Wired for Work: Exploring the Nexus of Technology & Jobs

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This paper is part of the Growth and Reducing Inequality Working Paper Series, which is a joint effort of the G-24 and Friedrich-Ebert-Stiftung New York to gather and disseminate a diverse range of perspectives and research on trends, drivers and policy responses relevant to developing country efforts to boost growth and reduce inequality. The series comprises selected policy-oriented research papers contributed by presenters at a Special Workshop the G-24 held in Geneva (September 2017) in collaboration with the International Labour Organization and the Friedrich-Ebert-Stiftung, as well as relevant sessions in G-24 Technical Group Meetings.

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Abstract

As technological advancements proceed at an unprecedented scale and speed upending traditional employment models, researchers across the globe are working frenetically to understand how the world of work is changing and what the future holds. This paper explores the most important questions that scholars, policymakers and practitioners are grappling with in understanding the nexus of technology and jobs. It outlines what we know and where gaps remain. Understanding the potential reach of technological change along with emerging preferences and modes of organization can help us balance priorities across a broad range of actors. There is a need for urgent action to direct the impact that technology has on jobs. This means deliberate choices about work design on the part of employers, exploring new and innovative ways of organizing workers and creating a new set of government policies and regulations to manage the proliferation and effect of technology on jobs.

1. Introduction

Tom Davenport refers to “The Future of Work” as a fabled idea (Davenport, 2018). The Group of 20 (G20) has a workstream dedicated to this theme; the International Labor Organization -- a centenary initiative (ILO, 2017). Scholars worldwide who are part of various initiatives, campaigns and conferences are consumed with unraveling the mysteries of how technology will affect jobs. The desire to predict the future is almost greater than the focus on how to manage the present.

This is understandable. Not only is technology advancing at an unprecedented scale and speed, but the relationship between technology, productivity, and the quantity and quality of jobs is dynamic and context-specific (Dewan & Randolph, 2016). The interaction between technology and jobs in different sectors and across different geographies is contingent on several exogenous factors, making it difficult to parse out its impact. And this is even more pronounced for developing countries that have complex, highly segmented labor markets, and where data and evidence of technology’s impact is lacking. Researchers across the globe are working frenetically to resolve the uncomfortable uncertainties.

What we do know is that the Fourth Industrial Revolution, described as the emergence of cyber-physical systems that embed technology into our lives in new ways (Schwab, 2016), is altering the way people live and work everywhere. Building on the digital, computing and communication systems of the Third Industrial Revolution, this current phase is upending traditional employment models at a magnitude and pace faster than the ability of policies and regulations to keep up with the change.

As technology restructures the world of work, the dominant questions on the demand side are about the extent to which technology is, and will, destroy jobs. Will there be a net gain or net loss of employment? What does evidence suggest about which sectors will gain and which stand to lose; and how is technology changing the spatial distribution of jobs? On the supply side, the critical questions are about who has access to the new jobs that technology creates? Which workers are managing to make the transition to this brave new technological world, and which, and how many, will be left behind?

Both sets of questions point to the need for urgent action to direct the impact that technology has on jobs. This means deliberate choices about work design on the part of employers, exploring new and innovative ways of organizing workers and creating a new set of government policies and regulations. On the part of governments, there is first a need for regulation to manage technological advancement while investing in the right education and skills training to equip workers for this ongoing digital revolution. Second, there is a need for safety nets to protect displaced workers from the inevitable churn that technology brings, as well as a need for mechanisms to ensure that the gains from higher levels of productivity and efficiency are distributed widely and equitably across workers (Loungani, 2016).

The pressing need to understand the impact of technology on employment and workers is fueling a great deal of much needed research, but amidst this frenetic activity, the systemic view is lost. This paper is a contribution toward remedying that. It highlights some of the most important questions that scholars, policymakers and practioners are grappling with in understanding the nexus of technology and jobs, broadly outlining what we know and where gaps remain. Moreover, it ends with some suggestions on how to manage the proliferation and impact of technology on employment.

2. Jobs Lost and Jobs Gained: The Demand Side

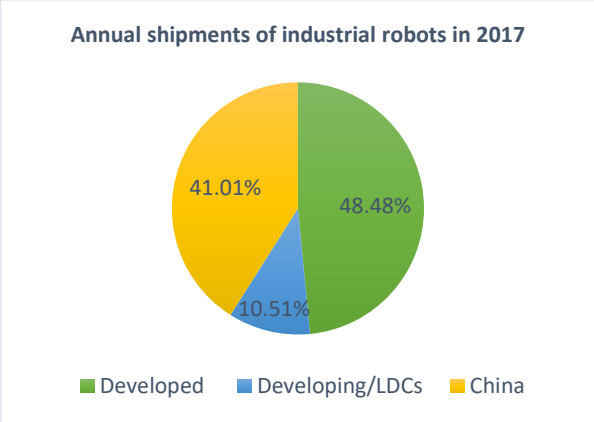
The World Economic Forum predicts that 7.1 million jobs will be destroyed, while two million new jobs will be created, leading to a net loss of approximately 5.1 million jobs in 15 major developed and emerging economies by 2020 (World Economic Forum, 2016). Based on scenarios across 46 countries, the McKinsey Global Institute estimates that up to one third of work activities could be displaced by 2030, with a midpoint of 15 percent; the proportion varying across countries (Manyika, Lund, *et al.*, 2017). The Organization for Economic Cooperation and Development (OECD) notes that approximately 14 percent of jobs in OECD countries are at risk of automation, while another 32 percent could see significant changes in the way they are carried out (OECD, 2018).

Anxiety over the extent to which technology is and will continue to eliminate jobs is widespread across developed and developing countries. It is unclear whether evolving technologies are augmenting human efforts or replacing them; how these trends are playing out in different sectors and across varying geographies; and ultimately, whether this means that technology is creating more jobs than it is eliminating or vice versa.

Automation & Augmentation

From automated checkout kiosks in supermarkets to the whirring of robots on the factory floor, there is visible evidence that technology is replacing workers. Firms may choose to replace workers with machines when the cost of deploying technology is low, along with the potential for higher rates and volumes of production or service delivery (Manyika, Chui *et al.*, 2017). Although developing countries tend to have a surplus of low-cost labor, the fact that the cost of labor is but one factor in the overall cost of production means that these nations are not immune to automation. The cost to automate, the benefits of labor substitution, regulatory and social considerations in addition to the cost of labor are all factors in the decision to automate (Manyika, Chui *et al.*, 2017).

But developed countries are currently experiencing the shift to automation faster than developing countries. China is an exception. In 2017, 48 percent of annual shipments of industrial robots were to developed countries, 11 percent to developing and less developed countries and 41 percent to China (International Federation of Robotics, 2018b).



Source: International Federation of Robotics, National

The automotive, electronics, metal and machinery industries deploy two-thirds of robots (World Bank, 2019). Estimates suggest that there will be a total of 2.6 million industrial robots worldwide by 2019 (Canning, Raja & Yazbeck, 2015).

These robots are replacing some workers. Foxconn Technology Group in China, the world's biggest electronics assembler, reduced its workforce by 30 percent after introducing robots into its production processes (*forthcoming* World Bank, 2019). E-commerce firm, Amazon, has reportedly deployed 30,000 robots in its warehouses worldwide (MSN, 2017). UK-based outsourcing firm, Capita, planned to replace 2,000 staff with automatons (Davies, 2016). Adidas – a German company - planned to open automated factories in the U.S. and Germany (The Economist, 2017).

But some companies are still holding out in the face of automation believing that a human production line can adapt to changes faster than industrial robots, that may take more time to realign and reprogram (Gibbs, 2016). In 2014, Toyota announced that it was replacing automated machines in some factories in Japan with heavily manual production lines staffed by humans. The company wanted to make sure that workers truly understood their work instead of feeding parts into machines and being helpless when one breaks down (International Federation of Robotics, 2018a).

These examples highlight instances when technology replaces humans. In other instances, technology augments human effort and vice versa. David Autor notes, "automation also complements labor, raises output in ways that lead to higher demand for labor, and interacts with adjustments in labor supply (Autor, 2015)." International logistics company DHL, for example, is using collaborative robots to perform packing, kitting and pre-retail tasks alongside humans (Demaitre, 2018). An application that provides information on weather patterns, for example, may help a farmer increase crop yields, expand the business, and generate a demand for more labor.

"Augmentation", Davenport and Kirby note, "…means starting with what humans do today and figuring out how that work could be deepened rather than diminished by a greater use of machines" (Davenport & Kirby, 2015). This requires a five-step process in which humans actively work to identify

which parts of the system could and should be automated based on the strengths and weaknesses of machines and those of humans (Davenport & Kirby, 2015). Ultimately, from the onset, humans should plan and build systems that maximize the capacities of both humans and machines. In his study of Digitization of Industrial Jobs in Germany, Hartmut Hirsch–Kreinsen ((2017)) makes a similar argument. He highlights the importance of deliberate work design that carefully assesses and manages the relationship between an organization and technology, the worker and technology, and the worker and the organization (Hirsch-Kreinsen, 2017).

Aside from the fact that augmentation reduces labor substitution, it can also be leveraged for other advantages. For instance, in a competitive luxury automobile market, customization has become a key distinguishing factor. Skilled workers that can understand the degree of customization required and deliver it with the help of technology are important to this end. This push and pull between automation and augmentation means that there is no clear answer to the question of which one will win, not least because technology continues to change. The likely scenario is that both will exist, eliminating some jobs and creating or supporting others across manufacturing, services and, increasingly, agriculture. But augmentation is clearly more desirable than automation, and this calls for a deliberate approach and incentive structures that support augmentation over automation.

Redistribution of Jobs Across Geographies

Beyond how the effects of technology will vary across developed and developing countries and sectors and its interaction with humans, there is the question of how technology will redistribute jobs across geographies. Advancements in information and communications technologies enabled the creation of new jobs and an off-shoring of business process operations from developed nations to countries like India over the last two decades (Krishnamurthy, 2018). The jury is still out on whether advances in computing power, artificial intelligence and automation will shepherd the off-shoring of a new generation of business services or whether such previously outsourced functions will be performed at home (Galperin & Greppi, 2014).

Internet-based labor platforms have also been hailed for their ability to connect skilled workers in poor countries with better employment opportunities in developed economies – ‘white-collar labor offshoring.’ But Galperin and Greppi warn that these effects can be overestimated. They develop a model to determine the likelihood that a worker from a developing country will be hired by an employer from a developed country through Nubelo, the largest Spanish-speaking online labor platform. They find that after controlling for other factors, Spanish employers are more likely to hire Spanish workers than workers from Latin America, even when the task can be performed remotely (Galperin & Greppi, 2014). The study identifies several information-related frictions in online labor platforms that tend to favor workers located in geographic proximity to employers. These stymie the migration of white-collar jobs to developing countries.

Alongside the question about tech-enabled off-shoring is a question about the extent to which technology is also enabling a re-shoring of work -- that is, a shift back to domestic production, especially in manufacturing. Ricardian theory of international trade was premised on a world where nations traded in primary commodities or simple finished goods produced close to where they would be consumed. Cheaper technology and transportation upended these assumptions creating fragmented global supply chains in which multinational firms from developed countries outsourced certain production functions to developing and emerging economies (Dewan & Suedekum, 2017). But now, technology is enabling a re-shoring of work.

In 2017, Adidas relied on 3-D printing to establish two factories for speedy shoe production in Germany and the United States. This led to a loss of over 1000 jobs in Vietnam (World Bank, 2019). "The eroding cost advantage of emerging economies, the underestimation of the full cost of offshoring, the need for production to be close to markets and innovation, the protection of intellectual property and the need to balance cost savings and risk dispersion are all factors that have been proposed on why reshoring has become more important in recent years (De Backer et al, 2016)." Yet, data on such reshoring is limited, largely based on limited company surveys and anecdotal evidence (De Backer et al, 2016). The limited evidence suggests that the effects of re-shoring on national economies are still limited (De Backer et al, 2016).

Reshoring does shorten supply chains, and the continued low cost of transportation ensures that companies can continue to access markets abroad even if the goods are produced at home. Whether offshoring or reshoring, both reflect the fact that technology enables footloose industries. These are industries that can relocate without incurring major changes in their cost of production. This geographic shuffling of economic activity because of technological advancement affects where and what kinds of jobs are created and lost.

Net Gain or Net Loss?

While some jobs are more susceptible to automation and relocation, others, such as care work and hospitality, cannot be adequately performed by machines or remotely. Frey and Osborne (2017) present a framework for the kinds of tasks that cannot be automated easily. These include those that are related to (a) perception or manipulation, (b) those involving creative intelligence, and (c) those related to social intelligence such as care work (Frey & Osborne, 2017). Somewhere in between these two extremes are those systems and tasks that are augmented by technology. The complex ways in which technology and jobs interact make it difficult to assess whether the advent of technology amounts to, or will amount to, a net gain or a net loss of jobs in the aggregate (Aaronson & Housinger, 1999). In September of 2015, The World Technology Network held the first World Summit on Technological Unemployment (The World Technology Network, 2015), where scholars[2] including

[2] Robert Reich, former U.S. Secretary of Labor, political economist, professor, author, and political commentator; Joseph Stiglitz, Nobel Prize-winning economist; Larry Summers, Former U. S. Secretary of Treasury, economist, President Emeritus and Charles W. Eliot University Professor of Harvard University David Autor, co-leader of MIT's School Effectiveness and Inequality Initiative

Robert Reich, Joseph Stiglitz, Larry Summers, and David Autor agreed that, "[T]hough, "creative destruction," in which lost jobs are replaced with new ones, will be a factor, our newest technologies have the clear potential to eliminate many more jobs than we create (The World Technology Network, 2015)."

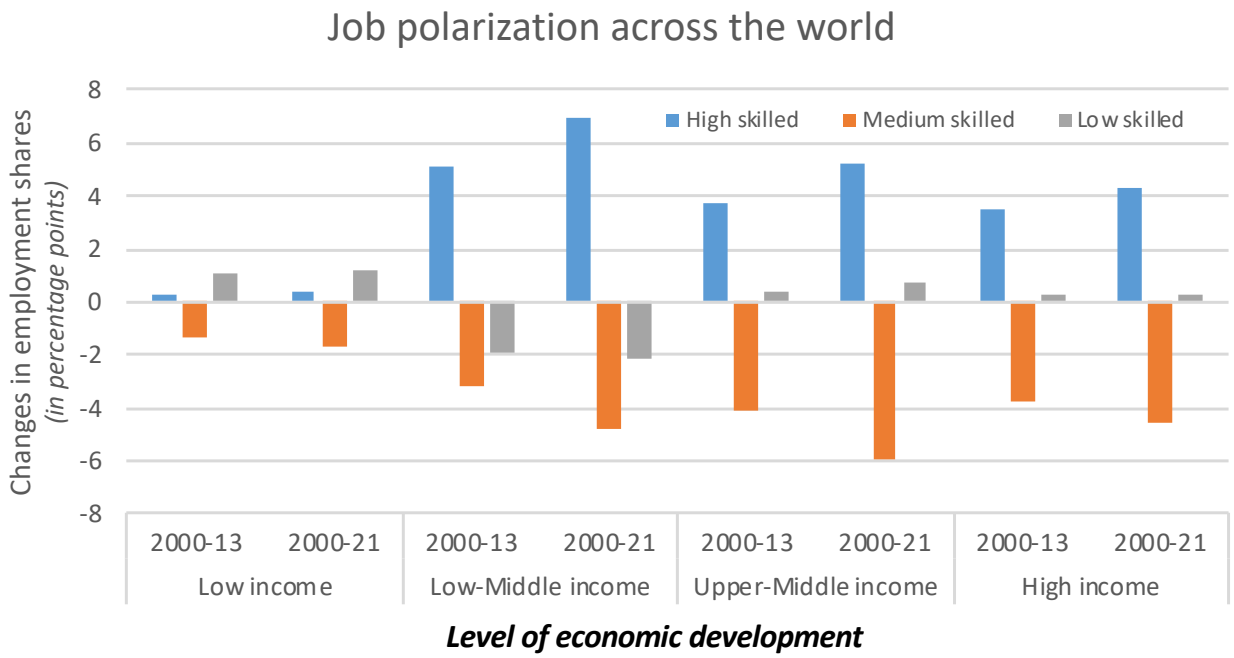
This fact lends itself to two key questions: who has access to jobs in this new technological world, and what actions are needed on the part of employers, workers and governments to manage the impact of technology? Sections three and four take each of these issues in turn.

3. Access to Work & Wages: The Supply Side

As technology alters the number and nature of jobs, it is also changing the demand for skills (Brynjolfsson & Mcafee, 2014; OECD, 2018). This has implications for wage's and labor's share of value added.

There now exists a broad consensus that technology is skill-biased. It brings "a shift … that favors skilled (e.g., more educated, more able, more experienced) labor over unskilled labor by increasing its relative productivity and, therefore, its relative demand" (Violante, 2008). What's more, as technology constantly alters labor markets, skilled workers have a greater ability to adapt to the churn, and those workers that can multi-task have a better chance of being retained (Violante, 2008).

Technological change in the 18th and 19th centuries was characterized by the development of mechanical systems that affected manual labor jobs. This was followed by transactional computers in the 20th century that had an impact on administrative and service jobs. Today, computers can undertake cognitive and analytical tasks that intersect with knowledge work (Davenport & Kirby, 2016). This wave of technology narrows the set of activities in which labor adds value (Brynjolfsson & Mcafee, 2014; Frey & Osborne, 2013). Along these lines, research suggests that the employment share of high-skilled professionals is growing, while low-skill occupations that do not interact with new technology as much remain less affected (*figure 2*). But jobs in the middle of the distribution, such as those involving clerical tasks or manufacturing jobs, are hollowing out (Eichhorst & Souza, 2017). The skill-biased nature of technology is fueling job polarization (Autor, Levy & Murnane, 2003).



Source: ILO, Trends Econometric Models, Nov. 2016
Note: Change in employment shares, in percentage points; forecasts after 2016

Arguably, this phenomenon poses a bigger challenge in low-income countries. Low-income countries lack adequate social safety nets and redistribution mechanisms to cope with the churn that technology brings. One could dispute the efficacy of existing safety nets and redistribution mechanisms in developed countries in alleviating the economic pain of their citizens, but in many developing countries, the most basic of protection institutions are missing not just in practice, but also in policy. What's more, labor markets in developing countries have large shares of the population in poverty, informality and with low levels of education. A hollowing out of medium-skilled jobs means that accessing better, more productive, opportunities becomes an even higher reach for those that are currently from disadvantaged segments. Going from a job that is focused on survival to one that is high-skilled is a much further leap.

This leap cannot be made without significant and urgent, though long-term, investments in human capital. In developing countries, many of which have large and growing youth populations, and where a large proportion of the population does not have access to basic quality education, the challenge of equipping young people with the skills they need to participate in a digital economy looms even larger (Dewan & Sarkar, 2017). Higher enrollment rates have not always translated into good quality education, and skills training will only have limited success if not built on a strong foundation of basic levels of good quality education (Dewan & Sarkar, 2017). Thus, the countries that need investments in human capital the most are the least able to provide them because of fiscal constraints exacerbated by demographic pressure.

The restructuring of employment, whether because of labor substitution or job polarization, has deep implications for wages. The destruction of jobs increases the labor surplus, exerting downward pressure on wages and working conditions as more workers compete for fewer available jobs. Alternatively, the wage bill may not rise as quickly as value-added (Autor & Salomons, 2018). In the case of skill-biased change, wage gains accrue to those at the top of the income and skill distribution (Autor, 2015). Those at the bottom continue to be in low-value added work with diminishing prospects for mobility because of the destruction of middle-skill jobs.

4. Managing the Impact

Against this backdrop, this section highlights three ways that stakeholders can be proactive in directing the impact of technology on jobs and workers.

1. Employers should institute 'work and systems design' that favor augmentation over labor-displacing automation

As noted earlier, augmentation is more desirable rather than labor displacing automation. However, this requires a deliberate 'work and systems design' that maximizes the productive potential of both individuals and machines (Davenport & Kirby, 2015; Hirsch-Kreinsen, 2017). The responsibility for this lies with employers, though there is a role for public regulation to both incentivize and possibly mandate such planning.

These new work systems will, and are already, altering tasks within jobs and associated education and skill requirements. The shifts in employment status to allow for more flexible working arrangements, contractual arrangements, and self-employment are already visible, but ongoing technology adoption is likely to exacerbate this trend and must be addressed through regulation.

2. Regulations must be adapted to protect workers as new work arrangements emerge

As technology upends traditional employment models, there is a need to revise regulation to help workers to adapt to the change and protect them against the churn that technology brings. This entails tackling three challenges. First, regulation must redefine the employee-employer relationship. Second, it must ensure that all workers are afforded a basic level of social protection, irrespective of their employment status. Finally, governments must invest appropriately in developing education and skills to prepare workers for a digital world. Taking each of these in turn.

2a. Clarifying the employer-employee relationship

Technology now affords workers greater flexibility in where and when they perform their work. Some workers, such as women trying to balance domestic responsibilities with income generation

activities, or the disabled that face mobility constraints, may benefit from such flexible work arrangements. But this breaking down of 'office culture' and norms related to place and time in the gig economy have also spawned a shift toward temporary and freelance work that weakens work security. In the absence of state provision of social protection, these self-employed, temporary, freelance workers are left to fend for themselves and are more vulnerable to shocks.

The emergence of the platform economy and flexible work arrangements are spurring a rise of contractual work and have blurred the lines between those that are self-employed, and those that work for an employer (Work and Permissions Committee, 2017). Platform providers do not see themselves as employers or human resource organizations, but rather intermediaries that deliver a technological solution to connect service providers with market demand (Bajwa et al., 2018).[3]

This shift in work engagements and opacity in the employer-employee relationship means that it is unclear who is responsible for providing job security, occupational safety, and social protection including health and disability insurance and pensions. This also has implications for working conditions such as working hours, breaks and sick leave. This loosening of protections is often referred to as the growing precarity in labor markets.

In order to ensure safe and just working conditions, regulations must define the employee-employer relationship. The California Supreme Court, for instance, adopted the simpler "suffer or permit" test under which the law presumes a worker to be an employee, entitled to overtime pay, meal and rest breaks (Eaton, 2018). A worker is considered an independent contractor only if the hiring entity meets each part of an "ABC" test: (a) The worker is free from the type and degree of control and direction the hiring entity typically exercises over its employees; and (b) the worker performs work outside the scope of the hiring entity's business, and whose work therefore would not ordinarily be viewed by others as working in the hiring entity's business; and (c) the worker is customarily engaged in an independently established trade, occupation, or business, taking such steps as incorporating his or her business, getting a business, trade license or advertising (Eaton, 2018).

Similarly, Germany identifies a further category of workers that fall outside of the definition of what is traditionally understood as an employee - "employee-like persons" or quasi workers that are not fully reliant on employers as regular employees are, but rather only economically dependent (Ford *et al.*, 2017). Some protections such as paid leave and protection against discrimination are extended to these workers through government regulation to be enacted through the firm, albeit on a piecemeal basis (Ford *et al.*, 2017). But the terms of these protections are subject to judicial scrutiny and workers are entitled to bargain collectively. Spain too has a statute that includes a new category of economically dependent self-employed workers (Ford *et al.*, 2017).

[3] Yet anecdotal evidence suggests that the degree of control exercised by platforms on workers is comparable to that of traditional employers. Platforms also reserve the power to unilaterally change terms of agreement without soliciting worker input (Bajwa *et al.*, 2018).

2b. Social protection matters

Beyond clarifying the employee-employer relationship there is a need to protect workers in the face of growing precarity, and to smooth consumption through the churn. Governments should focus on redistributive policies to ensure that the gains from higher levels of efficiency and productivity are shared widely (Loungani, 2016). Whether the net impact of technology is job creating or job destroying is arguably less important than the acknowledgement that robotization, artificial intelligence, and the platform economy[4] are displacing some workers. This calls for safety nets to protect displaced workers from the inevitable churn that comes with technology.

Policies must afford workers a basic degree of social protection regardless of their employment status -- in part-time, full-time, fixed-term or short-term contracts; temporary agency work; forms of self-employment or own-account workers (Eichhorst & Souza, 2017). Recognizing this need, recent years have seen a renewed interest in the debate about protecting workers rather than jobs (World Bank, 2013), and the emergence of the debate on a Universal Basic Income (World Bank, 2019).

2c. Invest in human capital

The notion that youth must be equipped with transferable and digital skills and that governments must invest in training for workers to help them retool for this new digital world is widely accepted. But there is no one-size fits all when it comes to models of skills development. Skills training models in Germany, Switzerland and South Korea build on the foundation of a good quality education. This is not necessarily the case in many developing countries where youth lack basic literacy and numeracy (Dewan and Sarkar, 2017). Governments must make the necessary investments to ensure that children are receiving good quality, basic education, and that digital skills and other forms of training build on this requisite level of education.

Furthermore, in developing countries with highly heterogeneous labor markets, the potential for technology to exacerbate inequalities further looms large. It is essential that governments recognize that education and skills training are urgent and necessary, though not sufficient (Ernst et al. 2018).

3. Explore new ways of organizing workers and leverage technology to do so

Platform economy companies have come under scrutiny for using their business models to skirt tax and labor regulations, but those firms have also aggregated large groups of workers that may have otherwise worked as disconnected, self-employed individuals. Even though workers using Uber-like platforms are not legally considered employees, they often perceive themselves as working for a company. As such, they can make demands. Fanggidae et al. (2016) illustrate how new forms of organizing and bargaining are emerging among platform economy workers in the global South. These

[4] The platform economy firms can be defined as those that link labor demand and supply through an internet-based/ digital platform.

nascent workers' organizations share information using digital technologies like WhatsApp and other social media platforms, frequently finding creative ways to subvert the power asymmetries between employers and workers.

This evidence suggests that technology, and particularly the growth of the platform economy, can have the effect of organizing systems of work, especially in the transportation and service sectors that otherwise tend to operate in disaggregated, decentralized and informal ways (Dewan & Randolph, 2016). The rise of GoJek in Indonesia provides a stylized example.5 Given this centralization and aggregation of work in such sectors, the platform economy, for instance, places workers in employment relationships that are perhaps more organized than other forms of self-employment would be (Randolph & Dewan, 2017).

3 Conclusion

The Fourth Industrial Revolution is altering the quantity and quality of jobs, the nature of tasks within jobs, the associated education and skill requirements, as well as employment relationships. Understanding these changes is critical to crafting appropriate policy responses that can help labor markets – the businesses and workers within them, adjust to the pace and scale of change.

This paper highlights how existing literature and discourse tease out the technology and employment nexus. What the net impact of technology is on jobs is difficult to parse out. The uncertainty is not just about the future. Whether technology is labor substituting or augmenting; whether it fuels offshoring or reshoring; whether it widens income and wage disparities; these are all questions that continue to plague policymakers, scholars and practitioners today. This is because the technology and jobs relationship is anything but straightforward; it is layered and complex. Technology is not a monolith: artificial intelligence, robotics and the platform economy all have varying impacts. The uncertainty is compounded by a lack of data, especially for developing countries, as well as the inability for policy and regulations to keep pace with the speed and scale of change.

This paper surveys existing literature and evidence to illustrate how technology is at once job-augmenting and job-displacing, and how these effects vary across sectors and geographies. It also provides some insight into the troubling trend of skill-biased technical change that is hollowing out mid-skill level jobs with consequences for working conditions and wages. The persistent uncertainty skews the focus toward how the technology story will play out rather than on how to manage it. But this paper underscores the need to go beyond the focus on the impact of technology to urgently assess, design and implement these mechanisms to manage it now.

[5] GoJek is a transportation provider in Indonesia that uses an Uber-like platform to link riders to motorcycle taxi drivers – an occupation that has long existed in Indonesia but was never formally organized. The company has seen meteoric growth. As of June 2016, the platform processed about 667,000 bookings per day (Lee, 2016).

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