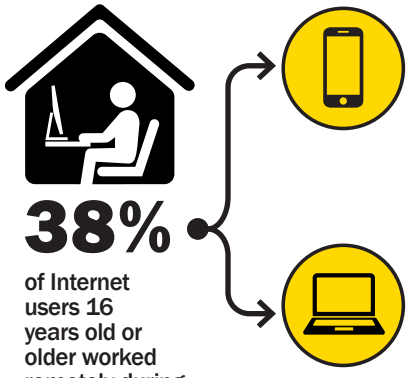
Remote work during the COVID-19 pandemic: data by Cetic.br

Worldwide, the COVID-19 pandemic has had considerable impacts on the labor market, not only in terms of employment rates, but also in the way employers and employees interact. With social distancing measures in effect, remote work supported by the use of digital technologies presented itself as an emergency strategy for many industries of the economy, especially those considered non-essential. At the same time, disparities in access to and use of ICT have become more evident amid the need for social isolation, indicating that the appropriation of the potential benefits of these technologies is lower among the most vulnerable population.

The third edition of the ICT COVID-19 Panel[31], carried out by Cetic.br|NIC.br, brought data on Internet use in Brazil during the pandemic of the new coronavirus, showing how Brazilian Internet users have used ICT to work during the pandemic.



38%

of Internet users 16 years old or older worked remotely during the pandemic.

Mobile phones were the device most frequently used in carrying out remote work activities (41%), followed by laptops (40%) and desktop computers (19%).

While laptops were the most used device by Internet users in higher social classes (52% among those in classes AB), with higher education (56% among those with High education), and older people (67% among those aged 60 or over), mobile phones were more used by Internet users in lower social classes (84% among those in classes DE), with lower levels of education (70% among those which have completed Elementary education) and younger (56% among those aged 16 to 24 years old).

In view of the limitations associated with accessing the Internet through mobile phones, it is essential to consider how the disparities in access to devices by the population may mean a more restricted use of functionalities offered by ICT.

Almost a third of the Internet users who worked during the period covered by the ICT COVID-19 Panel sold products or services through messaging applications (30%) or through social media (29%). Another 17% sold products or services through other platforms or applications, while 4% worked as drivers for applications and 4% as delivery people for applications.

Among users who worked through applications, more than half (53%) reported that this was a job to supplement their income, while about a third (32%) reported that it was the only work carried out during the pandemic.

[31] To see all the survey indicators, access: https://cetic.br/pt/pesquisa/tic-covid-19/indicadores/. This publication is available on: https://cetic.br/pt/publicacao/painel-tic-covid-19-pesquisa-sobre-o-uso-da-internet-no-brasil-durante-a-pandemia-do-novo-coronavirus-3-edicao/

Interview II

Internet Sectoral Overview (I.S.O.)_In your opinion, what are the main challenges the region faces in terms of integration of the countries for the development of a strong regional digital market?

Mario Cimoli (M.C.)_A regional digital market can be understood as a harmonized economic space where the exchange of goods and services through digital means or the trade of digital goods is carried out without restrictions in a secure environment. A market with these characteristics has the potential to promote cross-border trade by reducing transaction costs (both tariff and non-tariff), tapping into a broader market and generating economies of scale that facilitate the development of services and applications in the digital field. However, it is not just about removing cross-border barriers, but also about coordinating resources in terms of innovation, entrepreneurship, investment and skills development.

In this sense, one of the main challenges in the creation of a regional digital market is to define common rules that facilitate trade and generate trust in companies and consumers, in a region that has more than 650 million people. That is why regulatory equivalence and convergence must be a fundamental axis of a regional digital market. However, this convergence is complex due to the pre-existing institutional framework for commercial integration. At the regional level, there are several trade agreements, all of which include e-commerce agreements, but they vary in scope and depth. Likewise, at the global level there are regulatory frameworks and standards that are promoted by the main players in the digital economy, led by the US, China, and Europe.

That is why it is crucial to discuss how to move forward in achieving a regional digital market and the role of Latin America and the Caribbean. In concrete terms, this idea has already started to materialize in several efforts developed by regional blocs, such as the Pacific Alliance (PA), the Southern Common Market (Mercosur, for its acronym in Spanish), the Central American Common Market (CACM) and the Caribbean Community (Caricom). This type of strategy has the potential to generate a significant economic impact with several direct and indirect effects. This has been seen in Europe, where the creation of a single digital market showed a better level of digitization in the countries that comprise the bloc. For example, according to estimates we made, setting up a regional digital market strategy in the PA can increase the impact of digitization in relation to the Gross Domestic Product (GDP) from US$ 9,620 to US$ 13,886 million annually. Therefore, due to the unique effects of a regional digital market, over a five-year period the GDP could be increased by more than US$ 21,330 million, not to mention the spillover and chain effects that could be generated both within countries and in the block itself.

I.S.O._How can digital transformation accelerate the achievement of SDG 8 which promotes sustained, inclusive, and sustainable economic growth, full and productive employment, and decent jobs for all?

M.C._Digital technologies have proved to be a central instrument for innovation and, therefore, for economic agents to change the way they produce, interact with suppliers and customers, sell and add value to products and services. Thus,

Mario Cimoli
Deputy Executive Secretary of the Economic Commission for Latin America and the Caribbean (ECLAC).

"In a region like Latin America, where the relative productivity is far from converging with the most advanced economies, it is necessary to promote technological change to reverse this trend."

these technologies can affect variables such as productivity and competitiveness. The development of quality jobs is intrinsically linked to the productive structure and the participation in productive value chains. In a region like Latin America, where the relative productivity is far from converging with the most advanced economies, it is necessary to promote technological change to reverse this trend.
The pandemic has deteriorated the economic situation in the region. In 2020, the region's domestic product will return to the levels seen in the beginning of the decade. More than 2.7 million companies are expected to close, and more than 18 million jobs may be lost. Likewise, during the COVID-19 pandemic, we witnessed how digital technologies can help companies become more resilient, as those that have managed to adapt to the digital economy have been more able to cope with social distancing measures. Therefore, digitization has been also accelerated throughout the production structure. An analysis carried out by ECLAC shows that the number of business websites in countries such as Colombia and Mexico had an eight-fold increase, while in Brazil and Chile, there was a four-fold increase.
On the other hand, it is also important to highlight that digital transformation is not a process that simply follows the supply and demand for services; it is closely related to factors such as the environment in which companies operate, the facilitating framework and the ability to adopt and use technologies, all areas where politics play a key role. That is why, in order to fulfill the 2030 Agenda and achieve the SDGs, specifically SDG 8, national development strategies should comprise a digital agenda. In recent studies, we observed that there are several institutional and design features that can still be improved regarding digital agendas, such as coordination between institutions, measurement, and the resources that these instruments receive.

I.S.O._What is the importance of (and the difficulty in) collecting data on how employment is impacted by digital transformations, especially considering the advance of Artificial Intelligence, 5G, and the Internet of Things (IoT)?

M.C._One of the main challenges of policymaking is to have quality data and indicators that allow evidence-based decisions. Specifically, in relation to the adoption of emerging technologies, such as 5G, IoT or Artificial Intelligence, we do not have recent official data on the level of adoption of these technologies in production structures and companies. This is undoubtedly one of the major challenges that we have to overcome in order to better quantify the processes of technological change and their impact on productivity and employment, as well as to know what the needs are in terms of public policies to support this process.
There are several methodological aspects among the challenges faced in measuring the digital economy and new technologies, since, in many cases, there are still no international definitions for terms and concepts. On the other hand, the digital economy is invisible in economic terms because many activities are not monetized or go unnoticed by traditional metrics. Likewise, industry classifications for business services and sectors are out of date and hinder the estimation of new business models. At the same time, there are challenges in terms of resources and statistical standards.
Particularly in relation to the impact of technology on employment, ECLAC estimated, for 12 countries, that the risk of job destruction due to automation is on average 24%, and the countries with the highest proportion of workers in low productivity industries have a lower probability of being at risk of technological substitution. Thus, countries such as El Salvador, Honduras and the Plurinational State of Bolivia have less than 18% of workers in occupations at risk of being automated, and countries such as

Uruguay, Chile and Argentina have an average of 36% of workers at this risk.[32] Although the exact number of the probable percentage of jobs that can be automated is the result of debate – due to methodological reasons – it is certain that we are facing a change in consumption and production patterns and, therefore, in the forms and modalities of work. Decision-makers must take this aspect into account to reduce the negative effects of this change. Both the public and private sectors must work together to design strategies that reduce information asymmetries in the labor market, develop new skills and, therefore, guarantee the fulfillment of employee rights in the new economy.

I.S.O._During the COVID-19 pandemic, the acceleration of the online presence of businesses and the growth of digital platforms leveraged e-commerce. Do you think this phenomenon will continue in the medium and long run?

M.C._E-commerce has been definitely accelerated during the pandemic. There are different reasons for this trend and, although official data are scarce, we can conclude with sufficient certainty that this is a fact. Precisely, the data provided by e-commerce platforms such as Mercado Libre explain the increase in the number of purchase orders and new buyers. In some countries, this number doubled in the first months of the pandemic. However, the different nuances within this phenomenon are still not clear, such as the differences between domestic and cross-border e-commerce.[33]

This phenomenon will undoubtedly continue since the e-commerce penetration in the region is low if compared to other regions such as Asia and North America. The opportunity to grow is important. The impetus of the pandemic also served to break cultural barriers and the mistrust that existed in relation to these means of purchase. Likewise, governments made several efforts that promoted this change during the pandemic through capacity building, business financing, the development of technological solutions and the definition of facilitating regulations. These conditions will continue to drive e-commerce in the medium and long term.

On the other hand, it is also true that there are certain negative impacts and risks that must be taken into account. One of them is cybercrime, which has increased as online activities escalated, as shown by many researches and studies that have been recently conducted. The region continues to show signs of weakness with reference to aspects that relate to institutional, legal, and organizational design and the capacity to fight cybercrime. Therefore, strengthening cybersecurity strategies at the national level should be a priority. On the other hand, data protection should also be given attention; as consumers provide their personal information online, safeguards to ensure the correct use of that information should be clear. These aspects are vital for maintaining trust in e-commerce and for it to help maintain the companies' levels of activity, increase it and tap new markets.

Finally, one aspect that must also be observed is competition and consumer protection. Digital platforms have undoubtedly played a key role in the expansion of e-commerce, facilitating access to technology and to markets, but they have also increased their market power, which should draw the attention of regulatory authorities, in order to avoid abusive behavior and limited possibilities of developing new businesses and economic activities that allow the generation of more and better jobs.

"Both the public and private sectors must work together to design strategies that reduce information asymmetries in the labor market, develop new skills and, therefore, guarantee the fulfillment of employee rights in the new economy."

[32] Read more: https://www.cepal.org/es/publicaciones/44637-cambio-tecnologico-empleo-perspectiva-latinoamericana-riesgos-la-sustitucion

[33] Read more: https://www.linkedin.com/posts/mercadolibre_informe-e-commerce-activity-6666308882509385729-0Bqa/

Domain Report

The dynamics of registration of domains in Brazil and around the world

The Regional Center for Studies on the Development of the Information Society (Cetic.br) carries out monthly monitoring of the number of domain names in country code top-level domains (ccTLD) registered among G20 countries[34]. Combined, they exceed 77.5 million registrations. In November 2020, domains registered under .de (Germany) reached 16.68 million, followed by China (.cn), the United Kingdom (.uk) and Russia (.ru), with 14.50 million, 9.51 million and 4.99 million registrations, respectively. Brazil had 4.51 million registrations under .br, occupying 5th place on the list, as shown in Table 1[35].

TABLE 1 – REGISTRATION OF DOMAIN NAMES AMONG G20 COUNTRIES – NOVEMBER 2020

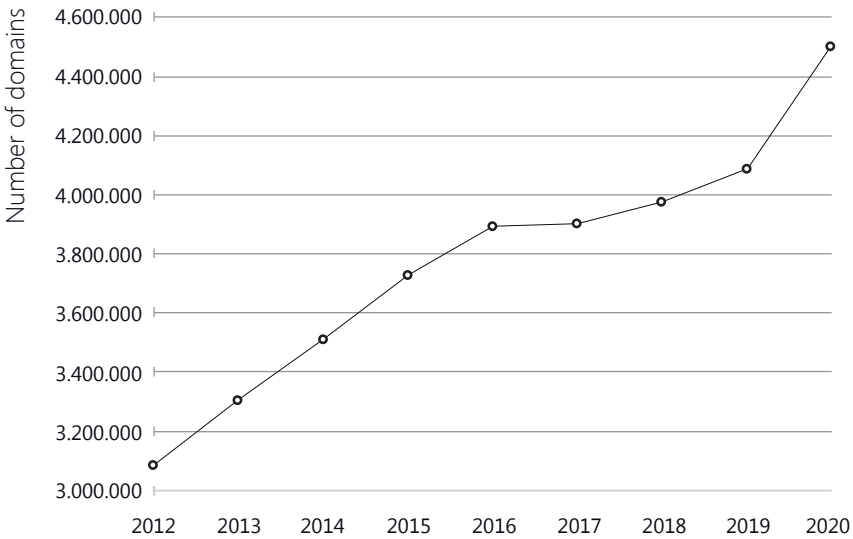
Position	G20 Countries	Number of Domains	Reference Period	Source
1	Germany (.de)	16.683.008	30/11/2020	denic.de
2	China (.cn)	14.498.293	30/11/2020	research.domaintools.com/statistics/tld-counts/
3	United Kingdom (.uk)	9.515.453	01/10/2020	nominet.uk/news/reports-statistics/uk-register-statistics-2020/
4	Russia (.ru)	4.988.631	30/11/2020	cctld.ru
5	**Brazil (.br)**	**4.507.512**	**30/11/2020**	**registro.br/dominio/estatisticas/**
6	France (.fr)	3.649.466	29/11/2020	afnic.fr/en/resources/statistics/detailed-data-on-domain-names/
7	European Union (.eu)	3.575.398	30/11/2020	research.domaintools.com/statistics/tld-counts/
8	Italy (.it)	3.366.201	30/11/2020	nic.it
9	Australia (.au)	3.234.359	30/11/2020	auda.org.au/
10	Canada (.ca)	2.999.446	30/11/2020	cira.ca
11	India (.in)	2.300.000	-	registry.in/
12	United States (.us)	1.659.478	30/11/2020	research.domaintools.com/statistics/tld-counts/
13	Japan (.jp)	1.610.484	01/11/2020	jprs.co.jp/en/stat/
14	South Africa (.za)	1.264.123	30/11/2020	zadna.org.za
15	South Korea (.kr)	1.092.695	01/10/2020	krnic.or.kr/jsp/eng/domain/kr/statistics.jsp
16	Mexico (.mx)	926.067	30/11/2020	research.domaintools.com/statistics/tld-counts/
17	Argentina (.ar)	658.565	01/10/2020	nic.ar/es/dominios/estadisticas
18	Indonesia (.id)	483.640	30/11/2020	pandi.id/?lang=en
19	Turkey (.tr)	428.986	29/11/2020	nic.tr/index.php?USRACTN=STATISTICS
20	Saudi Arabia (.sa)	71.748	30/11/2020	nic.sa/en/view/statistics

[34] Group of the 19 largest economies in the world and the European Union. More information available at: https://g20.org/en/Pages/home.aspx

[35] The table presents the number of ccTLD domains, according to the sources indicated. The figures correspond to the record published by each G20 country. For countries that do not present or publish official statistics provided by the authority for registration of domain names, the figures were obtained from: https://research.domaintools.com/statistics/tld-counts. It is important to note that there are variations among the reference periods, although it is always the most up-to-date one for each country. The comparative analysis for domain name performance should also consider the different management models for ccTLD registration. In addition, when observing rankings, it is necessary to bear in mind the diversity of existing business models.

Graph 1 shows the performance of .br since 2012.

Graph 1 – TOTAL NUMBER OF DOMAIN REGISTRATIONS PER YEAR FOR .BR – 2012 to 2020*



**Data in reference to November 2020.*

Source: Registro.br

In November 2020, the five generic Top-Level Domains (gTLD) totaled more than 182.5 million registrations. With 150.43 million registrations, .com ranked first, as shown in Table 2.

Table 2 – MAIN GTLDS – NOVEMBER/2020

Posição	gTLD	Domínios
1	**.com**	150.434.521
2	**.net**	13.284.684
3	**.org**	10.276.997
4	**.icu**	4.474.455
5	**.info**	4.154.659

Source: DomainTools.com
Retrieved from: research.domaintools.com/statistics/tld-counts

DO YOU KNOW HOW BRAZILIAN COMPANIES ARE ADOPTING TECHNOLOGICAL INNOVATIONS?

HERE ARE SOME INDICATORS FROM THE ICT ENTERPRISES 2019 SURVEY.[36]

Robotics, which may involve Artificial Intelligence, is one of the technologies that most promises to revolutionize production processes. Fed by data that are created throughout the entire production chain, it is able to have a high level of autonomy and precision.

IN BRAZIL, OF THE TOTAL OF ENTERPRISES THAT USED COMPUTERS:

4% **PERFORMED BIG DATA ANALYTICS** (or an estimated total of 19,861 enterprises)

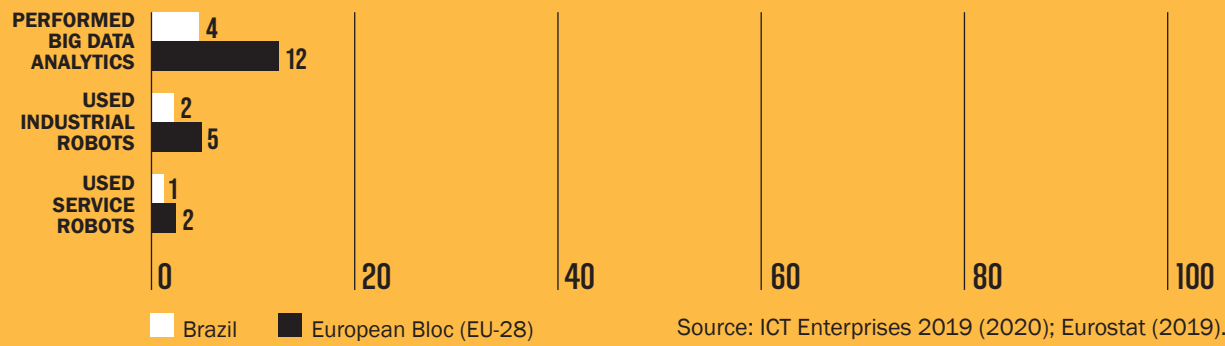
2% **USED INDUSTRIAL ROBOTS** (or an estimated total of 8,256 enterprises)

1% **USED SERVICE ROBOTS** (or an estimated total of 4,166 enterprises)

AND HOW IS THE SCENARIO OUTSIDE BRAZIL?

Although the use of industrial robots is low among Brazilian enterprises, the use of this technology is still incipient also in the European bloc when analyzing Eurostat data[37]. In addition, the low use of service robots was also identified by Eurostat, present in only 2% of enterprises that used computers in the European Union. The use of Big Data analytics is more present, being reported by 12% of enterprises in the European Union (Graph 1).

Graph 1 - ENTERPRISES, BY USE OF NEW TECHNOLOGIES - BRAZIL (2019) AND EUROPEAN COUNTRIES (2018)[38]
Proportion of the total number of enterprises that used computers (%)



Source: ICT Enterprises 2019 (2020); Eurostat (2019).

[36] Data from ICT Enterprises 2019 (2020), a survey carried out by Cetic.br|NIC.br. Read more: https://cetic.br/pt/publicacao/pesquisa-sobre-o-uso-das-tecnologias-de-informacao-e-comunicacao-nas-empresas-brasileiras-tic-empresas-2019/

[37] Institute of Statistics of the European Commission – Eurostat (2018). *Community survey on ICT usage and e-commerce in enterprises.* https://ec.europa.eu/eurostat/data/database

[38] EU-28 is the abbreviation of the European Union, which consists of a group of 28 countries that functions as an economic and political bloc.

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