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How changes in technology and automation will affect the labour market in Africa

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22. 02 2017

Question

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Contents

1. Overview

Estimates of how many jobs are vulnerable to being replaced by machine vary but it is clear that developing countries are more susceptible to automation compared to high-income countries. Traditionally, blue-collar routine jobs have been automated but with the emergence of greatly improved computing power, artificial intelligence and robotics, a much larger scope of occupations are at risk. Vulnerability to automation is now based on whether jobs or tasks are codifiable and whether they are routine or not. Highly-trained and skilled jobs can be more at risk than more varied, lesser skilled jobs.

Manufacturing jobs have been an important source of better-paying jobs as workers move out of agriculture, but manufacturing is likely to generate fewer jobs than in the past due to an increase in automation in this sector. Low-income countries will not achieve rapid growth by shifting workers from agriculture to factory jobs and will need to seek new models of growth. The service sector is also increasingly being automated. Future employment growth is likely to come from jobs that cannot be fully or partially automated. Among the low skilled, some services that must be delivered face-to-face or require awareness and situational adaptability (housekeepers, hairdressers) are likely to grow. Among the high-skilled, occupations will rely on modern skills involving creativity and social interactions and will use digital technologies to complement their tasks.

Middle-skilled jobs, often near the top of the income distribution in low-income countries, are increasingly being automated polarising the labour market into two groups doing non-routine work: highly paid skilled workers and low-paid unskilled workers. Through previous waves of technological advancement middle-skilled workers would have been able to seek jobs in other routine middle-skilled occupations. But the wider scope of routine occupations being automated means that the process of job creation and destruction will hurt individuals whose skills are substituted by technology, because they often do not have the skills required in many of the new jobs. Even for those who stay within the same occupations, jobs will be transformed, requiring modern skills. In the future, unless these people retrain and upskill, they will become an increasing supply for low-paid unskilled work. The change in incomes toward capital and away from labour is associated with increased wealth inequality where the rich will be able to invest in the new technology and own the robots and consequently accrue the benefits. Incentives will need to be found to stimulate entrepreneurship and protect workers displaced by robots whilst they adapt and learn new skills.

High-income countries face large disruptions to their labour market in the near future since they use more technology at work and are experiencing faster changes in skill requirements. Although they have smaller shares of employment in routine occupations susceptible to automation, their higher wages make it easier for automation to be economically viable. Low and middle-income countries also expect substantial changes to their labour market, given their rapid technological adoption and large number of workers in routine occupations, but not as soon. Lower wages and slower technological uptake means disruptions are likely to arrive more slowly, giving more time for policies and institutions to adapt. Automation could be more disruptive though in these countries with little consumer demand and limited social safety nets.

Increased use of robots in developed countries may compete with the labour-cost advantage of off-shoring to developing countries. However, evidence to-date on reshoring shows minimal economic benefit in developed countries with the minimal job creation that has occurred being mostly in high-skilled activities. Moreover, developed countries now lack supplier networks that some developing countries have built to complement assembly activities. Increasingly important are the size and growth of local markets. This means that the production of labour-intensive manufactures for rapidly growing markets in large developing countries that have domestic production linkages is unlikely to be moved back to developed countries.

Data shows that industrial robots have primarily been deployed in the automotive and electrical and electronics industry (United Nations Conference on Trade and Development October 2016). Widespread automation is not yet occurring in many labour-intensive industries, such as garment-making and whilst robots have become cheaper, current cost structures of replacing

large pools of low-skilled workers, may drive production costs up rather than down (United Nations Conference on Trade and Development October 2016).

Countries will need to develop modern skills among children and youth, but also retrain and upskill existing workers for lifelong adaptation to multiple jobs within a career. Whilst the labour market may change at a different pace and to a different extent in different countries, it will change. Education and training systems are difficult to change with reform taking many years to have an effect. The sooner countries prepare, the greater the digital dividends. Because skilled jobs are less susceptible to automation, the best hope for developing and emerging economies is to upskill their workforce to have skills that machines will find difficult to do. These include problem solving, critical thinking, learning and reasoning as well as the ability to work in a team, good interpersonal skills and to be creative. The worker will also need to have technical skills, which includes ICT skills (World Bank 2016).

The future workforce will likely shift towards more self-employment and online work where employers will think in terms of specialisms rather than employees. This may benefit and expand access to work for women, youth, older workers and the disabled, who may prefer the flexibility of working from home or working flexible hours. Online work will also provide access to a larger global labour market. However, these workers will require protection against poor pay and lack of career prospects.

Changes in the labour market will also require rethinking of social protection and tax systems (World Bank 2016). Workers protection will require major reforms in many countries and forward thinking design in countries just starting to develop social protection systems, rather than copying current models. The fiscal implications of robot deployment will also need to be considered to prevent a major hole developing in the public purse.

The impact of technology change on the economy is considered different this time for three reasons: (1) the pace of change has accelerated; (2) the scope of technological change is increasing; and (3) unlike innovation in the past, the benefits of technological change are not being widely shared - real median wages have fallen behind growth in productivity, and inequality has increased (Frey and Osborne 2015).

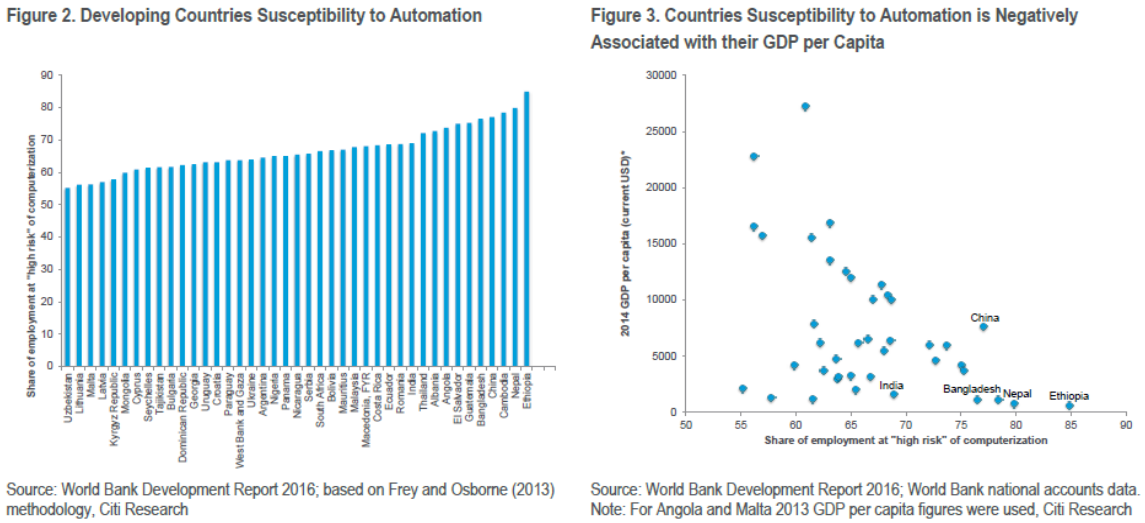
This rapid literature review found that whilst there is evidence, information and discussion of the impact of automation on the labour market in industrialised nations, there is much less on the potential impact in developing countries. The World Development Report 2016 Digital Dividends (World Bank 2016) was an excellent source of data and many of the figures presented are from this report. Whether you are a “techno-optimist” or a “techno-pessimist”, the impact of automation on the labour market will require long-term adjustment and policy changes to ensure the future of work is inclusive and sustainable and addresses increasing income inequality (Gelb and Khan December 2016) in an ever more automated and digital economy.

2. The risk of automation of jobs

In 2013, Frey and Osborne published a study examining how **susceptible jobs are to computerisation** (Frey and Osborne 2013). The probability of computerisation for 702 occupations were estimated. About 47 percent of total US employment was estimated to be at risk and wages and educational attainment exhibited a strong negative relationship with an occupation’s probability of computerisation. Based on Frey and Osborne’s methodology and using data from the World Bank Development Report 2016 Digital Dividends (World Bank 2016)

a Citi GPS report, co-produced by Citi and the Oxford Martin School at the University of Oxford, showed that jobs in developing countries are more susceptible to being replaced by automation (Frey, Osborne et al. 2016). Across Africa, the risk of jobs being replaced by automation varies by country from estimates of 65 percent in Nigeria, 67 percent in South Africa to a high of 85 percent in Ethiopia (figure 1). This compares to an OECD average of 57 percent. Countries more susceptible to their labour market being replaced by automation typically have lower levels of GDP per capita (figure 1). This report therefore warns that low-income countries are relatively vulnerable to automation.

Figure 1. Susceptibility of job automation in developing countries



Source: Citi GPS 2016 Technology at Work v2. 0: The Future Is Not What It Used to Be (Frey, Osborne et al. 2016)

The methodology used to generate these results, however, has been criticised by the Organization for Economic Co-operation and Development (OECD), whose own analysis gives a much more conservative estimate of 9 percent of all US jobs being at high risk of automation (over the same one- to two-decade time span) (Arntz and Zierahn). The OECD analysis used the same assessment of tasks at risk of automation as the Oxford/World Bank methodology but criticises the latter for assuming that “whole occupations rather than single job-tasks are automated by technology”. The OECD report argues that “this might lead to an overestimation of job automability, as occupations labelled as high-risk occupations often still contain a substantial share of tasks that are hard to automate”. Differences in risk between countries reflect cross-country differences in workplace organisation and job content, differences in national systems for education and skills development, and differences in previous investments into automation technologies. Although estimates of job losses vary based on the methodology used, the reports agree that adjustment will be required in response to increasing automation and digitalisation.

Previous advances in industrial technology have been associated with social panic (automation anxiety) about large numbers of job losses. The best known early example was the Luddite movement during the Industrial Revolution, in which a group of English textile workers protested against the automation of textile production which they believed would destroy their livelihood. There have been subsequent waves of panic over automation of the labour market including the introduction of computers into offices and robots on factory floors in the 1960s and the advent of personal computers in the 1980s. In fact, overall employment rose strongly in the long term

(Economist 2016). Historically, job displacement and losses from technological change are an integral part of economic progress. Increasing productivity, as technology replaces human labour but augments the skills of remaining and new workers, generates growth and frees human and financial resources for deployment in sectors with higher returns. It also reduces the need for humans to do physically hard, repetitive or dangerous work. However, in these previous episodes of technological advancement, workers had the option of moving from routine jobs in one industry to routine jobs in another and this may not be an option in the future as these alternatives will also be automated.

3. "Collar-blind" technological advances

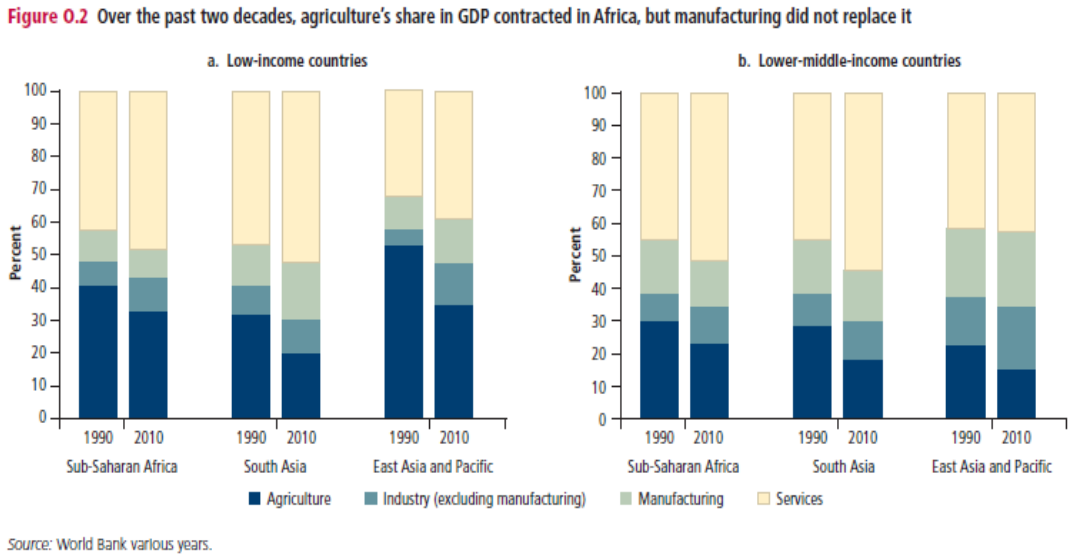
It is well known and established that manual work can be automated. The emergence of greatly improved computing power, artificial intelligence, and robotics that can replace complex cognitive tasks and human decision making by algorithms, machine learning and other computational techniques though raises the possibility of replacing labour on a scale not previously observed (Autor 2015). Highly-trained white-collar jobs are now at risk of also being automated with rapidly evolving ever-smarter machines. Vulnerability to automation is no longer based on whether the work is manual or white-collar but whether or not it is routine i.e. technology is fast becoming **"collar-blind"**. Highly-trained and skilled jobs can be more at risk than more varied, lesser skilled jobs. However, whilst automation does substitute labour, automation also complements labour – increasing productivity, raising earnings and augmenting demand for labour (Autor 2015).

The impact of automation on a job depends on what is required as to whether technology either complements or substitutes workers in those tasks. If a job is codifiable and routine, it is likely that an algorithm can do that job and this occupation will disappear (labour saving) or transform in the future. According to Chris Wilder, Internet of Things (IoT) analyst at Moor Insights & Strategy in Austin, Texas, "there is no doubt that many jobs will become obsolete, or outdated as IoT grows. New fields and expertise will emerge. Employees must evolve to compete in a knowledge-based economy. Growth in field services, asset management, robotic maintenance, remote diagnostics and analytics expertise will off-set job losses due to the proliferation of IoT" (Ambasna-Jones 2015).

Whether a job can be automated or not does not mean it will be automated. Capital cost of automation as well as certain jobs requiring human interaction may prevent an automatable job being automated. Parameters may change though as machine learning and mobile robotics develop rapidly (Economist 2016).

Countries are running out of industrialisation opportunities sooner and at much lower levels of income compared to previous industrialising nations (Rodrik 2016). Both globalisation and labour-saving technological progress in manufacturing has been suggested to be behind this 'premature deindustrialisation'. Manufacturing's share in GDP is lower in Sub-Saharan Africa today than it was in 1980 (figure 2). Over the same period in Asia, it rose in both lower- and middle-income countries which drove employment and economic transformation in East Asia.

Figure 2. Manufacturing's share of GDP

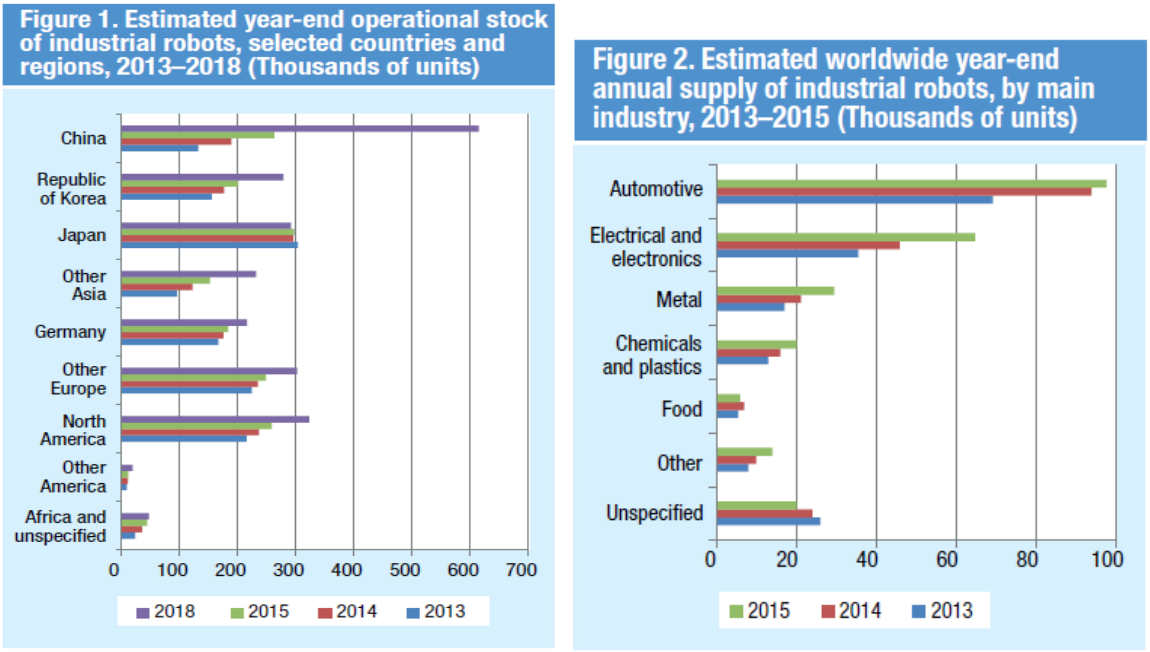


Source: Filmer et al 2014 (Filmer 2014)

Asia needs to continue to find ways to move up the value-added chain to stay competitive, not just with other emerging market economies, but with advanced economies that may be increasingly equipped with technology (Frey, Osborne et al. 2016). Due to an increase in automation in manufacturing, shifting workers from agriculture to higher-paying factory jobs in the emerging economies in African and South American countries is less likely to achieve the rapid growth seen by Asian countries (Frey, Osborne et al. 2016). Emerging and developing countries will need to search for new growth models and upskill workforces. One possibility is service-led growth but many low-skill services are now becoming equally automatable.

Data from the International Federation of Robotics showed that recent deployment of industrial robots has mostly been in China (figure 2). China has embarked on a government-backed robot-driven industrial strategy entitled "Made in China 2025" in response to a shrinking working-age population and rising labour costs, which has dented the country's cheap labour advantage. The data also shows that industrial robots have primarily been deployed in the automotive and electrical and electronics industry (figure 3). This will have greatest impact (reshoring) in developing countries, such as Mexico and any countries in Asia, that are involved in these two sectors. However, widespread automation is not yet occurring in many labour-intensive industries, such as garment-making. Whilst robots have become cheaper, current cost structures of replacing large pools of low-skilled workers, may drive production costs up rather than down (United Nations Conference on Trade and Development October 2016).

Figure 3. Deployment of robots by country and industry



Source: UNCTAD secretariat calculations, based on International Federation of Robotics, 2015, World Robotics 2015: Industrial Robots, available at http://www.ifr.org/industrial-robots/statistics/ (accessed 19 October 2016).

Source: UNCTAD 2016 Policy Brief no. 50 (United Nations Conference on Trade and Development October 2016)

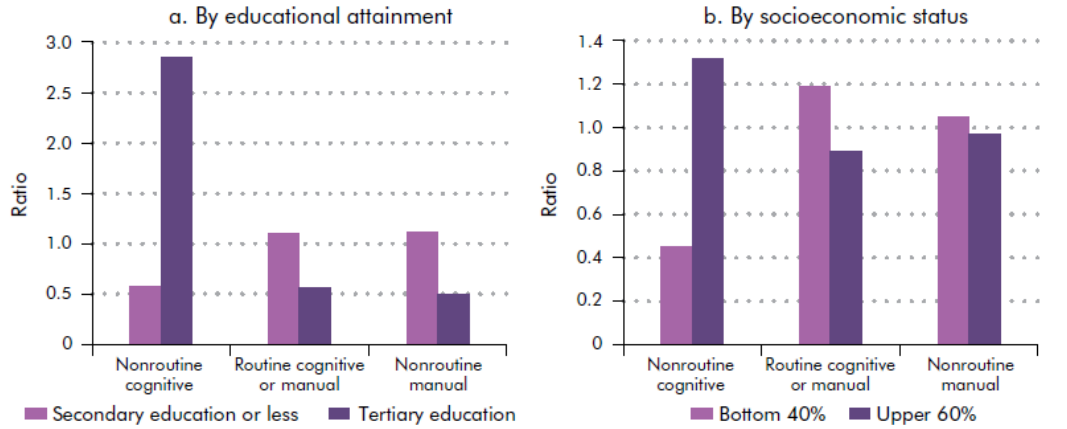
4. Rising inequality

Technology will complement the small share of high-skilled workers and allow them to be more productive and to find more rewarding opportunities and higher wages. Whereas low-unskilled workers will face increasing competition from redundant **middle-skilled workers** who don't have the additional skills to switch to higher paid non-routine jobs as their jobs are automated. Returns to tertiary education are highest, the returns to schooling are higher for women than for men and returns to schooling and labour market experience are strongly and positivity associated (Montenegro and Patrinos 2014). The biggest risk therefore from the digital revolution is not mass unemployment but widening income inequality. The less educated and those less well-off are most vulnerable to technological changes in the labour market (figure 4).

Figure 4. Employment by education and socioeconomic status

Figure 2.27 The less educated and the bottom 40 percent of the welfare distribution are most vulnerable to technological changes in the labor market

Ratio of employment by occupation type to total employment



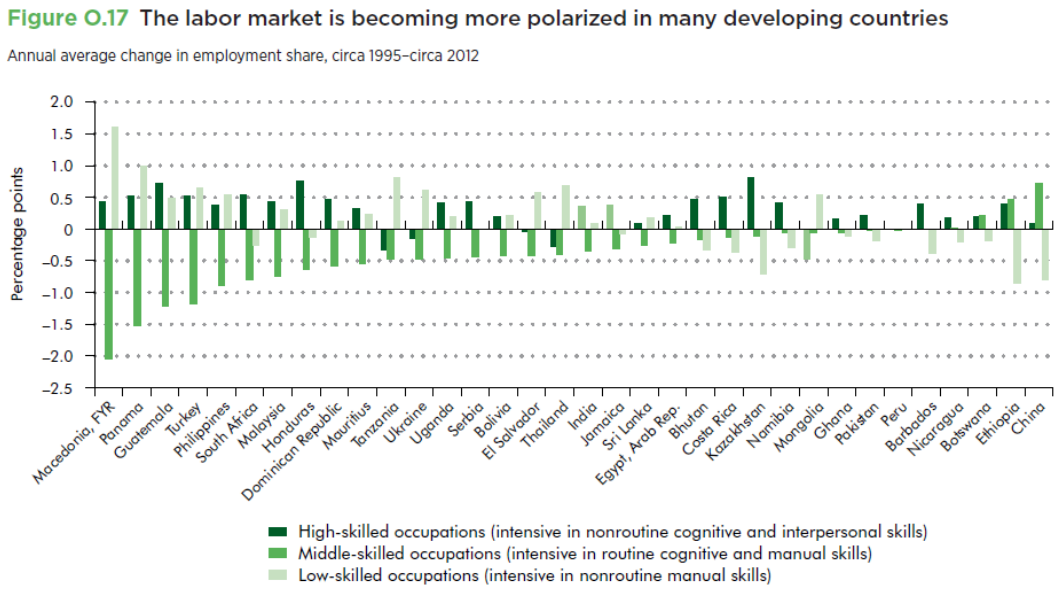
Source: WDR 2016 team, based on the I2D2 dataset (International Income Distribution Database; World Bank, various years). Data cover 117 countries. "Bottom 40%" and "Upper 60%" refer to the welfare distribution (either of income or consumption) of individuals' households. Classification of occupations follows Autor 2014. Data at http://bit.do/WDR2016-Fig2_27.

Note: A ratio higher than 1 means that workers with the given level of education are disproportionately likely to be in the given occupation type. A ratio lower than 1 means that workers are relatively unlikely to be in a given occupation type.

Source: World Bank. World Development Report 2016: Digital Dividends (World Bank 2016)

Increasingly, automation is replacing middle-skilled jobs (such as clerks, plant and machine operators), where most routine jobs fall, whilst high and low-skilled jobs are expanding. The workforce is therefore effectively polarising into two groups doing non-routine work: highly paid, skilled workers (such as architects, senior managers and professionals) and low-paid, unskilled workers (such as cleaners, service and sales workers). There is evidence of this **polarisation** in developed countries (Autor and Dorn 2013) and for the first time the World Development Report 2016: Digital Dividends shows evidence of this effect also happening in developing countries (figure 5). A decline is observed in most developing countries of middle-skilled occupations; types of jobs often near the top of the income distribution in low-income countries, however, there are exceptions. Ethiopia, with a large share of employment in manual occupations, is not polarising and neither are other countries rich in natural resources and who are commodity exporters.

Figure 5. Polarisation of the labour market in developing countries



Source: World Bank. World Development Report 2016: Digital Dividends (World Bank 2016)

Factors other than technological change are also likely to drive labour market polarisation. These include globalisation, urbanisation and structural transformation.

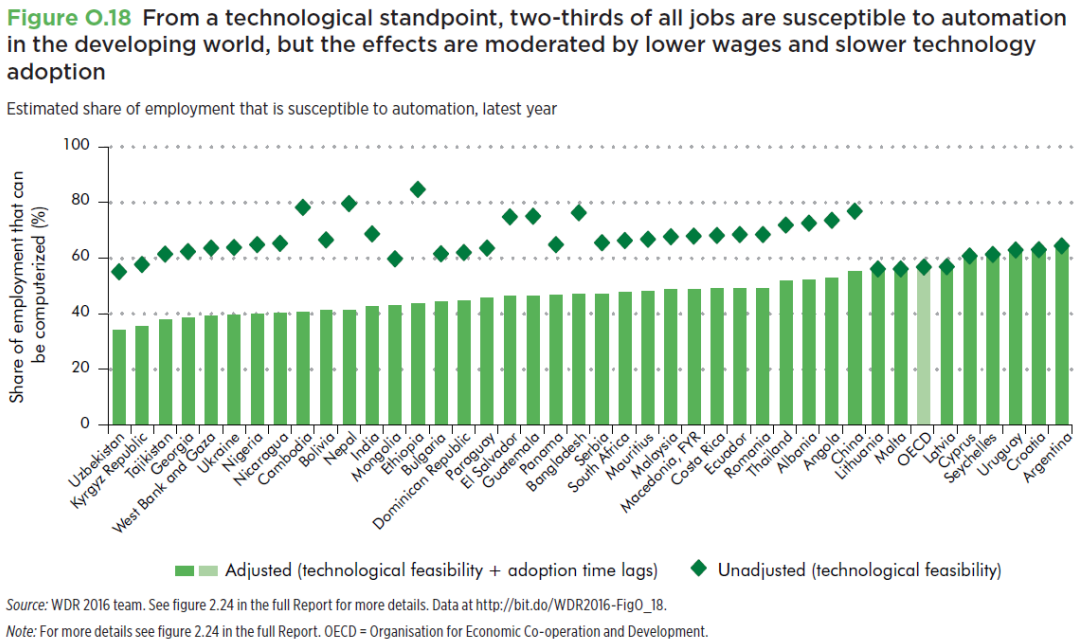
Digital technologies can increase productivity and enhance overall welfare but how are the gains shared in the labour market? The share of national income that has gone to labour, especially routine labour, has fallen in many countries, including some developing countries, although there are some exceptions including Brazil (World Bank 2016). The change in incomes toward capital and away from labour is associated with increased inequality (World Bank 2016). The futurist Jerry Kaplan from Stanford University Law School admits that increased use of robots could lead to increased wealth inequality (Bowles 2016). The robots will be owned by the rich who can invest in the new technology and will therefore naturally accrue the benefits. Zero unscheduled downtime and resource efficiency are big advantages to the automated labour market which lead to greater returns (Economist 2016). Kaplan suggests that we need to incentivise the poor. One possible solution to high unemployment could be job mortgages – so that people who are displaced by robots can take out loans toward future earnings in unknown jobs i.e. people should be able to learn new skills by borrowing against future earnings capacity (Bowles 2016).

5. Pace of technological change

Implications of technological change depends upon the pace at which it happens. The use of automation and robotics appears to have accelerated since the global financial crisis propelled by three main drivers (Frey, Osborne et al. 2016). First, rapid wage gains (plus aging populations) in large-manufacturing-producing countries, especially China, have induced demand for automation. Second, the prices of hardware and enabling software have declined markedly, making it an increasingly attractive investment. Third, technological advances have increased the scope and usability of robotics, making robots smarter, safer and more applicable across a broader range of processes delivering more consistent and better product quality. These drivers increase the scope for labour displacement and outsourcing.

The share of occupations that could experience automation is higher in developing countries than in more developed nations, where many of these jobs have already disappeared but it will take longer in lower-income countries where wages are lower, where there is a larger share of manual nonroutine labour and technology is adopted slower (figure 6). Investments here in technology will be less profitable for firms.

Figure 6. Share and pace of employment that can be computerised



Source: World Bank. World Development Report 2016: Digital Dividends (World Bank 2016)

6. Impact of automation on offshoring to low cost regions

The increased use of robots in developed countries competes with the traditional labour-cost advantage of developing countries (United Nations Conference on Trade and Development October 2016). Developed countries may **reshore** economic activities to regain international competitiveness in manufacturing and to address the decline in manufacturing employment and middle-skilled occupations in their own countries. Consequently, this could lead to a reduction in output and employment in the manufacturing sector of developing countries impacting on their industrialisation strategy for development (United Nations Conference on Trade and Development October 2016). However, evidence on reshoring that has happened, especially in activities where automation and other technological advancement are important for production processes, shows minimal economic-wide benefits (United Nations Conference on Trade and Development October 2016). Reshoring has mostly been accompanied by capital investment, such as in robots, with the minimal job creation that has occurred being mostly in high-skilled activities, contributing to polarisation. Moreover, developed countries now lack supplier networks that some developing countries have built to complement assembly activities.

Offshoring continues to take place with cheaper labour-costs still a factor in firms decision-making on where to locate production, especially of goods with a high labour content. But increasingly important are factors such as the size and growth of local markets. This means that production of labour-intensive manufactures for rapidly growing markets in large developing

countries that have domestic production linkages is unlikely to be reshored (United Nations Conference on Trade and Development October 2016).

Internet-enabled offshoring is an important source of jobs in developing countries and especially for women (World Bank 2016). These jobs are commonly in business processing - jobs that can be broken down into routine tasks but also those requiring high skills and judgement if they can be reliably performed and monitored remotely. Almost half of business process outsourcing (BPO) is in banking and financial services e.g. bookkeeping, and another 20 percent is in high-tech and telecommunications e.g. call centres (World Bank 2016). Some medical services are also increasingly becoming offshored.

New technologies are now challenging the BPO industry as many of the characteristics that make jobs "offshorable" also make them more vulnerable to automation. For example, a local health care company in South Africa is now using Watson, IBM's artificial intelligence system, to assist in customer service. However, outsourcing opportunities are increasing in other areas through **online work**, providing workers and companies with access to larger, global employment marketplaces. This can provide an opportunity to monetize skills that may not be in sufficient demand in the local economy e.g. an individual in Mongolia with expertise in web development (World Bank 2016). The internet connects a larger pool of individuals and firms at lower cost making labour markets more efficient. However, online job search remains concentrated among the youth and the best educated and grows with income and is still low in developing countries including Ghana, Sri Lanka and Vietnam (World Bank 2016). A challenge is reaching lower-skilled workers. Some services, including Duma in Kenya (https://dumaworks.com) have implemented innovations to reach these people. They use text messaging and "missed calls" to connect low-skilled and informal workers to vacancies.

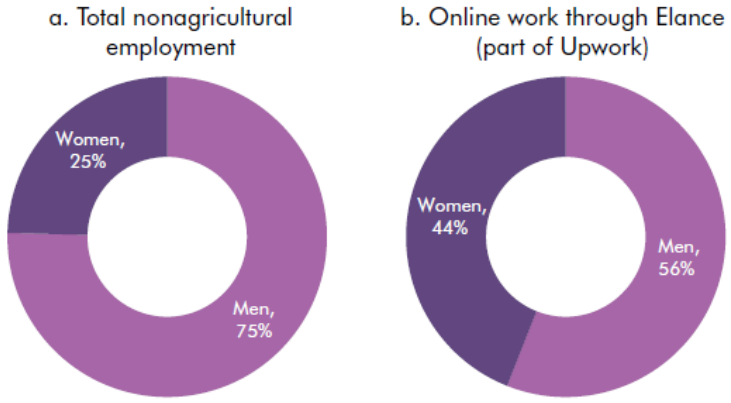
Online work expands access to work for women, youth, older workers and the disabled who may prefer the flexibility of working from home or working flexible hours (figure 7). However, whilst flexibility in hours and the ability to work from home are the main advantages relatively poor pay and lack of career prospects can be disadvantages to this way of working.

Figure 7. Flexibility of online work

Figure 2.7 Online work expands women's access to work

Global nonagricultural employment composition by gender, "offline" and online

percent of total employment

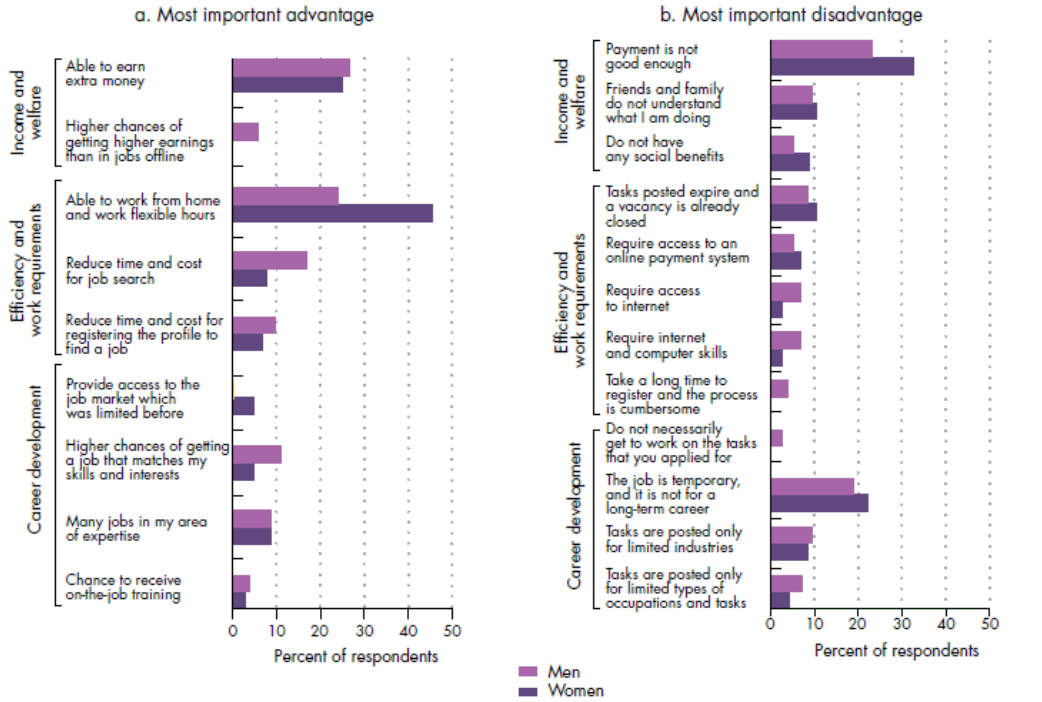


Sources: WDR 2016 team, based on World Development Indicators (World Bank, various years) and Elance Annual Impact Report "Work Differently," June 2013. Data at http://bit.do/WDR2016-Fig2_7.

Note: Results are population-weighted. China is not included. For panel a, latest available data between 2008 and 2013.

Figure 2.8 Flexibility in hours worked and the ability to work from home are the main advantages of online work, but relatively poor pay and lack of career prospects are concerns

Microworkers.com: Most important advantage (panel a) and disadvantage (panel b) of using an online work platform over a traditional job "offline"



Source: Survey of online workers at microworkers.com, where the majority of workers are from developing countries, especially South Asia. Based on Imaizumi and Santos, forthcoming, for the WDR 2016. Data at http://bit.do/WDR2016-Fig2_8.

Source: World Bank. World Development Report 2016: Digital Dividends (World Bank 2016)

Impact-outsourcing brings online work to vulnerable communities. For example, Samasource (https://www.samasource.org/), a private service provider that employs marginalised women and

youth, provides two workforce extension models to meet business needs. In 2015 Samasource operated in five countries, India, Kenya, Uganda, Haiti and Ghana with an average active workforce of 652 and a cumulative workers count of 7,190 since 2008.

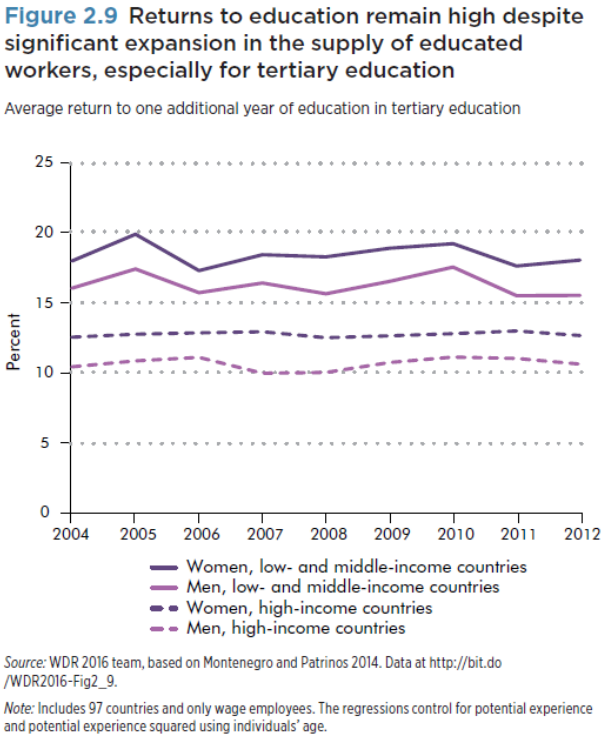
7. Education

Investment into education could be one of the most effective policies to offset the risk of automation impacting labour and wealth distribution (Frey, Osborne et al. 2016). Building on a foundation of basic literacy and mathematics, a well-educated worker in a modern economy needs to have skills which include problem solving, critical thinking, learning and reasoning as well as the ability to work in a team, good interpersonal skills and be creative. The worker also needs to have technical skills, which includes ICT skills which can range from ICT specialists to basic ICT users, who effectively use mainstream tools needed in their working (World Bank 2016). Workers need to be prepared for a career, not just a job, and have the ability for life-long learning to adapt and upgrade their skills to ever-changing environments. This will require mechanisms for lifelong learning outside of the formal education system, including an increase in online learning to improve skills across age ranges.

Education systems have been slow to respond to the rapidly changing types of skills needed in a modern economy (World Bank 2016), but many countries are starting to rethink their approach to education in which the teacher is no longer simply a source of information, but must teach students on how to find information and apply it in a new and unexpected context. This requires changes in teacher training and there are many examples of how digital technologies can assist both teachers and students. Technology can play a role in laying the foundation of cognitive and socioemotional skills (World Bank 2016). For example, the Khan Academy provides resources for independent learning, and benefited grade four children in Mumbai by using a gaming approach to math teaching. The quality of teaching remains of utmost importance, and technology can support and guide teaching. This model was used by the for-profit Bridge Academy in Kenya and elsewhere, where scripted instruction and automated administrative tasks help provide education at low cost. Frey suggests that governments “should not try to protect current or future jobs.” Instead, he says “it is crucial that governments take steps to reduce the cost of education while improving its quality” (Ambasna-Jones 2015).

Private returns to education remain high, at 10 percent per year, despite large increases in the supply of educated workers in the last few decades. Returns to tertiary education are the highest which reflect strong demand for advanced skills. Returns are also higher for women than men (figure 8).

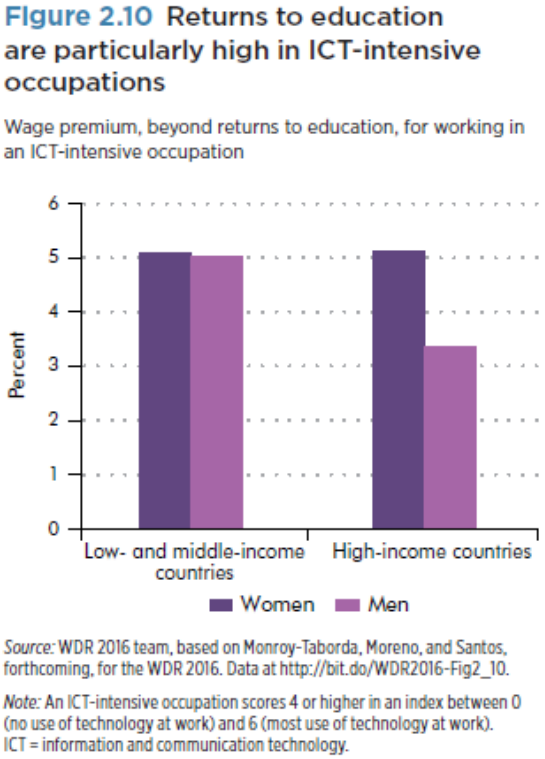
Figure 8. Returns to education



Source: World Bank. World Development Report 2016: Digital Dividends (World Bank 2016)

As more parts of the economy rely more on the internet, the demand for ICT skills is growing (World Bank 2016). Returns to education are high and have been rising more rapidly in ICT-intensive occupations compared to the rest of the economy (figure 9). Although only a small share of the workforce will be involved in developing software or systems design, exposing children to coding and basic ICT concepts can influence career choices for some and impart a basic understanding to many. NairoBits (http://www.nairobits.com/) is an organisation in Kenya that aims to promote creative and innovative use of ICT skills by young persons that would improve their ability to enter the labour market. Women are underrepresented in ICT and encouraging girls to enter this profession will increase the available workforce in fields with increasing demand for labour (World Bank 2016). AkiraChix http://akirachix.com/ is a not for profit organisation that aims to inspire and develop women at all levels from primary school to university to those who wish to have a career in technology to change Africa's future.

Figure 9. Returns to education in ICT-intensive occupations



Source: World Bank. World Development Report 2016: Digital Dividends (World Bank 2016)

8. The Future Economy

Rodrik asks 'How concerned should low- and middle-income countries be about their "premature industrialization"(Rodrik 2016)?' In low-income countries, industrialisation contributes to growth both because of the movement of workers from the countryside to urban factories and because manufacturing tends to experience relatively stronger productivity growth over the medium to long term. From this perspective, premature industrialisation is not good news for developing nations. The consequences are already being seen. In Latin America, as manufacturing has shrunk economy-wide productivity has slowed. In Africa, urban migrants are crowding into petty services instead of manufacturing, despite growing Chinese investment. McMillan and Rodrik analyse employment patterns in a broad cross-section of developing economies and find that labour has been moving in the wrong direction in Latin America and Africa to low productivity services and away from high productivity activities such as manufacturing (McMillian M.S and Rodrik 2011). However, there has been no lack of growth in the developing world since the mid-1990s driven not by traditional industrialisation but by capital inflows, external transfers or commodity booms, which raises questions about their sustainability (Rodrik 2016).

Digital and mechanical technologies, and deindustrialisation, mean that the manufacturing sector is likely to generate fewer jobs than in the past, especially for unskilled workers (World Bank 2016). In the absence of sizable manufacturing industries, these economies will need to discover new growth models and upskill their workforce. One possibility is services-led growth. Many services, such as IT and finance, are high productivity and tradable, however, these services are typically highly skilled and do not have the capacity to absorb, as manufacturing did, the type of labour that low and middle-income economies have in abundance (Rodrik 2016). Moderate

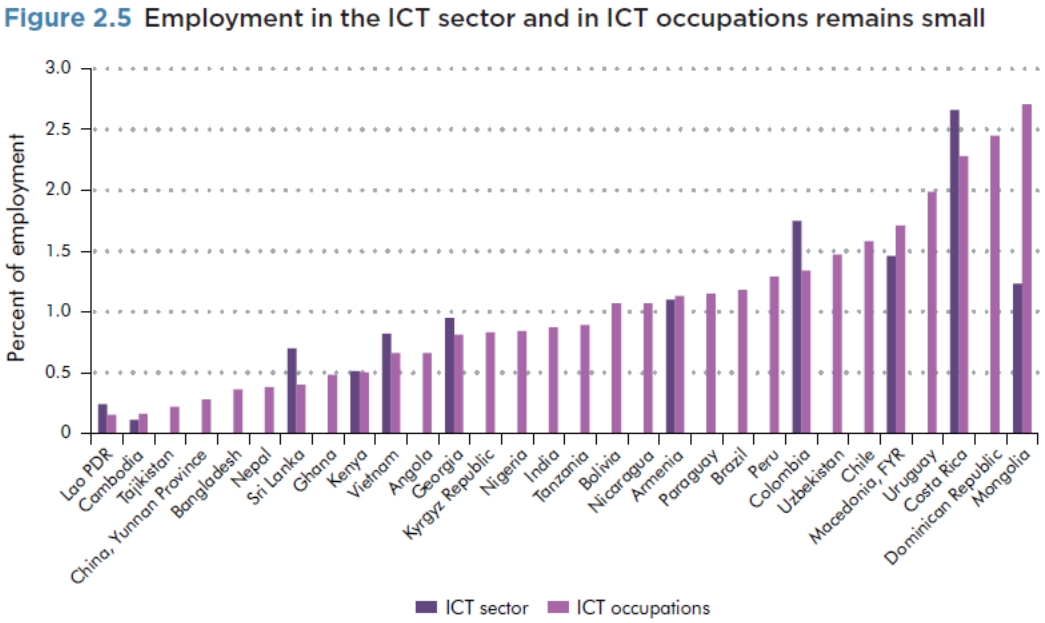
growth is possible, as developed countries have grown at rates between 1.5 and 2% per annum despite manufacturing decline, but catching up will require higher growth rates.

The most important public policy response is to help everyone gain the skills that technology complements, and not those that technology replaces to prepare workers for the modern world of work (Santos 2016). New fields and expertise will emerge and employees must evolve to compete in a knowledge-based economy. Growth in field services, asset management, robotic maintenance, remote diagnostics and analytics expertise will off-set job losses due to the proliferation of IoT (Frey, Osborne et al. 2016).

Unemployment in low and lower-middle-income African countries is low as most Africans cannot afford to not work (Filmer 2014). The unemployment rate is highest among university graduates, who mostly come from the top end of the income distribution. In Sub-Saharan Africa about 16 percent of the labour force receive a regular wage divided roughly equally between the public and private sectors. The industrial sector (mining, manufacturing and construction) accounts for less than 20 percent of wage jobs (about 3 percent of total employment) (Filmer 2014). Despite rapid growth in formal wage sector jobs, most jobs are on family farms (62 percent) or in household enterprises (22 percent), often with very low incomes. Increases in wage employment is expected to come from continued diversification of output and exports and from increased domestic demand for services as incomes grow. Service employment is expected to grow faster than industrial employment, where most nonfarm employment will be created. However, because this growth comes from such a small base, it will not be able to absorb the estimated 11 million youth expected to enter Africa's labour market each year. The World Bank Youth Unemployment in Sub-Saharan Africa report suggests that to boost young person's earnings, government needs to speed up overall business climate reforms, strengthen basic education, and male land, infrastructure, training and financing more accessible (Filmer 2014)

In terms of employment in developing countries the ICT sector is small, it employs on average 1 percent of the workers (figure 10), has high entry barriers and remains male dominated. Although the sector is not labour intensive, ICT jobs pay well and can generate additional jobs through consumption and production spillovers (World Bank 2016). The median hourly earnings in the ICT sector and in ICT occupations are 1.5 times higher than in urban non-ICT sectors or non-ICT occupation in developing countries. The high pay reflects a workforce that is better educated than average and also likely reflects the relative scarcity of ICT workers in some countries, driving up the skill premium (World Bank 2016). These high-paying jobs create more demand and new jobs outside of ICT with many of these additional jobs being low or medium-skilled occupations in local services such as retail cleaning and food preparation (World Bank 2016). For example, Hormuud Telecom, the largest operator in Somalia, employs 5,000 staff but supports 25,000 agents (World Bank 2016).

Figure 10. Employment in the ICT sector in developing countries



Source: WDR 2016 team, based on the Skills Towards Employability and Productivity (STEP) household surveys (World Bank, various years); Central Asia World Bank Skills surveys (World Bank, various years); Survey-based Harmonized Indicators Program (SHIP) (World Bank, various years); Socio-Economic Database for Latin America and the Caribbean (SEDLAC) (CEDLAS and World Bank); and South Asia Region MicroDatabase (SARMD) (World Bank, various years). Data at http://bit.do/WDR2016-Fig2_5. The STEP surveys used in this Report cover 11 countries: Armenia, Bolivia, Colombia, Georgia, Ghana, Kenya, Lao PDR, FYR Macedonia, Sri Lanka, Ukraine, and Vietnam, as well as China, Yunnan Province.

Note: The ICT (information and communication technology) sector includes ICT manufacturing industries, ICT trade industries, and ICT services (OECD 2011). ICT occupations refer to ICT specialists (OECD 2004, 2014).

Source: World Bank. World Development Report 2016: Digital Dividends (World Bank 2016)

Policy intervention will be necessary, such as labour market adjustment policies to support workers whose job (or the task-content of their job) is changing, and to adapt, expand and upgrade systems for skills development for people entering the workforce (Gelb and Khan December 2016). Active labour market policies, including upskilling, training and education are necessary to ensure that job losses deriving from technological advances and globalization of supply chains are offset by other employment opportunities (International Labour Office 2015).

Changes in the labour market also requires rethinking of social protection and tax systems (World Bank 2016). The modern on-demand economy will lead to more independent contracting, casual work, freelancing and other new forms of work in online labour markets. In most countries, social insurance schemes for pensions, unemployment and health are tied to formal employment paid through payroll taxes. Strict labour regulations common in developing countries, and overreliance on labour taxation will encourage faster automation by making hiring more expensive. The 2016 World Bank Report advises that it would be better to strengthen workers protection by delinking social insurance from the labour contract (World Bank 2016). This will require major reforms in many countries and forward thinking design in countries just starting to develop social protection systems, rather than copying current models.

Robots and machines do not pay national insurance and income tax. The fiscal implications of robot deployment need to be considered. Without the introduction of a major tax on robots as capital equipment, robot-based manufacturing cannot boost the fiscal revenues needed to finance both social transfers, to support workers made redundant by robots, and minimum

wages, to stem a decline in the living standards of low and medium-skilled workers (United Nations Conference on Trade and Development October 2016).

Key websites

The Oxford Martin Programme on Technology and Employment
http://www.oxfordmartin.ox.ac.uk/research/programmes/tech-employment

The Oxford Martin Programme on Technology and Employment was established in January 2015 toresearch implications of a rapidly changing technological landscape for economies and societies. The programme aims to provide evidence on the following:

- How technology is transforming companies and industries;
- Why some places are better at adapting to this transformation;
- Related implications for living standards, inequality and social mobility.

Digital Development Summit 2017
http://www.ids.ac.uk/events/digital-development-summit-2017

An inaugural Digital Development Summit to explore the future of work in a digital world.

9. References

Ambasna-Jones, M. (2015). Will automation and the internet of things lead to mass unemployment?, The Guardian.
https://www.theguardian.com/media-network/2015/may/27/internet-of-things-automation-unemployment

Arntz, M., T. Gregory and U. Zierahn The Risk of Automation for Jobs in OECD Countries, OECD Publishing.
http://dx.doi.org/10.1787/5jlz9h56dvq7-en

Autor, D. and D. Dorn (2013). "The growth of low-skill service jobs and the polarization of the US labor market." The American Economic Review 103(5): 1553-1597.

Autor, D. H. (2015). "Why are there still so many jobs? The history and future of workplace automation." The Journal of Economic Perspectives 29(3): 3-30.

Bowles, N. (2016). Our tech future: the rich own the robots while the poor have 'job mortgages', The Guardian.
https://www.theguardian.com/culture/2016/mar/12/robots-taking-jobs-future-technology-jerry-kaplan-sxsw

Economist, T. (2016). Automation and anxiety: Will smarter machines cause mass unemployment? Special Report Artificial Intelligence: The impact on jobs.
http://www.economist.com/news/special-report/21700758-will-smarter-machines-cause-mass-unemployment-automation-and-anxiety

Filmer, D. a. L. F. (2014). Youth Employment in Sub-Saharan Africa. Africa Development Series. Washington DC, World Bank.

http://documents.worldbank.org/curated/en/424011468192529027/pdf/840830v20REVIS0ll0Report0ER0English.pdf

Frey, C. B. and M. Osborne (2015). Technology at Work: The Future of Innovation and Employment, Citi GPS: Global Perspectives & Solutions.
http://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi_GPS_Technology_Work.pdf

Frey, C. B., et al. (2016). "Technology at Work v2. 0: The future is not what it used to be." CityGroup and University of Oxford.
http://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi_GPS_Technology_Work_2.pdf

Frey, C. B. and M. A. Osborne (2013). "The future of employment: how susceptible are jobs to computerisation?(2013)." University of Oxford. URL: http://www. oxfordmartin. ox. ac. uk/downloads/academic/The_ Future_of_Employment. pdf.
http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

Gelb, S. and A. Khan (December 2016). Towards a complete jobs picture: A new lens on labour data gaps and on automation. Briefing note. London, Overseas Development Institute.
https://www.odi.org/sites/odi.org.uk/files/resource-documents/11226.pdf

International Labour Office (2015). World employment and social outlook 2015: The changing nature of jobs. Geneva.
http://www.ilo.org/public/libdoc/ilo/2015/487836.pdf

McMillian M.S and Rodrik, D. (2011). Globalization, Structural Change and Productivity Growth. NBER Working Paper No. 17143. Geneva, International Labor Organization and World Trade Organization.
http://www.nber.org/papers/w17143.pdf

Montenegro, C. E. and H. A. Patrinos (2014). Comparable Estimates of Returns to Schooling Around the World. Policy Research Working Paper 7020, World Bank Group.

Rodrik, D. (2016). "Premature deindustrialization." Journal Economic Growth 21: 1-33.

Santos, I. (2016). Labor market polarization in developing countries: challenges ahead. The World Bank.
http://blogs.worldbank.org/developmenttalk/labor-market-polarization-developing-countries-challenges-ahead

United Nations Conference on Trade and Development (October 2016). Robots and Industrialization in Developing Countries. Policy Brief No.50.
http://unctad.org/en/PublicationsLibrary/presspb2016d6_en.pdf

World Bank (2016). World Development Report 2016: Digital Dividends. Washington, DC, World Bank.
http://documents.worldbank.org/curated/en/896971468194972881/pdf/102725-PUB-Replacement-PUBLIC.pdf

Acknowledgements

We thank the following experts who voluntarily provided suggestions for relevant literature or other advice to the author to support the preparation of this report. The content of the report is

the sole responsibility of the author and does not necessarily reflect the opinions of any of the experts consulted.

- Becky Faith, Institute of Development Studies
- Patricia Justino, Institute of Development Studies
- Seife Ayele, Institute of Development Studies
- Jodie Thorpe, Institute of Development Studies

Suggested citation

Millington, K. A. (2017). *How changes in technology and automation will affect the labour market in Africa.* K4D Helpdesk Report. Brighton, UK: Institute of Development Studies.

About this report

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