Can Digital Technology Drive Post-Pandemic Inclusive Growth in LDCs and EMDEs?[1]

Shahid Yusuf[2]
August 2021

The stylized facts associated with the standard growth model are being displaced by other facts reflecting a new (digital) technological epoch and the changing face of globalization. The Covid Pandemic has both accelerated digitalization by surviving firms, mainly larger ones[3], and is compelling transnational corporations to restructure their global value chains so as to enhance resilience. These developments present opportunities for countries that are quick to take advantage of digital technologies to "build back better" and to consolidate or enlarge their position in GVCs. For countries integrated with GVCs and others wanting to improve economic performance and participate more actively in global trade, digital technology could facilitate both endeavors. There is no proven recipe to guide those countries trying to catch up. However, countries in the catching-up stage benefit from the speed with which the technology is diffusing, the lower entry barriers for firms wanting to take advantage of digital techniques, and access to the wealth of experience accumulated by advanced economies. Much will depend on the dynamism of firms in the post-Covid environment and whether the economic recovery is strong enough to stimulate technology adoption, and entry of new fast-growing firms[4].

---

[1] The list of 46 Least Developed Countries as of February 2021 can be found at https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/ldc_list.pdf; EMDEs include Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Qatar, Russia, Saudi Arabia, South Africa, Taiwan, Thailand, Turkey, and United Arab Emirates (from the MSCI) plus Jordan, Kuwait, Singapore, and Vietnam. The LDCs from this list include India, Pakistan, Peru, Philippines, and Vietnam.

[2] Chief Economist, Growth Dialogue. Washington DC.

[3] According to a McKinsey report (2021) automation and digitization especially by larger firms has accelerated with firms adopting these technologies "20-25 times faster than they had previously thought possible". SMEs have exited in larger numbers because of declining sales competition from e-commerce, preponderance in retail and hospitality sectors, more severe financial constraints, and lack of delivery alternatives available to larger companies. "Will productivity and growth return after the Covid 19 crisis." https://www.mckinsey.com/industries/public-and-social-sector/our-insights/will-productivity-and-growth-return-after-the-covid-19-crisis

[4] The increased uptake following the Covid pandemic has according to McKinsey (2020) taken a quantum leap. https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever; Although lead firms have embraced digital technologies in OECD countries, many in the long tail have been slow to do so. An experience repeated by firms in EMDEs. D. Andrews et al (2018) Digital technology diffusion. https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ECO/WKP(2018)24&docLanguage=En McKinsey (2021) and others have also noted that new firm creation has slowed in many countries. In the OECD countries, this decline in start-up activity has been ongoing for well over a decade. R.A. Decker et al (2017) Declining dynamism. AER. https://www.aeaweb.org/articles?id=10.1257/aer.p20171020; OECD (2020) https://www.oecd.org/coronavirus/policy-responses/start-ups-in-the-time-of-covid-19-facing-the-challenges-

The paper is divided into six sections. Section 1 compares the new digital technology infused stylized facts of development with earlier ones. Section 2 examines the contribution of productivity to growth – and to income gaps - relative to other drivers. Section 3 reviews the projected impact of digitization on labor. The empirical evidence on productivity outcomes from digitization is the topic of section 4. And section 5 addresses the concern that technological change could result in greater inequality. Section 6 looks to a future productivity led boom – or a resumption of a slower old normal rate of growth.

1. Facts of Growth: Old and New

The stylized facts representing the growth process around the turn of the century assigned primacy to:

(i) The transfer of factors from the rural sector into urban activities with the share of the rural sector in GDP shrinking from as much as half or more to a fifth or less.

(ii) Structural change that favored industry with manufacturing serving as the leading sector and the principal source of jobs in countries undergoing change at a faster pace.

(iii) Increased (tangible) investment promoting urban industrialization and infrastructure building financed by domestic resource mobilization supplemented from external sources.

(iv) Capital (with embodied technology) as the driver of growth with labor inputs and factor productivity also contributing albeit to a lesser degree.

(v) Demand generated by exports, which complemented domestic spending, and determined both the rate of growth and its sustainability.

Rapid growth according to the earlier modeling framework was a function therefore, of factor inputs, principally capital that helped build an industrial economy and in the most successful developing countries, enabled expanding participation in global trade. As countries moved up the ladder of industrial complexity, the contribution of human capital and technology absorption to growth increased but remained secondary to capital. In all fast-growing economies, exports had a vital role (export earnings eased forex constraints, enabled scale economies, stimulated technology absorption, bolstered demand) although they usually accounted for less than a quarter of total demand.

The new stylized facts are partially displacing the earlier ones. Structural change and the sources of growth are now viewed differently.

i) In the majority of developing countries, the primary sector's share is much reduced. In the LDCs it averaged 21 percent between 2011 and 2017[5]. The share of manufacturing in value added rose from 10 percent to 12 percent in LDCs, while it

---

seizing-the-opportunities-87219267/; OECD (2016) https://www.oecd.org/sti/ind/Policy-Note-No-Country-For-Young-Firms.pdf

[5] The share of agriculture in GDP has fallen precipitously even in countries that are major producers and exporters of farm products such as Brazil (4.4 percent of GDP), Argentina (6.1 percent), Chile (3.5 percent). World Development Indicators 2021.

was around a quarter in the most industrialized EMDEs (Malaysia, Thailand, China) and at well below a fifth of GDP in others. Furthermore, deindustrialization is a notable characteristic of structural change in developing economies[6]. Resources are transferring directly from agriculture to services (formal and informal), or from manufacturing to services. Industries "without smokestacks" – mainly services - are among the drivers of growth in many LDCs (IWOSS)[7]. These include services based on ICT, tourism and travel, agribusinesses, horticulture and others. John Page (2019, 2020) notes that exports of services from countries in SSA grew six times faster than merchandise exports between 1998 and 2015. Before the Covid pandemic temporarily halted tourism, it accounted for 3 percent of SSA's GDP.[8] Both agriculture and manufacturing are becoming *servitized*[9]. Precision agriculture, which is coming within reach of LDCs, includes a host of digital services that can help conserve resources, increase productivity, and reduce waste throughout the value chain. The contribution of services to manufacturing is also on the rise as countries enter the 4.0 stage thanks to a change in corporate strategies on how best to serve the customer; on the realization that manufacturers could enlarge their profits by offering repair, monitoring, fleet management, and other services; and advances in

[6] D. Rodrik (2015) premature deindustrialization. https://drodrik.scholar.harvard.edu/publications/premature-deindustrialization; (2017) Growth without industrialization? https://www.project-syndicate.org/commentary/poor-economies-growing-without-industrializing-by-dani-rodrik-2017-10?barrier=accesspaylog M. Atolia et al (2018) Rethinking development policy. (IMF) trace the deindustrialization (more of labor than of output) to "intense competition among a number countries for relatively stable global demand for manufacturing goods, deficiency in complementary public fundamentals needed to attract foreign capital, technology, and skills, and the leveraging effect of globalization, which magnifies initial differences in fundamentals of these countries." https://www.imf.org/en/Publications/WP/Issues/2018/09/28/Rethinking-Development-Policy-Deindustrialization-Servicification-and-Structural-46253; Hope springs eternal. H. Kruse et al (2021) A manufacturing renaissance? Find that the share of the workforce engaged in manufacturing in the 18 sub-Saharan economies included in their sample rose by 1.2 percentage points to 8.4 percent during 2010-2018. Small scale firms (many informal) producing low quality goods for the domestic market were responsible for most of this increase and hence manufacturing productivity has remained low. https://www.wider.unu.edu/sites/default/files/Publications/Working-paper/PDF/wp2021-28-manufacturing-renaissance-industrialization-trends-developing-world.pdf

[7] A case study of Kenya by B. Munga et al (2021) finds that, "The three IWOSS sectors (horticulture, ICT, and tourism) reveal above-average output growth and are projected to continue being significant sources of wage employment for youth up to the year 2030. In contrast, except for construction, the industrial sectors performed below-average with respect to output growth over the two decades up to 2018." Industries without smokestacks in Africa. https://www.brookings.edu/wp-content/uploads/2021/07/21.07.27-Kenya-IWOSS.pdf

[8] J. Page (2020) Industries without smokestacks. https://www.brookings.edu/research/industries-without-smokestacks-firm-characteristics-and-constraints-to-growth/; J. Page (2019) How industries without smokestacks can address Africa's youth unemployment crisis. Brookings. https://www.brookings.edu/research/how-industries-without-smokestacks-can-address-africas-youth-unemployment-crisis/; J. Page and F. Tarp (2018) Industries without smokestacks. https://www.wider.unu.edu/publication/industries-without-smokestacks-2

[9] T.S. Baines et al (2009) The servitization of manufacturing. https://www.researchgate.net/publication/235301898_The_servitization_of_manufacturing_A_review_of_literature_and_reflection_on_future_challenges; M. Cozet and E. Milet (2015) The future of manufacturing lies in services. VoxEu. https://voxeu.org/article/future-manufacturing-lies-services;

technologies enabling firms to monitor product performance, transmit data in real-time, store the data in the Cloud, rapidly analyze and respond. For this reason, intra-industrial transfer of resources in some of the more advanced upper middle-income economies, is from low to high tech activities.

ii) Gross capital formation has been declining worldwide. However, it rose in LDCs from 25 percent in 2011 to 28 percent in 2017 as a result of higher expenditures on construction and equipment. The average for countries in SSA was 22 percent in 2019.[10] Capital formation has stabilized in most EMDEs within a 25 percent to 35 percent of GDP band.[11] As a source of growth, it remains one of the principal drivers in the lower middle-income and the least developed countries. In middle income and high-income countries, longer term growth is increasingly tied to gains in total factor productivity[12]. Moreover, the remaining gaps in per capita incomes among countries are largely explained by differences in productivity (Figure 1).

iii) Productivity improvements derive from a number of sources, technology, innovation, and allocative efficiency are among the ones receiving the most attention. But there are others as well[13]. Digital technology has emerged as potentially the key source of innovation and of productivity. And in that connection, the role of intangible capital has acquired prominence. To exploit digital technologies, firms need to build the skills to write and utilize software and to effectively utilize online platforms[14].

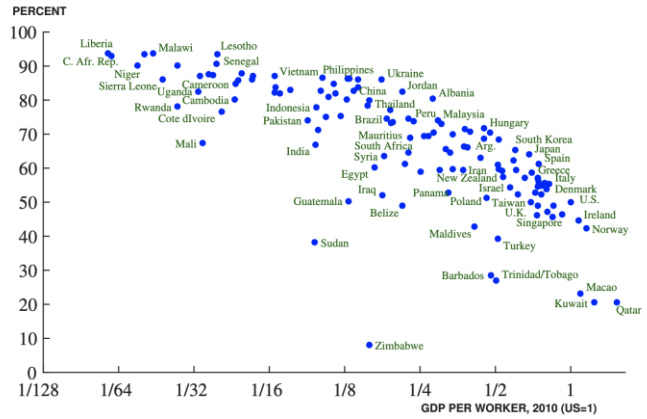
iv) As innovation moves to the center of the stage, the salience of human is rising as is that of investment in ST&I. There is a concomitant decline in the relative significance assigned to physical capital.

v) Services led development has focused attention on the productivity of providers, as they alongside manufacturers, will determine longer term prosperity.

vi) Export-led growth 2.0 for LDCs comprises a mix of farm products (horticulture, agroindustry) services and light manufactures. For upper middle- and high-income countries among the EMDEs complex manufactures and high value services offer the most promising prospects.

[10] https://data.worldbank.org/indicator/NE.GDI.TOTL.ZS?locations=XM
[11] https://data.worldbank.org/indicator/NE.GDI.TOTL.ZS
[12] Charles Jones (2015). Facts of Economic Growth. NBER. https://www.nber.org/papers/w21142
[13] Francesco Casseli (2005) Accounting for cross country income differences. *Handbook of Economic Growth.* https://ideas.repec.org/h/eee/grochp/1-09.html
[14] Brookings (2021) Foresight Africa 2021 (ch.1) https://www.brookings.edu/essay/the-great-reset-relaunching-african-economies/

Figure 1: Share of TFP in accounting for differences in GDP per worker



Source: Computed as described in the text and in Table 5 using the Penn World Tables 8.0 assuming a common value of $\alpha = 1/3$.

Source: C. Jones (2015) https://www.nber.org/system/files/working_papers/w21142/w21142.pdf

2. Productivity is the growth Elixir: But it can be slow acting

For countries still in the catching up phase and with their sights on sustaining growth over the longer term, productivity matters more than it did in the past. Capital will undoubtedly remain a driver as investment in infrastructure, in plant and equipment, in greening the economy, in urbanization, will continue to loom large. But absent productivity gains, growth will remain sluggish, income gaps with advanced countries will not be narrowed and it will be harder to generate sufficient employment or to eradicate poverty, which the Covid Pandemic has worsened[15]. The importance of productivity has focused attention on digital technology[16]. It could be a gamechanger and enable both LDCs and EMDEs to short circuit the development process.

Since their emergence in the last quarter of the twentieth century, digital technologies have diffused into every corner of the economy and by one estimate, may directly and indirectly underlie a quarter of global GDP[17]. Figure 2 offers a snapshot of the technology uptake in Southeast Asia and Figure 3 opens a window on the progress to date. Thanks to the availability of high-speed broadband (now being supercharged by 5G), the automation of manufacturing aided by the Internet of Things, the spread of e-commerce, the proliferation of web-based services, and the increasing use of AI/machine learning enabled by Big Data, the Cloud and superfast computers is enlarging growth potential but also displacing humans in a wide range of

[15] The Pandemic is likely to have added between 119 million and 124 million to the ranks of the poor in LDCs. https://blogs.worldbank.org/opendata/updated-estimates-impact-covid-19-global-poverty-looking-back-2020-and-outlook-2021

[16] See for example K. Li et al (2020) How should we understand the digital economy in Asia? https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7480531/; E. Solomon and A. van Klyton (2020) The impact of digital technology usage on economic growth in Africa. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7456578/

[17] Huawei and Oxford Economics (2017) https://www.huawei.com/minisite/gci/en/digital-spillover/index.html

routine and cognitive tasks and beginning to make inroads into the professions[18]. This has raised both expectations and fears. The expectation is that the digitization will generate productivity and growth acceleration by reducing the cost of inventing, designing, producing, distributing, and promoting products and services some of higher value. Higher growth rates could also create much needed employment in existing and new lines of work. The fear is that as machines take over an increasing number of tasks, occupations begin to disappear and some types of work is deskilled – as happened in the course of the First Industrial Revolution- that the world of work would change, job opportunities would become scarce (with women affected more than men[19]) and more polarized, and income disparities would widen[20]. This is more likely if digital technology fails to deliver the growth bonus. The economic scarring (uncertainty, exit of firms, loss of human capital, labor mismatches, bankruptcies, etc.) caused by the Covid Pandemic means that a return to trend or higher growth rates faces stronger headwinds.

Figure 2: Digital technology usage in Southeast Asia

	Connectivity			Payments			Logistics		Skills	Policy & Regulation			
	Mobile broadband subscribers (% of population)	Mobile broadband prices (2GB/Month) as a % of GNI per capita	Fixed broadband subscribers (% of population)	Made or received digital payments in the past year	Paid Online for Internet Purchase	% of Online Firms Using Digital Payments	Logistics Performance Index Score (out of 5)	Integrated index for postal development	Human Capital Dext Index Global Rank (out of 120)	Cross-Border Data Flow Restrictions	Data Privacy Regulations	Consumer Protection Regulations	Cybersecurity Expenditure as % of GDP
Indonesia	100%	1.4%	3.1%	34%	49%	51%	2.98	49.4	69	Yes	Yes	Yes	0.02%
Vietnam	82%	1.4%	12.%	22%	10%	51%	2.98	47.8	68	Yes	Draft	Yes	0.04%
Thailand	170%	1.2%	11%	62%	—	—	3.26	66.1	57	No	Yes	Yes	0.05%
Malaysia	116%	0.9%	8%	76%	52%	57%	3.43	66.0	52	Yes	Yes	Yes	0.08%
Cambodia	67%	1.1%	1.5%	16%	—	—	2.8	19.7	97	No	No	Yes	—
Lao PDR	51%	—	1%	12%	—	—	2.07	41.4	105	No	No	Draft	—
Philippines	40%	1.5%	3%	23%	—	52%	2.86	33.9	46	No	Yes	Yes	0.04%

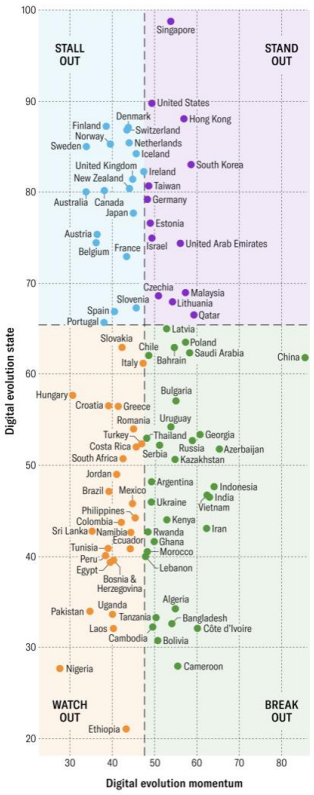
[18] S. Athey (2020) provides a succinct overview. Machines, AI and the Workforce. https://hai.stanford.edu/sites/default/files/2020-09/08.10.20Truth-in-Testimony-Form-SA-rev.pdf

[19] A Chernoff and C. Warman (2020) warn that an acceleration of automation caused by the Covid pandemic, puts jobs held by women at greater risk. Down and out. https://voxeu.org/article/pandemic-induced-automation-and-labour-market-disparities-covid-19; Covid 19 and implications for automation. NBER. https://www.nber.org/papers/w27249

[20] In fact, inequality has risen in most developed economies and some developing ones such as China. A number of countries in LAC, Asia and SSA have bucked the trend. However, wealth is becoming concentrated worldwide. UNDESA (2020) World Social Report. https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/02/World-Social-Report2020-ExecutiveSummary.pdf; The Covid pandemic, which has most severely impacted low skilled labor-intensive occupations, could widen income gaps with women most affected by losses of jobs and incomes. ILO (2021) Covid-19: Tackling the jobs crisis in the least developed countries. https://www.un.org/ohrlls/sites/www.un.org.ohrlls/files/covid-19_tackling_the_jobs_crisis_in_the_ldcs.pdf . Digital technology inserts another variable. M. Spence and L. Tyson (2017, p.172) pose the problem starkly. "As smart machines …challenge a fundamental feature of market systems: where most people gain their income by selling their labor …what happens when a large share of the working-age population, regardless of their education are rendered technologically redundant or no longer command an income adequate to provide a minimally decent or socially acceptable standard of living." Effects of Technology on Inequality. In H. Boushey et.al. *After Piketty*. HUP.

Source: World Bank (2019) The Digital economy in Southeast Asia.
https://openknowledge.worldbank.org/bitstream/handle/10986/31803/The-Digital-Economy-in-Southeast-Asia-Strengthening-the-Foundations-for-Future-Growth.pdf?sequence=1&isAllowed=y

Figure 3: Digital evolution: state and momentum



Source: B. Charavarti et al (2020) Which economies showed the most digital progress in 2020. https://hbr.org/2020/12/which-economies-showed-the-most-digital-progress-in-2020#

Digital technologies have diffused faster than general purpose technologies did in the past[21], but the anticipated productivity gains have not materialized and thus far, job displacement has been minimal in LDCs/EMDEs and manageable in advanced countries[22]. Mature economies, which have rapidly assimilated digital technologies, have undergone synchronized declines in

[21] M. Diermeier and H. Goecke (2017) Productivity, technology diffusion and digitization. https://www.econstor.eu/bitstream/10419/166707/1/cesifo-forum-v18-y2017-i1-p26-32.pdf

[22] M.J. Andrews, A. Chatterji and S. Stern remark (2020). "Beyond 140 characters." "We live in an era in which innovation and entrepreneurship seem ubiquitous, particularly in regions like Silicon Valley, Boston, and the Research Triangle Park, yet simultaneously many metrics of economic growth have been at best modest over recent years. We are currently struggling with a global pandemic that seems to be outpacing our ability to create and scale solutions." https://www.nber.org/chapters/c14372.pdf

productivity growth since the 1980s[23]. Recovery from the Financial Crisis was notably slower and weaker than recoveries from past recessions in both the most economies[24]. Potential growth rates also dipped (Figures 4&5). The slump in productivity following the Financial Crisis of 2008-2009 was the most severe and the productivity slowdown lasted longer than at any time in the past (Figure 6). Although employment had recovered by 2018-2019, there was little increase in real wages in part because there are fewer well remunerated jobs in manufacturing industries for unskilled and semi-skilled and the jobs available in services for such workers, pay lower wages[25].

Whether recovery from the Covid pandemic is V, U or K shaped will depend on how swiftly infections (including from new variants of the Corona virus) are brought under control worldwide through the equitable sharing of vaccines with LDCs, which currently have very low rates of vaccination and are struggling to acquire sufficient doses of the vaccines approved for emergency use[26]. David Malpass (2021) rightly states that "The COVID-19 pandemic will not truly end until everyone has access to vaccines, including people in the poorest countries."[27] This must go hand in hand with policy measures by countries hamstrung by limited fiscal headroom, the effective harnessing of technology, a revival of global trade and

[23] A. Dieppe and M.A. Kose (2020) The global productivity slump. Brookings. https://www.brookings.edu/research/the-global-productivity-slump-what-policies-to-rekindle/; Technology absorption notwithstanding, P. Johnson and C. Papageorgiou (2020) conclude that since 1960, developing countries have not closed the gap in per capita incomes. "What remains of cross-country convergence." https://www.aeaweb.org/articles?id=10.1257/jel.20181207; D. Patel et al (2018) contend that on average, developing countries have been growing faster than high income ones since 1990 but there is plenty of variation among the developers and Patel et al cannot account for the causes of the acceleration. The research on past growth accelerations suggests that they tend to peter out with a tendency for countries to regress to the mean growth rate. R. Hausmann et al (2005); L. Pritchett and L. Summers (2015). "Everything you know about cross country convergence." ;https://www.cgdev.org/blog/everything-you-know-about-cross-country-convergence-now-wrong; https://growthecon.com/blog/Convergence/; https://link.springer.com/article/10.1007/s10887-005-4712-0; https://www.frbsf.org/economic-research/files/Pritchett-Summers-AEPC2013.pdf

[24] https://fredblog.stlouisfed.org/2020/06/how-fast-can-the-u-s-economy-recover-v-shape-vs-swoosh/; https://fas.org/sgp/crs/misc/IN10520.pdf

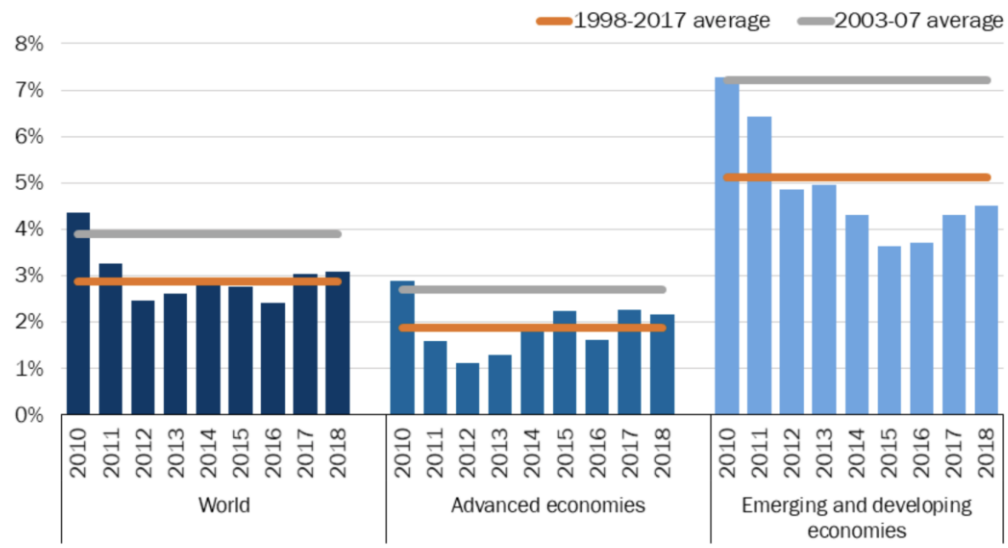
[25] N. Novta and E. Pugacheva (2019) estimate that this shift from manufacturing to services accounts for a quarter of the increase in inequality in the United States between the 1980s and the 2000s. "Manufacturing and Inequality." IMF Working Paper 19/191.

[26] K.P. Acharya et al (2021) Access to and equitable distribution of Covid 19 vaccine in low-income countries. https://www.nature.com/articles/s41541-021-00323-6; The COVAX facility established by WHO is helping procure and distribute vaccines to LDCs. https://www.who.int/news-room/feature-stories/detail/access-and-allocation-how-will-there-be-fair-and-equitable-allocation-of-limited-supplies. COVAX had delivered 209 million doses by August 2021 to 138 partners however, between $35 and $45 billion will be needed to provide enough doses over the course of the year (2021-2022) to immunize most adults. https://www.bbc.com/news/world-55795297; https://www.gavi.org/covax-vaccine-roll-out

[27] Malpass (2021) maintains that a global vaccination effort rests on three pillars. "First, countries with an adequate vaccine supply should immediately release doses to the vulnerable worldwide. Second, [there must be] greater transparency regarding contracts between governments, pharmaceutical companies, and organizations involved in vaccine production and delivery so that financing can be directed effectively, and countries can plan for receipt and deployment. The third pillar is increased vaccine production." How to vaccinate every country. PS. https://www.project-syndicate.org/commentary/global-covid19-vaccination-three-key-factors-by-david-malpass-2021-05

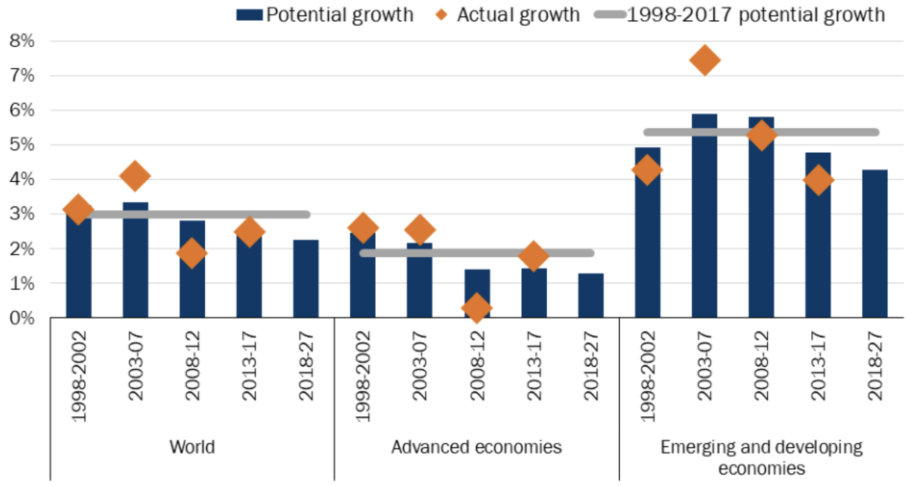
capital flows. There is a lot of uncertainty in the air because of the severity of the shock, the high and rising levels of developing country indebtedness, the weakened balance sheets of banks[28] and of surviving firms, and the lingering threat from trade tensions predating the pandemic.

Figure 4: Growth rates post- financial crisis and pre-Covid Pandemic



Source : S.K. Celik et al (2020) https://www.brookings.edu/blog/up-front/2020/02/27/can-policy-reforms-reverse-the-slowing-of-potential-growth/

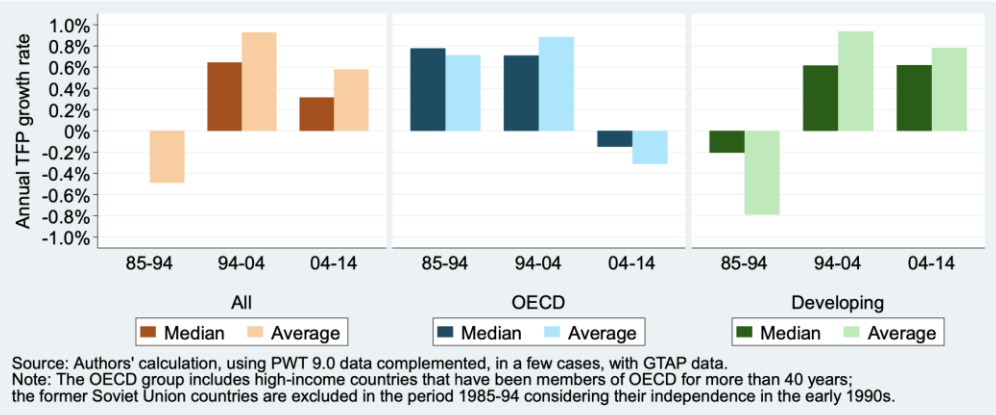
Figure 5: Potential growth



Source: S.K. Celik et al (2020) https://www.brookings.edu/blog/up-front/2020/02/27/can-policy-reforms-reverse-the-slowing-of-potential-growth/

[28] An increase in NPLs and an accumulation of arrears could weigh on bank balance sheets. E. Bosio et al (2021) The invisible burden. VoxEu. https://voxeu.org/article/how-arrears-could-unleash-banking-crisis; J. Kasinger et al (2021) Preparing for a wave of non-performing loans. VoxEu. https://voxeu.org/article/preparing-wave-non-performing-loans

Figure 6: Annual TFP growth in OECD countries and Developing (median and averages)



Source: Kim and Loayza (2019) Productivity Growth. http://documents1.worldbank.org/curated/en/130281557504440729/pdf/Productivity-Growth-Patterns-and-Determinants-across-the-World.pdf

3. Digital Technology Futures: Developing Countries in the OECD mirror

Major technological breakthroughs in the past have, after a lengthy lag[29], raised productivity, which has then fed through into increased employment and higher wages. Initially, a revolutionary new technology has given rise to fear that the loss of jobs from the introduction of new equipment or software would not be made good and countries would be saddled with armies of unemployed and rising inequality[30]. In some countries this threat aroused fierce resistance[31]. But each time around, higher productivity raised per capita incomes, fed demand and created jobs. New occupations widened employment opportunities. Although the pace of growth following the onset of the First Industrial Revolution in the late eighteenth century was slow, it did pick up speed in from the 1820s[32]. Growth responded with an equally long lag to the introduction of General Purpose Technologies (GPTs) such as electricity and the internal combustion engine, which launched the Second Industrial Revolution early in the twentieth century[33]. Growth was even more responsive to the third post-WW2 Industrial Revolution. Nevertheless, new technologies continue to evoke fears of irreversible job losses and revive memories of the Luddites who attempted over a three-year period (1811-1813) to slow the march of mechanization by destroying textile making equipment [34]. Digital technologies have

[29] It took a full half century (1910-1960) for tractors to replace horses and mules on American farms. R. Manuelli and A. Seshadri (2014) Frictionless technology diffusion. AER. https://www.aeaweb.org/articles?id=10.1257/aer.104.4.1368

[30] J. Cohen (2020) Good jobs. https://workofthefuture.mit.edu/research-post/good-jobs/

[31] C.B. Frey (2019) Robots and economic resistance. https://www.cgdev.org/blog/robots-and-economic-development-catch-growth-thing-past

[32] N. Craft and C. Mills (1992, 2017) https://www.jstor.org/stable/2597415?seq=; https://academic.oup.com/ereh/article/21/2/141/3044162

[33] P. David (1990) The dynamo and the computer. AER. https://www.jstor.org/stable/2006600

[34] https://www.smithsonianmag.com/history/what-the-luddites-really-fought-against-264412/ The uprising was short lived, did little damage and was firmly quashed.

aroused similar sentiments. There is worry that with the influx of robot capital most production line and farming jobs will gradually melt away, and many tasks in the services sector will also not be spared. Three decades of experience mostly accumulating in developed countries also raises doubts as to the growth enhancing productivity gains that might accrue from digitalization.

The fears concerning a labor displacing Fourth Industrial Revolution (4IR) have been fanned by a slew of projections. With the global economy needing to absorb three quarters of a billion new workers between 2010 and 2030, the projections have taken on an unusually ominous ring[35]. Although the focus is mainly on advanced countries, employment prospects in LDCs and EMDEs could be hit equally hard as they share many of the occupational groupings (Figure 7 & 8 on ASEAN workers at risk[36]). Frey and Osborne (2017) estimated that digital technologies could in principle, displace 47 percent of workers in the United States spread across 702 occupational groupings[37]. Automation in all its guises could put 25 percent of jobs at high risk in the United States according to Muro et al (2019)[38] and 36 percent at moderate risk. More than a third of jobs could be imperiled in Finland, 59 percent in Germany, and between 45 percent and 60 percent in Europe[39]. A report by the McKinsey Global Institute (2017)[40] projected the loss of 30 percent of jobs to automation worldwide by 2030 with 375 million workers affected. The nearly 2,000 experts surveyed by Pew also concluded that large numbers of occupations would shed jobs[41]. An OECD study (2018)[42] painted a more sanguine picture claiming that there is wide regional variation in the number of jobs at immediate risk – from 4 percent in Oslo to 40 percent in West Slovakia. Jobs in factories that absorb the unskilled and those with high school

[35] D. Bloom et al (2019) Global employment and decent jobs. https://onlinelibrary.wiley.com/doi/abs/10.1111/issr.12213

[36] There is a summary of estimates of productivity implications of digital technology and of jobs at risk from various studies in Table 2.1.3 in ADB (2018) https://www.adb.org/sites/default/files/publication/411666/ado2018-themechapter.pdf; ADB (2018) presents lower estimates of jobs at risk. Future of work. https://www.adb.org/sites/default/files/publication/481901/future-work-regional-perspectives.pdf

[37] C. Frey and Osborne (2017) https://econpapers.repec.org/article/eeetefoso/v_3a114_3ay_3a2017_3ai_3ac_3ap_3a254-280.htm; The warning is echoed by Martin Ford (2009). *The Lights in the Tunnel*. CreateSpace. ADB (2018) https://www.adb.org/sites/default/files/publication/411666/ado2018-themechapter.pdf

[38] https://www.brookings.edu/wp-content/uploads/2019/01/2019.01_BrookingsMetro_Automation-AI_Report_Muro-Maxim-Whiton-FINAL-version.pdf

[39] M. Pajarinen and P. Rouvinen (2016) https://www.etla.fi/wp-content/uploads/ETLA-Muistio-Brief-22.pdf; C. Brzeski and C. Burk (2015) https://ingwb.de/media/1398074/ing-diba-economic-research-die-roboter-kommen.pdf; J. Bowles (2014) https://www.bruegel.org/2014/07/the-computerisation-of-european-jobs

[40] https://www.mckinsey.com/~/media/mckinsey/featured%20insights/Future%20of%20Organizations/What%20the%20future%20of%20work%20will%20mean%20for%20jobs%20skills%20and%20wages/MGI-Jobs-Lost-Jobs-Gained-Report-December-6-2017.ashx

[41] https://www.pewresearch.org/internet/2017/05/03/the-future-of-jobs-and-jobs-training/

[42] https://www.oecd.org/newsroom/job-automation-risks-vary-widely-across-different-regions-within-countries.htm

education or less are becoming fewer even though the volume of manufacturing output is increasing[43]. Overall, some 20 million jobs could be lost to robots worldwide with each robot eliminating 1.6 workers (another estimate by Acemoglu and Restrepo estimates job losses of 3.9 workers per robot)[44]. According to Berg et al (2018)[45] automation could raise productivity but by displacing labor it might depress wages and worsen inequality. There is an additional wrinkle to the automation story. One side effect is a partial deskilling of the workforce with a number of craft skills becoming redundant[46]. More time is spent monitoring machines than in actually making things[47].

[43] India faces a jobs problem even though the absorption of digital technologies and factory automation is at a relatively early stage. The economy, which averaged a 6 percent per annum growth rate during 2011-2019, is not creating enough jobs to absorb the 12 million new entrants each year and has not done so for many years. Youth unemployment is close to 20 percent and the participation rate has been declining and was 37 percent in 2017. https://www.washingtonpost.com/world/2019/02/01/indias-job-crisis-is-worse-than-people-thought-its-government-tried-squelch-data/; https://www.bbc.com/news/world-asia-india-47068223; Nageswaran and Natarajan (2019) https://carnegieindia.org/2019/10/03/india-s-quest-for-jobs-policy-agenda-pub-79967

[44] Oxford Economics (2019) went on to add, "More than half the workers who left production jobs in the past two decades (in the United States) were absorbed into just three occupational categories: transport, construction and maintenance, and office and administration work. Ominously, our analysis found that these three occupational areas are among the most vulnerable to automation over the next decade". https://cdn2.hubspot.net/hubfs/2240363/Report%20-%20How%20Robots%20Change%20the%20World.pdf?utm_medium=email&_hsenc=p2ANqtz--S_yv5LZTWzdC5IER_NtSl3PcknlmRKCRLWkiY7DXoc24tLeHNQmxbfIluLCA4PrkWMen4_J_hWSH49WG3OQvHF61JIg&_hsmi=74013545&utm_content=74013545&utm_source=hs_automation&hsCtaTracking=07b1855a-24f4-4b99-bcb8-b0d2a13b715e%7C53b7a48e-9591-4179-8eab-694443190b4f; Between 1993 and 2007, one new robot was added per thousand workers in the United States and 1.6 per thousand in Western Europe. "The increase in the stock of robots (approximately one additional robot per thousand workers from 1993 to 2007) reduced the average employment to population ratio in a commuting zone by 0.39 percentage points and average wages by 0.77 percent (relative to a commuting zone with no exposure to robots)". Acemoglu and Restrepo (2019). https://economics.mit.edu/files/17106; D. Acemoglu and P. Restrepo (2020) Robots and Jobs. Estimate that the addition of a robot per thousand workers in the United States reduces the employment to population ratio by 0.2 percent and average wages by 0.42 percent. JPE. https://www.journals.uchicago.edu/doi/abs/10.1086/705716

[45] A. Berg et al (2018) Should we fear the Robot Revolution? IMF. https://www.imf.org/en/Publications/WP/Issues/2018/05/21/Should-We-Fear-the-Robot-Revolution-The-Correct-Answer-is-Yes-44923

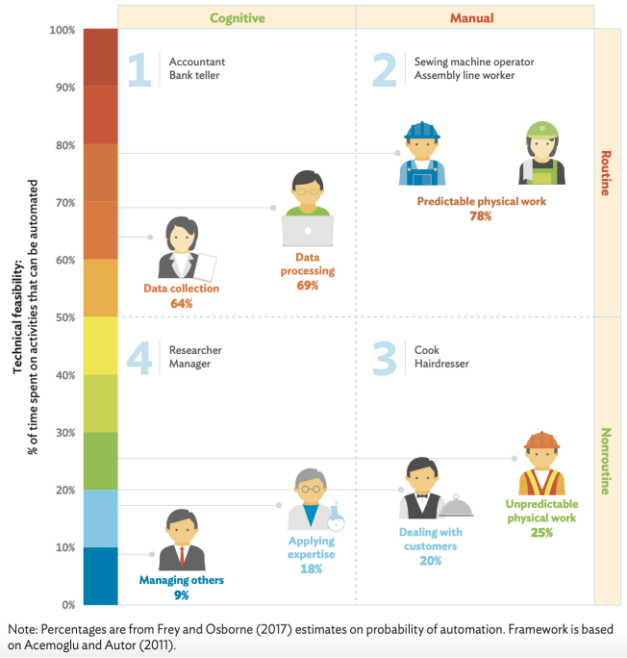
[46] While the majority of jobs lost to automation are of the unskilled, jobs of skilled craftsmen have also felt the edge of the automation axe. D. Kunst (2019) https://papers.tinbergen.nl/19050.pdf; D. Kunst (2019b) https://papers.tinbergen.nl/19033.pdf

[47] L. Wolters (2020) critically assesses the methodology and findings of the various studies and offers a reading on what their projections are worth. Robots, Automation and Work. https://workofthefuture.mit.edu/wp-content/uploads/2020/08/WotF-Working-Paper-05-2020.pdf

Figure 7: Occupation at risk in ASEAN 5

Source: ILO (2016) ASEAN in Transformation. https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---act_emp/documents/publication/wcms_579554.pdf

Figure 8: Automation impact on jobs



Note: Percentages are from Frey and Osborne (2017) estimates on probability of automation. Framework is based on Acemoglu and Autor (2011).

Source: ADB (2018) https://www.adb.org/sites/default/files/publication/411666/ado2018-themechapter.pdf

In a *World Without Work*, Daniel Susskind (2019)[48] foresees continuing "task encroachment". He maintains that advances in AI will begin displacing jobs done by professional and skilled

[48] https://www.ft.com/content/84bcb90c-2588-11ea-9305-4234e74b0ef3

workers as well[49] with more jobs lost through substitution than will be replaced through machine-labor complementarity[50]. The minority who will work with machines, write the algorithms, train the neural network learning programs and invent, design and engineer the hardware that undergirds digital technologies, are going to need increasingly specialized, tertiary level skills with STEM skills in highest demand (Blanas et al 2019; Morikawa 2017)[51]. That the diffusion of AI in the US economy is beginning to change the task structure of jobs in firms taking advantage of the technology is supported by Acemoglu et al (2021)[52]. They also find that the hiring of workers in non-automated tasks does not offset the workers displaced by AI. However, because the inroads by AI are relatively modest, its effects on the aggregate level of employment and wages have yet to surface.

Whether the projected displacement of jobs comes to pass remains to be seen. Research has not uncovered a significant winnowing of jobs in either advanced or developing countries. There has been displacement in some manufacturing industries, but nothing that approximates the projections – so far. In a few advanced economies, the combined effects of technology, globalization and other factors have increased inequality and the share of labor in GDP has drifted downward worldwide[53]. But research remains equivocal on causation. In Japan – and Germany - for example, robot intensity appears to have stimulated demand for labor, or at least has not resulted in a net reduction[54]. Data from Germany shows that robotization reduced manufacturing employment by 275,000 between 1994 and 2014. However, the displaced workers were absorbed into other jobs in their workplace with some retraining. New entrants

---

[49] The likelihood of a trend decline in professional jobs was also spelled out in R. Susskind and D. Susskind (2018) The Future of the Professions. https://www.amphilsoc.org/sites/default/files/2018-11/attachments/Susskind%20and%20Susskind.pdf; Susan Athey believes that "Off-the-shelf ML methods, for tasks such as prediction, classification and clustering, will become pervasive. There have already been a number of successful policy applications. Examples by Harvard economist Sendhil Mullainathan and coauthors include predicting whether an elderly patient will die within a year to determine whether to do a hip operation. Harvard economists Edward Glaeser, Andrew Hillis, Scott Kominers, and Michael Luca have helped cities to predict health-code violations in restaurants, in order to better allocate inspector resources. Using ML together with satellite imagery and street maps can predict economic quantities such as poverty, safety, and home values." Machine Learning methods. https://arxiv.org/abs/1903.10075

[50] See also H. Holzer (2018) The robots are coming. Brookings. https://www.brookings.edu/blog/up-front/2018/12/13/the-robots-are-coming-lets-help-the-middle-class-get-ready/

[51] https://voxeu.org/article/how-different-technologies-affect-different-workers; https://www.rieti.go.jp/en/publications/summary/17050007.html

[52] D. Acemoglu et al (2021) AI and jobs. VoxEu. https://voxeu.org/article/ai-and-jobs-evidence-us-vacancies

[53] D. Autor et al (2017) Concentrating on the fall of the labor share. NBER. https://www.nber.org/papers/w23108 L. Karabarbounis and B. Nieman (2017) Trends in factor shares. NBER. https://www.nber.org/reporter/2017number4/karabarbounis.html offer as explanations the increasing shares of industries that are relatively capital intensive and the substitution of capital for labor as its relative price (automation, robots) has declined.

[54] R. Dekle (2020) http://econbrowser.com/archives/2020/09/guest-contribution-robots-and-labor-demand-evidence-from-japan. The adoption of robots/automation in Japan is subject to less resistance because with its workforce shrinking, the country will need to rely more on these technologies. So, over the longer term will China. W. Dauth et al (2017) German Robots. https://ideas.repec.org/p/cpr/ceprdp/12306.html

who would have joined the factory workforce found employment in services, which averted a net loss of jobs[55]. Klenert et al (2020)[56] research on the EU concludes that the increased use of robots does not lead to a decline in employment generally and low skill employment in particular. Based on the survey of adult skills (PIAAC), a report from the OECD concluded that only about 9 percent of jobs were at high risk (M. Arntz et al 2016)[57]. A study focused on the United States by Mann and Puttmann (2017)[58] found that commuting zones generating more AI patents experienced an increase in employment overall although factory employment fell. Services were the big gainers. A study by Kunst (2020)[59] on manufacturing employment in 125 countries found that certain tasks of a formal and codified nature susceptible to automation were being lost in middle and upper middle-income countries but not in low-income ones. PwC (2018)[60] projects the net creation of 93 million jobs in China by 2037 mainly in services, substantially offsetting the jobs lost to robots in auto assembly, electronics and heavy engineering[61]. The telecom industry, mobile money and Fintech have taken root in several African countries notably Kenya and Nigeria but thus far, as the OECD (2021)[62] observes, digitization has created far too few jobs.

Although digitization and automation could have downsides, EMDEs and other LDCs cannot afford to delay adoption where appropriate. They must take the needed steps to make high speed broadband more widely accessible so as to increase usage by the rural population (only 26 percent use the Internet in SSA) and by women[63], to encourage adoption of technologies

[55] W. Dauth et al (2017) German Robots. https://ideas.repec.org/p/cpr/ceprdp/12306.html; W. Dauth et al (2017) Sectoral employment trends in Germany. VoxEu. Find "Little evidence that the rise of the service economy comes from incumbent manufacturing workers who directly switch jobs. The rise is, instead, entirely driven by young entrants who exhibit different sectoral entry behaviors than previous generations, and by returnees out of non-employment who take up jobs in different industries than their previous ones."

[56] https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/do-robots-really-destroy-jobs-evidence-europe

[57] M. Arntz et al (2016) The risk of automation of jobs in OECD countries. https://www.oecd-ilibrary.org/docserver/5jlz9h56dvq7-en.pdf?expires=1600370372&id=id&accname=guest&checksum=A79A23DF36365B5B44126B15253E9B0B

[58] K. Mann and L. Puttmann (2017) Benign effects of automation. VoxEu. https://voxeu.org/article/benign-effects-automation-new-evidence

[59] D. Kunst (2020) Premature deindustrialization through the lens of occupations. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3383582

[60] PwC (2018) The Net impact of AI and related technologies on jobs in China. https://www.pwc.com/gx/en/issues/data-and-analytics/artificial-intelligence/technologies-on-jobs-in-china.html

[61] Between 2013 and 2017, China's manufacturing sector shed 12.5 jobs and automation has sincwe accelerated with the payback period for robots falling below 2 years. C. Frey (2019) Robots and economic development. CGD. https://www.cgdev.org/blog/robots-and-economic-development-catch-growth-thing-past

[62] https://www.oecd-ilibrary.org/docserver/0a5c9314-en.pdf?expires=1621458275&id=id&accname=guest&checksum=2D644EC7A0C4FAC991DAACCC94C000A9

[63] Only a third of African cities are within 6 miles of a high-speed fiber optic network and only a quarter of rural dwellers have internet access. Moreover, just 17 percent of the population of SSA can afford 1 GB of data in a month vs. 47 percent in Asia. V. Harrison and M. Pezzini (2021) The digital transformation strategy Africa needs. https://www.project-syndicate.org/commentary/africa-digital-transformation-strategy-four-principles-by-victor-harison-and-mario-pezzini-2-2021-02 OECD (2021) Accelerating Africa's Development Dynamics 2021.

especially by lagging SMEs in the formal sector, to build tech literacy, assist start-ups take advantage of digital technology (only 31 percent of formal sector firms in Africa have a website vs. 39 percent in Asia), and to narrow the digital divide. "ICTs [can] play a key role in innovation by creating business opportunities, supporting the modernization of the economic system, reducing poverty, and generating opportunities for social and economic inclusion. Governments in LDCs an take the lead with or without supporting foreign investment in expanding the ICT infrastructure and putting in place regulations, which can catalyze start-up activity – as is occurring in Bangladesh[64], Kenya and Nigeria for example[65]. With 60 percent of the population in LDCs covered by a 3G network or better, progress to date has been encouraging and mobile broadband should be available to the majority of the population within a few years[66]. By 2020, sixty two percent of Bangladesh's population had an Internet subscription and 57 percent a mobile broadband subscription[67].

The wide diffusion of mobile phones serves is a starting point for digital literacy. Therefore, affordable and accessible mobile networks and services are a key element for STI-led development."[68] A study of mobile usage by Indian farmers found that the access to advice on agricultural practices led to increased adoption of high yielding varieties and other complementary inputs. By improving information flow, mobile telecommunications contributed to a notable gain in productivity[69]. Rwanda is also taking the lead in disseminating technology

---

https://www.oecd-ilibrary.org/docserver/0a5c9314-en.pdf?expires=1621458275&id=id&accname=guest&checksum=2D644EC7A0C4FAC991DAACCC94C000A9

[64] A hundred and twenty companies were exporting ICT products valued at $1 billion to 35 countries in 2018. https://www.weforum.org/agenda/2019/10/bangladesh-ict-development-economic-growth/

[65] J. Hjort and J. Poulsen (2019) have found that the access to fast Internet in African countries has led to an increase in employment, entry of firms and exports. The arrival of fast Internet and employment in Africa. https://www.aeaweb.org/articles?id=10.1257/aer.20161385&&from=f Mobile broadband has also helped raise consumption of households in Nigeria and reduce poverty. K. Bahia et al (2020) Welfare effects of mobile broadband internet. https://openknowledge.worldbank.org/bitstream/handle/10986/33712/The-Welfare-Effects-of-Mobile-Broadband-Internet-Evidence-from-Nigeria.pdf?sequence=1&isAllowed=y. A World Bank diagnostic of Nigeria's digital economy (2019) sees some encouraging developments but also lengthy future agenda for the authorities and the business community. "Lagos is a mature and active ecosystem with dynamic incubators, venture capital companies, and digital start-ups. Digital entrepreneurship ecosystems are also growing in the cities of Abuja and Port Harcourt, with a potential for expansion to other cities. Although urban Small and Medium Enterprises (SMEs) are increasingly using digital platforms for trading, digitalization of firms in traditional industries and rural locations remains limited. Larger firms are more actively using digital technology for basic business purposes, such as communication with customers, but more advanced uses of technology also remain limited." http://documents1.worldbank.org/curated/en/387871574812599817/pdf/Nigeria-Digital-Economy-Diagnostic-Report.pdf

[66] https://www.un.org/ohrlls/news/world's-least-developed-countries-target-achieve-universal-and-affordable-internet-2020

[67] https://www.trade.gov/country-commercial-guides/bangladesh-information-and-communication-technology-ict

[68] UNCTAD (2020) https://unctad.org/system/files/official-document/dtlstict2020d4_en.pdf

[69] A. Gupta et al (2020) Information technology adoption and productivity. NBER. https://www.nber.org/papers/w27192

via mobile devices to its agricultural population[70]. And in Mali, the myAgro service provides farmers with mobile devices to purchase agricultural inputs on layaway and makes available information on planting techniques[71]. Whether this alone will suffice to raise growth rates is uncertain although a late start means that there is greater room for catching up. Countries that do not take advantage of digital technologies will find that the gap between them and high-income countries will only widen[72]. In order to promote industrialization, a degree of automation that contributes to productivity may be necessary. Whether EMDEs and LDCs need to invest in 5G or in the suite of technologies, which are part and parcel of the 4IR, is debatable. Most cannot because they lack the capital or the skills and do not need to at their current stage of development.

The case of 5G in SSA is an example. Various providers of telecom services - MTN, Vodafone, Vodacom, Orange et al - have been pouring money into 3G and 4G systems over the past five years and may have spent upwards of $40 billion already. However, it seems that half or more of the users of telecom services only own cheap phones with very limited features, enough for making calls and texting. Moreover, the vast majority of those who access the mobile Internet use 3G services again because their devices cannot utilize 4G or 4G LTE networks. It could be years before users/firms in SSA can fully utilize the potential of 4G.

Under the circumstances, the telecom providers in SSA are unlikely to begin offering 5G services until large numbers of users can afford 5G phones and pay for the services, and also until such time as the advantages conferred by 5G can be exploited in factories, smart cities, accessing the Cloud, operationalizing AVs, and mainstreaming AI. Ownership of 4G compatible smartphones is also low in South and Southeast Asia outside of a few major cities. Cheaper Chinese smartphones are diffusing but they use 3G/4G networks and the benefits of a costly leap into 5G networks is far from obvious until the absorption of the current technology has been completed and the gains realized.

4. Will Productivity follow? Implications for LDCs

[70] https://www.un.org/africarenewal/web-features/africa-leapfrogging-digital-agriculture
[71] https://www.canr.msu.edu/news/malian_farmers_access_more_information_with_mobile_phones
[72] UNCTAD (2020) Least Developed Countries Report. https://unctad.org/system/files/official-document/ldcr2020overview_en.pdf; V. Harrison and M. Pezzinin (2021) also make the case for regionally coordinated action. "Policymakers must coordinate at the regional and continental levels. National digitalization strategies cannot work in silos. Integrating the continent's digitalized economies in the African Continental Free Trade Area calls for supranational cooperation in areas including digital taxation, data security, privacy standards, cross-border data flows, and interoperability. As of today, only 28 African countries have personal data-protection legislation in place, and just 11 have adopted substantive laws on cybercrime. These countries should share their experiences and lessons learned with the rest of the continent." https://www.project-syndicate.org/commentary/africa-digital-transformation-strategy-four-principles-by-victor-harison-and-mario-pezzini-2-2021-02; This elaborated in the Habler et al report (2020) https://www.oecd-ilibrary.org/docserver/0a5c9314-en.pdf?expires=1614628526&id=id&accname=guest&checksum=85C11A252DD44146835E127F2BE309DB

As long as digitization rapidly enhances productivity and growth, the displacement of labor from some activities would be offset by jobs created in other areas. Brynjolfsson et al (2018, 2020, 2021) [73] and McKinsey (2021) maintain that growth and employment benefits will follow the adoption of technology albeit with a lag. "However, along with installing more easily measured items like new types of physical equipment and structures, we emphasize that realizing the potential [of new equipment, structures, and software] requires large intangible investments and a fundamental rethinking of the organization of production itself. Firms must create new business processes, develop managerial experience, train workers[74], patch software, and build other intangibles. This raises productivity measurement issues because intangible investments are not readily tallied on a balance sheet or in the national accounts…. Total factor productivity growth will initially be underestimated because capital and labor are used to accumulate unmeasured intangible capital stocks. Later, measured productivity growth overestimates true productivity growth because the capital service flows from those hidden intangible stocks generates measurable output. The error in measured total factor productivity growth therefore follows a J-curve shape, initially dipping while the investment rate in unmeasured capital is larger than the investment rate in other types of capital, then rising as growing intangible stocks begin to contribute to measured production."

Already the consumption of free digital products may have substantially increased productivity and welfare but are not captured by conventional GDP accounting[75]. The leap in e-commerce during 2020 from single to double digit percentages of retail spending is encouraging, because it suggests that the pace of adoption could be speeding up. Nevertheless, some doubts remain. Doubts arising from the decline in total factor productivity in the United States and advanced European economies over close to two decades, a long enough period in which to accumulate intangible capital, improve managerial skills, and adapt organizations. Between 2010 and 2018, EMDEs derived 0.4 percent per annum of GDP growth from ICT capital but none from TFP. TFP of Asian developing economies excluding India and China, increased by 0.3 percent per annum

[73] E. Brynjolfsson et al (2020) The productivity curve. https://www.nber.org/system/files/working_papers/w25148/w25148.pdf; E. Brynjolfsson et al (2017) AI and the productivity paradox. https://www.nber.org/system/files/working_papers/w24001/w24001.pdf; E. Brynjolfsson et al (2021) How to solve the puzzle of missing productivity growth; https://www.brookings.edu/techstream/how-to-solve-the-puzzle-of-missing-productivity-growth/?campaign_id=116&emc=edit_pk_20210525&instance_id=31519&nl=paul-krugman&regi_id=72733126&segment_id=58970&te=1&user_id=bf99796c0ec3cbcc9489aba866b15964

[74] Access to talent with ICT skills complements managerial expertise. D. Andrews et al (2018) Digital technology diffusion. OECD. https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ECO/WKP(2018)24&docLanguage=En

[75] A measure called GDP-B created by E. Brynjolfsson et al (2019) attempts to value and account for he freely consumed digital products. GDP-B: accounting for the value of new and free goods in the digital economy. https://www.nber.org/system/files/working_papers/w25695/w25695.pdf

and that of Latin American countries fell by 0.7 percent per annum and by 1.7 percent in the Middle East and North Africa.[76]

Underscoring the modest productivity outcomes from digital technologies to date is the experience of the United States. Over a fifty-year period starting in 1967, total factor productivity (TFP) in the United States has trended downward. From an average rate of 0.68 percent per annum between 1985 and 1995, TFP rose to 1.52 percent between 1996 and 2004[77] before falling back to a 0.55 percent per annum during 2004-2016 and to below 0.5 percent between 2017 and 2019. EU productivity remains in the doldrums[78]. European countries started out at a lower rate, but any productivity gains were largely erased in the decade following the financial crisis[79]. According to the estimates made using the EU-KLEMS database, TFP was increasing annually at a 0.65 percent rate between 1985 and 1995; it fell fractionally to 0.43 percent between 1995 and 2007; and slid further to a 0.23 percent annual rate from 2007 to 2015[80]. Perhaps more alarming, productivity growth in manufacturing has slowed in the US, Germany and Japan since about 2004 (Baily, Bosworth and Doshi 2020)[81].

Could countries improve their productivity as the Covid pandemic wanes by building back better? There are mixed views on this for developed and developing countries alike. McKinsey (2021)[82] typically sees the glass as half full for the developed countries with eight industries leading the way, if they grasp the technological opportunities and invest in equipment and skills. "There is potential for an increase of 1.5 percentage points of productivity growth per year in the period to 2024 [with healthcare, construction, information and communications technology (ICT), retail, and pharmaceuticals sectors (gaining) around 2 percentage points per year]. For the total nonfarm business sector, the potential could be 1.1 percentage points of

[76] Conference Board (2019) https://www.conference-board.org/retrievefile.cfm?filename=TED_ProductivityBrief_20191.pdf&type=subsite

[77] R. Shackleton (2013) Total factor Productivity Growth in Historical Perspective. http://www.cbo.gov/sites/default/files/113th-congress-2013-2014/workingpaper/44002_TFP_Growth_03-18-2013_1.pdf; M. Baily, B. Bosworth and S. Doshi (2020). Productivity Comparisons: Learning from Japan, the United States and Germany. Brookings. https://www.brookings.edu/research/productivity-comparisons-lessons-from-japan-the-united-states-and-germany/

[78] G. Petropoulos (2019) https://www.bruegel.org/2019/12/ai-and-the-productivity-paradox/; M. Szczepanski (2018) https://www.europarl.europa.eu/RegData/etudes/BRIE/2018/630319/EPRS_BRI(2018)630319_EN.pdf; E. Brynjolfsson et al (2020) Understanding and Addressing the Productivity Paradox. https://workofthefuture.mit.edu/research-post/understanding-and-addressing-the-modern-productivity-paradox/

[79] N. Crafts and T. Mills (2017). Economic Models vs. Techno-optimism. https://voxeu.org/article/slow-productivity-growth-may-not-be-new-normal-us

[80] Computations by the OECD yield slightly higher numbers with TFP increasing by 0.06 percent per annum between 2007 and 2015. J. Fernald and R. Inklaar (2020). Does Disappointing European Productivity Growth Reflect a Slowing Trend? https://www.frbsf.org/economic-research/files/wp2020-22.pdf

[81] Productivity gains in manufacturing largely accrued from industries producing computers and electronic products. S. Houseman (2018) Understanding the decline in US manufacturing employment. https://research.upjohn.org/up_workingpapers/287/

[82] McKinsey (2021) Will productivity and growth return. https://www.mckinsey.com/industries/public-and-social-sector/our-insights/will-productivity-and-growth-return-after-the-covid-19-crisis; H-H Koptz et al (2021) Pathways to productivity and growth. VoxEu. https://voxeu.org/article/pathways-productivity-and-growth-after-covid-19-crisis

additional annual productivity growth. Our sensitivity analysis suggests that the potential could range between 0.7 and 1.5 percentage points."

5. And then there is Inequality

The possibility that productivity gains are by no means assured, sharpens a related worry. If post-Covid growth remains sluggish, EMDEs and LDCs could also be threatened by widening income inequality – with gender inequality worsening in LDCs[83]. Rising intra-country inequality was already an issue in many developing countries[84]. This is being compounded by a widening inter country divergence in "enhanced capabilities" including tertiary education, scientific knowledge and technological capabilities and access to broadband. That divergence in basic capabilities among countries are narrowing no longer suffices. In order to harness digital technologies, developing countries need much more than basic capabilities.[85]

Theoretical investigations surveyed by Erhart (2009)[86] suggest that an unequal distribution of income and wealth could hamper growth – a worry for a number of EMDEs. Slower growth could in turn draw incomes farther apart if it constrains productivity and income earning opportunities for households in lower income categories. According to suggestive but not entirely conclusive empirical research, inequality is a brake on the rate of growth and on its durability[87]. As Dabla-Norris et al (2015)[88] note "If the income share of the top 20 percent (the rich) increases, then GDP growth actually declines over the medium term, suggesting that the benefits do not trickle down. In contrast, an increase in the income share of the bottom 20 percent (the poor) is associated with higher GDP growth." Other research by the IMF (2017)[89] concludes that the persistence of growth can be undercut by political and economic crises that can be caused by worsening inequality. The OECD (2014)[90] estimates that the three-percentage point average increase in the Gini coefficient across OECD countries has reduced GDP growth by 0.35 percent per annum for a period of 25 years (Figure 9). Supporting evidence comes from Panizza (2002), Ostry et al (2014), Cingano (2014) and van der Weide and Milanovic (2018)[91].

[83] UNCTAD (2020) LDC Report. https://unctad.org/system/files/official-document/ldcr2020overview_en.pdf
[84] Z. Qureshi (2020) Tackling the inequality pandemic. Brookings. https://www.brookings.edu/research/tackling-the-inequality-pandemic-is-there-a-cure/
[85] UNDP (2019) Human Development Report 2019. http://hdr.undp.org/sites/default/files/hdr2019.pdf
[86] C. Erhart (2009) The effects of inequality on growth. https://core.ac.uk/reader/6713990
[87] This by no means a universal finding. Other research does not uncover a negative relationship.
[88] E. Dabla-Norris et al (2015) Causes and Consequences of Income Inequality. IMF. https://www.imf.org/external/pubs/ft/sdn/2015/sdn1513.pdf
[89] https://blogs.imf.org/2017/02/22/the-imfs-work-on-inequality-bridging-research-and-reality/
[90] https://www.oecd.org/social/Focus-Inequality-and-Growth-2014.pdf
[91] R. van der Weide and B. Milanovic (2018) Inequality is Bad for Growth of the Poor. J. Ostry et al (2014) Redistribution, Inequality and Growth. IMF. https://www.imf.org/external/pubs/ft/sdn/2014/sdn1402.pdf; A.V. Banerjee and E. Duflo (2003) Inequality and Growth: What can the data say. https://economics.mit.edu/files/753; F. Cingano (2014) Trends in Income Inequality and its Impact on Growth. OECD. http://www.oecd.org/els/soc/trends-in-income-inequality-and-its-impact-on-economic-growth-SEM-WP163.pdf; U. Panizza (2002) Income Inequality and Growth. Journal of Economic Growth. http://dept.ku.edu/~empirics/Courses/Econ915/papers/income-inequality-growth_jeg02.pdf; S. Aiyar and C.

But not all the cross-sectional evidence bears this out[92]. The outcomes appear to differ across regions. The relationship varies over time, is non-linear and can vary depending on the index of inequality. Although "The median response of real per capita GDP growth to shocks in income inequality is negative and significant for the full sample, the dispersion around the estimates is large, with at least one fourth of the countries in the sample presenting a positive effect, the negative median effect is driven by the Middle East and Central Asia and the Western Hemisphere. Across income levels, only the findings for emerging markets indicate that more inequality slows economic growth." (F. Grigoli et al 2016)[93]. Growth in countries with high levels of income inequality can be more unstable and recessions can persist for longer periods (Morelli 2017)[94]. While a case can be made on both social and economic grounds to contain or reduce inequality, the relationship between inequality and growth is far from settled.

The Pandemic could lead to a worsening especially in the less developed countries because of the numbers that have fallen below the poverty line and the differential impact of the crisis on those who can work remotely using digital technology and those who cannot[95]. The World Bank estimates that as many as 124 million people slipped into poverty during 2020[96]. A report issued by CEPAL (2021)[97] states that extreme poverty in LAC rose to 12.5 percent and 33.7 percent of the population was living in poverty in 2020 with average rural incomes pulling farther apart from those of urban inhabitants.

Low-income households are more exposed to infection and to experience higher fatality rates because of overcrowded living conditions and the because of the work they do[98]. Research conducted by NYU's Center for International Cooperation (2021)[99] on 70 countries found that for "every one-point increase in a country's Gini Coefficient was correlated with a 1.34-percent increase in coronavirus infection rate over the previous week--an initially slight change that

---

Ebeke (2019) The Missing Link between Income Inequality and Economic Growth. VoxEu. https://voxeu.org/article/inequality-opportunity-income-inequality-and-economic-growth

[92] R. Barro (2000) Inequality, growth and investment. NBER. https://www.nber.org/digest/aug99/w7038.html shows that inequality can retard growth at lower levels of income but not when incomes are higher.

[93] F. Grigoli et al (2016) Inequality and growth. IMF. survey the literature and offer new findings. https://www.imf.org/external/pubs/ft/wp/2016/wp16244.pdf

[94] S. Morelli (2017) Rising inequality and economic stability. In H. Boushey et al. *After Piketty*. HUP.

[95] Past epidemics led to widening income inequality. D. Furceri et al (2020) VoxEu. https://voxeu.org/article/covid-19-will-raise-inequality-if-past-pandemics-are-guide; The pandemic has increased within country inequality but reduced global inequality. A. Deaton (2021) Covid 19 and global income inequality. NBER. https://www.nber.org/papers/w28392; Economist (2020) Covid 19 leaves a legacy of increased inequality. https://www.economist.com/the-world-ahead/2020/11/17/covid-19-leaves-a-legacy-of-increased-inequality

[96] https://blogs.worldbank.org/opendata/updated-estimates-impact-covid-19-global-poverty-looking-back-2020-and-outlook-2021

[97] CEPAL (2021) Social Panorama of Latin America. https://www.cepal.org/en/pressreleases/pandemic-prompts-rise-poverty-levels-unprecedented-recent-decades-and-sharply-affects

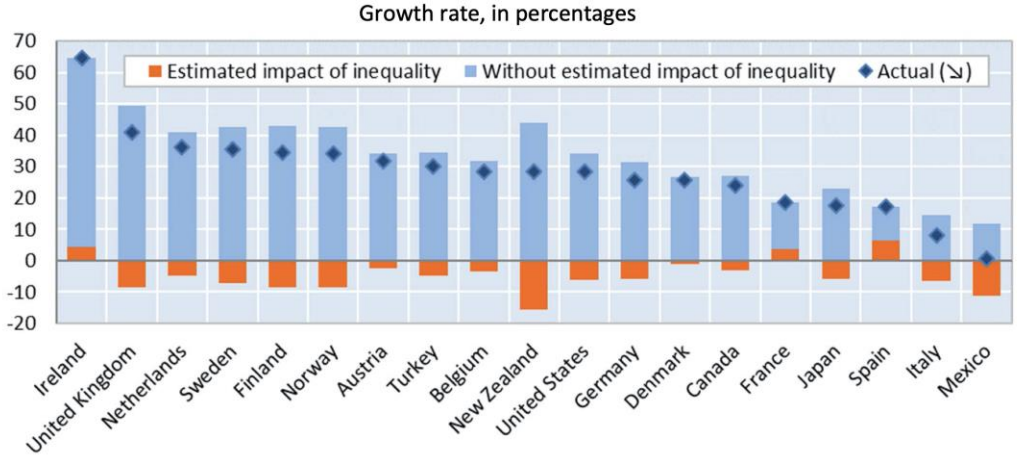
[98] CIDRAP (2021) https://www.cidrap.umn.edu/news-perspective/2021/05/income-inequality-tied-more-covid-19-cases-deaths

[99] https://www.nyu.edu/about/news-publications/news/2021/april/countries-marked-by-inequality-less-likely-to-contain-coronaviru.html; P. Von Chamier (2021) Inequality, Lockdown and Covid-19. https://cic.nyu.edu/publications/inequality-lockdown-and-covid-19-unequal-societies-struggle-contain-virus

accelerates as the pandemic continues. Due to compound accumulation, after 21 weeks (March through early August 2020), that one additional Gini point correlates with an approximately one-third (32.3 percent) higher overall number of cases in a country. This relatively small difference accrues in terms of infection rates and becomes significant after a few weeks… can be described as an 'inequality wedge' that develops over time, with more unequal countries getting notably worse at containing infections toward the end of the analyzed period."

The longer-term effects of the pandemic on inequality could stem from a number of sources. High rates of exit of small and micro firms could result in scarring that persists and hurts job creation and social mobility. Low skilled workers can be forced to endure long spells of unemployment which cuts lifetime earnings and erodes whatever skills they might have. Households forced to tighten their belts could suffer from nutritional deprivation that harms the cognitive development of young children and their future earning capabilities. And disruption of schooling can further undermine the learning imparted – already low in most LDCs.[100]

Figure 9: Effect of change in inequality in 1985-2005 on cumulative growth 1990-2010.



Source; OECD (2014) https://www.oecd.org/social/Focus-Inequality-and-Growth-2014.pdf

6. Digital Technology: Boom or boomlet?

Past shocks disrupted the labor market, but these disruptions tended to be transient in nature. The recession precipitated by the Financial Crisis recession was longer in duration however, laid off workers and new entrants were eventually absorbed by expanding activities, although political ripples in some countries have not died out.[101]. The optimistic assumption is that the past will be prologue with a difference, which is that digital technology will lift growth to higher trend rates in both LDCs and EMDEs once the investment in hard infrastructures is in place, there is some reallocation of resources, actions by governments and firms have mobilized the

[100] R. Hill and A. Narayan (2021) https://blogs.worldbank.org/voices/what-covid-19-can-mean-long-term-inequality-developing-countries
[101] Bughin (2018) https://voxeu.org/article/how-future-work-may-unfold-demand-side-perspective

soft skills and intangible capital[102] and technology assimilation proceeds apace[103]. Digitization need not cause extensive unemployment if new opportunities emerge[104], although occupational polarization and greater income inequality (and the drag they could exert on growth) cannot be ruled out (OECD 2016)[105]. Displaced workers could be absorbed by changes in the structure of demand into different jobs some of which will be newly emergent – with assist from technical and vocational education and training (TVET) (Bessen 2019)[106]. The analysis and management of large data sets and other IT related activities may multiply. Healthcare, hospitality, personal and leisure services are other areas where job growth is likely.

This optimism needs to be tempered by the Covid pandemic that has severely impacted employment especially low-end services. While many of these jobs could come back (albeit with transient issues arising from labor mismatches), the adoption of labor displacing digital technology, which has received a big boost from the pandemic, could reduce the total[107]. The bigger worry is that the lingering effects of the pandemic plus supply chain disruptions could depress potential output over the longer term[108]. In contrast, the business community is relatively more bullish with executives from China and India expressing greater optimism than

[102] A ten percent increase in intangible investment can improve labor productivity by 4.5 percent or more. L.E Christensen et al (2021) Getting back to growth. https://blogs.imf.org/2021/06/10/getting-back-to-growth/

[103] How long it might take for all these necessary inputs to be in place is hard to pin down. A few fast movers might manage in a handful of years, the majority could take longer. Happy talk about digital technology adoption must confront certain brute facts. It took the FAANGs many years to become profitable – and the experience of others as well suggests that only firms that become large reap the benefits. Much depends on the quality of management and on scale. Austin Vernon (2021) observes. "A computer sure looks like a magic technology that almost anyone can use to message or gather incredible amounts of information. A closer look shows that the GPT aspects are shallow. For software to increase TFP, it must mimic human tasks in great detail. It involves defining and reimagining processes and [adopting] a new management system. The spread of a [new] management technology is a slow plodding process. [Others] do not see the benefits …until the companies employing them have scaled and absorbed significant market share." https://austinvernon.eth.link/blog/softwareisprocess.html

[104] For example, social media, smart devices, and cloud computing have created an abundance of new jobs. T. Malone et al (2020) AI and the future of work. MIT https://workofthefuture.mit.edu/research-post/artificial-intelligence-and-the-future-of-work/

[105] OECD (2016) Future of work. https://www.oecd.org/els/emp/Policy%20brief%20-%20Automation%20and%20Independent%20Work%20in%20a%20Digital%20Economy.pdf

[106] https://voxeu.org/article/automation-and-jobs-when-technology-boosts-employment; The transition to new industries and new jobs could be a slow process and older workers might encounter greater difficulties. Frictional or more likely, structural unemployment will also lead to a fall in demand that could slow the emergence of new job opportunities. J. Bessen (2019) Automation and jobs. https://academic.oup.com/economicpolicy/issue/34/100

[107] The pandemic accelerated the adoption of digital technology by firms as e-commerce boomed. D. Revoltella and P. deLima (2020) Thriving in a post-pandemic economy. VoxEu. https://voxeu.org/article/thriving-post-pandemic-economy; M.C. Apedo-Amah (2020) Unmasking the impact of Covid-19 on businesses. World Bank. https://openknowledge.worldbank.org/handle/10986/34626

[108] N.M. Fuentes and I. Moder (2020) Scarring effects of Covid 19. VoxEu. https://voxeu.org/article/scarring-effects-covid-19-global-economy; J. Kozlowski et al (2020) Scarring body and mind. NBER. https://www.nber.org/system/files/working_papers/w27439/w27439.pdf; N. Bloom et al (2021) anticipate a negative within-firm effect on productivity but this could be partially offset by the exit of less productive smaller firms. Impact of Covid 19 on productivity. VoxEu https://voxeu.org/article/impact-covid-19-productivity

those from LAC, Europe and Asia-Pacific[109]. The optimism stems from the massive US stimulus program and accelerating growth during the first half of 2021 as well as the strong performance of the Chinese economy. The latter according to the forecasts issued by the IMF in July 2021 is expected to grow by 8.1 percent and the former by 7 percent. The growth of the global economy for 2021 is pegged at 6 percent[110].

Could digital technology drive the growth of developing economies in the 2020s and beyond? It could certainly contribute significantly to economic performance, but whether it does or does not will depend on several other factors. Policy and the global environment would play as large a role as they did in the past. A strong recovery hinges on policy actions and preferably a coordinated effort by the G-20. The community of nations must hope that black swans comparable to the Covid Pandemic are not lurking in the future (e.g., climate change) or if there is such a risk, sustainable growth will require investing in robustness[111]. Good policy backed by an adequate level of capital investment will not suffice absent a continual evolution of digital technologies and steady flow of commercial innovations that raise productivity. Moreover, innovations will move the productivity needle to the desired extent only if they diffuse widely from lead firms and start-ups to others in the tail. This is more likely in those countries that use the crisis to identify and ease the binding constraints to the effective harnessing of technology, constraints limiting the entry and growth of potentially fast-growing start-ups, and factors that induce large firms to muddle through or 'satisfice' underinvest in intangible capital, avoid organizational changes and steer away from the pursuit of growth through radical innovation. Even the most activist and capable development state can no more than incentivize, exhort, guide, and assemble some of the building blocks, but it is the dynamism of the private sector and capability building by firms[112] that delivers long-run growth[113].

A few EMDEs and LDCs could ride the digital wave to 'miracle' growth with good management and luck. The majority will most likely, muddle along.

---

[109] McKinsey (2021) https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/the-coronavirus-effect-on-global-economic-sentiment

[110] https://www.imf.org/en/Publications/WEO/Issues/2021/07/27/world-economic-outlook-update-july-2021; The OECD's Economic Outlook also expresses similar optimism. https://www.oecd.org/economic-outlook/march-2021/; However, these numbers could be revised downwards in light of the resurgence of Covid variants.

[111] McKinsey (2021) estimates that the average American utility company would save $1 billion over a 20-year period by strengthening infrastructure and building resilience using battery storage and micro grids. https://www.mckinsey.com/business-functions/sustainability/our-insights/the-challenge-of-climate-change

[112] https://www.mckinsey.com/business-functions/mckinsey-accelerate/our-insights/rethink-capabilities-to-emerge-stronger-from-covid-19

[113] Robert Gordon (2021) believes that there is plenty of room for innovation, with qualifications. The IoT, increased application of artificial neural networks (ANNs) for voice recognition, translation, image recognition, legal searches, radiology, and many others is unlikely to result in a night and day revolution. All of these plus remote working "once we get the rest of the economy sorted out – will give us a sizable jump in the annual growth of productivity. I would fully expect growth in the decade of the 2020s to be higher than in the 2010s but not as fast as it was between 1995 and 2005 [because] that was an extraordinary coming together of a lot of technology in a very short time." https://conversableeconomist.blogspot.com/2021/02/robert-j-gordon-thoughts-on-long-run-us.html