Technology, growth, and inequality

Changing dynamics in the digital era

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Abstract
Digital transformation is a defining feature of our time. The COVID-19 pandemic is accelerating this transformation. The new technologies hold considerable promise. But they also pose new challenges. Digital technologies have dazzled for sure, but they have not so far delivered the expected dividend in higher aggregate productivity growth. And inequality has been rising. As digitalization and new advances in artificial intelligence transform markets, policies must rise to the challenges of change. The digital economy must be broadened to disseminate new technologies and productive opportunities among smaller firms and wider segments of the labor force. Policies must play their part to better harness the potential of innovation in our digital era and turn it into a driver of stronger and more inclusive growth in economic prosperity.

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Era of brilliant new technologies

Ours is an era of dazzling new technologies. It is often referred to in epochal terms—as a time of technological renaissance powered by brilliant new technologies, a second machine age, and a new industrial revolution.[1] Some scenarios see the world approaching a technological singularity of accelerating technological change—and a consequent economic singularity of a takeoff in productivity and economic growth.[2]

Such exuberance is understandable. While some characterizations of technological change may be overly grand and visionary, the pace and scope of the advances being made are surely impressive. Technology has been booming in recent decades, led by an array of digital innovations. Ranging from increasingly sophisticated computer systems, software, and mobile telephony to digital platforms and robotics, these innovations have been reshaping markets and the worlds of business and work. New advances in artificial intelligence, machine learning, cyber-physical systems, and the Internet of Things are driving digital transformation further. This latest wave of innovations can take the digital revolution to a whole new level.[3]

COVID-19 digital accelerator: The future is arriving faster

The pace of technological change will accelerate as a consequence of the COVID-19 pandemic.[4] The crisis may be remembered as the Great Digital Accelerator, marking an inflection point in the advance of digital transformation.

The pandemic is reinforcing firm incentives to automate production processes. Trade and commerce are going digital at a faster clip. Digital platforms are expanding their economic sway. Teleworking has increased sharply. Education and training have rapidly shifted online. The use of automated and online processes is speeding up across most sectors of the economy. The digitalization of economic activity in general has intensified.

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[1] See, for example, Brynjolfsson and McAfee (2014) and Schwab (2016).
[2] Nordhaus (2015).
[3] West and Allen (2020).
[4] Chernoff and Warman (2020).

This trajectory of further technological change was expected, but the pandemic is making it happen sooner. The future is arriving faster than expected. Even as economies recover from the pandemic, some of its effects will be long lasting. Prior to the pandemic, a paradigm shift toward digitalization was already well underway. The pandemic has accelerated the shift.

Booming technology but slowing productivity and rising inequality

Technology drives productivity and productivity drives economic growth. But as digital technologies have boomed, productivity growth has slowed rather than accelerated. This is a great paradox of our time.[5] The new technologies have dazzled but so far not delivered the expected dividend in higher aggregate productivity growth. Economic growth, with its main engine slowing, has trended lower.

Productivity growth has slowed significantly in advanced economies since the 1980s. The slowdown extends across OECD economies. It is broad-based, affecting more than two-thirds of the sectors.[6] For the past decade or so, productivity growth has slowed in many emerging economies as well. Over the five-year period 2013-17, productivity growth was lower than the long-term average in about 65 percent of all countries.[7]

Concurrent with the slowdown of productivity growth, income inequality within countries has been rising. Inequality has risen in all major advanced economies since the 1980s, and quite appreciably in several of them. In many cases, there has been a particularly sharp increase in income concentration at the top end of the distribution. Wealth concentration at the top end of the distribution is still more acute—on average roughly twice as high as income concentration. Trends in income distribution are more mixed across emerging economies, but many of them have also experienced rising inequality over the same period.

While income inequality has been rising within many countries in recent decades, inequality between countries has been falling, thanks to the rise of faster-growing emerging economies that are narrowing the income gap with advanced economies.

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[5] Current statistical methods may not be fully capturing the new value created in the digital space. But research finds that, even allowing for such underestimation, the productivity slowdown is real, not illusory. See Derviş and Qureshi (2016). See also Qureshi (2016) for the debate among "techno-pessimists" and "techno-optimists" on the productivity growth potential of digital technologies.
[6] McKinsey Global Institute (2018).
[7] World Bank (2018). See also World Bank (2020).

Technological change poses new challenges for this economic convergence. Manufacturing-led growth in emerging economies has been propelled by their comparative advantage in labor-intensive manufacturing based on large pools of low-skilled, low-wage workers. This source of comparative advantage increasingly will matter less as automation of low-skilled work progresses, disrupting traditional pathways to development.[8] The COVID-19 pandemic could add to the challenges emerging economies face in recalibrating their growth models by disrupting global supply chains and triggering stronger moves to reshore production in advanced economies.

The U.S. economy vividly illustrates the concurrent trends of slowing productivity growth and rising within-country inequality. The United States has been the global leader in the digital revolution. Yet, productivity growth has slowed considerably since the early 2000s (Figure 1).[9] Over the last ten years, labor productivity growth has averaged less than half the growth rate of the decade prior to the slowdown. Total factor productivity growth shows a similar trend. Productivity growth picked up in the latter half of the 1990s, partly spurred by increased initial investment in the adoption of digital technologies. But this surge proved short-lived. Even as these technologies continued their advance in the subsequent two decades, and automation of production deepened and became more sophisticated, productivity growth slowed, settling into a longer-term trend of persistent weakness.

Meanwhile, income inequality in the United States has been rising—and more sharply than in other major advanced economies (Figure 1). Since the early 1980s, the share of the top 10 percent in national income has risen from 35 percent to 47 percent. The income share of the top 1 percent has roughly doubled from 11 percent to 21 percent. The share of the top 1 percent in wealth has risen from 23 percent to around 40 percent. Those with middle-class incomes have been squeezed. For the median worker, real wages have been largely stagnant over long periods. Real median wage growth has been weighed down not only by slower productivity growth but also by wages lagging productivity growth and rising wage inequality. Job insecurity has increased, with mounting fears of a "robocalypse"—large job losses from automation.[10] As income inequality has risen, intergenerational economic mobility has declined.[11]

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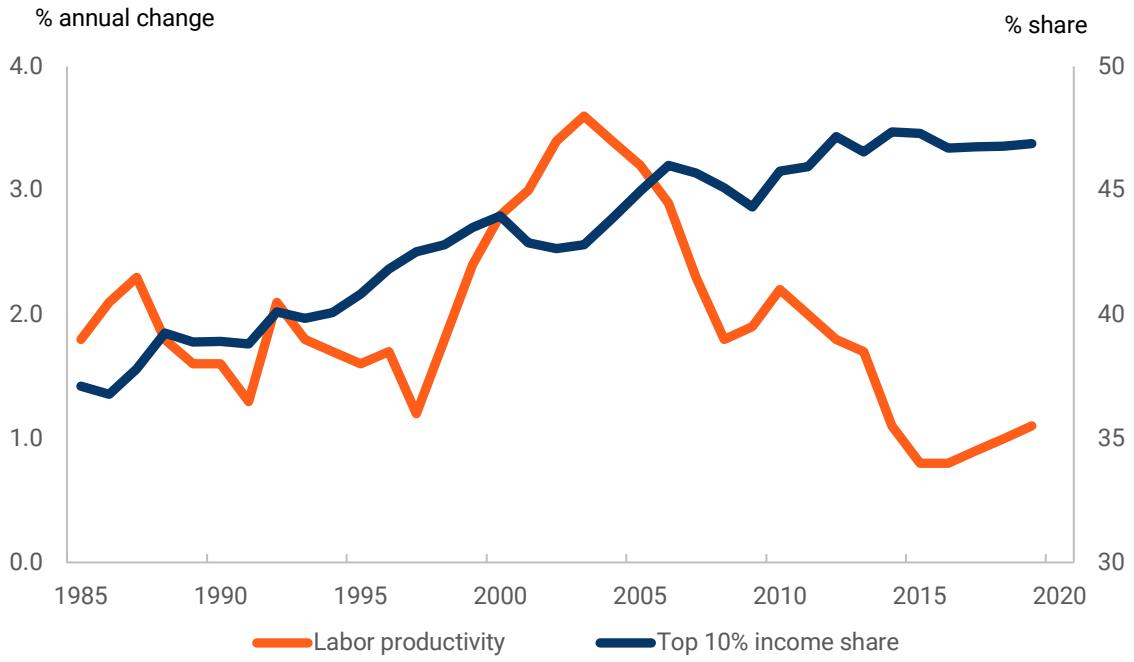
[8] Coulibaly and Foda (2020).
[9] The productivity series in Figure 1 shows five-year moving averages to smooth year-to-year fluctuations.
[10] Autor and Salomons (2017).
[11] Chetty, Grusky, and others (2017).

Figure 1. Falling productivity growth, rising inequality: United States, 1985-2019



Source: Bureau of Labor Statistics (nonfarm business output per hour worked) and World Inequality Database (pre-tax national income shares).

Across economies, rising inequality and related disparities and anxieties have stoked social discontent. They are a major fault line underlying the increased popular disaffection and political polarization that are so evident today.

Recent economic history, in short, presents a striking contrast between the promise of brilliant new technologies and the actual economic and social outcomes. The national economic pie has been growing more slowly and more unequally. The benefits of technological transformation have been shared highly unevenly. This should not, however, lead to a Luddite backlash against technology. Technology itself is not the problem. On the contrary, the new technologies hold considerable potential to boost productivity and economic growth, create new and better jobs to replace old ones, and raise human welfare. The challenge for policymakers is to better harness this potential and turn innovation in our digital era into a driver of stronger and more inclusive growth in economic prosperity.

Technology changing growth and distributional dynamics but policies lagging

Technological change is inherently disruptive and entails difficult transitions. Inevitably, it creates winners and losers. Policies have a crucial role to play, to improve the enabling environment for firms and workers—to broaden access to the new opportunities that come from technological change and to enhance capabilities to adjust to the new challenges.

Unfortunately, policies and institutions have been slow to rise to the challenges of technological change as it has shifted dynamics across product and labor markets. Slowing productivity growth and rising inequality are closely linked to the way new technologies have interacted with the prevailing policy and institutional environment. As discussed below, there is a strong, common nexus connecting technology, policies, and the productivity and distributional outcomes.[12]

Transformations affecting firms

Digital technologies are altering business models and reshaping market structures. How technology diffuses within the economy matters greatly for both productivity growth and income distribution. But so far, the benefits of digital innovations have not been diffusing widely across firms. They have been captured mostly by a relatively small number of large firms. There is a pronounced gap between the digital "haves" and "have-mores." Even the economy at the digital frontier—the United States—may be reaching only about a fifth of its digital potential.[13]

At its root, the slowdown in productivity reflects a growing inequality in productivity performance between firms. Productivity growth has been relatively strong in leading firms at the technological frontier. However, it has slowed considerably in the vast majority of other firms, pulling aggregate productivity growth lower. Over a fifteen-year period since 2000, labor productivity among frontier firms in OECD economies rose by

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[12] On these linked dynamics, see also Brookings Institution and Chumir Foundation (2019) and Furman and Orszag (2018a).
[13] McKinsey Global Institute (2015).

around 45 percent; among non-frontier firms, the increase was well below 10 percent.[14] Productivity divergence between firms is wider in more digital-intensive industries.[15]

A weakening of competition is one important reason for this outcome. Barriers to competition and related market frictions are preventing a broader diffusion of new technologies and causing a persistent rise in productivity and profitability gaps between firms. Evidence for OECD economies shows that in industries less exposed to competition, technological innovation and diffusion are weaker, inter-firm productivity divergence is wider, and aggregate productivity growth is slower. It links the weakness in productivity to diminished competitive intensity in markets.[16]

The erosion of competition is reflected in a variety of indicators: rise in market concentration in industries, higher markups showing increased market power of dominant firms, these firms' supernormal profits (rents) that account for a rising share of total corporate profits, low churning among high-return firms, and corporate ossification with declining business dynamism as measured by new firm formation.[17] The decline in business dynamism and the rise in market concentration are greater in industries that are more intensive users of digital technologies.

These trends are observable broadly across advanced economies but have been particularly pronounced in the United States. The share of top four U.S. companies in total sales has risen since the 1980s in all major sectors of the economy—and more sharply in digital-intensive sectors.[18] Markups over marginal cost for U.S. publicly traded firms are estimated to have nearly tripled between 1980 and 2016, with the increase concentrated in high-markup firms gaining market share, indicating a strong rise in their market power.[19] Over roughly the same period, rents (profits in excess of those under competitive market conditions) are estimated to have risen from a negligible share of national income to about one-fifth.[20] The distribution of returns on capital has become more unequal, with a relatively small number of firms reaping supernormal profits.[21] The share of young firms (five years old or less) in the total number of U.S. firms has

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[14] Andrews, Criscuolo, and Gal (2016) and Orbis data. Frontier firms in this estimate are defined as the top 5 percent of firms with the highest labor productivity within each two-digit industry. Non-frontier firms cover all other firms.
[15] Berlingieri, Calligaris, and others (2020).
[16] See, for example, Andrews, Criscuolo, and Gal (2016), Cette, Lopez, and Mairesse (2016), and Égert (2016). These studies use panel data for a broad range of OECD economies and industries. For a recent review of research on the productivity slowdown, see Goldin, Koutroumpis, and others (2020).
[17] Qureshi (2019).
[18] Autor, Dorn, and others (2020).
[19] De Loecker, Eeckhout, and Unger (2020).
[20] Eggertsson, Robbins, and Wold (2018). Mordechai Kurz (2018) estimates that, between 1985 and 2015, as monopoly profits boosted the market value of corporate stocks and produced outsize capital gains, the share of total U.S. stock market value reflecting monopoly power (what he terms "monopoly wealth") rose from negligible levels to around 80 percent.
[21] Furman and Orszag (2018b).

declined from about one-half to one-third.[22] American markets, a model of competition for the world, have been shifting toward more monopolistic structures.[23]

The new technologies are contributing to increased market concentration by altering competition in ways that produce winner-takes-all outcomes. They offer first-mover advantages, strong economies of scale and network effects, and the leverage of big data that encourage the rise of "superstar firms."[24] The rise of "the intangible economy"—where assets such as data, software, and other intellectual property matter more for economic success—has been associated with a stronger tendency toward the emergence of dominant firms.[25] The winner-takes-all dynamics are most marked in the high-tech sectors, as reflected in the rise of tech giants such as Apple, Facebook, and Google. But they are increasingly affecting economies more broadly as digitalization penetrates business processes in other sectors, such as transportation, communications, finance, and commerce. In retail trade, for example, the big box stores, which previously had replaced mom and pop outlets, are now losing market share to online megastores such as Amazon.

Failures in competition policy have reinforced these technology-driven forces producing higher market concentration. Competition policy has lagged behind the digital economy as it shifts market structures and poses new challenges to keep markets competitive, notably those related to data. Antitrust enforcement has been weak in the face of rising monopoly power and takeover activity. Facebook alone, for example, has acquired more than 70 companies over roughly 15 years, including potential competitors like Instagram and WhatsApp. Increased overlapping ownership of companies that compete, by large institutional investors, also has affected competition. Regulatory policies have not been consistently supportive of competition, with elements of both overregulation that restricts competition and deregulation without adequate safeguards to protect competition.

Flaws in patent systems have acted as barriers to new or follow-on innovation and wider diffusion of knowledge embodied in new technologies. These systems, which typically were designed many decades ago, have been slow to adapt to the knowledge dynamics of the digital era. In the United States, the ownership of patents has become more concentrated in the hands of firms with the largest stock since the 1980s—mirroring broader patterns of market concentration—coupled with more strategic use of patents by market leaders to limit knowledge diffusion.[26]

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[22] Decker, Haltiwanger, and others (2017).
[23] Philippon (2019) and Tepper (2019).
[24] Autor, Dorn, and others (2020).
[25] Haskel and Westlake (2017).
[26] Akcigit and Ates (2019).

Transformations affecting workers

As in product markets, technology has been the big story in labor markets. It has been transforming the nature and future of work. A similar interplay between rapid technology-driven change and lagging policies to that seen in product markets has been at work in labor markets, limiting productivity gains from new technologies and exacerbating inequality. While product markets have seen rising inequality between firms, labor markets have seen rising inequality between workers.

Automation and digital advances have shifted labor demand toward higher-level skills. In advanced economies, globalization has exerted pressure in the same direction. Demand has shifted, in particular, away from routine, middle-level skills that are more vulnerable to automation, as in jobs like clerical work and repetitive production. Job markets have seen an increasing polarization, with the employment share of middle-skill jobs falling and that of higher-skill jobs, such as technical professionals and managers, rising. The employment share of low-skill jobs has also increased but mainly in non-routine manual jobs in services such as personal care that are hard to automate. Over the two decades since the mid-1990s, the share of middle-skill jobs in total employment fell by about 9.5 percentage points in OECD economies on average, while the shares of high-skill and low-skill jobs rose by about 7.5 and 2 percentage points, respectively.[27]

As artificial intelligence advances, displacement risks will affect some higher-level skills as well, in contrast to previous waves of automation. However, the displacement risk at higher-level skills is likely to apply more at the task level than at the level of entire jobs or occupations as has been the case with low- to middle-level skills.[28]

As the demand for skills has shifted, adjustment on the supply side to equip workers with skills that complement the new technologies and support their transition to new tasks and jobs has lagged. Education and training have been losing the race with technology.[29] Even in an advanced country such as the United States, almost two-thirds of workers do not have a college degree. Growth in the years of education completed slowed considerably in the United States around the 1980s. So just when demand for higher-level skills picked up as the digital revolution gathered steam, the attainment of those skills slowed. While pre-college education gaps by family income level have narrowed, gaps in college and higher-level education have widened. The slowing of improvement in educational attainment is observable more broadly across economies—both advanced and emerging economies—around this period.[30] Moreover, the capacity of systems for continuing education has been far exceeded by the fast-growing need for

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[27] OECD Employment Database. See also World Bank (2019).
[28] Autor, Mindell, and Reynolds (2019) and Webb (2020).
[29] Autor, Goldin, and Katz (2020) and Goldin and Katz (2008).
[30] Barro and Lee (2013) and Morrisson and Murtin (2013).

worker upskilling and reskilling. Access to retraining is typically more difficult for lower-skilled workers.

Shortages of new and higher-level cognitive, technical, and managerial skills demanded by the digital economy have hampered technology diffusion across firms and broader productivity gains. Across industries, skills mismatches have increased: in OECD countries, on average around one-quarter of workers report a mismatch between their skills and those required by the job.[31] Workers with skills complementary to the new technologies have increasingly clustered in dominant firms at the technological frontier.

The shifting balance between skills demand and supply has increased the premium on higher-level skills and widened wage differentials, contributing to higher labor income inequality and diminished job prospects for less skilled workers. The skill premium has been rising since the 1980s and has more recently risen particularly sharply at the higher end of educational attainment—graduate and professional education. Skill-biased technological change has contributed to a "convexification" of returns to education and training.[32]

Inter-firm wage inequality has increased as well. Across OECD economies, increased inequality in firm productivity and profitability is mirrored by increased inequality in labor incomes. [33] As profitability gaps have widened between firms, so have wage gaps. Rent sharing also has contributed to wider wage differences between firms. Better-performing firms have reaped a higher share of total profits and shared part of their supernormal profits with their workers. Between-firm wage inequality has risen more in industries that invest more intensively in digital technologies.

While workers in firms at the technological frontier are earning more than those in other firms, gains from higher productivity at these firms have been shared unevenly, with wage growth lagging productivity growth. Wages have risen in the better-performing firms but by less than the rise in productivity. For most other firms, limited wage growth has reflected limited productivity growth, although even at these firms wage growth has tended to fall short of the meager gains in productivity. In the United States, between the mid-1970s and the mid-2010s, labor productivity rose by about 75 percent and average worker compensation in real terms rose by about 50 percent—with the productivity and compensation growth divergence increasing in the most recent decades. Over the same period, real compensation for the median worker rose by less than 15 percent, reflecting rising wage inequality.[34]

The decoupling of wages from productivity has contributed to a shift in income distribution from labor to capital. In the past couple of decades, most major economies

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[31] Adalet McGowan and Andrews (2017).
[32] Autor, Goldin, and Katz (2020).
[33] Criscuolo, Hijzen, and others (2020), Song, Price, and others (2019), and Berlingieri, Blanchenay, and Criscuolo (2017).
[34] Stansbury and Summers (2018).

have experienced both increasing inequality of labor earnings and declining shares of labor in total income.[35] In the United States, for example, the percentage share of labor in nonfarm business income dropped from the mid-60s around 2000 to the mid-50s around 2015.

Increased market concentration in product markets also has played a role in the shifting of income from labor to capital as it has reallocated labor within industries to dominant firms with supernormal profits and lower labor income shares.[36] Dominant firms are not only acquiring more monopoly power in product markets to increase markups and extract higher rents but also monopsony power to dictate wages in the labor market.[37] While employer market power has strengthened, worker bargaining power has weakened with a decline in unionization and erosion of minimum wage laws.

These labor and product market developments have reinforced the effect of the labor-substituting nature of many of the new technologies on the distribution of income between labor and capital. Production is shifting toward firms and processes using more capital (tangible and intangible) and less labor. The largest U.S. firm in 2017 (Apple) had a market capitalization forty times as high as that of the largest U.S. firm in 1962 (AT&T) but its total employment was only one-fifth that of the latter.[38] The shift of income from labor to capital has increased overall income inequality, as capital ownership is highly uneven.[39]

In advanced economies, international trade and offshoring also have contributed to the shift in income toward capital by putting downward pressure on wages, especially of lower-skilled workers in tradable sectors. The expanding digital trade—the new phase of globalization—can add to these pressures. With a growing range of digitally deliverable services, workers further up the skill spectrum also will face more competition from across borders.[40] Overall, globalization has played a significant role in the decline of the labor income share in advanced economies. However, its role has been much smaller than that of technology—about half or less.[41]

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[35] OECD (2018) and Schwellnus, Pak, and others (2018).
[36] Autor, Dorn, and others (2020).
[37] Azar, Marinescu, and Steinbaum (2017).
[38] West (2018).
[39] The role of uneven capital ownership and returns on capital as sources of inequality has been particularly emphasized by Thomas Piketty in his 2014 bestseller (Piketty 2014).
[40] Baldwin (2019).
[41] International Monetary Fund (2017). The study finds that, in advanced economies, technology accounts for about half of the decline in the labor income share, global integration accounts for about a quarter, and policies and institutions and other factors such as measurement issues account for the remainder.

COVID-19 reinforcing new market dynamics

The COVID-19 pandemic is reinforcing the technology-driven shifts in product and labor market dynamics as it accelerates the digitalization of production, commerce, and work. As economies recover from the immediate crisis, the further advances in digital transformation can spur productivity and boost economic growth. But they can also reinforce the market dynamics that have in recent years inhibited productivity growth and increased economic inequality.

In product markets, the pandemic may fortify the trend toward more concentrated market structures.[42] The big shift in demand toward online modes of business is adding to the pre-existing advantages of technologically advanced, well-positioned large firms. The pandemic is likely to disproportionately cull the ranks of smaller, less automation-intensive firms—also because smaller firms lack the liquidity and access to credit needed to survive in a crisis. While smaller firms struggle, tech giants are further increasing market shares. This is already evident in some industries, such as in retail trade where an unfolding wave of bankruptcies is pushing more business toward big tech retail giants. Market dynamism and competition will face added challenges with more firm exits and fewer new entrants, and increased takeover opportunities. The reinforcement of the dominant positions of large firms associated with more demand shifting online will not be limited to the period of COVID-19 shutdowns but will extend into the future.

In labor markets, increased automation and telework triggered by the pandemic can further tilt the balance against less-skilled, low-wage workers.[43] Forced by closures and social distancing requirements, firms are automating even more, discovering new ways to harness emerging technologies to accomplish tasks with less labor. This is happening more in industries with business models heavily reliant on human contact and a less-skilled workforce. The further consolidation of economic activity in large firms in product markets will reinforce recent trends toward higher wage inequality and lower labor income share.

The pandemic has spurred an overnight revolution in telework. The beneficiaries of telework are primarily higher-educated workers. Not only do low-skilled workers have fewer options to telework and are thus less shielded from the immediate impact of the crisis, they face longer-term job losses as telework reduces demand for a range of personal and business services that employ them in large numbers, such as office space

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[42] Rose (2020).
[43] Autor and Reynolds (2020).

maintenance, transportation, and hospitality. Much of the shift toward telework is likely to endure. Even after the pandemic has passed, the share of working days delivered through telework by full-time employees is expected to be at least three times higher than before.[44]

Policies must catch up with technological change

The rise of the digital economy is a defining feature of our time. Latest advances in artificial intelligence and machine learning are expanding the digital frontier. The COVID-19 pandemic is accelerating this technological transformation. But technological change is not delivering its full potential to boost productivity and economic growth. And it is pushing income inequality higher, with the distribution of both capital and labor income becoming more unequal and income shifting from labor to capital.

However, these outcomes are not inevitable. With more responsive policies, better outcomes are possible. Digital technologies can be the source of as much as two-thirds—or perhaps even more—of potential productivity growth over the next decade.[45] How to realize the potential of these technologies to deliver stronger and more inclusive economic growth lies at the core of the forward policy agenda. Today's innovation economy must be broadened from its narrow confines to disseminate new technologies and productive opportunities among smaller firms and wider segments of the labor force. Innovation must be "democratized."[46]

There is much concern today about rising inequality and its adverse economic, social, and political consequences. Policies to reduce inequality are often seen narrowly in terms of redistribution—tax and transfer policies. This is of course an important element, especially given the erosion of the state's redistributive role in recent decades as tax progressivity has declined and social programs have felt the pressure of tighter fiscal constraints. In particular, systems for taxing income and wealth should be bolstered in light of the new distributional dynamics. But there is a much broader policy agenda of "predistribution" that can make the growth process itself more inclusive.[47]

Much of the reform agenda to achieve more inclusive outcomes from technological change is also an agenda to achieve stronger growth outcomes, given the linked

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[44] Altig, Barrero, and others (2020).
[45] McKinsey Global Institute (2018).
[46] Qureshi (2020) and Rodrik (2020).
[47] Hacker (2011).

dynamics between the recent rise in inequality and the slowdown in productivity. Specific policy needs and priorities, of course, differ across groups of economies, especially between advanced and emerging economies. Broadly, there are five areas that need more focused attention from national policymakers.

First, competition policy should be revamped for the digital age to ensure that markets continue to provide an open and level playing field for firms. Antitrust enforcement should be strengthened, supported by updated laws and guidelines on mergers and acquisitions (M&As)—covering not only horizontal M&As but also non-horizontal ones. Recent filings of antitrust lawsuits in the United States against Facebook and Google and congressional antitrust hearings, together with related actions in the European Union, suggest that momentum may be building for reform of the antitrust legal framework and stronger enforcement.

New regulatory challenges posed by the digital economy must be addressed. These include regulatory responses to proprietary agglomeration of data, competition issues relating to digital platforms that have emerged as gatekeepers in the digital world, and market concentration resulting from tech giants that resemble natural or quasi-natural monopolies. An overarching issue is the regulation of data, the lifeblood of the digital economy. Issues relating to how data are handled—use, access, portability, openness while protecting privacy and security—matter increasingly for competition. There has been more action on these issues in Europe than in the United States, an example being the General Data Protection Regulation introduced in Europe.

To address the competition policy challenges of the digital economy, some countries are now establishing or contemplating new regulatory bodies focused on digital markets—such as Australia, France, Germany, and the United Kingdom.[48] These bodies would be tasked to develop pro-competition standards, rules, and codes of conduct for digital markets (including new competition issues that may arise as artificial intelligence and machine learning algorithms advance), and could also serve as focal points for international coordination on regulation of digital markets. There are also emerging proposals for similar reform in the United States.[49]

Second, in an increasingly knowledge-driven economy, the innovation ecosystem should be improved so that it spurs new knowledge and technological advances but also fosters their wide diffusion. Patent systems should be reformed with an eye to changing excessively broad and stringent protections, addressing the problems of patent thickets and trolling, aligning rules with today's realities, and giving freer rein to competition that, ultimately, is the primary driver of technological innovation and diffusion.[50] One possible reform is to replace the one-size-fits-all approach enshrined in current systems with a differentiated approach. While long patent terms may continue to be appropriate for —

[48] For the United Kingdom, for example, see Digital Competition Expert Panel (2019).
[49] See Wheeler, Verveer, and Kimmelman (2020) and Stigler Committee on Digital Platforms (2019).
[50] "The copyright and patent laws we have today look more like intellectual monopoly than intellectual property" (Lindsey and Teles 2017).

some innovations, such as in pharmaceuticals that involve protracted and expensive testing, the case is less clear for digital technologies that have much shorter gestation periods and typically build on previous innovations in an incremental fashion.[51]

Government investment in research and development (R&D), which has been falling in many countries, should be revitalized, as it supplies the important public good of basic research that produces broad knowledge spillovers and complements the focus of private R&D on narrower, applied research.[52] Public R&D support programs can improve access to innovation financing for small and medium enterprises.[53] Also, a robust public R&D program—including direct investment and tax incentives and subsidies—can influence the direction of technological change toward innovation that serves broader economic and social goals rather than the interests of narrow groups of investors. It can, for example, address the concern that the current private technological paradigm is geared toward "excessive automation," producing technologies that displace labor without much gain in total factor productivity.[54] Correcting biases in the tax system favoring capital relative to labor would also help.[55]

Many breakthrough innovations developed commercially by private firms originate from government-supported research. Examples include Google's basic search algorithm, key features of Apple smartphones, and even the Internet itself.[56] Governments should explore ways of better recouping some of their investment in research, not least to replenish their research budgets—producing a better balance in sharing risks and rewards of public research investment compared to the current paradigm where risks are socialized but rewards are privatized. Ensuring that companies do not take advantage of loopholes in the tax system and pay adequate taxes on their profits is the obvious way. Other possibilities include requiring companies to repay research grants if their products succeed financially or acquiring equity stakes in the commercialization of successful technologies directly supported by public research funds.[57]

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[51] Roin (2014) and Qureshi (2018). See also Galasso and Schankerman (2015) on differentiating patent policy by firm size. In tailoring patents to different types of innovation and innovators, care must be taken not to complicate the patent regime excessively. More research on possible approaches is needed.
[52] In the United States, for example, public R&D spending has fallen from 1.2 percent of GDP in the early 1980s to half that level in recent years, with its share in total R&D spending declining from 45 percent to less than a quarter (Shambaugh, Nunn, and Portman 2017).
[53] In the United States, venture capital plays a disproportionate role in financing startups. The industry is highly concentrated, with the top 5 percent of investors accounting for 50 percent of the capital raised (Lerner and Nanda 2020).
[54] Acemoglu and Restrepo (2019). The authors refer to these technologies as "so-so technologies."
[55] Acemoglu, Manera, and Restrepo (2020). The authors find that, in the United States, labor is taxed much more heavily than capital and that this difference has increased in recent years. They estimate that the U.S. effective tax rate in the 2010s was 25.5-33.5 percent for labor and 5-10 percent for capital.
[56] Mazzucato (2015).
[57] Mazzucato (2015) and Rodrik (2015). Ideas such as government acquiring equity stakes are not without controversy. Government stakes could be "passive" and temporary, with the research investments focused in priority areas that entail high risks that private investors would not take on their own, and managed by independent entities shielded from day-to-day political pressures.

Third, digital infrastructure must be strengthened to expand access to new opportunities. This requires increased public investment as well as frameworks to encourage more private investment to improve digital access. Broadband is becoming as much of a necessity in this century as electricity was in the 20th century. But the digital divide remains wide within economies, a fact brought into starker relief by the COVID-19 crisis. Most sectors of the U.S. economy are less than 15 percent as digitalized as the leading sectors, and there are large gaps in access between major urban/industrial centers and other areas.[58]

The digital divide is even wider in developing economies. A stronger foundation of digital infrastructure will be crucial for these economies as technology forces a shift toward growth models less reliant on low skill, low-wage manufacturing. It is essential to capturing the new growth opportunities that technology offers, such as the expanding trade in digitally deliverable services. Success in using mobile telephony to connect large populations to the formal economy, including financial markets, in many countries illustrates the new leapfrogging possibilities in development.

Fourth, education and training programs must be revamped to emphasize the acquisition of skills that complement the new technologies. This will require innovation in the content, delivery, and financing of these programs, including new models of public-private partnerships. With the fast-changing demand for skills and the growing need for upskilling, reskilling, and lifelong learning, the availability and quality of continuing education should be greatly scaled up.[59] The effort should span both the general education system and the institutions for vocational education. It should include expanded partnerships with employers, including exploring a larger role for apprenticeship arrangements.

To improve workers' access to retraining, one approach is through Lifelong Learning Accounts in which workers accumulate rights to training that are portable across jobs.[60] Such accounts have recently been introduced at the national level in some countries, such as France and Singapore. More flexibility can be built into government student aid programs (grants, loans, tax incentives) so that they benefit not just first-time college entrants but also returning older adults. The potential of technology-enabled solutions must be harnessed, supported by a stronger foundation of digital literacy. The COVID-19 pandemic has dramatically demonstrated the scope for scaling up the use of online learning tools.

Persistent inequalities in access to education and (re)training must be addressed. While gaps in basic capabilities across income groups have narrowed, those in higher-level capabilities that will drive success in the 21st century are widening.[61]

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[58] McKinsey Global Institute (2015).
[59] The need to scale up continuing education is reinforced by the aging of the workforce in many countries.
[60] Fitzpayne and Pollack (2018).
[61] United Nations (2019).

Fifth, social protection systems should be strengthened, indeed overhauled to realign them with the changing economy and nature of work. The pandemic has exposed weaknesses in these systems. Unemployment insurance schemes should better support workers in adjusting to change, retraining, and transitioning to new jobs. They should be designed to provide adequate coverage and encourage re-employment. Worker benefits systems, covering benefits such as pensions and health care, which traditionally have been based on formal long-term employer-employee relationships, will need to adjust to a job market with more frequent job transitions and more diverse work arrangements. This means greater portability and adaptability to address the needs of more people working independently. The gig economy is expanding.[62] The increased use of teleworking stemming from the pandemic will spur it further.

The dominant part of the policy agenda to make technology work better for all lies at the national level, especially in the key areas outlined above. But there is a complementary agenda at the international level. The rise of nationalist populism has increased protectionist sentiment. The pandemic can further stoke the backlash against globalization. Concerns about security of critical supplies can spur more reshoring of supply chains. International cooperation will need to ensure that past gains in establishing a rules-based global trading system are shielded from these headwinds. At the same time, new rules and cooperative arrangements must be devised to underpin the new phase of globalization led by digital flows to ensure open access and fair competition.[63] This includes adequate disciplines for digital trade, cross-border data flows and the fast-growing digitally deliverable services. In a more knowledge-intensive globalization, appropriate frameworks governing intellectual property take on added significance. International cooperation on tax matters becomes even more important in view of the new tax challenges of the digital economy.

Conclusion

Ours is a time of exciting technological change. The era of smart machines holds the promise of a more prosperous future for all. But it demands smarter policies to realize that promise. To capture potential gains in productivity and economic growth and to address rising inequality, policies will need to be more responsive to change as technology reshapes markets. And change will only intensify as artificial intelligence and other new advances drive digital transformation further—and at an accelerated pace in the aftermath of the COVID-19 pandemic.

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[62] Brynjolfsson and McAfee (2017) and Sundarajan (2016).
[63] Schwab (2019) and World Economic Forum (2019).

As technology shifts market dynamics, policies must ensure that markets remain inclusive and support broad access to the new opportunities for firms and workers. New thinking and policy adaptations are needed in areas such as competition policy, the innovation ecosystem, digital infrastructure development, upskilling and reskilling of workers, and social protection regimes. Fostering wider diffusion of new technologies among firms and building complementary capabilities in the workforce can deliver both stronger and more inclusive economic growth.

Major economic reform, inevitably, is politically complex. Today's deeper political divisions add to the challenges. But political support appears to be building in some key areas of reform, such as addressing the market dominance of tech giants and putting in place an adequate regulatory framework governing data. Crises can shift the political setting for reform. The fault lines exposed by the COVID-19 pandemic can catalyze action to address mounting economic disparities. All too often, reform is paralyzed by trite debates about conflicts between boosting economic growth and reducing inequality. Encouragingly, however, policy is increasingly being informed by research findings that show this to be a false dichotomy. In realizing the promise of brilliant new technologies, the growth and inclusion agendas are one and the same.

References

Acemoglu, Daron, Andrea Manera, and Pascual Restrepo (2020). "Does the U.S. Tax Code Favor Automation?" *Brookings Papers on Economic Activity,* Spring 2020.

Acemoglu, Daron, and Pascual Restrepo (2019). "The Wrong Kind of AI? Artificial Intelligence and the Future of Labor Demand," NBER Working Paper 25682, National Bureau of Economic Research, Cambridge, MA.

Adalet McGowan, Muge, and Dan Andrews (2017). "Labor Market Mismatch and Labor Productivity: Evidence from PIAAC Data," *Research in Labor Economics,* 45: 199-241.

Akcigit, Ufuk, and Sina Ates (2019). "What Happened to U.S. Business Dynamism?" NBER Working Paper 25756, National Bureau of Economic Research, Cambridge, MA.

Altig, David, Jose Maria Barrero, Nick Bloom, Steven Davis, Brent Meyer, Emil Mihaylov, and Nick Parker (2020). "Firms Expect Working from Home to Triple." Macroblog, Federal Reserve Bank of Atlanta, Atlanta,

Andrews, Dan, Chiara Criscuolo, and Peter Gal (2016). "The Best Versus The Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy," *OECD Productivity Working Paper,* No. 5, OECD Publishing, Paris.

Autor, David, Claudia Goldin, and Lawrence Katz (2020). "Extending the Race between Education and Technology," NBER Working Paper 26705, National Bureau of Economic Research, Cambridge, MA.

Autor, David, David Dorn, Lawrence Katz, Christina Patterson, and John Van Reenen (2020). "The Fall of the Labor Share and the Rise of Superstar Firms," *Quarterly Journal of Economics,* 135 (2): 645-709.

Autor, David, and Elisabeth Reynolds (2020). "The Nature of Work after the COVID Crisis: Too Few Low-Wage Jobs," The Hamilton Project, Brookings, Washington, DC.

Autor, David, David Mindell, and Elisabeth Reynolds (2019). *The Work of the Future: Shaping Technology and Institutions,* MIT Task Force on the Work of the Future, Massachusetts Institute of Technology, Cambridge, MA.

Autor, David, and Anna Salomons (2017). "Robocalypse Now: Does Productivity Growth Threaten Employment?" in *Proceedings of the ECB Forum on Central Banking: Investment and Growth in Advanced Economies,* Sintra, European Central Bank.

Azar, José, Ioana Marinescu, and Marshall Steinbaum (2017). "Labor Market Concentration," NBER Working Paper No. 24147, National Bureau of Economic Research, Cambridge, MA.

Baldwin, Richard (2019). *The Globotics Upheaval: Globalization, Robotics, and the Future of Work,* Oxford University Press.

Barro, Robert, and Jong-Wha Lee (2013). "A New Data Set of Educational Attainment in the World, 1950-2010" *Journal of Development Economics,* 104 (September): 184-198.

Berlingieri, Giuseppe, Sara Calligaris, Chiara Criscuolo, and Rudy Verlhac (2020). "Laggard Firms, Technology Diffusion, and its Structural and Policy Determinants," OECD Science, Technology and Industry Policy Papers, No. 86, OECD Publishing, Paris.

Berlingieri, Giuseppe, Patrick Blanchenay, and Chiara Criscuolo (2017). "The Great Divergences," OECD Science, Technology and Industry Policy Papers, No. 39, OECD Publishing, Paris.

Brookings Institution and Chumir Foundation (2019). *Productive Equity: The Twin Challenges of Reviving Productivity and Reducing Inequality.* Report. Washington, DC.

Brynjolfsson, Erik, and Andrew McAfee (2017). *Machine, Platform, Crowd: Harnessing Our Digital Future,* W. W. Norton & Company.

Brynjolfsson, Erik, and Andrew McAfee (2014). *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies,* W. W. Norton & Company.

Cette, Gilbert, Jimmy Lopez, and Jacques Mairesse (2016). "Market Regulations, Prices, and Productivity," *American Economic Review,* 106 (5): 104-08.

Chernoff, Alex and Casey Warman (2020). "COVID-19 and Implications for Automation," NBER Working Paper 27249, National Bureau of Economic Research, Cambridge, MA.

Chetty, Raj, David Grusky, Maximilian Hell, Nathaniel Hendren, Robert Manduca, and Jimmy Narang (2017). "The Fading American Dream: Trends in Absolute Income Mobility since 1940," *Science,* 356 (6336): 398-406.

Coulibaly, Brahima, and Karim Foda (2020). "The Future of Global Manufacturing," in *Growth in a Time of Change: Global and Country Perspectives on a New Agenda,* Hyeon-Wook Kim and Zia Qureshi (eds.), Brookings Institution Press.

Criscuolo, Chiara, Alexander Hijzen, and others (2020). "Workforce Composition, Productivity, and Pay: The Role of Firms in Wage Inequality," OECD Social, Employment and Migration Working Papers, No. 241, OECD Publishing, Paris.

Decker, Ryan, John Haltiwanger, Ron Jarmin, and Javier Miranda (2017). "Declining Business Dynamism, Allocative Efficiency, and the Productivity Slowdown," *American Economic Review,* 107 (5): 322-26.

De Loecker, Jan, Jan Eeckhout, and Gabriel Unger (2020). "The Rise of Market Power and the Macroeconomic Implications," *Quarterly Journal of Economics,* 135 (2): 561-644.

Derviş, Kemal, and Zia Qureshi (2016). "The Productivity Slump – Fact or Fiction: The Measurement Debate," Research Brief, Brookings, Washington, DC.

Digital Competition Expert Panel (2019). *Unlocking Digital Competition: Report of the Digital Competition Expert Panel,* March 2019, London.

Égert, Balázs (2016). "Regulation, Institutions and Productivity: New Macroeconomic Evidence from OECD Countries," *American Economic Review,* 106 (5): 109-13.

Eggertsson, Gauti, Jacob Robbins, and Ella Getz Wold (2018). "Kaldor and Piketty's Facts: The Rise of Monopoly Power in the United States," NBER Working 24287, National Bureau of Economic Research, Cambridge, MA.

Fitzpayne, Alastair, and Ethan Pollack (2018). "*Lifelong Learning and Training Accounts: Helping Workers Adapt and Succeed in a Changing Economy*, Aspen Institute, Washington, DC.

Furman, Jason, and Peter Orszag (2018a). "Slower Productivity and Higher Inequality: Are They Related?" Working Paper 18-4, Peterson Institute for International Economics, Washington, DC.

Furman, Jason, and Peter Orszag (2018b). "A Firm-Level Perspective on the Role of Rents in the Rise in Inequality," in *Toward a Just Society: Joseph Stiglitz and Twenty-First Century Economics,* M. Guzman (ed.), Columbia University Press.

Galasso, Alberto, and Mark Schankerman (2015). "Patent Rights and Innovation by Small and Large Firms," NBER Working Paper 21769, National Bureau of Economic Research, Cambridge, MA.

Goldin, Claudia, and Lawrence Katz (2008). *The Race between Education and Technology,* Harvard University Press.

Goldin, Ian, Pantelis Koutroumpis, François Lafond, and Julian Winkler (2020). "Why is Productivity Slowing Down," OMPTEC Working Paper No, 2020-1, Oxford Martin School, Oxford.

Hacker, Jacob (2011). "The Institutional Foundations of Middle Class Democracy," *Policy Network,* May 6, 2011.

Haskel, Jonathan, and Stian Westlake (2017). *Capitalism without Capital: The Rise of the Intangible Economy,* Princeton University Press.

International Monetary Fund (2017). *World Economic Outlook,* April 2017, Chapter 3 on "Understanding the Downward Trend in Labor Income Shares," Washington, DC.

Kurz, Mordecai (2018). "On the Formation of Capital and Wealth: IT, Monopoly Power and Rising Inequality," Institute of Economic Policy Research, Working Paper 17-016, Stanford University, Stanford, CA.

Lerner, Josh, and Ramana Nanda (2020). "Venture Capital's Role in Financing Innovation: What We Know and How Much We Still Need to Learn," *Journal of Economic Perspectives,* 34 (3): 237-61, Summer 2020.

Lindsey, Brink, and Steven Teles (2017). *The Captured Economy: How the Powerful Enrich Themselves, Slow Down Growth, and Increase Inequality,* Oxford University Press.

Mazzucato, Mariana (2015). *The Entrepreneurial State: Debunking Public vs Private Sector Myths,* Anthem Press.

McKinsey Global Institute (2018). *Solving the Productivity Puzzle: The Role of Demand and the Promise of Digitization,* McKinsey & Company.

McKinsey Global Institute (2015). *Digital America: A Tale of the Haves and Have-Mores,* McKinsey & Company.

Morrisson, Christian and Fabrice Murtin (2013). "The Kuznets Curve of Human Capital Inequality: 1870-2010," *Journal of Economic Inequality,* 11 (3): 283-301.

Nordhaus, William (2015). "Are We Approaching an Economic Singularity? Information Technology and the Future of Economic Growth," NBER Working Paper 21547, National Bureau of Economic Research, Cambridge, MA.

Organization for Economic Cooperation and Development (2018). *OECD Economic Outlook,* Volume 2018, Issue 2, Chapter 2 on "Decoupling of Wages from Productivity: What Implications for Public Policies?" OECD Publishing, Paris.

Philippon, Thomas (2019). *The Great Reversal: How America Gave Up on Free Markets,* Harvard University Press.

Piketty, Thomas (2014). *Capital in the Twenty-First Century,* Harvard University Press.

Qureshi, Zia (2020). "Democratizing Innovation: Putting Technology to Work for Inclusive Growth," Report, Brookings, Washington, DC.

Qureshi, Zia (2019). "The Rise of Corporate Market Power," *Up Front,* May 21, 2019, Brookings, Washington, DC.

Qureshi, Zia (2018). “Intellectual Property, Not Intellectual Monopoly,” *Project Syndicate,* July 11, 2018.

Qureshi, Zia (2016). “The Productivity Outlook: Pessimists versus Optimists,” Research Brief, Brookings, Washington, DC.

Rodrik, Dani (2020). “Democratizing Innovation,” *Project Syndicate,* August 11, 2020.

Rodrik, Dani (2015). “From Welfare State to Innovation State,” *Project Syndicate,* January 14, 2015.

Roin, Benjamin (2014). “The Case for Tailoring Patents Based on Time-to-Market’” *UCLA Law Review,* 61: 672-759.

Rose, Nancy (2020). “Will Competition be Another COVID-19 Casualty?” The Hamilton Project, Brookings, Washington, DC

Schwab, Klaus (2019). “Globalization 4.0: A New Architecture for the Fourth Industrial Revolution,” *Foreign Affairs,* January 2019.

Schwab, Klaus (2016). *The Fourth Industrial Revolution,* World Economic Forum, Geneva.

Schwellnus, Cyrille, Mathilde Pak, Pierre-Alain Pionnier, and Elena Crivellaro (2018). “Labor Share Developments over the Past Two Decades: the Role of Technological Progress, Globalization and “Winner-Takes-Most” Dynamics,” Economics Department Working Paper, No. 1503, OECD Publishing, Paris.

Shambaugh, Jay, Ryan Nunn, and Becca Portman (2017). “Eleven Facts about Innovation and Patents,” The Hamilton Project, Brookings.

Song, Jae, David Price, Faith Guvenen, Nicholas Bloom, and Till von Wachter (2019). “Firming Up Inequality,” *Quarterly Journal of Economics,* 134 (1): 1-50.

Stansbury, Anna, and Lawrence Summers (2018). “Productivity and Pay: Is the Link Broken?” Working Paper No. 18-5, Peterson Institute for International Economics, Washington, DC.

Stigler Committee on Digital Platforms (2019). *Final Report,* University of Chicago Booth School of Business, September 2019.

Sundarajan, Arun (2016). *The Sharing Economy: The End of Employment and the Rise of Crowd-Based Capitalism,* MIT Press.

Tepper, Jonathan (2019). *The Myth of Capitalism: Monopolies and the Death of Competition,* Wiley & Sons.

Webb, Michael (2020). “The Impact of Artificial Intelligence on the Labor Market,” Economics Department paper, Stanford University, Stanford, CA.

United Nations (2019). *Human Development Report 2019: Beyond Income, Beyond Averages, Beyond Today - Inequalities in Human Development in the 21st Century,* New York

West, Darrell (2018). *The Future of Work: Robots. AI, and Automation,* Brookings Institution Press.

West, Darrell, and John Allen (2020). *Turning Point: Policymaking in the Era of Artificial Intelligence,* Brookings Institution Press.

Wheeler, Tom, Phil Verveer, and Gene Kimmelman (2020). *New Digital Realities; New Oversight Solutions in the U.S. – The Case for a Digital Platform Agency and a New Approach to Regulatory Oversight,* Harvard Kennedy School, August 2020.

World Bank (2020). *Global Productivity: Trends, Drivers, and Policies*, Alistair Dieppe (Ed.), World Bank, Washington, DC.

World Bank (2019). *The Changing Nature of Work: World Development Report 2019,* Washington, DC.

World Bank (2018). *Global Economic Prospects: Broad-Based Upturn, but for How Long?* January 2018, Washington, DC.

World Economic Forum (2019). *Globalization 4.0: Shaping a New Global Architecture in the Age of the Fourth Industrial Revolution,* White Paper, Geneva.

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