Digital technologies such as robotics, information and communication technologies (ICT), and artificial intelligence, will transform the world of work. They improve labor productivity, lower transaction costs, and reduce barriers to market entry. This will in turn accelerate innovation, possibly inducing a virtuous circle of economic opportunity, growth and prosperity. Yet technology also changes the types of skills that employers demand, the relationships between employers and workers, and the trade flows between countries. This, in turn, risks causing disruption, posing a threat to those too slow to or unable to adjust.

Richer countries, and the better skilled and better connected population groups within countries, stand to benefit most. But developing countries, and especially the poorer segments of the population within them, often do not have proper access to digital technology, nor the skills or enabling environment to benefit from it, while at the same time bearing the brunt of the risks. There is a fundamental danger that inequality will deepen, across and within countries, undermining the prospect of globally shared prosperity itself. Much of that prospect will depend on what will happen to the patterns of employment and whether developing countries will be able to harness and share the job opportunities and benefits technologies present.

This note reflects on the implications of technological change for developing countries. Most of the discussion so far has concentrated on the labor consequences for the developed world. Yet, to reach the twin goals of eradicating extreme poverty by 2030 and fostering globally shared prosperity, developing countries will need to: (1) address bottlenecks in technology access; (2) invest in skills and (3) create an enabling environment.

The future of work requires more, not less technology in developing countries.
THREATS AND OPPORTUNITIES

Digital technology directly and indirectly affects the economic parameters that shape the organization and location of production and exchange, and thus the world of work. By facilitating automation, connectivity and market entry, it changes the price of capital versus labor, the fixed cost of production, the cost of transacting, and the speed of innovation. This fundamentally changes the organization and location of production and exchange, and thus the quantity, quality, and distribution of jobs. The effects can be positive or negative (Table 1) and may be felt directly, by substituting or complementing labor, or indirectly, at another location, through trade.

Automation, for example, expands the range of tasks that machines can cover and the precision with which they do so. This makes it technically, and if the prices come down sufficiently, also economically feasible to replace labor, with robots no longer taking over only routine non-cognitive, but also routine, cognitive tasks. This reduces the number of available low and medium skilled jobs, at home, but possibly also abroad, through reshoring. Automation can also augment labor, such as robots assisting surgeons (implying higher earnings), and give rise to new products, firms and jobs, such as computer animation.

<table>
<thead>
<tr>
<th>Positive effects</th>
<th>Negative effects</th>
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<tbody>
<tr>
<td><strong>Quantity of jobs</strong></td>
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<tr>
<td>Access to markets and resources, due to improved connectivity, helps firms grow and create jobs, or attract work to new markets that are more competitive.</td>
<td>Susceptibility of today’s jobs increases, due to automation, as machines can take on more tasks, or due to innovation reshaping industries and firms.</td>
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<tr>
<td>Product innovations, created and distributed using various technologies, give rise to new industries, firms, and jobs.</td>
<td>The nature of jobs changes, as technology reshapes and alters connections among workers, work, and employers.</td>
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<tr>
<td><strong>Quality of jobs</strong></td>
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<tr>
<td>Productivity increases due to the augmentation of workers’ capabilities through automation lead to related increases in wages and improvements in working conditions.</td>
<td>Workers bear more risk, as connectivity reorganizes where work is done and by whom, diffusing the traditional formal employer-worker relationship.</td>
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<td></td>
<td>Wages stagnate or fall, as technology allows employers to automate or trade more tasks; this could lead to wage polarization and inequalities depending on task content of jobs.</td>
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<tr>
<td><strong>Distribution of jobs</strong></td>
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<td>Inclusion of previously disconnected workers, as connectivity and automation lowers search costs and helps workers overcome physical and social barriers; allows firms to overcome skills constraints to grow, creating jobs.</td>
<td>Exclusion or lagging participation occurs, as workers, employers, and economies could suffer missed opportunities and degrading competitiveness.</td>
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</table>

1 For example, the global automotive industry installed 98,900 robots in 2014. IBM’s Watson AI assists oncologists to diagnose lung cancer. Automation causes middle-skill job creation to stagnate and drives down wages.

2 Computer animation has created 60,000 jobs in India and 64,000 jobs in the U.S., but displaced traditional animator jobs.
ICT increases access to information, lowering transaction costs and facilitating trade. This increases market scale and competition, opening up opportunities for new and better jobs. By introducing new economies of scale (as in platform economies, where the benefits to users increase with platform size), it may also induce new oligopolies and “winner takes most” competition, reducing the labor share in GDP and thus the level of earnings. Digital technology can also reduce the fixed cost of production (for example, 3D printing), reducing economies of scale, and thus the barriers to market entry. These processes accelerate innovation, in business processes and product development, possibly instigating new opportunities and a virtuous circle of development.

The effects will differ across countries and population groups within countries. How these economic forces play out across different countries and population groups within countries will further depend on 1) the extent of technology diffusion, which in turn depends on the regulatory and infrastructural support as well as the demographic composition, such as aging versus youth bulges, which affects the capital-labor price ratios; 2) the population’s skill mix and 3) the enabling business environment, including the reigning labor market regulations and trading environment. As a result, the effects will differ between developed and developing countries, and between the skilled and connected, and the unskilled, poorer, and excluded populations within these countries.

Perhaps the most talked about effect today, especially in developed countries, is the displacement of labor, with technology substituting for human effort in some or most tasks, as the capital/labor price ratio drops. The starker of these predictions suggest that many occupations will be automated away, and job losses will be significant. The more nuanced suggest that some occupations might be entirely susceptible to automation, but that more might be transformed as some share of tasks are automated or traded. The process also bears on the labor markets in developing countries.

The decline in low and middle skilled occupations in developed countries due to outsourcing of labor

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3 Mobile phones ease farmers’ access to market information, improving earnings. Car sharing services link riders with underutilized drivers but put traditional taxis out of work.

4 While digital technologies often weaken the market power of long-standing incumbents, new oligopolies and rent seeking may also arise when there are important economies of scale such as with most platforms, whose benefits to users increase with size. New empirical evidence for the US suggests for example that the secular decline in the labor share of GDP is linked to the increase in “winner take most” competition, with a small number of highly profitable (and low labor share) firms commanding a growing market share (Autor et al., 2017).

5 3D printing helps manufacturers cut prototyping and testing costs.

6 Frey and Osborne (2013).

intensive manufacturing (China) and more recently also routine services (India) from developed to developing countries has been widely documented. It followed improved connectivity and trade liberalization and has underpinned the labor-intensive export led development model of many developing countries, especially in Asia. It has also helped East and South-East Asia reduce extreme poverty.

Yet following recent advances in automatization in the developed world, altering the capital/labor price ratios again, reshoring of these tasks has started. This threatens to close the door for labor-intensive, export-led development as a pathway out of poverty. This is especially problematic for low-income countries with a youth bulge, as in most African countries. In the absence of clear alternative development models, it also raises the specter of growing inequality and migration between countries. Gaps in mean incomes already account for more than 80 percent of global income differences, with wages between unskilled workers in rich and poor countries often differing by a factor of 10 to 1.11

The direct effects of automation on the demand for low and routine medium-skilled tasks in middle- and lower-income countries themselves may be limited for some time, as firms there are slower to adopt digital technologies. Yet at least some workers and firms are using such technologies to be more productive, have better access to markets, and become more innovative.12 Combined with the reshoring of some of these tasks to developed countries, and further off-shoring to lower-income countries, this is already introducing a decline in medium-skilled occupations in some lower-middle-income countries and a polarization

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of their labor market, raising the specter of growing inequality within countries (see Figure 1).

**But the broader economic payoffs from adopting new digital technologies can also be large, given high transaction costs.** Technology facilitates business and product development, providing opportunities for new employment generation. The adoption of mobile telephones and applications such as mobile money and e-agricultural services are commonly cited examples of such leapfrogging. Reduction in the fixed cost of investment and technology adoption such as with 3D printing further reduces barriers to market entry, also enabling smaller firms to participate in production or distribution activities. This can increase labor productivity of skilled and unskilled individuals in urban and remote areas alike.

**Digital technologies are also disrupting the traditional employer–worker relationships.** They allow new forms of work, such as the gig economy, and delink workers from employers. With many social security benefits linked to traditional employment arrangements, workers may lose many benefits and protections. Given that informality is prevalent in the developing world, there is likely less of a direct concern about workers losing full-time formal employment and the attendant social protections. In fact, the digital technologies that enable the gig economy could even foster transparency in the labor market about demand and wages, for example, and create opportunities for workers to access markets far away. These technologies have at times even empowered informal workers in India and improved their ability to get wage raises. It does not do away, however, with the need to find alternative ways to provide social security, for example through greater reliance on self-contributory systems that delink social security provision from employment. But institutional leapfrogging may facilitate the adoption of such alternatives.

![Figure 1](image-url)
Digital technologies thus present both threats and opportunities for the employment agenda in developing countries. Yet many countries lack the means to take full advantage of these opportunities (see Figure 2), because of limited access to technology, a lack of skills, and the absence of a broad enabling environment, i.e., analog complements.¹⁴

Technology access in the developing world often lags the developed world, and within countries, it is typically major cities and towns that are online. Most rural or remote communities, which house four-fifths of the poor,¹⁵ are not online, or they face higher prices or poorer quality services. Divisions also exist across different demographic groups. Women, people with disabilities, social and ethnic minorities, and older people typically lag behind in access to and use of digital technology.¹⁶ Many individuals and businesses will thus be unable to take advantage of technology to improve productivity and incomes, simply because they do not have access to the hardware.¹⁷

But even if the technology is available, limited skills imply that few developing countries, and businesses and individuals within those countries, will be in a position to use those technologies in a productive manner. Skill gaps exist at two levels. First, many developing countries have limited pools of technically highly-skilled workers, limiting innovation, technology transfer, or simple adoption and maintenance. Second, many workers in the developing world do not have the digital literacy—and in some cases, even more basic cognitive and technical skills—to use technology in their occupations (see Figure 2). For example, in Africa, about 70 percent of people who do not use the Internet say it is because they do not know how

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to use it. They miss the opportunity of increasing productivity, while increasing the risk that they may be substituted by technology in the future.

Finally, other analog complements of digital development—rules and institutions—are often also weaker in developing countries. Key socioeconomic development indicators reflect these divergences, including access to finance that allows workers to buy technology and firms to innovate, and core utilities such as electricity, and social protection strategies that would support displaced workers through transitions and prevent a deterioration in job quality.

This does not mean that developing countries and groups within countries cannot benefit from technological change. Some have skipped over traditional methods and leapfrogged into adopting new technologies, taking advantage of their greenfields to deploy systems such as biometric identification for social programs (for example, India), or drones for medical deliveries rather than by road (for example, Rwanda). About a third of the robots bought by Chinese firms are now manufactured in China, and countries such as India and the Philippines are world leaders in business process outsourcing and IT services. Yet absent technology access, skills, and good analog complements, such advances might be limited to a few businesses or individuals in the larger cities, exacerbating inequality.

**TOWARD A MORE INCLUSIVE FUTURE OF WORK**

Public policies could position countries better to mitigate the risks and take maximum advantage of the opportunities. Key measures include:

**Overcoming existing divides by addressing bottlenecks in technology access.** Focus on addressing regulatory and market failures that hold back the provision of affordable and reliable Internet access, access to electronic payment systems, and access to low-cost devices. Public interventions may be necessary to overcome the divides that limit the participation of women, the poor, people with disabilities, and rural communities in the digital economy. For example, a number of countries in South Asia and Africa have invested in public-private partnerships to extend Internet connectivity into rural areas.

**Building skills for the workforce of the future.** Educational systems need significant reforms to impart the basic, technical and socio-emotional skills needed to allow the next generations to participate fully in a global digital economy. In cases where wholesale reform is difficult, bridging from education to employment could help close some skills gaps. In some contexts, additional outreach to communities may be required to ensure that women and people with disabilities—who can gain from online work or learning opportunities—are not excluded. The World

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19 See World Development Report 2016, Overview chapter.
Bank has funded such training programs, focusing on connecting young people to jobs by improving access to IT certifications (for example, Mexico) or via online work platforms (for example, Kosovo).

**Investing in enabling environments.** Improving access to finance, to infrastructures such as electric power, logistics, and public services, will be critical to unlock the full range of benefits from digital development. Social safety nets would need to reform to protect gig workers and to support those who lose their jobs or need transition assistance. If the future is one of little work, cash transfers and universal basic income strategies—being piloted in the U.S. and Finland—may need to be developed.\(^{20}\)

Technology can in turn help overcome the bottlenecks to access, build skills (long distance learning) and deliver the analog complements to leapfrog weak logistics, through digital financial services, renewable energy, mobile government services, and innovations such as drones.