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# Can the new world of work be rendered inclusive?

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## Introduction

If artificial intelligence proves to be as revolutionary as electricity, the work environment will be unrecognizable in a matter of decades. Most of the world's population could not imagine living without electricity; it transformed communications, transport, health care, and housework, to name just a few. More innovations are on their way as we head toward an all-electric economy ultimately powered by renewable sources of energy.

Since the 1990s, the internet has worked its way into every corner of our working lives, much in same way as electricity did.<sup>1</sup> As it spreads, entirely new occupations that cater to the internet are replacing traditional types of work. The internet and ongoing computerization have in turn unleashed digital technologies that are paving the way for automation and widening the reliance on artificial intelligence. In fact, artificial intelligence could well become as ubiquitous and indispensable as electricity.<sup>2</sup>

Automation enhanced by AI has the potential to revive productivity and growth worldwide across virtually all the subsectors of the economy.<sup>3</sup> In addition to raising incomes, these technologies could nurture a host of

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<sup>1</sup> The internet made possible low cost and high volume communication among computers. The layering of new technologies over the basic TCP/IP protocols has vastly increased the utility of the internet and the collection of data (Goldfarb and Tucker 2017). <http://www.nber.org/papers/w23684>

<sup>2</sup> The machine learning guru Andrew Ng believes that AI could be the new electricity. <https://www.alexkras.com/ai-is-the-new-electricity-andrew-ng/>

<sup>3</sup> The Industrial Revolution introduced machines enhanced muscle power; the AI Revolution is about machines that enhance brainpower. Computerized image recognition is now a shade better than what humans can manage—96 percent. And Amazon's robots have reduced the click and ship time to 15 minutes as against one hour by humans and the robots use half the space. Bughin and Hazan (2017) <http://voxeu.org/article/new-spring-artificial-intelligence-few-early-economics>

new occupations. But much like earlier technological disruptions, the brave new digital economy threatens to eliminate a swathe of jobs, starting with routine and repetitive tasks that require minimal or modest cognitive and judgmental inputs. By mid-century, if not earlier, progressively “intelligent” machines could displace many skilled and professional workers. However, when laid-off workers have access to new and more productive jobs, countries that harness new technologies will benefit from shared prosperity. If, on the other hand, labor markets do not seamlessly adjust, economic growth is fitful, new jobs are sparse, or workers do not acquire valuable skills, then countries will need to cope with a surge in unemployment, income inequality, and poverty. Undoubtedly, much depends on how quickly technologies evolve, are diffused, and how they affect productivity. Slower workforce growth will ease the pressure on some countries. But a number of stylized facts, detailed in the next section, raise warning signals: new technologies will not necessarily deliver inclusive growth. Policy action will be needed to raise growth rates, match skills with job opportunities, and ensure that the fruits of growth are widely shared, possibly with the help of redistributive fiscal policies.

This essay examines the issue of new, disruptive technologies in five parts. The first section reviews stylized facts that serve as a backdrop to the evolving world of work; the second is a capsule account of growth drivers, growth being the ultimate determinant of job opportunities; the third lays out the key implications of digitalization and AI for the labor market; the fourth explores the fiscal and redistributive measures that could make future growth sustainable and more inclusive; the final section offers some concluding observations.

## 1. Stylized facts from 2000 onwards

Although global economic growth accelerated in 2017,<sup>4</sup> five facts signal a forewarning of economic shoals ahead:

1. Productivity, the principal source of long-run growth, has slowed over the past decade in developed and developing countries, with virtually all activities, including high-tech manufacturing, experiencing a prolonged downturn (Acemoglu et al 2014; Byrne and Sichel 2017).<sup>5</sup> Adjusting productivity estimates for quality improvements using adjusted deflators and taking into account the emergence of new products and services does not materially change the picture. Thus far, the growth of the digital economy, a steady increase in R&D spending worldwide,<sup>6</sup> the numbers of researchers, cross national research collaboration, crowd sourcing of ideas, and registered patents have not averted the slide in productivity.<sup>7</sup>
2. Leading industrial firms continue to innovate incrementally and raise their productivity, but there are many laggards.<sup>8</sup> These low-productivity firms survive because of barriers to exit, preventing the efficient reallocation of resources. A decline in startup activity,<sup>9</sup> in the emergence of “gazelle” firms,

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<sup>4</sup> The International Monetary Fund (2017) forecasts a growth rate of 3.5 percent for 2017 up from 3.2 percent in 2016. <https://www.imf.org/en/Publications/WEO/Issues/2017/07/07/world-economic-outlook-update-july-2017>

<sup>5</sup> <https://economics.mit.edu/files/11603>; <http://voxeu.org/article/productivity-slowdown-even-more-puzzling-you-think>. Growth of world trade also slowed after 2012 and through 2016, trade was increasing annually by about 3 percent a steep decline from the 7 percent per annum rates averaged during 1990-2007.

<sup>6</sup> Since the crisis of 2008-2009, R&D spending has either flattened or declined in many OECD countries, as has employment in research activities. The downturn in basic research in the U.S. and in applied research by businesses in the European Union could be growth inhibiting over the longer term.

<sup>7</sup> The sharp increase in patenting by Chinese residents has contributed significantly to the upsurge.

<sup>8</sup> OECD (2015) finds that the leading firms are steadily raising productivity but most are not. Access to cheap credit might be one reason why less productive firms do not exit. <https://www.oecd.org/eco/OECD-2015-The-future-of-productivity-book.pdf>; Bergeaud et al. (2017) <http://voxeu.org/article/secular-stagnation-versus-technological-shock-scenarios>

<sup>9</sup> Start-ups and young fast growing firms are among the principal drivers of growth and net creators of jobs. However, start-up activity and the dynamism of young firms have been declining among all OECD countries (OECD 2016)

and in churning at the top signal that competitive pressures are weak and that lead “superstar” firms are becoming older, larger, arguably less dynamic, and gaining in market power.

3. In advanced and emerging economies, slower growth parallels the automation displacing mainly blue-collar workers with few transferable skills and limited education. Labor markets have not been able to adjust to the pace of automation. Workers, especially older ones, have proven to be less mobile than economists assumed,<sup>10</sup> less able to upgrade and diversify their skills, and less entrepreneurial. Consequently, many have dropped out of the workforce or entered the ranks of the long-term unemployed in developed countries, whereas in emerging economies, an increasing number have to scrape a living doing relatively unproductive tasks in the informal sector.<sup>11</sup>
4. The dearth of formal sector jobs<sup>12</sup> with decent lifetime prospects and benefits—a result of slowing growth, labor-displacing technologies, globalization, and the decline of unionization—is compelling workers to opt for self-employment and a variety of alternative, short-term work arrangements. Affordable mobile devices and the proliferation of internet-based businesses have made it easy for people to engage in part-time work, whether it is moving furniture, delivering pizza, driving for a car hailing service, renting space in a dwelling, or selling jewelry. More recently, internet-based employment has begun spreading in low and lower middle-income countries as well, taking its place alongside jobs in the informal economy.
5. The combined effects of globalization, digital technologies, weakening trade unions and affiliated political parties, the shrinking contribution of manufacturing to GDP,<sup>13</sup> industrial concentration,<sup>14</sup> and the lingering shock administered by the financial crisis of 2008, have been unsettling for both developed and emerging economies. The net result is a socially corrosive stagnation of wages, together with an increase in inequality and the rise a “precariat” of underemployed and unemployed workers, too many of which live close to or below the poverty line (Standing 2016).<sup>15</sup> The labor share of national income is trending down globally, in most advanced economies and in many emerging economies as well.<sup>16</sup>

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<https://www.oecd.org/sti/ind/Policy-Note-No-Country-For-Young-Firms.pdf>. In the U.S. the Kauffman Index of Entrepreneurial Activity for 2017, shows a modest revival of start-up activity after several years of decline. If this uptick persists, Tyler Cowen’s worry that Americans are becoming more risk averse and complacent might prove to be unfounded.

<sup>10</sup> Housing market frictions (selling a primary residence and finding affordable housing in places where work is plentiful) may be partly to blame and in the U.S., certification requirements inhibit cross state migration.

<sup>11</sup> The average size of the informal economy as a share of measured GDP (2007) ranged from 17 percent in the high-income OECD countries to 41 percent in LAC. Schneider (2012). <http://ftp.iza.org/dp6423.pdf>. By one estimate, India has only 30 million jobs in the organized sector as against 440 million in the unorganized sector. [http://www.business-standard.com/article/current-affairs/7-million-jobs-can-disappear-by-2050-says-a-study-116101600378\\_1.html](http://www.business-standard.com/article/current-affairs/7-million-jobs-can-disappear-by-2050-says-a-study-116101600378_1.html)

<sup>12</sup> This dearth is also visible in India one of the most rapidly growing EME. The Labor Bureau estimates that the Indian economy created 135,000 formal sector jobs in 2016 as against 419,000 in 2011. In the first four months of 2017, the economy shed 1.5 million jobs. And according to current projections, only 7 million organized sector jobs will be added by 2050 whereas the population will have increased by close to 600 million. [http://www.business-standard.com/article/current-affairs/7-million-jobs-can-disappear-by-2050-says-a-study-116101600378\\_1.html](http://www.business-standard.com/article/current-affairs/7-million-jobs-can-disappear-by-2050-says-a-study-116101600378_1.html); [http://www.business-standard.com/article/opinion/1-5-million-jobs-lost-in-first-four-months-of-2017-117071000571\\_1.html](http://www.business-standard.com/article/opinion/1-5-million-jobs-lost-in-first-four-months-of-2017-117071000571_1.html)

<sup>13</sup> The share of manufacturing in GDP—long a source of well-remunerated blue-collar jobs that served as a stepping-stone to a middle class lifestyle—has been on its way down since 1995 from 21.7 percent to 15.3 percent in 2016. It contributed 15 percent to the GDP of high-income countries and 16 percent to that of lower middle income ones. <http://wdi.worldbank.org/table/4.2>. In absolute terms, manufacturing output has continued rising.

<sup>14</sup> Both industrial concentration and globalization have increased the power of capital relative to labor even as neo-liberal politics and policies have accelerated the decline of unionization.

<sup>15</sup> <https://www.weforum.org/agenda/2016/11/precariat-global-class-rise-of-populism/>. Standing (2017, p.77) refers to a precarity trap when individuals are unwilling to accept part time jobs for fear that they would lose social benefits. Guy Standing (2017). *Basic Income*. Yale University Press.

<sup>16</sup> Of the 59 countries surveyed by Karabarbounis and Neiman (2014), the share of labor declined in 42 from 1975 to 2012. The findings of Dao et al (2017) are similar.

These developments<sup>17</sup> highlight the necessity of an adequate social safety net for the vulnerable and basic services by the state—especially services that improve the quality of human capital and enable the workforce—to develop marketable skills. If inequality is not contained, too much concentration of income and wealth in the hands of the top 5 percent could starve the economy of demand, as the consumption propensity of high-income individuals is significantly lower than the average.<sup>18</sup>

Few countries currently have the fiscal headroom<sup>19</sup> to strengthen their safety nets and improve services, which is why an inclusive approach to growth calls for a focus on revenue mobilization and rethinking how best to deliver essential services and minimize the incidence of poverty. Revenue mobilization and income redistribution are a lot easier when the overall pie is growing. Thus, growth is a precondition for the viability of inclusive policies.

## 2. Accelerating growth

Research on growth has yet to identify sufficient conditions. However, the key findings to date can be briefly summarized as follows:

1. Investment in fixed assets, including infrastructure,<sup>20</sup> remains one of the primary drivers of growth (Jorgenson and Vu 2010; Jones 2016).<sup>21</sup> The increasing knowledge intensity of production has induced firms to shave their investment in physical capital and emphasize the accumulation of intangible capital, which includes R&D, software, intellectual property, the harnessing of information and communication technologies, marketing, and organization-specific competencies (Corrado et al 2012; van Ark and Hulten 2007; Alexander and Eberly 2016, Jonathan and Stian 2016).<sup>22</sup> Public fiscal and industrial policies can influence physical and intangible capital investment, although the efficacy of policy instruments should not be exaggerated. Moreover, the productivity of R&D is beyond the reach of policy (Bloom et al 2017).<sup>23</sup>
2. Improvements in workforce quality (a function of schooling), an emphasis on STEM subjects as well as soft skills, and opportunities to augment basic education with technical skills all contribute to

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<sup>17</sup> Mention should also be made of telescoping global value chains that are beginning to concentrate manufacturing and associated services in fewer countries, and of advances in 3-D technology that makes possible the reshoring of production closer to consumer markets.

<sup>18</sup> A dearth of “decent” jobs and inequality deemed unfair by the majority is implicated with the rise of populist politics, xenophobia, and creeping protectionism in some western countries. The job drought might also be an underlying cause of the opiate crisis and the “deaths of despair” in the United States.

<sup>19</sup> See OECD (2016) on the increasing government indebtedness of OECD countries and EMEs.

<https://www.oecd.org/sti/Megatrends%20affecting%20science,%20technology%20and%20innovation.pdf>

<sup>20</sup> Telecommunication infrastructure is a key component as is the infrastructure for generating and distributing electricity.

<sup>21</sup> <http://www.sciencedirect.com/science/article/pii/S0161893810000700>; <http://www.hoover.org/sites/default/files/jones-facts040.pdf>

<sup>22</sup> <http://repec.iza.org/dp6733.pdf>; [http://www.scb.se/statistik/\\_publikationer/OV9999\\_2007A01\\_BR\\_07\\_X76BR0801.pdf](http://www.scb.se/statistik/_publikationer/OV9999_2007A01_BR_07_X76BR0801.pdf); [https://www.imf.org/external/np/res/seminars/2016/arc/pdf/Alexander\\_Eberly\\_Session2.pdf](https://www.imf.org/external/np/res/seminars/2016/arc/pdf/Alexander_Eberly_Session2.pdf); Jonathan and Stian (2016) note that intangibles are potentially more scalable, generate more spillovers and benefit from synergies.

<http://www.theintangibleeconomy.com/?p=60>. Investment in intangibles has thus far minimally affected on the job training that remains low even though firms constantly complain that the skills they need are in short supply.

<sup>23</sup> Bloom et al (2017) find that the research productivity is heading down and good ideas are becoming more elusive. Because the low hanging fruit has been picked, taller ladders are needed and AI might assist in this respect.

<https://web.stanford.edu/~chadj/IdeaPF.pdf>; Mokyr (2015) [https://www.philadelphiafed.org/-/media/research-and-data/events/2015/fed-policy-forum/papers/mokyr-technology\\_progress\\_thing.pdf?la=en](https://www.philadelphiafed.org/-/media/research-and-data/events/2015/fed-policy-forum/papers/mokyr-technology_progress_thing.pdf?la=en)

growth (Hanushek and Woessman 2015). This needs to be complemented by management quality, itself an important determinant of productivity (Bloom et al 2008; 2016).<sup>24</sup>

3. Policies that reduce the variance in productivity among firms (i.e., measures that diffuse technologies from frontier firms to the rest) could substantially augment growth.<sup>25</sup> A more competitive environment that facilitates entry and exit, industrial extension services, and a regulation “lite” environment<sup>26</sup> can narrow the dispersion in firm performance.<sup>27</sup>
4. An increase in entrepreneurial activity that stimulates new entry and the proliferation of fast-growing gazelle firms funded by “angel” investments and venture capital are associated with improved growth performance. To achieve results, policy must work on at least three registers: encouraging entrepreneurship, lowering barriers to entry, and enlarging the volume of (private) risk capital so that startups gain traction and are able to tap other sources of capital to fully exploit scale economies.
5. With most economic activity concentrated in cities, a well-governed urban environment, furnished with efficient services and enough affordable housing<sup>28</sup>, can boost productivity through the emergence of agglomeration benefits. The urban dimension of growth has acquired salience, as major cities have become the focus of talent, technology development, innovation, startup activity and clustering (Glaeser 2011, Florida 2016).<sup>29</sup>
6. Last but not least, general-purpose technologies such as electricity and the internet, germinate innovations over decades and are key to productivity and growth.<sup>30</sup>

Automation and AI, underpinned by digital technologies and advances in areas such as the Internet of Things, quantum computing and communications, and nano- and bio-technologies could restore the growth momentum of 1995-2005, but only if policy addresses the above listed co-drivers of growth. Moreover, in order to make this growth inclusive, governments will need to anticipate the implications for jobs and for income inequality. Early movers could acquire an enduring advantage in terms of innovativeness and productivity even if it entails paying substantial adjustment costs upfront and a disruptive reallocation of resources. If digital technologies are in fact the future, delaying their adoption would only hamper productivity, innovation, and competitiveness. The test for policymakers and politicians will be in minimizing the pain of shifting to a new technological regime—the so-called “fourth industrial revolution.”<sup>31</sup>

The direction of current trends should inform fiscal and redistributive policies. Both the likely impact and the nature of the policy response are described below.

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<sup>24</sup> <http://www.nber.org/reporter/2008number4/bloom.html>; [http://www.hbs.edu/faculty/Publication%20Files/16-133\\_57bdc522-5c6f-4f26-8155-0f67b4de4f76.pdf](http://www.hbs.edu/faculty/Publication%20Files/16-133_57bdc522-5c6f-4f26-8155-0f67b4de4f76.pdf)

<sup>25</sup> Smaller firms invest less in intangibles, which might partially explain why their productivity lags behind that of larger firms. Participation in global value chains opens channels for the vertical transfer technology.

<sup>26</sup> Labor laws that discourage layoffs are listed among the factors that slow the process of firm exit. Bankruptcy laws and courts to enforce them—where they exist—can make exit easier or very difficult. State ownership or patronage can also permit ‘zombies’ to survive and annex valuable resources.

<sup>27</sup> Openness to trade and to ideas supports the cause of competitiveness and technology transfer.

<sup>28</sup> Spiraling housing prices force young workers in the San Francisco Bay Area and in New York for example to seek housing far afield and endure long commutes or relocate. It can become a serious constraint on the growth of these agglomerations.

<sup>29</sup> <http://skyriscities.com/news/2016/04/every-economy-has-its-geography-richard-florida-and-creative-class-theory>

<sup>30</sup> A discussion of frontier technologies and policies that could accelerate technological change can be found in OECD (2017) <http://www.oecd.org/publications/the-next-production-revolution-9789264271036-en.htm>

<sup>31</sup> Schwab (2017) <https://www.weforum.org/about/the-fourth-industrial-revolution-by-klaus-schwab>

### 3. Digital technologies and jobs

Mechanization and automation have been ongoing for two centuries—ever since the start of the first Industrial Revolution—and have aroused the fear of workers for at least that long.<sup>32</sup> Each major wave of technological change has triggered anxiety of impending jobless growth or jobless secular stagnation—in the 1930s and again in the 1960s—all of which have proven to be groundless.<sup>33</sup> Automation laced with increasingly more capable AI has given rise to similar outpourings—the fear that Autor and Salomons (2017)<sup>34</sup> have labeled “robocalypse.” As always, opinions are divided, but a majority of researchers straddling several disciplines believes that the pace of automation has quickened, that platform-based businesses will continue multiplying, and that AI has found its stride and will make deep inroads into the workplace. These developments are likely to reinforce two job market trends that have been surfacing over the past two decades.

First, digital technologies, progressive automation, and big leaps in AI have begun hollowing out blue- and white-collar jobs involving repetitive and routine tasks. Anything that computers can be taught to do is fair game. As their capabilities improve and mass production reduces their cost, robots will compete with low wagers in numerous occupations (Ross 2016).<sup>35</sup> Future job opportunities could cluster (until robots catch up) at the two ends of the job spectrum—those requiring post-secondary education, technical and/or soft skills, and the capacity to work with computers and smart machines;<sup>36</sup> and jobs that involve face-to-face interaction and a personal touch (Morikawa 2017).<sup>37</sup> The number of jobs available in the former category will depend upon the progress of AI. McAfee and Brynjolfsson (2017, p. 17) warn, “Machines aren’t simply following carefully codified instructions provided by human programmers, they are learning how to solve problems on their own. This vastly enlarges the scope of applications and tasks that machines can now address.”

A number of studies have attempted to tally the number of jobs at risk. Frey and Osborne (2013)<sup>38</sup> estimate that computerization and intelligent digital technologies could in time eliminate 47 percent of all jobs in the United States.<sup>39</sup> David (2017) arrives at a figure of 55 percent for Japan.<sup>40</sup> The World Bank’s World Development Report (2016) finds that employment in current occupations might contract even more: 57 percent in the OECD; 69 percent in India; 72 percent in Thailand; 77 percent in China; and a massive 85

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<sup>32</sup> Taking their cue from Ned Ludd, the Luddites vented their anger on machines that were stealing their jobs in 1811-1812.

<sup>33</sup> Moky, Vickers and Ziebarth (2015) observe that anxiety over technological change is a recurrent phenomenon.

<http://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.29.3.31>

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[https://www.ecbforum.eu/uploads/originals/2017/speakers/Speech/D\\_Autor\\_A\\_Salomons\\_Does\\_productivity\\_growth\\_threaten\\_employment\\_Final\\_Draft\\_20170619.pdf](https://www.ecbforum.eu/uploads/originals/2017/speakers/Speech/D_Autor_A_Salomons_Does_productivity_growth_threaten_employment_Final_Draft_20170619.pdf)

<sup>35</sup> Foxconn is substituting thousands of workers in its Chinese electronics factories with robots.

<sup>36</sup> Sachs and Kotlikoff (2012) believe this trend favors older workers with skills and intangible capital over younger, less experienced workers. And Tyler Cowen has said that these high-end jobs will demand above average skill sets Cowen (2013). McAfee and Brynjolfsson (2017, p.37) observe that, “Getting rid of human judgments altogether—even those of experienced and credentialed people—and relying solely on numbers plugged into formulas, often yields better results.” Such data driven decisionmaking is taking off (Brynjolfsson and McElheran 2016). As the Economist (2017, May 6) observed, data is the fuel of the future.

<https://www.aeaweb.org/articles?id=10.1257/aer.p20161016>

<sup>37</sup> <http://voxeu.org/article/who-fears-losing-their-job-ai-and-robots-japanese-survey-data>

<sup>38</sup> [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)

<sup>39</sup> PwC (2017) arrived at a less forbidding forecast for the U.K.: 30 percent of jobs are susceptible to automation by the early 2030s. Forty six percent of workers with only high school diplomas could be replaced by robots but only 12 percent with undergraduate degrees. <https://www.pwc.co.uk/economic-services/ukeo/pwcukeyo-section-4-automation-march-2017-v2.pdf>

<sup>40</sup> <http://www.sciencedirect.com/science/article/pii/S0889158317300011>

percent in Ethiopia.<sup>41</sup> A study by the International Labor Organization (2016) that applied the Frey and Osborne (2013) methodology to employment prospects in five ASEAN countries concluded that technology is set to jeopardize 56 percent of jobs during the next two decades.<sup>42</sup> The report identifies hospitality, retail and wholesale trade, construction, and manufacturing as the sectors most susceptible to automation. Garment workers in Cambodia, shop assistants in Thailand, and office clerks in Indonesia are in the crosshairs of the new technologies.

According to McKinsey Global Institute (2017),<sup>43</sup> the technical feasibility jobs of automating jobs is greatest in accommodation and food services (73 percent),<sup>44</sup> followed by manufacturing (automation is technically and economically most feasible in the automotive and electronic industries), agriculture, transportation and storage, wholesale and retail trade, and mining (51 percent).<sup>45</sup> The transportation sector is a special case because autonomous vehicles could deeply affect driving jobs, estimated to be 15.5 million in the U.S.—or 9 percent of the workforce in 2015.<sup>46</sup> A study by Acemoglu and Restrepo (2017)<sup>47</sup> on the impact of industrial robots on employment and wages in the U.S. between 1990 and 2007 concluded that adding one robot reduced employment by 5.6 workers (0.34 percent) and wages by 0.5 percent. Thus far, estimates of the number of jobs lost to automation range from 360,000 to 670,000. However, if the number were to quadruple by 2025, the employment-to-population ratio would drop by between 0.94 and 1.76 percentage points. In the German context, Dauth et al (2017) show that each robot replaces two workers in the manufacturing sector although automation does not appear to have affected employment in the aggregate.<sup>48</sup>

The activities least threatened by automation are education (27 percent), management, professional services, information, health care, and administration (39 percent), in that order. But even these are not immune. The scope for substituting online and distance education for traditional teacher- and classroom-based education is increasing and becoming cost-effective. Smart programs and AI are encroaching on professional services such as legal,<sup>49</sup> accounting, real estate, human resources, architectural, and engineering. Health care is a candidate for disruption by cognitive computerized systems such as Watson, by mobile devices and numerous apps (West 2012), by implants and sensors that can be monitored by computers at a distance, and eventually by hospital based “carebots” and “medibots” such as the ones currently being tested in Japan. Digital technologies could also substantially reduce the administrative costs of health care, and in the process eliminate a large number of clerical jobs (Beisdorf and Niederman 2014).<sup>50</sup>

Should these forecasts be taken with a grain of salt? At least with respect to job displacement, other research offers findings that are more temperate. Studies by the Information Technology and Innovation Foundation (ITIF) conclude that the degree of job churn in the U.S. is at a historic low, suggesting that the impact of

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<sup>41</sup> World Development Report (2016).

<sup>42</sup>[http://www.ilo.org/public/english/dialogue/actemp/downloads/publications/2016/asean\\_in\\_transf\\_2016\\_r1\\_tech.pdf](http://www.ilo.org/public/english/dialogue/actemp/downloads/publications/2016/asean_in_transf_2016_r1_tech.pdf)

<sup>43</sup> <http://www.mckinsey.com/global-themes/employment-and-growth/automation-jobs-and-the-future-of-work>; Another MGI study (Manyika 2017) concludes that close to a third of all activities in 60 percent of occupations worldwide could be automated. That encompasses one half of global GDP and puts 1.2 billion workers at risk from existing technology.

<sup>44</sup> Self-service kiosks are becoming more common in restaurants and in time could become the norm.

<sup>45</sup> Open cast mines in Chile and Australia are being rapidly automated with remotely controlled self-driving trucks a commonplace.

<sup>46</sup> Vehicle operators in the U.S. number 3.8 million and 11.7 million are on-the-job drivers who use motor vehicles. (OCE 2017). [http://www.esa.doc.gov/sites/default/files/Employment%20Impact%20Autonomous%20Vehicles\\_0.pdf](http://www.esa.doc.gov/sites/default/files/Employment%20Impact%20Autonomous%20Vehicles_0.pdf)

<sup>47</sup> <https://economics.mit.edu/files/12763>; <http://voxeu.org/article/robots-and-jobs-evidence-us>

<sup>48</sup> <http://voxeu.org/article/rise-robots-german-labour-market>

<sup>49</sup> A report by Deloitte (2016) indicated that smart machines could imperil 114,000 jobs in the legal profession (39 percent of the total) within the next decade. <https://www.legaltechnology.com/latest-news/deloitte-insight-100000-legal-roles-to-be-automated/>

<sup>50</sup> <http://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/healthcares-digital-future>

digital technologies lies in the future. On revising the Frey and Osborne (2013) results using a different measure of occupations at risk, ITIF found that just 8 percent of workers are in high-risk occupations and that these are likely to increase by 2 percentage points by 2024. A third of occupations are in the moderately high-risk category, and 16 percent are moderately risky (ITIF, 2017a, 2017b).<sup>51</sup> Similar findings using a task-based approach are reported by Arntz et al (2016), who identify just 9 percent of jobs in the OECD as readily automatable. A study by Graetz and Michaels (2016)<sup>52</sup> of 17 countries for the period 1993-2007 showed that the use of robots in factories and warehouses contributed to gains in productivity and caused only modest job losses, mostly for low-skilled workers. Gaggli and Wright (2015)<sup>53</sup> also uncover little evidence of significant layoffs because of computerization and information and communication technologies to date, and are of the view that these are likely to occur with a considerable lag. What is technically feasible does not necessarily make economic sense as yet. Whereas, the automation of auto and electronic assembly and the production of rubber plastic and chemical products are moving forward, that of garments, of food and beverages, of leather goods and of wood and paper fails the economics test especially in countries where wages are low (Mayer 2017; UNCTAD 2017, ch.3).<sup>54</sup>

Could other jobs take the place of the ones that might be eliminated? Morikawa (2017) and Autor and Salomon (2017) are optimistic that jobs for high-skilled workers will be plentiful, as will be jobs in human-intensive services.<sup>55</sup> And ITIF (2017a) estimated that between 2010 and 2015, for every 10 jobs lost to technology six more were created. As always, good news needs to juxtapose the bad: Berger and Frey (2016) found that only 0.5 percent of the U.S. workforce had shifted into activities that were digital technology-intensive through the 2000s.<sup>56</sup> And Beaudry et al (2013) observed that even demand for high-skilled workers is weakening because of encroaching automation.<sup>57</sup> The news from India also strikes a warning note. While the demand for highly skilled workers in fields such as data analytics, machine learning, and connected devices is on the rise, it is weakening for programmers and call center workers (Mundy 2017).<sup>58</sup>

Second, permanent, full-time jobs with generous benefits are becoming fewer, instead being replaced by contract employment and on-call jobs of varying lengths.<sup>59</sup> Workers no longer expect to spend a lifetime at a single firm, employment can be terminated at short notice (loyalty is neither owed nor expected), benefits are being trimmed to the minimum, and saving for retirement is devolving more on the individual even in advanced countries, with the government barely providing a minimum safety net. Moreover, employers are even less likely to expend time and resources in training contract workers or regular employees if turnover is high.

David Weil views this increase in alternative work arrangements (AWA) as a fissuring of the workplace.<sup>60</sup> In the U.S., the percentage of workers in this category—i.e., temporary help agency workers, on-call workers,

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<sup>51</sup> <https://itif.org/publications/2017/06/05/sound-alarm-robots-are-disrupting-far-too-few-jobs>;  
<https://itif.org/publications/2017/08/07/unfortunately-technology-will-not-eliminate-many-jobs>

<sup>52</sup> [http://personal.lse.ac.uk/michaels/Graetz\\_Michaels\\_Robots.pdf](http://personal.lse.ac.uk/michaels/Graetz_Michaels_Robots.pdf)

<sup>53</sup> <http://voxeu.org/article/short-run-view-what-computers-do>

<sup>54</sup> <http://voxeu.org/article/industrial-robots-and-inclusive-growth>;

<http://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=1782>

<sup>55</sup> <http://voxeu.org/article/who-fears-losing-their-job-ai-and-robots-japanese-survey-data>

<sup>56</sup> [http://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi\\_GPS\\_Technology\\_Work\\_2.pdf](http://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi_GPS_Technology_Work_2.pdf)

<sup>57</sup> <http://www.nber.org/papers/w18901>

<sup>58</sup> <https://www.ft.com/content/282a93fe-1ff4-11e7-a454-ab04428977f9>

<sup>59</sup> See Pedulla (2011) <https://www.princeton.edu/esso/working-papers/WP6.pdf>

<sup>60</sup> Weil (2017) observes that the traditional relationships between employer and employed are fracturing with employers preferring contract workers who are less costly, impose fewer responsibilities and burdens on the firm and are easier to hire and fire. Already it



contract company workers, independent contractors, and freelancers—accounted for almost 16 percent of the workforce in 2015 (Katz and Kreuger 2016).<sup>61</sup> As many as 45 million American have engaged in AWA, and between 1.9-3.2 million are working through an online intermediary at any given time, with these numbers rising rapidly each year and expected to double by 2020 (Bruckner 2017).<sup>62</sup> AWA and in particular internet- and app-linked jobs are spiraling in the U.K., Nordic countries, Latin America, and in low-income economies in South Asia. While they provide no-strings-attached, flexible employment that appeals to some, they do render contingent on-demand and self-employed workers much more vulnerable to fluctuations in income. As Tyson and Mendonca (2015) note, “They bypass the traditional channels through which the U.S. and many countries deliver benefits and protections to their workforce... With the proliferation of digital job platforms, the social safety net for workers in the U.S.—threadbare to begin with—is at risk of unraveling for a growing share of the workforce.”

Assuming that the trend toward AWA is irreversible and that competition from smart machines and creeping automation<sup>63</sup> will put increasing pressure on the earnings of contingent workers and those in the informal sector, inclusive development will necessitate a strengthening of social safety nets and welfare states. Absent this, the labor share of income will continue falling, inequality will rise, and more people will slip below the poverty line.<sup>64</sup>

Clearly, some forward thinking on benefits and income support is desirable, as the wheels of political decisionmaking turn very slowly. How might countries avoid a perfect storm in the workplace? Tyson and Mendonca (2015) propose three conditions that a scheme should satisfy.<sup>65</sup> “They should be portable, attached to individual workers rather than to their employers. They should be universal, applying to all workers and all forms of employment. And they should be pro-rated, linking employer benefit contributions to the time worked, jobs completed, or income earned.” One option is “the creation of individual security accounts encompassing portable benefits that would be available to all workers, regardless of employment status and would accrue via pro-rated automatic payroll contributions.”

Another option that has resurfaced is the provision of a universal basic income (UBI) by the state.<sup>66</sup> Charles Fourier first mooted this idea more than 150 years ago, and it has reappeared since in many guises, including in the form of a “negative income tax” as proposed by Milton Friedman (who got it from Abba Lerner).

If the stylized facts stated earlier and the job-displacing implications of digital technologies are approximately on-target, major redistribution of income by the state, starting with the advanced economies, is in the cards. Countries will need to consider a variety of schemes while keeping a close eye on costs. For example, UBI could be phased in slowly, with the amount initially being set below the poverty line; it could be allocated to

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has affected some 29 million workers in the U.S. spread across 10 industries. <https://hbr.org/2017/03/making-employment-a-fair-deal-in-the-age-of-contracting-subcontracting-and-temp-work>

<sup>61</sup> <http://www.nber.org/papers/w22667>

<sup>62</sup> <http://www.american.edu/kogod/news/Shortchanged.cfm>

<sup>63</sup> Delivery robots are already prowling the streets of Europe and the U.S. Starship being one of the lead contenders.

<https://www.starship.xyz/for-businesses/>

<sup>64</sup> Benzell et al (2015) also foresee the possibility that savings of workers, especially the young would decline which would affect the accumulation of capital and hence long run growth. <http://www.nber.org/papers/w20941>

<sup>65</sup> <https://www.project-syndicate.org/commentary/employee-protection-gig-economy-by-laura-tyson-and-lenny-mendonca-2015-11?barrier=accessreg>

<sup>66</sup> See van Parijs and Vanderborght (2017) <http://www.hup.harvard.edu/catalog.php?isbn=9780674052284>; Santens (2017)

<https://www.weforum.org/agenda/2017/01/why-we-should-all-have-a-basic-income/>; Boston Review Forum (2017)

<http://bostonreview.net/forum/ubi-van-parijs>

each family rather than to each individual and have its scope broadened over time.<sup>67</sup> And countries would need to tailor their programs to their circumstances. However, all would need to gauge the fiscal cost of inclusive income support and the implications for other existing welfare benefits and social security programs.

#### 4. The buck stops with ministries of finance

As captured by the stylized facts, the financial crisis and its aftermath have increased fiscal pressures on many economies. Welfare, medical, pension, and unemployment benefits have become more burdensome, especially in light of aging populations and rising dependency ratios. The increasing numbers of self-employed workers create additional issues that will need tackling to ensure that revenues keep abreast of fiscal outlays. Revenue efforts commensurate with an inclusive growth strategy, especially one that makes universal basic income or other redistributive measures<sup>68</sup> a longer-term objective, must ensure that the self-employed both contribute their fair share to the social security system and in turn are adequately supported by it. The current assumption is that, as with the informal economy, a significant portion of the earnings of the self-employed (some of which are transacted in cash) is not taxed.<sup>69</sup>

In regards to the standard tax instruments and collection issues associated with each, the “gig” platform-based economy has raised a number of new issues regarding the appropriate classification of workers. Many self-employed individuals engage in a variety of activities and accrue income from wages as well as self-employment. When they work for Uber or TaskRabbit, or rent through AirBnB, are they doing so as independent contractors or as dependent employees? As far as the U.S. Internal Revenue Service is concerned, the classification rests on the degree of control to which an individual is subject, the independence he or she enjoys, and whether the relationship is determined by written contracts and involves the provision of benefits by the employer. If the individual does not meet these criteria, they are subject to self-employment taxes with their own tax forms, schedule of exemptions, business-related deductions, filing rules, and quarterly estimated payments.<sup>70</sup> In the U.S., an individual not classified as an employee may not receive unemployment insurance or workers compensation, and may not be protected by rules governing safety, discrimination, and minimum wages. Because independent contractors are treated differently, it is in the employer’s interest to avoid classifying them as employees so as to not shoulder the cost of benefits and the payment of employment taxes (Jackson et al 2017).<sup>71</sup>

Rules affecting the self-employed vary across countries, as do welfare contributions. For example, the self-employed in the U.K. are eligible to receive benefits whether or not they pay national insurance contributions (NICs). Their pensions are flat-rated while their NIC payments are lower, which constitutes a considerable subsidy (Stupples 2017).<sup>72</sup>

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<sup>67</sup> The several pilots underway in Finland, France, and Italy will help identify what is feasible and the downsides.

<https://www.oecd.org/els/soc/Basic-Income-Policy-Option-2017-Brackground-Technical-Note.pdf>

<sup>68</sup> Atkinson (2015) puts forward a number of proposals affecting tax rates and welfare payments that would be welfare enhancing and would reduce income inequality in the United Kingdom. Anthony Atkinson. *Inequality: What can be done?* Harvard University Press.

<sup>69</sup> Bruckner (2017) states that those participating in the on-demand platform economy derive between 20 and 30 percent of their income from this source—between \$344 and \$533—or in the region of \$15,000 annually.

<sup>70</sup> Gig workers can end up being misclassified as “business owners” in which case they must keep records of expenses and can be required to make quarterly payments.

<sup>71</sup> <https://www.treasury.gov/resource-center/tax-policy/tax-analysis/Documents/WP-114.pdf>

<sup>72</sup> <https://www.bna.com/gig-economy-ticking-n57982086235/>

Internet-based businesses are sure to enlarge their share of GDP and employment. Hence, governments will need to find ways of taxing the contractors or employees who work for these firms fairly. A detailed study of how to tax the “gig economy” in the U.S. by Thomas (2017)<sup>73</sup> offers two suggestions: One is a requirement that internet-based companies withhold taxes for their workers to minimize evasion; a second is a generous standard deduction for the self-employed that would absolve them of the need to keep records of job-related expenses.

The issue raised by cash transactions remains, and narrowing this loophole may necessitate greater reliance on trackable electronic payments and a reduced role for paper money (particularly large denomination bills). Rogoff (2016) is convinced that cash is a curse and contributes to tax evasion and the underground economy.<sup>74</sup> A shift to electronic means of payment is gathering momentum—notably in China—and in time cash might be pushed to the margins, but it is unlikely to happen soon.

## Concluding observations

The world of work will go through a sea of change; it might be a slow process at first, because of the need for complementary innovations, organizational changes and the building of specialized human capital but the pace is sure to accelerate as investments in AI and automation begin to pay off (Brynjolfsson, Rock and Syverson 2017)<sup>75</sup>. Countries need to prepare for an upheaval. If Mokyr, Brynjolfsson, et al are forecasting correctly, many new occupations will arise—as they have done in the past—and create plentiful job opportunities. Many of these will require new and demanding skillsets that involve working with smart machines and the Internet of Things. Equipping workers to take advantage of these jobs will require investment in training—and lifelong learning. For the many who will be unable to take advantage of these high-tech and high-touch occupations and are therefore rendered either unemployed or engaged in part-time or low-paid jobs, inclusive social policies must ensure that they do not fall through the cracks. A fiscal regime geared to substantial redistribution may be unavoidable. As stated above, the future only looks hopeful and inclusive if there is continuing growth.

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<sup>73</sup>[http://www.law.nyu.edu/sites/default/files/upload\\_documents/Taxing%20the%20Gig%20Economy\\_%20Thomas.pdf](http://www.law.nyu.edu/sites/default/files/upload_documents/Taxing%20the%20Gig%20Economy_%20Thomas.pdf)

<sup>74</sup> <http://press.princeton.edu/titles/10798.html>; Larry Summers (2016) sides with Rogoff and argues for a withdrawal of large denomination notes e.g. the \$100 bill as such currency encourages illicit activity and money laundering. [https://www.washingtonpost.com/news/wonk/wp/2016/02/16/its-time-to-kill-the-100-bill/?utm\\_term=.ea0ccc6fcb96](https://www.washingtonpost.com/news/wonk/wp/2016/02/16/its-time-to-kill-the-100-bill/?utm_term=.ea0ccc6fcb96)

<sup>75</sup> <http://www.nber.org/chapters/c14007.pdf>

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