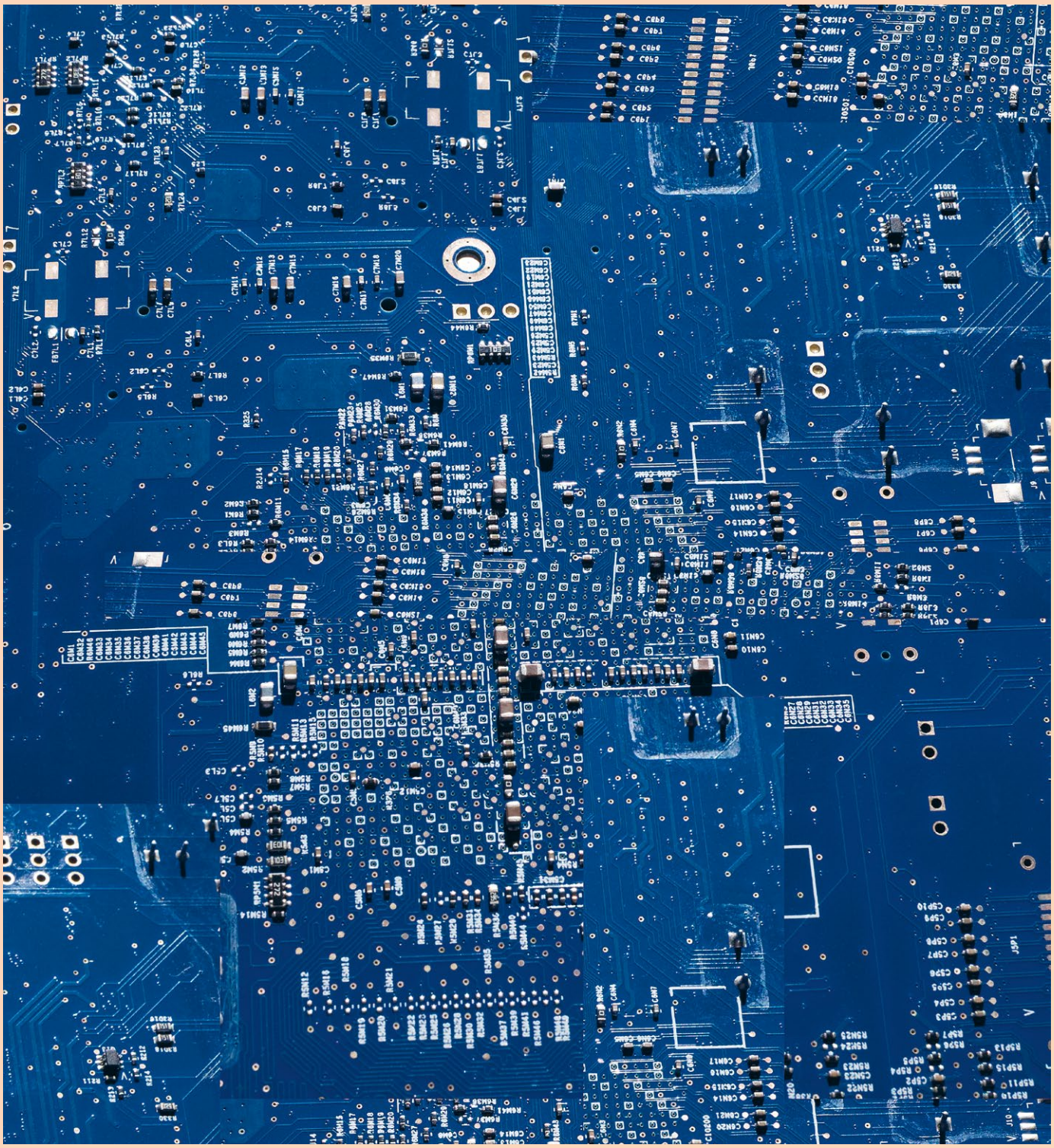
WORK IN THE AGE OF DATA



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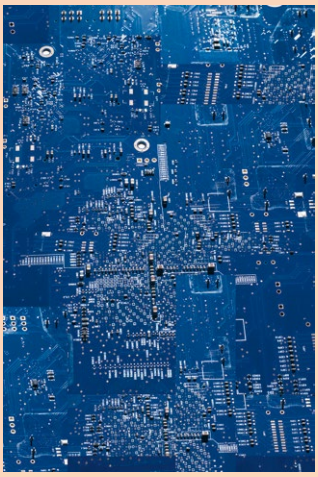

Work in the Age of Data
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Work in the Age of Data

It is an honor for me to present *Work in the Age of Data*, the twelfth book in the annual series published by OpenMind.

OpenMind (www.bbvaopenmind.com) is an online community created by BBVA in 2011 in response to the excellent reception of our first two books. It is a completely altruistic, autonomous initiative with a mission to disseminate the best available knowledge on the key issues of our time; those issues that concern us all, affect our day-to-day life, and determine our future.

To this end, we work with a large and ever-growing collection of authors and contributors (currently more than three hundred), leading academics and experts whose articles are published in both Spanish and English, and made available free of charge in various formats.

OpenMind's aim is to give voice to relevant opinions and initiatives and to be a benchmark source of information accessible for its growing audience. In 2019, OpenMind will receive over ten million visits from users all around the world. The members of this community interact through the website and the principal social media platforms, on which OpenMind already has over 215,000 followers.

All the books have followed the same model, one which has proved very successful: they are compilations of articles in which various authors—prominent figures in their respective fields—address a range of topics from different perspectives, such as the advances in science and technology, globalization and the social changes and ethical problems they give rise to, as well as their impact on politics, the economy, business, culture, communication, and everyday life.

In this undertaking we always strive to be as objective as possible, pointing out risks but also highlighting the opportunities that open up to us, and proposing ways for these opportunities to materialize.

In recent years, we have focused on the digital revolution and its impact. This is in line with BBVA's purpose "to bring the age of opportunity to everyone."

The exponential increase in data processing, transmission, and storage capacity brought about by the digital revolution, and the concomitant reduction in costs per unit, marks the start of a new era: the "age of data." We are in the midst of a period of rapid transformation, in the economy, society, and our way of life. And these changes are having particularly far-reaching effects on the world of work.

The changes that we are already seeing in this key aspect of the economy and of people's lives, added to uncertainty about the future impact of technologies, such as artificial intelligence, are attracting increasing attention from governments, multilateral agencies, regulators, and businesses worldwide.

Work in the Age of Data addresses this issue through articles by nineteen leading international experts, whom I take this opportunity to thank for their invaluable collaboration and for their support of OpenMind.

This book sets out firstly to review the effects of the digital revolution on growth, income distribution, productivity, and investment, which have important consequences for the labor market around the world.

In addition, it analyzes the fundamental changes in the structure of the labor market itself, such as the polarization of employment growth (the growth of employment in the upper and lower segments of the market to the detriment of the middle segments) that contributes to increasing inequality, and the recent boom in alternative forms of work, which have collectively come to be known as the "gig economy."

Finally, the book seeks to encourage analysis and discussion of the individual and collective decisions we must make in order to achieve a fairer, more efficient, and more productive labor market in the age of data. It concludes with a reflection on the major global challenges that we must overcome to ensure that technology's enormous potential does, in fact, result in improved working conditions and greater well-being for society as a whole.

To conclude, the transformation we need to bring about is radical and very complex. But the alternative is a more unequal and unstable world, in which we would also be wasting precious time and energy to use technology as a decisive tool for solving the major problem we all share: the growing threat to the sustainability of the planet.

Carlos Torres Vila, Chairman, BBVA

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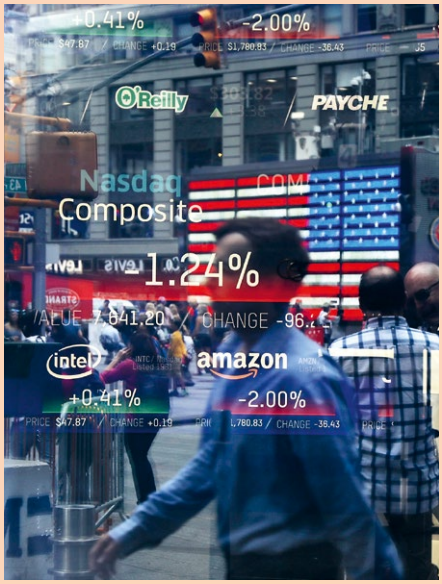
What's Happening with the Global Economy?



People are reflected in the window of the Nasdaq MarketSite in Times Square, New York City, 2018

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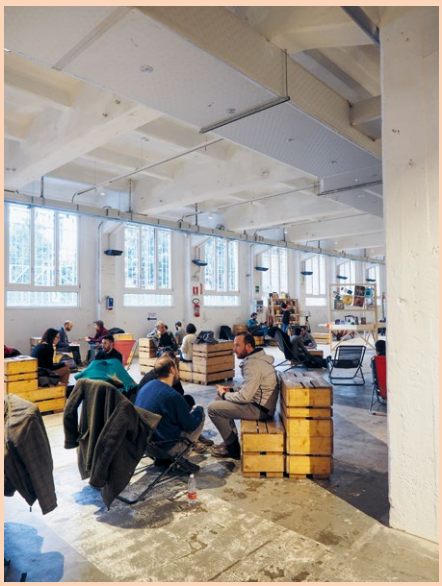
What's Happening in the World of Work?



Interactive and coworking multispace, Milan

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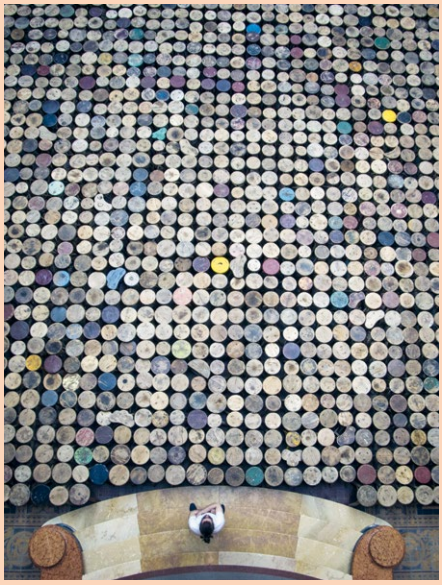
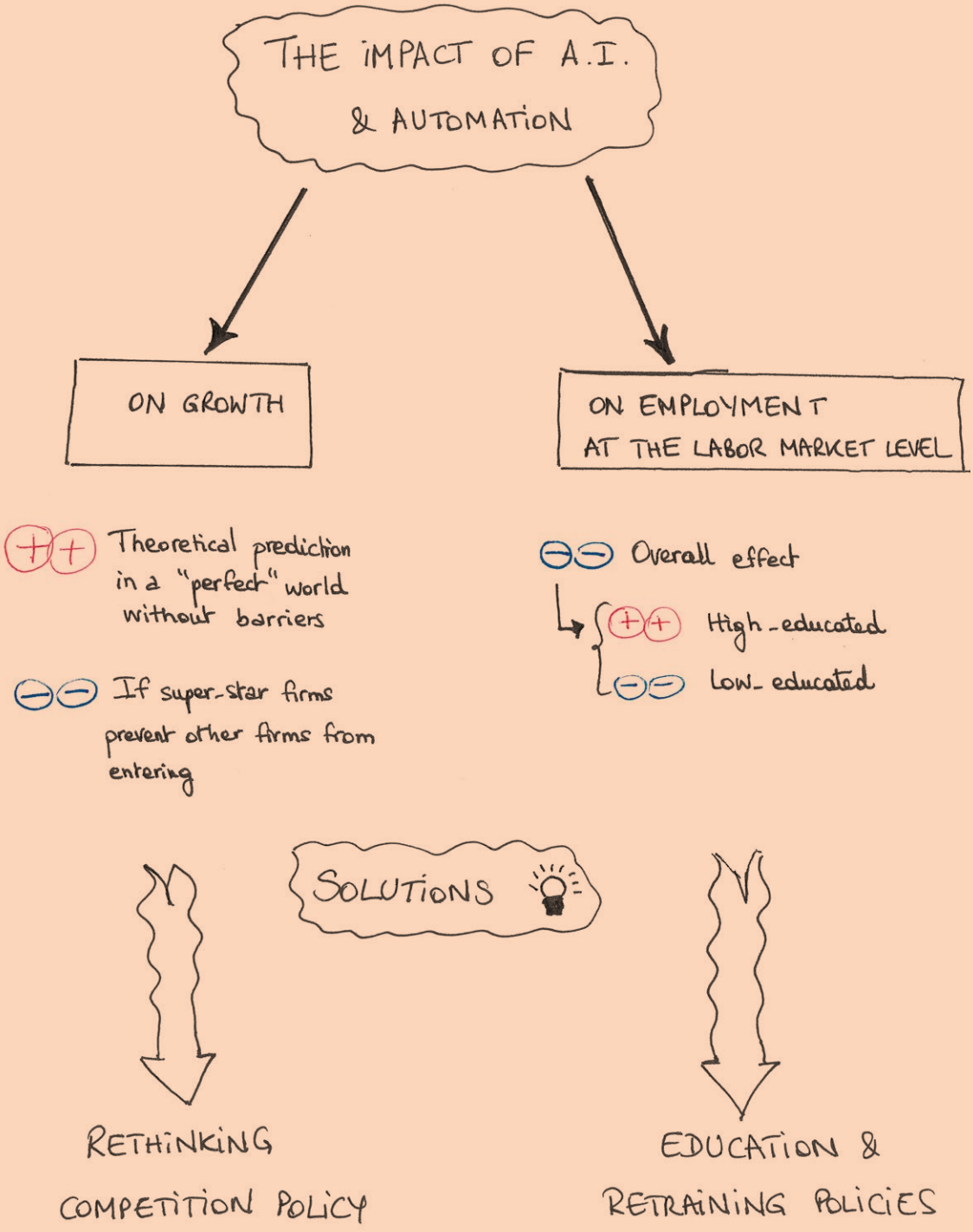
What to Do about All This?



A worker looks at the installation titled *Stools*, made of wooden stools by Chinese artist Ai Weiwei as part of the exhibition *Evidence* at the Martin-Gropius-Bau museum in Berlin, 2014


THE IMPACT OF A.I. & AUTOMATION
ON GROWTH
ON EMPLOYMENT AT THE LABOR MARKET LEVEL
++ Theoretical prediction in a "perfect" world without barriers
-- If super-star firms prevent other firms from entering
-- Overall effect
++ High-educated
-- Low-educated
SOLUTIONS
RETHINKING COMPETITION POLICY
EDUCATION & RETRAINING POLICIES

On the Effects of AI on Growth and Employment

Philippe Aghion, Céline Antonin, and Simon Bunel

In this paper, we argue that the effects of artificial intelligence (AI) and automation on growth and employment depend to a large extent on institutions and policies. In the first part of the paper we survey the most recent literature to show that AI can spur growth by replacing labor by capital, both in the production of goods and services and in the production of ideas. However, AI may inhibit growth if combined with inappropriate competition policy. In the second part of the paper we discuss the effect of robotization on employment in France over the 1994–2014 period. Based on our empirical analysis on French data, we first show that robotization reduces aggregate employment at the employment zone level, and second that noneducated workers are more negatively affected by robotization than educated workers. This finding suggests that inappropriate labor market and education policies reduce the positive impact that AI and automation could have on employment.

This paper borrows unrestrainedly from our article on AI and economic growth, published in *Economics and Statistics* (Aghion et al., 2019).

Introduction

Artificial Intelligence (AI) is typically defined as the capability of a machine to imitate intelligent human behavior. True, since 1820 our economies have seen several technological revolutions which resulted in the automation of tasks previously performed by labor. First came the steam engine revolution in the eighteenth century, then the combustion engine revolution in the early twentieth century and then the semiconductor and IT revolutions in the 1970s–1980s. However, AI goes one step further by automating tasks such as driving a car, providing medical advice or playing chess games, which we thought could never be automated.

Now, if one were asked what the effects of AI on growth and employment should be, at first glance the answer would be: AI is good for growth as it fosters productivity but bad for employment as it replaces labor by machines. Yet, in this survey we shall argue that the matter is more complicated, and that the effects of AI on growth and employment crucially depend upon the institutional and policy environment.

Let us first consider the effect of AI on growth. Since the financial crisis of 2008, secular stagnation, that is, the prospect of a durable decline in productivity growth, has become a source of concern for economists and policy advisers. One response to the pessimistic view held by Robert Gordon (see Gordon, 2012) is that the AI revolution will come to our rescue and put us back on a sustained growth path. Indeed, AI can spur growth by replacing labor, which is in finite supply, by capital, which is in unbounded supply, both in the production of goods and services and in the production of ideas. However, we will report on recent work suggesting that AI may end up inhibiting growth if combined with inappropriate institutions, in particular with inappropriate competition policy.

Similarly, we will argue that the AI revolution does not necessarily have a negative impact on employment. First, the aggregate employment impact of automation appears to be positive on skilled labor. Second, those plants that automate end up increasing employment, which suggests that labor market frictions should lie at the heart of any negative correlation one might find between automation and aggregate employment. This in turn points to the importance of education and labor market policies in determining the effect of automation on aggregate employment.

The remaining part of the paper is organized as follows: section 2 discusses the effects of AI on growth; section 3 looks at the effects of AI and automation on employment; and section 4 concludes.

1. Does AI always Boost Economic Growth?

In this section we develop two main points. First, AI has the potential to boost economic growth. Second, with inappropriate institutions, and in particular with inappropriate competition policy, AI may slow down economic growth.

1.1 Why AI Boosts Economic Growth

The simplest model which illustrates how AI can boost economic growth, is the model by Zeira (1998). Here we present a simple version of the Zeira model developed in Aghion, Jones, and Jones (2017). Assume that final output is produced according to the Cobb-Douglas technology:

$$Y=AX_1^{\alpha 1}.X_2^{\alpha 2}\dots X_n^{\alpha n}$$

where $\Sigma\alpha_i=1$ and intermediate inputs X_i are produced according to:

$$X_i=\begin{cases}L_i & \text{if not automated}\\ K_i & \text{if automated}\end{cases}$$

While Zeira thought of the X_i as intermediate goods, these can also be viewed as tasks (Acemoglu and Autor, 2011). Hence, tasks that have not yet been automated are produced one-for-one by labor. Once a task is automated, one unit of capital can be used instead of labor (Aghion, Jones, and Jones, 2017). Automation spurs economic growth as it replaces labor, which is in finite supply, by capital, which is in unbounded supply, as the basic production input. Indeed, letting K and L denote aggregate capital stock and labor supply respectively, we can express the above equation for final good production as:

$$Y=AK^{\alpha}L^{1-\alpha}$$

where α reflects the overall share of tasks that have been automated.

Hence the rate of growth of per capita GDP (i.e., of $y=Y/L$) is equal to:

$$g_y=\frac{g_A}{1-\alpha}$$

Automation (e.g., as resulting from the AI revolution) will increase α, which in turn will lead to an increase in g_y, that is, to an acceleration of growth. One issue with this model, however, is that it predicts a rise in capital share, which in turn contradicts the so-called Kaldor fact that the capital share tends to be stable over time.

1.2 New Tasks Replacing Old Tasks

Acemoglu and Restrepo (2016) extend Zeira (1998) by assuming that final output is produced by combining the services of a unit measure of tasks $X\in[N-1, N]$, according to the CES technology:

$$Y=\left(\int_{N-1}^{N}X_i^{\sigma-1/\sigma}\,di\right)^{\sigma/1-\sigma}$$

where: (i) tasks X_i with $i>I$ are nonautomated, produced with labor alone; (ii) tasks X_i with $i<I$ are automated, that is, capital and labor are perfect substitutes in producing X_i; (iii) σ denotes the elasticity of substitution between tasks.

The dynamics of I and N (i.e., the automation of existing tasks and the discovery of new lines) results from endogenous directed technical change. Under reasonable parameter values guaranteeing that innovation is directed toward using the cheaper factor, there exists a unique and (locally) stable Balanced Growth Path (BGP) equilibrium. Stability of this BGP follows from the fact that an exogenous shock to I or N will trigger forces which bring the economy back to its previous BGP with the same labor share: the basic intuition is that if a shock leads to too much automation, then the decline in labor costs will encourage innovation aimed at creating new (more complex) tasks which exploit cheap labor.

What makes the capital share remain constant on this BGP, is the fact that the automation of existing tasks is exactly offset by the creation of new tasks which require labor, at least initially. Note that the constancy of the capital share relies entirely on the continuous arrival of new labor-intensive tasks. The model by Aghion, Jones, and Jones (2017), which also extends Zeira (1998), proposes an alternative explanation for the constancy of the capital share and to reconcile AI with the possibility of a constant growth rate in the long run.

1.3 AI and the Baumol's Cost Disease

In the following model by Aghion, Jones, and Jones (2017), it is the complementarity between existing automated tasks and existing labor-intensive tasks, together with the fact that labor becomes increasingly scarcer than capital over time, which allows for the possibility that the capital share and the growth rate both remain constant over time.

More formally, final output is produced according to:

$$Y_t=A_t\left(\int_0^I X_{it}^{\rho}\,di\right)^{1/\rho}$$

where $\rho<0$ (i.e., tasks are complementary), A is knowledge and grows at constant rate g and, as in Zeira (1998):

$$X_{it}=\begin{cases}L_{it} & \text{if not automated}\\ K_{it} & \text{if automated}\end{cases}$$

Letting β_t denote the fraction of tasks that have been automated by date t, the above aggregate production function can be rewritten as:

$$Y_t=A_t\,(\beta_t^{1-\rho}\;K_t^{\rho}+(1-\beta_t)^{1-\rho}\;L^{\rho})^{1/\rho}$$

where K_t denotes the aggregate capital stock and $L_t\equiv L$ denotes the aggregate labor supply.

In equilibrium, the ratio of capital share to labor share is equal to:

$$\frac{\alpha_{Kt}}{\alpha_L}=\left(\frac{\beta_t}{1-\beta_t}\right)^{1-\rho}\left(\frac{K_t}{L_t}\right)^{\rho}$$

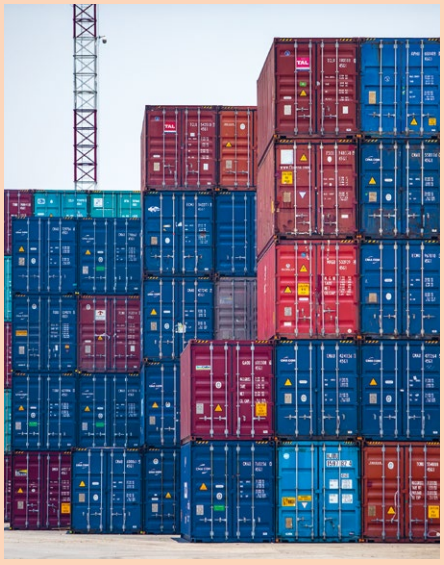
Hence an increase in the fraction of automated goods β_T has two offsetting effects on α_{Kt}/α_L: (i) first, a direct positive effect which is captured by the term $(\beta_t/1-\beta_t)^{1-\rho}$; (ii) second, a negative indirect effect captured by the term $(K_t/L_t)^{\rho}$ as we recall that $\rho<0$. This latter effect relates to the well-known Baumol's cost disease: namely, as K_t/L_t increases as a result of automation, labor becomes scarcer than capital which, together with the fact that labor-intensive tasks are complementary to automated tasks (indeed we assumed $\rho<0$), implies that labor will command a sustained share of total income.

What about long-run growth in this model? Let us first consider the case where a constant fraction of not-yet-automated tasks become automated each period, that is:

$$\dot{\beta}=\theta(1-\beta_t)$$

In this case, one can show that the growth

AI may end up inhibiting growth if combined with inappropriate institutions, in particular with inappropriate competition policy



Export freight containers with Mexican-produced goods are seen ready to be shipped to the US in the Pantaco customs complex on June 7, 2019, in Mexico City

rate converges toward a constant in the long run.

Next, let us consider the case where all tasks become automated in finite time, that is, where $\beta_t \equiv 1$ for $t>T$. Then, for $t>T$ aggregate final good production becomes:

$$Y_t = A_t K_t$$

so that, if capital accumulates over time according to:

$$\dot{K} = sY - \delta K$$

we get a long-run growth rate equal to:

$$g_Y = g_A + sA - \delta$$

which increases unboundedly over time as A grows at the exponential rate g_A.

1.4 AI in the Production of Ideas

Aghion, Jones, and Jones (2017) also consider the case where automation affects the production of knowledge. Namely they consider an economy where final output is produced with labor:

$$Y_t = A_t L_t$$

but where automation affects the growth of A_t:

$$\dot{A} = A_t^{\varphi} \left(\int_0^1 X_{it}^{\rho} \, di \right)^{1/\rho}$$

where, as before, $\rho<0$ and

$$X_{it} = \begin{cases} L_{it} & \text{if not automated} \\ K_{it} & \text{if automated} \end{cases}$$

Letting β_t denote the fraction of "idea-generating" tasks that have been automated by date t, then the knowledge growth equation *supra* becomes:

$$\dot{A} = A_t^{\varphi} \left(\beta_t^{1-\rho} K_t^{\rho} + (1-\beta_t)^{1-\rho} L^{\rho} \right)^{1/\rho}$$

Let us first consider the case where a constant fraction of not-yet-automated tasks become automated at each period, that is:

$$\dot{\beta} = \theta (1 - \beta_t)$$

In this case, one can show that:

$$g_y = g_A = -\frac{1-\rho}{\rho} \frac{\theta}{1-\varphi}$$

so that, even though we assume decreasing returns to knowledge accumulation as in Jones (1995)—that is, $\varphi>0$—automation in the production of ideas maintains a positive long-run growth rate of (per capita) GDP.

Now consider the case where all tasks become automated in finite time, that is, where $\beta_t \equiv 1$ for $t>T$. Then, for $t>T$ the growth of knowledge satisfies the equation:

$$\dot{A} = A_t^{\varphi} K_t$$

where:

$$\dot{K} = sY - \delta K$$

In this case Aghion, Jones, and Jones show that $A_t = Y_t/L$ becomes infinite in finite time. This extreme form of explosive growth is referred to as a "singularity."

1.5 Why IT or AI can Generate a Growth Decline

We have not observed a surge in growth as predicted by the above models with AI, but quite the opposite: TFP growth has been sharply declining in the US since 2008, and so has the rate of new firm creation or intangible investments. At the same time, we have observed an increase in the average markup and in the degree of sales or employment concentration.

Aghion et al. (2019) propose the following explanation. Suppose that there are two main sources of heterogeneity across firms in the economy. The first one is "product quality" which improves as a result of innovation on each product line. But on top of product quality, some firms—call them "super-star" firms—may enjoy a persistent "efficiency advantage" over other firms. Natural sources of such an advantage are the organizational capital, the development of networks, or the ability to escape taxation: these help super-star firms to enjoy higher markups than non-super-star firms with the same level of technology. The story developed by Aghion et al. (2019) is that a technological revolution, by reducing the firms' cost of monitoring each individual activity, will induce all firms to expand their range of activities. However, since super-star firms enjoy higher profits on each product line than non-super-star firms with the same level of technology, the former will end up expanding at the expense of the latter. But this, in turn, will deter innovation by non-super-star firms, as innovating on a line where the incumbent firm is a super-star firm

always yields lower profits than innovating on a line where the incumbent firm is a non-super-star firm. Thus, overall, the technological revolution can result in lower aggregate innovation and lower average productivity growth in the long run, following an initial burst of growth associated with the expansion of super-star firms into more product lines.[1]

This can explain why productivity growth in the US has declined continuously since 2005, after a burst of growth between 1995 and 2005, in the wake of the AI revolution following the IT revolution. Moreover, it also accounts for the fact that, over the past decade, the average markup has markedly increased in the US, and why this was mostly due to a composition effect: namely, the share of higher-markup firms in the economy has gone up, but markups within firms have not shown any significant upward trend.

This explanation illustrates the fact that technological revolutions like IT or AI may end up having adverse effects on productivity growth if the appropriate institutions are missing. Indeed, it is the combination of the IT revolution and the absence of appropriate competition rules that has made it possible for super-star firms to expand boundlessly, thereby discouraging innovation and entry by non-super-star firms. Here we have particularly in mind the absence of M&A regulations or the fact that super-star firms are under no obligation to share their data success with other firms. The challenge is then to rethink competition policy so that the IT and AI revolutions can fully deliver on their growth promises.

Having stressed the importance of appropriate institutions and policies for turning IT and AI into a growth opportunity, in the next session we look at the impact of AI on employment, where, again, institutions and policies matter: there we have in mind education and labor market policies.

2. Automation and Employment

2.1 A Brief Survey of the Existing Literature

Since AI is only in its infancy, empirical job data with hindsight are not available yet. It is therefore impossible for now to deliver a serious message on the potential impact of AI on employment. Hence, empirical studies have focused on automation in a broad sense and on its impact on employment. Several consequences of automation have been highlighted:

- an increase in the wage gap due to a better return on education (Katz and Murphy, 1992; Krueger, 1993; Autor et al., 1998; Bresnahan et al., 2002; Acemoglu, 2002; Autor and Dorn, 2013);
- an increase of unemployment: technological unemployment increases (Lucas and Prescott, 1974; Davis and Haltiwanger, 1992; Pissarides, 2000), manufacturing and routine jobs disappear because of automation (Jaimovich and Siu, 2012);
- the over-qualification of workers: Beaudry et al. (2013) show that there is less demand for qualified workers, who are therefore "forced" to accept underqualified jobs, while non-qualified workers may be kicked out of the labor market;
- the polarization of the labor market. Automation would give rise to more high-skilled and low-skilled jobs, while crowding out medium-skilled jobs (Goos and Manning, 2007). Autor and Dorn (2013) focus on the structural change in the labor market: middle-income jobs in the manufacturing sector would be replaced by low-income jobs in the service sector, which are less threatened by automation.

Some authors have tried to be prospective and to go beyond the scope of "traditional" automation by questioning the feasibility of automating jobs given current and presumed technological advances. They notably relax the assumption according to which automation could not threaten nonroutine jobs. Whereas Autor et al. (2003) argued that nonroutine tasks, such as legal writing, truck driving, medicine, selling, could not be substituted, this view has been questioned by Brynjolfsson and McAfee (2011) who advocate that automation is no longer limited to routine tasks, recalling the example of self-driving cars. Frey and Osborne (2017) have followed this path and shown that automation can also affect nonroutine tasks like legal writing or truck driving. Frey and Osborne (2017) have estimated the probability of computerization[2] of 702 jobs, in order to analyze which ones were at risk, and to investigate the relationship between the probability of computerization, wages, and educational level. Their main conclusion has showed that 47% of employment in the US is at risk of automation in the next ten or twenty years, whereas only 33% of jobs have a low risk of automation. Their method is based on assessments from AI experts on the scope for automation in occupations across seventy jobs, and extended to other jobs according to their main features thanks to a probabilistic scoring method. They have also showed that there is a strong negative relationship between, on the one hand, wages and educational attainment and, on the other, the probability of computerization.

Frey and Osborne have been under harsh criticism: they condone the task content of the jobs, and do not factor in the variability of a specific occupation across workplaces. Yet, automation would put at risk some tasks rather than an entire job, therefore their method would overestimate job destruction. Arntz et al. (2017) show that when factoring in the heterogeneity of tasks within occupations, only 9% of all workers in the US face a risk of automation that exceeds 70%. Frey and Osborne also do not take account of the legal and ethical barriers which could prevent some job destruction. Lastly, their method does not integrate the response of the economy in a general equilibrium model, that is, the cost of automation, the response of wages, and the creation of new jobs. Despite technological advances, the cost of substitution between machines and labor could prevent firms from automating rapidly, especially if wages adapt. Moreover, other activities could develop and hire the redundant workers. Therefore, being prospective without reasoning in a general equilibrium pattern seems very unrealistic. Thereupon, Hemous and Olsen (2014) provide the first dynamic model to analyze the interaction between automation and the creation of new products and tasks.

2.2 Automation and Employment in the US

Getting an accurate measure of automation is crucial, and this is what recent studies have tried to do. Earlier studies were based on the measure of computers or IT (Krueger, 1993; Autor et al., 1998, Bresnahan et al., 2002), whereas recent papers investigate other measures of automation like automation-related patents (Mann and Püttmann, 2017), or the number of robots (Autor and Dorn, 2013; Acemoglu and Restrepo, 2017; Dauth et al., 2017; Graetz and Michaels, 2018; Cheng et al., 2019). As regards the impact of robots on net employment, evidence is mixed. Chiacchio et al. (2018) report negative effects—one

more robot per thousand workers reduces the employment rate in six EU countries by 0.16–0.20 percentage points. Yet, Autor et al. (2015) and Graetz and Michaels (2018) find no effect of automation on aggregate employment. On German data, Dauth et al. (2017) find no evidence that robots cause total job losses, but they show a significant negative effect on employment in the manufacturing industry: each additional robot per thousand workers reduces aggregate manufacturing employment-to-population ratio by 0.0595 percentage points.

In their paper "Robots and Jobs: Evidence from US Labor Markets," Acemoglu and Restrepo (2017) analyze the effect of the increase in industrial robot usage between 1990 and 2007 on US labor markets. They answer this question using within-country variation in robot adoption. They notably show that, for each labor market, the impact of robots on jobs may be estimated by regressing the change in employment and wages on the exposure to robots and finally find that one more robot per thousand workers reduces the employment-to-population ratio by about 0.37 percentage point and wage growth by 0.73 percent.

In detail, Acemoglu and Restrepo focus on the 722 commuting zones covering the US continental territory. For each commuting zone, they gather employment and wage data, and build a measure of the exposure to robots. Then they run regressions on all commuting zones, in order to investigate the impact of this exposure on the change in employment and the change in aggregate wages, that is, to estimate the following relationships:

$$\begin{cases} dlnL_c = \beta_L . US\ exposure\ to\ robots_c + \varepsilon_c^L \\ dlnW_c = \beta_W . US\ exposure\ to\ robots_c + \varepsilon_c^W \end{cases}$$

Data on robots are provided by the International Feder-ation of Robotics (IFR), which gathers sales data from robot producers worldwide, the destination of sales, and their classification by industrial sector. The IFR defines a robot according to an ISO standard, as "an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications." The main feature lies in the autonomy of the robot to perform tasks. From these data, they deduce the stock of robots by country and by year from 1993 on,[3] but only on a country—or a group of countries—scale. The IFR provides data on the stock of robots for nineteen employment categories.

Acemoglu and Restrepo (2017) build a local index, which is based on the rise in the number of robots per worker in each industry and on the local distribution of labor between different industries.

For each commuting zone, the index measuring the exposure to robots between 1990 and 2007 is constructed in a similar way as the index measuring the exposure to Chinese imports, which has been developed by Autor, Dorn, and Hanson (2013). The main idea underpinning this index is to exploit the variation in local industry employment structure before the period of interest, in order to spread a variable (robots, imports, etc.) which is only available at the national level. The measure used in the paper to measure the robot exposure at the commuting zone level is:

$$US\ robot\ exposure\ 1993\_2007_c = \sum_{i \in I} l_{ci}^{1970} = \left(\frac{R_{i,2007}^{US}}{L_{i,1990}^{US}} - \frac{R_{i,1993}^{US}}{L_{i,1990}^{US}} \right)$$

The sum runs over all the nineteen industries i in the IFR data. l_{ci}^{1970} stands for the 1970 share of employment in industry i for a given commuting zone i. R_i and L_i stand for the stock of robots and the number of people employed in a particular industry i.

The variation of robot exposure between commuting zones is then used in order to explain the observed evolution of employment and wages. Several controls are included in the regressions. An important feature is to take into account changes in trade patterns. Acemoglu and Restrepo therefore use data from Autor, Dorn, and Hanson (2013) to construct measures of the exposure to imports from Mexico. Another feature is controlling for growth of capital stock (other than robotics) and growth of IT capital. Other controls include the share of employment in routine jobs in 1990, a measure of offshoring of intermediate inputs, baseline differences in demographics in 1990, baseline shares of employment in manufacturing, durable manufacturing and construction, as well as the share of female employment in manufacturing.

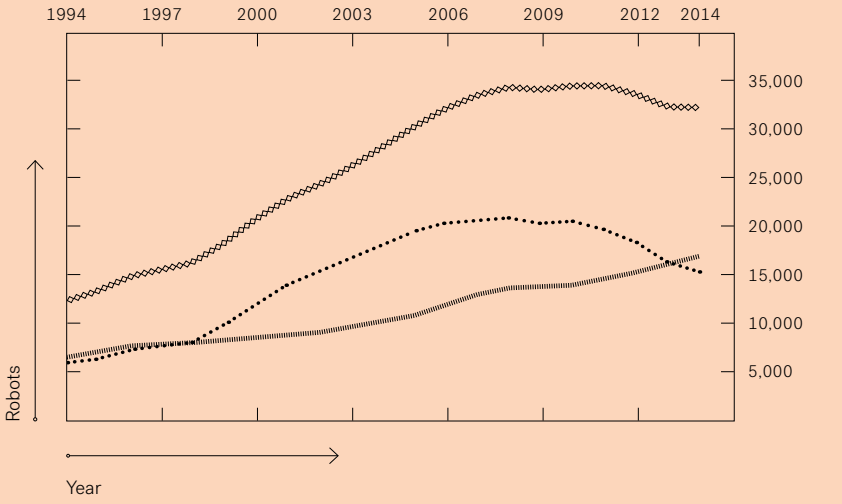


Fig. 1. Evolution of the number of robots in France (1994–2014)

(Source: International Federation of Robotics)

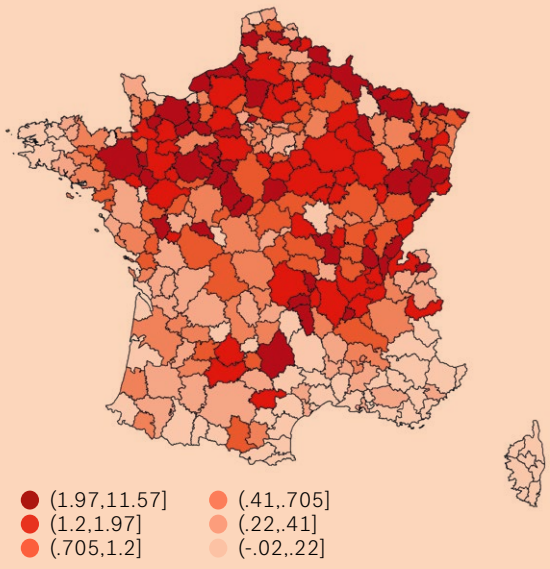


Fig. 2. Exposure to robots in France (1994–2014)

(Source: authors' calculations)

A major concern with this empirical strategy is that the adoption of robots in a given US sector could be related to other trends in that sector. Therefore, Acemoglu and Restrepo adopt an instrumental variable strategy, using the exogenous exposure to robots in selected advanced European countries as a proxy for the world technology frontier of robots. The main result is that the commuting zones which are the most exposed to robots have experienced the worst evolutions in terms of employment and in terms of wages between 1990 and 2007.

In their main specification, Acemoglu and Restrepo (2017) estimate that each additional robot per thousand workers reduces aggregate employment-to-population ratio by 0.37 percentage points and aggregate hourly wages growth by about 0.73 percent. Adding control variables such as Chinese and Mexican import volumes, the share of routine jobs and offshoring has little impact on the estimates. Excluding the commuting zones with the highest exposure to robots does not change the magnitude of the estimates. Therefore, their results are not solely driven by highly exposed areas.

2.3 Automation and Employment in France

We reproduce the method developed by Acemoglu and Restrepo (2017) on French data over the 1994–2014 period.

Figure 1 plots how the number of robots evolved in France from 1994 to 2014. Data on robots are provided by the IFR. The overall number of robots grows steadily between 1994 and 2007, then stagnates from 2007 to 2011, and finally slightly decreases between 2012 and 2014.

Following Acemoglu and Restrepo (2017) and Dauth et al. (2017), we define the exposure to robots in a French employment zone[4] between 1994 and 2014:

$$US\ Robot\ exposure\ 1994\_2014_c = \sum_{i \in I} \frac{L_{ic,\ 1994}}{L_{c,\ 1994}} \left(\frac{R_{i,\ 2014}}{L_{i,\ 1994}} - \frac{R_{i,\ 1994}}{L_{i,\ 1994}} \right)$$

where $L_{ic,\ 1994}$ refers to employment in the employment zone c in industry i in 1994, $L_{i,\ 1994}$ refers to employment in employment zone c in 1994 and $L_{i,\ 1994}$ refers to employment (in thousands) in industry i in 1994. $R_{i,\ 1994}$ and $R_{i,\ 2014}$ respectively stand for the total number of robots in industry i in 1994 and 2014. Data on employment are obtained from the French administrative database DADS.

Our index therefore reflects the exposure to robots per one thousand workers between 1994 and 2014. Figure 2 plots the geographical distribution of the exposure to robots. The average exposure in France is 1.16 between 1994 and 2014, well below the average exposure in Germany of 4.64 during the same period. This exposure is also more homogeneous in France, with a standard deviation of 1.42 versus 6.92 in Germany. The order of magnitude of exposure to robots in France is closer to the exposure in the United States between 1993 and 2007. Figure 2 shows a fairly marked north/south divide in France. Indeed, while the north has high exposure rates, most southern employment zones have exposures close to 0. The northeast, with a strong industrial heritage, but also the west (Normandy and eastern Brittany) are among

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RobotsExposure $_{1994\text{-}2014}$	-1.090*** (0.253)	-0.749*** (0.263)	-0.594** (0.239)	-0.515** (0.243)	-0.549* (0.294)	-0.398 (0.244)	-0.430 (0.324)
TICEExposure $_{1994\text{-}2014}$		-3.099* (1.586)	-2.397 (1.594)	-2.495* (1.455)	-0.304* (1.620)	-0.165 (1.576)	-0.154 (1.588)
TradeExposure $_{1994\text{-}2014}$		-0.743*** (0.247)	-0.690*** (0.215)	-0.825*** (0.239)	-0.0857*** (0.243)	-0.123 (0.278)	-0.124 (0.280)
Demographics			Yes			Yes	Yes
Region dummies				Yes		Yes	Yes
Broad industry shares					Yes	Yes	Yes
Remove highly exposed areas							Yes
Observations	297	297	297	297	297	297	295
R-squared	0.058	0.090	0.198	0.205	0.249	0.407	0.406

Dependent variable: Change in employment-to-population ratio 1990-2014 (in % points)

Table 1. The effect of robot exposure on employment, 1990–2014, OLS estimates (Source: authors' calculations)

Demographics control variables are population share by level of education and population share between 25 and 64 years old. Broad industry shares cover the share of workers in manufacturing, agriculture, construction, retail and the share of women in manufacturing in 1994. Broad region dummies refers to the 13 metropolitan regions of France. Highly exposed areas are Poissy and Belfort-Montbéliard-Héricourt. Robust standard errors in parentheses. Levels of significance: ***p<0.01, **p<0.05, * p<0.1. Sources: IFR, COMTRADE, EUKLEMS, DADS, Census data.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RobotsExposure $_{1994\text{-}2014}$	-1.317*** (0.325)	-1.010*** (0.322)	-0.974*** (0.271)	-0.737** (0.296)	-0.790*** (0.300)	-0.686*** (0.241)	-0.986*** (0.351)
TICEExposure $_{1994\text{-}2014}$		-2.569 (1.618)	-1.699 (1.578)	-2.094 (1.444)	-0.176 (1.590)	-0.0323 (1.518)	0.101 (1.538)
TradeExposure $_{1994\text{-}2014}$		-0.670*** (0.242)	-0.589*** (0.211)	-0.773*** (0.230)	-0.110 (0.240)	-0.0922 (0.276)	-0.088 (0.279)
Demographics			Yes			Yes	Yes
Region dummies				Yes		Yes	Yes
Broad industry shares					Yes	Yes	Yes
Remove highly exposed areas							Yes
Observations	297	297	297	297	297	297	295
First-stage F statistic	53.7	29.4	24.0	25.7	25.1	23.6	46.5
R-squared	0.055	0.087	0.193	0.203	0.248	0.405	0.400

Dependent variable: Change in employment-to-population ratio 1990-2014 (in % points)

Table 2. The effect of robot exposure on employment, 1990–2014, IV estimates (Source: authors' calculations)

Demographics control variables are population share by level of education and population share between 25 and 64 years old. Broad industry shares cover the share of workers in manufacturing, agriculture, construction, retail and the share of women in manufacturing in 1994. Broad region dummies refers to the 13 metropolitan regions of France. Highly exposed areas are Poissy and Belfort-Montbéliard-Héricourt. Robust standard errors in parentheses. Levels of significance: ***p<0.01, **p<0.05, * p<0.1. Sources: IFR, COMTRADE, EUKLEMS, DADS, Census data.

the highly exposed regions. In the least exposed regions, one finds the entire Atlantic coast and the French Riviera.

In the first and most naive specification, we study the impact of exposure to robots on the evolution of employment-to-population ratio between 1990 and 2014. This ratio is constructed from census data. However, we control for other characteristics that may impact the evolution of the employment-to-population ratio. To do so, we construct two other exposure indices. First, an exposure index for information and communication technologies (ICT) *TradeExp*, built in a similar way as the exposure to robots index. The number of robots is replaced by the ICT capital stock in industry *i*. Second, we build an international trade exposure index *TradeExpr*. The number of robots is replaced by net imports from China and selected Eastern Europe countries in industry *i*. In some regressions, we also add a vector X_c of control for the employment zone *c*: demographic characteristics in 1990 (population share by level of education and population share between twenty-five and sixty-four years old), broad industry shares in 1994 and broad region dummies. Finally, we can write:

$$\Delta \frac{L_{c,\,1994}}{Pop_{c,\,1994}} = \alpha + \beta_1 RobotsExp_c + \beta_2 TradeExp_c + \beta_3 TICExp_c + \gamma X_c + \epsilon_c$$

Table 1 displays the results of the OLS regressions. This table shows a negative correlation between exposure to robots and change in employment-to-population ratio. However, the correlation becomes nonsignificant in column 6 when we include all the controls and in column 7 when we exclude the commuting zones with the highest exposure to robots. In the first five columns where the correlation is significant, the magnitude of the effect ranges between -1.090 and -0.515.

Even if these control variables partially purge OLS estimations, an instrumental variable approach is necessary to discuss causal impact of robots on employment. In fact, one may imagine a shock, which we do not capture in our controls, but which may impact both the installation of robots at local level and local labor markets' characteristics. In the instrumental variable regression shown in table 2, the coefficients of robot exposure are significant whatever the specification chosen, even the one with all the controls. Moreover, we observe that the magnitude of the effects increases in comparison with those obtained by OLS. In column 1 (regression without any control), the negative impact of exposure to robots on employment is massive: one more robot per one thousand workers leads to a drop in the employment-to-population ratio of 1.317 percentage points. When adding controls on ICT and imports exposures (column 2), there is a negative impact of net imports on employment-to-population ratio, as in Autor, Dorn, and Hanson (2013) for the United States, even though the ICT exposure coefficient is not statistically significant. The coefficient for exposure to robots remains of the same order of magnitude. Columns 3 to 5 successively test three other controls, while column 6 incorporates them simultaneously. First, column 3 adds demographic characteristics. Then, column 4 adds broad region dummies. Finally, column 5 adds broad industry share before 1994. In each specification, the coefficient of exposure to robots remains negative and significant, even if its magnitude decreases slightly. On the contrary, the coefficient of exposure to imports becomes insignificant when we add information about the industry composition of the employment zones. Finally, column 6 combines all the controls and column 7 removes highly exposed areas. The effect of the exposure to robots is still negative and significant, even though its magnitude has been reduced in comparison with the specification without any control.

In our last specification, we obtain a negative effect of exposure to robots on employment: one more robot per one thousand workers leads to a drop in the employment-to-population ratio of 0.686 percentage points. A quick calculation allows us to conclude that the installation of one more robot in a commuting zone reduced employment by 10.7 jobs.[5] The order of magnitude is similar to Acemoglu and Restrepo (2017), who found an impact of 6.2 fewer jobs for one more robot. According to the IFR, the number of robots in France increased by around 20,000 between 1994 and 2014. Our result implies a loss of 214,000 jobs (10.7*20,000) during this period due to robots.

Finally, we investigate the possibility of heterogeneous employment effects of the exposure to robots across education levels.[6] Coefficients estimation of exposure to robots on population by education level is presented in fig. 3 (with confidence intervals of 90 %). The Certificate of Professional Aptitude (CAP) and the Diploma of Occupational Studies (BEP) are both French professional education degrees. The lower the level of education, the greater the negative impact of exposure to robots. The impact is nonsignificant for people with a high-school diploma. The effect is even positive, even if slightly nonsignificant, for college graduates. This heterogeneity highlights the key role played by education and the need for public policies. In order to limit the negative effects of automation on employment, public policies should aim at raising the education level and at promoting continuous training.

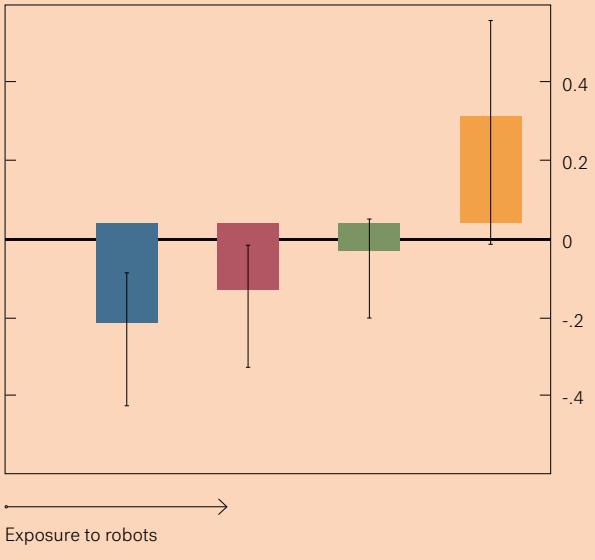


Fig. 3. The effects of robot exposure by education level
(Source: authors' calculations)

Those plants that automate end up increasing employment, which suggests that labor market frictions should lie at the heart of any negative correlation one might find between automation and aggregate employment

TFP growth has been sharply declining in the US since 2008, and so has the rate of new firm creation or intangible investments

2.4 Moving from Aggregate to Plant-Level Analysis

In current work with Xavier Jaravel, we analyze the effect of automation on employment using French plant-level and firm-level panel data. We measure automation using electricity consumption in a way that excludes heating and other fixed-cost components of energy consumption by plants. Our main preliminary findings are that: (i) more automation today raises plant-level employment in the short and long run; (ii) the increase in employment is positive for middle-skilled (specialized workers, etc.), and high-skilled workers (engineers, etc.); it remains positive but less significantly so for low-skilled employees. Another finding is that plants that automate less today are more likely to exit the market in the future. Thus, the negative correlation we found between automation and employment at the aggregate employment zone level is not so much due to automating firms laying off redundant labor; rather, it seems to reflect a business-stealing effect whereby automating firms drive out nonautomating firms.

Conclusion

In this paper, we have surveyed recent work on artificial intelligence and its effects of economic growth and employment. Our conclusion is that the effects of AI and automation on growth and employment depend to a large extent on institutions and policies.

In section 1 we argued that while AI can spur growth by replacing labor which is in finite supply by capital which is in unbounded supply, on the other hand, AI may inhibit growth if combined with inappropriate competition policy.

In section 2, we discussed the effects of AI and automation on employment: our analysis suggested that a better education system and a more effective labor market policy enhances the positive effect of automation on employment.

A natural next step would be to bridge the analysis in the two sections, by investigating how labor market characteristics affect the nature of innovation: for example, whether innovation is aimed at automation versus the creation of new lines. This and other extensions of the analyses presented in this paper await future research.

A new hybrid operating room of the IHU, Institute of Image-Guided Surgery in Strasbourg. It combines the most advanced minimally invasive surgery techniques and the latest medical imaging technologies, resulting in the most advanced surgery platform of the world



Philippe Aghion is a Professor at the Collège de France and at the London School of Economics, and a fellow of the Econometric Society and of the American Academy of Arts and Sciences. His research focuses on the economics of growth. With Peter Howitt, he pioneered the so-called Schumpeterian Growth paradigm, which was subsequently used to analyze the design of growth policies and the role of the state in the growth process. Much of this work is summarized in their joint books *Endogenous Growth Theory* (MIT Press, 1998) and *The Economics of Growth* (MIT Press, 2009), in his book with Rachel Griffith on *Competition and Growth* (MIT Press, 2006), and in his survey "What Do We Learn from Schumpeterian Growth Theory?" (joint with U. Akcigit and P. Howitt). In 2001, Philippe Aghion received the Yrjo Jahnsson Award for the best European economist under age forty-five, and in 2009 he received the John Von Neumann Award.

Céline Antonin has been working as a senior researcher at the OFCE (Sciences Po research center in economics) and a lecturer at Sciences Po since 2009. At the OFCE, she is part of the Forecasting and Analysis Department and covers a large spectrum of topics, ranging from country analysis to structural and macroeconomic issues. In addition, her current research topics include digital economy and economics of innovation. She is also a research associate at the Collège de France, where she currently studies the macro- and microeconomic impact of digital transformation on the labor market. Céline graduated from the ENSAE and Sciences Po Paris. She also holds a MSc from the Ecole Normale Supérieure and a PhD in economics from the Paris School of Economics. In 2018, she was awarded the PhD thesis special prize "Benjamin Delessert", presented by the Federation des Caisses d'épargne and the Bank of France.

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Notes

1. On the slowdown of productivity growth and its link with the rise of corporate market power and firm concentration, see also Liu et al. (2019).
2. Computerization is defined as job automation by means of computer-controlled equipment.
3. Yet, for the US, the repartition of robots is not fully detailed by manufacturing industry on the 1993–2004 period. The full detail is given from 2004 on. Outside manufacturing, the number of robots is given for six main categories: agriculture, forestry and fishing; mining; utilities; construction; education, research, and development; and services.
4. According to the official definition provided by the INSEE, an employment zone is a geographical area within which most of the labor force lives and works. It provides a breakdown of the territory adapted to local studies on employment.
5. Our exposure to robots is defined in "robots for one thousand workers." According to the OECD, the average employment-to-population ratio was 0.64 in 2014. Hence, the installation of one more robot reduced employment by (0.686/100)*1000/0.64=10.7 jobs.
6. Since we only have this kind of information for individuals between twenty-five and fifty-four years old, we restrict our analysis to this population.

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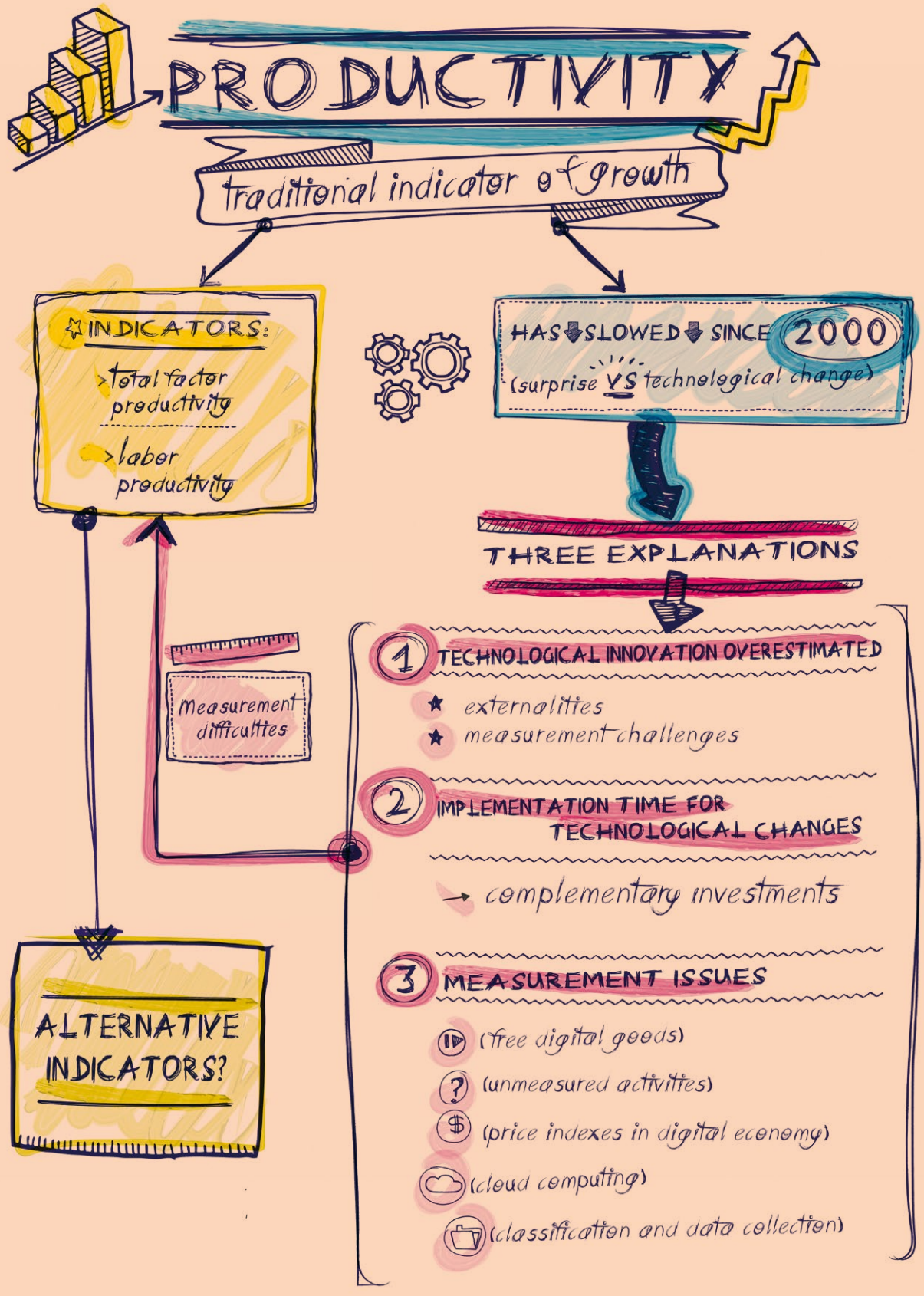
PRODUCTIVITY
traditional indicator of growth
INDICATORS:
> total factor productivity
> labor productivity
HAS SLOWED SINCE 2000
(surprise VS technological change)
THREE EXPLANATIONS
Measurement difficulties
1 TECHNOLOGICAL INNOVATION OVERESTIMATED
externalities
measurement challenges
2 IMPLEMENTATION TIME FOR TECHNOLOGICAL CHANGES
complementary investments
3 MEASUREMENT ISSUES
(free digital goods)
(unmeasured activities)
(price indexes in digital economy)
(cloud computing)
(classification and data collection)
ALTERNATIVE INDICATORS?

Measuring Productivity in the Context of Technological Change

Diane Coyle

Technological change is making it harder to interpret disappointing productivity figures in many economies. Although there are likely to be many contributory factors, such as post-financial crisis debt overhang and demographic change, technological change complicates the interpretation of the evidence in two ways. One is the delay between companies adopting new technologies and their impact on productivity because of the organizational or management changes and the complementary investments that are also needed. The other is the mismatch between how official GDP and productivity figures are defined and the character of the digital economy, such as zero price, advertising-funded services, or the switch to cloud computing. A more fundamental question is whether "productivity" is a useful concept in economies consisting to such a large extent of services and intangibles.

Productivity matters because over the long run it is the measure of how much more effectively a society can turn its available resources into valued goods and services. Stated in this general way, it is the ultimate indicator of progress; and, indeed, productivity growth at "modern" rates significantly above zero began with the Industrial Revolution. However, measuring productivity is not straightforward, and linking its behavior to the underlying drivers still less so. Since the mid-2000s there has been a slowdown in trend productivity growth in many OECD economies, often described as the "productivity puzzle" precisely because its causes are not understood—and particularly because the pace of innovation in fields including digital, biomedicine, and materials appears to be at last as rapid as ever (fig. 1).

The standard approach is "growth accounting," the attribution of real terms of GDP growth to growth in measured inputs of capital and labor and a residual, known as multifactor or total factor productivity (TFP) growth.[1] TFP is where technological progress, innovations enabling more output for the same inputs, ought to show up. However, the measured residual also includes the effects of failing to measure all inputs well, or omitting some of them. Over time the measurement of capital and labor inputs has become more sophisticated, with adjustments for the skill level of workers, for example, or the introduction of some types of intangible capital. These improvements chip away at the unexplained residual, which Moses Abramovitz famously labeled "the measure of our ignorance."[2] For example, a recent literature has identified the importance of management quality for productivity at the firm level.[3] If it were possible to include an aggregate measure of national management quality in the growth accounting exercises, as a form of intangible capital, this would reduce measured TFP.

Its residual character thus makes TFP somewhat unintuitive. A more intuitive, and more easily measured, alternative is labor productivity. This is simply real GDP per hour worked. It also makes it easier to see the role of technology, as embodied in capital equipment. For example, a construction worker becomes more productive not by digging faster with a shovel or taking fewer rest breaks, but by having a mechanical digger to work with instead. So we should

Since the mid-2000s there has been a slowdown in productivity growth in many OECD economies, a trend often described as the "productivity puzzle"

The technological innovations of the first half of the 20th century had profoundly more important economic consequences than today's incremental improvements in digital entertainment or the digitalization of services

expect periods of technological change to manifest themselves in faster labor productivity growth as well as faster TFP growth.

However, whichever is selected, productivity measures now pose a puzzle. Although the pace of innovation continues, on the face of it, to be very rapid, all measures of productivity growth have slowed significantly, particularly since the mid-2000s. In the UK, where the slowdown has been particularly marked, the level of labor productivity is about one-fifth lower than it would be had the pre-crisis trend continued. But labor productivity growth has slowed everywhere across the OECD.

Any complex phenomenon will have a number of contributory factors, and in this case the drawn-out effects of the financial crisis on firms' investment spending, decreasing competition in key economic sectors, or adverse demographic change in the OECD countries are all plausible parts of the productivity story.[4] Still, there is a striking paradox in the combination of seemingly rapid innovation in a number of technological fields—advanced materials, biomedicine, green energy, autonomous vehicles, small satellites, the "Fourth Industrial Revolution" in manufacturing—and dismal productivity figures. The media and bookshops are full of warnings about the likely effect of the next wave of robotics on jobs, but there is absolutely no sign yet of the robot apocalypse as that would certainly have boosted the labor productivity figures.

There are three potential explanations for this paradox.

One prominent perspective is that it is more apparent than real, and that, in fact, there has been far less technological innovation than the hype would lead us to believe. Robert Gordon is a forceful advocate of this view. In his book *The Rise and Fall of American Growth* he argues that the technological innovations of the early to mid-twentieth century, such as indoor plumbing, electricity, or the initial communications technologies of telegraph, telephone, and radio, had profoundly more important economic consequences than today's incremental improvements in digital entertainment or the digitalization of existing services and products. While Gordon has a narrow focus in terms of today's frontier technologies, his argument has had some support from recent estimates of a sharp decline in research productivity.[5] It is not only Moore's Law that is showing signs of running out of steam; the number

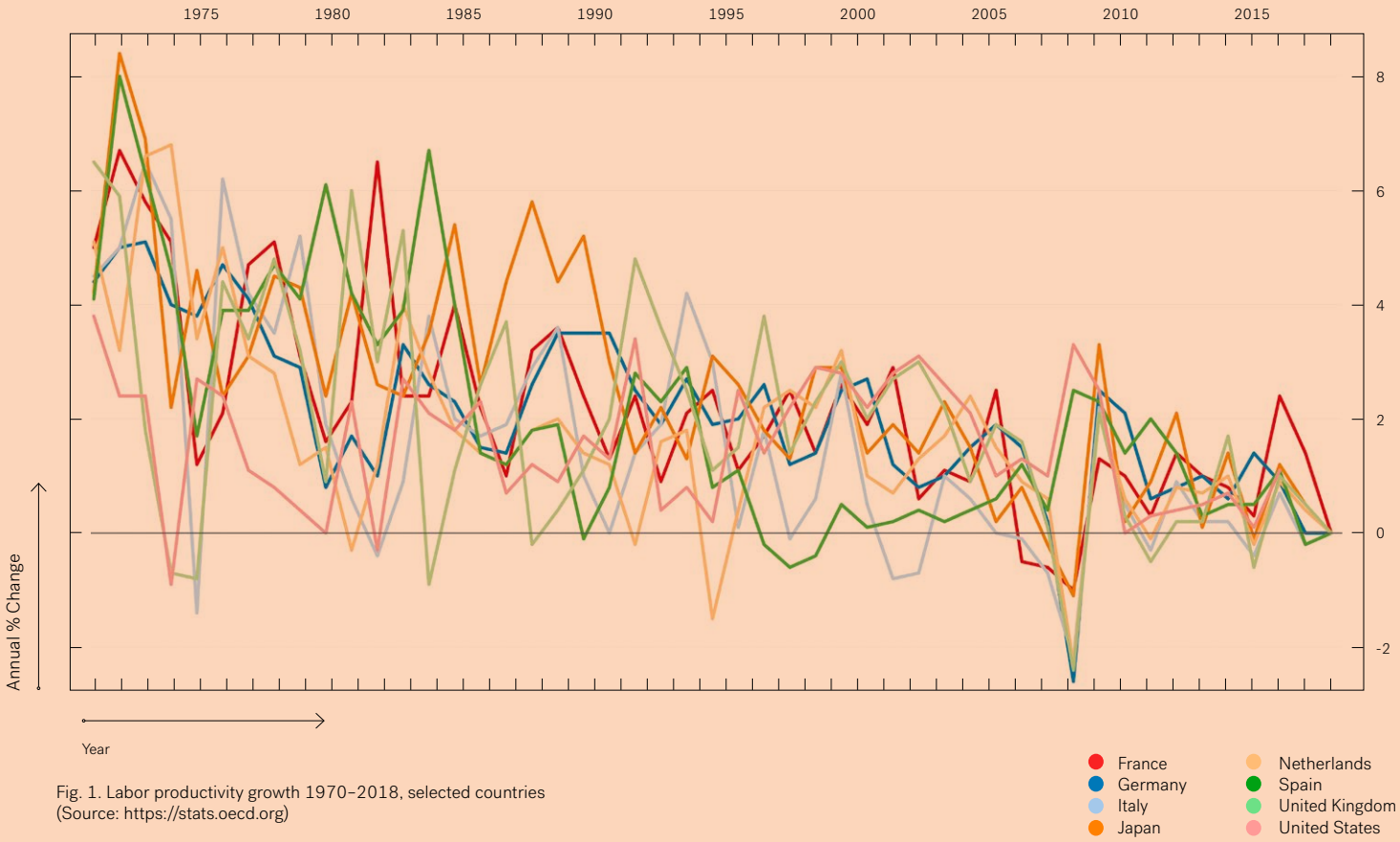

Fig. 1. Labor productivity growth 1970–2018, selected countries
(Source: https://stats.oecd.org)

of researchers in the United States is more than twenty times greater now than in the 1930s, and yet there has been a long-run trend decline in TFP growth for some forty years now.

Not surprisingly, given the range of innovations reported currently, the technology community is dismissive of the claim that the pace of change is slowing. It is hard to evaluate the claim that there are severely diminishing returns to new ideas. Part of the impact of new technologies may never be measured or measurable. For instance, if today's renewable energy technologies enable the decarbonization of electricity generation, this will represent a profoundly important innovation that will never be captured in GDP or productivity measurement because the carbon externalities are not included. A discovery like the use of mini-aspirin doses—a cheap and old compound—to help prevent cardiovascular illness will extend many lives but hardly affects the growth statistics at all.

In general, GDP as a value-added measure does not reflect well innovations that improve the efficiency of production processes, as opposed to innovations that give rise to new products or services; few statistical agencies calculate the relevant gross output deflated by the appropriate input and output prices at each stage of the production chain. Over the past twenty years or so there has been a major reorganization of business globally creating extended international supply chains, with each stage more specialized than previously. Adam Smith's insight about the gains from specialization has been taken to the global scale. Yet trend productivity growth has slowed in the OECD nations spearheading this phenomenon, which can be thought of as a significant process innovation—for if it were not benefiting companies in some way, why would it have become so pervasive? This is in effect to restate the productivity puzzle, but it suggests a shortfall in our understanding of the economic processes—and measurement, including how to take proper account of the use of intermediate inputs to production.

A second possibility is that the current wave of innovation in many fields will increase the productivity growth rate—eventually. However, important innovations can take a long time to lead to the changes in firms' activities and consumers' behavior that are reflected in economic transactions and hence the GDP and productivity statistics. Economic historian Paul David provided a canonical example of the long delays between innovation and productivity outcomes in his 1999 study of the adoption of electricity in the early twentieth century. Not only was new infrastructure needed for distribution networks; as David pointed out, crystallizing the benefits of electricity also required major investments such as new low-level factory buildings configured for assembly lines in place of old mills built over several stories around their steam engines' drive shafts. Additionally, getting the full benefit of the assembly line required innovations in management techniques and workflow organization. In that case the lag between original innovations and full productivity impact was some fifty years.[6]

Research on the initial wave of the digital revolution also highlighted the importance of management and organizational change, leading to either delays, or even failure on the part of some firms to gain any productivity benefit from their investments in information and communication technology equipment. In their survey of this evidence, Erik Brynjolfsson and Lorin Hitt described this as a role for a form of intangible capital, which they argued was many times more important than investment in ICT equipment, and extended over about a decade before it showed up in productivity improvements.[7] For example, businesses could hold lower stocks of inventories, requiring changes in logistics chains and practices. Workers needed to have more flexible job responsibilities and more autonomy to take decisions on the basis of information that could now flow to them faster and more cheaply. In their study of the US productivity boom of the late 1990s, McKinsey also highlighted the role of logistics and inventories, finding that Walmart alone had a measurable impact on the aggregate figures.[8]

Similarly, additional complementary investments may be needed to reap the benefits of some current technological innovations. Obvious examples are autonomous vehicles requiring significant infrastructure investment and institutional changes in law and insurance products; renewable energy requiring major investment in the distribution and transmission networks; or management and work practice changes in "Internet of Things" production and service provision, as well as extensive investment in 5G communications. In recent work on the importance of intangible investments such as business process redesign, new business models, or additional investments in human capital for the use of technologies such as artificial intelligence, Erik Brynjolfsson and his colleagues characterize this as a "productivity J curve," whereby innovation leads to lower productivity before any improvements are observed.[9] Some of the current much-hyped innovations, such as AI and machine learning systems, or the Internet of Things, are anyway not yet as widely deployed in business as headlines would suggest so it remains to be seen if they will live up to expectations. Others—such as computing, discussed below—are widely used, however.

The final possible explanation concerns the difficulty in measuring productivity. This line of explanation also has its skeptics. A number of studies have explored the potential for measurement error and concluded that, if anything, the measurement difficulties were even greater before the mid-2000s, so this argument deepens the productivity puzzle. Byrne, Fernald, and Reinsdorf correct US productivity figures for several biases such as the need to quality-adjust prices for ICT equipment, and the need to measure intangible investments better, and yet conclude the measurement challenges are no worse than they used to be so cannot explain the observed slowdown.[10] Looking specifically at the prices used to deflate nominal GDP, Reinsdorf and Schreyer find that there has been meaningful overstatement of prices and therefore understatement of real output and productivity, but again conclude that this was a bigger problem in the past.[11]

However, others (including me) conclude that there remain some significant measurement challenges, across a range of factors affecting either real GDP and productivity, or indeed our broader understanding of the structure of the economy. These challenges include the following.

Free Digital Goods

The treatment of digital goods that are free to consumers poses an obvious issue for GDP statistics, which are intended to measure total monetary transactions in the economy. What should be done about transactions

where no money is changing hands, with consumers paying, instead, in attention and data? The issue is the same as with advertising-funded free-to-air television, but the scope in the economy is wider now. Ignoring the goods is not an attractive option because there is some substitution between free and paid-for digital goods—for example, a service like Spotify has both free and subscription options for the same service, differing only in the advertisements in the former case.

One possibility is to think of these advertising-funded zero price goods as a sort of barter transaction. Consumers are paid in free digital services in exchange for seeing advertising; households produce "viewership services" that they barter for useful digital services or entertainment. Advertisers in turn pay for the content of these services. One estimate of the contribution these barter transactions make to GDP suggests it would have added a tenth of a percentage point to US real GDP growth from 1995 to 2014, with a very modest acceleration post-2005. In other words, the effect on productivity measurement is small and does not help account for the slowdown.[12]

An alternative is for statisticians to attempt to estimate directly the value consumers gain from these free goods. Erik Brynjolfsson and his coauthors have used the kind of contingent valuation methods previously widely applied to non-monetary environmental goods, and find that consumers (in the US) attach high values to some free digital goods. The authors suggest adding these values to GDP in order to calculate a monetary economic welfare measure, their argument being that the technique provides an estimate of the consumer surplus (welfare gain in excess of the price paid) for these goods.[13] The method has attracted interest and is currently being applied in other countries and repeated for the US, not least to test its robustness.

More recently, however, this approach has been challenged. While agreeing that willingness to pay type methods can provide an estimate of the value of free digital goods, Heys et al. argue that these are most appropriately regarded as intermediate inputs into household production—for example using Google Maps allows faster provision of transport services when driving to the shops—and therefore add value outside the market in the household account rather than adding value to the marketed economy GDP is intended to capture.[14]

At present, then, there is no consensus about the best approach to measuring this undoubtedly important economic activity, and the proposals have rather different implications for measuring real GDP and productivity.

Crossing the Production Boundary

As this latter argument suggests, one of the consequences of digitalization is the increased scope of activities crossing the "production boundary," whereby transactions previously involving monetary transactions in the market economy and GDP are substituted by activities within households, which are unmeasured. Such substitutions across the production boundary occur constantly: this present digitalization shift is a mirror image of the shift out of household activities into marketed ones in the postwar era, as women increasingly took paid employment and bought in services or conveniences as substitutes for unpaid domestic labor—a transition that may have flattered measured productivity growth in the 1960s and 1970s. Examples of digital shifts from market to household sector include online banking or travel booking (rather than going to the high street), "volunteer" production such as uploading entertaining videos or posting open-source software, or some "sharing economy" activities. In the absence of updated time-use data, which would enable the development of household account statistics for digital activities, it is hard to know the scale of this shift.[15]

Price Deflators

There are significant challenges in calculating price indices for sectors experiencing substantial digitally enabled innovation, and it is highly likely that some price indices are overstated, and therefore real output and productivity are understated. For example, telecommunications services appear to be one of the slowest-growing sectors in the UK post-2005. But the previous price index for the sector had taken no account of the massive improvements in quality, such as improved compression techniques, faster data speeds, reduced latency. Even a modest improvement in the price index could turn a zero decrease in prices over five years as re-

GDP as a value-added measure does not reflect well innovations that improve the efficiency of production processes, as opposed to innovations that give rise to new products or services

Some of the current much-hyped innovations, such as AI and the Internet of Things, are not yet as widely deployed in business as headlines would suggest so it remains to be seen if they will live up to expectations

corded by the official index into a decline of more than one-third. Further methodological improvements, reflecting the vast increase in the volume of telecommunications traffic, point to even more dramatic price declines in the sector.[16] Similarly, calculating the price businesses pay for computing services to reflect the progressive switch to cloud computing would indicate substantial declines in the relevant price index.[17]

In general, well-known challenges in constructing consumer price indices when there are innovative and new goods are particularly acute in the digital economy.[18] There is a considerable literature looking at how to adjust for quality improvements in technology goods such as computers or smartphones or software. William Nordhaus pointed out the difficulty of measuring the price over long periods of time of radically changing technologies such as lighting or computing power, because prices are attached to specific products, whereas what people get value from is a more fundamental service embodied in different products.[19] He calculated the supply side cost of providing these basic goods—although his method cannot tell us how much value consumers attached to each successive embodiment of lighting or computing. Similar challenges could even apply to deflators for other sectors, including "old economy" ones such as construction, as new methods are incorporating features such as digital sensors, improving the performance along dimensions such as energy efficiency, reliability or reduced maintenance, none of which is captured in the deflation of nominal output. The standard theoretical approach of hedonic adjustment (taking account of certain measurable quality improvements) is not widely applied by statistical offices and also faces both practical and methodological hurdles.[20] Finding methods for calculating more accurate deflators, in ways statistical agencies can apply in practice, is another active area of research.[21]

Changing Business Practices and Intermediate Goods

Changes in business practices are making the measurement of sectoral productivity and international trade statistics more chal-

The number of researchers in the United States is more than twenty times greater now than in the 1930s, and yet there has been a long-run trend decline in TFP growth for some forty years now

Classic hip-hop photography on display at the launching party of Spotify's playlist "The Hundred" at the Royal Swedish Opera, Stockholm, 2018

lenging. Cloud computing is one example. Its price has declined dramatically since the launch and rollout of these services by Amazon Web Services and others some seven years ago. Firms substitute from investment in fixed capital equipment (servers, etc.) to the purchase of cloud services which are cheaper, higher quality, more secure, and constantly being upgraded. Using cloud services is, in measurement terms, similar to an operational lease on capital equipment owned by another firm. The business investment and output statistics are based on surveys in which firms report their capital and operational expenditure. Use of the cloud means a switch from the former to the latter, with the cloud providers undertaking the investment expenditure instead. It is in any case not clear that the large US-domiciled cloud providers who are market leaders (Amazon Web Services, Microsoft, Google, IBM) report their investment spending to statistical authorities in the separate national markets. What is more, in calculating sector multifactor productivity, without an adjustment for the purchase of capital services from cloud providers, the productivity of the cloud users will be overstated and that of the cloud providers understated.[22] As for the trade statistics, while it is reasonably straightforward to measure imports of ICT equipment, it is tricky even to conceptualize all the cloud service flows, such as when a German automaker organizes its global supply chains and production via use of cloud services from a US-based company with data centers in multiple countries.[23]

A similar example is the case of "factoryless manufacturing," whereby firms retain intellectual property and customer relationships but contract—often overseas—all the manufacturing activity, relying on digital communications and modern logistics. In general, trade figures are hard to interpret as innovative firms digitally transmit their IP such as blueprints and designs across borders (retaining ownership) in non-recorded data flows. Meanwhile, the products resulting from this IP are recorded in trade figures. Furthermore, some big firms thought of as manufacturers may be classified as distributors, with some evidence that the size of the manufacturing sector, often of particular interest to policy makers, is understated. Existing business surveys do not capture the scope of factoryless manufacturing (and similar models such as toll processing), but novel web scraping methods suggest that about 18% of firms in some sectors of UK manufacturing, and 14% in the case of the US, use contract manufacturers.[24]

Data

Pervading many of these challenges is the treatment of data. In the current framework, only a small component of the accumulation of data is currently incorporated into GDP (namely the costs of digitizing and managing a database). Given the explosion of the acquisition, use and transmission of data, and the increasing tendency of firms to treat both own-account and purchased data as a strategic asset, the current practice with respect to investment in data seems too restricted.[25] Yet at present there is no consensus about how to conceptualize, measure, and value the flows of data of different types, and the cross-border aspect of data flows in many of the business models described above—and others based on data including the free digital goods models described above—makes these issues all the more challenging.[26] While there are standard physical measures of the volume of data in computing terms (Gigabytes, Zettabytes, etc.) and of communication channel capacity, the economic value will depend on the information content. The economic characteristics of data make the valuation particularly difficult because, although there are some market transactions in data allowing prices to be discovered, data is a non-rival, public good with externalities, meaning there is a wedge between market valuation and economic welfare. The national accounts are concerned mainly with market transactions but the wider context is important for economic policy. This is another area of active research including an international debate focused on the national accounts about taxonomies and classification.[27]

Classification and Data Collection

Cutting across these conceptual measurement issues is the need for innovation in the collection of the raw data used to construct GDP and productivity measures. The classification structure for economic

The well-known challenges in constructing consumer price indices when there are innovative and new goods are particularly acute in the digital economy

The business investment and output statistics of firms are based on surveys in which they report their capital and operational expenditure. Use of the cloud means a switch from the former to the latter, with the cloud providers undertaking the investment expenditure instead

statistics in terms of industrial sectors and occupations has not kept up with new activities and new skills, still reflecting the manufacturing-heavy economy of the 1940s despite subsequent updates, and at present omitting altogether some industries of interest to policy makers. For instance, sectors such as video games have grown in importance but are hard to track in the existing statistics, and occupational categories are shifting rapidly. New methods such as web scraping are being tested as an alternative to the traditional survey-based data collection methods.[28] An additional problem stems from the extended production supply chains noted above. For example, many manufacturing services are understandably classified in the service sector rather than manufacturing, but with insufficient granularity so the size of the manufacturing-centric part of the economy is easily understated. One study suggested that the "true" size of the UK's manufacturing sector could be understated by up to a half by counting specialist service activities outsourced from manufacturing in with services such as retail or accountancy.[29]

It is certain that new data sources and methods will be needed to develop more accurate measurement of output and productivity, reflecting the structure of modern economies. Great strides are being made in using novel big data methods, such as extended use of scanner data to improve price indices,[30] web scraping and other novel online data such as text or listings,[31] "big data" datasets recording massive individual transactions or linkages,[32] and satellite data.[33] The UK's Office for National Statistics has established a Data Science Campus to develop innovative methods. Yet initiatives such as these are in their infancy, and far from being systematized by statistical offices.

Conclusions

This list of measurement artifacts and challenges, extensive as it is, may not in the end add up to a significantly different aggregate productivity picture, given other important contributory drivers of the long-term trends. Even so, there is a growing volume of research into economic statistics, much of it due to the digital revolution; some of the issues listed above will be addressed in the upcoming periodic revision of the international System of National Accounts. Yet the fact there are so many measurement issues raises the more fundamental question of whether "productivity" is the best way to conceive of how well the economy is progressing. After all, the OECD economies consist for the most part now of services, not products.

As long ago as his 1994 Presidential Address to the American Economic Association, Zvi Griliches observed that "our measurement and observational tools are becoming increasingly inadequate in the context of our changing economy."[34] Labor productivity had flatlined in what he then considered "unmeasurable" sectors of the economy: construction, trade, finance, other services and government. In the subsequent twenty-five years, the scope of the "unmeasurable" has extended. Not only do some of those original unmeasurables account for a greater share of GDP in many OECD economies, but in addition some of the previously "measurable" sectors, including communication and manufacturing, are giving more trouble. One of Griliches' examples was pharmaceuticals, and the difficulty of treating generic and new drugs prices adequately in constructing a price index and hence real output of the sector; while it is relatively straightforward to measure the number of pills being taken or shots being given, biomedical innovation means the health outcomes per product are dramatically improved. The GDP statistics were developed in an era of mass production and consumption, so are harder to interpret for the present era of highly differentiated services.[35]

This points to one of two substantial difficulties with the current measurement framework, which is what "real terms" output means. The idea of deflating nominal GDP is to remove the part of the expansion of the dollar or euro total due simply to inflation by calculating what amount of output would leave people with the same level of utility as before. There is a vast literature on price indices concerning how best to achieve this constant utility ideal. But it is, needless to say, a heroic abstraction at the best of times. And when there is rapid innovation and quality change, there is no satisfactory conceptual solution. Economists often think that the statistics simply need "hedonic" adjustment, a regression technique to correct prices of goods for the measurable quality improvements (say, air conditioning in cars, faster processing speeds in laptops). This is somewhat arbitrary in any case. But it can

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Workers on a break take a nap near the conveyor belt at the Nike factory in Ho Chi Minh City, 2001

Its economic characteristics make data valuation particularly difficult because, although there are some market transactions in data allowing prices to be discovered, data is a non-rival, public good with externalities, meaning there is a wedge between market valuation and economic welfare

potentially lead to implausibly high calculated growth rates for sectors such as ICTs. This possibility was flagged up early in the debate about hedonic adjustment of prices by Milton Gilbert, one of the architects of the System of National Accounts, who pointed out that in the extreme the method could suggest growing real output of a product whose physical volume was shrinking toward zero: if people happily wore nothing at all on the beach would we argue that the "real" output of bathing suits was the same as in the Victorian era, he asked? As the great Thomas Schelling once pointed out: "[W]hat we call 'real' magnitudes are not completely real; only the money magnitudes are real. The 'real' ones are hypothetical."[36]

Not surprisingly, price indices will be a major focus of the work contributing to the next revision of statistical standards. However, some researchers have suggested more radical approaches moving away from the idea of real GDP as the benchmark for economic welfare. One suggestion, from Charles Hulten and Leonard Nakamura, is to introduce an expanded GDP concept, taking the conventional GDP figures based on efficiency of resource use in production and augmenting them with additional efficiency in consumption, the additional value consumers gain from given output thanks to innovation.[37] Another, which goes still further away from the present focus on production and productivity, is to consider how people use their time and the value they gain from different activities, as time use seems a natural metric for a services-based economy.[38] Some services will be more "productive" the faster they can be carried out, and these will be the more routine and potentially automatable. Others, more bespoke, will be more valuable to consumers if they take more time, and provide higher quality. In this latter case, the price consumers pay will directly reflect the perceived value. These two varieties could exist in the same conventionally defined sector: consider routine blood tests versus care in the intensive care unit, or a quick shave at the barber versus a designer haircut. It is early days and there will be other suggestions for rethinking the conceptual framework for the economy before economists and statisticians converge on the successor to today's lens on the economy, including the powerful arguments for thinking far more broadly about what measurement "beyond GDP" is needed for a valid sense of economic welfare or well-being.[39]

None of this implies there is no productivity problem. In the ten years-plus since the financial crisis, too few people in the OECD middle classes have seen the steady gains in prosperity that sustain stable societies.[40] New innovations are welcome but they must deliver wide benefits for consumers. Addressing the pessimistic sense that the next generation will be worse off than their parents is one of the policy challenges of our times.[41] There are plenty of signs that this will be a politically turbulent period, like previous decades of sustained slow growth in the twentieth century. Measurement questions might seem like a distraction at times like this, but when the questions are as extensive and complex as they are now they point to deeper questions: what do we mean by the idea of progress, and what measures do policy makers need to understand what is happening in the economy and society, and to deliver broad-based, sustainable improvements in citizens' lives.

An image from a presentation at the 2018 Computing Conference: "Empower Digital China," held at the Yunqi Cloud Town International Expo Centre in Hangzhou

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Inequality in the Digital Era

Zia Qureshi

The digital revolution is transforming economies. Potential economic gains from digital technologies are enormous, but with new opportunities come new challenges. Within economies, income and wealth inequalities have risen as digitization has reshaped markets and the world of business and work. Inequalities have increased between firms and between workers. The distribution of both capital and labor income has become more unequal, and income has shifted from labor to capital. Technological change, however, is not the sole reason for the rising inequalities. Policy failures have been an important part of the story. Policies will need to be more responsive to the new dynamics of the digital economy to achieve outcomes that are more inclusive.

We are living in an era of mounting societal discontent and political divisiveness. In many countries, social disaffection with economic outcomes is up sharply, stoking populist and nationalist sentiment. Increasing income inequality is one important reason behind this sociopolitical tumult.

We are also living in an era of major technological change, led by the digital revolution. Today's technological changes—advances in computer systems and software, mobile telephony, digital platforms, robotics, cloud computing, artificial intelligence, and cyber-physical systems—are arguably unparalleled in their scope and speed.

Are these two megatrends of our time connected? The answer is yes. Digital technologies are reshaping the world of business and work in profound ways. Policies have been slow in adapting to the new dynamics. The interaction between technological change and market conditions as influenced by the prevailing policy environment has been a key factor driving income inequality higher. Disruptions caused by technological change have added to business and worker anxieties.

A more unequal distribution of income, however, is not an inevitable consequence of a digitizing world. Outcomes that are more inclusive are certainly possible with better, more responsive policies.

Rising Income Inequality amid Booming Digital Technologies

Income inequality has risen in practically all major advanced economies since the 1980s, a period of a rising boom in digital technologies (fig. 1). It has risen particularly sharply at the top end of the income distribution. Wealth inequality is still more acute, roughly twice as high as income inequality. The increase in inequality has been especially marked in the United States. Over a two-decade period ending in 2015, US disposable income inequality, as measured by the broadest measure of inequality (the Gini Index), increased by more than 10%. The income share of the richest 1% has more than doubled since the early 1980s, to around 22%. The share of the top 1% in wealth has risen to around 40%. Those with middle-class incomes were squeezed and the typical worker saw largely stagnant real wages over long periods. Higher inequality has been associated with a decline in intergenerational economic mobility (Chetty et al., 2017).

This article focuses on advanced economies, but the rise in income inequality is not confined to this group. In emerging economies, income distribution trends are more mixed but many major emerging economies also witnessed a rise in income inequality. In the two largest emerging economies, China and India, inequality has increased appreciably.[1]

In the cauldron of political debate, much of the blame for the rise in income inequality and underlying business and job dislocations is heaped on globalization—often from both ends of the political spectrum. The backlash against globalization threatens a retreat into economic nationalism and inward-looking policies. Globalization has, indeed, been a factor behind rising inequality. However, a much bigger factor has been technological change.

Not only is the proverbial economic pie being shared more unequally, it has also been growing more slowly, adding to social discontent. Paradoxically, productivity growth in major economies has slowed rather than accelerated during the boom in digital technologies. This has slowed overall economic growth. Research finds that the same interaction between technological change and policy failures that contributed to higher income inequality also explains why the new technologies have not delivered their full potential to boost productivity (Brookings Institution and Chumir Foundation, 2019). Developments in income distribution and productivity have been linked by shared dynamics.

Transformations in the World of Business

Digital technologies are altering business models and how firms compete and grow. They are reshaping market structures. Change affects all markets, from production and commerce to finance. The manner in which the new technologies deploy across industries and firms has important implications for their economic impact and the distribution of rewards.

Uneven Diffusion of New Technologies and Widening Gaps between Firms

How technological innovation diffuses within economies and interacts with market conditions matters greatly for both productivity growth and income distribution (Comin and Mestieri, 2018; OECD, 2018a; Aghion et al., 2019). The benefits of the new technologies have not been diffusing widely across firms. They have been captured for the most part by a relatively small number of larger 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, typically smaller firms, pulling aggregate productivity growth lower. Between 2001 and 2013, in OECD economies, labor productivity among frontier firms rose by around 35%; among non-frontier firms, the increase was only around 5% (Andrews et al., 2016).[2] Aggregate labor productivity growth in OECD economies in the decade to 2015 was only about half of that in the preceding two decades. The growing inequality in productivity performance between firms not only depressed productivity growth, but also caused income disparities to rise.

A weakening of competition is one important reason for these adverse productivity and distributional dynamics. Barriers to competition and related market frictions are preventing a broader diffusion of the 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 (Cette et al., 2016; Égert, 2016). Studies of the United States and European economies also find that lower competitive intensity in markets depressed investment in new productive capital, as firms

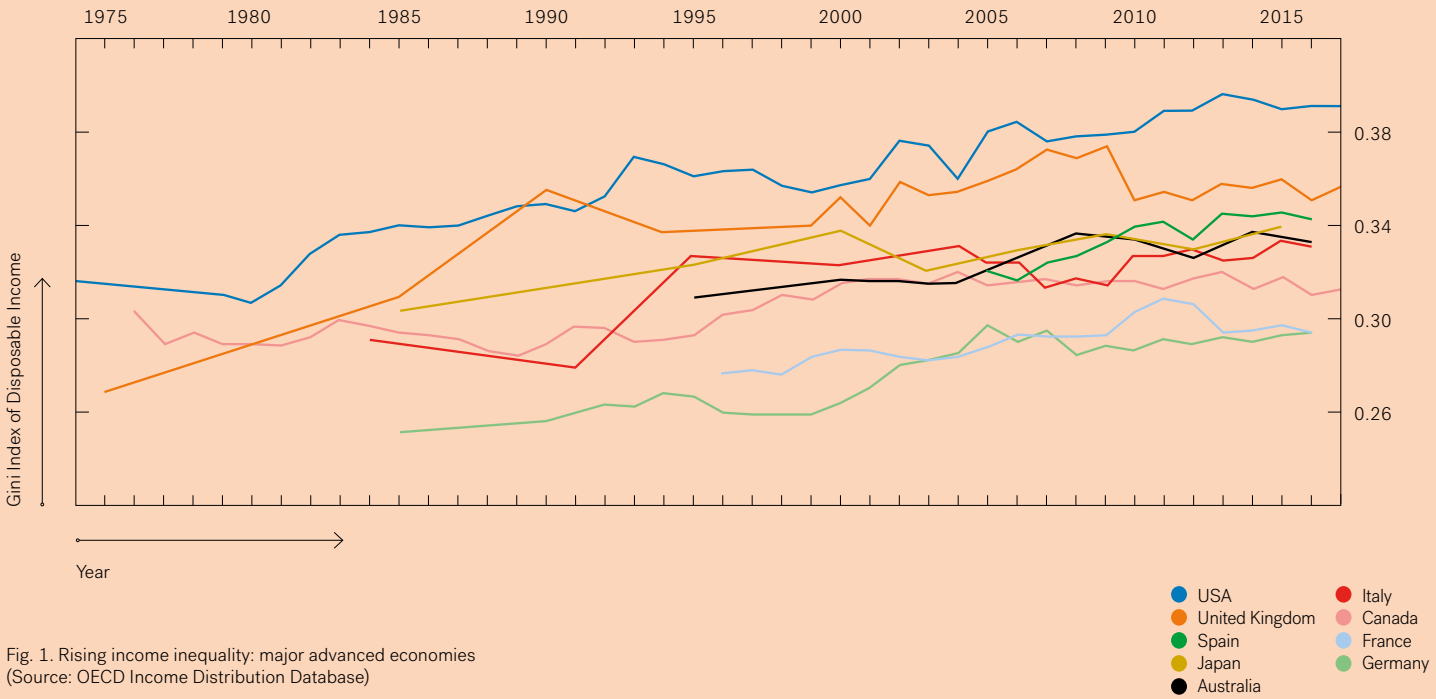

Fig. 1. Rising income inequality: major advanced economies
(Source: OECD Income Distribution Database)

Between 2001 and 2013, in OECD economies, labor productivity among "frontier firms" rose by around 35%; among other firms, the increase was only around 5%

Establishments like the legendary department store Harrods in London, which had previously replaced small retailers, are now losing market share to online megastores

wielding increased market power invested less and made a lot more on existing capital through higher markups and increased stock buybacks (Gutiérrez and Philippon, 2017; Égert, 2018).

The erosion of competition is reflected in a variety of indicators: rise in market concentration in industries, higher markups showing increased market power, and corporate ossification with declining business dynamism as measured by new firm formations. These trends are observable broadly across advanced economies but have been particularly marked in the United States. The share of top four US companies in total sales has risen since the 1980s in each of the major sectors covered by the US Economic Census (Autor et al., 2017). The rise in market concentration is greater in industries that are more intensive users of digital technologies. Markups over marginal cost for US publicly traded firms have nearly tripled, with the rise concentrated in high-markup firms gaining market share (De Loecker et al., 2018). The share of young firms (five years old or less) in the total number of US firms has declined from about one-half to one-third (Decker et al., 2017).

With increased market power, the distribution of returns on capital has become more unequal, with a relatively small number of firms reaping supernormal profits. In the United States, for example, the ninetieth percentile firm earned a return on invested capital reaching around 100% in 2014, which was more than five times the return earned by the median firm; this ratio was around 2 about twenty-five years ago (Furman and Orszag, 2018). The uneven distribution of returns on capital was particularly marked in technology-intensive industries. There is also evidence of low churning among high-return firms, with a large proportion of such firms persistently achieving high rates of return.

Markets have shifted toward more monopolistic structures, giving rise to higher economic rents (Krugman, 2016; Stiglitz, 2016; Summers, 2016). The share of "pure profits" or rents (profits in excess of those under competitive market conditions) in total income in the US economy rose from 3% in 1985 to 17% in 2015 (Eggertsson et al., 2018). As monopoly profits boosted the market value of corporate stocks and produced large capital gains, the share of total US stock market value reflecting monopoly power ("monopoly wealth") rose from negligible levels to around 80% over the same period (Kurz, 2018).

There has been much innovation in financial services based on the new technologies, but much of it has focused on areas such as trading and asset management that primarily benefit the well-off

The largest US firm in 2017, Apple, had a market capitalization forty times as high as that of the largest US firm in 1962 (AT&T), but its total employment was only one-fifth that of the latter

A worker grinds metal at a workshop in Mumbai

Winner-Takes-Most Dynamics and Competition Policy Failures

Why is market power rising and competition weakening? First, the new technologies are contributing to increased market concentration by altering competition in ways that produce "winner-takes-most" outcomes. Digital technologies offer first-mover advantages, scale economies, network effects, and leverage of "big data" that encourage the rise of dominant firms—and globalization reinforces the scale economies by facilitating access to markets worldwide. The rise of "the intangible economy," where assets such as software and intellectual property matter more and more for economic success, has been associated with a stronger tendency toward the emergence of dominant firms (Haskel and Westlake, 2017). Digitization also allows firms controlling big data to extract more of the consumer surplus through increasingly sophisticated algorithmic pricing and customization of offerings.

The winner-takes-most dynamics have been most marked in the high-tech sectors, as reflected in the rise of "superstar" firms such as Facebook and Google. Increasingly, however, they are affecting economies more broadly as digitization 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.

Second, failures in competition policies have reinforced the technology-driven dynamics producing more concentrated market structures. These include weaknesses in antitrust policies, flaws in patent systems that act as barriers to a wider diffusion of innovations, and regulatory acts of omission and commission (deregulation unsupported by competition safeguards, and regulations that restrict competition). Related factors include an increase in overlapping ownership of companies that compete by large institutional investors, rise in rent seeking, and firm behavior showing greater adeptness in erecting barriers to entry through product differentiation and other means.

Financialization

Digital technologies have been instrumental in the financialization of economies, reinforcing the impetus from financial sector deregulation. In OECD economies, credit and other financial intermediation has grown three times as fast as economic activity in recent decades. The rapid financialization compounded the inefficient and unequal outcomes resulting from decreased competition in markets (OECD, 2015; Philippon, 2016). In the credit boom that preceded the global financial crisis, the lion's share of the credit went to households rather than firms, boosting stock and real estate markets rather than productive investment—an allocation of credit with negative implications for growth, stability, and income distribution. There has been much innovation in financial services based on the new technologies. A large part of it, however, has been focused on areas such as trading and asset management that primarily benefit the well-off and do not have first-order effects on economic productivity.

Rewards in the financial sector rose sharply relative to the real economy. In the United States, the financial sector captured an outsize share of profits—35–40% of all corporate profit in the years leading to the financial crisis. A sizable part of these high profits reflected rents in an increasingly concentrated sector: the top five banks' share of banking assets increased from 25% in 2000 to 45% in 2014. In European countries, financial sector workers on average accounted for one in five of the top 1% of earners even though they accounted for only one in twenty-five of the total workforce (Denk, 2015). Financial wealth boomed but benefited mainly those at the top; in the United States, the top 1% of the wealth distribution held half of stock and mutual fund assets in 2013, and the top 10% held more than 90% (Wolff, 2014).

Transformations in the World of Work

Just as transformations in the world of business caused by digitization-driven technological change have been a key factor influencing the distribution of capital income, technology-driven transformations in the world of work have been a key factor influencing the distribution of labor income.

Rising Wage Inequality and Falling Labor Income Share

Across OECD economies, increased inequality in firm productivity and profitability is mirrored by increased inequality in labor incomes. As profitability gaps widened between firms, so did wage gaps. Rent sharing

also contributed to wider wage differences between firms. Better-performing firms reaped a higher share of total profits and shared part of their supernormal profits with their workers. Increased fissuring of the workplace through outsourcing played a role as well, with noncore activities typically employing low-skill workers farmed out to other firms, cutting such workers from the rent sharing. Between-firm wage inequality rose more in industries that invest more intensively in digital technologies. Overall, wage inequality has risen sharply in the past couple of decades and much of that rise is attributable to increased wage differences between firms (Song et al., 2019).

While workers in firms at the technological frontier earned more than those in other firms, gains from higher productivity at these firms were shared unevenly, with wage growth lagging behind productivity growth. Wages rose in the better-performing firms but by less than the rise in productivity. For most other firms, limited wage growth reflected limited productivity growth, although even at these firms wage growth tended to fall short of the meager gains in productivity (OECD, 2018b; Schwellnus et al., 2018). In the United States, net labor productivity increased by 72% between 1973 and 2014, while real hourly compensation of the median worker increased by only 9% (Bivens and Mishel, 2015).

The decoupling of wages from productivity contributed to a shift in income distribution from labor to capital. In the past couple of decades, most major economies have experienced both increasing inequality of labor earnings and declining labor-income shares. In the United States, for example, the percentage share of labor in total income dropped from the mid-60s around 2000 to the mid-50s around 2015.

Increased market concentration has played a role in the shifting of income from labor to capital as it reallocated labor within industries to dominant firms with supernormal profits and lower labor-income shares (Autor et al., 2017). Dominant firms not only acquired more monopoly power in product markets to increase markups and extract higher rents but also monopsony power to dictate wages in the labor market (CEA, 2016; Azar et al., 2017). A new phenomenon has been the fast-expanding digital labor markets—online jobs platforms such as Task Rabbit and Amazon Mechanical Turk. Here too, employer concentration has been high (Dube et al., 2018). While employer market power strengthened, worker bargaining power weakened with a decline in unionization and erosion of minimum wage laws.

These developments reinforced the effect of labor-substituting technological change on the distribution of income between labor and capital. Production shifted toward firms and processes using more capital (tangible and intangible) and less labor. The largest US firm in 2017 (Apple) had a market capitalization forty times as high as that of the largest US firm in 1962 (AT&T) but its total employment was only one-fifth that of the latter (West, 2018). The shift of income from labor to capital increased overall income inequality, as capital ownership is highly uneven.[3]

International trade and offshoring also contributed to the shift in income toward capital by putting downward pressure on wages, especially of lower-skilled workers in tradable sectors. Overall, research shows that globalization has played a significant role in the decline of the labor-income share. However, it also shows that globalization's role has been much smaller than that of technological change and related outcomes. IMF research finds that, in advanced economies, technological change has contributed about twice as much as globalization to the decline in the labor-income share (IMF, 2017a).

Shifts in Labor Demand, Job Polarization, and Skills Mismatches

Technology has been the dominant force in reshaping the demand for labor. Digital technologies and automation have shifted demand toward higher-level skills. 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 nonroutine manual jobs in services such as personal care that are hard to automate. Between 1995 and 2015, 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.[4] A concurrent development has been the rise of the "gig" economy, with more workers engaged in nonstandard work arrangements, such as temporary or part-time contracts and own-account employment.

As the demand for skills has shifted, supply has been slow to adapt. Education and training have been losing the race with technology (Goldin and Katz, 2008; Autor, 2014). Shortages of higher-level skills demanded by the new technologies have prevented a broader diffusion of the innovations across firms. Workers with skills complementary with the new technologies have been clustered increasingly in leading firms at the technological frontier. 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 (Adalet McGowan and Andrews, 2017).

Imbalances between skills demand and supply have fueled income inequality, by increasing the wage premia on higher-level skills (Autor, 2014; Hanushek et al., 2015). The skill premium rose in all major economies, especially over the 1980–2000 period. The rise has been particularly sharp in the United States: those with a postgraduate degree could expect to earn around 215% of the wages received by those with only a high-school education in 2016, compared to around 155% in 1980.5 The rise in nonstandard work arrangements imparted more flexibility to the labor market. However, it probably also contributed to increased earnings inequality as nonstandard jobs (especially at lower skill levels) typically paid less than standard jobs.

Weakening Redistributive Role of the State

As technological change interacted with developments in product, financial, and labor markets to drive income inequality higher, making the distribution of both capital and labor income more unequal and shifting income from labor to capital, the state's role in alleviating the inequality of market incomes arising from the interplay of these forces weakened. In advanced economies, taxes and transfers reduce market income inequality on average by about one-third: in 2015, the average Gini Index for disposable income in these economies was 0.31 compared with 0.48 for market income. Between 1985 and 1995, fiscal redistribution offset about 60% of the increase in market income inequality in advanced economies. Between 1995 and 2010, it hardly offset any (OECD, 2016).

IMF research finds that, in advanced economies, technological change has contributed about twice as much as globalization to the decline in the labor-income share

Innovations such as mobile financial services, digital platforms, equity crowdfunding, and blockchains have much potential

Fiscal redistribution declined because of reduced progressivity of personal income taxes and lower taxes on capital as well as tighter spending on social programs as countries took steps to rein in fiscal deficits and rising public debt. In OECD economies, the average top personal income tax rate fell from 62% in 1981 to 35% in 2015. International tax competition resulting from capital mobility led to a large fall in corporate income tax rates as well. The average corporate tax rate in advanced economies fell from around 45% in 1990 to 26% in 2015 (IMF, 2017b).

Harnessing Technology for More Inclusive Growth

The rise of the digital economy has pushed income inequality higher. At the same time, the potential of the new technologies to spur productivity growth has not been fully realized. However, this should not provoke despair, much less a negative backlash.

Most dynamic economic change is inherently disruptive, creates winners and losers, and entails difficult transitions. Technology—and globalization—are no exceptions. They are key forces that drive economic progress. Advances in digital technologies hold great promise to boost productivity and economic growth, create new and better jobs to replace old ones, and enhance human welfare. Policies have a crucial role to play in ensuring that the potential gains are captured effectively and inclusively—by improving the enabling environment for firms and workers to broaden access to the new opportunities that come with change and to enhance capabilities to adjust to the new challenges. Unfortunately, policies and institutions have been slow to rise to the new challenges of the digital economy. Indeed, they have often exacerbated rather than ameliorated the outcomes.

Policies to reduce inequality are often seen narrowly in terms of redistribution—tax and transfer policies. However, there is a much broader policy agenda of "predistribution" that can make the growth process itself more inclusive. 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 dynamics between the recent rise in inequality and the slowdown in productivity.

Revitalize Competition for the Digital Age

Competition policies should be revamped for the digital age to ensure that markets continue to provide an open and level playing field for firms, keep competition strong, and check the growth of monopolistic structures. This includes regulatory reforms and stronger antitrust enforcement. The winner-takes-most dynamics associated with digital technologies is raising new challenges for competition policies, including how to address market concentration resulting from tech giants that resemble natural or quasi-natural monopolies. Once in dominant positions, firms can entrench themselves by erecting a variety of barriers to entry and taking over rising competitors. The beneficiaries of an open, competitive system often work to close the system and stifle competition, necessitating reform to "save capitalism from the capitalists" (Rajan and Zingales, 2003; Krugman, 2015). Competition policy also needs to become more global to address cross-border issues posed by multinational tech giants that affect market concentration and competition in many countries.

Proprietary agglomeration of data, as in digital platforms, is an increasingly important source of competitive advantage. Regulations pertaining to digital platforms, ownership of data, how user data are handled, and privacy protections matter increasingly for competition. There has been more action on this agenda in Europe than in the United States, an example being the General Data Protection Regulation (GDPR) introduced in Europe in 2018.

Enhancing competition is also important in financial markets, to address issues such as increased concentration, interconnectedness, and rent seeking. It would spur better use of advances in digital technology to expand the range of financial services and reduce their cost, open new gateways to entrepreneurship, and democratize access to finance. Innovations such as mobile financial services, digital platforms, equity crowdfunding, and blockchains have much potential. Young FinTech firms are in the vanguard in the application of such innovations. A challenge for policy-makers is to foster the growth of these new entrants into the financial industry while managing associated risks.

Improve Innovation Ecosystem for Wider Technology Diffusion

Intellectual property regimes need to be better balanced so they reward innovation but also foster wider economic impacts. "The

copyright and patent laws we have today look more like intellectual monopoly than intellectual property" (Lindsey and Teles, 2017). Arguing that patents are locking in incumbents' advantages rather than spurring the hoped-for bursts of innovation, some have called for a complete dismantling of the patent system (Boldrin and Levine, 2013). That would be too radical an approach. What is needed is a fundamental reexamination, to change excessively broad or stringent protections, align the rules with current realities, and give freer rein to competition. Long patents may have been appropriate for pharmaceutical innovations, which involve protracted and expensive testing, but the case is less clear for advances in digital technologies that have much shorter gestation periods and typically build on previous innovations in an incremental fashion.

Government research and development (R&D) spending focuses on supplying the public good of basic research, which often produces knowledge spillovers that benefit the economy at large. Yet, it has been declining. In the United States, government R&D spending has fallen from 1.2% of GDP in the early 1980s to half that level in recent years (Shambaugh et al., 2017). This underscores the need to revitalize public research programs and ensure broad access to their discoveries. Many breakthrough innovations developed commercially by private firms originate from government-supported research. Recent examples include Google's basic search algorithm, key features of Apple smartphones, and even the Internet itself. Governments should consider how to give taxpayers a stake in such profitable outcomes from publicly supported research, not least to replenish public R&D budgets. Here, the tax system has an important role to play.

Infrastructure that supports digitization should be strengthened. Despite progress, the digital divide remains wide. Even in advanced economies, population remaining offline could be as high as one-fifth (ITU, 2016). Most sectors of the US economy are less than 15% as digitized as the leading sectors (McKinsey, 2015).

Invest in Skills for a Changing World of Work

Advances in digitization, robotics, and artificial intelligence have led some to draw up dire scenarios of massive job losses from automation (a "robocalypse"). However, experience

Many breakthrough innovations developed commercially by private firms originate from government-supported research. Recent examples include Google's basic search algorithm, key features of Apple smartphones, and even the Internet itself

An underwater room installed by the Airbnb online accommodation platform at the Aquarium of Paris for a contest in which winners spent a night sleeping with sharks

The wealth dynamics of recent decades paint a picture of private riches and public poverty. While private wealth has soared, public wealth has declined, hobbling the capacity of public policy

with past major episodes of automation shows that as technological change made some old jobs redundant, it generated new ones by creating new roles and tasks and spurring economic growth. How technological change impacts employment must be seen as a dynamic adjustment process of old jobs giving way to new ones (Acemoglu and Restrepo, 2018; World Bank, 2019). Looking ahead, not only will the skill needs of jobs continue to evolve, but the composition of employment will evolve as well, with more people working independently—including as microentrepreneurs in an expanding "crowd-based capitalism" enabled by digital platforms, as exemplified by Uber and Airbnb (Sundarajan, 2016; Brynjolfsson and McAfee, 2017).

The main issue is that the nature of work is changing, and the main policy challenge is to equip workers with nonroutine, creative, and higher-level skills that the new technologies demand and to support workers during the adjustment process. Traditional formal education must be complemented with new models and options for reskilling and lifelong learning. As the old career path of "learn-work-retire" gives way to one of continuous learning—a process reinforced by the aging of many economies' workforces—the availability and quality of continuing education must be scaled up. This will demand innovations in the content, delivery, and financing of training, including new models of public-private partnership. It will involve experimentation, and learning from what works, such as the apprenticeship system in Germany. The potential of technology-enabled solutions, such as online learning platforms, must be harnessed, supported by a stronger foundation of digital literacy.

A strong commitment to improving access to affordable and quality education, including skills upgrading and retraining, for the economically disadvantaged is also vital. Even in an advanced economy such as the United States, almost two-thirds of workers do not have a college degree. Gaps in higher education attainment by family income level have widened rather than narrowed (Turner, 2017).

Revamp Labor Market Policies and Social Protection

Labor market policies and social protection arrangements must be reformed to improve workers' ability to change jobs. This means shifting the focus from backward-looking policies, such as the stringent job protection laws in many European economies that seek to keep workers in existing jobs, to forward-looking policies that encourage reemployment, including innovative unemployment/wage insurance mechanisms, retraining, and placement services.

Other barriers to worker mobility and competition in labor markets, such as the ever-increasing professional licensing requirements and noncompete covenants in worker contracts, should also be addressed. Well-functioning labor market institutions—collective bargaining, minimum wage laws, labor standards—are important to ensure that workers get a fair share of economic returns, especially at a time of rising market power of dominant firms.

Social contracts will need to be overhauled. Benefits such as pension and health care, traditionally based on formal long-term employer-employee relationships, need to be made more portable and adapted to evolving work arrangements, including the expanding gig economy. Here, several proposals have been put forward, including a universal basic income currently being piloted in some jurisdictions, a negative income tax up to a certain income threshold, and social security accounts that pool workers' benefits and are portable across jobs. Reform options will need to be considered in a context where many social security systems already face financial sustainability challenges.

Pursuing labor market and social protection reforms as a package will have the advantage of capturing reform synergies and easing the adjustment for workers. For example, in 2017, France implemented reforms to its job protection laws to boost labor market flexibility combined with the introduction of a portable "personal activity account" that enables workers to accrue rights to training across multiple jobs.

Reform Tax Systems

Tax policy is often seen as presenting trade-offs between efficiency and growth on the one hand and equity on the other. Trade-offs do exist, but there are win-win opportunities for reform. In labor-income taxation, reducing the tax wedge for low-wage workers through greater use of options such as earned-income tax credit can boost labor force participation as well as improve distributional outcomes. Countries may consider shifting part of the financing of social benefits to general tax revenue to avoid overburdening

social security contributions and labor-income taxation (OECD, 2017). Such a shift in financing may also be needed to extend social security coverage to those working independently or in short-term or other atypical contracts. The changing nature of work will require more attention to horizontal equity in taxes and transfers for workers in different types of work arrangements.

In capital income taxation, recent progress under OECD/G20 processes on international cooperation to curb tax base erosion and profit shifting should enable national tax authorities to make better use of corporate taxes that have been driven lower in recent years by international tax competition for mobile capital. In a period when corporate profits have been high, boosted by rents associated with increased market power, the optimal policy would be to tax profits at relatively high rather than low rates. In an increasingly networked global economy and fast-expanding digital commerce, international cooperation on tax matters will be even more important.

Making better use of wealth taxes can improve both the efficiency and equity of tax systems. Wealth taxes are underutilized and have not kept pace with the surge in wealth. High wealth inequality is a key driver of intergenerational persistence of income inequality. Thomas Piketty's work on inequality (Piketty, 2014) has attracted controversy, but one key proposal—to find a better way to tax wealth—certainly has merit. The wealth dynamics of recent decades paint a picture of private riches and public poverty. While private wealth has soared, public wealth has declined, hobbling the capacity of public policy.6

There is scope to recover some of the lost tax progressivity without hampering economic growth (IMF, 2017b). Higher progressivity does not necessarily mean sharply raising marginal tax rates. A more efficient way is to reform the assortment of regressive and distortive tax expenditures that characterize most tax systems—and curb tax evasion.

Conclusion

Digital technologies are transforming the world of business and work. A key challenge for policies is to harness the potential of these technologies to produce more robust and inclusive economic growth. Policies will need to be more responsive to change, which will only intensify as advances in artificial intelligence and other innovations take the digital revolution to another level. New thinking and policy adaptations will be needed in areas such as competition policies, innovation systems and knowledge diffusion, infrastructure underpinning the digital economy, upskilling and reskilling of workers, social protection regimes, and tax policies. The era of smart machines will demand smarter policies.

The politics of reform is inevitably complex. Reform may seem even more daunting in the current political environment. One thing reform action should not be paralyzed by, however, is continued trite debates about conflicts between growth and equity. Research has increasingly shown this to be a false dichotomy.

The dominant part of the agenda for change to make technology—and globalization—work better for all lies at the national level. Reforms are needed at the international level as well so that rules of engagement between countries in trade and other areas are fair. Not only must past gains in establishing a rules-based international system be protected from the recent rise of nationalist and protectionist sentiment, but new disciplines and cooperative arrangements must be devised to underpin the next phase of globalization led by digital flows.

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Notes

1. While income inequality has risen *within* many countries, which is the focus here, inequality *between* countries has fallen, thanks to faster-growing emerging economies that are narrowing the income gap with advanced economies. However, technological change poses new challenges to this process of convergence as automation erodes the comparative advantage based on low-cost, low-skilled labor that has propelled many emerging economies' growth.
2. Frontier firms in this estimate are defined as the top 5% firms with the highest labor productivity within each industry. Non-frontier firms cover all other firms. The estimate covers firms in twenty-four OECD countries.
3. 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).
4. OECD Employment Database.
5. US Bureau of Labor Statistics data.
6. Most major economies experienced this pattern. In the United States, while net private wealth increased from 326% of national income in 1970 to about 500% in 2015, net public wealth fell from 36% to -17% (Alvaredo et al., 2018).

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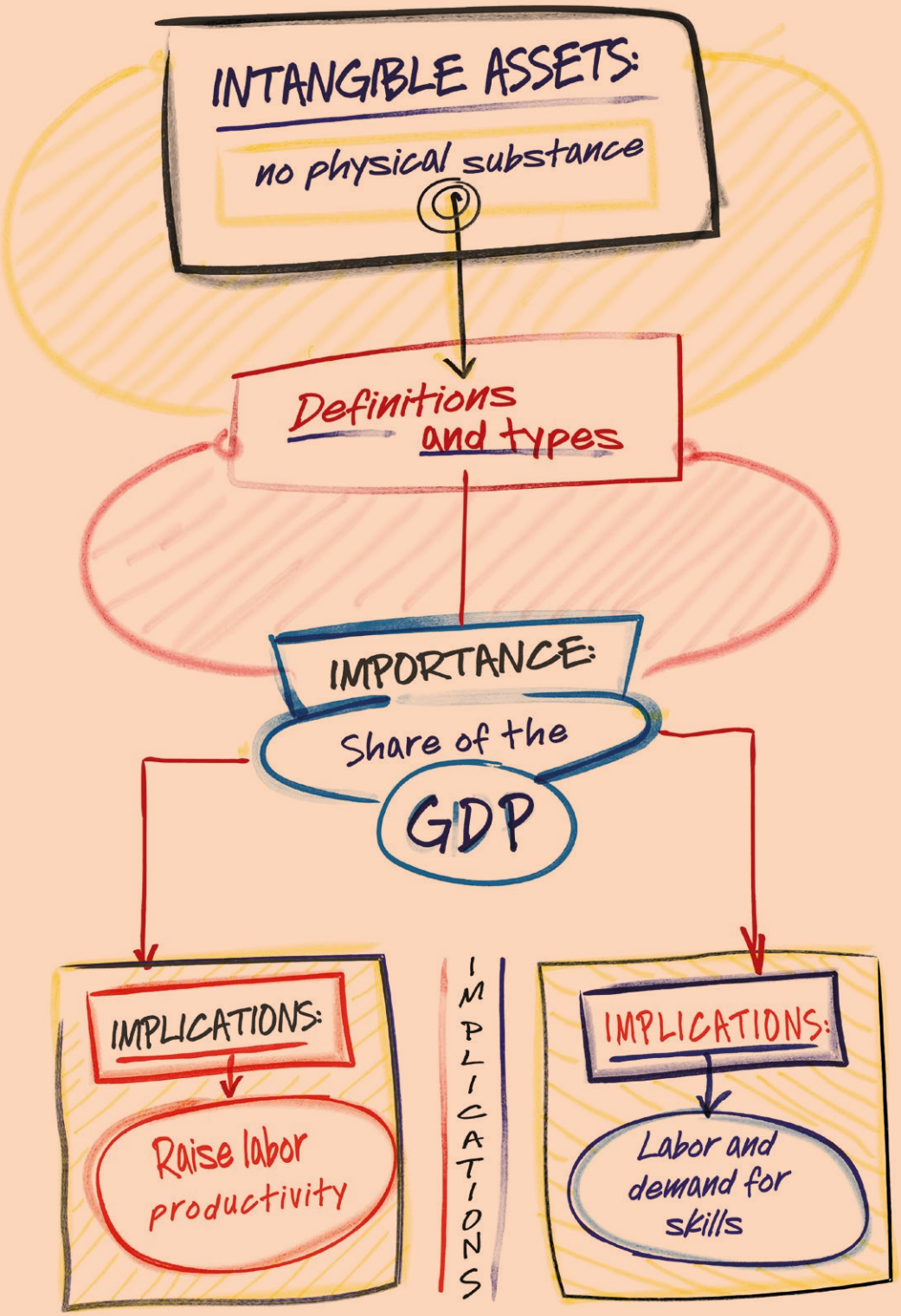

INTANGIBLE ASSETS:
no physical substance
Definitions and types
IMPORTANCE:
Share of the GDP
IMPLICATIONS:
Raise labor productivity
IMPLICATIONS
IMPLICATIONS:
Labor and demand for skills

Intangible Capital, Productivity, and Labor Markets

Mary O'Mahony

Modern production requires increasing use of intangible assets such as computerized information, innovation-generating activities, and organizational capital. Investments in these assets have been growing rapidly over the past few decades. They represent a greater share of aggregate economic activity in the United States than in Europe, although some European countries such as Sweden invest more than the US. Intangible assets are an important contributor to raising labor productivity growth, both directly through increasing capital per worker and indirectly through changing production practices. However, there is evidence that they are associated with a reduced return to labor, especially for workers with skills below university level.

Introduction

Funding from the European Union Framework Programmes for Research has led to a greater understanding of the magnitudes of the role of intangible assets in explaining economic activity.

In recent years there has been considerable interest, both in the academic and policy communities, in evaluating the impact of investments in intangible assets on economic activity. These investments have not generally been well measured in official economic statistics, with only a few asset types, such as software and artistic originals, and more recently research and development expenditures, currently included in national accounts. Intangible assets have often been described as the "missing input," whose inclusion in economic statistics might affect performance at the aggregate economy, sector, or firm level. Recently, an extensive research effort has been put in by economists to measure the value of intangibles, their growth over time, and their impact on productivity, as reviewed below. Less research has been carried out on their impact on labor markets or on the type of work carried out in firms, so the evidence presented is more limited.

This chapter first reviews the literature on measuring intangibles, at both the aggregate economy and industry levels. It then presents evidence on intangible capital's impact on productivity, including some recent work at the firm level. This is followed by a discussion of the extent to which intangibles substitute or complement different types of workers. The chapter reports on some recent work examining the impact of intangibles on aggregate labor's share of GDP.

The research reported in this chapter owed considerably to the willingness of the European Commission Framework Programmes to fund cross-country comparative research, first at the aggregate economy level in the projects COINVEST and INNODRIVE, at the industry level in the project INDICSER, and for the public sector in the project SPINTAN.[1]

What Are Intangible Assets?

Investment in intangible assets are expenditures by firms on activities that raise future output but have no physical substance.

Computer software together with large databases have been recognized as intangible fixed assets in national accounts since the mid-1990s, while R&D was added recently

Investments in intangible assets are widely recognized as major determinants of innovation, growth, and employment in the "knowledge economy." The pioneering work on measuring intangibles was by Corrado, Hulten, and Sichel (2005, 2009), hereafter CHS, who addressed the conceptual problem of defining intangible assets using an inter-temporal framework. These authors concluded that "any use of resources that reduces current consumption in order to increase it in the future qualifies as investment." In this analysis they argue that all types of capital, intangibles as well as tangible assets such as structures and equipment, should be treated symmetrically. CHS developed expenditure measures for intangible investment in the United States, classifying intangible capital into three broad categories: computerized information, innovative property, and economic competencies. At that time only software and artistic and entertainment originals were recognized as assets in official guidelines for national accounts. Since then, the national accounts fixed asset boundary has been expanded to include R&D, as set out in the *System of National Accounts 2008*. The pioneering measurement effort for the US by CHS broadened the scope of intangible assets to include a greater range of asset types and, in turn, spurred a research effort to measure these assets and their impacts for a larger group of, mostly developed, countries—see Corrado et al. (2017a) for a review.

Table 1 summarizes the CHS list of intangible assets, dividing into the market sector (on the left) and the nonmarket (public) sector (on the right). Computer software together with large databases were recognized as intangible fixed assets in national accounts since the mid-1990s. Research and development, defined as the value of expenditures that lead to an increase in the stock of knowledge, was added recently, as noted above. Non-national accounts intangibles include innovative property, other than R&D, designed to capture a range of assets that may have intellectual property protection associated with them, for example design rights. Economic competencies, instead, aim at capturing a range of knowledge assets that firms invest in to run their businesses, but that might have no intellectual property rights. These include the costs of marketing and launching new products, including ongoing investments to maintain the value of a brand, and firm-provided human capital in the form of training (CHS, 2005, 2009).

Economic competencies also include organizational capital which is conceptually more complex and has a different characterization according to whether we refer to the business or public sectors. Organizational capital is the cumulated knowledge that is built up in firms through investment in organizing and changing the production process. These investments can be purchased externally by the firm, by spending on management consultancy, or can be produced within firms, known as own account. CHS see own-account organizational capital as knowledge produced by persons in authority in a firm (managers), which yields a firm specific capital good jointly produced with output, and embodied in the organization itself. In the public services there may be other high-level employees who also possess authority, and so the definition of own-account organizational capital needs to be broadened to include some professionals such as senior doctors, who have the specific knowledge to set goals and the authority to ensure they are implemented.

There are many similarities in the types of assets in the business and public sectors, as described in Table 1. While the character of some assets is rather different when produced by public institutions, for example public investments in brand include information on health and safety, this is not so different from investments in activities that promote new products in private firms. Likewise, computer software, purchased investments in organizational capital, and employer-provided training are similar in the two sectors. As well as the differences in organizational capital referred to earlier, open data and cultural assets need to be added. Open data refers to information assets in the form of publicly collected data for general use, such as spending on statistical agencies, the weather service, and so on. Cultural assets are public intangible assets whose services are used in production in cultural domains as defined by the UNESCO Framework for Cultural Statistics.

How Important Are Intangible Assets?

Intangible assets represent a greater share of GDP in the US than in the EU.

Data on intangible investments by asset type are publicly available[2] and have been

From 1995 to 2015, Sweden had the highest share of intangible investment in GDP, relatively higher than the US and France (which had a similar share to the US). The intangibles shares were particularly small in Spain and Greece

described and analyzed in a series of papers (see Corrado et al., 2013; 2017a; 2017b). Figure 1 shows the share of each asset in total intangibles for the market for the United States in 2015. Software and databases accounted for 17% of total intangible investments. Innovative properties accounted for 38% overall. Within this group R&D has the largest share, but artistic originals and mineral oil exploration and design also have significant shares. The remaining 45% is accounted for by economic competencies with organizational capital representing more than half of this group.

The data for the market sector shows that the average share of intangible investment in GDP across the period 1995 to 2015 was relatively higher in the US (14%) than in the average across EU countries (10.5%). However, there is significant variation within the EU. Figure 2 shows that the intangibles share tends to be significantly higher in northern and central European countries, than in southern and eastern countries. Sweden had the highest share of any individual country, surpassing the US, with France having a similar share to the US. The intangibles shares were particularly small in Spain and Greece. Corrado el al. (2016) show that the investment gap between the EU and the US is more related to the lower contributions of computer software and databases, artistic originals, mineral exploration, brand and training than to the contribution of R&D.

Finally, the constructed datasets also show that the market sector dominates and accounts for the lion's share of intangibles in all countries covered. The GDP share of intangible investment in the nonmarket sector accounted for 1% of GDP in EU countries, on average, in 2010, contrasting with the about 10% of GDP for the market sector. In the US the share of GDP of nonmarket intangibles was 2.6% at the same time, so there was an American lead also in nonmarket intangibles. The evidence suggests that the most knowledge-intensive economies, the UK and Sweden, experienced faster accumulation of intangibles in the nonmarket sector compared to most of the other EU countries.

Intangible Assets: Impacts on Productivity

Intangibles have a large impact on raising output per worker, both directly through providing more capital per worker, and indirectly through knowledge spillovers on productivity.

One of the motivations for constructing measures of intangible assets at the aggre-

Market Sector	Nonmarket Sector
Computerized Information · Software · Databases	Information, Scientific and Cultural Assets · Software · Databases including open data
Innovative Property · R&D, broadly defined to include new product development costs · Entertainment and artistic originals · Design · Mineral Exploration	Innovative Property · Basic and applied science research, industrial and defense R&D · Cultural and heritage · Design · Mineral exploration
Economic Competencies · Brand · Own-account managerial capital · Purchased organizational assets · Employer-provided training	Societal Competencies/Social Infrastructure · Brand · Own-account professional/managerial capital · Purchased organizational assets · Employer-provided training · Schooling-provided education

Table 1. Classification of intangible assets.

(Source: adapted from Corrado et al. [2017a], table 1.)

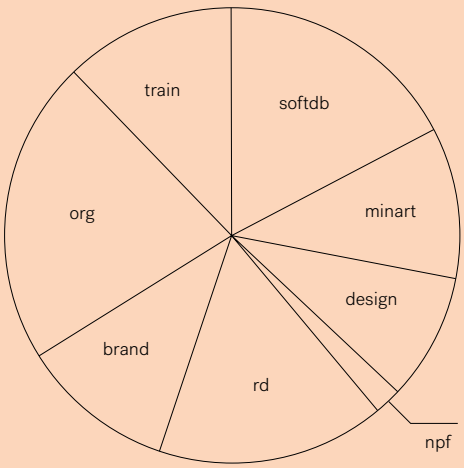


Fig. 1. Shares of intangible assets by type, US, 2015.

Asset types: softdb (software and databases); minart (entertainment, artistic and literary originals + mineral explorations); design; nfp (new product development costs in the financial industry); rd (research and development); brand; org (organizational capital); train (firm-provided training).

(Source: www.intaninvest.net.)

gate economy level was to try to explain differences across countries in productivity growth—in particular why the US experienced a productivity upsurge in the decade from 1995 which was not matched in Europe; see Timmer et al. (2010) for a discussion of comparative productivity trends during this period. Here we distinguish between the growth in labor productivity (output per worker-hour) and total factor productivity (TFP) which is defined as output growth minus the weighted growth of labor and capital inputs.

Corrado et al. (2013), using a growth accounting framework,[3] show that, over the period 1995–2007, intangible capital accounted for 28% of labor productivity growth in the US, compared to 23% in the EU. Within Europe, intangibles accounted for close to the US percentage points in the UK and Nordic countries, but was significantly lower in Spain and Italy. Their results show that intangibles can explain some of the growth gap between the US and Europe during this period, but most of the gap remains unexplained. The contribution of TFP to labor productivity growth was nearly 40% in the US compared to only 19% in the EU. In a more recent paper Corrado et al. (2016) provide growth accounting evidence before and after the great recession in 2008–09. The major findings were that tangible investment fell massively during the great recession and has hardly recovered, whereas intangible investment has been relatively resilient. Intangible investments recovered fast in the US but lagged behind in the EU. However, their analysis shows that since the great recession, the slowdown in labor productivity growth has been driven by a decline in TFP growth with relatively minor roles for both tangible and intangible capital.

An issue with the growth accounting framework is that it cannot account for any impacts of intangible capital directly on TFP. This relates to an earlier literature, based on evidence at the firm level, that suggested that gaining benefits from new technologies, such as information and communications technology (ICT), required significant additional investments in research, training, and organizational changes, which are part of intangible investments. Therefore, an examination of these interactions required researchers to go beyond growth accounting and instead use an econometric approach. These efforts investigated the presence of knowledge externalities, often called spillovers, that are suspected if the estimated marginal product of a factor exceeds the marginal product implied by the factor remuneration under competitive markets. Knowledge generated by the use of intangible capital has benefits above those accruing to the owners of those assets.

Using data for the market economy for thirteen countries, Roth and Thum (2013) suggest that, once accounting for business intangibles, the combined impact of greater capital per worker-hour, which includes both tangible and intangible capital, becomes the dominant source for explaining labor productivity growth, with a diminishing explanatory power from TFP growth. In econometric production function estimates, these authors report a coefficient on intangible investment of about one-quarter—this turns out to be much higher than the coefficient identified by this asset's factor share in growth accounting.

A first attempt to produce internationally comparable estimates of intangible investments at the industry level was undertaken by Niebel at al. (2014). The growth accounting estimates by industry suggest that the importance of intangible capital assets by type varies across sectors, with R&D the most important asset in manufac-

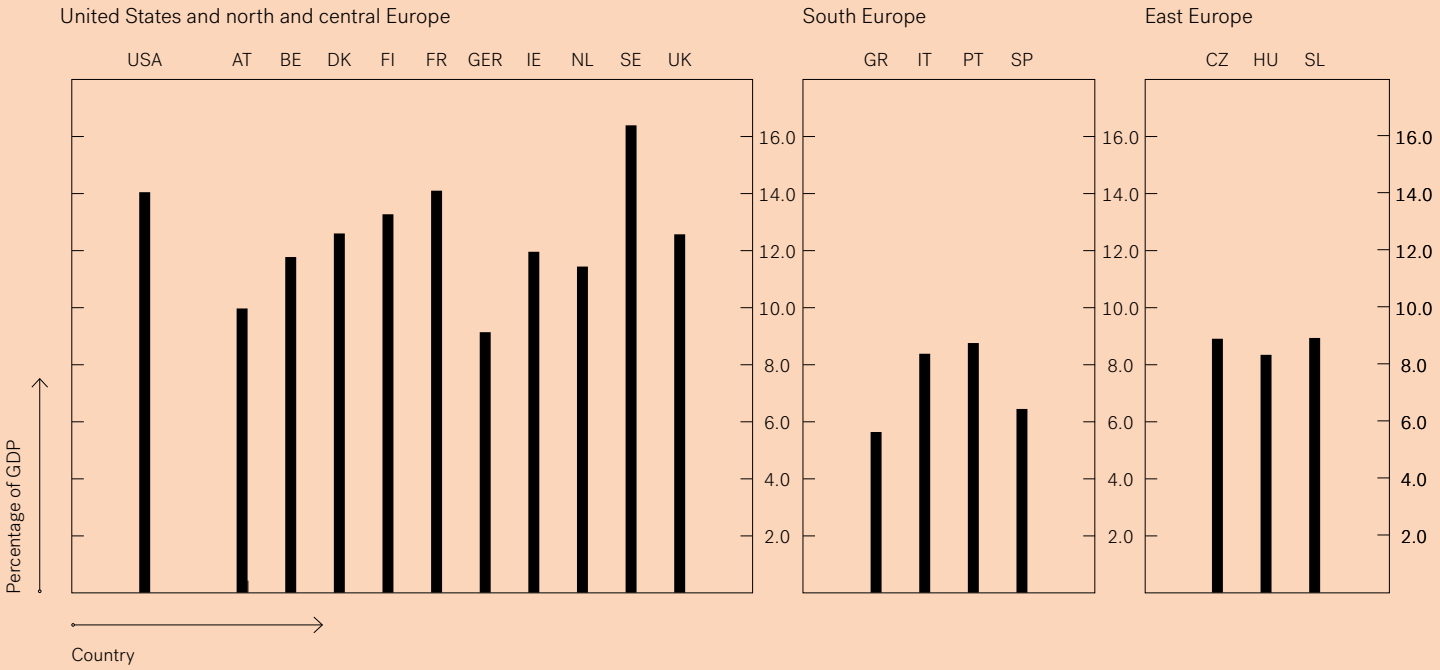


Fig. 2. Intangible investments as a share of GDP, market sectors, average 1995–2015.

Countries: US: United states; AT: Austria; BE: Belgium: DK: Denmark; FI: Finland; FR: France; GER: Germany; IE: Ireland; NL: the Netherlands; SE: Sweden; UK: United Kingdom; GR: Greece; IT: Italy; PT: Portugal; SP: Spain; CZ: Czech Republic; HU: Hungary; SL: Slovenia.

(Source: www.intaninvest.net.)

turing whereas organizational capital dominates in many service sectors. In terms of contributions to labor productivity growth, however, there appear to be common sectoral patterns across countries, with high investment in all sectors in some countries (the UK and the Netherlands) and low investment in others (Italy and Spain). The paper performed an econometric estimation of the relationship between indicators of intangible capital and labor productivity growth at a sectoral level. This confirms the positive impact of intangible capital on economic performance as found by previous authors. However, the paper estimates an impact of intangibles, ranging from 10% to 17%, which is much lower than the coefficients using aggregate data. This finding suggests that unexplained heterogeneity at the macro level is likely to account for this difference and such biases are partially addressed using industry data. Nevertheless, these estimates remain higher than average growth accounting impacts, consistent with spillovers from this asset type.

Corrado et al. (2017b) also find large magnitudes for the impact of intangible capital. Their results strongly support the possibility of productivity spillovers. Moreover, they find evidence of a complementarity between intangible and ICT capital—the output elasticity of intangible capital depends upon ICT intensity. Therefore, it appears that returns to ICT depend crucially on the presence of "unmeasured" intangibles.

Another group of studies examined productivity at the firm level, using information on occupations of different types of labor (e.g. IT workers, R&D staff, and managers) to measure intangible investments. Looking across sectors, the association between R&D intangible assets and productivity was found to be positive in many industries, but appears particularly strong in mining and quarrying, and high-technology manufacturing. IT capital provides a significant and positive contribution across all sectors. Organization capital has a significant and positive contribution in nearly all sectors. In more mature, low technology manufacturing sectors (such as wood products or textiles), where R&D is not as significant, organizational capital is particularly important. This illustrates these sectors' reliance on achieving economic performance increases through process innovation rather than technological innovation (Riley and Robinson, 2011).

Overall these research efforts point to an important role of intangible capital in facilitating increases in labor productivity and TFP growth. With greater amounts of intangible capital to work with, output per hour of employee time is increased, and the additional knowledge generated and reorganization of production processes increases underlying productivity. However, this does not tell us much about the use of different types of labor, their employment and the returns they receive in the labor market. We now turn to this important issue.

Intangibles and the Labor Market

Intangible assets appear to substitute for labor overall, with those with low-skill levels most adversely affected.

In their recent book, *Capitalism Without Capital: The Rise of the Intangible Economy*, Haskel and Westlake (2018) point to a major shift in the way modern firms do business. Much investment is now in the form of intangible assets, but do these assets complement or substitute for labor? The answer is that we do not know but the available evidence suggests that overall labor may have lost out from this phenomenon. Traditionally economists studied the substitution/complementarity relationship by estimating production functions, employment equations or labor share of value-added equations, where the latter takes account of both impacts on earnings and employment. Difficulties in measuring intangible assets until recently implied there was very little direct evidence of the interactions between this type of capital and labor.

O'Mahony et al. (2019) is one of the few papers that directly looks at the impact of intangible capital on labor's share of value added. Using panel data for industries and countries, and the data constructed by Niebel et al. (2014) referred to above, they suggest that overall the impact is to lower labor's share, suggesting intangible assets substitute for labor. When intangibles are divided into innovative property and economic competencies, however, these interactions become more complex. While investments in innovative property such as R&D appear to complement labor,

The major findings were that tangible investment fell massively during the great recession and has hardly recovered, whereas intangible investment has been relatively resilient

Knowledge generated by the use of intangible capital has benefits above those accruing to the owners of those assets

Staff at the Frieder Burda Museum in Baden-Baden hang up *Love is in the Bin* by Banksy, which was partially destroyed seconds after it was sold at a Sotheby's auction. The artwork was on display for a few months at the German museum

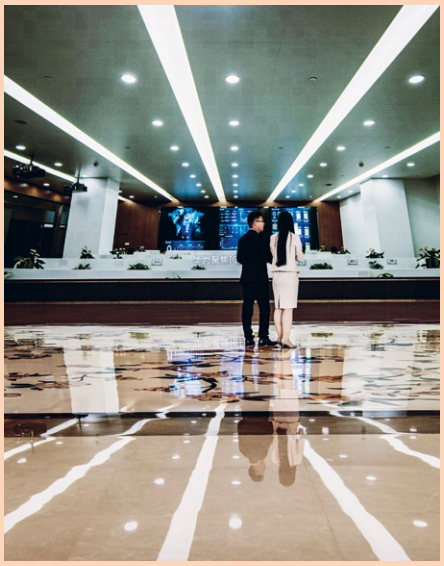
the much larger investments in brands, firm-provided training, and organizational capital appear to substitute for labor. The authors also divide labor into those with high-level skills—university degrees and equivalents—and all other workers. Intangible capital affects these two types of labor in different directions, complementing the higher-skill workers and substituting for other workers. The former can be seen as a continuation of skill-biased technical change which was shown to be a significant driver of inequality between workers in a vast number of studies, stemming from the wave of technological changes related to ICT. While ICTs require specific high-level skills in their implementation, it is not so immediately clear why intangible assets should do so.

In the case of firm-provided training, there is ample evidence that this is most likely to be provided to workers who already possess high-level skills—see O'Mahony (2012) for a detailed examination of this intangible asset by country and sector in Europe. The direction of the effect for investing in organizational changes is not clear but we might expect that implementing changes would increase the demand for generic skills in communication and team working that are commonly associated with university level qualifications, and reduce demand for workers who do not possess skills compatible with new production methods.

The impact of brand development is more nuanced. There is a growing body of literature that suggests that profits have been rising, especially for firms in high-tech sectors which are those most likely to be investing in intangible capital. This literature suggests that it is not so much a question of substitution of capital for labor but rather an increase in markups or profits that reduce labor's share. Brand development is one way that firms can ensure they capture a greater share of their market pies. If correct, this development is likely to lead to greater disparity between workers and owners of capital and especially adversely affect the bargaining power of lower-skilled workers who are more easily replaced by technology.

Overall, the impact on labor markets of the growth in intangible capital is likely to have been associated with greater inequalities, between the high skilled and those with lower skills and between the owners of capital and workers. The important question for policy is will this persist? It may be that we are in a period of transition to new forms of production requiring new skills and competencies which become embodied in labor and raise that input's return in the long run. A less sanguine scenario is that these increased investments have led to a period of concentration of production in the hands of very large firms, increasing profits for the few, at the expense of wages for the many. Only time will tell if the more optimistic or pessimistic scenarios will prevail.

Brand development is one way that firms can ensure they capture a greater share of their market pies. If correct, this development is likely to lead to greater disparity between workers and owners of capital, and above all adversely affect the bargaining power of lower-skilled workers



New Huawei R&D campus in Dongguan, near Shenzhen, which is considered China's Silicon Valley

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Notes

1. See the following websites: www.coinvest.org.uk; www.innodrive.org www.indicser.org; www.spintan.net. These efforts were made possible by the European Union's Framework Programmes for Research, under grant agreements nos: 217512; 214576; 244709; and 612774.
2. Available on www.intaninvest.net for market sector, www.spintan.net for public sector.
3. Growth accounting decomposes output growth into the growth of inputs and TFP where the former (usually capital and labor) are weighted by their payment shares in the value of output. This method relies on the specification of a neoclassical production function with perfect markets and constant returns to scale.

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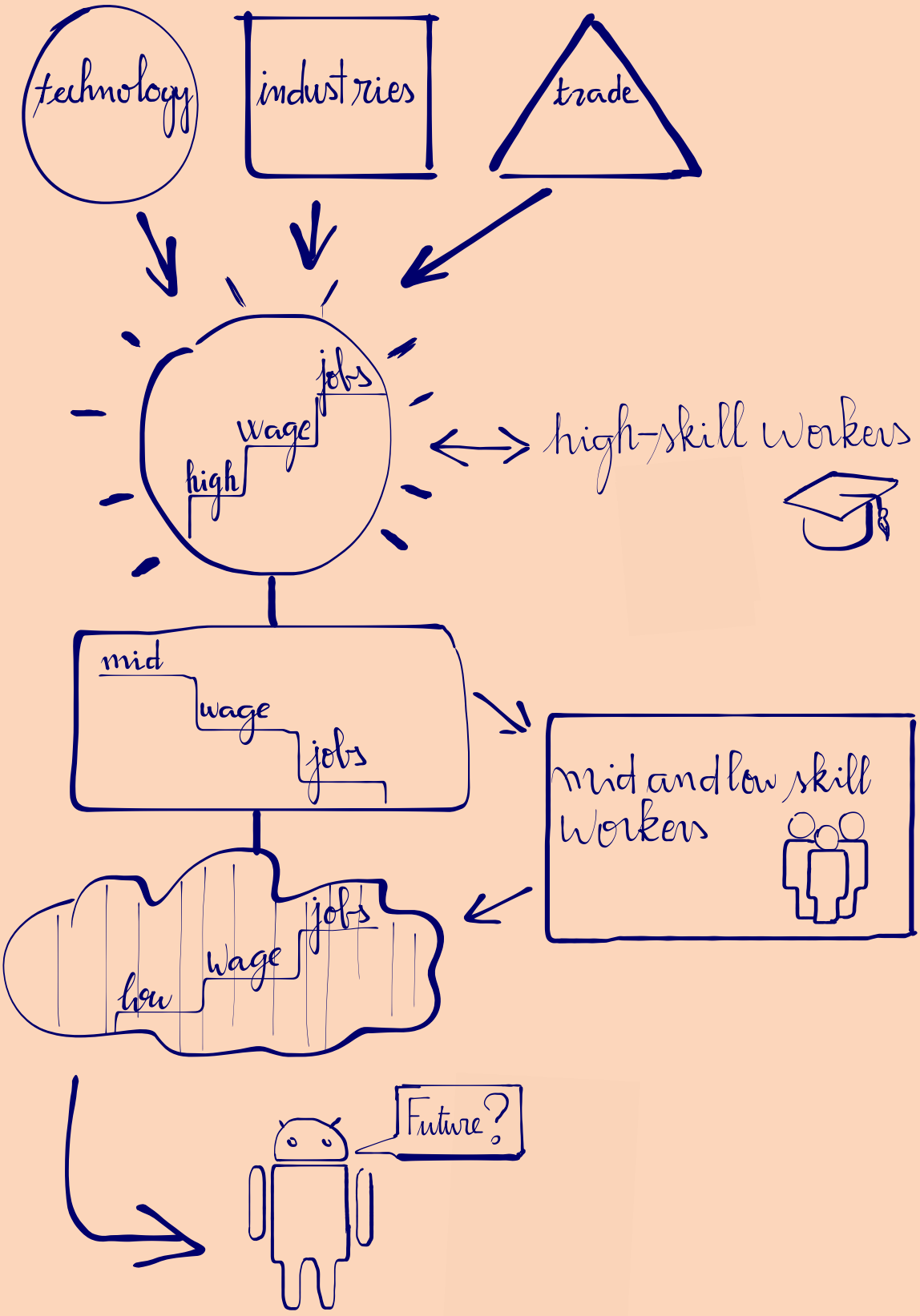
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Future?

The Causes and Consequences of Job Polarization, and Their Future Perspectives

Michael J. Böhm

Job polarization is a major trend that took place in advanced countries' labor markets over the past several decades. This article uses administrative data as well as established sources from the literature to achieve three aims: first, it shows how the rise of high- and low-wage occupations, and the commensurate decline of traditional mid-wage occupations, has had adverse effects on the less-skilled share of the workforce. It then identifies the underlying driving forces of job polarization, which include biased technological changes, international trade and offshoring, and pervasive shifts of the industry structure, among others. Finally, the article provides an outlook of the trends to come, for example, whether in future some high-wage jobs may decline, and discusses the interaction with policy.

Job Polarization and Its Consequences for Workers

The distribution of jobs is one of the most important characteristics of a labor market. When employment in an economy is characterized by well-paying and secure jobs that give their holders purpose and a sense of producing something valuable, this can provide many wider benefits to the individuals, their families, and society at large.[1] Changes of employment across jobs are also a driver of the rising inequality of wages and earnings in various countries (Acemoglu and Autor, 2011; Böhm, 2019; Böhm et al., 2019). Finally, the current debate about the changing nature of work, that is, because of smart robots or artificial intelligence, is mostly about which jobs will rise (be newly created) or decline (disappear).

The changing distribution of jobs could mean several things, including trends of employment or wages in occupations such as doctors, machine operators, and cleaners; or in industry sectors such as manufacturing and services. It could also imply a changing share of individuals in part-time as opposed to full-time work or temporary as opposed to permanent employment. When labor economists nowadays think about the changing distribution of jobs, most of them would have in mind the so-called trend of "job polarization." In my view, this trend is rightly very prominent because job polarization is so forceful and pervasive that it decidedly altered the labor market composition of most advanced economies. In this article, I will discuss the effects that job polarization has had on workers, the causes that underlie it, and give an outlook on how these trends might evolve in the future. I begin by describing the facts.

Goos and Manning (2007) were among the first to show that over the preceding thirty years employment shares of the occupations with the highest and lowest (mean or median) wages had increased in the United Kingdom, whereas employment shares of middle-wage occupations had plummeted. Goos and Manning (2007) were also the first to coin the term "job polarization" in this context. Around the same time, Autor, Levy, and Murnane (2003) found that the employment share of codifiable routine occupations, which are often middle-wage jobs, had dropped in the United States, too. Spitz-Oener (2006) soon showed evidence along those lines for Germany; later came

Adermon and Gustavsson (2015) for Sweden, and Green and Sand (2015) for Canada, among many other countries.

Figure 1 presents one way of depicting job polarization for Germany, using data from my ongoing cooperation with my colleagues Hans-Martin von Gaudecker and Felix Schran (2019). These data come from unique administrative records of the German unemployment insurance, containing individual-worker panel information and detailed occupations. I collapse the detailed occupations into four mutually exclusive and exhaustive groups, which include managers, professionals, and technical (Mgr-Prof-Tech); sales and office (Sales-Office); production, operator, and crafts (Prod-Op-Crafts); and services and care (Srvc-Care) occupations. This is similar to Acemoglu and Autor (2011)'s classification into four broad occupation groups for the US.

Panel A of fig. 1 shows that, even in Germany with its large and historically successful manufacturing sector, the employment share of Prod-Op-Crafts declined strongly during the three-and-a-half decades between 1975 and 2010, dropping from almost 55% to around 35–40%. At the same time, the employment shares of all other occupation groups increased. Panel B depicts annual full-time equivalent wages in the occupation groups, with earnings in Mgr-Prof-Tech substantially higher (55% on average) than in Prod-Op-Crafts (and in Sales-Office), which in turn are decidedly higher (33%) than in Srvc-Care. Therefore, jobs in Germany are clearly polarizing, too, in the sense that employment in middle-wage occupations is continuously declining whereas employment in high- as well as low-wage occupations is rising.[2]

As mentioned above, job polarization is a transformative change of the economy

Job polarization is a transformative change of the economy because employment in high-wage occupations is rising, which should be a good thing. But employment is also rising in low-wage occupations

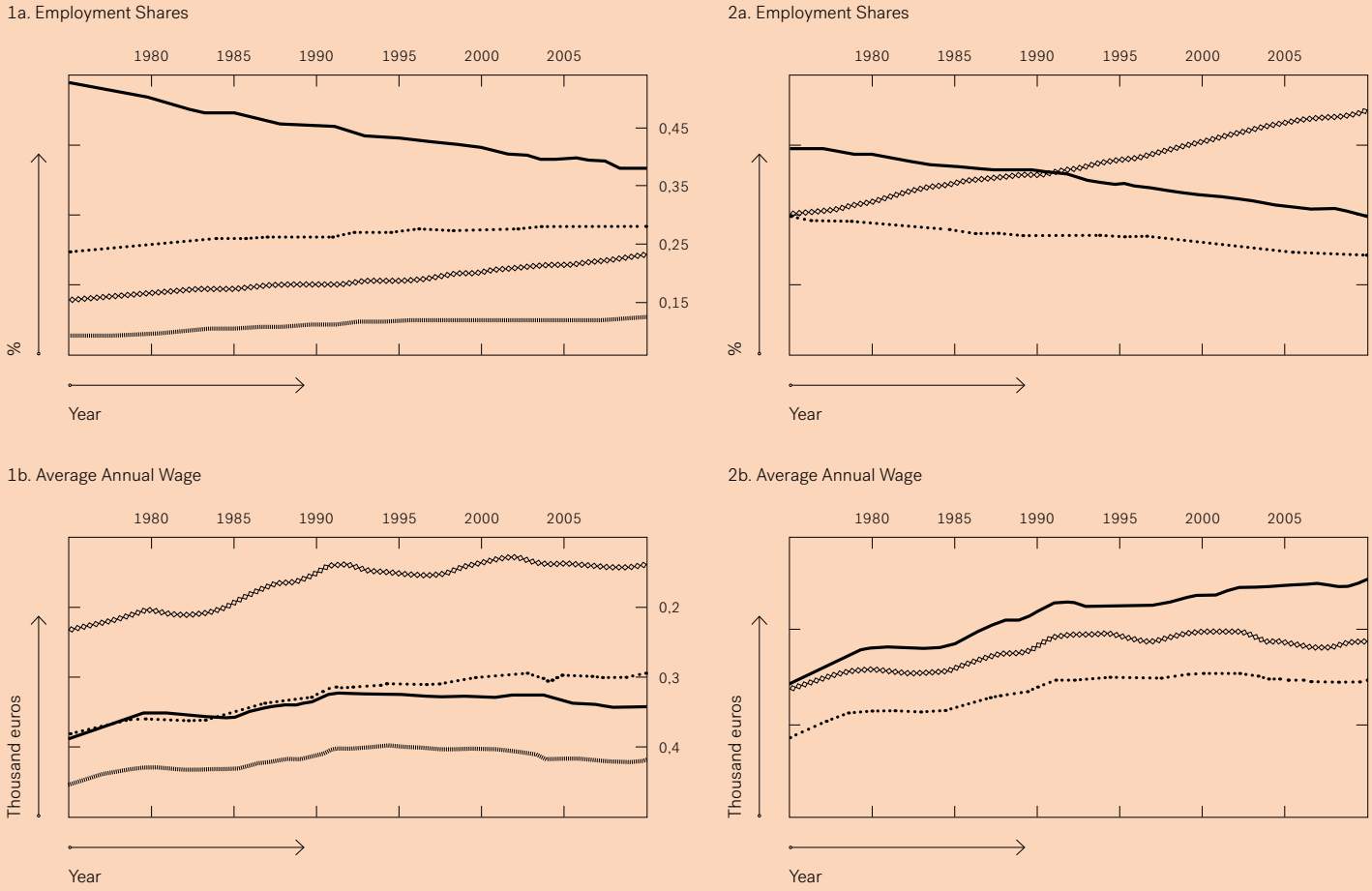

Fig. 1. Employment and wages by broad occupation

SIAB 2% random sample of administrative social security records from 1975 to 2010 provided by the IAB institute. Sample restricted to West German males and females aged twenty-five to fifty-four (c. 450,000 unique individuals). Occupation groups are managers, professionals, and technical (Mgr-Prof-Tech); sales and office (Sales-Office); production, operator, and crafts (Prod-Op-Crafts); and services and care (Srvc-Care). Daily wages accumulated to annual full-time equivalent earnings (in 2010 euros).

Mgr-Prof-Tech
Sales-Office
Prod-Op-Crafts
Srvc-Care

Fig. 2. Employment and wages by broad industry sector

For data source, sample selection, and wage definitions see notes to fig. 1. Industry sectors are processing of primary materials, machinery and car production, and construction business (manufacturing); food, hospitality, repair services, wholesale trade, and retail trade (low-skill services); professional and related services, finance, insurance and real estate, transport and communications, utilities, education, and public administration (high-skill services).

High-skill services
Low-skill services
Manufacturing

Knowing the reasons for job polarization offers the opportunity to understand several key trends in the labor market over the past decades but also promises insights into what may happen in the future

In Western countries, Prod-Op-Crafts jobs drastically declined, while Mgr-Prof-Tech and Srvc-Care increased. In addition, wages in Mgr-Prof-Tech increased relative to the other occupations

exactly because employment in high-wage occupations is rising, which should be a good thing. But employment is also rising in low-wage occupations, with many workers who previously (would) have done Prod-Op-Crafts jobs now employed in Srvc-Care occupations. Sticking to my German example, Table 1 shows the employment of high-, medium-, and low-educated workers in the four broad occupations. We see that Prod-Op-Crafts have been by far the largest employer of low- and medium-educated workers with shares of 69 and 52%, respectively. However, these shares have declined substantially over time, dropping by seven percentage points each. Especially in the case of medium-educated workers, this drop has gone in hand with substantial occupational downgrading. That is, almost all of the decrease in Prod-Op-Crafts employment is accounted for by an increase of employment in low-wage Srvc-Care occupations.

In contrast, Prod-Op-Crafts never played a particular role for highly educated workers and the decline of employment in it is almost negligible.[3] Therefore, in the past Prod-Op-Crafts appears to have been a particularly attractive employment opportunity for medium- to low-educated workers (among them especially men). This has continuously diminished over time in Germany as well as in other Western countries such as the US or the UK.[4]

The decline of middle-wage Prod-Op-Crafts jobs is a reason for concern not only because of the lower wages that those medium- and low-educated workers are earning, who are now instead in low-wage Srvc-Care occupations. It is also potentially problematic because further important job characteristics, such as union coverage, full-time and permanent contracts, health insurance and other benefits, as well as alternative work arrangements (one-hour contracts, pseudo self-employment, etc.), are substantially more advantageous in Prod-Op-Crafts than in Srvc-Care and even than in some of the Mgr-Prof-Tech and Sales-Office occupations.

As an illustration of these differences with respect to additional dimensions of job quality, Table 2 reports the transition rates of the four occupation groups. We see that Srvc-Care has by far the lowest rate of job stability with less than 85% of workers staying in the occupation group over a period of two years. That is, the turnover rate is almost 16%. In contrast, Prod-Op-Crafts features high job stability, or low turnover, almost at par with Mgr-Prof-Tech. Everything might be fine if many of the workers leaving Srvc-Care were transitioning into higher-wage occupations. Unfortunately, this is not the case either: more than 9% of all Srvc-Care workers are not in employment two years later; once again, much higher than in any of the other occupations. Therefore, Table 2 presents one illustration why also in non-wage dimensions the Prod-Op-Crafts occupations of the past have been very attractive jobs, and why the rise of Srvc-Care may be problematic in these dimensions too.[5]

The rest of this article will investigate in detail the reasons for these striking, and at least partly worrying, changes of the employment structure, for the German example shown here as well as advanced econ-

Origin (t) ↑

	Low	Change	Medium	Change	High	Change
Mgr-Prof-Tech	3,7	*+3,8*	13,0	+0,0	77,4	−14,4
Sales-Office	12,4	*+1,0*	27,6	+1,2	14,7	+13,7
Prod-Op-Crafts	68,9	*−7,0*	51,9	−7,1	6,1	−1,4
Srvc-Care	15,0	*+2,3*	7,5	+5,8	1,8	+2,1

→

Employment by education level (1975) and changes (2010–1975), in %

Table 1. Occupational employment by level of education

For data source, sample selection, and occupation definitions see notes to fig. 1. Low-education group are high-school graduates below Abitur with no apprenticeship training (i.e., no post-secondary education). Medium are Abitur holders or apprenticeship training. High are college graduates (general university or university of applied sciences). The columns sum to 100% (levels) and 0% (changes), respectively.

Origin (t) ↑

	Mgr-Prof-Tech	Sales-Office	Prod-Op-Crafts	Srvc-Care	Non-Empl
Mgr-Prof-Tech	91,7	3,0	1,4	0,5	3,4
Sales-Office	2,4	89,9	1,4	0,7	5,6
Prod-Op-Crafts	1,3	1,2	91,3	0,9	5,3
Srvc-Care	1,3	2,3	3,0	84,4	9,1

→

Destination (t + 2), in %

Table 2. Two-year transition rates by origin occupation

For data source, sample selection, and occupation definitions see notes to fig. 1. The Table shows percentage shares of destination occupations or non-employment in year t+2 for workers originating in one of the four origin occupations in t. Rows sum to 100%.

omies more broadly. I will also speculate on the prospective developments of these trends, whether, for example, with improvements in artificial intelligence, jobs at the fringes of the wage distribution will start to decline in the future.

What Are the Underlying Causes of Job Polarization?

What are the drivers of transformative and long-running shifts of the distribution of jobs? Knowing the reasons for job polarization offers the opportunity to understand several key trends in the labor market over the past de-cades but also promises insights into what may happen in the future.

The most prominent explanation for polarization is routine-biased technical change, originally due to Autor, Levy, and Murnane (2003, henceforth ALM). ALM argued that in order to understand the impact of information and communication technology, especially computers and other programmable machines, on the labor market, one would have to focus on the tasks that they are good at performing. At the time of ALM's writing and up until recently, these were the tasks that could be described by clear rules and procedures that a machine lacking flexibility and judgment can follow at each possible contingency. Computers and computerized machines have therefore been highly productive and reliable at performing tasks that programmers could codify; but also not very productive at anything else. The scientific literature has followed ALM thereafter and referred to these tasks as "routine," in the sense that they are sufficiently well understood to be fully specified in a series of codes to be executed by a computer.

ALM then went on to show that occupations that contained many routine tasks as part of their job descriptions were often in middle-wage cognitive and manual occupations such as record-keeping and calculation; repetitive customer service; repetitive picking, sorting, and assembly; or monitoring jobs. Occupations that had a lot of such job content were therefore at risk of being dissembled into their constituent parts, with the routine tasks now carried out by computers, or outright replaced by programmable machines. These are approximately the Sales-Office and Prod-Op-Crafts occupations shown in fig. 1 above (see also discussion in Acemoglu and Autor, 2011, who use a similar broad occupation grouping).

At the other side of the spectrum, ALM argued, were jobs intensive in nonroutine problem-solving and complex communication tasks, which are characteristic of professional, managerial, technical, and creative occupations similar to the Mgr-Prof-Tech from above. These were at the top of organizational hierarchies or needed data and information as inputs and were thus complementary to routine tasks. When the overall amount of routine tasks rose, due to computers completing so many of them as humans would never be able to, the productivity and demand for nonroutine Mgr-Prof-Tech occupations rose. In addition, the relative demand for low-wage Srvc-Care occupations has also risen, according to ALM, as tasks such as waiting tables or nursing elderly patients were still beyond the realm of what computers could do.

Is ALM's routine-biased technical change hypothesis borne out in the data? We saw in fig. 1 that employment in Prod-Op-Crafts indeed drastically declined and that employment in Mgr-Prof-Tech as well as in Srvc-Care increased. In addition, wages in Mgr-Prof-Tech increased relative to the other occupations. These facts persist in essentially all Western countries (Acemoglu and Autor, 2011; Goos, Manning, and Salomons, 2014). The employment shares of Sales-Office are, however, rising in Germany. Also in the US the corresponding occupations are more or less stable, at least when considering a longer time frame from the 1960s onward, and surely even over the last few decades Sales-Office are not declining as fast as Prod-Op-Crafts (Acemoglu and Autor, 2011, fig. 13).

It seems that routine-biased technical change describes the data over the past decades pretty well with a partial exception of not matching the much stronger decline of Prod-Op-Crafts compared to Sales-Office. But maybe this is not surprising given that other powerful factors than computers seem to have worked on the labor market. Out of those, the factor that has received most attention recently is international trade and offshoring, in particular in relation to China. Mediated by the fall of Socialism in Eastern Europe, trade policy (especially China's joining of the WTO), as well as again information and communication technology, world trade has increased exponentially

A combination of biased technological change, international trade, and offshoring, together with the long-running changes of the industry structure, can explain the broad historical changes of employment that can be observed in most Western countries in recent decades

An employee secures the rear wheel of a tractor inside the Fendt GmbH agricultural machinery factory in Marktoberdorf, Germany

over the last twenty to thirty years. This is likely to have had an outsize impact on sectors and occupations producing tradable goods, many of which are in manufacturing industries and in Prod-Op-Crafts jobs.

After somewhat of a hiatus, Autor, Dorn, and Hanson (2013) were among the first to revisit the role of trade for the decline of manufacturing jobs in the US economy (see also Ebenstein, Harrison et al., 2014). Autor, Dorn, and Hanson show that local regions which were exposed to import competition from China by virtue (actually misfortune) of their initial industry mix (i.e., import-competing manufacturing industries) experienced rising unemployment, lower labor force participation, and reduced wages. Aggregating this effect to the whole US economy, Autor, Dorn, and Hanson show that import competition accounts for one quarter of the decline in manufacturing employment during 1990–2007.

International trade and offshoring may therefore well explain why employment in Prod-Op-Crafts occupations dropped so much even conditional on routine-biased technical change. However, it is probably still not the whole story for why jobs have polarized. First, the impact of trade was much more benign for Germany, and potentially several other advanced countries, than it was for the US. This is shown by Dauth, Findeisen, and Suedekum (2014), who find that overall there were more export-oriented regions in Germany that benefited from trade than there were import-competing regions. Also, the benefits in Germany accrued largely from trade with Eastern Europe rather than with China.

Second, rising trade with either world region did not start to take off before the 1990s, whereas the decline of Prod-Op-Craft occupations began much before that in Germany (fig. 1 above) as well as the US (Acemoglu and Autor, 2011, fig. 13). Computerization rates reported by Spitz-Oener (2006) make it also unlikely that routine-biased technical change had a massive impact on the German labor market before the late 1970s. Therefore, another, complementary explanation is needed and it is provided by Bárány and Siegel (2018). First of all, Bárány and Siegel document that job polarization started as early as the 1950s in the United States. They then link job polarization to another key change of the employment structure, this time across industry sectors: structural transformation.

Structural transformation is characterized by the shift of employment and value added away from agriculture (earlier) and manufacturing (nowadays) toward services industries. The reasons for structural transformation itself are still under debate, as is the case for job polarization. Most of the academic literature[6] explains structural transformation through a shift in consumption demands in response to technological change. These explanations are alternatively based on differential productivity growth across sectors or on non-homothetic preferences paired with growth in overall incomes. In the former case, uneven productivity growth induces changes in relative prices and, provided that sectoral outputs are complements in consumption, lead to a reallocation toward the sector experiencing lower productivity growth (Ngai and Pissarides, 2007). In the latter explanation (first formulated by Kongsamut, Rebelo, and Xie, 2001), any form of technological change reallocates consumption and thus overall output demands across sectors. Recent work by Boppart (2014) finds that both the consumption reallocations through price and through income effects explain about 50% each of structural transformation in the US.

Removing agriculture, Bárány and Siegel (2018) then split up the services industries into a high-skilled and a low-skilled sector based on consumption and average education considerations to show that employment in both of them have been increasing compared to manufacturing since the 1960s. As far as is possible, I replicate Bárány and Siegel's US evidence for my German example in fig. 2a. Again, we see that manufacturing's employment share has been declining continuously and quite steeply since 1975, while the employment share of high-skill services has risen sharply. Contrary to the US, low-skill services' share has also declined but consistent with Bárány and Siegel it did rise relative to manufacturing.

In addition, panel B of fig. 2 depicts the average wages of each sector. In line with the corresponding evidence above, we see that manufacturing wages are quite high. In fact, they are the highest out of the three sectors and they seem to be rising somewhat further over time. This underscores the point made above that the long-run decline of Prod-Op-Crafts/manufacturing employment poses reasons for concern; even

Technological development and its adoption is endogenous to other market outcomes, government regulations and policies, and fundamental societal changes

An important trend in which technology, policy, and general economic conditions have interacted is the rise of alternative work arrangements: temporary help agency workers, on-call workers, contract workers, and independent contractors or freelancers

Google Vice President and General Manager Phil Harrison speaks on stage during the annual Game Developers Conference in San Francisco, California, in March, 2019

in a country like Germany, which boasts a comparatively successful manufacturing sector, and, on balance, has not suffered from the expansion of international trade during the past decades.

I have argued that a combination of biased technological change, international trade and offshoring, and long-running changes of the industry structure can explain the broad historical changes of employment that are observed in Germany, the US, and most other Western countries over the past several decades. However, as readers might imagine by now, there exist further potential aspects to this, including the supply of skills (e.g., due to changes in the education system and population demographics), demand for low-skill services (Manning, 2004, Mazzolari and Ragusa, 2013), and the fact that recessions seem to accelerate job polarization (Jaimovich and Siu, forthcoming). These aspects may have worked in conjunction with the main driving factors to produce some of the differences in (the extent of) job polarization that can be observed across time periods and countries.

Future Perspectives and Interactions with Policy

Looking into the future is notoriously hard. Much of the research and policy debate focuses on the likely impact of rapid progress in artificial intelligence, digitization, and smart robots. One question is whether these technological advances will replace and therefore reduce an unprecedented amount of human labor or whether, in fact, a lot of new tasks for humans will open up in the ensuing economic transformation, and what the transition path and timing might look like (e.g., Acemoglu and Restrepo, 2018a). Equally important is the question of which tasks will be replaced that were up to now shielded from technology or trade, and whether job polarization will continue or jobs at the top or bottom end of the wage distribution will be more affected.

The current fundamental shift of technology is that codifiability and perfectly contingent rules and procedures are no longer necessary because—with vast amounts of data, computing power, and statistical procedures at hand—smart machines can learn to cope with a much expanded array of situations themselves. In this situation, Frey and Osborne (2017) use job characteristics derived from experts' interviews to develop automation scenarios for detailed occupations in the US. Their striking finding is that almost half of jobs are at high risk of automation now. In addition, Blinder and Krueger (2013) find that 25% of jobs could be susceptible to further offshoring.

However, such scenarios may overestimate the share of jobs that will eventually be automated or offshored because, as argued by Arntz, Gregory, and Zierahn (2016, 2017), they neglect the substantial heterogeneity of tasks within occupations and the adaptability of workers and jobs in terms of tasks. Consistent with this, Graetz and Michaels (2018) find that, at least in the past, the adoption of industrial robots did not result in job losses but rather increased labor productivity and wages at the sector level. Therefore, it remains unclear to what extent automation will replace jobs (tasks), although a distinct possibility exists that the new technologies may have a large effect in the future.

There is an ongoing debate about what public policy may do in reaction to such changes. In terms of education policy, education systems need to be updated, providing training in some of the abstract (coding, data analysis) and manual skills (dexterity, flexibility) that are ever more important (Saunders, 2018). In addition, interpersonal skills have become highly demanded (Deming, 2017). Life-long learning and retraining workers who have lost their jobs is another aspect of education and training, which Germany seems to manage better than the US (e.g., Battisti, 2017). Finally, labor market policy should adapt to the fact that working life will increasingly fragment and many employees may become contractors or gig workers (see also discussion further below). This includes portability and expansion of insurance programs, especially health, unemployment, and retirement benefits (Qureshi, 2018).

I will not delve into additional details of these (very sensible) general policy responses but refer to the existing literature (nicely summarized in an earlier book in the OpenMind series, *The Age of Perplexity: Rethinking the World We Knew* by Qureshi, 2018, and Saunders, 2018). The remainder of my article instead focuses on the interactions of policy with the trends themselves, also calling on some specific sectors of the economy for examples.

As in the historical case of job polarization, it is wrong to assume that technology and all the other factors work in isolation. In fact, technological development (e.g., Acemoglu, 1998) and its adoption (Beaudry and Green, 2002) is endogenous to other market outcomes, government regulations and policies, and fundamental societal changes. A recent paper by Graetz (2019) for example shows that, *ceteris paribus*, automation technology is adopted more intensely for tasks in which there are expensive training requirements for workers. Policy decisions and regulations therefore have an important role to play. For example, when unions insist on too high wages for Prod-Op-Crafts workers or when the minimum wage rises excessively, firms may respond with technology replacing relatively expensive jobs. Acemoglu and Restrepo (2018b) show that also societal changes, such as demographic aging, lead to faster automation adoption. Moreover, international trade policy (e.g., the US-Chinese trade war or Brexit) as well as changing terms of trade (especially rising wages in China, which squeeze firms' profits from offshoring there) may actually turn around the impact of trade and offshoring.

Another important trend in which technology, policy, and general economic conditions have interacted is the rise of alternative work arrangements: temporary help agency workers, on-call workers, contract workers, and independent contractors or freelancers have become much more prevalent in countries such as the US (Katz and Krueger, 2019) and Germany (Böhm et al, 2019) since the early 1990s.[7] This trend was most likely driven by a confluence of factors including weak demand (e.g., unemployment and the great recession), regulation (labor market liberalizations), and new technologies (Katz and Krueger, 2017). The flipside to it is the (domestic) outsourcing of many services activities from large firms to separate and specialized entities with lower wages and fewer other benefits, as studied for the case of food, cleaning, security, and logistics services by Goldschmidt and Schmieder (2017).

The role of regulations has been hotly debated at the lower end of the earnings distribution (e.g., distortionary versus inequality reducing effects of minimum wages). However, we often fail to recognize that

many high-wage occupations are among the most regulated. This is especially the case in sectors such as law, finance and insurance, and in health care, which exhibit some of the highest susceptibilities to the technologies that are now becoming available because they rely heavily on data collection and analysis. Many legal and financial-services related tasks, such as collecting sources and devising trading strategies, have already been automated. We are now in the process of seeing near-complete computerization of vast areas of the law (e.g., legal writing) and finance (payment services and personal accounts).

The sector where perhaps all these forces interact most interestingly is health care. Health care is the most regulated industry and this may also be the reason why automation technology has arguably made the least inroads. Medical spending is becoming an ever larger share of GDP everywhere and especially so in the US and Germany (OECD, 2017). The question is whether the financial pressures will eventually become so large—due to ever more demographic aging, expensive medical procedures, and perhaps mediated in a more general economic downturn—that savings will rise high on the political agenda. As examples out of many, artificial intelligence with access to vast medical databases can nowadays perform a lot of diagnoses and treatment tasks (identifying a common cold and prescribing medication; but also detecting much less common and obscure diseases) at least as well as a specialist with many years of training. At the same time, fast improvements are being made in the robotization of surgeries as well as nursing and care tasks.

One final big question is in how far, again via policies and regulations, our societies will be willing to transfer decision power from human experts to machines. Cases that are ambiguous and require (moral) judgment abound, not only in the medical field but also in the areas of self-driving cars, legal opinions, investment decisions, care and personal services, and others. Therefore, changes such as demography and political opinions will be

Changes such as demography and political opinions will be very important, by acting on the economy directly as well as by interacting with the new data-driven technology and the attitudes toward it

Top Chinese and US trade officials returned to the bargaining table, in February 2019, after the trade crisis between the world's two largest economies, Washington, D.C.

very important, by acting on the economy directly as well as by interacting with the new data-driven technology and the attitudes toward it. Overall, in my view, it is quite conceivable that future changes of the job structure could be characterized by shrinking employment in some (formerly) high-wage as well as low-wage occupations compared to middle-wage occupations. That is, job polarization may in fact go into reverse at some point in the future, at least partially.

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Notes

1. On the other hand, deterioration of employment opportunities—particularly severe for low- and medium-educated men—have been linked to societal trends of wider relevance. These include, among others, rising morbidity and mortality in midlife (Case and Deaton, 2015) as well as political polarization in various guises (Autor et al., 2016; Fetzer, forthcoming).
2. Sales-Office is a bit of a special case in Germany, with relatively high wages (as also noted by Cavaglia and Etheridge, 2019) and rising employment. But qualitatively the trends are consistent with those in the US, see discussion in the next section.
3. The movement of high-educated workers into Sales-Office is striking though, potentially explaining both the rise in this occupation's employment and wages in fig. 1.
4. The level of education in middle-wage Prod-Op-Crafts is in fact not higher than in low-wage Srvc-Care; while the share of basic educated workers is about the same, the share of medium-educated workers is higher in Prod-Op-Crafts and the share of high-educated workers is higher in Srvc-Care.
5. Being able to compute transition matrices such as the one in Table 2 is a unique strength of having access to high-quality panel data. Also, the results were equally striking when I computed the transition matrix for males only or for one-year or five-year transitions (not shown for brevity).
6. Notable exceptions include Caselli and Coleman (2001) and Acemoglu and Guerrieri (2008) who point to differences in human or physical capital intensities across sectors, implying that accumulation of this production factor induces reallocations of activity across sectors.
7. These include workers in the (new) service and gig economy such as Uber drivers, Airbnb hosts, Task Rabbit taskers, or Deliveroo cyclists, as well as more manufacturing related jobs such as temp agencies hiring out "assistants" to industry firms for a limited amount of time.

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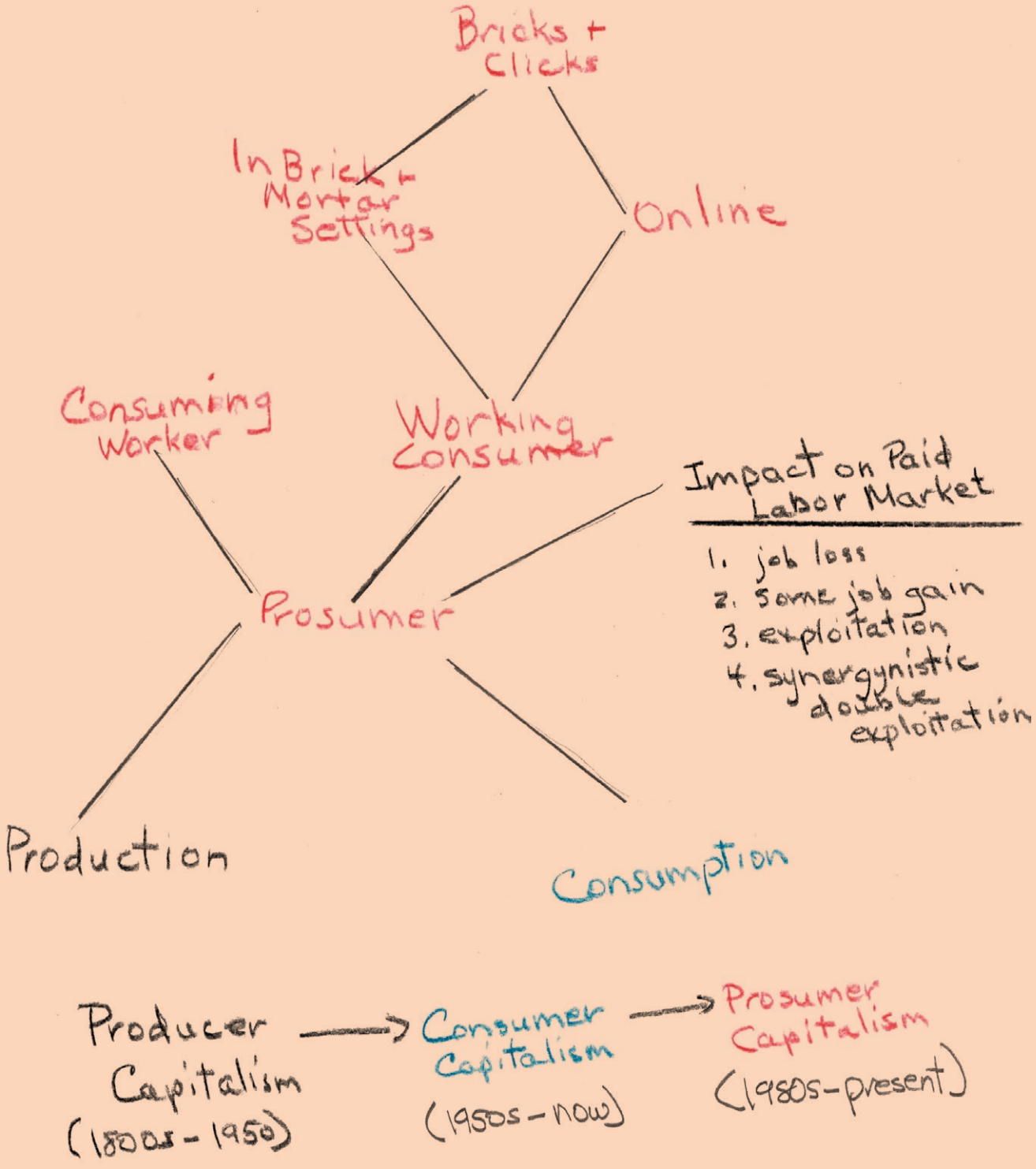

Bricks + Clicks
In Brick + Mortar Settings
Online
Consuming Worker
Working Consumer
Prosumer
Impact on Paid Labor Market
1. job loss
2. some job gain
3. exploitation
4. synergynistic double exploitation
Production
Consumption
Producer Capitalism (1800s - 1950)
Consumer Capitalism (1950s - now)
Prosumer Capitalism (1980s - present)

The Increasing Importance of Working Consumers: The Impact on Paid Workers

George Ritzer

Prosumers, especially the sub-type of working consumers, are of increasing importance in various ways, including in their impact on paid employees. Working consumers are doing work traditionally done by those employees. They offer many advantages over paid employees, such as requiring little or no pay and benefits. While the increasing role of working consumers leads to the creation of many new jobs (e.g., in Amazon.com's warehouses), they constitute a bigger but little recognized threat to many paid employees.

The world of work and labor is being transformed in many different ways and by an array of well-known and well-documented forces (e.g., automation, globalization). One force that has been largely invisible and little discussed is the role played in that transformation by the increasingly omnipresent "working consumer" (Dujarier, 2016; Rieder and Voss, 2010). While consumers have always worked, a series of relatively recent changes (especially new self-service technologies; the explosion of consumption on the Internet) has served to increase the importance of the working consumer. This has even led to concern about the "overworked consumer" (Andrews, 2019). In many cases, the consumer has little choice other than to work in order to consume. As a result, workers ("consuming producers") have become less significant in those contexts in which working consumers have been of growing importance. In many cases workers have lost their jobs because of the increasing array of tasks undertaken by working consumers. The basic argument to be made here is that the increasing amount of work being done not by workers but rather by consumers is a largely invisible aspect of the "work revolution." Such consumers offer many advantages over workers, not the least of which is that they often work for little or nothing.

There are a series of senses in which consumers work. For example, they work psychologically and emotionally to produce awareness of, and desire for, various products (for example, a meal at a cafeteria; a Big Mac at McDonald's; one of Amazon.com's innumerable products) long before they ever enter the physical or digital setting in which they are able to consume them. Once the desire is created, working consumers then need to produce the actions required to get to the brick-and-mortar locations (or the Web sites) where the products are available for sale. Once there, the initial desire needs to be reproduced (or possibly altered) and translated into the steps needed to actually obtain and purchase goods and services. In many cases, especially on the Internet, consumers do not consider what they are doing as work (e.g., Googling a product or service of interest), or, even if they do, they do not consider it odious and may even regard it as fun.

The immaterial psychological work done by consumers is abundantly obvi-

Working consumption is a sub-type of the more general process of "prosumption," or the fusion of production and consumption

Beyond the threat posed by human working consumers, there is also job loss due to the proliferation of new technologies that produce as they consume, and consume as they produce

ous in many contexts, especially in media events of all sorts. At one time there was a tendency to see audiences as passive consumers of the content being produced and promulgated by the media. However, that view has long been rejected and replaced by a view of the audience as, in the terms of this analysis, actively working to produce (define, interpret, etc.) content as they consume it. The same point can be made about brands. Brand meanings are not simply produced by marketers and advertisers; they are actively produced by the very people who consume them.

However, from the point of view of this discussion, the most important kinds of work undertaken by working consumers is the increasing number of instances in which they must now do work that in the past was done for them by paid employees. Working consumers "labor" in such bricks-and-mortar settings as supermarkets, department stores, IKEA, and in fast-food restaurants. In the latter, for example, they serve as waiters, buspersons, and, in the case of food obtained at the drive-through window, as garbagepersons taking their debris with them and then disposing of it. They also do work online, such as searching for information, products or services that, to the degree there were parallels to this work in the pre-Internet world, was done for them by paid employees. However, the vast majority of work done by consumers online is increasingly unconscious and done for them by systems of which they are largely unaware. For example, a click on something of interest online might automatically prompt the appearance of a relevant online site on one's screen. Similarly, wearable technology (a major facilitator of working consumption, although the technology does much or all of the work) can lead to an array of prompts, not the least important of which are those from commercial interests. In addition, and more problematic, is that it might lead to the use of information about users' actions that are invisible to them and often designed to lead them to consume.

Working consumption is a sub-type of the more general process of prosumption, or the fusion of production and consumption (Ritzer and Jurgenson, 2010; Ritzer, 2014). Prosumption has always existed, but it is taking many new forms in the contemporary world. This is true in both bricks-and-mortar settings (e.g., the consumption sites mentioned above), but especially in online digital sites (most notably, Amazon.com, Facebook, and Google). The fusion of production and consumption as well as of the digital and the material is even more the case in augmented settings involving both the digital and material. One example is the way in which Amazon supplements its powerful presence online with its bricks-and-mortar settings, such as its chain of Whole Foods supermarkets and its convenience stores.

While there has been some scholarly use of the term working consumer, more attention has been devoted to prosumption and the prosumer. These terms are virtually unknown in the popular literature, but many scholars have been using them, as well many others that overlap with them, for years. Further, many other scholars have dealt with the process in the past without labeling it prosumption or using similar terms. In fact, the phenomenon itself is not only *not* new, it is arguably primordial; it is undoubtedly more primordial than either production or consumption. For example, hunter-gatherers were prosumers who often both produced their own food and then consumed it; they may even have consumed it as they were producing it. People were prosumers before they were thought of, and thought of themselves, as either producers or consumers. That distinction probably gained traction with the Industrial Revolution as large numbers of people left home (or farm) to work in settings (workshops, factories) devoted to production. The more recent Consumer Revolution (Cohen, 2003) brought with it a sense of people as consumers and the development and proliferation of distinct sites where people went to consume.

As a result, scholars and laypeople have long made, and continue to make, a historical error—the tendency in analyzing the economy to focus on *either* production *or* consumption, or worker or consumer—that is in desperate need of correction. Concern with prosumers in general and working consumers in particular serves to correct that error.

While we have always been prosumers and, more specifically, working consumers, today's increasing fusion of work (production) and consumption is abundantly obvious to the casual observer and to scholars in various fields who have created, and expanded upon, concepts that reflect this

reality. Beyond the concept of "prosumer," others in an array of fields that deal with the same, or closely related, phenomena are "produser" (Bruns, 2008), "co-creation" (Prahalad and Ramaswamy, 2004), marketing's "service-dominant logic" (Vargo and Lusch, 2004), "wikinomics" (based at least in part on the idea that businesses put consumers to work on the Internet) (Tapscott and Williams, 2008), "craft consumption" (Campbell, 2005), DIY (Fox, 2014), and, most importantly for our purposes here, the "working consumer" (or customer). While all of these ideas and others (e.g., the consumer as manager of workers on such sites as Yelp) overlap and each has its strengths, it is the idea of the prosumer that has been most influential in the social sciences and in my work.

Contemporary interest in, and usage of, the prosumer concept is traceable to Alvin Toffler's (1980) thinking on the "rise of the prosumer," as well his prescient later work with Heidi Toffler (2006) on the "coming prosumer explosion." However, that work was only part of the Tofflers' broader thinking on social change, especially the "third wave." While that idea got a great deal of attention for a time, it was more of popular interest than one that attracted the interest of scholars and that found its way into the academic literature. Although Toffler's work on prosumption was lost sight of by most scholars (including myself), I began writing about what was, in effect, that idea and phenomenon in my study of McDonald's and its broader influence through the "McDonaldization of Society" (Ritzer, 1983; 1993). One of the many things that interested me about McDonald's was the way in which it (as well as its emulators, extenders, and some predecessors [e.g. cafeterias]) put its customers to work in its bricks-and-mortar restaurants. For example, customers in those restaurants were (and are) required to "produce" their own meal by doing work that was formerly done by paid employees (and still is in higher-end restaurants). Thus, the line between consumer and worker is blurred, at least in part, in fast-food restaurants.

This is also the case in many other bricks-and-mortar settings. At one time, the traditional department store had lots of paid workers doing a wide range of tasks for consumers. However, with employees few and far between, consumers must now do much of the work themselves (e.g., locate what they are seeking among a vast array of products, scan tags to check prices or to find missing prices, in some cases scan purchases when they leave via a self-service lane). Supermarkets still have many employees, but they are often supplemented by self-service checkout lanes where customers are required to scan their own purchases, including, at times, even weighing their own produce and bagging their purchases. Gone are the days when there were employees available to pump gasoline in service stations. Customers now not only pump (produce) their own gasoline, but they are likely to pay for it by scanning their credit cards. Customers also increasingly check themselves in at hotels and airports. They are more and more likely to be on their own to find their cars in car rental lots, to wash their own cars at automated car washes, and to check their selections out of libraries. IKEA's customers must not only trek through seemingly endless mazes largely on their own in an effort to find what they are looking for (and likely discovering and selecting other products in the course of their rambles through the store), but, in at least some cases, they must put together at home products purchased in the store (e.g. bookcases).

Perhaps the epitome, at least thus far, in the use of the working consumer in bricks-and-mortar settings is to be found in Amazon Go's convenience stores (ten had been opened by early 2019 and as many as 2000 are planned). Amazon Go's stores are in the forefront of efforts by bricks-and-mortar shops and malls to compete better with online sites (and to augment Amazon.com) by, among other things, further increasing the use of working consumers and reducing the number and availability of paid employees. As a result, customers are forced to perform work traditionally done by such employees. This is made possible by, among other things, Amazon Go's "grab-and-go" system which allows consumers to enter the brick-and-mortar shop and, on their own, to quickly and easily make their selections (groceries, ready-to-eat meals, meal kits, among other products). Because of the extensive use of digital technology in Amazon Go shops, it is not necessary for customers to wait in line in order to pay for their purchases on checkout; Amazon Go offers checkout-free shopping. All shoppers need do is use the Amazon Go app on entering the store, select whatever automatically detected products they want to purchase, and leave the store. (Uber has done much the same thing; since rides are prepaid through an app, passengers can exit an Uber without the need to pay or to tip.) Consumers must pick up desired items on their own without the help of employees and they are able to leave the store without pausing at the checkout station or with the involvement of those who traditionally work at those stations in conventional shops. Purchases are scanned while still in the bag by sophisticated scanners rather than by employees. Amazon Go's "Just Walk Out Technology" is connected to the Internet and employs computer vision, sensors, and deep learning. All of this serves to make shopping at Amazon Go far more efficient than it is in traditional brick-and-mortar convenience stores or supermarkets; consumers do it all with the assistance of advanced technologies, but with little or no help from employees. Other shops and malls are likely to follow this model by, for example, recognizing customers and their preferences as soon as they enter and leading them to likely sites and products.

Amazon is likely to increasingly integrate its Amazon Go convenience stores, its Whole Foods' supermarkets, as well as its brick-and-mortar bookstores into its far more important digital business. It might, for example, use such stores as distribution centers for digitally ordered products or as launch pads for its nascent drone-delivery system. In fact, Amazon is expanding in so many different directions and augmenting its online business in so many different ways that it has raised the fear of the emergence (it may already exist) of a modern monopoly similar to the nineteenth-century railroads that led, in their day, to the development of anti-monopoly laws.

We are clearly in the early stages of the development of augmented businesses involving ever-tighter integration of the digital and the material and the degree to which they augment one another. In addition to the use of drones, other advances being considered are shops staffed by robots that employ facial-recognition software, as well as the use of 3D printing (additive manufacturing).

The discussion of these advanced technologies leads to the point that such technologies have played a major role in enabling working consumers and in allowing them to do things (e.g. manufacturing

products with 3D printers) that in the past could only be done by paid employees.

While the working consumer is important to the existence and further development of today's bricks-and-mortar businesses as well as to those that integrate "bricks-and-clicks," the most important and complete contemporary examples of the increasing centrality of the working consumer are to be found on Internet sites, most notably Google, Facebook, Amazon.com, as well as more specific sites such as TurboTax and LegalZoom. It is nearly impossible to find and deal with human employees on most Internet sites, including those that sell goods and services. This is because the work done by humans is comparatively expensive, prone to errors and to being unreliable. The near-total absence of human employees online is also traceable to the fact that much of the online work is performed by advanced technologies. More importantly and central to this argument is the fact that online consumers must do a lot more unpaid work not required of them in bricks-and-mortar settings. In fact, they usually have no choice but to do such work. For example, on Amazon.com working consumers must do all of the digital work involved in ordering the myriad other products that are available on the Web site (and innumerable others like it). In the case of books, those who buy them, perhaps on the basis of online reviews produced by other working consumers, may also produce reviews of other books themselves. Increasingly, these working consumers may even author the digital books for sale on Amazon.com. As a result of all of the work being done by its working consumers, Amazon.com has little or no need for such paid employees as "clerks" and book reviewers (although it employs hundreds of thousands of people to, for example, work in distribution centers and to deliver products to its working consumers). The increasing power of Amazon.com is forcing many bricks-and-mortar shops, most notably those dealing in books, out of business with a consequent loss of jobs and an increase in unemployment in such settings.

While there is no shortage of attempts to understand the causes of unemployment, one suggested by this discussion is the heretofore unexamined role played by working consumers in unemployment. Beyond the threat posed by human working consumers, there is also job loss due to the proliferation of new technologies ("prosuming machines" [Ritzer, 2015b] such as additive manufacturing, wearable technologies with built-in sensors, self-driving cars) that produce as they consume; consume as they produce.

To simply state the basic argument being made here, those traditionally thought of as consumers are now doing more and more of what was once considered work (or production) *and* they are usually doing it without pay (beyond the tasks associated with self-service of all types, there are, for example, those who write reviews for Amazon, Yelp, and many other Web sites) or for little economic reward (e.g. those who do crowdsourced work on, for example, Amazon's "Mechanical Turk"). Business owners are coming (consciously and unconsciously) to understand the benefits of using working consumers in this way and, in the process, that they are reducing labor costs and the need for large numbers of paid employees in bookshops, banks, the taxi industry, and libraries, among many others. For their part, many working consumers are embracing their productive activities (such as doing all of the work in ordering books online at Amazon.com, using ATMs rather than human bank tellers, driving part-time using their own automobiles for ride-sharing companies such as Uber and Lyfft). However, working consumers are also being increasingly *forced* into doing such work by, for example, the absence of readily available employees on online sites, of full-service pumps and their attendants at gasoline stations, of supermarket checkout counters staffed by employees, and of jobs in the taxi industry. While not all forms of working consumption contribute substantially to unemployment (e.g., writing reviews on Yelp), it is clear that at least some forms do cause unemployment.

The news media offer excellent examples of the relationship between technological change, automation, working consumers, and unemployment (Rusbridger, 2018). There is no question that technolog-

Pedestrians check their mobile phones near an Amazon Go sign as they wait for the lights to change, Chicago, 2018

Customers order food at a self-ordering kiosk at a McDonald's fast food restaurant in Hong Kong, 2019

ical change and later automation were directly involved in decimating employment in the newspaper industry by, for example, eliminating the need for typesetters and, more recently, proofreaders. On the other hand, technological advances in the news media have made possible the greater contributions of working consumers who, in turn, have played a major role in unemployment in the newspaper business. For example, computers and the Internet have made possible the development of online news sites (many people increasingly get their news from Facebook and Twitter) as well as a bewildering number and array of blogs. Fewer people read newspapers and an increasing number get their news from such online sources. These developments, among others, are contributing to the decline in the need for reporters, among others. Fewer reporters are being hired and schools of journalism are not training as many reporters, at least in traditional ways and for traditional jobs.

Much the same could be said of the need for professional photographers and videographers given the ease with which "amateurs" (or "pro-ams") are able to do this work and upload their photos and videos free of charge. This work is made possible not only by the Internet, but also by smartphones and digital cameras that make it more likely that those with little or no training will be able to produce (relatively) high-quality photographs and videos. Bloggers and amateur photographers have also contributed to the decline, even the demise, of many outlets for the work of journalists and professional photographers, such as newspapers and magazines. With fewer outlets for their work, there are fewer paying jobs for, among others, reporters and photographers.

In sum, because of the increasing importance of working consumers people are losing jobs, are being forced to work part-time, are otherwise underemployed, or are not getting paid jobs in the first place. Working consumers are doing what was once, or still could be, paid work. However, they are doing it, and often seemingly happily, on an unpaid or poorly paid basis. But the advantages of working consumers do not stop at being unpaid or poorly paid. Such working consumers offer the profit-making organization many other advantages in comparison to even poorly paid employees (as well as to traditional customers on whom much needs to be spent on marketing, advertising, and salespeople in order to induce them to consume).

For example, while profit-making organizations still have many short- and long-term obligations to paid workers, there are few, if any, responsibilities to working consumers and they are almost

Because of the increasing importance of working consumers, people are losing their jobs; they are being forced to work part-time or to be otherwise underemployed, or they are not getting paid jobs in the first place

all short term, even immediate. In addition to paying a wage, the employer may be responsible, although to a decreasing degree, for various costly benefit programs for paid workers, such as health insurance, retirement programs, and paid vacations. There are no such responsibilities for working consumers.

In addition, paid workers, at least historically and to a large degree even today, must be provided with the necessary and often costly "means of production," such as places to work (offices, factories), tools and machines (assembly lines, computers). In contrast, some working consumers pay for the purchase and upkeep on their own means of production (offices at home, utility costs associated with those offices, computers, and automobiles if they drive for a ride-sharing company, etc.). Working consumers also cost less to serve. Fewer paid personnel are needed in shopping sites (e.g. department stores) because prosumers now do much of the work themselves. There are even greater savings in terms of the increasingly important consumption on the Internet (e.g. Amazon.com, eBay, travel sites such as trivago, KAYAK, and Expedia) where paid employees are almost totally absent, at least as far as users are concerned, and the unpaid working prosumers do virtually all of the work. Other savings are derived from the fact that products are either stored by working consumers (in the case of much for sale on eBay; used books on Amazon.com) or are sold on more of a just-in-time than a just-in-case basis (Amazon.com). Amazon.com does not warehouse the vast majority of the "long tail" of books (and other products) it offers for sale, but rather obtains them as they are ordered, frequently from third-party sellers (often, themselves, working consumers).

These advantages and savings are an irresistible attraction to profit-making organizations which covet both fewer responsibilities and, most importantly, from the point of view of profits, a great reduction in costs.

It is worth noting that working consumers fit well with the reigning neoliberal philosophy. They are on their own to both produce and consume. They must make their own way in, and negotiate, the maze-like structure of the capitalist system. In contrast, the traditional employee in this system is provided an array (but declining number) of things by the business owners and both are bound by agreements and contracts. Thus working consumers can be seen as a model for a neoliberal economy.

While we have discussed its role in job loss, working consumption also leads to job creation. As mentioned above, one of the best-known examples involves bloggers, who turn their activities into paid work by, for example, finding advertisers for their blogs or by using their success as bloggers as a springboard into becoming reporters, book authors, and so on.

More importantly, working consumption (and prosumption more generally) relies on and leads to the creation of millions of new jobs for paid employees. For example, because of the billions of dollars spent by its working consumers, Amazon employs about 600,000 paid employees. Then there are the uncountable number of workers in various companies involved in producing the systems—iPhones, ATMs, self-checkout technologies, Web sites, and so on—that make working consumption the norm. It is possible that more jobs are lost as a result of working consumption than are created by it, but of even greater importance is the fact that those who gain the new paid jobs are not likely to be the same kinds of people who lose their positions as a result of the working consumer. For example, relatively unskilled supermarket checkers and bank tellers are not likely to find their way into the high-tech industries that owe their existence, at least in part, to the increasing centrality of working consumption. Those industries often require a more advanced, or at least a different, skill set (although Amazon, among others, also employs many relatively unskilled workers such as warehouse workers).

The poorly concealed secret of classical capitalism was—and is—paying workers less, usually far less, than the value of what they produce (Marx, 1867/1967). While that continues to be the case, an even better kept secret in today's economic system is that working consumers are paid little or nothing for what they produce. Most of the magic of early capitalism was to be found in the gap between what manufacturers charged for their products and what those who actually produced them—the workers—were paid (poorly) for their labor. Capitalism today is a far more magical economy, at least for profit-making organizations, because most working consumers work for little or nothing. Instead of a great deal (of products, profits, and so on) emanating from very little (in terms of wages), much is now being created out of thin air; out of nothing (at least in terms of wages). Further, most working consumers do it gladly, even happily, with little of the alienation associated with paid workers and no nasty problems such as absenteeism, goldbricking, and going out on strike.

The purest example of this contemporary "magic" is to be found in the abundance of "big data" (Radford and Lazer, forthcoming) provided free of charge, often unknowingly by users, to the new digital giants of capitalism—Google, Facebook and Amazon—and aggressively harvested and used by them and many others. Even if it was possible to hire marketing firms to gather this enormous and ever-expanding body of "big data"—and it is not—it would cost companies an unfathomable amount of money. The data collected in this old-fashioned way would be minuscule in terms of quantity and quality in comparison to that provided free of charge by working consumers. Indeed, Amazon's top executive, Jeff Bezos, has made it clear that the enormous amount of data provided, consciously and unconsciously, by those who access, click on, and buy products on the site are more valuable in the long run to Amazon than the sale of those products. The data can be used to learn more about their own consumers, better target them, predict their behavior, and sell to them in the future. In addition, they can sell that data to others. This has helped to make Amazon an economic powerhouse and Bezos the richest man in the world. Abundant and free data is even more the source of the wealth and power for, among others, Google and Facebook. After all, Google and Facebook sell no conventional products; their main resource is the tracking and using by them and others in myriad ways of information provided free of charge by their billions of prosumers.

Digital sites lend themselves easily to the collection of massive amounts of data. These data are provided, usually free of charge and often unknowingly, by users and providers. The users provide that data (e.g. preferences for various products) unknowingly and free of charge every time they click, for example, on a search item or on products available on Amazon.com. Facebook users do even more and provide even more detailed information on

themselves and their "friends" by writing on their walls, as well as those of others. Facebook and Google extract and use that data in various ways, most obviously in targeting users with ads for products related to their preferences. They use extracted search data to sell targeted ad space to advertisers. Such data are now the source of almost all Google's (and Facebook's) revenue. Remember that virtually all of these data come from working consumers who are not compensated for their contributions.

This is but a small part of what it, and many other entities, are doing in ushering us into the computational culture's era of "datafication" (Couldry, forthcoming). The goal is to turn as many things as possible, even the self through self-tracking devices such as Fitbit, into data.

Amazon's acquisition of the Whole Foods chain of supermarkets reflects the growing importance of big data provided, consciously and unconsciously, by working consumers. Supermarket chains have not been able to create, or to have access to, the abundance of big data that is available to Whole Foods now that it is under the Amazon umbrella. Such data, along with other Amazon's advantages, could allow Whole Foods to become a much more significant player in the supermarket business, much more powerful than it heretofore has been. Larger and more established supermarket chains will need to do a better job of obtaining and using such data. Whole Foods will also enable Amazon to gather much more big data on food shopping. It can then use that not only to enhance Whole Foods' position in the supermarket world, but also to improve Amazon's role in the online sale of food.

In describing and theorizing about capitalism in the nineteenth century Karl Marx was clearly dealing with an economic system dominated by production (industry, manufacturing, poorly paid manual laborers, etc.). This focus was obvious in many places in his work, especially in his definitions of the two key players in the capitalist system: the capitalist and the proletariat. The capitalist was defined above all by ownership of the means of *production* and the proletariat by the necessity of selling their ability to *produce*—their labor (really their labor time)—in order to have access to the means of production. They needed that access in order to be productive and, in so doing, to earn a wage that allowed them—and perhaps their families—to subsist.

At an abstract theoretical level of the economy in general, Marx saw production and consumption of equal importance. However, the vast majority of Marx's work is focused on the specific economic form—capitalism—that was of growing importance in the mid-nineteenth century (and is of far greater importance today). Marx concentrated almost exclusively on production because early capitalism was dominated by it; consumption was rather primitive and of secondary economic importance. To put it another way, it was the dynamics of production that were of greatest interest to Marx (and most later Marxist and mainstream economists). Nevertheless, while capitalism was driven by production, that which was produced in capitalism had to be, at least in the main, consumed. A capitalist system in general, as well as a specific capitalist enterprise, which fails to sell what it produces in the market, or at least much of it, will fail. To put it in more Marxian terms, the "exchange values" produced by the capitalist system of production must be "use values" that meet consumers' needs and that produce a demand for them.

Marx's "productivist bias" was *not* inherent in his overarching theory. Rather, it was driven by the realities of the capitalism of his day. While early capitalism *was* dominated by production, it is *not* the case that later forms of capitalism would inevitably be dominated by production.

Capitalism today continues to be a system that *appears* to be dominated by production. However, as pointed out above, there was a shift in the US, especially after the end of World War II, away from an economy dominated by production to one in which consumption is predominant. The predominance of consumption has increased dramatically in the decades since the end of World War II. In fact, it is often contended that seventy percent, or more, of the US economy in the early twenty-first century is accounted for by consumption.

The key point from the perspective of this discussion is that it is possible to think of not only producer capitalism, but also consumer capitalism. The US, at least since World War II, is better seen as increasingly characterized by consumer rather than producer capitalism. While to Marx, the great source of

Working consumers fit well with the reigning neoliberal philosophy. They are on their own, to both produce and consume. They must make their own way in, and negotiate, the maze-like structure of the capitalist system

The purest example of this contemporary "magic" is to be found in the abundance of big data provided by users free of charge, and often unknowingly, to the new digital giants of capitalism

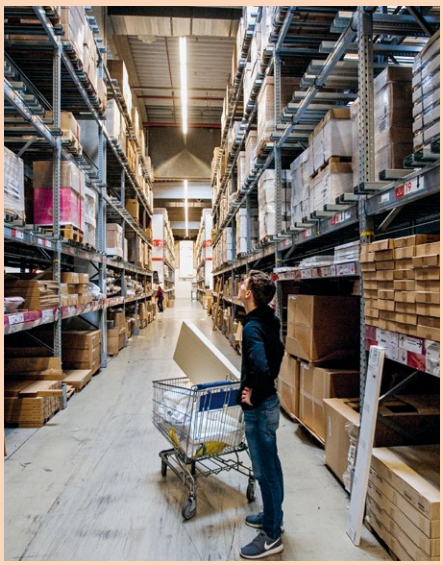
the "success" of producer capitalism, at least from the point of view of the capitalist, was the ability to exploit the proletariat, it could be argued that the (or at least a) great source of success in consumer capitalism is the ability to exploit the consumer. Of course, production continues to be important, indeed essential, within consumer capitalism and the exploitation of the proletariat continues as well. However, in contrast to producer capitalism, consumer capitalism can be seen as a *doubly exploitative* economic system. In other words, the capitalist earns profits through the exploitation of people in their roles as workers *and* as consumers. However, we have moved beyond this double exploitation to *synergistic double exploitation* (Ritzer, 2015a). The exploitation of prosumers as producers used to take place mainly in settings such as factories, while that of prosumers as consumers was found primarily in, for example, grocery stores or butcher shops. Now, the exploitation of the prosumer (both as producer and consumer) is increasingly likely to take place in the same setting (in the "social factory"; see below) and at the same time. That is, the exploitation of the prosumers as producers *and* as consumers interpenetrate creating a synergy that results in a higher level of exploitation than ever before.

The focus here on prosumers being synergistically doubly exploited is in their role as consumers because that is where we find the most important changes leading to such exploitation. Needless to say, the best examples of synergistic double exploitation, at least in the material world, are to be found in the wide array of self-service systems already discussed. In all of these systems they are being exploited as producers, but this is occurring *at the same time* they are being exploited as consumers. Synergistic double exploitation is clearest in these cases since there is a more or less equal measure of consumption and production to be exploited and the exploitation of both is occurring more-or-less simultaneously. Furthermore, the capacity to exploit consumption and production has been honed and heightened over the years by earlier (and continuing) advances in producer and consumer capitalism. Prosumer capitalism is now making its own contributions to this by creating, refining, and heightening the ability to exploit prosumers.

In effect, those corporations that rely heavily on self-service (e.g., McDonald's, Walmart, Google, Amazon.com) have learned the lessons of both producer and consumer capitalism and employed the best of both, at least as far as capitalists and their profits are concerned. To this, they have added more recent advances in prosumer capitalism and those advances are likely to accelerate in the future. In bringing all of the lessons of producer, consumer, and prosumer capitalism together in one system, the leaders in prosumer capitalism have operationalized, combined, and enhanced the principles of how best to exploit prosumers as *both* producers *and* consumers, as well as in the integration of those two forms of exploitation. While most of these forms of exploitation were undertaken independently in producer and consumer capitalism, they are not only adopted together in prosumer capitalism, but they are employed in a synergistic fashion to create unprecedented levels of, and possibilities for, exploitation and therefore for the profitability of capitalist enterprises.

One way of thinking of the exploitation of consumers is the process by which they are induced to go far beyond the consumption of the basics needed for survival and to become hyperconsumers (Ritzer, 2012). They do so by buying and being sold more goods and services than they "need"; paying more, often far more, for them than the commodities are "worth"; and ideally expanding the pool of money available for consumption by going into debt (often deeply) in order to be able to pay for them.

The preceding discussion is a prelude to the argument that while producer and consumer capitalism are alive and well, a new (based, paradoxically, on the very old, if not primal, process of prosumption) form of capitalism—"prosumer capitalism"—has emerged as arguably at least one of the defining forms of capitalism in the twenty-first century (among the other candidates for names for contemporary capitalist systems are "platform," "digital," and "surveillance" capitalism), especially in the US and the developed West. This development has gone unrecognized by most observers as well as by those intimately involved in the system. Thus, a new "grand narrative" is evolving: producer capitalism>consumer capitalism>prosumer capitalism is being suggested here. However, all of these capitalist systems coexist today and each has elements of the others; *all*



Customer in a self-service area at an IKEA store in Cologne, 2007

involve some combination of production, consumption, and prosumption.

Much of this discussion is in accord with the perspectives of the later autonomist Marxists, especially their thinking on the social factory (Gill and Pratt, 2008). That is, from this perspective, much production is no longer derived from workers, nor does it take place in the traditional factory or office. Rather, it now occurs in both material and immaterial forms in the larger society composed, largely, of working consumers. While additive manufacturing came into existence long after the work done by the autonomist Marxists, it seems to be the ultimate example (at least so far) of the kind of development they were thinking about. Of course, those who work in order to consume in self-service settings can also be seen as existing in the social factory.

All economic systems, including all capitalist systems, are systems of prosumption involving working consumers. What, then, is so different about the situation today? First, a variety of recent social changes have served to create new forms of working consumption (as discussed above, especially on the Internet) and to give the process even greater importance in the economic system. Given the exploitation that serves to define capitalism, the nature of the exploitation of the working consumer within prosumer capitalism takes center stage. This all matters because all of us, and to an increasing degree, are working consumers. As such, as pointed out above, we are being doubly and synergistically exploited as producers and consumers. Not only are virtually all of us being doubly exploited, but we are to a large degree, if not totally, oblivious to it.

Examples of double synergistic double exploitation are found in self-service gasoline stations, self-operating kiosks in fast-food restaurants, ATMs, self-checkouts at supermarkets, self-check-ins and -outs at hotels, and especially on online consumption sites such as Amazon.com. In all of these systems work that was once done by paid employees is now performed by working consumers who do many of the same tasks, but they do them largely on an unpaid basis. In doing so, they are being exploited as producers, but this is occurring *at the same time* they are being exploited as consumers by, for example, over-paying for gasoline, hamburgers, bank services, groceries, airplane tickets, hotel accommodations, and the myriad goods and services for sale online.

The counterargument to the idea that working consumers are exploited, if not doubly and synergistically exploited, is that they are rewarded for their "work" not by a paycheck, but in the lower prices available to them (or rooted out by them because they are "educated consumers"). That is, working consumers are simply being rewarded in a different way than they were in the past. They do the work associated with contemporary forms of consumption mainly because they believe that they are getting lower prices and that those savings are an adequate reward for the work involved. This is certainly a possibility and it would be the argument made by those who own today's profit-making organizations increasingly reliant on working consumers.

However, the strongest and clearest evidence that working consumers do *not* ordinarily get lower prices is to be found in the cases where self-service systems coexist with older systems staffed by paid employees providing services to consumers. Typical is the case of the checkout lanes in supermarkets and in many other retail businesses. Those who use self-checkout do unpaid work that was (and is) done by paid cashiers on traditional lanes. However, those working consumers who use the self-checkout lanes pay the *same* amount for their purchases as those who use traditional lanes and have the work done for them by paid employees. More generally, supermarkets save money (and enhance their profitability) because of that free labor and the lower labor costs associated with the reduced need for paid employees. However, *the full savings (or even part of it) are not directly passed on to the working consumers who are doing the work; who are providing the free labor.*

It *is* possible, however, that all shoppers (those who are working consumers and those who continue to consume in the traditional way with the help of paid employees) get lower prices because of the free labor done by working consumers. In that case, working consumers would be subsidizing more traditional consumers (now "free riders"). If that was the case, there would be no net gain to the owners of those supermarkets and no economic inducement to invest in the new technology needed to enable working consumers.

The best examples of synergistic double exploitation, at least in the material world, are to be found in the wide array of self-service systems

Working consumers are simply being rewarded in a different way than they were in the past. They do the work associated with contemporary forms of consumption because they believe that they are getting lower prices

How can anything be done about this exploitation, especially given the fact that working consumers are unaware of the process in and through which the exploitation occurs? Exploitation is quite clear in the traditional case of paid workers. In fact, it was even reducible to mathematical formulae in Marx's work. Those formulae are based on the fact that workers produce a great deal, but are only paid for a small part of what they produce. Alternatively, workers labor many hours during the work day, but only a small part of that time is needed to pay their wages; the gains from the rest of the work day go to the capitalist. Some of it is used to pay expenses, but most importantly it is the source of the profits that are the goal and basis of capitalism. As a theory, exploitation obviously has a negative connotation and that is supported by the relative lack of economic success of workers, their lack of positive feelings toward their work, and even their alienation from, and rebellion against, it.

Exploitation is less clear-cut in the case of working consumers; it cannot be reduced to a simple mathematical formula. It seems clear that unpaid or poorly paid working consumers are exploited as workers, but less clear-cut is the ways in which they are exploited as consumers. However, such a multidimensional measure of the exploitation of working consumers is far more difficult than it is in the much simpler (but still highly complex) case of the paid worker. How does one calculate how much work working consumers do and how much they should be paid for it?

Working consumption is also much more difficult to think of in terms of alienation. Rather than being characterized by the frequently negative feelings of workers toward production, working consumers are generally highly positive, if not downright ecstatic, about what they do and that which they derive from it (goods and services). Put another way, it is easy to think of Marx's workers as alienated, but it is difficult or impossible to apply that term, at least in its social-psychological sense, to working consumers. (Structurally it can be argued that working consumers *are* as alienated—separated—from other consumers, the consumption process, the products they consume, and their essential being as are workers from other producers, the production process, the products they produce, as well as their being.)

This lack of alienation is clearest in the case of today's working consumers on the Internet, especially on social networking sites (Facebook, Twitter, etc.). What exists on these sites, their content (writings on Facebook walls, tweets) is created by working consumers. At the same time, it is those same people, or others just like them, who consume that content. Virtually all of those involved in these processes and systems have positive feelings toward them. It is almost impossible to think of users as alienated from those sites since they are to a large extent responsible for the production and use (consumption) of the content on them.

In terms of the grand narrative being suggested here—producer capitalism>consumer capitalism>prosumer capitalism—a key issue is its practical applicability rather than merely as an abstract conceptual and theoretical point of view.

First, most people continue to think of themselves as either workers or consumers, or workers at one time and in one place and consumers at another time and place, but few, if any, think of themselves as working consumers. How could they when the concept as well as others like it (prosumers, co-creators) were (and are) known to only a very small number of scholars working in a number of diverse fields. The fact that these ideas exist in diverse fields and forms further inhibits not only academic work on this topic but also the ability of those outside of academia to have a way of conceptualizing and thinking about these new realities. Nothing else is possible, at least practically, unless people are able to begin to think of themselves and what they do as working consumers.

Secondly, and far more importantly, this constitutes a new domain that capitalists are capturing and using to further increase profits. This is not to say that capitalists are much more consciously aware of the working consumer than most others, but for quite some time they have implicitly understood the basic dynamics that undergird the utility of the working consumer. Thus, in the early twentieth century the owners of supermarkets did not understand, at least explicitly, that they were transforming consumers in grocery stores into working consumers in supermarkets, but that was the consequence of various changes designed to rationalize their operations and increase their profits.

In their roles as producers and as consumers, prosumers are doubly exploited in a synergistic fashion that leads to unprecedented levels of exploitation

It is easy to think of Marx's workers as alienated, but it is difficult or impossible to apply the term—at least in its social-psychological sense—to working consumers

The same kind of thing can be said about fast-food restaurants in the mid-twentieth century. More recently, Facebook did not fully understand that it would become a nearly hundred-billion-dollar company largely because of the content and data provided by its working consumers. The same could be said of Amazon.

As the concept of the working consumer gains greater visibility and notoriety and reaches the larger public, many more capitalists will be drawn in the direction of modifying or creating enterprises that rely more and more on them. Thus, we are likely to see the spread of this model, as well as a growing realization of the fact that there are ever-greater profits to be derived from it.

For their part, working consumers, at least in the short run, are not likely to be nearly as quick to understand that they are working consumers, that they will increasingly be working consumers, and the implications of this reality for them, especially their greater vulnerability to exploitation.

Conclusion

While what is being presented here is a highly pessimistic view of the current state, and especially the future, of working consumers in prosumer capitalism, it is possible to offer a more optimistic scenario based especially on non-profit sites (e.g., Wikipedia, Firefox, most blogs) on the Internet. Here are sites and enterprises controlled by working consumers that operate largely for their benefit rather than for the profitability of capitalists. Working consumption can be empowering because people are in control of what they both produce and consume. They do so to benefit themselves and *not* the bottom line of capitalistic enterprises. More importantly, they do so—and without pay—for many other working consumers who can use the systems they help to create at little or no cost. The collaboration that occurs on prosumption sites enables the offering of many goods and services free of charge (or close to it). Consequently, working consumption can be seen as destabilizing to traditional capitalism. Thus, working consumption is capable of producing a new economic system that is empowering, democratic, and of benefit to all (or, at least, many more) involved.

While one would like to embrace this more optimistic scenario, the fact is that the rewards of maintaining and expanding control over this system are simply too great for capitalists to ignore. They will draw on their great resources to dominate this domain and in the process work hard to limit, if not scuttle, efforts to turn it into a more equal and democratic system oriented to the needs and interests of working consumers rather than to the profitability of capitalist enterprises.

Finally, it should be reiterated that the working consumer is a major force in revolutionizing work and labor. The consumer is not generally seen as having such a role, let alone a significant one, in the transformation of work and labor. Such a role is usually accorded to forces internal to what we have traditionally thought of as work and labor. We need to reflect on and study the changes in paid labor that are traceable to the burgeoning role for working consumers.

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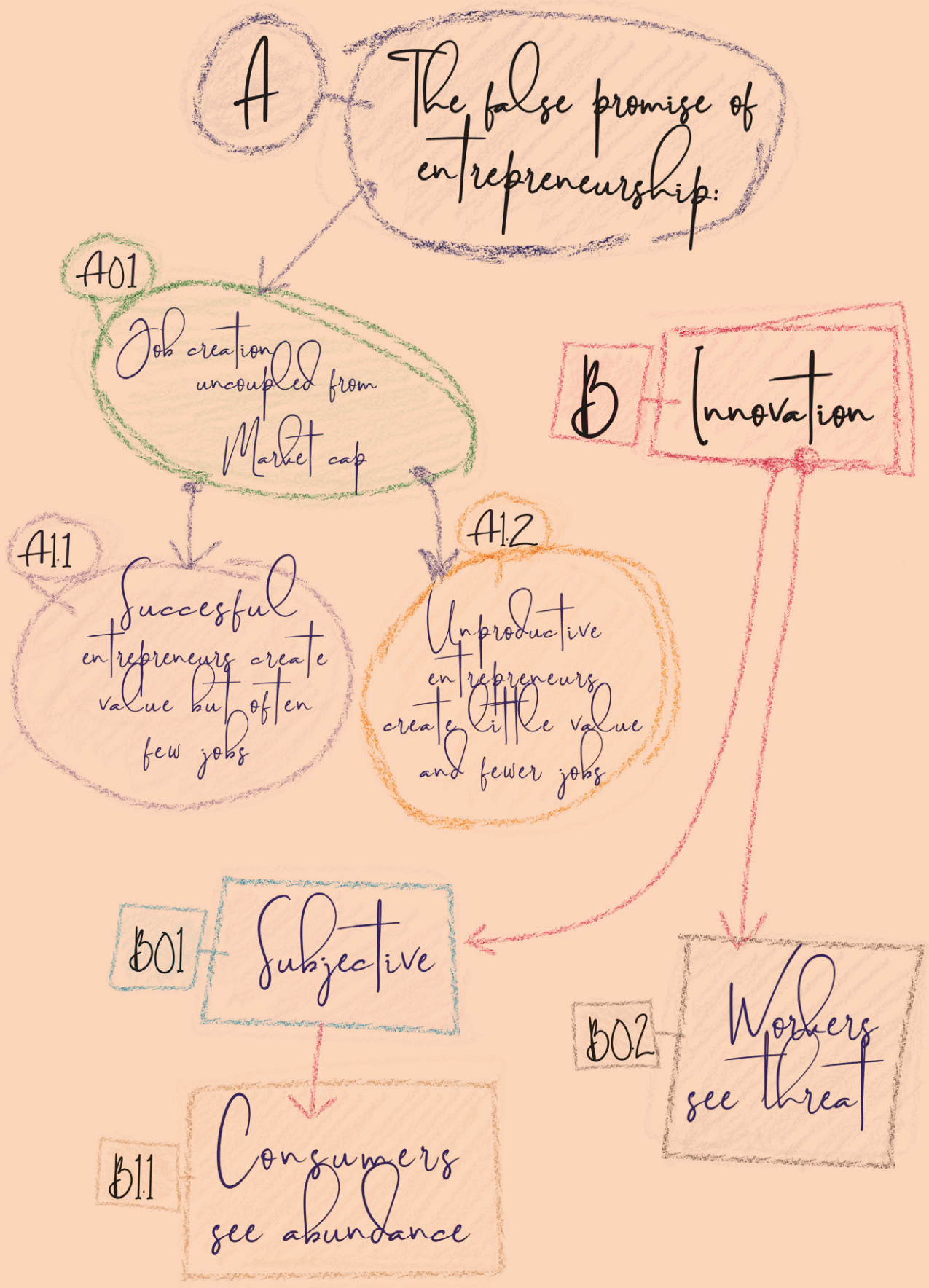
A
The false promise of entrepreneurship:
A01
Job creation uncoupled from Market cap
A1.1
Succesful entrepreneurs create value but often few jobs
A1.2
Unproductive entrepreneurs create little value and fewer jobs
B
Innovation
B01
Subjective
B1.1
Consumers see abundance
B02
Workers see threat

The Hard Realities of Entrepreneurship in a Global Economy

Ellen Ruppel Shell

The power of entrepreneurs to "create jobs" is overblown: most entrepreneurs fail, and the vast majority of those who succeed create relatively few jobs. The vast majority of jobs are "created" by legacy companies—firms that have been in business for twenty-five years or more. Still, work in a globalized, digital economy has become increasingly fragmented and unstable. Centralized workplaces—be they factories or offices—are still with us, of course, but in declining numbers. Increasingly "noncore" work functions—be it IT or transportation, food delivery or janitorial services—are outsourced to contract providers, or in some cases sent off to be done in lower-cost locations. An increasing number of us are working independently, as freelancers and contract employees. So we find ourselves faced with the challenge of making a meaning of work in which the workplace itself plays a far less central role. In a sense, we are circling back to the time of the independent tradesman, farmer, and craftsman, and toward an economy in which our working identity relies less on any particular institution and more on our relationship to the work itself.

> "I know that starting and growing a business takes tremendous grit and that facing the unknown requires determination. I also know that taking on that risk makes our nation and our world a better place."
>
> President Donald J. Trump

Google's "connected campus" in Cambridge, Massachusetts, occupies a complex spread across two office towers tucked behind a gourmet vegetarian sandwich shop. It is surprisingly difficult to find, so difficult that visitors typically walk past it once or twice before asking passersby just where it is located—a taciturn reminder, perhaps, that Google has no need to trumpet a brand that is among the world's most recognizable. This is especially true when it comes to attracting talent. Google, it seems, is the dream job of nearly every bright young person on the planet. In surveys, one of every five American college graduates cited Google as his or her employer of choice.[1] A poll of college students *the world over* surfaced a similar response. No other company comes close.

At this writing, Google is also, after Apple, the world's most valuable brand.[2] The company invests in such a broad array of endeavors that even its employees have difficulty keeping track: a browser called Chrome, a smartphone operating system called Android, a suite of cloud computing platforms called Google Cloud Platform, a video-sharing platform called YouTube, and online services that include Google Maps, Gmail, and Google Docs. Alphabet, Google's parent company, is a force in the self-driving car realm, and its investment arm, GV, has a piece of more than 300 other "cutting-edge" companies, including Uber. All this is mind-bogglingly impressive, but incomplete, as it neglects the segment of Google business that generates the vast bulk of its revenue stream.

Roughly 90% of Google's revenue comes from advertising, more than three-quarters of it plastered across the company's own websites. This bounty comes thanks to very little effort on the part of Google employees. The beauty and profitability of this arrangement does not escape the company's legion of faithful investors.

A Googling of Google brings the expected—fanciful spaces filled with what look like toys and an array of tempting

In summer 2016, Amazon, Google, Apple, Facebook, and Google had a market cap of more than $1.8 trillion, roughly equivalent to the gross domestic product of India, which is home to more than 1.25 billion people

While Amazon, Apple, Facebook, and Google are wildly successful at attracting both capital and the public eye, in the matter of sustainable job creation not one of these tech dynamos could hold a candle to legacy companies like IBM or McDonalds

snack options. And it also brings the less expected—for example, images of marketing manager Shawn Aukland in a Google company lunchroom in London, proposing marriage to his boyfriend and fellow Googler, Michael, while being serenaded by a Google acapella group crooning Bruno Mars' "I Think I Want to Marry You." Not all of us would relish this experience, but apparently enough of us would to make it unremarkable that so many people the world over have set their sights on scoring a Google employee ID badge. What *is* remarkable are the odds against any one of these hopefuls making the cut: with an estimated three million applicants in a single year, only one in 428 got the offer. (The odds of an applicant getting into Harvard are quite a bit better: 1 in 14.)[3] For while Google may well be one of the world's most entrepreneurial companies, it has no need to employ all that many actual human beings.

Andrew McAfee, coauthor of the *Second Machine Age* and principal research scientist at the Center for Digital Business at MIT's Sloan School of Business, joined me to mull over the implications of this at Legal Seafoods, a popular fish restaurant just a few steps from Google's Cambridge campus.[4] At the time, McAfee seemed a tad preoccupied, as though he, too, was dreaming of Google. And in a way, he was. While simultaneously checking his e-mail and ordering a crab cake sandwich, McAfee grabbed a pen and scribbled four words on a napkin—Amazon, Apple, Facebook, and yes, Google (aka Alphabet). In the summer of 2016, these "four horsemen" (as he called them) had a market cap of more than $1.8 trillion, roughly equivalent to the gross domestic product of India. India is home to more than 1.25 billion people. In 2016 the four horsemen together employed fewer than 400,000 Americans, including those working in Apple retail stores and Amazon warehouses.[5] (Amazon had yet to purchase Whole Foods or hire the 100,000 employees—most of them warehouse employees—it anticipated it would in coming years.) "That's less than the number of net new jobs we need *every three months* to hold the employment rate steady," McAfee said. Indeed, he continued, while wildly successful at attracting both capital and the public eye, in the matter of sustainable job creation, not one of these tech dynamos could hold a candle to legacy companies like IBM or McDonalds.[6]

McAfee is an avid booster of technology, which he habitually calls "a creator of abundance." Certainly, it works for him, and for that happy band of Googlers hacking and snacking in Google offices next door. And he points out that it works for all of us—Instagram, Facebook, SnapChat, YouTube, Twitter, and of course Google search—are all part of what McAfee calls "the bounty." But he acknowledges that this bounty is created through the efforts of relatively few paid employees. That is the nature of the digital age beast. "What we're looking at is an economy that is incredibly wealthy without needing work in the way that we came to think about it in the industrial age," he said.

So how has our thinking about work changed? Consider two companies: Instagram, a product of the digital age; and Eastman Kodak, a product of the late industrial age. Instagram, cofounded by Mike Krieger and Kevin Systrom, gathered a small team of young engineers and marketers in a small San Francisco space to create and market a single app through which hundreds of millions of people share billions of photographs. Kodak, founded by George Eastman, gathered as many as 145,000 employees in an expansive industrial park to build an iconic firm that in its heyday furnished 90% of the nation's film, and 85% of its cameras.

Within less than two years of its founding in 2010, Instagram was sold to Facebook for $1 billion—leaving a Baker's dozen of instant multimillionaires in its wake. A few months before the sale of Instagram, Kodak—a 132-year-old company that held 110,000 patents—declared bankruptcy, leaving scores of loyal employees in the lurch.

In the age of Kodak, productivity, employment, and median income rose as one. Company founder George Eastman felt an obligation to his employees, and also to the city where he and most of them lived—Rochester, New York. In a letter to a colleague he wrote: "I want to make Rochester for the thousands of people I have gathered here the best place on the face of the earth to live in and bring up their families." Today, there is far less to motivate such largesse: the Internet knows no geography, and the global economy

demands far less of employers in matters of employee or community loyalty.

The digital age brings with it what one observer called the "yawning disparity" between the "subjective experience of innovation and the objective measures of its real economic impact."[7] That is, innovation affects us differently depending on whether we are buyers or makers. As consumers, many millions of users reap the "abundance" that McAfee described. But as workers, not so much. "Our nation is tremendous at creating abundance," he told me. "But we have only one way to tap into it—by offering up our labor. That's not working for everyone. I don't think that's a trivial problem, but it's not my job to solve it."

So one cannot help but wonder, whose job is it? Politicians and pundits on both side of the aisle tend to put their faith in entrepreneurs. At the Global Entrepreneurial Summit at Stanford University in 2016, President Obama declared entrepreneurship "the engine of growth ... that creates good-paying jobs; that puts rising economies on the path to prosperity, and empowers people to come together and tackle our most pressing global problems." Two years later, presidential candidate Hillary Clinton pledged to find a way to forgive student loans to graduates who start a new company or join an existing start-up. Donald Trump built his personal brand on a boast of being a canny businessman and entrepreneur, a strategy that held great appeal for millions of voters.

Of course, America has long had a soft spot for risk-takers willing to gamble almost everything in an effort to create something new. While in Europe schoolchildren may be taught to revere poets and philosophers, in America schoolchildren are primed to lionize entrepreneurs like Steve Jobs, Bill Gates, and Elon Musk. The very term "business hero" has a distinctly American ring. And by hero, we are generally meant to think "innovator."

Economist Joseph Schumpeter, a towering giant of twentieth-century thought, coined the phrase "creative destruction" to describe the process by which innovation creates new technologies, businesses, and jobs and destroys the old. Schumpeter was known in particular for his striking insight that innovation is the driving force of both capitalism and economic growth, and that entrepreneurs—not inventors—are the agents of that innovation. In *Capitalism, Socialism, and Democracy* (1942) he wrote: "...The same process of industrial mutation—if I may use that biological term—that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism."

The idea that new, innovative firms drove the bulk of job growth continued to gather steam in the late 1970s, thanks in part to the work of David L. Birch, a business consultant and researcher at the Massachusetts Institute of Technology. In a slim, fifty-two-page report, *The Job Generation Process*, Birch estimated that only 15% of new jobs were created by established firms with 500 or more employees, and that six of ten jobs were generated by firms with twenty or fewer employees, most of them newly established firms.[8] Later, he amended those figures to support the astonishing claim that new small businesses created fully eight of every ten new jobs.[9]

Birch's claim played into a David and Goliath narrative that captured both the public imagination and the approbation of policy-makers. The idea that scrappy, risk-taking entrepreneurs could—free of government intervention and union meddling—sustain and grow the nation through job creation held great appeal. Suddenly, small entrepreneurial efforts were no longer mere "Mom and Pop" anachronisms, but veritable job generation machines.[10] And such prolific job creators, politicians agreed, should be given substantial regulatory leeway and tax-payer support.

In 2010, The Ewing Marion Kauffman Foundation published findings that seemed to bolster Birch's already wildly popular theory. In a widely quoted analysis, Kauffman economist Tim J. Kane concluded that for most years between 1977 and 2005 established firms were net job *destroyers*, costing Americans about a million jobs a year (that is, these firms fired a million more people than they hired). Start-ups, by his reckoning, created an average of three million jobs annually.[11] Kane's thundering conclusion was: "... Start-ups aren't everything when it comes to job growth. They're the *only* thing."

Between 1977 and 2005, established firms fired a million more people than they hired, while start-ups created an average of three million jobs annually. In the words of Kauffman economist Tim J. Kane: "Start-ups aren't everything when it comes to job growth. They're the *only* thing"

It is nearly impossible to overstate the influence of Kane's report, the conclusions of which galvanized thinkers—and informed public policy—around the globe. In the US, the Kauffman Foundation was called upon to help craft the bipartisan Startup Acts 2.0 and 3.0, legislation aimed at (among other things) exempting individual start-up investors from capital gains tax and reducing other regulatory burdens, as well as making it easier for foreign entrepreneurs to acquire US visas. The foundation was also behind the 2012 Jumpstart Our Business Startups Act (JOBS) also aimed at reducing regulations on new businesses. And the passage of the tax cuts put into place by the Trump administration relied heavily on the central claim that reducing taxes on corporations and wealthy individuals would spark entrepreneurship that would generate jobs.

The problem with all this is that the link between entrepreneurship and job growth is far more tenuous than many policy-makers contend. The question is: are start-ups really creating permanent jobs, or do we simply believe they do, and cherry-pick our facts to "prove" it? Before tackling that vital and enormously complicated question, it is helpful to acknowledge that the terms start-up and "entrepreneur" mean different things to different people.

Hearing the word "start-up" we may think of companies like McAfee's "four horsemen"—dazzlingly innovative firms with sky-high market caps. But technically, a start-up is any newly registered firm with at least one employee (often the founder). Broadly defined, entrepreneurs include anyone who creates that business—be it a hot-dog vendor or a maker of a groundbreaking medical device. Economists make a distinction between "replicative" entrepreneurs and "innovative" entrepreneurs. Replicative entrepreneurs (for example, the hot-dog vendor) reproduce an existing business model, while innovative entrepreneurs

Data cables are seen above the main office floor at the Google campus near Venice Beach, in Los Angeles, California

Our misplaced obsession with the new—be it a new app, a new diet aid, or a new video game—risks undermining innovation of the sort that can create real value and lead to lasting jobs

Clinging to the idea that the future of work hinges on a spirit of entrepreneurism risks incentivizing what economists call "unproductive entrepreneurs" who create little value and few if any new jobs

One of the artworks adorning the walls at the Google campus in Boulder, Colorado, which is expected to be completed in late 2019. The campus consists of three buildings providing over 200,000 square feet of office space

(like the medical device maker) create something new.

For the purposes of his survey Kane counted as a "job creator" *any* new business that created at least one job, including that hot-dog vendor who, like most entrepreneurs, "created" a job only for himself. Moreover, under his logic a company that went bust and let all its employees go—as do most new businesses within five years—also counted as a "job creator" because it had, after all, created at least one job. It is unclear why he chose to proceed in this fashion, but what is clear is that measuring *net* job creation—new jobs created minus old jobs lost—is far more difficult than simply counting the total number of jobs created. And once the calculation of net new jobs is made, it is fairly clear that entrepreneurs actually create very few lasting jobs in the US, or, for that matter, in other nations of the world.

In fact, a nation's level of entrepreneurship tends to be *negatively* correlated with its competitiveness. In Uganda, the world's most entrepreneurial nation, more than 28% of workers are entrepreneurs. The world's second most entrepreneurial nation is Thailand, followed by Brazil, Cameroon, Vietnam, Angola, Jamaica, and Botswana. Few of us would mistake these nations as powerhouses of innovation or prosperity: in 2018, Uganda had a per capita income of roughly $720.[12] Nor would we mistake most American small-business owners—of nail salons, barber shops, cafes, cleaning and landscaping services, Airbnbs, and the like—as what Schumpeter called "engines of progress." These replicative small businesses may well be entrepreneurial, but they create few jobs, and fewer still living-wage jobs. The truth is that the vast majority of new small-business owners have no intention of building a company, but rather essentially engaged in what would otherwise be called self-employment.

Perhaps surprisingly, start-ups are neither more innovative nor more productive than legacy companies. On the contrary, innovation and productivity of firms tends to increase with age. And while many things—even start-ups—improve with age, keep in mind that in the US the typical start-up is dead long before its fifth birthday.

Even David Birch came to question the power of small new companies to create jobs.[13] In 1994, he penned an essay in collaboration with one of his most vocal critics, Harvard economist James Medoff, in which they concocted a sort of taxonomy of American companies: elephants, mice, and gazelles. Elephants are large, lumbering companies that employ plenty of people but do not generate many *new* jobs (think Walmart). Mice are small, twitchy businesses that ultimately generate little value and few jobs (think that hot-dog stand). Gazelles are nimble, rapidly expanding firms that—though far less stable than elephants—create real value and real jobs. Gazelles can be found in almost every sector, and not necessarily those we associate with innovation: in the 1990s a disproportionate number were technology firms, but in the early 2000s many were in housing-related services. Birch and Medoff concluded that high-impact gazelles made up less than 4% of US companies, and created 70% of the new jobs. On average, gazelles are twenty-five years old—elders by Silicon Valley standards.

Paul Nightingale, a former industrial chemist and professor of strategy at the Science Policy Research Unit at the University of Sussex, told me that in fact entrepreneurship has never been a powerful engine of economic growth. Jobs generated by start-ups are typically less productive and lower paying than jobs at established firms, he said, and far less stable. "Entrepreneurial firms actually tend to be less innovative than established firms," he said. "Most entrepreneurial activity just generates churn, workers shifting from one job to another, not the creation of new jobs."[14] Nightingale added that the extraordinary success of a handful of firms, especially new technology and social media companies like Google, Facebook, Amazon, and Twitter, has blinded us to the reality that roughly nine out of ten new companies fail quickly and completely, dragging their workforce (if any) down with them.

As Scott Shane, a professor of entrepreneurial studies at Case Western Reserve, once coyly observed, it takes forty-three entrepreneurs starting new companies to create nine jobs that last even a decade. Not exactly, he wrote, "the spectacular yield you might think we'd get if you read the press reports about the job creation of start-ups."[15]

Our misplaced obsession with the new—be it a new app, a new diet aid, or a new video game—risks undermining innovation of the sort that can create real value and lead to lasting jobs. But this sort of innovation does not come easy, or, for that matter, cheap. The private sector once played a much greater role in basic research, especially as co-investors with the public in big, risky, high pay-off ventures such as those once conducted at research divisions of major corporations like Xerox PARC Research Center, IBM Research, DuPont Labs, Bell Labs, and Microsoft Research Silicon Valley Lab. But in recent decades, these and many similar institutions have been sold off, closed down, or cutback. In many cases, business efforts have been redirected at meeting the immediate demands of growth for investors rather than at innovations that may serve real human needs.[16] And something similar is happening in the public sphere. The American Association for the Advancement of Science reported that as a share of the total federal budget, research and development (R&D) fell from 11.7% in 1965 to a low of roughly 3.4% in 2016.[17] But even that was deemed far too high by the Trump administration, whose 2018 budget stipulates further cuts of up to 22% in key research agencies.[18]

New companies can and do thrive and grow—Instagram, Facebook, and yes, Google were once mere twinkles in their founders' eyes. But clinging to the idea that the future of work hinges on a spirit of entrepreneurism risks incentivizing what economists call "unproductive entrepreneurs" who create little value and few if any new jobs. Entrepreneurship, technological innovation, and growth all contribute to what economists call the "bounty." But increasingly that bounty is not being shared in the form of good jobs. The truth is that start-ups employ less than 3% of US workers, a rather slender reed upon which to hang our hopes.

The technological capacity to create ever more efficient machines that shrink the market demand for human labor seems almost limitless. And it pales when compared to the capacity of digital technology to diminish the market demand for human *thought*. We are at a turning point, a critical juncture at which past experience is not a reliable guide to the future. We have a pressing obligation to reconsider the prospects and purpose of work in the digital age, and to lay out a plan built not on nostalgic nostrums, but on hard evidence. We can no more know the "jobs of the future" than we can predict the weather of the future—there are far too many variables and unknowns. But we can protect ourselves from the worst disruptions of the digital revolution. The first step is to sort out the elements of work that we need to preserve, elements that extend beyond the narrow confines of what it means to have a "job."

Centralized workplaces—be they factories or offices—are still with us, of course, but in declining numbers. Increasingly "noncore" work functions—be it IT or transportation, food delivery or janitorial services—are outsourced to contract providers, or in some cases sent off to be done in lower-cost locations. An increasing number of us are working independently, as freelancers and contract employees. So we find ourselves faced with the old challenge of making meaning of work in which the workplace itself plays a far less central role. In a sense, we are circling back to the time of the independent tradesman, farmer, and craftsman, and toward an economy in which our working identity relies less on any particular institution and more on our relationship to the work itself.

In the late 1970s, Hungarian-born psychologist Mihály Csíkszentmihályi made note that while 80% of adults claimed they would prefer to work even if they did not need the money, the vast majority also said they could hardly wait to leave their jobs every night. From this he concluded that while humans very much desired work, many did not desire their jobs. So he set out to uncover what it was about work that held such appeal, and what it was about jobs that did not. To that end, he studied people at work, and was struck by several factors. One thing in particular surprised him: that some of the happiest and most satisfied workers feel no real connection to the product of their labors.

Early in his career Csíkszentmikályi observed a group of visual artists, with the goal of figuring out what motivated them. He noted that these artists pursued their work with great intensity, so much so that they sometimes forgot to eat or sleep. That was hardly surprising. But he was surprised that the artists seemed to pay almost no notice to the fruits of their labor. That is, rather than proudly display their paintings, they stacked them in piles like so much cord wood, then went back to work on yet another piece. What made this behavior so intriguing was that it seemed to contradict a widely held paradigm of behavioral psychology: that is, that people are motivated to work by the expectation of a desirable external—be it food, sex, money, or praise. But the artists did not seem to care all that much about food, and sex, while always welcome, did not come into play in this case. And the artists acknowledged that their paintings were unlikely to be purchased—or even noticed by the general public—so it was not money or praise that kept them going. For them, it seemed the process of creation was an end in itself. It was the practice of art—not the art itself—that made meaning for them.

So why do so many of us fail to find a meaning through our jobs? The problem, as framed recently by Princeton University political philosopher Elizabeth Anderson, is that "the amount of respect, standing, and autonomy" workers receive does not depend on their essential humanity, but is "roughly proportional to their market value."[19] The centerpiece of Anderson's argument is that the free market economic system was designed for a preindustrial world in which workers were essentially free agents–farmers, tradesmen, and craftsmen who were basically self-employed. The industrial revolution changed all that, of course, but the "free market" system remains. Within this system today, she contends, most workplaces are essentially dictatorships in which bosses are unaccountable to the employees they "govern." Certainly, there is some truth to this—as we all know, under capitalism, most workplaces are autocratic, and some of the most successful companies are headed by enlightened dictators: think Steve Jobs or Elon Musk. And yet, since at least the industrial age, quite a number of us have knowingly traded our independence for a secure and stable working life. Today that stability is fading, and more work is returning to the free-agent model of our preindustrial-age ancestors. The difference is that in the modern global economy, free agents can reside—and do business—almost anywhere, and in a

digital economy not all free agents need to be human. So what happens to our sense of self when our job identity fades?

Psychologist Sally Maitlis of the Saïd Business School, University of Oxford, addressed this question obliquely, through the life stories of forty performing artists she had followed over the course of nearly two years. Half of these artists were professional dancers, the other half professional musicians. And each one of them due to illness or injury had been forced to abandon jobs they loved. "These were people who had devoted their entire lives to their work, who *were* their work," Maitlis told me. As one horn player lamented: "I defined my whole life by this piece of metal and what I could do with it."

Maitlis spoke to each artist twice, with eighteen months between interviews. From what she described of these conversations, it is hard to imagine individuals more forcefully called to their vocation, or more devastated at the prospect of its loss. Their responses to her questions surprised her, as they neatly contradicted what she, her colleagues, and many others had come to believe about work and its centrality in our lives. It seemed that even in the arts, passion for one's job is truly a double-edged sword.

The artists who felt *most* passionate about their former positions in symphony orchestras or dance companies were the least likely to recover from their loss. After being sidelined by their injuries, they grew frantic, dashing from doctor to doctor, and therapy to therapy in pursuit of a cure. They spent endless hours surfing the web for remedies, and complained constantly to loved ones. At least one artist confessed to thoughts of suicide. Like the "broken" factory workers of Marienthal, they saw no life for themselves beyond their jobs.

By contrast, those artists who expressed *less* passion for their jobs in dance companies and orchestras fully recovered from their loss, some triumphantly. It is not that these artists did not love their work, or feel strongly about it—of course they did. Most of them had devoted their life to their art. But as Maitlis explained it, these seemingly "less passionate" individuals had uncoupled their job identity from the core of their work identities. Their relationship to their work was not defined by their job—rather, they had internalized their devotion, and no matter the circumstances, it remained part of who they were. And from that internalized devotion, they were able to create something new.

No longer able to play his instrument, the former trumpet player recognized that his love of music transcended his desire to perform. "So I'll go back to my original love," he told Maitlis. "I'll go back to being a dedicated listener." Listening did not substitute for performance; he still needed to make a living, and he did—as a teacher. But being an expert in a field he adored—and exercising that connoisseurship—gave him joy, meaning, and purpose. He and the other artists in this group had found ways to make meaning of work that did not manifest in what we would call a job. By moving beyond the job they were able to maintain control of their work, and their lives.

What shielded the second group of artists from the despair suffered by the first was not a heroic struggle to beat the odds, to somehow rise above their injuries to return to their profession. What shielded them was the optimism and self-confidence that allowed them to maintain their work identity in the absence of a formal job affiliation. They prevailed by finding new ways to reignite the passion for which *the job* they once held constituted only one of many possible outlets. Channeling their artistic drive in new directions, they created meaning from a genuine engagement with the art itself. The job was gone but the work—and the meaning made from the work—would always be with them.

Maitlis's findings have implications that extend well beyond the artist's realm, to almost any occupation or vocation. She said that flourishing in a global economy requires us to see ourselves independent of our jobs while maintaining a strong grasp of our work identity. It is not the job that defines us, but the work over which we can gain both mastery and control. By maintaining a broad view of ourselves and the work we want and are able to do, we can put our jobs into perspective—something worth doing, certainly, and a means of providing for ourselves and our families, but not to be relied on as our primary source of dignity and sense of purpose.

Where we find meaning, and how we make meaning of our work is a deeply

Why do so many of us fail to find a meaning through our jobs? The problem, as framed by political philosopher Elizabeth Anderson, is that "the amount of respect, standing, and autonomy" workers receive does not depend on their essential humanity, but is "roughly proportional to their market value"

Engineer and investor Elon Musk in 2008, six years after creating his company Space X. Nowadays Musk is an icon of technological entrepreneurship

Flourishing in a global economy requires us to see ourselves independent of our jobs while maintaining a strong grasp of our work identity

Open lounge area of the Instagram Inc. office in New York

personal matter. Acknowledging this offers us a sense of liberation, the freedom to untether our very human need for a sense of purpose in our vocations from our very practical need to earn a living. While it is healthy—even essential for us all to strive to make meaning from our work—not all of us can make meaning from our jobs, nor should we be expected—or driven—to pretend to do so.

As traditional jobs grow scarcer, our response should not be to try to "make" more meaningful jobs, but to expunge the idea that "job creators" are also "meaning creators." Our challenge is not only the obvious one of creating new twenty-first-century jobs. Our challenge is also rebalancing an economic system based on twentieth-century metrics, metrics that overvalues the importance of jobs, and undervalues vital work—care work, creative work, innovative work—from which many of us could build a sense of purpose and direction. We cannot rely on the twentieth-century concept of "job" or the promise of jobs to sustain our collective psychic buoyancy. On the contrary, reimaging work for the twenty-first century requires us to find ways to generate the psychological, emotional, and economic benefits of work *outside* a traditional employment context. There is no end of work needed to be done, and the world would be a far better place were each and every one of us able to indulge our natural inclination to do it. It is up to us to move beyond the structures and priorities that have trapped us in a "jobs above all" mindset, and prepare ourselves—and our children—for a life of purposeful work. And it is up to any forward-thinking government to look beyond the demands of the ever-fickle marketplace to ensure this essential human right.

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Notes

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2. See https://www.forbes.com/sites/forbespr/2017/05/23/forbes-releases-seventh-annual-worlds-most-valuable-brands-list/#611e6a475b55.
3. See https://qz.com/285001/heres-why-you-only-have-a-0-2-chance-of-getting-hired-at-google/.
4. Google brags that its Boston office is a mere "529 Smoots (plus or minus a couple of ears)" from MIT's main entrance. If you are among the majority who do not know what a Smoot is, you might want to Google it.
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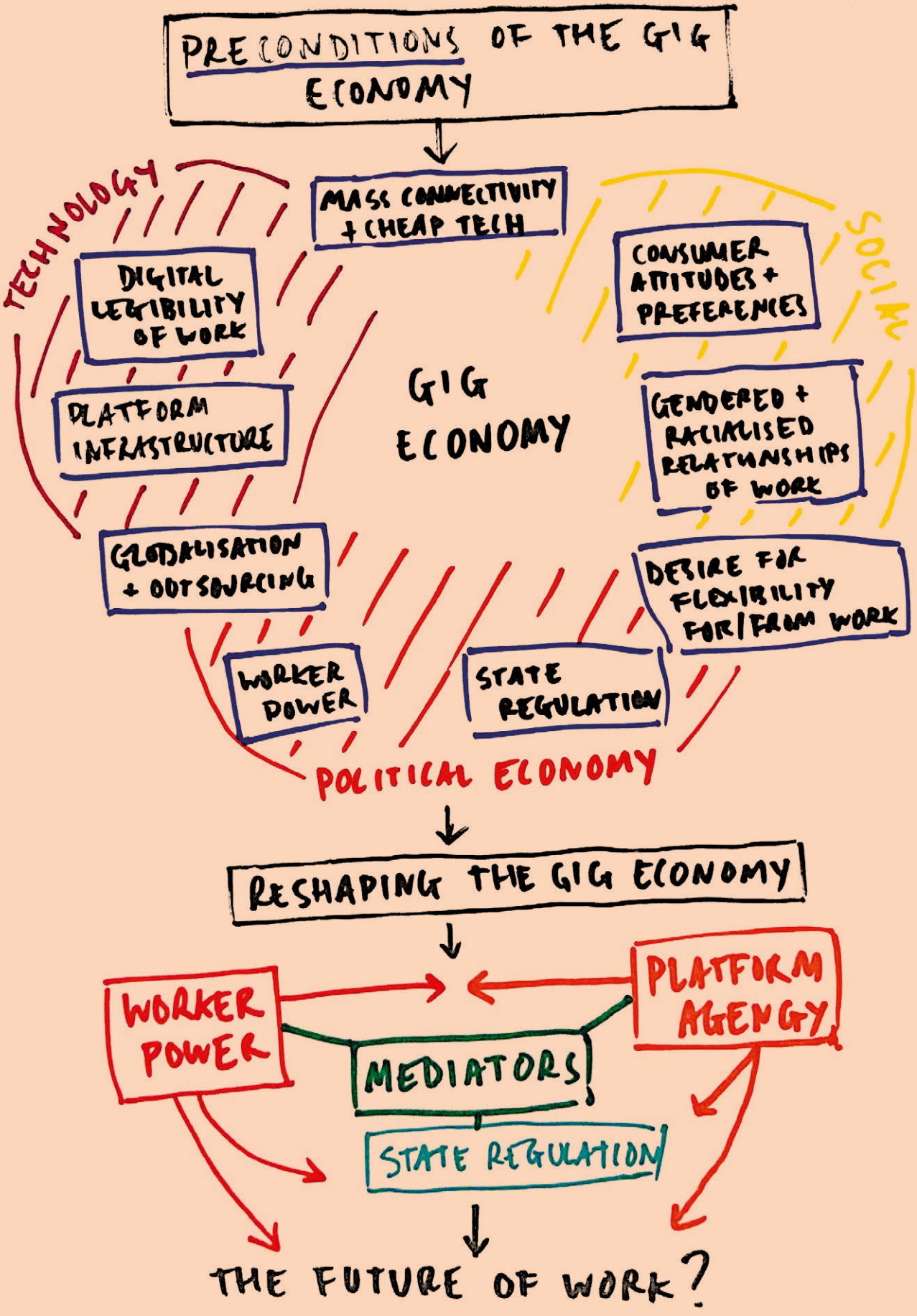
PRECONDITIONS OF THE GIG ECONOMY
TECHNOLOGY
MASS CONNECTIVITY + CHEAP TECH
DIGITAL LEGIBILITY OF WORK
PLATFORM INFRASTRUCTURE
SOCIAL
CONSUMER ATTITUDES + PREFERENCES
GENDERED + RACIALISED RELATIONSHIPS OF WORK
GIG ECONOMY
GLOBALISATION + OUTSOURCING
DESIRE FOR FLEXIBILITY FOR/FROM WORK
WORKER POWER
STATE REGULATION
POLITICAL ECONOMY
RESHAPING THE GIG ECONOMY
WORKER POWER
PLATFORM AGENCY
MEDIATORS
STATE REGULATION
THE FUTURE OF WORK?

The Impact of the Gig Economy

Jamie Woodcock

This chapter discusses the impacts of the gig economy on labor markets in Europe. The gig economy and platform work have become popular topics, while reshaping the experience of work for increasingly larger numbers of people. However, too often debates around the gig economy lack empirical insight. This chapter seeks to introduce readers to these issues, starting with the preconditions that shape the emergence and dynamics of the gig economy. The next part examines the resulting labor market trends, including effects beyond the gig economy; the experience for workers, drawing on current research; and possible future directions, both positive and negative.

The gig economy, along with the future of work, has become a popular topic of discussion. The gig economy, broadly speaking, involves working arrangements that are closer to "gigs" than traditional kinds of jobs. This riffs off the ideas that work is becoming more like playing a music gig at a venue, with no guarantee of continuing work, but with workers also free to choose where to go next. Short-term or precarious work has a history longer than formal work arrangements, both within jobs that now have so-called "standard employment contracts" and roles that remain informalized, like domestic work.

The current interest in the gig economy has also been spurred by the application of digital technology and the use of platforms. Often, when talking about the gig economy, the subject is usually platform economy—and more specifically platform work. App-based transportation—like Uber, food delivery, or other consumer-facing services—represents particularly visible changes to work. Throughout this chapter, the focus will be narrower than the gig economy, examining how gig work is increasingly being mediated via digital platforms. As Nick Srnicek (2017: 48) has argued:

> Platforms, in sum, are a new type of firm; they are characterized by providing the infrastructure to intermediate between different user groups, by displaying monopoly tendencies driven by network effects, by employing cross-subsidization to draw in different user groups, and by having designed a core architecture that governs the interaction possibilities.

This focus is important because, although broader gig work has existed for a long time, the platformization of this work is drastically reshaping the gig economy—with the potential to create widespread impacts across the entire economy. To give some sense of the scale, Richard Heeks (2017) estimates that around seventy million people have found work via a platform. In the slightly longer term, McKinsey estimates that 540 million people could be seeking work through "online talent platforms" by 2025, with a prediction that up to 230 million would find work (Manyika et al., 2015). Moreover, Guy Standing (2016) predicts that, by then, one third of all work will be mediated via digital platforms.

This chapter seeks to introduce readers to these issues, starting with the preconditions that shape the emergence and dynamics of

the gig economy. The next part examines the resulting labor market trends, including effects beyond the gig economy; the experience for workers, drawing on current research; the impact on society more widely; and concludes with possible future directions, both positive and negative.

The Preconditions of the Gig Economy

Before examining the impacts of the gig economy, it is first worth exploring the preconditions that shape its emergence. Otherwise, there is a risk of seeing the gig economy as only taking a particular form, shaped by technological factors, thereby reducing the agency of other important actors in the process. At its core, the platforms that mediate gig work use "tools to bring together the supply of, and demand for, labor" (Graham and Woodcock, 2018: 242). However, both aspects of labor are shaped by preconditions, which then facilitate and encourage the growth of this kind of work. As identified by Woodcock and Graham (2019), there are nine preconditions that shape the gig economy, involving

The gig economy, broadly speaking, involves working arrangements that are closer to "gigs" than traditional kinds of jobs

aspects of technology, society, politics and their combination.

The first precondition is technological: "platform infrastructure." The availability of underlying technology, including 4G connectivity, cloud computing, GPS networks and so on, is an important factor in facilitating the rapid growth of platforms as a model. The second precondition involves the "digital legibility of work," which refers to whether or not the work can be mediated via a digital platform. For example, delivery work has a high level of digital legibility as it involves a discrete task that can be mapped onto a process with defined steps. However, there are many kinds of less well-defined work that can be challenging to organize via a platform. The third precondition combines technological and social aspects: "mass connectivity and cheap technology." The availability of affordable smartphones with regular Internet connectivity is important for both workers and consumers of platforms. Without this, services can be unreliable and do not meet the needs of either party. Transportation platforms excel at offering a service at any time—and often when other alternatives are not possible—

Bike couriers working for Foodora and Deliveroo take to the streets to demand higher wages, Berlin, June 2017

Gig work can be divided in two: "geographically tethered work," which requires workers to be in a particular place, and "cloudwork," which refers to work that can be completed remotely via a computer

and this is facilitated by technology that is cheap enough for mass uptake.

The fourth is a social precondition related to "consumer attitudes and preferences," tying into the previous factor. These kinds of platforms can only grow if there is an existing market for these kinds of services (or one can be manufactured in various ways) and customers are amenable to accessing these services via platforms. For example, domestic work platforms require—of course—a market for domestic workers that involves customers who are used to having workers in their homes. In countries where these practices are more common, for example in South Africa, there are existing ways through which domestic workers are recruited and managed. These often draw upon longer informal relationships, often with vouching or other forms of trust playing a key part in both. For domestic work platforms like SweepSouth or Domestly to be successful, there has to be a shift in customer attitudes and preferences toward using digital platforms instead. This example connects with the fifth social precondition: "gendered and racialized relationships of work." Domestic work has long been gendered as female work, as well as being racialized with minority and migrant workers. Similarly, in the UK and other global north countries, driving and delivery work has historically been considered as male work, while often racialized too. In both cases, this means many workers who are not covered by effective employment regulation due to irregular status, as well as facing racist marginalization more widely. Many of these dynamics can be carried over into platform work.

The sixth precondition is a combination of social aspects and political economy: the "desire for flexibility for/from workers." There are two pushes for the flexibilization of work with platforms that are closely related. The first is platforms seeking a high flexible workforce that can be engaged at short notice with little commitment to continuing work. For example, delivery drivers who are paid only to make deliveries, particularly at peak times, not needing to be paid during times they are not needed. This allows platforms to scale rapidly, while reducing staffing costs—particularly through the use of self-employment status, which will be discussed in more detail later. However, only considering this imperative for flexibility misses the demand—and indeed often discussed benefit by workers—for more flexible working practices. Many workers want more flexibility than traditional employment offers, being able to schedule work around other aspects of life, or to be able to work more or in addition to other jobs. While there are a variety of reasons why this may be, including the prevalence of low paid and bad quality jobs, this desire for flexibility of workers is an important factor to consider.

The seventh and eighth preconditions are related to political economy and involve "state regulation" and "worker power." Both of these factors shape the environment from which the gig economy and platforms are established. The first, state regulation, sets the regulatory environment that provides limits upon—or indeed facilitates—the growth of this kind of work. However, in many cases, existing regulation will not have been designed to consider the specificity of this kind of work, meaning platforms can evade or avoid regulation. Worker power, on the other hand, refers to the strength of the existing labor movement, understanding how its relative power can shape the environment in which platforms operate—tipping the scale in favor of workers and their rights. For example, in countries with strong trade unions of taxi drivers, the entry of platforms has been frustrated or blocked. In other cases, worker-friendly regulation has been brought in following pressure. The balance between worker power and corporate lobbying therefore sets an important terrain upon which platforms are established and developed.

The ninth and final precondition is a combination of political economy and technology, referring to the dynamics of "globalization and outsourcing." In a sense, this refers more specifically to one particular kind of gig work. Broadly, gig work can be divided in two. First, "geographically tethered work," which requires workers to be in a particular place—whether cleaning a house, delivering food, or so on. The second is "cloudwork" which refers to work that can be completed remotely via a computer. This could either be microwork on platforms like Amazon Mechanical Turk, with the short tasks like image tagging or transcription, or the longer online freelancing on platforms like UpWork (Woodcock and Graham, 2019). Clearly, the latter involves dynamics of outsourcing that build on increasingly globalized networks of digital logistics. For example, much of the behind the scenes work of the Internet is completed by these remote gig workers, like moderating video content in the Philippines. However, the former also involves these processes as much of this work is undertaken by migrant workers, moving

across borders and becoming outsourced workers within new national boundaries.

These preconditions do not determine the form that the gig economy will take, but when taken together they have a deep influence on shaping the potential outcomes of the gig economy in different countries. It is important to draw attention to these different preconditions, particularly those that are not directly related to technology, in order to show how there are "actually myriad *gig economies* all over the world that are experienced in significantly different ways" (Woodcock and Graham, 2019). Despite this, as the remainder of the chapter will show, there are increasingly common threads, dynamics, and outcomes that are emerging—but that these do not foreclose the possibilities for this kind of work to be reshaped in the near-future.

Labor Market Trends

Building upon these different preconditions, the gig economy has grown and developed. In an earlier phase, some researchers discussed this as the start of the "sharing economy" (Sundararajan, 2017). However, these promises of the gig economy have not come true. For example, Sarah Kessler (2018: x) describes a story told to her by a start-up founder: that "we could work for our neighbors, connect with as many projects as we needed to get by, and fit those gigs between band rehearsals, gardening, and other passion promises." This proposed way of working has, instead, arrived not to fit around existing relationships, but, instead, to begin breaking up previous ways of working. In particular, this involves a break from what has been called the "standard employment relationship." This denotes an expectation for workers that they will have a "stable, socially protected, dependent, full-time job" that is subject to protections from the state and influenced by collective agreements (Bosch, 2004: 618).

In particular sectors, like transport and delivery, there are clear and visible trends emerging. Uber now has an estimated four million drivers globally, with over 40,000 in London. In a study by Huws et al. (2016), they concluded that platform "work is not only growing fast but spreading into diverse occupational areas," including both work completed online, or forms of gig work like delivery that are mediated online. They also note that there is "evidence that this model is spreading to other diverse areas including health services, teaching, legal services and a wide variety of manual and maintenance tasks" (Huws et al., 2016: i). Across the countries they surveyed in Europe, 9% of people in the UK had carried out paid work via platforms, with 9% in the Netherlands, 10% in Sweden, 12% in Germany, and 19% in Austria. In a US-based study, it was found that 8% of Americans worked on an online "gig" platform in 2016, rising to 16% for the eighteen to twenty-nine age bracket (Smith, 2016). However, for many workers, this was supplemental income in addition to other forms of employment. The findings of the survey argue that for a small, but growing, number of workers, platform work is becoming a main part of their income. Workers are "choosing it from a desperation to find any source of income, rather than as an active career choice" (Huws et al., 2016: iii).

Despite these findings, it has proven difficult to accurately measure the size of the gig economy. First, there are important differences on how researchers define the gig economy—meaning that the contours change from study to study. Second, there is little data available at present. As noted earlier, Heeks (2017) estimates seventy million registered workers on platforms, but that only around 10% are active at any one time. The flexibility and low barrier to entry means that many people may try working on platforms, or move between this kind of work and other forms. Despite the difficulty in providing an accurate measure, it is clear that "ever more work ... is being mediated by platforms" (Woodcock and Graham, 2019). For example, in the UK one estimate puts the gig economy workforce at 1.1 million, this is as many as work for the NHS (Balaram et al., 2017). Regardless of the quantitative figures, the gig economy is creating important qualitative changes—both for workers and society more broadly.

The Experience for Workers

The experience of working in the gig economy, like that of working many jobs, is diverse. People bring a wealth of experiences, wants, and needs to work with them. It is therefore not possible to say there is a singular experience of the gig economy. In a US context, Alexandrea Ravenelle (2019: 1) has argued that there are "strugglers," "survivors," and "success stories" in the gig economy. If you look hard enough, on every platform these typologies can be found—as well as many in between. However, there are important dynamics that are becoming increasingly common across experiences of the gig economy.

The first is related to the flexibility of the gig economy. Flexibility is an overused concept that can mean a variety of things in practice—from workers having the ability to choose when to work, to the freedom for employers to hire and fire at will, and so on. Flexibility is therefore often experienced within constraints, flexibility from or to something. For those with relatively little power, this flexibility is often experienced as precarity. This means difficulties in predicting how much they will earn, or how long paid work will continue. To illustrate this, it is worth returning to an example from my own fieldwork with Deliveroo drivers in London (Woodcock and Graham, 2019). The story articulates many of the issues involved with this kind of work:

> One of the riders, who had been a participant in Jamie's research since the beginning, told a particularly revealing story about the experience of working for Deliveroo. At the end of an interview, Jamie asked the driver what he thought the most challenging part of the work was. Expecting the driver to mention the low pay, insecure contracts, or threat of accidents, he was instead told the following story. The driver worked at two other jobs in addition to Deliveroo. In the morning he would wake up and go to the first job, trying to eat breakfast before he left. Over lunch he worked a shift for Deliveroo, making sure to grab something quick to eat on the way. In the afternoon he worked at the third job, before starting the evening shift at Deliveroo. The most challenging aspect of the work was making sure he ate enough food once he got home to ensure he had the energy to get up and repeat the process the next day ... Deliveroo is marketed as a service for delivering food to stylish young professionals, but the reality is that many of his deliveries were to people too exhausted from working to make their own dinner. This is especially ironic given how Deliveroo brands itself. His story is therefore a damning indictment of the realities of gig work in London: a worker struggling to eat enough calories to deliver food to people who are too tired from work to make their own.

This is an important story for a number of reasons. First, it is an indictment of the working practices that many workers face in the gig economy. While they have the flexibility to work when they choose, for this worker it meant trying to top up the minimum wage income of other jobs in order to try and survive in a highly expensive city like London.

This worker had never met anyone who was employed by Deliveroo. The first meeting was with people considered legally self-employed like him to register and set up the app, while any problems were handled through an outsourced call center. This meant it was a very different experience to either the café, the bookshop, or other forms of low-paid work common in London. The irony of his struggle to consume enough calories to deliver food draws attention to the continuing materiality of this kind of platform work. This means understanding how the road networks, with other drivers and risks of accidents, the weather, personal fitness, the ease or difficulty of finding addresses, remaining phone battery and data signal, and all the other aspects that are hidden behind the digital interface of the app.

There is an increasing body of research that points toward the negative outcomes for workers in the gig economy (Aloisi, 2016; Scholz, 2017; Graham et al., 2017; Graham and Woodcock, 2018; Wood et al., 2018; Woodcock and Graham, 2019; Cant, 2019). The use of self-employment statuses exacerbates many of these negative aspects, beyond what is found in precarious work like call centers (Woodcock, 2017a). For many workers, the experience is that work is increasingly precarious. As defined by the ILO (2011: 5),

> In the most general sense, precarious work is a means for employers to shift risks and responsibilities on to workers. It is work performed in the formal and informal economy and is characterized by variable levels and degrees of objective (legal status) and subjective (feeling) characteristics of uncertainty and insecurity. Although a precarious job can have many faces, it is usually defined by uncertainty as to the duration of employment, multiple possible employers or a disguised or ambiguous employment relationship, a lack of access to social protection and benefits usually associated with employment, low pay, and substantial legal and practical obstacles to joining a trade union and bargaining collectively.

The use of self-employment statuses exacerbates many of the negative outcomes for workers, beyond what is found in precarious work like call centers

Freedom from traditional forms of work has the potential to create larger societal problems in the future. In many countries, social security is connected to the standard employment contract

This precariousness has been driven by a range of "social, economic, and political forces" that "have aligned to make work more precarious" (Kalleberg, 2009: 2). The actual precariousness of a job—that is, the likelihood that it will end—is also related to the experience of precarity—the threat that the job could end at any time (Woodcock, 2014). The impact of precarity can become greatly amplified beyond actual figures of workers losing their jobs. This also effects workers beyond the workplace, feeding into workers ability to engage in other aspects of society too.

The Impact on Society

The gig economy is reshaping not only work, but also aspects of society more broadly. One of the key preconditions discussed earlier was the "desire for flexibility for/from workers," as well as "consumer attitudes and preferences" (Woodcock and Graham, 2019). These could be combined to make sense of the impact of the gig economy on society more broadly: workers, platforms, and consumers are all seeking greater flexibility from these kinds of platform services. Workers are seeking to find more flexible and adaptable ways to work; platforms are freeing themselves from previous employment regulations, and consumers increasingly expect on-demand services.

Due to the customer-facing nature of many of the high-profile platforms these are changing consumption patterns. For example, Uber has widely increased the provision of private-hire drivers, with a surplus of drivers, meaning consumers often only have to wait a short time for a pickup. The lower prices have meant increased take-up of these services, transforming transport practices across many cities. Food-delivery platforms are also changing consumption patterns. They have also shifted the relationship with restaurants, through the establishment of so-called "dark kitchens" (Butler, 2017) in which the food is no longer made in a restaurant, but in special purpose-built delivery units, often hosted in shipping containers.

These shifting consumption patterns have a common trend that ties them together. Whether passenger journeys, delivery of food, or other on-demand services, these allow other workers to externalize aspects of their "social reproduction" (cf. Bhattacharya, 2017), that is, recovering from and preparing

Uber co-founder Ryan Graves, with CEO Dara Khosrow, rings a ceremonial bell at the New York Stock Exchange as the company makes its initial public offering on May 10, 2019

for work. At the most obvious level, faster transportation options open up more time—either staying later at work or having more non-work time—while delivery food does not require time to prepare. Therefore, the gig economy connects to broader trends of work intensification that can be seen throughout other sectors of the economy (Graeber, 2018). This involves taking parts of our lives that might previously have been organized in the home—notwithstanding all the problems that that can entail—and opening them up to the market and venture capital.

This freedom from traditional forms of work also has the potential to create larger societal problems in the future. In many countries, social security—whether to cover sickness, retirement, or maternity/paternity—is connected to the "standard employment contract" in various ways. The short-term flexibility of the gig economy has brought some benefits to people working the gig economy, as well as to those who now rely on externalizing the costs of overwork in various ways. However, given the lack of social provisions for people in the gig economy, the social costs of their work will be borne predominantly by private individuals.

As has been noted, the gig economy relies upon a self-employment status which frees the platform or company from the requirement to pay benefits and cover the risks of work. For workers driving in the gig economy this is particularly important. In a study of gig workers in London:

> 42% said they had been involved in a collision where their vehicle had been damaged and 10% of the total sample said that someone had been injured as a result and this was usually themselves ... three quarters of respondents (75%) said that that there had been occasions while working when they have had to take action to avoid a crash (Christie and Ward, 2018: 4–5).

Moreover, the authors of the study warned that the incentive systems in the gig economy encouraged "chasing jobs," exacerbating risks to get more work, which further "increases the exposure to risk." They conclude that "these faceless digital brokers take no responsibility for the health and safety of the people who accrue income for them" (Christie and Ward, 2018: 5). These risks extend beyond the time that people are working. The insurance group Zurich has warned that there is "a blind spot in the current pension system. Gig economy workers don't have access to a workplace pension, meaning millions aren't saving enough for retirement" (quoted in Shaw, 2017). They estimate five million people are at risk of not having adequate pension provision—including those working for platforms but also insecure forms of work like zero-hour contracts.

There is also little discussion of the environmental impact of platform work. The Internet infrastructure and the vast server farms upon which these services run is having an increasing impact on the environment. For example, platform operations now

Parts of our lives that might previously have been organized at home—such as cooking—are opening up to the market and venture capital

In the absence of traditional forms of trade unionism, like collective bargaining, platform operators have been shaping work and also actively influencing state regulation through lobbying

Signage outside the co-working office space group WeWork in London

consume an estimated three percent of the global supply of electricity, while producing two percent of global greenhouse gas emissions—an equivalent carbon footprint to the airline industry (Woodcock, 2017b).

Future Directions

It is possible that all work could become organized over platforms and become part of the gig economy. There are many jobs that can be split into smaller parts, paid by the task, with employers that could see the benefit of a much more flexible workforce. However, as pointed out in this chapter, the growth of platform work is not determined solely by technology. Instead, there are a range of preconditions that shape how the gig economy develops. In some forms of work, both employers and workers would be opposed to this; in other cases just one or the other, or a range of other social, technological, or political economy factors may not facilitate this.

In particular, there are two preconditions that continue to act as important mediators on how the gig economy operates and how it will develop. They are both related to political economy: "state regulation" and "worker power" (Woodcock and Graham, 2019). These combine with a third important factor not mentioned in the preconditions, which is the agency of platform operators themselves. There is, therefore, an important three-sided dynamic that has the potential to exert considerable influence on the future direction of work. As workers on platforms start organizing, they are beginning to raise demands about how they want to work. For example, workers have now been on strike from London to Bangalore and Guangzhou, so much so that "we need to stop talking about resistance as emerging in platform work"—it has arrived (Cant and Woodcock, 2019). In the process, they are attempting to change how platforms operate, but also state regulation. On the other hand, platform operators have been shaping work in the absence of traditional forms of trade unionism, like collective bargaining, while also actively influencing state regulation through lobbying (Woodcock and Graham, 2019). This contradiction between the interests of platform operators and independent contractors is increasingly mirroring the historical struggles between workers and employers—particularly at early phases of an industry's operation. In addition to this, the state in different countries is beginning to introduce new regulation—often favoring platform operators, but sometimes favoring workers. Given the three-sided nature of this, the current directions and outcomes of the competition between these different groups remains unresolved.

The importance of this competition is that it has the potential to reshape much more than only the gig economy. The impact of the gig economy is not only about the numerical growth of the number of people working in this way. It also becomes an important test case of a new way of managing labor. Thus, while the quantitative impact of the gig economy may be relatively small, it has the potential to make a huge qualitative change in how work will be organized in the future. As Callum Cant (2019) has argued, the gig economy acts as a "laboratory" from new management techniques. This is much like how previous forms of digital work, like call centers, have early roots in the Taylorism of factories, then go on to influence the emergence of the gig economy (Woodcock, forthcoming). Thus, what methods prove successful in this new testing ground will be adapted and used across the economy more broadly. It is, therefore, crucial to understand what is happening within the gig economy now, in order to chart a better future of work and for workers.

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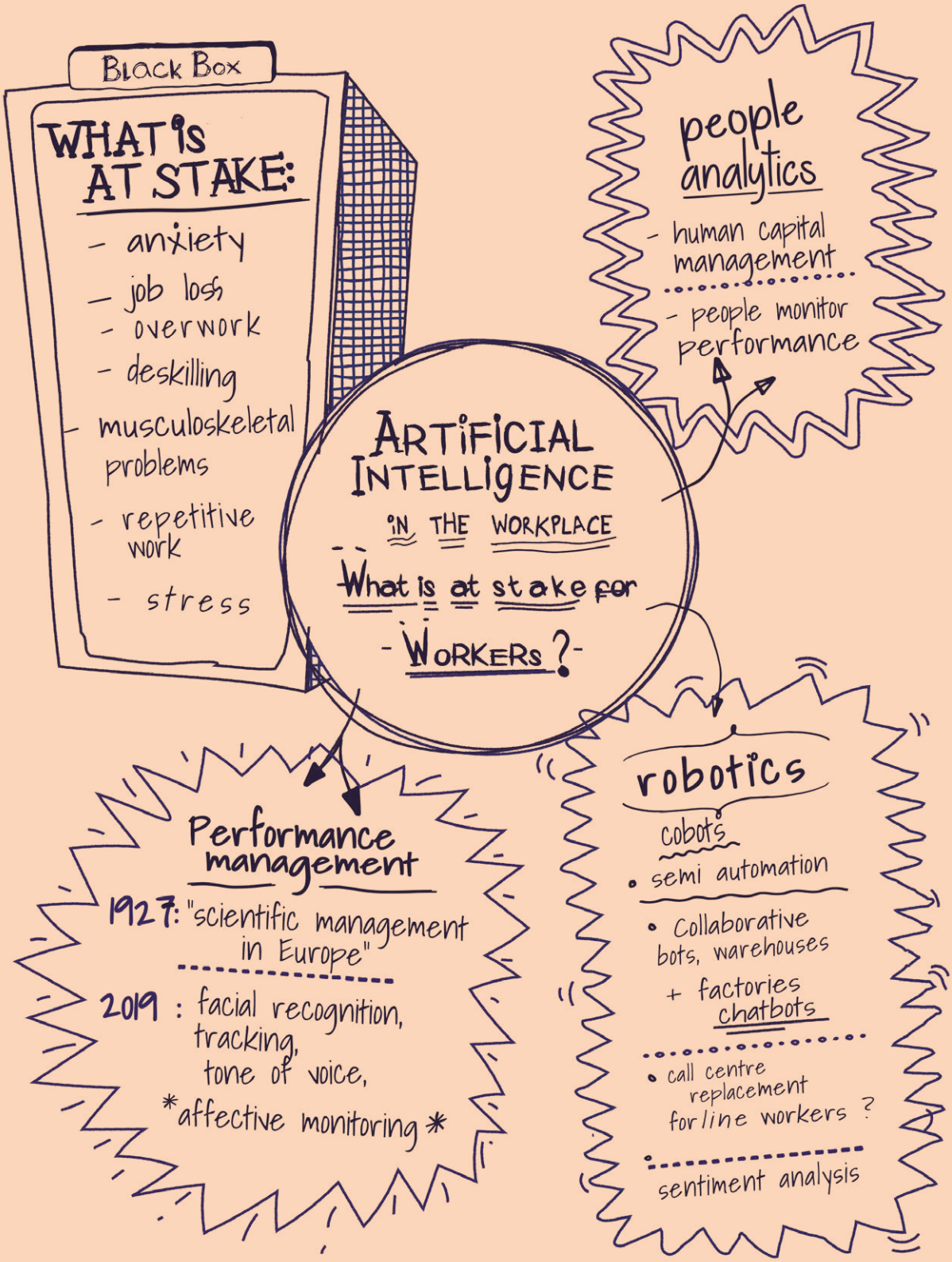
Black Box
WHAT IS AT STAKE:
- anxiety
- job loss
- overwork
- deskilling
- musculoskeletal problems
- repetitive work
- stress
ARTIFICIAL INTELLIGENCE IN THE WORKPLACE
What is at stake for - WORKERS ?-
people analytics
- human capital management
- people monitor performance
robotics
cobots
• semi automation
• Collaborative bots, warehouses + factories
chatbots
• call centre replacement for line workers ?
• sentiment analysis
Performance management
1927: "scientific management in Europe"
2019 : facial recognition, tracking, tone of voice,
affective monitoring

Artificial Intelligence in the Workplace: What Is at Stake for Workers?

Phoebe V. Moore

Machines, both analog and digital, have been used over time to help workplace designers calculate outputs of work and, indeed, to replace work through automation, now, via the integration of artificial intelligence (AI) tools and applications. What types of "intelligence" are expected from technologies? How does management use personal data acquired by machines and make assumptions of respective types of intelligence? Data has been gathered from job candidates' and workers' activities over time, where even physical movements and sentiments, as well as precise social media use, are tracked. When "big data" is big enough, it is used to train algorithms that predict talents and capabilities; monitor performance; set and assess work outputs; link workers to clients; judge states of being and emotions; provide modular training on the factory floor; look for patterns across workforces; and more. How does AI become central to this process of decision-making? In this context, what risks do workers face today in the digitalized, AI-augmented workplace?

Workers have always faced worker tracking and performance monitoring where an overarching business profit motive dominates the terms of the employment relationship, and workers want a decent and enjoyable life, paid for by their work and commitment to their employer and wage provider. Today, however, the employment relationship is changing, and there is a new type of "actor" in the workplace. Machines, both analog and digital, have been used over time to help workplace designers calculate outputs of work and, indeed, to replace work through automation; now, via the integration of artificial intelligence (AI) tools and applications, some machines have new responsibilities and even autonomy, as well as being expected to display various forms of human intelligence and make decisions about workers themselves.

Figure 1 outlines where, and how, new technologies are being implemented into workplaces; the types of "intelligence" which are expected from these technologies; and then, the precise ways that management uses the data produced by such technological processes with the assumptions of respective types of intelligence. There are a number of ways that the newest technologies are being used by management as AI takes center stage. Data has been, and is being, accumulated from job candidates' and workers' activities over time, from telephone calls, computer use, swiping in and out with "smart cards," and up to today, where even physical movements and sentiments, as well as precise social media use, are tracked and monitored.

For human resources, called "big data" when reaching a large enough volume, collections of data are being used to train algorithms that predict job candidates and workers' talents and capabilities; monitor, gage, and encourage performance; set and assess work outputs; link workers to clients; judge states of being and emotions; provide modular training on the factory floor; look for patterns across workforces of, for example, sickness; and much more.

This chapter, in line with these developments, outlines how AI is increasingly part of the process of decision-making and identifies the risks that workers face today, which should be acknowledged and recognized by policy-makers and management stakeholders alike.

People analytics is an increasingly popular HR practice that uses big data and digital tools to "measure, report, and understand employee performance, aspects of workforce planning, talent management, and operational management"

1. People Analytics: Human Capital Management and Performance Monitoring

AI is seen today as the most innovative and promising arena for workplace and workforce management. Forty percent of human resources (HR) functions being applied across the world in companies small and large are now using AI-augmented applications. These companies are mostly based in the USA, but some European and Asian organizations are also coming on board. A PricewaterhouseCoopers survey shows that more and more global businesses are beginning to see the value of AI in supporting workforce management (PwC, 2018). It is claimed furthermore that 32% of personnel departments in tech companies and others are redesigning organizations with the help of AI to optimize "for adaptability and learning to best integrate the insights garnered from employee feedback and technology" (Kar, 2018). A recent IBM report (IBM, 2018) shows that half of chief HR officers identified for the study anticipate and recognize the potentials for technology in HR surrounding operations and the acquisition and development of talent. A Deloitte report shows that 71% of international companies consider people analytics a high priority for their organizations (Collins, Fineman, and Tsuchida, 2017) because it should allow organizations to not only provide good business insights but also deal with what has been called the "people problem."

"People problems" are also called "people risks" (Houghton and Green, 2018). These have several dimensions, outlined in a Chartered Institute for Personnel Development (CIPD) report as involving:

- talent management;
- health and safety;
- employee ethics;
- diversity and equality;
- employee relations;
- business continuity;
- reputational risk (Houghton and Green, 2018).

"People analytics" is an increasingly popular HR practice, where big data and digital tools are used to "measure, report, and understand employee performance, aspects of workforce planning, talent management, and operational management" (Collins, Fineman, and Tsuchida, 2017). Every sector and organization require HR, which is responsible for everything from recruitment activity to preparing employment contracts and managing the rela-

Technology:	Platforms (algorithms, artificial intelligence [AI], machine learning [ML])	People analytics, chatbots (filming interviews, software, AI, ML, emotion coding)	Cobots, wearables (RFID, dashboards, tablets, GPS, data glasses/Hololens)
Type of intelligence:	Predictive, prescriptive, descriptive	Affective, assistive, predictive, descriptive	Assistive, collaborative
Where/what:	Home, street (gig work)	Office, call center (service work)	Factory, warehouse (manual work)
Decision-making:	Human resource (HR), performance monitoring (PM), micro-management (MM)	HR, PM, MM	HR, PM, MM

Fig. 1. Technologies in workplaces

There is some discrepancy as to the role of HR. While some argue its function is only bureaucratic, others claim that it should play a prominent role in business operations and execution

A form of people analytics involves filmed job interviews, where AI is used to judge both verbal and nonverbal cues. One such product, made by HireVue, is used by over 600 companies

tionship between workers and employers.

Clearly there is some discrepancy in the role of HR, where some argue its function is only bureaucratic, while others claim that it should play a prominent role in business operations and execution. People analytics practices are part of both levels of HR, where computerization, data gathering and monitoring tools allow organizations to conduct "real-time analytics at the point of need in the business process ... [and allow] for a deeper understanding of issues and actionable insights for the business" (ibid.). Prediction algorithms applied for these processes often reside in a "black box" (Pasquale, 2015), where people do not fully understand how they work, but even so, computer programs are given the authority to make "prediction by exception" (Agarwal et al., 2018). "Prediction by exception" refers to processes whereby computers deal with large data sets and are able to make reliable predictions based on routine and regular data, but also to spot outliers and even send notifications "telling" the user that checks should be done, or whether human assistance or intervention should be provided.

Also called "human analytics," "talent analytics," and "human resource analytics," people analytics are defined broadly as the use of individualized data about people to help management and HR professionals make decisions about recruitment, that is, who to hire; in worker appraisals and promotion considerations; to identify when people are likely to leave their jobs; and to select future leaders. People analytics are also used to manage workers' performance. First, this section looks at the human capital management aspects of people analytics, where recruitment and talent prediction occur. Second, performance management with the use of people analytics is outlined.

1.1 Human Capital Management

AI-enhanced HR practices can help managers obtain seemingly objective wisdom about people even before they hire them, as long as management has access to data about prospective workers, which has significant implications for tailoring worker protections and preventing occupational, safety, and health (OSH) risks at the individual level. Ideally, people analytics tools can aid employers to make good decisions about workers. Indeed, algorithmic decision-making in people analytics could be used to support workforces by aligning employee performance feedback and performance pay, and workforce costs, with business strategy and support for specific workers (Aral et al., 2012, cited in Houghton and Green, 2018, p. 5). Workers should be personally empowered through having access to new forms of data that help them to identify areas of improvement, stimulate personal development, and achieve higher engagement.

Another form of people analytics involves filmed job interviews, where AI is used to judge both verbal and nonverbal cues. One such product is made by a group called HireVue and is used by over 600 companies. This practice is carried out by organizations including Nike, Unilever, and Atlantic Public Schools, who are using products that allow employers to interview candidates on camera. The aim is to reduce bias that can come about if, for example, an interviewee's energy levels are low, or if the hiring manager has more affinity to the interview based on similarity, for example, age, race, and related demographics. However, evidence has already emerged that preferences from previous hiring managers are reflected in hiring, and heterosexual white men are, a report by Business Insider reveals, the hiring preference *ceteris paribus* (Feloni, 2017). If data provided to an algorithm reflects the dominant bias reflected over time, then it may score someone with "in-group" facial expressions higher and rate other cues tied to sexual orientation, age, and gender that do not resemble a white male, lower.

1.2 Performance Management

While performance management is seen in most workplaces, there are hundreds of methods that have been tried and tested over many years. Perhaps the best-known era when performance management began to use technology to make decisions about workers' performance in the industrializing world was the period of scientific management. The well-known industrialists Taylor and the Gilbreths devised schemes to understand workplace productivity as linked to specific, measured human actions in the workplace. These industrialists searched for scientific methods to identify and depict perfect bodily movements for ideal productive behaviors through technologically informed work designs.

In 1927 the League of Nations published papers from the 1927 International Economic Conference entitled "Scientific Management in Europe." This report was printed in the interwar period, when nations were furiously seeking to set up interdependent organizations and establish a climate of cooperation to reduce the chances for any further wars. Interestingly, a standardization of industrial practices was advocated in this report, and scientific management was heralded as a field "*par excellence* for international cooperation." Indeed, at the conference, scientific management was defined as:

> ...the science which studies the relations between the different factors in production, and especially those between the human and the mechanical factors. Its object is to obtain, by the rational utilization of these various factors, the optimum output.

So, Taylorism was not only a project of worker performance management but had a larger remit and ideology. The International Labour Office reported that scientific management had already "overflowed the limits within which it was originally applied by Taylor" and its recommendations and practices "now cover all departments of the factory, all forms of manufacture, all forms of economic activity, banking, commerce, agriculture and the administration of public services."

Looking at micro-movements by using a series of technological devices including a spring-driven camera, an electric motor-driven camera, and a microchronometer, which was an instrument for measuring very small intervals of time, these scientists looked for the hoped "best way" to carry out work in bricklaying and in steel factories. The Gilbreths also measured workers' heart rates using a stethoscope and stopwatch—a foreshadowing of the heart rate measurements seen in fitness armbands that are increasingly being used in workplace initiatives today (Moore, 2018a).

There is a large literature about performance management, perhaps beginning with *scientific management*, that emerged from various disciplines, from organizational psychology, sociology, sociology of work, and critical management studies, in which researchers looked at the ways organizations try to balance productivity with the management of workers' activities and to organize various mechanisms that surround these processes.

The school of *human relations* followed scientific management, followed by *systems rationalism* in which "operations research" dominated, followed by the *organizational culture and quality* period of work design history, and now the era I have called *agility management systems* (Moore, 2018a). Each period of work design history involves attempts to identify the "best" logic of calculation, where performance management (PM) is a calculative practice that is also institutionally embedded and socially transformative. Increasingly, ways to calculate workers' behaviors are founded in a neoliberal economic rationality.

Economic practices of calculation create markets (Porter, 1995) and enter organizations with a logic of value calculation, which, in turn, shapes the organization as well as requires "responsibility from individuals rendered calculable and comparable" (Miller and O'Leary, 1987). Through quantification, the designer of a PM system decides what will be considered calculable and comparable. While there are assumptions of the "bottom line," productivity and efficiency do not hold an automatic link to workers' safety and health, contract and livelihood protections. Any time there is a method designed to characterize a person, that is, the ideal worker with the best performance scores, we are making people up (Hacking, 1986). The enumeration of characteristics then allows for the generation of statistics which function as specified calculus that are seemingly neutral, docile, and immune to query. Desrosières indicates that "placing acts, diseases, and achievements in classes of equivalence... then shape how the bearer is treated" (2001, p. 246). Rose stated that "numbers, like other 'inscription devices,' actually constitute the domains they appear to represent; they render them representable in a docile form—a form amenable to the application of calculation and deliberation" (Rose, 1999, p. 198, cited in Redden, 2019, pp. 40–41). Despite the range of arguments about what should be measured, too little research has focused on how decisions are taken in determining what work characteristics and factories are seen as worthy of measure.

OSH risks

If processes of algorithmic decision-making in people analytics and performance management do not involve human intervention and ethical consideration, these human resource tools could expose workers to heightened structural, physical, and psychosocial risks and stress. How can workers be sure decisions are being made fairly, accurately, and honestly if they do not have access to the data that is held and used by their employer? OSH risks of stress and anxiety arise if workers feel that decisions are being made based on numbers and data that they have no access to, nor power over. This is particularly worrying if people analytics data leads to workplace restructuring, job replacement, job description changes, and the like. People analytics are likely to increase workers' stress if data is used in appraisals and performance management without due diligence in process and implementation, leading to questions about micromanagement and feeling "spied on." If workers know their data is being read for talent spotting or for deciding possible layoffs, they may feel pressured to advance their worker performance, and begin to overwork, posing OSH risks. Another risk arises with liability, where companies' claims about predictive capacities may later be queried for accuracy or personnel departments held accountable for discrimination.

One worker liaison expert indicated[1] that worker data collection for decision-making, such as seen in people analytics, has created the most urgent issues arising with AI in workplaces. Often, works councils are not aware of the possible uses of such management tools. Or, systems are being put into place without consultation with works councils and workers. Even more OSH risks arise, such as worker stress and job losses, when the implementation of technologies is done in haste and without appropriate consultation and training, or communication. In this context it is interesting to mention a project run at the headquarters of IG Metall, in which the workplace training curricula are being reviewed in 2019, in the context of *Industrie 4.0*.[2] Findings demonstrate that training needs updating not only to prepare workers for physical risks, as has been standard in heavy industry OSH training, but also for mental and psychosocial risks introduced by digitalization at work, which includes people analytics applications.[3]

2. Cobots and Chatbots

2.1 Cobots

Having visited several car factories and technology centers, I have seen the huge orange robot arms in factories whirring away in expansive warehouses in industrial landscapes, building car parts and assembling cars where conveyor belts lined with humans once stood. Robots have directly replaced workers on the assembly line in factories in many cases, and sometimes, AI is confused with automation. Automation in its pure sense involves, for example, the explicit replacement of a human's arm for a robot arm. Lower-skilled, manual work has historically been most at risk and is still at a high risk of automation. Now, automation can be augmented with autonomous machine behavior or "thinking." So, the AI dimension of automation reflects where workers' brains, as well as their limbs, may no longer be needed. Now, as one EU-OSHA review on the future of work regarding robots and work indicates, while robots were at first built to carry out simple tasks, they are increasingly enhanced with AI capabilities and are being "built to think, using AI" (Kaivo-oja, 2015).

Today, cobots are being integrated into factories and warehouses where they work alongside people in a collaborative way. They assist with an increasing range of tasks, rather than necessarily automating entire jobs. Amazon has 100,000 AI-augmented cobots, which has shortened the need for training workers to less than two days. Airbus and Nissan are using cobots to speed up production and increase efficiency.

2.2 Chatbots

Chatbots are another AI-enhanced tool which can deal with a high percentage of basic customer service queries, freeing up humans working in call centers to deal with more complex questions. Chatbots work alongside people, not only in the physical sense but within the back-end of systems; they are implemented to deal with customer queries over the phone.

For example, Dixons Carphone uses a conversational chatbot now named Cami which can respond to first-level consumer questions on the Curry website and through Facebook messenger. Insurance company Nuance launched a chatbot named Nina to respond to questions and access documentation in 2017. Morgan Stanley have provided 16,000 financial advisers with machine-learning algorithms to automate routine tasks. Call-center workers already face extensive OSH risks because of the nature of the work, which is repetitive and demanding and subject to high rates of micro-surveillance and extreme forms of measure (Woodcock, 2016).

An increasing number of activities are already recorded and measured in call centers. Words used in e-mails or stated vocally can be data-mined to determine workers' moods, a process called "sentiment analysis." Facial expressions likewise can be analyzed to spot signs of fatigue and moods that could lead to making poor judgments and thus lower OSH risks emerging with overwork. But chatbots, while designed to be assistive machines, still pose psychosocial risks around fears of job loss and replacement. Workers should be trained to understand the role and function of workplace bots and to know what their collaborative and assistive contributions are.

OSH risks

Cobots can reduce OSH risks as they allow AI systems to carry out other types of mundane and routine service tasks in factories which historically create stress, overwork, musculoskeletal difficulties, and even boredom of repetitive work for people.

In EU-OSHA's "Foresight on New and Emerging Occupational Safety and Health Risks Associated with Digitalization by 2025" (EU-OSHA, 2018) report, it is indicated that robots allow people to be removed from dangerous physical work and environments with chemical and ergonomic hazards, thus reducing OSH risks for workers (p. 89).

As a recent Netherlands Organization for Applied Scientific Research (TNO) report states, there are three types of OSH risks in human/cobot/environment interactions:

1. Robot/human collision risks, where machine learning can lead to unpredictable robot behavior;
2. Security risks, where robots' Internet links can affect the integrity of software programming, leading to vulnerabilities in security;

The AI dimension of automation shows that, in some cases, workers' brains, as well as their limbs, may no longer be needed

Chatbots pose psychosocial risks around fears of job loss and replacement. Workers should be trained to understand the role and function of workplace bots and to know what their contributions are

Two delivery robots developed by Starship, the company set up by two of the cofounders of Skype, pass on the pavement as they make home deliveries of groceries from a Co-op food store, Milton Keynes

3. Environmental, where sensor degradation and unexpected human action, in unstructured environments can lead to environmental risks (TNO, 2018, pp. 18–19).

AI-permitted pattern and voice recognition and machine vision mean that not only non-skilled jobs are at risk of replacement, but now, a range of nonroutine and non-repetitive jobs can be carried out by cobots and other applications and tools. In that light, AI-enhanced automation enables many more aspects of work to be done by computers and other machines (Frey and Osborne, 2013). One example of the protection of workplace OSH via AI-augmented tools is found in a chemicals company that makes optical parts for machines. The minuscule chips that are produced need to be scanned for mistakes. Previously, one person's job was to detect mistakes with their own eyes, sitting, immobile, in front of repeated images of chips for several hours at a time. Now, AI has fully replaced this task. The OSH risks, which have now been, of course, eliminated, include musculoskeletal difficulties and eye strain and damage.[4]

However, AI-augmented robots in factories and warehouses create stress and a range of serious problems if they are not implemented appropriately. Indeed, one UK-based trade unionist indicated that digitalization, automation, and algorithmic management, when "used in combination... are toxic and are designed to strip millions of folks of basic rights."[5] Potential OSH issues may also include psychosocial risk factors if people are driven to work at a cobot's pace (rather than the cobot working at a person's pace); and collisions between a cobot and a person.[6] Another cobot-related case of machine/human interaction creating new working conditions and OSH risks is where one person is assigned to "look after" one machine and is sent notifications and status updates about machines on personal devices like a smartphone or a home laptop. This can lead to risks of overwork, where workers feel responsible to take note of notifications

The market for industrial and health-care wearable devices is predicted to grow from USD 21 million to USD 9.2 billion by 2020

These vertical farming beds growing a variety of baby greens use an algorithm of controlled light, nutrients, and temperatures, Newark, New Jersey

Not all algorithms utilize AI, but the data produced by client-worker matching services and customer assessment of platform workers train profiles that then lead clients to select specific people for work over others

in out-of-work hours, where a work/life balance is disrupted.[7]

One expert[8] in AI and work discussed developments around the Internet of Things (IoT) in workplaces, where machine-to-machine connected systems work alongside human labor in factories and warehouses. Data-input problems, inaccuracies, and faults with machine-to-machine systems create significant OSH risks as well as liability questions. Indeed, sensors, software, and connectivity can be faulty and unstable, and all vulnerabilities introduce questions about who is legally responsible for any damage that emerges. Is it a cobot's fault if it runs into a worker; the worker's fault; the company who manufactured the cobot originally; or the company that is employing the worker and integrating the cobot? The complexities abound.

Human-robot interaction creates both OSH risks and benefits in the physical, cognitive, and social realm, but cobots may someday have the competences to reason, and must make humans feel safe. To achieve this, cobots must demonstrate perception of objects versus humans, and the ability to predict collisions, adapt behavior appropriately, and demonstrate sufficient memory to facilitate machine learning and decision-making autonomy (TNO, 2018, p. 16) along the lines of the previously explained definitions of AI.

3. Wearable Technologies

Wearable self-tracking devices are increasingly seen in workplaces. The market for wearable devices in industrial and health-care wearables has been predicted to grow from USD 21 million in 2013 to USD 9.2 billion by 2020 (Nield, 2014). From 2014 to 2019, an increase of thirteen million fitness devices were predicted to become incorporated into workplaces. This is already happening in warehouses and factories where GPS, RFID, and now haptic sensing armbands—such as the one patented by Amazon in 2018—have entirely replaced the use of clipboards and pencils.

One new feature of automation and *Industrie 4.0* processes where AI-enhanced automation is underway is in the area of lot size manufacturing.[9] This process involves cases in which workers are provided with glasses with screens and virtual reality functionality, like HoloLenses and Google glasses, or computer tablets on stands within the production line which are used to carry out on-the-spot tasks in production lines. The assembly line model has not disappeared completely, where a worker carries out one repeated, specific task for several hours at a time, but the lot size method is different. Used in agile manufacturing strategies, this method involves smaller orders made within specific time parameters, rather than constant bulk production that does not involve guaranteed customers.

Workers are provided with visual on-the-spot training enabled by a HoloLens screen or tablet and carry out a new task which is learned instantly and only carried out for the period of time required to manufacture the specific order a factory receives. While, at first glance, these assistance systems may appear to provide increased autonomy, personal responsibility, and self-development, that is not necessarily the case (Butollo, Jürgens, and Krzywdzinski, 2018).

The use of on-the-spot training devices, worn or otherwise, means that workers need less preexisting knowledge or training because they carry out the work case by case. The risk of work intensification thus arises, as head-mounted displays or tablet computers become akin to live instructors for unskilled workers. Furthermore, workers do not learn long-term skills because they are required to perform on-the-spot, modular activities in custom-assembly processes, needed to build tailor-made items at various scales. While this is good for the company's efficiency in production, lot size methods have led to significant OSH risks in that they de-skill workers; skilled labor is only needed to design the on-the-spot training programs used by workers who no longer need to specialize themselves.

OSH risks

OSH risks can further emerge because of the lack of communications, where workers are not able to comprehend the complexity of the new technology quickly enough and particularly if they are also not trained to prepare for any arising hazards. One real issue is in the area of small businesses and start-ups, which are quite experimental in the use of new technologies

and often overlook ensuring that safety standards are carried out before accidents occur, when it is, of course, too late.[10] An interview with those involved in the IG Metall Better Work 2020 project (Bezirksleitung Nordrhein-Westfalen/NRW Projekt Arbeit 2020) revealed that trade unionists are actively speaking to companies about the ways they are introducing *Industrie 4.0* technologies into workplaces (Moore, 2018b). The introduction of robots and worker monitoring, cloud computing, machine-to-machine communications, and other systems, have all prompted those running the IG Metall project to ask companies:

- what impact will technological changes have on people's workloads?
- is work going to be easier or harder?
- will work become more or less stressful?
- will there be more or less work?

The IG Metall trade unionists indicated that workers' stress levels tended to rise when technologies are implemented without enough training or worker dialog. Expertise is often needed to mitigate risks of dangerous circumstances that new technologies in workplaces introduce.

4. Gig Work

Next, we turn to another arena in which AI is making an impact, the "gig work" environments.

"Gig work" is obtained by using online applications (apps), also called platforms, made available by companies such as Uber, Upwork, or Amazon Mechanical Turk (AMT). The work can be performed *online*—obtained and carried out on computers in homes, libraries, and cafes, for example, and includes translation and design work—or *offline*—obtained online but carried out offline, such as taxi driving or cleaning work. Not all algorithms utilize AI, but the data produced by client-worker matching services and customer assessment of platform workers provide data that train profiles that then result in overall higher or lower scores that then lead, for example, clients to select specific people for work over others.

Monitoring and tracking have been daily experiences for couriers and taxi drivers for many years, but the rise in offline gig workers carrying out platform-directed food delivery by bicycle, delivering orders, and taxi services is relatively new. Uber and Deliveroo require workers to install a specific application onto their phones, which perch on vehicle dashboards or handlebars, and they gain clients through the use of mapping satellite technologies and by matching algorithmically operated software. The benefits of using AI in gig work could be driver and passenger protection. DiDi, a Chinese ride-hailing service, uses AI facial-recognition software to identify workers as they log on to the application. DiDi uses this information to ensure the identities of drivers, which is seen as a method of crime prevention. However, there was a very serious recent failure in the use of the technology in which a driver logged in as his father one evening. Under the false identity, later in his shift, the driver killed a passenger.

Delivery gig workers are held accountable for their speed, number of deliveries per hour, and customer rankings in an intensified environment that has been proven to create OSH risks. In *Harper's Magazine* a driver explains how new digitalized tools work as a "mental whip," noting that "people get intimidated and work faster" (*The Week*, 2015). Drivers and riders are at risk of deactivation from the app if their customer rankings are not high enough or they do not meet other requirements. This results in OSH risks including blatant unfair treatment, stress, and even fear.

Algorithms are used to match clients with workers in online gig work (also called microwork). One platform called BoonTech uses IBM Watson AI Personality Insights to match clients and online gig workers, such as those gaining contracts using AMT and Upwork. Issues of discrimination have emerged that are related to women's domestic responsibilities, when carrying out online gig work at home, such as reproductive and caring activities in a traditional context. A recent survey of online gig workers in the developing world conducted by ILO researchers shows that a higher percentage of women than men tend to "prefer to work at home" (Rani and Furrer, 2017, p. 14). Rani and Furrer's research shows that 32% of female workers in African countries have small children and 42% in Latin America. This results in a double burden for women, who "spend about 25.8 hours working on platforms in a week, 20 hours of which is paid work and 5.8 hours considered unpaid work" (ibid., p. 13). The survey shows that 51% of women gig workers work during the night (22.00 to 05.00) and 76% work in the evening (from 18.00 to 22.00), which are "unsocial working hours" according to the ILO's risk categories for potential work-related violence and harassment (ILO, 2016, p. 40). Rani and Furrer further state that the global outsourcing of work through platforms has effectively led to the development of a "twenty-four hour economy ... eroding the fixed boundaries between home and work ... [which further] puts a double burden on women, since responsibilities at home are unevenly distributed between sexes" (2017, p. 13). Working from home could already be a risky environment for women who may be subject to domestic violence alongside the lack of legal protection provided in office-based work. Indeed, "violence and harassment can occur ... via technology that blurs the lines between workplaces, 'domestic' places and public spaces" (ILO, 2017, p. 97).

OSH risks

Digitalizing nonstandard work such as home-based online gig work, and taxi and delivery services in offline gig work, is a method of workplace governance that is based on quantification of tasks at a minutely granular level, where only explicit contact time is paid. Digitalization may appear to formalize a labor market in the ILO sense, but the risk of underemployment and underpay is very real. In terms of working time, preparatory work for reputation improvement and necessary skills development in online gig work is unpaid. Surveillance is normalized but stress still results. D'Cruz and Noronha (2016) present a case study of online gig workers in India, in which "humans-as-a-service" (as articulated by Jeff Bezos; see Prassl, 2018) is critiqued for being the kind of work that dehumanizes and devalues work, facilitates casualization of workers, and even informalizes the economy. Online gig work, such as work obtained and delivered using the AMT, relies on nonstandard forms of employment which increases the possibilities for child labor, forced labor, and discrimination. There is evidence of racism, whereby clients are reported to direct abusive and offensive comments on

the platforms. Inter-worker racist behavior is also evident: gig workers working in more advanced economies blame Indian counterparts for undercutting prices. Further, some of the work obtained on online platforms is highly unpleasant, such as the work carried out by content moderators who sift through large sets of images and are required to eliminate offensive or disturbing images, with very little relief or protection around this. There are clear risks of OSH violations in the areas of heightened psychosocial violence and stress, discrimination, racism, bullying, unfree and underage labor because of the lack of basic protection in these working environments.

In gig work, workers have been forced to register as self-employed workers, losing out on the basic rights that formal workers enjoy, such as guaranteed hours, sick and holiday pay, and the right to join a union. Gig workers' online reputations are very important because a good reputation is the way to gain more work. As mentioned above, digitalized customer and client ratings and reviews are key to developing a good reputation and these ratings determine how much work gig workers obtain. Algorithms learn from customer rankings and quantity of tasks accepted, which produces specific types of profiles for workers that are usually publicly available. Customer rankings are deaf and blind to the consideration of workers' physical health, care and domestic work responsibilities, and circumstances outside workers' control that might affect their performance, leading to further OSH risks where people feel forced to accept more work than is healthy, or are at risk of work exclusion. Customer satisfaction rankings, and number of jobs accepted, can be used to "deactivate" taxi drivers' use of the platform, as is done by Uber, despite the paradox and fiction that algorithms are absent of "human bias" (Frey and Osborne, 2013, p. 18).

Overall, while there are benefits from integrating AI into gig work, including driver identity protection and allowing flexible hours of work, good for people's life and work choices, these same benefits can result in rising risks, such as the case of the DiDi driver and the case of a double burden of work for women online workers. OSH protections are generally scarce in these working environments and the risks are many (Huws, 2015; Degryse, 2016) and involve low pay and long hours (Berg, 2016), endemic lack of training (CIPD, 2017), and a high level of insecurity (Taylor, 2017). Jimenez (2016) warns that labor and OSH laws have not adapted to the emergence of digitalized work, and other studies are beginning to make similar claims (Degryse, 2016). The successes of AI are also its failures.

5. Toward a Conclusion

The difference with AI and other forms of technological development and invention for workplace usage is that because of the intelligence projected onto autonomous machines they are increasingly treated as decision-makers and management tools themselves, thanks to their seemingly superior capacity to calculate and measure. Where many recent reports on AI try to deal with the questions of "what can be done" or "how can AI be implemented ethically," the issue is greater. A move to a reliance on machine calculation for workplace intelligent decision-making actually introduces extensive problems for any discussion of "ethics" in AI implementation and use.

In Locke's "An Essay Concerning Human Understanding," this empiricist philosopher wrote that ethics can be defined as "the seeking out [of] those Rules, and Measures of humane Actions, which lead to Happiness, and the Means to practice them" (Essay, IV.xxi.3, 1824, p. 1689). This is, of course, just one quote, by one ethics philosopher, but it is worth noting that the seeking out of and setting such rules, as are the parameters for ethics depiction, has only been carried out and conducted, so far, by humans. When we introduce the machine as an agent for rule setting, as AI does, the entire concept of ethics falls under scrutiny. Rather than talking about how to implement AI without the risk of death, business collapse, or legal battles, which are effectively the underlying concerns that drive ethics in AI discussions today, it would make sense to rewind the discussions and focus on the question: why implement AI at all? Will the introduction of AI into various institutions and workplaces across society really lead to prosperous, thriving societies as is being touted? Or will it deplete material condi-

In a study of online gig workers, what Jeff Bezos called "humans-as-a-service" is critiqued for being the kind of work that dehumanizes and devalues work, facilitates the casualization of workers, and even informalizes the economy

Digitalized customer ratings are key to developing a good reputation, and determine how much work gig workers obtain. Algorithms learn from customer rankings and quantity of tasks accepted

Drivers stand by cars on the day of the launch of Shouqi Limousine & Chauffeur, the first taxi-booking service authorized by the Chinese government, September 2015

There are benefits from integrating AI into gig work, including driver identity protection and allowing flexible hours of work. But there are also risks, such as a double burden of work for women online workers

Rather than talking about how to implement AI without the risk of death, business collapse, or legal battles, it would make sense to rewind the discussions and focus on the question: will the introduction of AI into various institutions and workplaces lead to prosperous, thriving societies?

tions for workers and promote a kind of intelligence that is not oriented toward, for example, a thriving welfare state, good working conditions, or qualitative experiences of work and life?

While machines have more memory and processing power than ever before, which is how they can participate in machine learning, they lack empathy and full historical knowledge or cultural context within which work happens. Machines cannot intentionally discriminate, but if workplace decisions have been discriminatory (that is, more men or white people have been hired over time than others; more women or people of color have been fired and not promoted than others, and so on), then the data that is collected about hiring practices will itself be discriminatory. The paradox is that if this data is used to train algorithms to make further hiring/firing decisions, then, obviously, the decisions will show discrimination. Machines, regardless of what forms of intelligence management attributes to them, do not, and cannot see the qualitative aspects of life, nor the surrounding context. Cathy O'Neil, author of *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*, made an insightful observation in a recent interview with the current author. While watching Deliveroo riders hurtle past her in the rain, Dr. O'Neil considered the platforms directing the riders' work, which operate on the basis of efficiency and speed and thus instigate riders to cycle in unsafe weather conditions. This clearly puts riders' very lives at risk. Dr. O'Neil calls algorithms "toy models of the universe," because these seemingly all-knowing entities actually only know what we tell them, and thus they have major blind spots.

If it is accepted that machines hold the same competences as humans, or even better competences than us, will we begin to reduce management accountability? Further questions: can there be an ethical use for AI, given the complexity of rulemaking, when something besides an intelligent human mind is expected to make rules? Where will the final say in intelligence lie? Why do we want machines to behave as we do, given that evidence already shows that machine learning can only learn as much as already exists in the data that trains it, and if the data reflects humans' discriminatory behavior, then the algorithms, almost necessarily, will demonstrate or promote discrimination? The mythical invention of E. M. Forster's all-encompassing machine in his classical science fiction story (1928/2011) was not, of course, subject to a range of ethical and moral review panels before all of humanity began to live within it under the Earth's crust. As we enter a new era of AI, it will remain important to recall the tension points in positioning technologies into places of power in workplaces and maintain, rather than the looming horizon where machines are in command, a "human in command" (De Stefano, 2018) approach to rolling out any new technologies into workplaces. Human responses to this trend should involve careful regulation, in which human intelligence takes precedence, as the machine becomes increasingly evident in our working lives.

Dr. Phoebe V. Moore is the leading researcher in the "quantified work" field, having published several pieces on digitalized work, monitoring, and tracking, including her recent book *The Quantified Self in Precarity: Work, Technology and What Counts* (Palgrave, 2018). Moore's groundbreaking research has attracted significant public, media, and governmental attention from such organizations as the UN's International Labour Organization, European Union Agency on Safety and Health at Work, and the European Parliament; as well as media platforms such as the *Financial Times*, BBC Radio 4, BBC World Service, *The Atlantic*, *The Independent*, *Wired*, *Imperica*, and *Business Investors Daily*; and research groups such as Nesta and the Royal Society of Arts.

Some text presented here is adapted from P. V. Moore, "OSH and the Future of Work: Benefits & Risks of Artificial Intelligence Tools in Workplaces," for EU-OSHA (2019).

Notes

1. Dr. Michael Bretschneider-Hagemes, Head of the Employees Liaison Office of the German Commission for Occupational Health and Safety and Standardization (KAN), spoke to the author in an interview for this report, September 18, 2018.
2. *Industrie 4.0* is a much-debated term that originated in German manufacturing circles designed to advance manufacturing in marketing terms. Some critics argue that it is a narrative rather than a reality today. Nonetheless it is commonly accepted that, if there is to be a trajectory of industrial revolutions, *Industrie 1* is the term for the First Industrial Revolution and thus the invention of the steam engine. The second is linked to science advancements and the third, to digitalized inventions as incorporated into production. Today, the "Internet of Things," where machines technically communicate with another, advanced robotics, and increased capacity for memory and processing power are seen as the driving force for the concept of *Industrie 4.0*.
3. Antje Utecht who works in the training and policy department at the headquarters of IG Metall in Frankfurt, Germany, shared these insights with the author during an interview for this report October 16, 2018.
4. Ibid.
5. Interview with Maggie Dewhurst of the Independent Workers of Great Britain (IWGB) in 2017.
6. Interview with Dr. Sam Bradbrook, specialist in the Health and Safety Executive's Foresight Centre in Great Britain, in September 2018.
7. Interview with Antje Utecht as cited above.
8. Based on the author's interview with Dr. Sam Bradbrook as cited above.
9. Interview with Dr. Michael Bretschneider-Hagemes as cited above.
10. Prof. Dr. Dietmar Reinert, PEROSH Chairman, Institute for Occupational Safety and Health of the German Social Accident Insurance, indicated this in an interview with the author, September 13, 2018.

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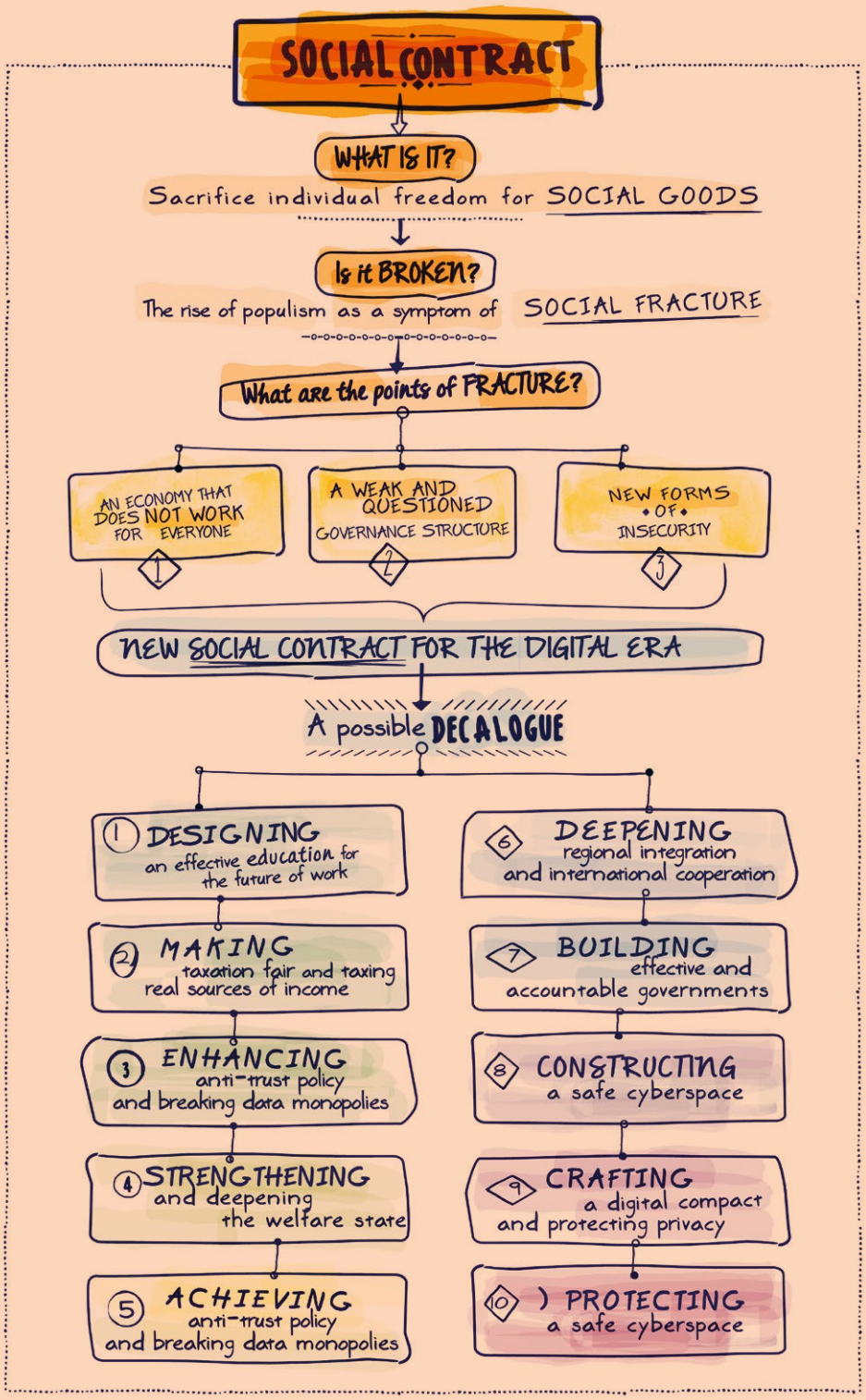
SOCIAL CONTRACT
WHAT IS IT?
Sacrifice individual freedom for SOCIAL GOODS
Is it BROKEN?
The rise of populism as a symptom of SOCIAL FRACTURE
What are the points of FRACTURE?
AN ECONOMY THAT DOES NOT WORK FOR EVERYONE
1
A WEAK AND QUESTIONED GOVERNANCE STRUCTURE
2
NEW FORMS OF INSECURITY
3
NEW SOCIAL CONTRACT FOR THE DIGITAL ERA
A possible DECALOGUE
1 DESIGNING an effective education for the future of work
2 MAKING taxation fair and taxing real sources of income
3 ENHANCING anti-trust policy and breaking data monopolies
4 STRENGTHENING and deepening the welfare state
5 ACHIEVING anti-trust policy and breaking data monopolies
6 DEEPENING regional integration and international cooperation
7 BUILDING effective and accountable governments
8 CONSTRUCTING a safe cyberspace
9 CRAFTING a digital compact and protecting privacy
10 PROTECTING a safe cyberspace

A New Social Contract for the Digital Age

Manuel Muñiz

This essay forwards the thesis that the social contract in Europe and the United States is under severe stress. The rise of populism is the clearest manifestation of current social and economic fracture across the Atlantic, with its politics amounting to a re-crafting of the preceding order along more nationalistic, interventionist and, in some instances, openly antidemocratic lines. A new social contract is therefore needed that addresses the economic, political, and even physical insecurities brought about by rapid social and technological change. The chapter suggests a full "Decalogue" of measures to be considered by policy-makers. These include measures in the education, taxation, antitrust policy, governance, security, and sustainability spaces. Taken all together, these measures could make up an initial exercise in the crafting of a new and effective social contract for the digital era.

We seem to be living through a deep political convulsion in the US and Europe. The rise of populism is changing the face of policy-making domestically and internationally. Populists advocate for an agenda that upends decades-old consensus about the role of the state, the importance of diversity, the centrality of trade and open markets in our economy, and, in many ways, the value of democracy itself. This new political landscape is a warning call; one that tells us that there are profound ills within our societies and deep social fractures that need mending.[1]

It could be argued that technological and social transformation has been so deep over the last decades that fundamental features of our social-contract have become undone. Some of the sources of social contract fracture would include the rise in economic uncertainty, the sense of lack of political representation or, even, a rise in insecurity brought about by new threats in cyberspace. These trends draw a rapidly changing world and one in which a debate about the resilience of our most fundamental norms and political arrangements is warranted.

Concept and Fracture of the Social Contract

The social contract has been defined over the centuries in many different ways. In its most abstract form it could be described as the tacit agreement between citizens and the society they live in. On the basis of that agreement, individuals give up some of their most fundamental freedoms in exchange for rules, common practices, and public services.[2] In most societies, for example, people are willing to give up their capacity to use physical violence as a means of resolving social conflicts in exchange for common security measures to be implemented by the collective. This is so because it is generally understood that security is better procured if administered under certain clear rules and by a public entity. Another emblematic manifestation of the social contract would be that of the generalized acceptance of taxation in exchange for some form of common services.

In the aggregate, these recurrent instances of acquiescence with certain norms constitute a code of collective behavior that enables social cohesion. In its classical definition by Hobbes, the social contract enables humans to move from the *state of nature* to

The rise of Fascism and Marxism can be understood as symptoms of a dying social contract and of the rigidity of societies unable to accommodate to a new socioeconomic reality

League party leader Matteo Salvini greets supporters during a rally in Pontida, Italy, September 2019

a *social state* where one's radical freedoms are constrained in exchange for public goods of various kinds and for the possibility of living in a larger grouping.[3] The sustainability of this contract is dependent on there being a broad social consensus that the norms, written and otherwise, under which people live are worthwhile, fair, and just.

Now, the concept of the social contract can be problematized *ad infinitum*. For starters, many argue that it is a social science construct to legitimize certain preexisting power structures. Nobody is really born free, the argument would go, and is then offered the possibility of joining this or that social contract. Rather, people find themselves belonging to a particular society and having to abide by its rules without having had a real say in their shape or content. Those rules are set by people with influence over government and with little say from others, let alone from future generations. In this sense the term "contract" is in itself problematic given that people do not really sign it or explicitly accept it. Seen through this lens the social contract is simply a theoretical construct that attempts to lend legitimacy to what are fundamentally unfair norms and practices set by those with power and in attempt to codify and extend the *status quo*.

Some scholars, including some of the classical political philosophers that helped craft this concept, have pointed out that written constitutions epitomize the notion of the social contract. These important documents capture the general consensus about what is right and wrong in a given society and establish both rights and obligations for citizens. Constitutions can be amended and adapted to social changes and, in democratic societies, be put to the people for ratification, giving them broad legitimacy. Arguably people can leave a certain society and move to another if they disagree with certain aspects of its constitutional or normative structure. However, equating constitutions to the social contract is in itself problematic. It might, in fact, be too narrow an approach given how matters that fall well beyond the scope of particular constitutional clauses can affect people's lives, well-being, and their perception of living in a fair and just society.

The truth of the matter is that the social contract is constantly tested, and hence rendered legitimate or illegitimate, by citizens. Indeed, citizens evaluate the fairness of the

society they live in and react accordingly. Beyond the actual behavior of citizens, John Rawls suggested a theoretical exercise from which one could extrapolate a conclusion about the just or unjust nature of a given society. In this experiment people would be asked whether they would accept the risk of joining a given society without being told the place they would occupy in it.[4]

This leads us to another set of important questions surrounding this issue: when are social contracts born? And how do they break? Have there been instances of social-contract fracture in the past? This essay will argue that social contracts are a living concept. They are born at particular moments, expanded and changed as time goes by. Over the last decades Western societies have seen, for example, a major expansion of the social and political rights encompassed within their social contract. There are economic rights, such as generalized access to health care or education, which are considered fundamental by many Western citizens today but would have constituted truly extravagant propositions at the turn of the nineteenth century. Clearly, therefore, the elements of what citizens consider a fair set of social arrangements is mutable and its delineation requires analysis and interpretation.

What is certain is that in particular moments societies fail to adapt to fundamental changes in their environment and hence their norms become ineffective or obsolete. The fracturing of the social contract that ensues is accompanied by periods of social instability or outright unrest. This is manifested in social and political behavior that deviates from the norm and that, ultimately, seeks deep changes to the preexisting political or economic structure. Jurists sometimes refer to these moments as "constituent" in the sense that they produce a new "constitutional" reality. Thinkers like Rousseau anticipated this debate and spoke of the troubles that would follow if the government failed to forward the "general will" or to tend to the general interests of members of society.

In some instances, political stability only returns once a new social contract is crafted. This re-crafting of the contract might entail establishing new socioeconomic rights, generating new political processes and structures, or granting political representation to certain groups. The speed at which this new political and economic architecture is crafted determines the length and cost of the convulsion that precedes it. One could, in fact, speak of the rigidity or flexibility of political systems based on the ability of those systems to adapt to fundamental changes besieging them. Rigid systems would be those that need to sustain high levels of social and economic pain before they react and try to find a new and sustainable equilibrium. It takes major political fracture for these systems to adapt and in many instances prior institutions are flattened before new ones are built. Flexible systems, however, can adapt to a changing environment without leaving major social stakeholders behind.

A classical example of fairly rigid systems, I would argue, would be Western European societies in the second half of the nineteenth century and the early twentieth century. Changes brought about by the Industrial Revolution in everything ranging from where people lived, to how they earned a living, to how they communicated and socialized, were met with extremely modest political reform. In very general terms, the importance of the birth of a new socioeconomic class, the proletariat, was not fully grasped until in most cases that new class was behaving in deeply revolutionary ways. The rise of Fascism and Marxism can, indeed, be understood as symptoms of a dying social contract and of the rigidity of societies unable to accommodate to a new socioeconomic reality. The convulsion that ensued in the first half of the twentieth century could be seen, therefore, as a direct consequence of a poorly crafted social contract. The new consensus born out of the ashes of World War II could be summarized as, on the political front, the radical expansion of the suffrage to the working classes, and, on the economic front, the birth of the welfare state. These changes were constitutional in nature and required adjustments in political processes, taxation, and many others.

Now, we find ourselves in need of answering a fundamental question: is our current social contact broken? If it is, what are the forces driving its fracture? And, most importantly: how can it be fixed?

Populism and Social Pain

We seem to be living through a period of political convulsion epitomized by the rise of populism. At an aggregate level this is represented by the clear rise of populist rhetoric and politics over the last three decades.[5] There is a populist holding the presidency of the United States and there are fourteen European countries, including Germany, France, the UK, and Italy, in which populist parties poll at over 10%.

There are numerous explanations for the rise of populist politics but a consensus seems to be emerging around the notion that insecurity, be it economic or cultural, has been a key driver of political behavior in countries such as the UK or the US.[6] This rise in insecurity and fear of the future is leading to growing support for political forces that sit on the extreme of the political spectrum.

Numerous scholars have defined populism as a way of doing politics, centered around the notion of the "pure people" vs. the "elite."[7] For many, therefore, populism is a process or a set of tactics more than an ideology. However, if one looks at the key drivers of this phenomenon as well as at its protagonists and the agenda they are putting forward, one starts to see echoes of past instances of social-contract fracture. The populist agenda varies depending on the country and the particular ideological tilt of its proponents. Right-wing and left-wing populists, however, seem to coincide on an overarching goal: that of undoing fundamental features of the preexisting, and fundamentally liberal, order. Many of these new political movements are anti-trade, oppose porous borders, and its corollary, cosmopolitanism, and in some instances are openly anticapitalist or, even, antidemocratic. If applied in full, some of these populist agendas would lead to the outright upending of the preestablished order, making them deeply revolutionary.

Could one, therefore, argue that indeed the social contract is broken? Is populism truly a harbinger of deeper shocks to the political systems or an ordinary political manifestation that will be dealt with within normal democratic procedures? How could that fracture be categorized and analyzed? This essay will argue that our current social contract is under stress and it is so along the following three vectors: economics, political representation, and security. The section below will address each of these categories.

1. The Economics of Technology

Over the last decades, most OECD economies saw very rapid rates of growth. US GDP went from 2.8 trillion USD in 1980 to over 20 trillion USD today. UK GDP, in turn, went from just over 560 billion USD to over 2.6 trillion USD during the same time

period. This aggregate growth, however, did not trickle down to the middle classes in these two countries. There is now abundant data showing that Western middle classes have undergone a process of stagnation over the last three decades and in some instances of outright decline.[8] The US case is perhaps the most acute of all with 70% of households seeing no real market income increase in the last thirty years.

Stagnation of the middle classes at a time of growth in the aggregate is the consequences of rent capture by a small group of people. Inequality has, unsurprisingly, risen markedly over that last decades in the US and most European countries. The top 1% of income earners in the US is capturing today over 20% of total national pre-tax income, which is twice the amount it did in the 1950s or 1960s and more than the total income captured by the bottom 50%. Growing inequality also shows in the manager to staff salary ration, in wealth figures and many others.

High levels of income and wealth inequality have pernicious consequences, including rises in stress-related pathologies, greater insecurity, and other social ills.[9] In the US, for example, there are communities today where the life expectancy of children is shorter than that of their parents, something unseen since the days of World War II. The work by Anne Case and Angus Deaton on "deaths of despair," or fatalities caused by drug overdose, suicide, and alcoholic liver disease, points toward a clear correlation between economic decline and an increase in acute social pain.[10]

This hollowing out of the middle of the income distribution seems to also be producing the hollowing out of the middle of the political spectrum with growing support for extremist parties across the Atlantic. Fear about the future of work, the inability to raise a family, to purchase a home or simply the generalized sense that the economic environment has turned for the worse are all strongly correlated with support for populist parties.

It has proven extremely difficult to pin down the driver(s) of this process of middle-class erosion. Some have pointed to globalization and the effect on the wages of Western middle classes of competition from low-paid workers in the developing world. The growing consensus, however, is that one has to factor in the effects of technology on work and income to be able to see the full picture.[11] By doing this, what becomes apparent is that emerging technologies have played a key role in displacing certain types of jobs and automating key tasks within certain job categories. In the aggregate, emerging technologies are leading to the erosion of the middle of the jobs distribution by reducing demand for middle-skilled routine jobs, which are, in fact, the cornerstone of middle-class income earning.[12] Some jobs have been created in the low-skill, low-pay end of the spectrum, in large part because many of these are hard to automate, and a small number of well-paying jobs have emerged in the higher end of the spectrum for highly skilled workers. In the aggregate, however, these new jobs seem to be less than the ones being displaced in the first place.

In addition to the changes in the jobs space itself there seems to be a greater force at play as well, driving income toward capital and away from labor. Since 1970 the total share of national income accruing to labor in advanced economies fell from over 54% to under 40% (in 2015).[13] This means that there is something to how the digital economy functions that enables businesses to, in the aggregate, capture a greater proportion of wealth without having to employ more people or remunerate them better. As we will see, this has dramatic effects on the redistributive role that wages play and on the vital role that firms play in generating social prosperity.

Interestingly, technology and digitalization in particular are also radically changing the corporate landscape. Scale and network effects are altering the way markets operate, creating clear winners in the digital race and clear losers. Firms that can capture and process information about their operations, clients and others are capable of increasing their productivity and, hence, be more competitive. The rest fall behind. This is, in turn, leading to winner-takes-all markets and to a digital economy that has strong oligopolistic if not outright monopolistic characteristics. One of the clearest ways in which this is captured is through the study of productivity growth in the private sector. The OECD has discovered that the corporate sector is being segregated into firms whose productivity has grown over the last thirty years, which it terms "frontier firms" and which represent less than 5% of the total, and the rest, called "laggard firms," whose productivity growth has stalled.[14] This decoupling of the private sector is problematic for many reasons. It concentrates income in a very reduced number of firms, which can then build highly sophisticated strategies to reduce their tax footprint; it also narrows down the offer of high-quality and high-paying jobs, as it is mostly frontier firms that generate these; and, ultimately, it poses a competition and antitrust challenge.

The debate about the drivers of the erosion of the Western middle class and of the rise in inequality will be an ongoing one. What is clear, however, is that some of the fundamental tenets of our economic model have shifted significantly over the last decades. We now live in a world where middle-skilled employment is decreasing and where income is accruing to capital holders. This draws a highly competitive world; a perilous one, in fact, where economic opportunity is harder to come by.

One could well argue that all of the changes described above amount to a fracture in the social contract. While in the past one could, with some degree of certainty, craft a path toward economic stability through academic and professional achievement, today such an exercise is much harder. Not even with abundant forward planning can one have the certainty that this or that profession will fare well. The velocity at which technology is changing our environment makes forward planning extremely complicated. So a fundamental equation of our social contract—study, work hard and in exchange you shall receive stability, a decent income and you will live within an equitable society—is now under clear stress.

2. Politics in an Interdependent World

In parallel to the process of economic transformation described above the world of politics has undergone a set of radical changes as well. Two are of particular importance for the debate around the fracturing of the social contract: the deepening of interdependence and the worsening of what Robert Putnam termed the two-level problem, or the inability of individual political actors to tackle complex problems alone.[15]

Interdependence is defined in the field of international relations as the phenomenon of having linkages across states. The most obvious example is that of economic interdependence which is a product of trade across borders. Interdependence produces the necessity of interstate collaboration and, when sufficiently strong, leads to supranational governance arrangements. Many would argue, for example, that the EU is the most emblematic case of a set of institutional arrangements agreed upon in an attempt to manage

deep levels of interdependence. The reason why the EU exists, the argument would go, is to manage the complex relations of its member states through common regulation and the setting of Union-wide standards in the fields of trade, labor rights, environmental protection, and others. One of the consequences of interdependence is, therefore, the elevation of certain governance issues to an intergovernmental level, distancing the decision-making process from national fora. Globalization would be another good example of interdependence with the plethora of institutions that it has given birth too being also good examples of how linkages across borders lead, necessarily, to intergovernmental governance arrangements.

One of the fundamental challenges of managing interdependence is that it forces national authorities to engage in international debates about rule setting and in some instances to delegate decision-making to supranational bodies. This all equates to sacrificing part of their powers and distancing decision-making from their electorate. Some authors have, in fact, questioned whether globalization and democracy are fully compatible given the effects of interdependence on sovereignty and accountability of decision-making.[16]

The two-level problem theory, on the other hand, addresses a similar but somewhat different challenge: that of the inability of national political tools to address global challenges. According to this theory some global problems, like climate change, overwhelm the capacity of single states and require concerted action if they are to be properly addressed. Or to put it differently, the scale of a problem is greater than the reach of the policy-making tools available to any single state.

Recent decades have seen a rise in the number and scale of two-level problems. Digitalization has itself produced a whole range of challenges of this nature given how unable individual states are of managing online content, regulating or taxing Internet companies, and others. Two-level problems tend to be better addressed by elevating governance to a higher level and hence equating the scale of challenges to the reach and power of governance tools. However, if this outcome is not achieved, citizens perceive that their elected representatives are only able to address some of the challenges that affect their daily lives, while others remain obscure, complex, and out of reach. This sense of loss of political control over one's own destiny and of the community one inhabits is extremely detrimental to the legitimacy of the social contract. Indeed, a core principle of social-contract theory is that citizens abide by the rules, pay taxes, and, in exchange, get to participate in the political process and to have a voice in public affairs. If political representatives fail to address pressing problems, then the contract is perceived as broken.

The two challenges identified above, the distancing of decision-making as a consequence of interdependence and the inability of national political elites to deal with global challenges, could seem contradictory. On the one hand, citizens are concerned about their ability to affect decisions being taken in intergovernmental and supranational institutions such as the UE or the UN, but, on the other, they also feel that their governments are unable to address problems of a global scale which would require, in essence, further use of institutions such as the EU or the UN. And, indeed, there is a contradiction in these feelings but this does not make them less real or consequential. In fact, it seems that growing numbers of Western citizens are critical of the functioning of international institutions and are at the same time concerned about the inability of their governments to tackle global challenges. The consequence has been for many to want to go back to a more insular world, one of hard borders and a false sense of control. This is one of the greatest paradoxes of populism: its rise is explained to some extent by the insecurity brought about by the mismanagement of global challenges but the solutions that it forwards would lead to the dismantlement of precisely the institutions that could address those very challenges. Perhaps, and as we will see later in this essay, what is truly needed is a better and more legitimate system of global governance.

3. Data, Privacy, and the Future of the Biosphere

As argued above, one of the fundamental features of the social contract was the notion of giving up fundamental freedoms, including that of using force, in exchange for the public provision of security. Digitalization and changes to our economic model have led, however, to the rise of new forms of insecurity. This is derived from a new feature in global affairs: the radical porousness of borders and the fact that certain threats can now impact the most intimate and private dimensions of individuals' lives.

A fundamental social equation of our social contract—study, work hard, and in exchange you shall receive stability and a decent income and you will live within an equitable society—is now under clear stress

The world of politics has undergone a set of radical changes. Two are of particular importance for the debate around the fracturing of the social contract: the deepening of interdependence and the inability of political actors to tackle complex problems alone

A protester wearing an Anonymous mask and a dollar bill with the words "they won't silence us!" at the sixth anniversary of the 15M social movement. Born in Madrid on 15 May 2011, the movement's demands included jobs and decent wages for young people

The growth and deepening of cyberspace is perhaps the most emblematic example of this process. Cyberspace has become a new battleground for security where pernicious actors operate and seek advantage. What is unique about cyberspace is that it penetrates people's lives to the point of, literally, being in their pocket at almost all times. This opens up a number of risks of which I would highlight three.

First, it increases the risk of cybercrime, including the theft of valuable data and IP, altering banking transactions, digital extortion or the use of ransomware.[17] Second, the generalized use of the Internet and of an app ecosystem built on the back of exploiting people's data generates a significant privacy challenge for individuals. This is not just manifested in cases of identity theft but also in the growing capacity of certain firms to know the full detail of people's behavior, wants, and needs. As knowledge of neuro and behavioral sciences increases, abundant data on someone could well mean being able to nudge that person into certain types of behavior if not to outright manipulation. This questioning of free will and of individual agency brought about by an abundance of data on people's behavior will be a major source of concern for citizens and governments moving forward. Third, digitalization exposes our information systems to external interference and, hence, to manipulation by actors that do not seek to enhance the quality of our public debate but rather distort it for partisan reasons. Indeed, we have witnessed over the past years an increase in what has been termed "election hacking" or instances where hostile actors seek to disrupt a particular democratic process through the spreading of misinformation to the electorate.

What makes the cases above relevant is how sophisticated, pervasive, and invasive they are. Many individuals feel that borders and frontiers no longer serve the purpose of containing external threats. Governments, on the other hand, are scrambling to first of all understand the nature and scope of these threats and to come up with the right governance mechanisms to contain them. In the void left by government inaction a sense of inefficacy on the part of public actors is born, further hindering the legitimacy of the social contract.

A separate but significant example of an emerging security threat is that of climate change. The climate crisis shares with digitalization one fundamental feature: it ignores national borders and affects individuals in a very direct manner. The scope and scale of the challenge is such that it is impossible to ignore, with consequences of mismanagement ranging from the loss of biodiversity to the destruction of human habitats and livelihoods. Here again policy-makers are faced with the difficult task of managing a problem that requires intense interstate cooperation.

Crafting a New Social Contract for the Digital Era

It is evident from the analysis above that governments around the world have a very difficult task ahead of them. The rate, nature, and implications of social and technological change have brought enormous challenges forward. It is now urgent that we set on the task of putting forward solutions and of regaining the trust of citizens in their institutions.

The following pages will address a "Decalogue" of solutions to the challenges identified in the preceding section.

1. Education for the digital era

One of the first areas in dire need of effective public policy action is that of higher education. The reason is simple: the world of work is changing extremely rapidly and educational institutions must adapt accordingly. Despite the ominous predictions about the unavoidable loss of work due to automation there are numerous studies that in fact suggest that there are many jobs to be filled at the frontier of the economy. According to the European Centre for the Development of Vocational Training (CEDEFOP), skills shortages affect a majority of firms in the EU to a large extent because people are not getting the right education and training.[18]

And yet there is abundant information about the types of knowledge and skills that are required to navigate the digital revolution. We know, for example, that jobs demanding high social and quantitative skills have been on the rise over the last two decades.[19] Social skills, such as empathy or team management, are growingly important in a world where robots and algorithms take on the most repetitive tasks. We also know that from all of the "quantitative skills" the ones in most demand are "digital skills." According to the Brookings Institution, two-thirds of all jobs created in the US between 2002 and 2016 required medium- or high-level digital skills; with these being defined as the ability to engage with hardware and software in a sophisticated manner.[20] The transformation this is producing in the jobs market is enormous. According to the same Brookings report, the total number of jobs in the US requiring low or no digital skills collapsed from 69 million, or 56% of all jobs, in 2002 to 41 million, or 30% of the total of jobs only fourteen years later.[21] This means that jobs that do not require digital skills are on a clear path to extinction. Graduating today without some knowledge of key software management, data analytics, comprehension of coding, and other related disciplines is an extremely risky path to follow.

So, part of a new social contract should include a true revamping of our university system. Academic institutions need to be agile and adaptive. Their programs need to be interdisciplinary and embed technology throughout the curriculum. This would significantly reduce the transition cost to the new economy and provide opportunity for millions of recent graduates.

2. Fair and effective taxation

One of the greatest contradictions in economic policy of the last decades has been the evolution of tax pressure in advanced economies. In parallel to a process of decline of labor-income share and of growing precariousness of labor-income earners, there has been a steep rise in tax pressure on labor income; and a dramatic decline in the effective tax pressure over capital. This latter point is particularly true for Internet companies, whose activities are harder to identify, track, and tax. According to the *Financial Times*, the effective tax pressure over corporations in OECD countries has declined 10% from the mid-1990s to today.[22] The drop goes up to 20% for Internet companies. So not only have salaries for the middle class stagnated or declined over the last thirty years but tax pressure on those salaries has increased, in large part to make up for the loss of public revenue from capital earnings. This has led to the incongruous situation of collectives that should now be the beneficiaries of redistributive policies being the ones asked to help solve public funding problems or bail out mismanaged banks.

A fairer and more sustainable distribution of the tax burden would require recalibrating tax pressure from labor to capital, closing loopholes for corporations, fighting

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There is no reason to believe that the welfare state cannot be deepened. Logic would state that with the increases in productivity brought about by the technological revolution it should be feasible to procure higher taxation income for states, and to build a more solid social safety net

against tax havens, and finding ways to tax digital companies more effectively. Additionally, states could also enter the investment space and through public sovereign wealth funds and venture capital funds provide liquidity, support innovation, and procure the public with some form of fiscal traction over capital income. Public stockholdings in frontier firms would surely be a boon to public budgets. Some countries are already following similar policies through their sovereign wealth funds or by creating specific investment vehicles.[23]

3. An enhanced competition and antitrust policy

It is growingly clear that the digital economy has strong oligopolistic forces within it. Firms with scale, access to data, and the capacity to process that data dominate their core markets and are beginning to take on adjacent markets with ease. Not only are we seeing strong market concentration in certain actors but, as indicated above, productivity diffusion is almost non-existent. Additionally, the rate of churn in the economy, the number of firms being born and shut down, is slowing down, in a sign of a loss of economic dynamism that could well be explained by the market dominance of a few actors. Large digital firms, such as Google, Facebook or Amazon, have also very radically increased their merger and acquisitions activity, another sign that they now have the financial capacity to purchase potential rivals and stifle competition.

The argument that these dynamics do not pose a competition problem because customers are still getting an excellent service, and, in some instances, a service for which they are not charged a price (i.e., customers are paying with their personal data) is one that legislators and regulators should tackle head-on. Data portability and other measures that seek to break the monopoly over data that some of these firms have might be a first step but it is hard to imagine a more effective solution than breaking them up into smaller units.[24]

4. New redistribution mechanisms

If the fiscal traction and competition problems are solved, states should have the capacity to both fund public services properly but also experiment with new redistributive mechanisms. Governments could experiment with new measures such as conditional cash transfers (CCTs), a negative income tax or, perhaps, a "universal basic income" (UBI). The truth of the matter is that we have scant evidence about the effects of many of these measures, with perhaps the exception of CCTs, which have been extensively used in developing economies; UBI has proven to be an ineffective tool for creating employment opportunities in Finland, for example, but it did improve social trust and perceptions of political elites.[25] Some other cases exist that point to the pernicious effects of UBI-like measures on social cohesion, transparency of public institutions and corruption, and on social psychology dynamics. Pilot programs and testing the effects of new measures should be a central feature of policy-making in the coming decades.

The bottom line here, however, is that there is no reason to believe that the welfare state cannot be deepened. In fact, logic would state that with the increases in productivity brought about by the technological revolution it should be feasible to procure higher taxation income for states and to build a more solid social safety net. Such a process would surely enhance the perception of equity of the social contract for many of those at the bottom of the socioeconomic pyramid.

5. A new and expansive role for the private sector

Some of the trends identified above, but particularly those that point to a decline in labor-income share, bring into question the sustainability of a private sector exclusively focused on shareholder value. In an environment where firms can gain productivity and competitiveness without employing more people or remunerating those in employment better, then having as a sole purpose that of maximizing shareholder value is insufficient. In fact, if all firms had such a narrow goal they might find themselves performing extremely well against their own metrics but causing havoc in the social fabric. Indeed, firms could be doing extremely well but not contributing to the establishment and advancement of a healthy middle class of labor-income earners. This would, in turn, pose a major challenge for business sustainability given that, as we have shown before, precarious and unequal societies lead to populist politics. It is populists who then initiate trade wars, limit the inflow of foreign talent into their countries, attack regional integration projects and currency unions, and intervene on open markets in the name of national security. A large portion of the cost of such actions will be born by

businesses, which means that they too have a significant interest in building an equitable and fair society. The effect of technology on corporate models and employment structure, therefore, calls for a redefinition of business sustainability.

A private sector committed to positive social and environmental impact would go a long way in solving some of the challenges delineated above. Companies can support local communities, fund educational programs, and lead on the application of the environmental sustainability agenda. All of these measures would greatly contribute to the enhancement of our social contract and make of the private sector one of its strongest guarantors. Luckily, this message seems to have reached business leaders in the US and some have now formally stated their desire to expand the social footprint of their firms.[26]

6. Deeper and more effective regional integration and international cooperation

Despite concerns about the functioning and transparency of regional and global organizations such as the EU or the UN, the truth of the matter is that they are more needed than ever. Some of the most significant challenges of our time require concerted action on the part of states and other actors. The only fora capable of managing such scale and complexity are organizations such as these. We, therefore, need a push toward greater integration in these institutions.

An emblematic case for Europeans is, of course, the EU, which needs to see its competencies strengthened in everything from the European Monetary Union (EMU), and in particular through the full development of its Banking Union project, to the Single Digital Market, to the Energy Union. Additionally, the EU should continue its push to regulate emerging technologies, with measures such as the General Data Protection Regulation (GDPR) being a case of success when it comes to protecting privacy. Other areas where concerted action at the EU level is now more important than ever would include the fight against tax evasion by large corporations, particularly Internet firms, as well as expanding and applying in full an effective antitrust agenda. These are all

Compensating for the loss of public revenue from capital earnings has led to the incongruous situation of collectives that should now be the beneficiaries of redistributive policies being the ones asked to help solve public funding problems or bail out mismanaged banks

A man takes a break after eating at the Capuchin Soup Kitchen in Detroit, Chicago, which started serving hundreds of people after the 2008 crisis devastated the city. Detroit had been known as "Motor City" because of its powerful automobile industry

matters that no single EU member state can address alone and where acting through the EU would enhance Europe's economic potential, attract more talent, enable deeper and more-widespread innovation and entrepreneurship, and better protect the interest of European citizens.

The UN agenda is enormous and complex but one issue is worth mentioning here. What comes closest to a full re-crafting of a new social contract is the 2030 Development Agenda with its seventeen Sustainable Development Goals (SDGs).[27] Approved by the UN General Assembly in 2015, the SDGs are a perfect example of how much could be achieved if the international community were to work together to address global problems. A key component of the new social contract should include supporting initiatives such as the 2030 Agenda and looking for ways to enhance international cooperation across the whole spectrum of global challenges.

7. Better global governance and a digital government

Calling for more intergovernmental mechanisms will not suffice. One has to address the issue of their governance, transparency, and efficacy as well. Elevating governance beyond the nation-state calls for the re-crafting of democratic systems for a higher level of governance. This can be done through many mechanisms but there is one which deserves particular attention: applying advanced technologies to governments and international organizations. The field of GovTech, or technology geared toward improving governance and tackling public problems, is expanding at a very rapid pace.[28] Governments would not only fare better through the use of technology but they would be perceived as closer to the citizen, more accountable and transparent. Additionally, digital governments would serve as true catalysts for innovation by sustaining a socially minded ecosystem of start-ups and entrepreneurs.

8. A secure cyberspace

Just as in past instances of technological transformation, we are faced today with the need to procure security in a new domain. Citizens demand today that their governments take effective action against cybercrime and other forms of misuse of the Internet. Doing this in an effective manner will require creating new capacity within government, producing the right regulatory framework, and acting decisively. A particular area of activity should be that of IP theft and online corporate espionage, an area where the private sector has not received sufficient public support.[29]

Problems associated with misinformation and election hacking should be addressed in partnership with online platforms. In fact, it is quite likely that social networks will have to deal with growing regulation regarding the veracity of the content shared on their platform; in a move that will bring them closer to a media company.

Additionally, data and the management of data networks should be the object of stricter regulation and oversight on the part of governments. The recent Huawei case is perhaps the tip of the iceberg of a process that will produce the "securitization" of the data ecosystem. Governments will almost certainly be forced to look at their data infrastructure as strategic and, therefore, worthy of particular regulatory attention. Who owns the infrastructure and the data that travels on it will be a fraught issue moving forward. This should be perceived not so much as a threat to free and open markets but rather as governments performing their duty of protecting their citizens and corporations from external interference.

9. Data protection and a digital compact

Data regulation seems to be moving in three different directions in the US, China, and Europe. In the US it is large corporations such as Facebook that collect, process, and store people's data. In China it is the government, which, ultimately, holds all data. This is the case even if the initial collector of the information was a private corporation. In Europe, however, and particularly after the approval of GDPR, data ownership has been attributed to the individual that produced it in the first place. This is a first and modest step in the direction of providing a clear set of rules and regulations that protect individuals' data and privacy.

The economics of this process could end up being extremely significant given how valuable data is becoming. Some economists have even argued that data should be considered a factor of production, just like land, labor, and capital, rather than just a by-product of other activates.[30] If data is a full factor of production and if it is owned by the individual that produced it, then that individual should be paid for the use of his or her data. This could end up being a significant source

It is increasingly clear that the digital economy has strong oligopolistic forces within it. Firms with scale, access to data, and the capacity to process that data dominate their core markets and are beginning to take on adjacent markets with ease

The field of GovTech, or technology geared toward improving governance and tackling public problems, is expanding at a very rapid pace. Governments would not only fare better through the use of technology, they would also be perceived as closer to the citizen, and more accountable and transparent

Software engineer Aruna Sooknarine uses her mobile phone next to a Google Maps/ Google Earth icon during the 2010 Google I/O Developers' Conference in San Francisco, California

We need a true digital compact to emerge, a full code made up of norms, regulations, and common practices that enshrine privacy and put the individual back at the center of the data-ownership debate

of revenue for individuals, particularly as the amount of data on people increases with the full rollout of the Internet of Things (IoT) and the deepening of data analytics knowledge.

All of the above calls for a true digital compact to emerge, a full code made up of norms, regulations, and common practices that enshrine privacy and put the individual back at the center of the data-ownership debate. Such a compact could be developed in Europe first and then be exported to other regions and jurisdictions. Such a change would greatly enhance people's perception of security online and contribute to their appreciation for the rights provided to them by the societies they live in.

10. Environmental sustainability

None of the measures above will amount to much if the environment and biodiversity are not protected. Environmental degradation is perhaps the most existential of the challenges addressed in this essay. Full implementation of the Paris Agreement should be a priority for every government.[31] This will entail changes in every sector from the finance sector, with the necessary rise of green finance, to infrastructure, to energy, to the food industry. What is clear, however, is that the social contract will remain broken if young people perceive that the planet they will inherit will be a barren one. It will also be impossible to think of equitable development or of social justice if large swathes of the planet are under severe climate-related stress.

Conclusion

The implementation of the measures described in the preceding section would lead to a more secure and a more sustainable future. A society with an effective and well-calibrated education system would be capable of creating opportunity and of furthering innovation. More competitive markets and a better-balanced taxation system would not only be a source of legitimacy for political systems around the world but it would also enable greater fiscal traction over corporate profits and, hence, the provision of better public services; something much needed to compensate for the wealth-concentration effects of emerging technologies. A private sector that is, in turn, committed to these goals would be a requirement for sustainable growth. Additionally, better governance mechanisms would assuage doubts about the efficacy of public institutions and, ultimately, of democracy as a system of government. If all of this is accompanied by an effort to enhance data protection, security in cyberspace, and a push for environmental sustainability, the general sense of personal security on the part of citizens would be greatly enhanced.

A different world to the one we have today is therefore possible. It seems feasible to do away with some of the most significant drivers of social pain within our societies. It is hard to imagine that if those issues are addressed in a systematic and effective manner populism would still thrive. Extremist and radical rhetoric should find unfertile ground in a well-educated, prosperous, and optimistic society.

Arriving at a solution requires a flexible and dynamic polity. One that is willing to listen to the concerns of its citizens and act decisively. Rigidity, or the inability to react to the clear signals of stress in our social contract, will only result in greater social pain and a deeper political convulsion. The hope should remain that academics, policy-makers, and business leaders come to the realization that our societies need profound changes if they are to be truly sustainable.

The challenge we face is not one of resources or scarcity but one of managing abundance. Many of the problems studied throughout this essay are a product of the human ability to build complexity into its social and economic structures. That complexity has been an enormous source of intellectual, social, and economic prosperity. It has, however, also become a challenge in itself, given the difficulty of governing a highly complex, interdependent, and fast-changing society. We are faced, therefore, with the task of proving that our social intelligence can match the complexity of the society we have built.

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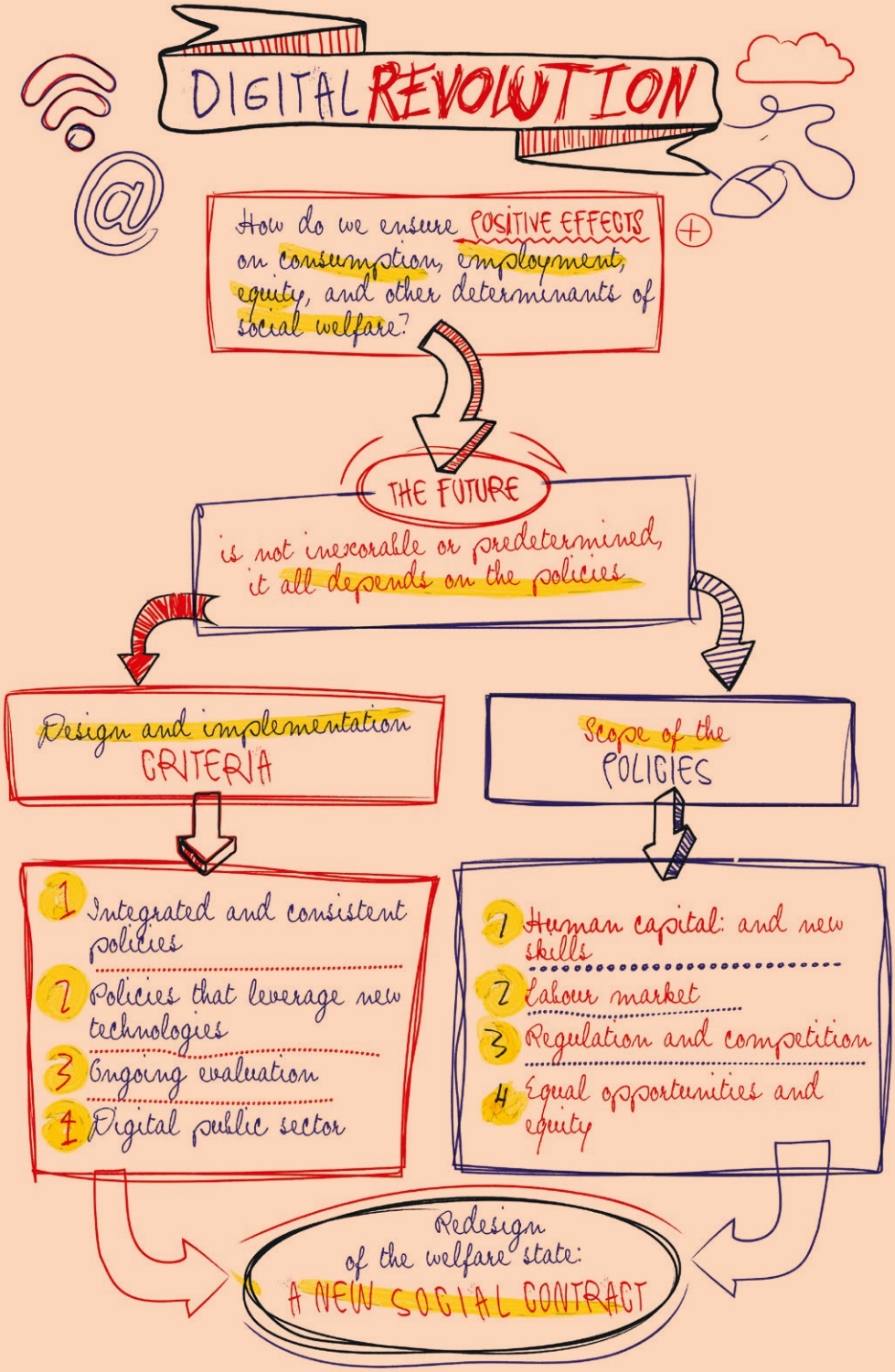
DIGITAL REVOLUTION
How do we ensure POSITIVE EFFECTS on consumption, employment, equity, and other determinants of social welfare?
THE FUTURE
is not inexorable or predetermined, it all depends on the policies
Design and implementation CRITERIA
Scope of the POLICIES
1 Integrated and consistent policies
2 Policies that leverage new technologies
3 Ongoing evaluation
4 Digital public sector
1 Human capital: and new skills
2 Labour market
3 Regulation and competition
4 Equal opportunities and equity
Redesign of the welfare state: A NEW SOCIAL CONTRACT

Public Policies in the Age of Digital Disruption

Javier Andrés and Rafael Doménech

As in previous industrial revolutions, there is nothing inevitable or predetermined about the effects of the digital revolution. Its consequences on productivity, consumption, employment, inequality, and other determinants of social welfare will depend on the design and implementation of public policies for the management of the technological transformation of our societies. Governments, firms, and workers need efficient, coherent, and comprehensive strategies subject to permanent evaluation that make the most of the opportunities offered by new technologies in key areas such as human capital, the labor market, competition, and the regulation of goods and services markets, as well as a redesign of the welfare state and a new social contract to reduce inequality. The success of these policies will determine the extent to which our societies will be able to increase productivity, create employment, and grow in an inclusive manner, thereby increasing social welfare.[1]

We are witnessing a new wave of technological progress with enormous but uncertain potential to profoundly transform our societies. This trend, together with globalization and the demographic changes associated with it, is generating far-reaching changes in the global economy.

Despite the fact that the process of economic growth is almost exclusively related to industrial revolutions and is thus relatively recent in human history, social adaptation to technical change has generally been a slow and, therefore, reasonably smooth process. It took between three and five decades for the use of some of the main innovations brought by the Second Industrial Revolution—such as electricity, the telephone, or the automobile—to become widespread. The impact of these innovations and the social changes that public policies were required to address also occurred gradually, so that individuals, firms, and the societies of the time as a whole were able to come to terms with them. In the case of the digital revolution, however, there are indications that changes are taking place more rapidly, reducing the response time available to successfully deal with the new challenges it brings. The success of this response will determine our societies' capacity to improve productivity, create employment, and grow in an inclusive way, thereby increasing our social welfare.

Evidence from the past two centuries allows us to draw various lessons regarding the importance of effectively managing this process of change. Firstly, that the significant increase in social welfare in advanced economies (as shown in fig. 1 from 1960 to the present) and in most of its determinants (per capita consumption, leisure, and life expectancy) is due to technological progress. Secondly, the uptake of innovations is not always simple and, as such, not without costs to individuals and society as a whole. For instance, the new technologies and production methods and the new goods and services available may have harmful effects on the environment or very diverse consequences on different social groups and occupations, with significant implications for inequality. Thirdly, not all countries have been able to capitalize on this progress to the same extent, or to do so in a way that is inclusive for the majority of their citizens, giving rise to economic and social miracles and also failures, examples of which abound in recent history.

The digital revolution does not call for heightened optimism about the ability of robots or of artificial intelligence to do our work while we enjoy more leisure and higher levels of income. Nor does it call for the pessimism of those who think we are heading for technological unemployment, and bound to lose both our jobs and our livelihood to robots. There is no call for utopias or dystopias, but for a balanced analysis of its possible effects in the reasonable timescale of the next two or three decades. Machines and algorithms will not by any means destroy all jobs, but they will destroy some of them while others will be created. If past experience is a useful guide for the future, we can expect the overall balance to be positive. Even so, individuals and firms may lack the capacity to adapt, and those who lose their position may find it difficult to access the new opportunities. This may lead to social polarization in employment status (employed vs. unemployed) and in the quality and remuneration of available jobs. This polarization, and the resulting threat of greater inequality, is a risk to guard against.

As in the previous industrial revolutions, there is nothing inexorable or predetermined about the effects of the digital revolution. Some societies will be successful because they will be able to make the most of the opportunities created by these changes to increase employment, productivity, and a more equal distribution of income and wealth, thus enhancing social welfare. At the other extreme, those countries which fail to adequately manage this process well may see an increase in unemployment and inequality, with sluggish or stagnant productivity. Even if it is managed well, there is no way to predict whether this technological, economic, and social transformation will be as successful in terms of welfare as the previous industrial revolutions eventually proved to be, even though they also went through periods of serious economic problems and social and political upheavals. Whether the Fourth Industrial Revolution currently underway will or will not end in another leap forward in welfare will depend on how it is managed. A widespread rejection of innovation and globalization may provoke a backlash. In this case, some societies will lag behind others and will not be able to take advantage of opportunities created by new technologies.

Well-designed public policies will be required to strengthen the positive effects of technological change in the four key areas that affect us all: as consumers, as workers, as entrepreneurs, and as taxpayers and beneficiaries of the welfare state. It is necessary to improve the efficiency and equity of the labor market, to strengthen high-quality, inclusive education and lifelong learning, to support the increased use of new technologies, to ensure that these new technologies do not reduce competition in the markets but work for the benefit of all, and to apply redistributive measures that mitigate the negative effects of technological change wherever they arise. Success on these fronts will strengthen all, in what should be a comprehensive and coherent economic policy strategy for governing digital societies. A strategy that we need to implement quickly and effectively, with the help of an important ally: technological innovation itself. Used wisely, new technologies can be placed at the service of these public policies to identify new needs, design solutions, deploy measures quickly and efficiently, streamline processes, reduce costs and improve services, evaluate results, and select the characteristics and beneficiaries of effective redistributive measures.

Education and New Digital Skills

The digital revolution favors certain skills and types of knowledge at the expense of others. In general, many of the jobs that are created by new technologies require more skills and abilities than the jobs that are destroyed. Skills-biased technological progress tends to increase the wages of workers with higher qualifications, compared to lower-skilled workers. But with many recent innovations, the relationship between human capital and employment has become more complex. The new robots and algorithms pose a significant risk of automation of jobs

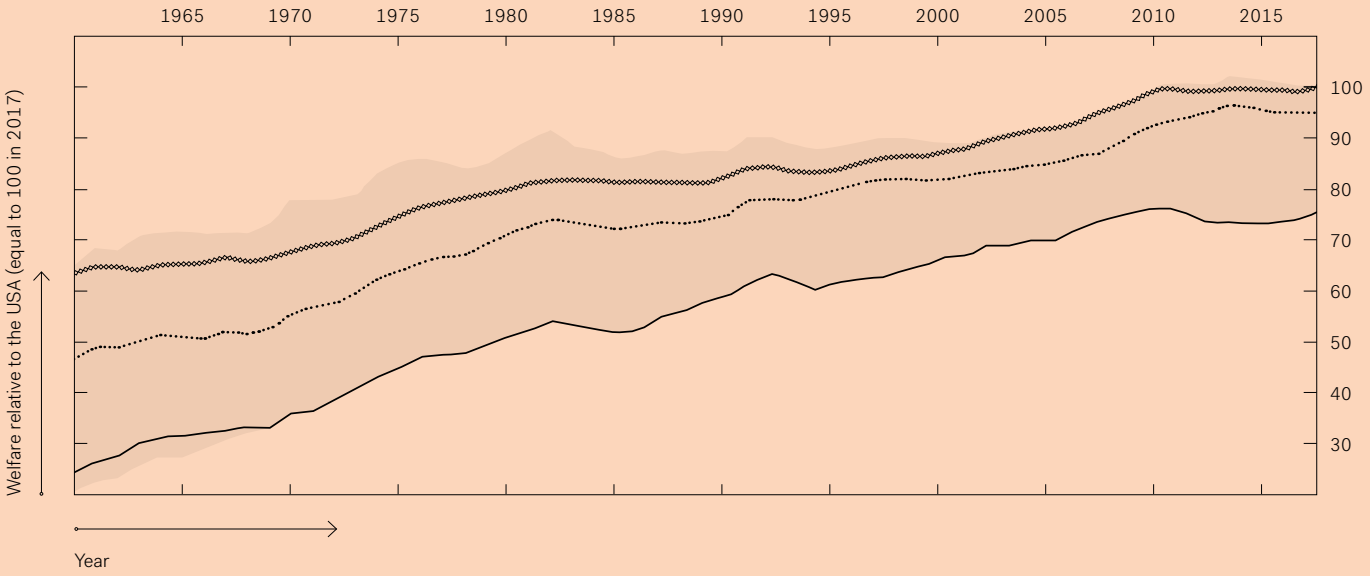

Fig. 1. Relative social welfare in the United States, Spain, and another eight advanced economies, 1960–2017

E8 comprises Austria, Belgium, Germany, Denmark, Finland, the United Kingdom, the Netherlands, and Sweden. (Source: compiled by the authors based on PWT 9.1, AMECO, OCDE, and Gapminder)

These active and passive labor market policies are crucial to increasing the likelihood of finding new jobs and reducing the transition costs associated with the disappearance of certain occupations

with a greater proportion of routine tasks, which do not always correspond to those with higher or lower qualifications. For this reason, it is necessary to ensure that investment in human capital is increasingly geared toward developing skills that are complementary to robots and artificial intelligence. Complementary in a double sense: skills that are unachievable by robots (at least within a reasonable timeframe), and that allow collaboration between machines (or software programs) and workers, increasing their productivity. The prerequisite for achieving these complementary skills is education—both before entering the labor market and through continuous training in increasingly complex, changing working lives—to secure equal opportunities and ensure that everyone can benefit from the digital revolution.

To start with, however, there are major differences between countries in human capital endowment. The educational level of adult populations varies greatly, even among advanced economies, as a result of differences in early leavers from education and training, in the quality of the education received during the years of schooling, and in the access to continuous training. It thus comes as no surprise to find a huge gap between different countries in cognitive and professional development skills such as reading and numerical skills, and problem-solving in computerized contexts.

The new occupations will increasingly require a capacity for analytical reasoning, critical thinking, creativity, originality and initiative, personal leadership, social influence, emotional intelligence, language command, commitment to the job, and social skills, combining technical and humanistic education and with the ability to manage and coordinate teams and projects. But it would be unrealistic to think that we all have to become "superworkers" with all those attributes. It is essential for each person to find where they fit into the production process, and to thrive in this ever-changing and dynamic world. Given the range of skills that can be useful in the digital world of the future, with new or totally modernized occupations, the parameters of what is considered a good education will shift and continue to change over time. A good basic education, flexibility, and adaptability will be decisive for success in this new and changing environment. It is essential to learn to learn, and public policies must ensure high-quality programs that meet these new needs and that provide firms and workers with the opportunity to continue their training and acquire new skills where necessary.

Workers and firms, as well as public administrations, will have to identify labor market trends and anticipate the new emerging occupations and the qualifications they may require. New technologies can play a key role in detecting these needs. There are now algorithms that search the Internet and map the text of job descriptions offered by firms in the form of job characteristics. The education system and ongoing training must also increasingly use new technologies that reduce the cost of investment in education and improve educational performance, removing geographic barriers that limit access to centers of educational excellence.

Policies for a New Labor Market

Improving the human capital and skills of the working population is a necessary but not sufficient condition to achieve abundant, high-quality employment if the labor market is dysfunctional and inefficient. The variation in unemployment and temporary employment rates, and in job quality, indicates that there are major differences between countries in terms of the efficiency of labor regulations and active labor market policies. To prevent the digital revolution from generating unemployment, polarization, and unstable careers doomed to low remuneration, it is essential to remove barriers to job creation and to investment, innovation, and growth; to increase legal certainty in labor relations; to strike a balance between labor market flexibility and employment security for workers; to facilitate the financing of start-ups; and to simplify and improve labor regulations to make them more efficient. In all of these areas, and overall in the generation of a business environment that increases the level and quality of employment, the public sector plays a key role.

The digital revolution is introducing major changes in the hiring process. The nonconventional forms of work that have already begun to proliferate call for new measures to ensure enhanced quality and safety standards. Exploring new legal solutions while maintaining existing labor leg-

An Airbus trainee shows the use of data goggles (Microsoft Hololens) used in maintenance and installation on an aircraft component during a demonstration at the Airbus premises in Hamburg

islation and traditional contractual modalities is unlikely to suffice unless the root of the problem is addressed: the underlying differences in costs and incentives for arbitrage between self-employed and employed workers. A consistent approach requires establishing a charter of common social rights for all workers, regardless of their status, and that all of them contribute to their financing in the same way. The combination of efficient, unbiased regulations for all types of employment contracts and competition between firms in goods and services markets should ensure compatibility between the flexible labor relations required by new technologies and business models and a social protection system similar to that enjoyed by full-time workers in permanent contracts, who are now in the majority.

Another area in which the challenge of digitalization is fundamental is that of active and passive labor market policies, in order to enable rapid reallocation of the workers who are most at risk of being replaced due to the automation of the tasks they perform. These policies are crucial to increasing the likelihood of finding new jobs and reducing the transition costs associated with the disappearance of certain occupations. And they are even more important as we face a profound structural change in labor markets, rather than cyclical fluctuations. But their efficiency varies greatly among advanced economies. Some countries in central and northern Europe have effectively managed labor market policies for years, as in, for example, the "flexicurity" model in Denmark, the Netherlands, and other European countries. Education and training measures for the unemployed and continuous on-the-job training must be at the frontline in the fight to ensure job destruction does not lead to an increase in structural unemployment.

In this field, too, new technologies should be used as a way to shorten the transition period between old and new occupations. This requires a complete overhaul of the institutions responsible for providing intermediation in the labor market, both public employment services and private firms. The digitalization of work records, profiling, knowledge of the characteristics of available vacancies, and the provision of information on labor market tendencies

and appropriate training courses are imperative for streamlining the job search process in both the conventional activities and the gig economy. Continuous training is not just necessary for developing new skills for those looking for employment, but also to acquire the basic financial, organizational, and management skills required to move between changing occupations and new forms of labor relations.

In a world in which "winners take most," collective bargaining has to prevent firms from falling behind in the adoption of technology and innovation, which would jeopardize their survival. Internal organizational flexibility and collective bargaining within firms should favor the adaptation and development of new technologies, the implementation of training programs, and target-based variable remuneration to increase the workers' share in firm profits. This more flexible collective bargaining must extend to all types of workers, including those under new forms of professional relationships. Like employed workers, independent workers on platforms must have the opportunity to defend their rights through the creation of associations, even if their bargaining power does not extend to price collusion or unjustified professional qualification requirements that may reduce competition.

Competition and Regulations in Goods and Services Markets

Market regulation is one of the key public sector interventions in the organization of economic activity. Technological change and globalization can give rise to the emergence of firms with a huge concentration of market power and externalities or asymmetries in data and information use, leading to situations that are inefficient from the economic and social point of view. One of the characteristics of many new technology firms is the fact that the fixed costs of R&D and innovations are very high, but once the technology is available (a software program, for example), the average cost of producing new units tends to zero, favoring the emergence of natural monopolies.

The digital revolution will create more opportunities, increase social welfare, and be perceived as fairer to the extent that it becomes easier for firms, workers, and consumers to access innovations and to reduce the gap with the world technological frontier, leveling the playing field and favoring conditions for increased competition. To this end, the public sector must invest in conventional, technological, and communication infrastructures; develop regulatory and legal frameworks at the national and supranational levels to reduce the uncertainty associated with the adoption of new technologies; promote the digitalization of the public administration; and foster innovation and forms of artificial intelligence with the potential to create new jobs, more productive occupations, and new forms of work that contribute to an increase in social welfare.

As well as closing the digital divide, public policies should prevent new sectors and firms from gaining excessive market power that limits competition and innovation to the detriment of social welfare. Competition policy must closely monitor changing market conditions and ensure there is effective competition between firms. Measures that can be used to achieve this objective include the diffusion of technological advances and patents to facilitate the entry of new competitors and the financing of start-ups; the protection of consumer rights; access to big data, supercomputers, and cloud computing; and data sharing, when permitted by data owners.

The use of big data helps make our lives easier and more creative. But competition policy must ensure the neutrality of access to information by all firms, so that the IT giants do not gain leverage from the use of their existing user data in the case of the vertical integration of new products and services in their platforms. Regulations must ensure the correct use of this data and of artificial intelligence for the benefit of users, protecting the right to privacy. Algorithms have to be transparent and verifiable, and they must be evaluated to prevent any type of bias or illegal discrimination in their design. Policies should promote the use of "sandboxes," pilots, and experimental protocols, as in the case of self-driving cars, for example.

Lastly, a crucial field of action for the public sector in the use of new technologies has to do with cybersecurity, to which the usual characteristics of public goods apply (the existence of externalities, non-rivalry, and nonexclusion of potential beneficiaries). Just as ensuring national security and the physical and legal security of individuals and firms are fundamental public services, public administrations must also ensure cybersecurity in order to expand the digital economy.

Equal Opportunities and Redistribution

As in previous industrial revolutions, the available evidence suggests that the digital revolution is already having some mixed effects on workers and firms. In principle, if the net social benefits are positive, it will suffice to design efficient redistribution mechanisms to compensate those who lose out, so that they will also benefit from the new technologies and globalization. But these mechanisms must be carefully designed if they are to be truly useful and efficient, and this is not always easy. The efficiency and quality of the welfare state and institutions is essential to guarantee equal opportunities first, and then provide a safety net for individuals facing unexpected adverse situations. Societies that are already doing better in terms of equal opportunities and *ex post* redistribution have a head start when it comes to facing the challenges of the digital revolution in regards to inequality.

Efficient redistribution must satisfy a number of principles in order to maximize its benefits and reduce its costs. Firstly, redistribution should be carried out at the lowest possible cost in terms of management and of the use of taxes in income policies. Secondly, the beneficiaries should be properly identified so that benefits, public services, or tax reductions are provided to those who really need them. Thirdly, redistributive policies should be financed through a tax system that is as non-distorting as possible. The distortionary effects of taxes have been thoroughly studied by the optimal tax theory. To the extent that taxes generate distortions and incentives, they end up affecting economic activity, investment, innovation, and employment. It is necessary to strike a balance between an efficient tax structure (to boost innovation and employment creation) and sufficient income (to finance public expenditure and to reduce the inequality of disposable income after taxes and transfers).

Insofar as automation destroys jobs, should robots pay taxes? This proposal presents several problems. First of all, at least for the time being, automation and robots

destroy some occupations but create jobs in others, so that the most automated and digitalized countries also have the lowest rates of unemployment. Just as there is no reason to fear mass technological employment for now, there is also no reason to tax the use of robots, at least in the near future. On the other hand, it makes no sense to discourage the production of new goods and services or the adoption of available technologies that increase productivity, lower production costs, and eliminate the need to employ workers for dangerous or unpleasant tasks. In any case, it is very difficult to quantify how many jobs are directly affected by new technologies, and thus to determine the appropriate tax base for a hypothetical tax of this kind. Lastly, given globalization, internationally tradeable activities that do not incorporate robots or available technologies because of these taxes would be at the mercy of foreign competition, jeopardizing the survival of firms and their jobs.

Since the objective must be to distribute the new wealth, not impede its creation, it makes more sense to tax profits through corporate taxation, regardless of the technologies they are using. Or to expand other taxes that, even if distortionary, do not directly affect the incentive to innovate, which would eventually stall the engine of economic growth. If innovation were to lead to higher unemployment in the long term, it would be necessary to fight inequality through more intensive redistribution of income, with gradual increases in the taxes that can raise the most revenue with less distortions in employment, innovation, and productivity.

On the expenditure side: is "universal basic income" (UBI) the best redistributive transfer? Although UBI has some advantages (it is unconditional, eliminates the risk of absolute poverty if generous enough, does not stigmatize recipients, and is easy to manage because it is universal), it would be very expensive to ensure a minimum level of well-being to all citizens. Funding a UBI would require significant tax increases. The increased progressivity and tax burden would also reduce labor supply by making work more expensive relative to leisure. At the same time, the UBI generates an income effect that encourages people to consume more and also to enjoy more leisure. Higher levels of capital taxes also discourage saving and investment, which negatively affects labor demand and productivity. The result of a lower supply and demand of labor is a lower level of employment, with ambiguous effects on wages. And globalization also increases the costs of UBI. Higher tax rates on labor and capital incomes encourage more qualified workers and internationalized firms to move to other countries with a lower tax burden. Some estimates suggest that the distortionary effects of generous-enough UBI as intended by some of its most ardent supporters could lead to significant decrease in the GDP.

Given that it is more efficient to redistribute, to those who are genuinely in need, through spending, many countries have already been running programs that are more selective, conditional, and less expensive than the UBI, such as earned income tax credits for lower-income individuals and households. The level of social acceptance of these kinds of conditional programs is usually very high, because they reduce poverty more selectively, at a lower cost, and without discouraging employment. And these wage supplement programs for employees with low pay are provided in addition to the minimum wage, which seeks to reduce wage inequality and reduce the risk that firms may have the power to set wages below productivity.

Another alternative to UBI is the participation income proposed by Anthony Atkinson: an income conditional on participation in social activities that would supplement other social security benefits and allowances. Contribution to society is understood in a broad and not exclusively economic sense, through work, education and continuous training, active job search, or the care of children and the elderly, except in the case of illness or disability. Participation income is very general, but it would explicitly exclude individuals who in the hypothetical case of receiving this income would choose to devote their time to leisure. Atkinson himself proposed starting to implement the participation income with a child income program in the European Union.

Before launching new redistribution mechanisms to deal with problems that do not yet exist—such as massive technological unemployment—we must fully exploit the margins of the existing welfare state policies and improve their coverage and efficiency, as some societies are already doing. At least in the short term, there are options that are more economically sound and viable than UBI, with the potential to achieve better

New technologies should be used as a way to shorten the transition period between old and new occupations. This requires a complete overhaul of the institutions responsible for providing intermediation in the labor market, both public employment services and private firms

The digital revolution will create more opportunities, increase social welfare, and be perceived as fairer to the extent that it becomes easier for firms, workers, and consumers to access innovations and to reduce the gap with the world technological frontier

Logistics and fulfillment center for the online fashion retailer Zalando in Erfurt

outcomes in the fight against inequality, particularly against extreme inequality and poverty.

Here again, new technologies can help improve the results of existing policies, as the Opportunity Insights project in the United States is doing, for example.[2] Artificial intelligence applied to big data makes it possible to identify the beneficiaries who really need assistance in the form of wage supplements, guaranteed minimum income, school aid, or subsidies for intergenerational and geographical mobility, or to eliminate child poverty. New technologies could also be used to determine optimal minimum wages, so as to reduce the power of monopsonists without jeopardizing employment. For all of this, it is necessary to consolidate information on all the social benefits, aid, and subsidies provided by all public administrations, on recipients and their socioeconomic conditions, and on the characteristics of firms and employees.

Toward a New Social Contract

The digital revolution is giving rise to a new society. The social contract and the welfare state that emerged after the Second Industrial Revolution were crucial to the prosperity of most societies in advanced economies, and did much to reduce the high levels of inequality in the first third of the twentieth century. Now, with the digital revolution, it has become necessary to rethink and redesign the welfare state. Failure to do so may give rise to social antagonism that could jeopardize the actual process of technological change, as is already happening in the case of globalization. The welfare state will very soon come under pressure in terms of both expenditure and revenue. New spending policies will emerge, and it will be necessary to protect those who lose in the digital disruption process. On the revenue side, there is an erosion of the tax base due to globalization and activities in the gig economy and new forms of employment relationships. It is foreseeable that the welfare state will move away from Bismarck's conception of the state as an intermediary guaranteeing contributory insurance (health and pensions) to those who participate in its financing, toward a more general Beveridge model that provides support for all, although taking into account the economic capacity of each citizen. In this context, international cooperation is essential, as is tax harmonization for processing income generated in the digital economy.

We do not believe that it will be necessary to reinvent the market economy in the next few decades, but only to adapt its institutions and rules so that increased income and welfare will extend to all citizens.

Many countries have already been running programs that are more selective, conditional, and less expensive, than the UBI, such as earned income tax credits for lower-income individuals and households

Artificial intelligence applied to big data makes it possible to identify the beneficiaries who really need assistance in the form of wage supplements, guaranteed minimum income, school aid, or subsidies for intergenerational and geographical mobility, or to eliminate child poverty

As part of the campaign for the UBI referendum in Switzerland in June 2016, the Swiss Initiative for an Unconditional Basic Income produced an 8,000-square-meter poster that was displayed for a few days on the Plainpalais square, Geneva

The further we progress along this path, the greater the likelihood that society in general will benefit from technological progress, and the smaller the likelihood that it will oppose it. Faced with this challenge, the public sector has an enormous responsibility to ensure an environment in which the private sector can improve and develop its potential, while also ensuring equal opportunities. Governments have to embark on a process of permanent improvement of their efficiency, reducing administrative costs and unnecessary burdens for firms and workers. And they must lead the technological and digital transformation, providing more and better services to citizens and businesses, and constantly evaluating the effectiveness of their policies.

There are reasons to be optimistic about the future, but only if our societies are able to properly manage the changes, promoting economic growth and providing a welfare state that adapts to the new individual and collective needs. It is very likely that some countries will do this more successfully than others. The social impact of new technologies will depend on how the new challenges are managed. In this process of change, there is no trade-off between fairness and efficiency: societies that are able to design a welfare state that works more efficiently will make the most of new technologies to increase social welfare, while at the same time attaining lower levels of inequality and greater intergenerational equity.


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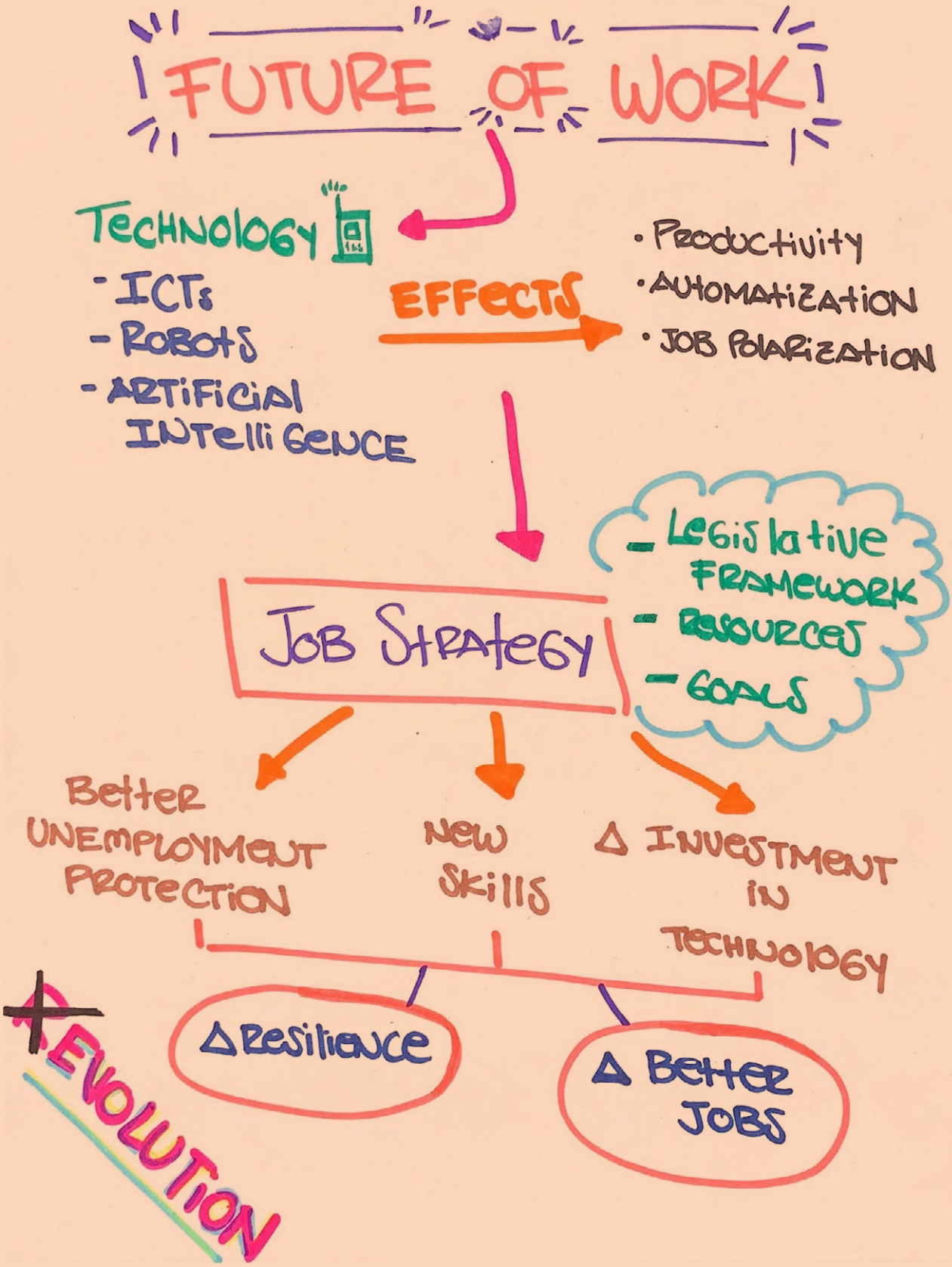
Notas

1. En el capítulo cuarto del libro de Javier Andrés y Rafael Doménech, *La era de la disrupción digital. Empleo, desigualdad y bienestar social ante las nuevas tecnologías globales* (Ediciones Deusto, 2020), se realiza un análisis más detallado y extenso de las políticas públicas con las que afrontar con éxito la revolución digital. El lector interesado puede encontrar en él un amplio conjunto de referencias bibliográficas sobre los temas aquí tratados.
2. Para conocer más detalles de este proyecto puede consultarse su web: www.opportunityinsights.org.


FUTURE OF WORK
TECHNOLOGY
- ICTs
- ROBOTS
- ARTIFICIAL INTELLIGENCE
EFFECTS
• PRODUCTIVITY
• AUTOMATIZATION
• JOB POLARIZATION
JOB STRATEGY
- LEGISLATIVE FRAMEWORK
- RESOURCES
- GOALS
BETTER UNEMPLOYMENT PROTECTION
NEW SKILLS
Δ INVESTMENT IN TECHNOLOGY
Δ RESILIENCE
Δ BETTER JOBS
+ EVOLUTION

Institutions, Policies, and Technologies for the Future of Work

Carmen Pagés Serra

In recent years, there has been a proliferation of publications about the future of work. Many of these adopt a somewhat sensationalist tone, predicting a dystopian future without employment; others point to our historical coexistence with technology to attest to our capacity to continue creating new occupations and tasks for humans. This paper goes deeper into this debate by looking at recent studies on the impact of artificial intelligence (AI) and robotics on labor markets. It predicts an acceleration of the ongoing labor market transformation, which in many countries is already putting pressure on society, polarizing the political discourse, and undermining democracy. The first part focuses on the need to develop a strategy that improves the resilience of workers and firms and increases the creation of quality jobs. The second part discusses the nature of this strategy and how to put it into practice.

Many studies, events, books, and articles in newspapers and social media draw our attention to the future of work. Most take a markedly pessimistic point of view, in which the world is on the brink of an unprecedented employment crisis: we humans will be replaced by robots, chatbots, and increasingly clever, capable, and intelligent algorithms that will do our tasks. Others, on the other hand, look for signs of what may come and find reasons for optimism in the past history of mankind: since the Industrial Revolution, humans have been able to find tasks and occupations that allow us to keep working while coexisting with technology.

This article explores this debate, searching for clues as to what awaits us in the future, analyzing what has happened in the labor market throughout history in response to the introduction of new technologies. From the introduction of information and communication technologies (ICTs) in the 1980s to the incipient use of robots and artificial intelligence (AI) today, we can draw interesting parallels to understand the impacts of the budding industrial revolution that will take place when the use of robots and AI becomes widespread.

Our analysis finds that the effects of technology are not imminent, they have, in fact, already begun. The Third Industrial Revolution, marked by the widespread use of ICTs, has had significant consequences in the labor markets of most countries around the world. Similarly, in places where robots are being used on a scale large enough to detect their effects, there are worrying signs of their potential future impact. All of this suggests that we are not facing a revolution, but rather the acceleration of a labor market evolution that began a few decades ago. In many countries, this evolution has led to increased inequality, the disappearance of a large number of jobs that allow a middle-class lifestyle, an increase in the proportion of insecure jobs without economic or social security, and a lower income and standard of living for many workers. All of this, in addition to other megatrends, such as globalization, offshoring, and migration, is placing pressure on societies, increasingly polarizing politics, and undermining democracies.

In this context, we argue that although we cannot expect the market to take care of this problem, there is no call for a defeatist attitude either. We discuss the need to shift

from the status quo to the implementation of a strategy designed to improve the resilience of workers and firms facing these changes, and to increase the percentage of "good jobs," which Dany Rodrik and Charles Sabel broadly define as "stable formal-sector employment that comes with core labor protections," including safe working conditions and collective bargaining rights.[1] This new pact seeks to restore a strong, empowered middle class as the engine for more inclusive growth. The second part of the paper discusses the nature of this strategy and how to put it into practice. In some countries, it means modifying or adjusting existing institutions or policies, in coordination with companies, workers' organizations, and educational centers. In others, it involves making greater efforts to reach consensus between governments and other stakeholders in order to create or strengthen the required institutions, policies, and tools. In all cases, it means harnessing the potential of new technologies so that they cease to be the source of the problem and instead became a significant part of the solution.

Evolution or Revolution?

Exponential Technological Change

Since the early 1980s, we have seen the introduction and rapid expansion of a range of technologies. The Third Industrial Revolution brought personal computers (whose computational power has increased exponentially as its costs fell), the Internet, cloud computing, and smartphones, allowing for the interconnection of billions of devices and the digitization and automation of countless processes. Yet, it has been the advent of the Fourth Industrial Revolution, and the spread in the use of robots and artificial intelligence (AI), driven by exponential advances in data availability, that has set off alarms in society. The evocation of science-fiction stories in which human-looking robots subjugate humanity may explain a greater apprehension toward these technologies. But aside from a potential overreaction, what does the available research allow us to say about the future impact of these trends on the labor market?

Our analysis gives rise to the conclusions discussed below.

The Third Industrial Revolution Had Lasting Consequences on the Labor Market

Analyzing the effects of the Third Industrial Revolution (ICTs) on the labor market provides insights into the potential impact of the Fourth. Like artificial intelligence, ICTs are all-purpose technologies that can be applied to any sector or industry. Most available studies find that the introduction of ICTs did not have adverse effects on employment levels, but it had an impact on the composition of employment. For example, James Bessen (2017) found that ICTs did not lead to a decline in employment. Instead, they favored its growth. In fact, Bessen shows that the greater the introduction of ICTs in a sector, the more employment is generated in that sector.

However, many studies also conclude that the introduction and spread of ICTs brought significant changes to the types of jobs generated in the labor market. In particular, they show that ICTs—which have a strong advantage over humans when it comes to performing easily codifiable, routine, repetitive tasks—have replaced workers in routine occupations, such as accountants, administrators, and operators. At the same time, ICTs have increased the demand for nonroutine jobs, such as university lecturers and hairdressers (Autor, Levy, and Murnane, 2003; Goos and Manning, 2007; Acemoglu and Autor, 2011; Darvas and Wolff, 2016).

The impact of ICTs by occupation type, however, was not as significant as the impact by economic class: researchers agree that the introduction of ICTs has led to a fall in middle-class employment. Many of the jobs classified as "routine" require medium-skilled workers and pay wages close to the average. Therefore, the decline in the proportion of routine jobs in overall employment as a result of technological change has been a blow to the middle class. Between 1993 and 2010, the share of medium-skilled employment in total employment fell between six and fourteen percentage points in all European countries (Goos, Manning, and Salomons, 2014).

At the same time, technology has led to an increase in the demand for workers in the upper and lower part of the wage distribution. To understand the reasons for this phenomenon, it is important to note that technology gives rise to various different effects. On the one hand, it generates productivity increases that allow prices to fall, resulting in a greater demand for goods and services. This, in turn, contributes to a greater demand for labor in occupations and tasks that cannot be replaced by machines. Many of the goods and services for which demand increased were either carried out by low-skilled workers in low-wage jobs (such as personal services) or else, by high-skilled people in occupations that pay high wages (such as engineering). This rise in the best- and worst-paid jobs, accompanied by a decline in the employment (and income) of the middle classes, is known as "job polarization", and is taking place in almost all OECD countries (Darvas and Wolff, 2016). Also, although to a lesser extent, in Latin America (Amaral et al., 2019), and other countries in the rest of the world (AfDB-ADB-EBRD-IBD, 2018).

Analyzing the Impact of the Introduction of Robots Brings up Worrying Signals Regarding Its Potential Future Effects

The available studies suggest that, to some extent, there is an ongoing replacement of human labor by robots. Most studies conclude that the incorporation of robots has been accompanied by a decline in employment or in salaries, particularly in the manufacturing sector. It is estimated that the introduction of one additional robot per thousand workers reduces the employment rate by 0.16 to 0.2 percentage points (Acemoglu and Restrepo, forthcoming, for the United States; Chiacchio et al., 2018, for a group of European countries) and that the introduction of robots also reduces wages by around 0.42 percent (Acemoglu and Restrepo, forthcoming). In a 2019 article, Borjas and Freeman also found that robots have a negative impact on employment and wages equivalent to the arrival of an additional two to three workers per thousand inhabitants (Borjas and Freeman, 2019). Nonetheless, not all studies find the same negative impact. In the case of Germany (which has one of the world's highest robot penetration rates), for example, no negative impact was found on overall employment, although findings did indicate a negative impact on employment in the manufacturing sector (Dauth et al., 2018). This study did, however, agree with the aforementioned ones in finding that the introduction of robots is accompanied by a significant reduction in wages.

It is important to emphasize that these are preliminary results, given that the adoption of robots is still at a very early stage in most countries. According to some estimates, the number of robots per worker

Two trainees in electronics and mechanics at the Opel training center in Ruesselsheim, Germany

could quadruple between now and 2025, which would be equivalent to adding 5.25 additional robots per thousand workers. In terms of jobs, the expansion of robots would reduce employment by around 1% of the workforce. A significant impact, certainly, but hardly the end of employment.

Studies on the Impact of Artificial Intelligence Suggest a Greater Potential Replacement of Work

Artificial intelligence is at an even earlier stage of adoption than robots. As this makes it impossible to rely on direct observation of the effects of its introduction into production, studies that attempt to predict its impact estimate these effects in much more tentative and less accurate ways. In particular, they analyze what occupations may be automated by AI and how many workers currently employed in these occupations would be affected in the case of such automation. The first studies along these lines came up with figures that made headlines around the world. According to one famous study by two Oxford researchers, Carl Benedikt Frey and Michael A. Osborne, 47% of employment in the US could be automated by artificial intelligence (Frey and Osborne, 2017). Other studies using a similar methodology came up with even higher figures: between 48% and 73% potential automation in various countries around the world, with the highest figures corresponding to developing countries (World Bank, 2016).

These terrifying figures were reanalyzed by later studies that argued about the need to account for the fact that not all tasks within an occupation are equally automatable. Taking this into account, this second wave of studies came up with lower, but still substantial figures: 9% of employment in the USA and 8% in Eastern European countries could potentially be automated by artificial intelligence in the next few years (Arntz et al., 2016). However, the fact that an occupation is automatable by AI does not mean that it will in fact be automated: this will depend on whether it is worth investing in the technology based on current wages. For example, there are now robots in the construction field that can install 250 bricks per hour, while a mason can only lay 250 per day. This machine costs around 400,000 dollars. The amount a company would need to invest in a machine like this would cover

ICTs had an adverse effects on workers with medium skills and wages, while the introduction of robots appears to negatively affect workers with both medium and low skills and wages

the wages of ten masons for ten years in a row in El Salvador, but only 7.5 masons for one year in the United States.

The Negative Impact of Robotics and AI Is Greater for Medium- and Low-Skilled Workers, Young People, and Workers in Routine Occupations

A large majority of studies find that the adverse impacts of technology have been (and will probably continue to be) greater for medium- or low-skilled workers, and that some, but not all, new technologies tend to stimulate greater employment growth for workers with a higher educational level.

For example, as noted above, the adverse effects of ICTs applied principally to workers with medium skills and wages. The introduction of robots, however, appears to adversely affect workers with both medium and low skills and wages, with some divergence between studies. In one study that analyzes the impact of the introduction of robots in seventeen developed countries, Georg Graetz and Guy Michaels (2018) found that the impact of the reduction in labor demand was concentrated on workers with low skills and low wages. Another similar study for a group of six countries from the European Union found that the negative impact of robots was greatest for workers of middle education and wages (Chiacchio et al., 2018). Similarly, in Germany, robots adversely affected medium-skilled workers most and low-skilled workers to a lesser extent, while they stimulated employment for high-skilled workers (Dauth et al., 2018). Conversely, a study based on US data found robots had adversely affected employment for workers at all levels (Acemoglu and Restrepo, forthcoming; Borjas and Freeman, 2019), while the negative effects on wages were concentrated on workers with a low or medium educational level.

Like ICTs, robots compete more directly with people employed in more routine—particularly manual—occupations (Acemoglu and Restrepo, forthcoming), and in occupations with a higher probability of automation (Borjas and Freeman, 2019). A study looking at data by occupation for Europe found that the introduction of robots increased employment rates for professionals, technicians, and service workers, and reduced them for clerks, agricultural workers, artisans, and plant and machine operators (Chiacchio et al., 2018). In the specific case of Germany, the introduction of robots generated a greater demand for managers, legal specialists, and technicians, while systematically reducing the demand for plant and machine operators.

A final point to note is that although studies also find that the introduction of robots increases labor productivity, this does not translate into wage increases for workers. For this reason, the growth of robotics has led to the decline of the labor income share (Dauth et al., 2018). All of this confirms that the incorporation of robots has resulted in greater inequality, both between low- and middle-income workers and high-income workers, and between workers and capital income.

Based on the foregoing, it seems highly probable that, without government intervention, the massive introduction of artificial intelligence and robots will continue to reduce employment opportunities for people with medium and low educational levels and increase inequality. The big difference with the past is that now, artificial intelligence makes it possible to automate activities carried out by highly educated people, such as radiologists and credit-card fraud-detection analysts, broadening the scope of impact.

The Evidence so far Indicates that the Decline of Employment Owes More to Less Hiring than to More Layoffs

A very small group of studies analyzes the way in which the adjustment to the introduction of technology takes place. If employment declines, is it due to an increase in layoffs, to more retirements, or to less hiring? Does unemployment go up, or do people leave the workforce? The available evidence suggests that the main means of adjustment is a reduction in the hiring of new staff in declining sectors, rather than an increase in layoffs of current employees.

In the case of ICTs, a study based on United States data found that the decline of routine employment has mostly occurred in two ways. On the one hand, the fall in employment has been due to a decline in the inflow of workers from unemployment to routine employment. And to a lesser extent, to an increase in the outflow from these routine occupations to unemployment (Cortes et al., 2014).

It appears that young people bear much of the burden of the adjustment. A study based on German data looks at how different generations are affected by robots.

When robots are introduced, firms freeze new hires rather than laying off existing middle-aged workers. Given that new hires principally tend to be young people joining the workforce for the first time, there is a decline in the recruitment of young people. At the same time, those who were already employed by the company gain greater job security, but in exchange for being reassigned to other tasks or divisions within the same firm and at the cost of lower wage growth (Dauth et al., 2018). The freezing of new hires has led to an increase in the average age of the workforce in the more roboticized plants. Other studies carried out in the context of the European Union also confirm that the introduction of robots principally reduces the employment of young individuals relative to that of adults (Chiacchio et al., 2018).

Further research is needed to confirm whether the results found by these two studies can be generalized to other studies and countries. It is particularly important to be able to draw on this kind of information for designing policies that increase worker resilience to changes in the labor market and increase the percentage of good jobs. Tentatively, studies seem to conclude that firms reduce the recruitment of new hires, and possibly send some workers into early retirement, rather than increasing mass layoffs. Young people with medium and low educational levels suffer the greatest impact, given that their opportunities to find a job that secures them a place in the middle class have significantly decreased. Another part of the adjustment appears to take place through a drop in participation levels by those who abandon the search for work given the declining opportunities.

Technology also Creates Inequalities at the Local Level

The technological revolution also has significant effects at the local level. The type of employment in a particular area influences the future development of employment. Studies indicate that rural and semi-rural areas with a higher prevalence of medium- and low-skilled workers have suffered most from the effects of polarization, while cities have tended to have higher-than-average increases in employment and income (particularly the subset of cities with more human capital at the start of the introduction of ICTs). The evidence for the United States indicates that human capital has tended to concentrate in places that already had a higher share in the early 1970s and 1980s (Austin et al., 2018).

The Creation of New Tasks and Occupations for Humans Is Key to Restoring Employment

Throughout history, technology has destroyed jobs, but the employment-to-population ratio has continued to increase. How can these two trends be reconciled? The explanation is that the introduction of new technologies does not just destroy jobs, it also creates them through two different channels. Firstly, the introduction of new technology generates productivity gains that then lead to increased revenue and consumption, stimulating labor demand in nonautomated tasks. Secondly, new technologies create new tasks and occupations (Acemoglu and Restrepo, 2018). The Internet, for example, has given rise to social networks which, in turn, produced a new occupation: social media manager. In fact, about one third of the jobs created in the US in the past twenty-five years, including computer programmers, fitness instructors, and medical technicians, did not exist (or were only just starting to exist) twenty-five years ago (McKinsey, 2015).

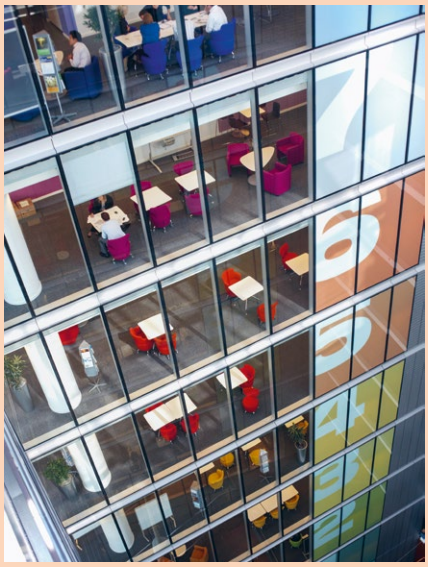
Thus, even when the replacement of humans by technologies has adverse effects on employment in the short term, it is difficult to predict the medium- and long-term effects that will result from these two forces, and whether it will be different this time. In the case of ICTs, as noted above, the impact has been neutral or positive, but it is too early to know whether robots and AI will produce a different effect. One cause for concern is that, as Daron Acemoglu points out, the bulk of investment in artificial intelligence seems to be geared toward replacing workers, not toward generating new tasks that create more jobs.[2] Moreover, even if new technologies do not affect employment in the medium term, their effects on income and employment distribution may last for decades (judging by the lasting distributional consequences of the introduction of ICTs).

Institutions, Policies, and Solutions for Successfully Addressing Technological Change

The future of work is already the present. The changes described above make it clear that technology is inexorably transforming

The freezing of new hires has led to an increase in the average age of the workforce in the more roboticized plants

One third of the jobs created in the US in the past twenty-five years, including computer programmers, fitness instructors, and medical technicians, did not exist twenty-five years ago



The European headquarters of Ernst & Young at the More London development, London

the labor market. These forces are contributing to increasing inequality and decreasing employment opportunities and income, particularly for medium- and low-skilled workers, and even more markedly for the younger cohorts. At the same time, many firms are finding it difficult to adapt to the increasingly rapid waves of technological change (McKinsey, 2015). Firms that fail to successfully incorporate new technologies run the risk of dying. The lack of workers with the right skills is a key factor hindering the adjustment. According to a recent Manpower report, 45% of small firms and 67% of large firms report difficulty finding candidates with the skills they need, and these figures have been growing in recent years (Manpower, 2018).

In this scenario, where both workers and firms find it difficult to successfully address the changes that the future of work brings, public policy has two choices: to continue with the status quo, or to follow a much more active strategy developing policies, institutions, and technological tools to enhance the resilience of individuals and firms in the face of these changes, as well as promote greater growth of good jobs.

Traditionally, economists have not been in favor of pro-employment policies on the grounds that employment is driven by economic growth and, as such, the priority should be to promote the latter. However, the opinion of the profession seems to be changing. Several recent studies draw attention to the negative effects on society of the disappearance of "good jobs" and to the fact that the market, on its own, does not produce a sufficient number of good jobs. Researchers find, for example, that a decline in good jobs leads to an increase in the impact of numerous social problems, such as addictions, deaths resulting from these addictions, child poverty, and mental illness (see, for example, Rodrik and Sabel, 2019, and Austin et al., 2018). The loss of good jobs also involves high costs for governments. In the United States, for example, the fiscal cost of the loss of employment ranges from 21% to 36% of the wages earned by low-income workers (Austin et al., 2018). In addition, there is the loss of social insurance coverage and the protections associated with formal employment, which have to be financed by the government through social protection programs. The studies also find that the loss of good jobs is linked to political polarization (Autor et al., 2017) and to a loss of confidence in democracy (Ballard-Rosa et al., 2018). Effects of this kind have been found in the US, Sweden, the United Kingdom, and other EU countries (Rodrik and Sabel, 2019). As such, the creation of good jobs will not only keep people in the middle class, it is also crucial to the health of democracies.

Remedying this situation requires a public policy response—in coordination with other actors, such as companies and workers' representatives—to the growing polarization of labor markets and the insufficient creation of good jobs. Technology is advancing rapidly and we must quickly decide what kind of society we want. Adapting a concept developed by Danny Rodrik and Charles Sabel in a recent article (Rodrik and Sabel, 2019), we propose that governments should develop a deliberate strategy to increase both the resilience of workers and firms in the face of these changes and the number of "good jobs." This strategy should comprise *an appropriate regulatory framework* for the creation or strengthening of a series of *institutions, policies, and technological solutions designed for this purpose*, the *resources* required to carry the plan forward, and a series of *milestones and a timetable* for its implementation.

The *regulatory framework* establishes the parameters and incentives for the public-private collaboration in order to ensure that: firms adapt to the technological challenges and retrain their employees to carry out new tasks/roles in the same firm or others; employees affected by downsizing have sufficient financial security for a period that allows them to train to perform new occupations; appropriate training programs are developed to build the skills required by the labor market; and technological tools are designed and made available to workers to guide them through their many transitions.

More specifically, and by way of illustration, this framework could establish the elements described below.

A. Instruments that Allow Firms to Adapt to New Technologies and Workers to Retrain in order to Transition to New Tasks and Occupations

The successful adoption of technologies that already exist in the world or in a particular country is the main engine driving the growth of countries (McKinsey, 2015). Continuing to introduce information technologies, such as broadband, and to make progress with the digitalization of processes, in conjunction with an increasing use of artificial intelligence and robotics, will lead to productivity gains that are key to sustaining high growth in a rapidly aging world. However, as noted above, this technological progress must *coincide with the development of new activities for humans*. There are various examples of successful public policies around the world that can speed up the introduction and use of new technologies, as well as the development of new roles, tasks, and occupations for workers. An interesting example is competitive public funds, which allow firms to submit investment proposals to public bodies and compete for funding to finance them. Submissions must include the description of the company's plan to invest in new technologies and programs to develop new skills, specifying the amount of co-financing that they are prepared to provide and the good jobs they can create. These proposals are assessed by a technical committee that decides on financing based on the quality of the proposals. Instruments of this kind have been used successfully in developed countries such as the United Kingdom, Australia, and the United States, and are also starting to be used in some Latin American and Caribbean countries. They can be scaled relatively quickly. Also, financing priorities can be adjusted flexibly over time to meet the changing needs of firms, workers, and governments. To be useful, these programs must establish fast, transparent mechanisms for the allocation and disbursement of funds. Governments should focus on financing training that promotes the development of skills that are transferrable to other firms or industries. In addition, government should ensure the quality and relevance of the training and the portability of skills between companies by means of industry-recognized certifications.

Another way to protect people from the risk of obsolescence, complementary to the mechanism outlined above, is to expand social insurance to cover workers from the depreciation of their skills. This can be done through the creation of individual training accounts financed by payroll contributions (see, for example, Fitzpayne and Pollack, 2018). The accumulated amounts can be used to finance the training chosen by workers, as long as it meets standards of quality and relevance.

B. Adequate Protection from Dismissal, Combined with Sufficient Unemployment Insurance to Allow Laid-Off Workers to Acquire New Skills to Carry Out New Tasks or Occupations

The right mix of unemployment insurance and employment protection (in the form of severance pay) is the most efficient combination to insure workers against the risk of losing their jobs (Blanchard and Tirole, 2008). On the one hand, making layoffs more difficult or expensive means that firms can internalize the aforementioned harmful effects of unemployment on society. It also creates more incentives for firms to retrain employees to perform other roles or occupations within the company. At the same time, unemployment insurance means that firms laying off workers do not have to bear the entire cost of the adjustment, which is particularly important for small or less productive firms that are not able to cover the total cost. However, it should be noted that if the cost of payroll tax or of laying off workers is excessively high, the opposite effect may occur: it could disincentivize the shift from "old" to "new" activities, and promote the creation of bad jobs.

Technological obsolescence places workers who lose their jobs in a particularly complex situation. Technological change permanently reduces employment opportunities for laid-off workers, often forcing them to choose between accepting a lower-quality job in a different sector or leaving the job market. As such, it may be worth establishing supplementary unemployment benefits—for a sufficient period of time—to allow workers who lose their jobs to embark on training or retraining processes in order to be able to transition to occupations on the rise. These benefits should cover the cost of training as well as a living allowance for the person and his or her family. Payment could be subject to workers performing well in their training, and choosing to train for an occupation that is in demand. To ensure this last point, it is important to provide information on labor market trends and appropriate counseling to guide workers' training decisions (see point D).

C. Incentives and Financing for the Development of Flexible, High-Quality Training Programs

Technological change leads to the rapid obsolescence of some skills, particularly technology-related skills (see, for example, Deming and Noray, 2019), and creates demand for new ones. Jeremy Augur, cofounder of the training company D2L, points out that the average lifespan of a skill in the tech world is now only eighteen months.[3] Studies have found an increasing demand for advanced digital skills (Amaral et al., 2018), advanced cognitive skills such as critical thinking and problem-solving, and social skills such as the ability to work in a team and strong communication skills (Deming, 2017). But many of these skills are scarce in the workforce. On the one hand, technological skills change rapidly and the training system is unable to keep up. On the other, the educational system in many countries has not placed enough emphasis on developing advanced cognitive and social skills.

In this context, it is essential to promote the development of flexible, modular training programs that allow people to acquire new skills and certifications or to retrain for new occupations, without necessarily having to do so through long educational programs designed for young, recent, high-school graduates. These new programs may be online, blended, or face-to-face. An example is the "digital bootcamp" model, intensive programs that train people as software developers and for other roles within the digital industry (Cathless and Navarro, 2019).

Just as the industrial revolution led to the public financing of secondary education, our new labor environment requires a commitment to financing this new kind of flexible, modular training that allows people to engage in lifelong learning and to earn post-secondary education credentials. This is particularly important in the case of young people who dropped out of high school and now have fewer opportunities to find a good job than their parents or grandparents did.

Instead of directly funding training centers (in the traditional way), funding could be offered directly to workers or firms through the mechanisms suggested in the previous sections. Past experience with occupational training systems shows that training programs are more likely to be attuned to labor market needs when the financing mechanisms are aimed at the demand rather than the supply of training. However, in order to achieve a system that is truly relevant to the needs of people in this new world of work, it is essential to ensure the provision of quality learning that genuinely leads to improvements in

The loss of good jobs is linked to political polarization and to a loss of confidence in democracy

An interesting example of public policies is competitive public funds, which have been used successfully in developed countries such as the United Kingdom, Australia, and the United States, and are also starting to be used in some Latin American and Caribbean countries

An unemployed woman receives career advice during a jobs fair in Washington, DC. In 2010, when the photograph was taken, the unemployment rate in the US rose to 9.9 percent

people's living and working conditions. This can be done by setting up a system of quality assurance to monitor the results in terms of employability and the career paths of the training recipients, and by processing and disseminating this data so that it can inform the decisions of firms, workers, and training centers. Likewise, the government should encourage experimentation among training providers to develop the programs that best meet the needs of various target groups (young, middle-aged, older adults, people with certain disabilities, and people with a low initial educational level, to mention a few).

D. Technological Tools to Guide Workers and Support Their Transitions

Employment services have traditionally been government bodies with the role of providing information and guidance to job seekers and to people who want to improve their employment prospects. These actors are gaining relevance in an increasingly changing world where people go through more transitions in the course of their working lives and have less linear career paths (AMSPE-BID-OCDE, 2015). New technologies offer a unique opportunity to expand the range and enhance the effectiveness of employment services. Digital tools based on big data processing and visualization, together with administrative and survey data, can provide near real-time data to firms, workers, and training institutions on the skills and occupations that are most rapidly growing in demand, the occupations in decline, and the skills workers need in order to shift from a declining occupation to one that is on the rise (Amaral et al., 2018; 2019). Tools based on artificial intelligence can help people find the jobs that best fit their skills. Governments can directly integrate these tools as part of their services, or make data available and set up agreements with third parties to develop tools to guide career transitions. Other key digital tools to guide transitions include maps to help people navigate through the increasingly diverse supply of credentials (see, for example, credentialengine.org), and career advisors to provide guidance on training options (such as the Fundación Telefónica training advisor chatbot).[4]

The four lines of action described above do not cover some important issues. For

instance, given that our focus is on responses to increasing automation, we have not discussed how to improve working conditions of workers in the gig economy, even though this issue must be of central importance in strategies that seek to increase good jobs.

We have also not mentioned how to reorient educational policy to ensure the education that future citizens receive in the first stage of their lives is in line with future needs. In this sense, the educational system faces a much more complex task than the vocational training described in this paper, because it is obviously more difficult to predict the skills that will be needed in ten or fifteen years than to do so for a much shorter time frame. Given the uncertainty of how to educate the generation of children and young people who will have to repeatedly reinvent themselves throughout their working lives, the best strategy is to ensure they have a good grounding in the basic skills (mathematics, reading and writing, and sciences) as well as advanced digital, social-emotional, and cognitive skills as a foundation for lifelong learning (Mateo Diaz, 2019).

Finally, we did not touch on how to restore the balance in the bargaining power of workers in this new world of work. This is a key issue in a labor market that is increasingly dominated by large firms. Some opportunities in this field include incorporating new technologies in labor inspection and in trade union management and intervention. And we did not mention a subject that has been extensively discussed in the literature on the future of work: universal basic income (UBI). This was not an accidental omission. We believe that the mechanisms proposed here have distinct advantages over the UBI. The transfers we propose are aimed at those who are affected by automation, not at everybody, regardless of whether they need it or not, and this significantly reduces their cost. The support is offered in exchange for investment in human capital that yields productivity gains and makes it possible to cover the cost of the policies. And lastly, the proposals set out here are based on the conviction and the fact that work has an intrinsic value, in that it gives us an identity and a purpose. The institutions, policies, and technological tools outlined here actively help people to find and rediscover their place in the labor market.

Who Foots the Bill?

This new social pact for resilience and good jobs will require additional resources, which will not be easy to obtain in the context of financial restrictions. However,

To avoid a future characterized by authoritarian, protectionist governments, it is necessary to move toward an agenda that promotes good jobs. In developed countries, this means strengthening the existing social safety net to adapt it to the needs of the twenty-first century

Donald Trump speaks to a group of engineers specializing in heavy equipment at a center in Richfield, Ohio, March 2018

it can be argued that the costs of not acting will be even higher. These include the costs associated with unemployment, low productivity growth, and social protection, as well as those that could arise from increasing protectionist policies, economic and political polarization, and the decline of democracies.

Conclusion

In recent years there has been almost universal discussion and a great deal of anxiety concerning the potential effects of artificial intelligence, robots, and digital platforms in the labor market. But the fact is that we still know little about how labor markets will adjust to these new technologies. As McKinsey researcher Susan Lund is quoted as saying in an article in *The New York Times*: "The lesson is, change is evolutionary, not revolutionary."[5] We are seeing the evolution of something that has been taking place since at least the early 1980s, with the start of the widespread introduction of personal computers and other ICTs in production. And while it has not brought the dreaded effects of mass unemployment, the impacts of these new technologies have led to increasing polarization and inequality. Rather than reassuring us and making us choose to take no action, this realization should lead us to study the lessons arising from the last few decades and to act decisively.

Unlike the previous industrial revolutions, the technological change associated with information technologies, combined with other megatrends such as globalization, has created opportunities for those who are best prepared to take advantage of them, leaving the rest behind. Early studies of the impact of robotics point to the same conclusions, and there is no reason to think that the impact of artificial intelligence will not follow suit. If anything characterizes the impact of these technologies, it is their effects on the erosion of "good" jobs that allow a middle-class lifestyle, while enlarging the lower tail of the curve of bad-quality, precarious, low-income jobs. All of which has undermined citizens' trust in institutions, politicians, and democracy.

To avoid a future characterized by authoritarian, protectionist governments, it is necessary to move toward an agenda that promotes good jobs. In developed countries, this means strengthening the existing social safety net to adapt it to the needs of the twenty-first century (Furman, 2017). In developing countries, it means prioritizing the construction of that net, which is often incomplete or does not exist. And it means promoting the responsible introduction of technology at the same time. As noted in the first article in the Inter-American Development Bank's series on the future of work (Bosh et al., 2018), technology is not destiny; destiny is in our hands. Let us take on the task of creating a better future as soon as possible.

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Notes

1. See Rodrik and Sabel, 2019.
2. See https://www.weforum.org/agenda/2019/04/the-revolution-need-not-be-automated/.
3. See https://www.weforum.org/agenda/2019/05/soft-skills-are-hard-to-measure-and-in-demand-can-they-be-taught.
4. See https://credentialengine.org/ and https://planetachatbot.com/chatbot-fundacion-telefonica-orientador-e742929548d5.
5. See https://www.nytimes.com/2019/09/27/business/economy/jobs-offshoring.html?smid=nytcore-ios-share.

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KEY CHANGES IN EDUCATION FOR THE DIGITAL ECONOMY
Current Situation
Future of Education
Potential Impact
A
FUNDING
Funding for education is covered by the individual or the State government in most instances.
A1
Financial mechanisms of education will be collaboratively supported by industry, governments, and higher education institutions. Universal Basic Income and shorter work weeks may supplement this funding.
A2
More opportunities for adult learning that are work-place relevant should emerge. Quality education in primary, secondary, and tertiary bands should increase. Access will improve.
A3
B
DURATION
Education is front loaded in the first 25 years. Professional and technical training is provided to some thereafter
B1
Education is lifelong. Work-learn schemes will lengthen secondary and tertiary education. Adult training and reskilling will be constant. Badges and certifications will dominate verification of knowledge.
B2
Physical infrastructure and cyber-space for learning will increase. Norms and cultures of learning will evolve in societies and in organizations. Many more educators are needed.
B3
C
HOW WE LEARN
Content is currently discipline specific, and insufficiently global. Information transfer is the purpose of primary and secondary education. Pedagogy and assessment has little individualized adaptations. Emphasis is on what you know, not how you use it.
C1
Content is interdisciplinary and application of knowledge to real work settings and global context is emphasized. Pedagogy is individualized with aid of data and technology. Material coverage includes wellness, resilience, and sustainability in all subject areas.
C2
Recall of content and ability to transfer to new context will be the norm where quality education is available. New metrics for competencies will exist, replacing tests of rote memorization.
C3
D
KNOWN UNKNOWNS
How access to technology will change cognitive capacities is unknown. Neural implants, and other such technological advances in bioengineering, could entirely disrupt the education sector as it is currently known.

The Digital Economy and Learning

Nancy W. Gleason

Education is changing because the digital economy is shifting the skills and talents needed to lead a successful life and foster personal well-being. Talent gaps persist and are deepening around computer science and creativity. Learners need to be cognitively adaptive, and able to constantly learn new things and apply old knowledge to new contexts. Lifelong learning is the new normal. Three major shifts in education are identified: (1) changes in the funding of education; (2) changes in the duration of learning; and (3) changes in how we learn. Collaborations between industry, government, and education institutions will be the hallmark of education in the digital economy.

The digital economy is changing what we need to be able to do cognitively to lead successful lives and pursue well-being. Artificial intelligence, the Internet of Things, 3D printing, virtual reality, distributed ledger technology, biotechnology, and robotics are combining to change how we work and live.[1] Talent gaps persist and are deepening around computer science and creativity. The gig economy is changing employment and benefits structures around the globe as platforms enable people to share resources. Employment disruption is predicted to be considerable, though the pace of technological uptake, the nature of the welfare state, and the demographics of a given country will help determine the scale and duration of unemployment due to the automation of human work (OECD, 2018).[2] There will be new tasks and competencies in high demand. Higher education, in particular, will play a key role, in reskilling, upskilling, and educating the global labor force of the Fourth Industrial Revolution.

All that is technologically possible still may not be politically or economically rational or feasible.[3] This is why we are likely to see significant initial job displacement for the digital economy, regardless of what education institutions can do to upskill, reskill, and educate talent. The pace of change is such that there is likely to be considerable unemployment in the near term. Education institutors will be able to help individuals manage a transition to a new reality.

What is needed to thrive in the digital economy involves cognitive competencies matched with technological skills. The competencies are a shifting set of skills. Learners need to be adaptive, cognitively curious, and able to constantly learn new things and apply old knowledge to new contexts. The key to employability is cognitive adaptability. Employees will need to learn and unlearn constantly. Education systems need to prepare learners, both adult and youth learners: what I call, *learning resilience*. Learning resilience is about the ability to adapt with ease to new truths in your knowledge, repeatedly. It is about being accepting of your prior knowledge being rendered irrelevant under new circumstances.

The current global education landscape was designed to meet the needs of the Industrial Revolution that emerged in the 1850s with the mechanization of physical labor. There has long been a growing divide between graduate skills and employer expecta-

tions. For universities and high schools alike, there is a battle for time between soft skills and hard skills—or social-emotional competencies versus technical skills. There is resistance from academics, who see themselves as content knowledge experts who develop and verify knowledge, to teach vocational skills. Yet in countries where higher education is not subsidized by the government, the burden of debt students take on in order to be employed cannot be serviced or justified by content knowledge alone. The change is that universities are no longer the sole purveyors of information. Information is everywhere. It is what you do with information that matters. Furthermore, the jobs that are available in the digital age are shifting so quickly that technical degrees cannot guarantee preparation for the future of work. This is why learning resilience is essential.

This is not to say that education as we know it is obsolete; indeed, it is essential to inclusive economic growth. What do you want a formal education to deliver to your future employee? Many jobs require technical skills and that content has to be learned. You cannot do coding without calculus. You cannot model economic outcomes without sound econometrics skills. And you cannot conduct research in the social sciences without sound information literacy. These competencies have to be learned in order to perform the associated trade. Content is still essential. But it is insufficient. Primary, secondary, and tertiary education need to shift their focus to *how* to learn, not *what* to learn. And recruiters need to shift their metrics of talent to acknowledge soft skills, and resilience. Content knowledge is still essential, but it is what you do with that information that really matters.

Competencies are the current focus of good education, however, and the mainstream literature in this area is leading the charge. The current books coming out on what education should be in the digital economy advocate for a specific set of skills being developed by universities. Joseph Aoun, the president of Northeastern University in Boston, famously calls for creativity, entrepreneurship, and numeracy in *Robot-Proof* (Aoun, 2017). Angela Duckworth (2016) calls for grit in *Grit: The Power of Passion and Perseverance*. In one of the most important books on this issue, Erik Brynjolfsson and Andrew McAfee, in *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies* (2014), write that talent needs enhanced capacities in the areas of ideation, large-frame pattern recognition, and complex communication. And for the very high-end employee, Cynthia Solomon and Xiao Xiao have edited a 2019 volume with MIT Press, *Inventive Minds, Marvin Minsky on Education*, musing on how to develop inventive thinkers who can create. All of these publications offer important insights; however, none of them identifies the most important ingredient, though they are useful predictors and elements of leading a successful life in the digital economy and address ways in which education institutions can help get graduates there.

This has always been the approach of liberal arts Colleges. Liberal arts colleges, such as Ashoka University in India, NYU Abu Dhabi in the United Arab Emirates, Williams College in the United States, and Yale-NUS in Singapore, are developing truly global talent. They do this through small enrolment sizes per class, where undergraduates have access to the world's best researchers, and apply authentic learning with student-centered pedagogy. Real effort is made to integrate the messaging of global movements, such as the Sustainable Development Goals (SDGs), and this is made tangible through innovative curriculum and experiential learning in the field. These learning environments are designed and developed to help learners be comfortable with ambiguity, and to transfer knowledge from one context to another and apply it in new ways.

These colleges graduate a small number of students annually relative to the global labor supply. The liberal arts model is too expensive per pupil to scale up to address the anticipated hundreds of millions of people who need to be reskilled over the next decade or two. However, the liberal arts model, of interdisciplinary understandings of humanity's challenges, remains an excellent pool from which to draw on future-ready talent for the digital economy because graduates are taught to inquire, analyze, and create regardless of discipline, and to use a global outlook for addressing problems. These students are able to apply science, arts, and social science to strategic questions while developing social skills in an international setting. They have numeracy, digital literacy, and emotional intelligence. This is the thinker of the Fourth Industrial Revolution that we seek. The challenge is to scale its best attributes.

The "how" of developing these skills is expensive. There is simply not enough financial support currently being spent on education and reskilling in the public sector in most countries today. The scale of the talent gaps means industry needs to collaborate with government and higher education to implement a skill shift in the global labor population. Small classroom sizes are costly, but essential to students receiving quality feedback and access to the professor or high-school teacher. Experiential learning is well evidenced to bring students to authentic learning environments that allow them to apply content in the real world, aiding retention of material as well. This, combined with internships, enables students to get exposure to how the content of a course or major will play out in a given workplace or type of industry. The combination of these things allows a student to reach a higher order thinking that results in the ability to problem-solve and create new knowledge. Regardless of what area a student chooses to study in, they must be able to write, to communicate ideas clearly (both quantitively and qualitatively), and to understand how knowledge is created. Inside the classroom, having cutting-edge researchers who bring their work into the classroom helps students understand how knowledge is actually created. This is essential in the age of fake news, augmented imagery, big data, and algorithm bias.

Three Major Shifts in Education for the Digital Economy

The three major changes coming for education as outlined below are based upon exposure to literature, private sector reporting, and practice around the globe. It is important to highlight the governance structures, economic stability, labor relations, and the uptake of technological advances as relevant context for each country and educational institution. Three major shifts in education are identified: (1) changes in the funding of education; (2) changes in the duration of learning; and (3) changes in how we learn. The following sections will walk through each major shift for the future of education.

1. Funding Mechanisms for Education

The biggest change that will come to the future of education is more deliberate engagement between industry, government, and educational institutions for funding

learning and talent development. This was clearly called for in Klaus Schwab's *The Fourth Industrial Revolution* (2016) and continues to be championed by the World Economic Forum. There is a well-established link in the literature between economic development and education of the population. Governments need people to live, work, and earn, in order to maintain various different kinds of social contracts. Amanda K. Oleson and colleagues in a 2016 book with Harvard Education Press, *Beyond the Skills Gap: Preparing College Students for Life and Work*, advocate for employers sharing responsibility with the education sector for preparing students to work in the digital economy. If this does happen that will be an excellent change for education in the future digital economy. Industry will have to help pay to reskill and educate differently the global labor pool. This also involves paying to reskill teachers and professors too. The cost is part of the reason for the need in change of funding flows; the scale of the number of people is the other reason for the needed change. McKinsey Global Institute anticipates that nearly 1.2 billion people are currently working in automatable jobs. This is not to say that they will lose their jobs, but nearly all of them will be tasked with doing different work within their organizations in the coming decade. Yes, technology produces opportunities for financially efficient solutions, but in this case, not fast enough. Employers need to assist governments and education institutions to upskill and reskill the workforce.

Around the world, access to quality education is a challenge regardless of the digital economy. For those who do make it to and through higher education, the issue of funding is prohibitive. In the United States, the Federal Reserve claims that Americans are carrying $1.5 trillion in student loan debts in 2018. A full fee-paying student at Harvard University can expect to spend $78,000 a year in tuition, room and board, fees, and living expenses. In Europe fees are considerably lower; in Spain for example, public university fees range from €2,000–€3,500 per year, and private universities vary between €5,500–€18,000 per school year. In Argentina, higher education is free, but schools are overcrowded and quality can suffer as a result. In India, there are simply not enough seats to the order of millions of youth not having an opportunity to attend tertiary education. This is untapped talent. This is untapped economic opportunity. This is squandered well-being.

The gap between the haves and have-nots will continue to grow, especially along gendered lines, as computer access will determine potential for success in education and employability. It remains to be seen which, if any countries, will adopt some form of "universal basic income" for wealth distribution, or if most countries will go to a four- or three-day work week without pay decreases to address the growth in capital profit and corresponding decrease in human profit. Relying on philanthropy and tuition for higher education will need to change, and tax dollars alone will not be able to fund public education exclusively in welfare economies.

The final reason the funding mechanisms need to change is that lifelong learning demanded by the digital economy means that front-loading our education to the first fifteen to twenty-five years of life is no longer a sufficient model. This will be discussed in greater detail below, but it is important to note here that we will all learn throughout our lives from here on out. That change in education is now, not in the future. For adult and corporate education, it is not effective to purchase a course on critical thinking for your employees. You cannot develop resilience and creativity in a three-day training course. Learning to connect ideas and create solutions in novel ways takes time and funding to develop. A commitment to a resilient and effective workforce means providing financial support for lifelong learning from governments, industry, and education institutions. This includes funding research in the learning science as it pertains to adults particularly. It is anticipated that this field of study will be vitally important in the years and decades ahead. Indeed, funding such research could reflect corporate social responsibility.

2. Duration: Lifelong Learning, Upskilling

Education will no longer be front-loaded in the earlier years of life. Education is now a lifelong endeavor where people will have to learn, unlearn, relearn, and learn again. Lifelong learning is essential to survival and thriving in the digital economy. People can learn new facts and gain more knowledge, or they can learn how to do something through instruction of a given skill; or they can learn why something matters which can inspire creativity and drive success. Every organization needs a learning culture that

Primary, secondary, and tertiary education need to shift their focus to *how* to learn, not *what* to learn. And recruiters need to shift their metrics of talent to acknowledge soft skills and resilience

Small classroom sizes are costly, but essential to students receiving quality feedback and access to the professor or high-school teacher

Students from N High School, an online school launched in Japan in 2015 to develop the vocational skills of its students, who are all digital natives. In the photo, students in a distant city watch a video broadcast of the ceremony to mark the start of the school year at the main campus in Okinawa

is based on growing and improvement. High performing teams will be composed of those who know how to learn, and not what to learn. Cultures of growth and change need to be embedded to access in schools and in the workplace.

The pace of technological change shifts too quickly for talent development to stop at the age of twenty-five or younger. What we need to know shifts too quickly. And the millions of new jobs that will come into existence will demand technical and social skills we cannot predict at any given time. Lifelong learning is costly, which means governments and industry need to help subsidize it to keep the economy going. Executive education is likely to skyrocket in scope. Likely education institutions in the private sector that can offer badges and certifications of knowledge will be new players in the adult education sector in a way they have not been before.

Furthermore, as reported by the OECD in 2018, pay-compensated reduction in working hours may be a regulatory tool that can compensate for loss in income due to creative disruption of jobs. In this scenario, and the one of universal basic income, people will be freed up to learn new things. More hours of the week can be spent learning. This change in social structures will change how corporate education and training can work. There will be more capital to invest to make the education of adults a reality and a consistent practice.

The OECD has developed a Learning Compass as part of its Future of Education and Skills 2030 project, and seeks to guide education systems across the world to enable students to thrive in seeking well-being in the future. The Learning Compass, as shown in fig. 1, details ways of thinking rather than specific competencies and content knowledge. There are other such schematics being developed by comparable global agencies, as the world grapples with a major shift in what is needed in the workforce, today and in the future. The point is that how we prepare thinkers who can adapt to constantly changing environments is no longer front-loaded in the first twenty to twenty-five years of life, and rote memorization is entirely insufficient for a viable employee. Education centers, both private and public, will work to ensure that learners know how to think and learn, and this is key to their success and long-term well-being.

The schematic of fig. 1 is helpful in understanding how people will best learn for successful lives. In the classroom, this means education will have to better leverage technology to both access more learners and free up human educators to do what they do best. This means grading will likely be automated in the near future. Algorithms are biased, but there are patterns we can identify and correct. For humans it is much harder to correct for implicit bias. Technology can deliver lectures, curate content, and mark assessments. Educators will need to learn how to facilitate learning, rather than simply share their knowledge. Student-centered learning is essential. Classrooms and online activities should be authentic and relevant to the students' interests. Where economically and

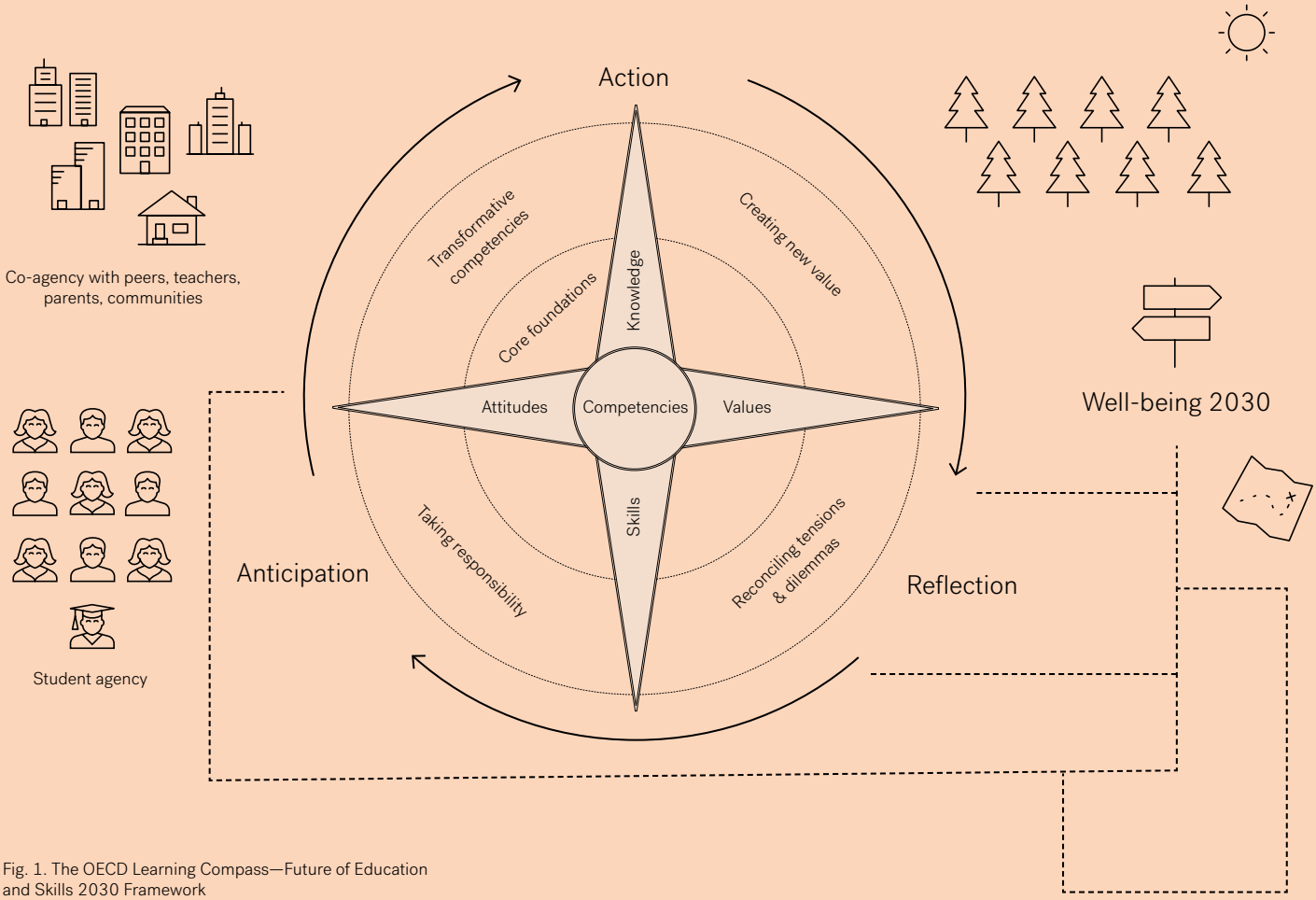

Fig. 1. The OECD Learning Compass—Future of Education and Skills 2030 Framework

The OECD Learning Compass 2030 is a learning framework that aims to help students navigate towards future well-being. It creates a common language about broad education goals

physically possible, students should be taught in small, diverse groups, regardless of age.

Workplace upskilling and reskilling of current employees will be a key feature of corporate action in this area for the medium term. This is also important in the longer term as GenZ employees seek firms who can offer valuable development opportunities relevant to the gig economy. Visa corporation is a great example of what this change should look like for larger firms. Visa University now has two physical campuses: one in Foster City, California, and one in Singapore in their Southeast Asia headquarters. They also have a massive online digital campus which is learner driven, rather than being compliance driven, as they had been before. They have also hired a chief learning officer, Kerie Willyerd, who is the co-author of *Stretch*, a book about how to develop peoples' skills in the automation economy. All of this is intended to develop a learning culture across the organization, one that is trackable with data and strategically aligned to the organization's business goals and ethics. Larger firms will all need to take such measures to keep their current employees—who are valuably aware of the corporate culture already—and develop their new ones. Visa is also making money off its talent, running Visa Business School, which offers online courses, interactive workshops, and custom training in all areas of the payments industry. They have wisely positioned themselves to be a key player in education for the digital economy within the payments industry and beyond.

3. Changes in How and What We Learn—Technology and Education

The schools with the appropriate funding are making exciting strides in education. While sitting in their classrooms, students can visit a faraway archaeological dig, or a museum, or a hospital, through virtual reality. Students can wear virtual reality goggles and be propelled into a sustainable world where environmental degradation has been reversed. Students can 3D-print a series of molecules in a chemistry class to understand the scale of the atoms relative to each other. And they can watch an algorithm-produced video of a deceased poet from centuries back read their poem aloud. Augmented and virtual reality are changing what is possible in the classroom. Access to laptops and iPads gives educators real-time data about student understanding in their classrooms. Simulations allow nurses and doctors to practice surgery without a cadaver. When technology is available, it alters the relationship between the educator and the learning. Individualized, self-directed learning for students becomes possible. Content is transferred online, outside of class, and then the in-class time can be spent reviewing and learning to apply the material. This blended learning model is likely to be the new norm, as evidence suggests this is the most effective way for people to learn.

Virtual reality (VR) is already allowing those with access to learn anywhere about everything. An example of the technology being brought to bear on this is a firm called VERE360, which develops research-based education products in virtual reality so learners do not have to travel. This approach is also useful as it breaks away from traditional adult training because it better engages the learner. The goal of this firm is to deliver products in VR that help learners understand complex issues and topics that are difficult to understand, such as the complexity of climate change, or mental health. The technology deployed by firms such as VERE360 enables the personalization of corporate and classroom learning and intends to deliver the learning in a shorter time and a more engaging manner than traditional training. VERE360—and its competitors—are working to produce global content on social issues for socially drive organizations and education institutions on less expensive hardware. Hundreds of millions of people in the global workforce need exposure to this technology in order to be competitive and thrive in the digital economy.

In the opposite direction, the Hickory Hill Nature School in Connecticut, USA,[4] is an outdoor school where children are immersed in all-weather learning, whereby there is no indoor space. The purpose is to foster a deep and personal connection to the natural world. Inquiry-based and child-led, with small class size, the pedagogy aligns with evidence-based best practice for developing creative and cognitively flexible learners who are well connected to nature and sustainability. This is the primary and secondary version of liberal arts college without the technical skills scaffolded into the curriculum *per se*. These sorts of school will likely proliferate in the digital economy as employers and parents seek to foster creativity and retreat from the numbers of learning. This type of learning will be valued in the future (currently there are only two such schools accredited in the United States) because it delivers a connection to

Industry will have to help pay to reskill and educate the global labor pool differently. This involves paying to reskill teachers and professors too

The final reason funding mechanisms need to change is that the lifelong learning demanded by the digital economy means that front-loading our education to the first fifteen to twenty-five years of life is no longer a sufficient model

nature that artificial intelligence will likely not possess, and because it is evidence-based best practice for fostering stewardship and emotional intelligence.

Assessment and grading are also being automated. When testing children, there are now ways to apply adaptive computer-based testing that allows each learner to demonstrate their academic proficiency at their own pace. Eric Mazur, Harvard's world-renowned physicist and expert teacher, has developed Perusall, a software application that grades students' reading annotations. Learning simulations will eventually be able to replace the teacher as the deliverer of content. How we certify knowledge will shift accordingly. Global talent will be able to badge itself in different ways and, hopefully, much less expensive ways.

The automation economy and the digital technologies that have brought it on will also influence changes in secondary and tertiary curricula. STEM and STEAM (Science, Technology, Engineering [Art], and Mathematics) remain very important, and produce talents that are in high demand in the workforce. However, environmental pressure mounts from the climate crisis as well. Students of the automation economy are also students (young and old) living in a time of ecological breakdown. Education institutions will need to adjust their curricula to help people grapple with the science, humanity, social impacts, and solutions. A good education will combine automation and environmental sustainability in the years and decades ahead. And an excellent education will produce resilient learners who can adapt to change effectively.

Online learning will have to be a part of the solution given the scale of the technologically displaced in the short and medium term. While Massive Open Online Courses (MOOCs) have not delivered the learning they were first purported to, the idea that learning can happen online in the absence of brick-and-mortar access to quality education is important. The number of humans who crave access to quality education is just too large to ignore the online model of free, open-access information. In the future, we will do better at leveraging this tool.

A curricular topic that will likely be added to formal and adult education is mindfulness. The stresses of constant change and better awareness of mental health means that

Students of the automation economy are also students (young and old) living in a time of ecological breakdown. Education institutions will need to adjust their curricula to help people grapple with the science, humanity, social impacts, and solutions

A march for teachers' salary increase and against budget cuts in Argentine public universities, Buenos Aires, August 2018

education about how to self-regulate and practice self-care will be a societal must. Current models of education require the fortunate to access this support in their own time and within their own financial means. Very few can do so. But sleep, mediation, and nutrition will become vital education pieces in the digital economy. Not only for our mental well-being, but also because we will be living much longer lives in the digital economy, and self-care will be paramount as a result.

Unknowns of the Future of Education

Technology also changes the learners themselves. iPhones, social media, and the culture of the Internet has changed the human attention span, for example. Most people turn off after eight seconds. But this is a change that has not involved the alteration of the human body. Wearable technology is changing how students engage in the classroom and in athletics in schools. In the future, biometrics will likely tell education administrators about individual learning as real-time health data enters into the education process. What is unknown is how cultural sensitivities to privacy will influence the use of such technologies in schools. Where the technology is available and financially supported, will administrators and parents opt to use it? It remains to be seen if employers would have the legal right to use such technology.

At the more advanced end of the technology advancement spectrum, it is possible that people will be using implantable brain-computer interface (BCI) technology, or brain implants, to enhance their knowledge base. With this outcome, education as we know it would fundamentally change. There would be substantial equity and access issues to grapple with from the start but, nonetheless, the possibility of this eventuality is real. Elon Musk's NueraLink company is working to develop implantable chips that would give the human brain artificial intelligence capacities. These people will be cyber-physical systems in their truest sense. How they are educated will depend on the neuroscience and psychological advances we can make as a society in the coming years. In addition to the access and equity issues involved, there will be significant ethical issues as a result of this new kind of intelligence and what it is *allowed* to learn.

The difference between machine probability and human creativity is real and will remain so, but how education institutions will teach people about the difference is little explored at this time. Likely, ethics training will be essential for global talent regardless of your industry or profession. There is very little, if any, preparation in the education world for this sort of technological change in how information is ascertained by humans. Nonetheless, it is an eventuality that is best placed in the long-term planning of a given organization, educational institution, and government.

These changes have fostered renewed interest in the sciences of learning all the more imperative. As MIT has reported in its report *Work of the Future, Shaping Technology and Institutions, Fall 2019 Report*, these changes require a better understanding of how adults learn. Research is currently being done to connect the science of learning to workplace adult learning in practice.[5] It remains unknown how learners of different ages and educational attainment learn best, let alone how cultural context may impact that learning. This will be an area for important research and discovery going forward.

Conclusion

The digital economy is changing what is needed in terms of education to lead a successful life with well-being. Access and quality will continue to be challenges in the digital economy, but there are new opportunities in both areas due to the changes that technological revolution brings. New collaborations between governments, education institutions, and industry will foster a new area in education that is lifelong and technologically enhanced. There are known unknowns to consider in long-term planning, most notably the potential for neural implants changing how humans interact with information cognitively. Education in the digital economy will change in its funding structures. Education and learning will change in duration, no longer being front-loaded in the first decades of life. And education will be changed by technology itself, not just in the ways we deliver information and learning, but also in what is actually learned. Environmental sustainability and well-being will need to be understood by all for a successful life of wellness in the digital economy. These are exciting times for change, but to ensure the outcomes have a net positive impact on society more concerted and deliberate effort around education needs to be pursued by all stakeholders. The costs of not doing so appear to be dire.

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Notes

1. See Gleason, 2018, "Introduction", p. 1.
2. OECD, 2018, p. 3.
3. Ibid.
4. See https://www.hickoryhillnatureschool.org.
5. See the 2019 MIT report under Autor et al., 2019, p. 39.

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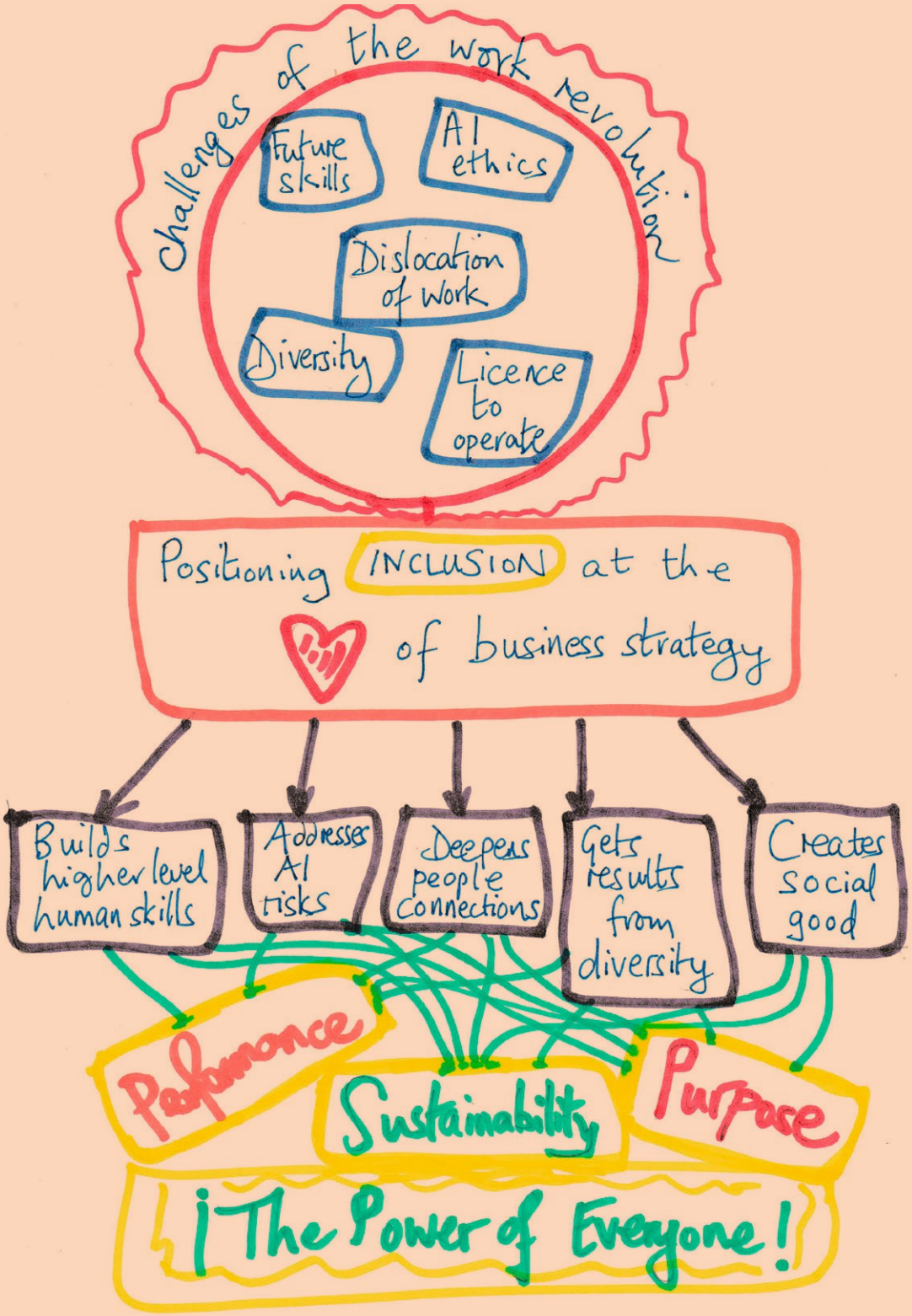

Challenges of the work revolution...
Future skills
AI ethics
Dislocation of work
Diversity
Licence to operate
Positioning INCLUSION at the
of business strategy
Builds higher level human skills
Addresses AI risks
Deepens people connections
Gets results from diversity
Creates social good
Performance
Sustainability
Purpose
¡The Power of Everyone!

The Power of Everyone: Why the Work Revolution Demands a Fresh Focus on Inclusion

Alison Maitland

Most companies say they want an inclusive culture that values difference, but many struggle to achieve this. The work revolution presents new reasons to prioritize the pursuit of environments that work for all. Inclusion not only enables the broadest range of diverse ideas, talents, and experiences to find breakthrough solutions; it is also a key to addressing future skills, the ethical use of AI, the dislocation of work, heightened scrutiny of companies, and social good. With illustrative examples, the chapter also describes a comprehensive new approach for organizations to build inclusion internally and externally, to achieve better results for business and society.

The combination of digital disruption and environmental, political, and social upheaval is posing huge challenges for our world and our workplaces.

Under constant pressure to adapt to a fast-shifting landscape, no single company or business leader can address these challenges alone. Partnerships and collaboration across conventional boundaries are essential to access the widest possible range of perspectives and talents and find breakthrough solutions.

How can organizations ensure this collaboration happens across today's diverse workforce? How can they count on people to contribute their unique skills and ideas willingly? How can they harness the "power of everyone" to meet the challenges ahead?

The well-documented benefits of diversity—for innovation, performance, and growth—cannot be achieved if work environments do not truly welcome and value it. Most organizations now recognize this, with over 70% of companies aspiring to have an inclusive culture that values difference, according to Deloitte.[1]

Yet it is apparent from news headlines that many companies still struggle to achieve basic equality and diversity goals, such as equal pay or gender-balanced leadership. Inclusion remains elusive, with research by The Conference Board finding that most companies are uncertain how to measure it.[2] Without proper metrics, organizations cannot evaluate whether they are doing well or badly, or what they need to change.

Even recognized leaders in the field acknowledge that bold new approaches are needed. "Diversity without inclusion is a promise unfulfilled," says Rohini Anand, head of corporate responsibility and global chief diversity officer at Sodexo, an international services company with 460,000 employees and a strong reputation for equality and inclusion. "There need to be more sophisticated ways to measure belonging, inclusion, and the impact on business outcomes. We need to use different strategies to have an impact, make a difference, and make this work more sustainable."

Five New Reasons to Focus on Inclusion

To make inclusion a business priority, organizations have to understand why it can

help them achieve their goals. It often takes a crisis—or the threat of one—to precipitate change. The work revolution, with its huge risks and opportunities, presents new reasons to invest time and energy in designing work environments that work for all.

The importance of inclusion has never been greater. Here are five reasons to pay attention to:

1. Future skills
The rise of smart machines threatens to replace many tasks done by humans, while holding out the prospect of new opportunities. As well as being digitally savvy, people will need strong interpersonal and cognitive skills to thrive alongside intelligent machines. Developing inclusive behavior in leaders, middle managers, and individual employees is a powerful way to spread these higher-level human skills across the workforce.

2. Ethics in artificial intelligence (AI)
AI brings risks as well as opportunities. Research and experience have demonstrated that it can reinforce discrimination and exclusion, unless there is deliberate intervention to avoid this. Inclusive processes must be built into how AI is developed and used, to prevent it going badly wrong. With careful forethought, and inclusive management of diverse design teams, AI can help humans to eliminate bias.

3. The dislocation of work
Digital communications enable many people to work anywhere, any time, without the need for a physical workplace community. While this is liberating for those with sought-after skills, it risks leaving others isolated and rootless. The "on-demand" workforce, on whom companies increasingly rely, covers a wide spectrum from prosperous free agents to cash-strapped workers juggling several jobs to make a living. Extending inclusive policies and practices to this increasingly fluid workforce, and creating a sense of community and purpose, is a way to cultivate trust, loyalty, and responsiveness.

4. Heightened scrutiny
The diversity of the workforce is a reality, yet discrimination and inequality persist. Social media have encouraged and amplified messages of hate, and at the same time enabled campaigns such as #MeToo and #TimesUp to challenge harassment and other excluding behavior. This new level of transparency has increased pressure on companies—from investors, regulators, customers, and employees—to report on what they are doing to counter discrimination and promote inclusion, in the physical workplace and online.

5. Social good
The disruption caused by the work revolution demands system-wide solutions. Chief among these are economic and social responses to inequality and joblessness, such as the idea of a "universal basic income" to protect the most vulnerable and enable societies to keep functioning. Alongside such responses, or in the absence of them, organizations have an important role to play in bridging divides and fostering inclusion, both inside and beyond their boundaries. There is a strong business case for doing so, to increase reputation, talent attraction, and brand loyalty.

Let us look at each of these in more detail.

Future Skills

Inclusive behavior requires deliberate intent and continuous practice—to seek out different perspectives that challenge the "norm," to take account of different thinking and working preferences, to ensure that conflict is constructive rather than destructive, and to collaborate across differences to create innovative solutions for the widest mix of end-users.

In its *Future of Jobs Report 2018*, the World Economic Forum said that more than half of all employees would need to learn new skills or significantly increase their existing skills over the next four years. It highlighted the importance of developing the soft skills that enable people to "leverage their uniquely human capabilities" in a world of smart machines.[3] These skills include active learning, emotional intelligence, leadership and social influence, negotiation, flexibility, and complex problem-solving.

Some companies are already investing in developing inclusive leadership behavior, such as emotional intelligence and social influence, at the senior executive level. This is important. But middle managers and the wider workforce need to develop these skills too.

In a 2019 LinkedIn survey of human resources professionals, more than 90% said that soft skills mattered as much as, or more than, hard skills when they are hiring. Moreover, 80% said these soft skills were increasingly important to company success.[4]

The survey of 5,000 talent specialists around the world highlighted three other big requirements for employers, in addition to developing soft skills:

- enabling work flexibility;
- preventing harassment;
- creating pay transparency.

Together, these four requirements reinforce the importance of ensuring that work environments are "open to all." Exclusion costs companies money, through loss of talent, reduced motivation, wasted energy, and, ultimately, litigation, as well as external costs such as lost customers. Conversely, research shows that inclusive groups, in which everyone is able to contribute, and in which people pay attention to each other's views, outperform those with lower "social intelligence."[5]

Acknowledging the costs of exclusion, and recognizing the business benefits of inclusion, is a helpful first step to harnessing the power of everyone.

Ethics in Artificial Intelligence (AI)

Artificial intelligence relies on large sets of data to detect patterns and make predictions. The data reflect human history, with all its inherent biases. Without careful thought and intentional action to avoid this, AI risks reinforcing or even worsening exclusion.

One example of what could go wrong, reported by Reuters, was an experimental recruiting tool that Amazon decided to scrap when it was found to discriminate against women. The hiring engine was rejecting women for technical posts because it was programmed to vet people based on patterns and words in the CVs of previous successful candidates, who were mostly men.[6]

Some companies are counting on machine learning to speed up their searches for candidates and determine who is "the best fit." But there is a danger that teaching machines to search for certain traits, such as the speech patterns and body language of top performers, will lead to hiring the same type of people over and over. This in turn increases the risk of "groupthink"—when the desire of a group to conform leads to poor decisions.

Women, as well as some minority ethnic groups, are poorly represented in the technology profession, and this lack of diversity has implications for how products are developed and used, as the AI Now Institute at New York University points out. It has called on the tech sector to hire experts from fields such as law, medicine, education, ethics, and social science to better understand structural biases in society and workplaces.

In a recent research paper, it says: "Systems that use physical appearance as a proxy for character or interior states are deeply suspect, including AI tools that claim to detect sexuality from headshots, predict 'criminality' based on facial features, or assess worker competence via 'micro-expressions.'"[7]

Companies introducing AI to assist decisions about people have a responsibility to ensure that it eliminates bias, rather than reinforcing it. A robust inclusion strategy ensures rigorous testing and monitoring of AI systems against unintended consequences in hiring, promotion, and how projects are assigned—as well as seeking out AI tools designed to detect and minimize bias.

The Dislocation of Work

When Google ran a project codenamed "Aristotle" to discover what makes teams effective, it identified the following dynamics: team members feeling safe enough to take risks and show vulnerability, being dependable, having clear roles and goals, and having a sense of purpose and impact.[8]

How can we cultivate these dynamics in the new world of work? While connecting us more closely online, the digital revolution is also dislocating working life. Virtual teams working across cultures and time zones may rarely, if ever, meet face to face. Businesses contract out piecemeal tasks to the "human cloud"—millions of individual freelancers around the world—via online work platforms. The benefits of flexibility in the tech-enabled gig economy can be offset by the lack of a workplace community, the absence of career development, and the precarious nature of many jobs.

A one-size-fits-all approach is no longer appropriate for today's workforce, if it ever was. To attract, motivate, and keep the workers they need, employers must develop a more holistic approach: respecting each person's whole identity, and their distinct skills and work styles, while at the same time building supportive communities that respond to the human desire for belonging and purpose.

A comprehensive inclusion strategy will take account of the army of independent workers on whose services companies rely. Some may be well-paid consultants, while others may be struggling to get by as couriers or cleaners. These independent workers may also be the company's customers, or potential future employees.

The most innovative businesses are better at encouraging input from a wide range of external collaborators, as well as communicating the strategic importance of inclusion and holding employees accountable for helping to create the right kind of work environment, according to a study on diversity and inclusion and innovation by Rebekah Steele and Marjorie Derven.[9]

What opportunities is a company therefore missing by failing to extend its benefits, or failing to communicate fairly, to its growing external workforce? Could some of these independent workers be the ones to fill its future skills gaps? Could they have the ideas the company needs to break through to the next level of innovation?

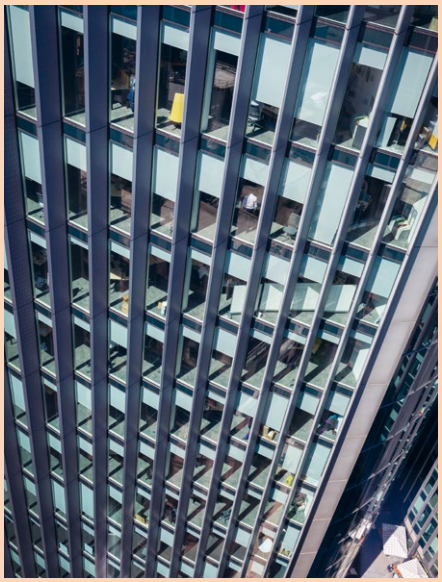
Heightened Scrutiny

For a long time, it was easy for companies to brush aside issues such as the gender pay gap, poor training opportunities for older workers, or racial and sexual harassment at work. Online transparency and viral campaigns have hastened change. Pictures of all-white, all-male conference panels or management teams, for example, now risk instant condemnation or derision.

Transparency has empowered campaigners. Regulators and institutional investors are also stepping up demands on companies to

In its *Future of Jobs Report 2018*, the World Economic Forum highlighted the importance of developing the soft skills that enable people to "leverage their uniquely human capabilities" in a world of smart machines

Exclusion costs companies money, through loss of talent, reduced motivation, wasted energy, and, ultimately, litigation, as well as external costs such as lost customers



Office building in the heart of the financial district of the City of London

Companies that count on machine learning to speed up their searches for candidates and determine who is "the best fit" risk teaching machines to search for certain traits, which can lead to hiring the same type of people over and over

The workers of the future are eager for business leaders to be proactive in contributing to social goals, says Deloitte

demonstrate they have diverse boards, senior executive teams, and pipelines, and that their hiring, promotion, and pay practices are fair and transparent. Organizations are under growing pressure to spell out in public what they are doing on inclusion.

There is a positive reason for businesses to embrace this transparency, as it leads to better decision-making and outcomes. Monitoring who is involved in decision-making processes can help avoid groupthink and improve business performance.

Cloverpop, a San Francisco-based enterprise decision platform, explains how it discovered and rectified flaws that left women out of almost half its decisions. The company says it was shocked when it looked at its own processes because it had expected to be "amazing" at inclusive decision-making.

"Instead, we found that only 56% of our decisions included women. In other words, we were decision software experts and below average decision-makers," it says in a paper called "Hacking Diversity with Inclusive Decision Making."[10]

Auditing its decisions revealed a number of reasons why women were left out, including that the CEO had omitted the CFO from some financial decisions because her husband was ill, and the company had no senior female engineers, which meant many technical decisions were made by a group of men. "But the biggest reason was that we were overconfident and unaware of the problem," it says.

Hiring more women engineers, and carefully tracking decisions to ensure a diverse range of people was involved, made a difference within six months. The company says the increased inclusiveness of its decision-making led to higher revenues and productivity, faster innovation, and better understanding of the market.

Social Good

Organizations are part of society, and their fortunes are bound up with the health of those societies. Amid the disruption created by technology, the climate emergency, and geopolitical upheaval, they have a responsibility as well as a vested interest to find new ways to bridge divides, address gaping inequities, and tackle intolerance.

This responsibility lies heavily with large companies, which wield enormous power and influence, for good or ill.

The biggest global companies accrue far greater revenues than the governments of most countries, according to figures compiled by Global Justice Now, a social justice organization. Comparing 2017 revenues, it found that sixty-nine of the top 100 economic entities were corporations, not governments. The top ten companies by revenue included Walmart, State Grid, Sinopec, China National Petroleum, Royal Dutch Shell, and Toyota, each of whose revenues exceeded those of Russia, Belgium, India, and Switzerland.[11]

Multinational groups also dominate world trade, with the top 1% of exporting firms in each country accounting on average for more than half the country's exports, according to the United Nations.[12] Not surprisingly, big companies face increasing scrutiny, as shown by the record $5-billion fine that Facebook agreed with the US Federal Trade Commission in mid-2019 to settle data privacy violations.[13]

As it happens, there is currently a big opportunity for responsible companies that want to build trust and enhance their "social license to operate." Disruptive times have diminished people's faith that the system will work in their interests, and more people are turning to their employers to take a lead action on social and environmental issues. According to the widely watched Edelman Trust Barometer, 58% of employees now look to their employer—a relationship they see as within their control—to be a trustworthy source of information on contentious issues.

Moreover, 67% of employees expect prospective employers to join them in taking action on social issues, and 71% say it is critically important that their CEO responds to challenging times, says Edelman in its 2019 report. Over three-quarters of the general population want CEOs to take the lead on change, rather than waiting for governments to act.

Meeting these expectations offers sustained benefits to businesses. Employees who trust their organization are far more likely to advocate for it, and are more engaged, loyal, and committed than those who are more skeptical about their employer, says Edelman.

Other surveys point to similar benefits. The workers of the future are eager for busi-

ness leaders to be proactive in contributing to social goals, says Deloitte.[14]

Young people want leaders to commit to making a tangible impact on the world, while also providing them with the skills to adapt to the latest wave of technological change. They feel greater loyalty to companies that encourage open communication, ideas from all employees, mutual support and tolerance, and a strong sense of purpose beyond financial success, according to another Deloitte study.[15]

These are all ingredients of an inclusive work environment.

Inclusion Has No Borders

How can businesses seize this opportunity? One way is to use their voice to advance inclusion in society, just as some leading companies promote environmental sustainability. They can also hire or procure supplies from under-represented communities, develop products for under-served markets, support NGOs that are tackling exclusion, and promote dialog with shareholders on increasing returns on investment in inclusion.

These initiatives make a direct link between inclusion and diversity on the one hand, and corporate responsibility and sustainability on the other. This is fertile territory to explore for organizations that are genuinely ambitious about inclusion.

One example is a group of companies that are taking action on the global refugee crisis, seeing it as an opportunity to reap business benefits while doing good. Starbucks is one such company, having committed to hiring 10,000 refugees worldwide over five years. In the UK, it linked up with a leading charity, the Refugee Council, to offer refugees training in preparation for barista roles in its London coffee shops. Other companies to have pledged jobs for refugees around the world include Hissho Sushi, US yogurt maker Chobani, and global services provider Sodexo.[16]

Thousands of refugees fleeing violence and persecution have headed for Brazil in recent years, from countries like Syria, Cuba, Haiti, and Venezuela. Four years ago, Sodexo

Pictures of all-white, all-male conference panels or management teams, for example, now risk instant condemnation or derision

Demonstrators at the Women's March on Washington hold up a photograph of the project *Inside Out* by French artist JR. The March was held on 21 January, 2017, the day after the inauguration of President Donald Trump, in response to sexist comments made by the new president. It was described by the media as the largest protest since the Vietnam War

Teams that are made up of a broad mix of people have the potential to make better decisions and be more innovative than teams in which everyone is similar

In Brazil, Sodexo reports heightened morale and engagement in teams that have welcomed refugees. At the same time, refugees are often highly skilled, and able to transfer skills such as languages to other employees

An employee of the largest networking Web site for professionals walks out of one of the offices at LinkedIn Corp. headquarters in Mountain View, California

committed to hiring at least three refugees a month, building up the numbers over time. It worked with refugee resettlement agencies and produced practical guides for refugees and potential employers.

It also prepared "hearts and minds" among existing employees before the refugees arrived at work, explaining who was coming and what a refugee is, and reminding employees of the company's commitment to inclusion.[17]

This attention to the work environment is crucial. Teams that are made up of a broad mix of people have the potential to make better decisions and be more innovative than teams in which everyone is similar. But they can also experience higher rates of friction and turnover. Research shows that managers who develop inclusive, high-quality relationships with all members of the team can significantly cut employee churn by reducing misunderstandings and unhealthy conflicts.[18] This saves hiring costs and supports diverse teams to achieve their potential to outperform.

There are other business benefits. Sodexo points to research showing that companies known to support refugees enjoy increased reputation, sales, and recruitment. In Brazil, it reports heightened morale and engagement in teams that have welcomed refugees. Refugees are often highly skilled, and able to transfer skills such as languages to other employees.

Sodexo has committed to hiring refugees in Sweden, the US, Canada, France, Germany, and Italy, says Rohini Anand. "We have an incredible opportunity to increase diversity in the workplace, and to address talent gaps while doing so. There's evidence that refugees have higher retention rates. With our talent gaps, we'd like to do more with this population. The business outcome is our main driver."

A Comprehensive Approach to Inclusion at Work

What is the starting point for organizations that want to build an ambitious inclusion strategy? One is to recognize that there is a challenge to address, and that addressing it probably requires the willingness to change, right at the top.

In a courageous article on LinkedIn, Michael Litt, cofounder and CEO of Canadian software company Vidyard, wrote about his desire to change the "brogrammer" culture in the company—a reference to the stereotypically masculine world of programmers. He said redressing the low representation of women in his executive team would require a serious self-reckoning.

"Looking back, we built Vidyard to tackle a customer problem with an engineering solution," he wrote. "We did that by writing code and finding highly skilled people to help us fulfill our mission. These people, more often than not, were men. In hindsight, it's no surprise that we ended up falling into the same 'brogrammer' patterns as so much of Silicon Valley."

Describing the lessons his company had learned so far from its efforts to change, he said: "If every company is now a tech company, it's due time we truly figured out how to make tech a more inclusive space."[19]

Feeling the desire to change is a first step, but is not enough on its own. Cultivating inclusion at work frequently requires people to start acting differently, which can be uncomfortable or inconvenient. To make it easier to maintain this new behavior, organizations also have to create supportive signals and processes.

Too often, conventional approaches to diversity and inclusion lack these crucial structures and signposts to reinforce change. They take a narrow view that constrains their ability to achieve a lasting impact on the well-being of businesses, employees, and other stakeholders.

In response to these limitations and to companies' frustration at the lack of progress, D&I strategist Rebekah Steele and I have extensively researched and designed a comprehensive approach that we call Inclusion IMPACT®.

Our method starts with asking organizations how inclusion can help achieve their business goals and desired impact. It involves comprehensive assessment of the current work environment to determine where change is needed.

It takes account of everyone—leaders, middle managers, individuals, and external stakeholders. Designing an inclusive work environment with everyone's needs in mind, and with everyone's participation, ensures that the broadest mix of people will benefit. We advocate taking account of people's whole identities, rather than categorizing them by a single part of who they are, such as their gender, age, cultural

To envisage a more inclusive future, we cannot rely on our brains alone. Inclusion has to be lived and breathed. My experience is that part of the answer, at least, lies in messages and actions that connect us to our common humanity

origin, or sexual orientation.

To help organizations better understand the broad reach and impact of inclusion, we break this broad concept down into ten key ingredients—including trust, transparency, participation, shared purpose, and shared power—which must all be present.

Our approach addresses not only people's perceptions of inclusion, and their actual behavior and actions, but also the whole organizational system. As well as creating new structures to support inclusion, we recommend that companies review existing processes that may hold up progress. Standard HR systems may, for example, hamper efforts to tailor roles to individuals, thereby excluding talented people who want to work differently and slowing a company's adaptation to the diverse world of work. Contracts and performance metrics may be based on hours rather than agreed outcomes, preventing people from adopting alternative working patterns that are more productive.

There are often hidden organizational biases and assumptions, too, such as the still pervasive belief in some industries that people must work long hours to demonstrate commitment and ambition. Assumptions like these can block people's career advancement unless they are exposed and addressed head-on.

While everyone is responsible for inclusion, our approach recognizes that leaders have additional responsibility. They must behave as role models of inclusion, and hold others accountable for doing the same. They must also ensure that the organization's formal and informal processes promote inclusion.

Without transparent processes and clear signals, our experience is that people who are different from "the norm" are easily left out or overlooked, even if that is not the conscious intention. Without comprehensive structures in place, sustaining an environment that works for all will be difficult, if not impossible.

Case Study: How Virtual Reality Can Help Change Behavior

Behavioral change takes time, and can be bumpy. Leaders with power and privilege may think they represent the norm and see those who are different as somehow falling short of that norm. They may be blind to how their behavior disempowers others.

Some organizations are using Virtual Reality (VR) as a way to learn inclusive skills fast through users experiencing what it is like to be someone different, or to be on the receiving end of excluding behavior.

At PwC's London headquarters, I experienced a VR scenario the firm developed for a financial services client that wanted to address low engagement, high staff turnover, and poor performance in one of its divisions. First, I sat in the seat of a woman middle manager in a tense meeting with her bullying male boss. Then I experienced being her junior male colleague as she channeled her stress and frustration into belittling him. I felt anger and disbelief at the male boss who ignored everything that "I" (the woman) said, and spent most of the meeting on his smartphone. I felt dismay as the behavior then cascaded down to "me" (her direct report). I wanted to escape this toxic environment—as did the junior employee. In the VR scenario, he leaves for a better job at a competitor company, triggering a serious inquest at the management committee meeting into staff turnover and missed targets in the bullying boss's department.

What was the reaction to the VR experience at the client company? Raw emotion, initial denial, and shock that this was how staff perceived leaders.

"If you can make people feel deeply uncomfortable through VR and give them an emotional response, there are lots of ways you can use this for inclusion," says Brenda Trenowden, a partner in PwC UK's people consulting practice and Global Co-Chair of the 30% Club, which campaigns for more women on boards. "This is about up-skilling people. If you're not a forward-thinking manager, it's going to be much harder for you to manage the workforce of the future."

Messages That Move Us

Harnessing the power of everyone needs everyone to be on board for change. Inclusion impacts everyone to a greater or lesser extent, and it is everyone's responsibility. To make that happen, people need to see what is in it for them—and that may be different for leaders, middle managers, and individual workers. Communications must cater for these different constituents. For

some, it may be the business advantage, or enhanced reputation with competitors, that matters, while for others it may be the sense that they are helping to make the world a better place.

To envisage a more inclusive future, we cannot rely on our brains alone. Inclusion has to be lived and breathed. What does it feel like? What moves us to trust people who are very different from us, to experience compassion and connection with them? What motivates us to share ideas, to listen, and to combine our perspectives to achieve outcomes that will probably amaze us?

My experience is that part of the answer, at least, lies in messages and actions that connect us to our common humanity. "All That We Share" is a short video made by TV2, a Danish government-owned television channel, which went viral in 2017. You can watch it here.[20] The film, which promotes inclusive programming in divisive times, is itself one of the most shared advertisements ever. Justin Trudeau, Ellen DeGeneres, and Richard Branson are among the influencers who sent it to their followers.

The ad's simple but powerful message is this: we put other people in boxes, based on our kneejerk reactions. Are they like us or not? Are they friendly or threatening? Are they powerful or pitiable? We make rapid assumptions that may be completely wrong. When we are willing to meet the whole person behind our caricature of them, we find we have more in common than we think.

The story of "All That We Share" demonstrates how companies can achieve their business goals and benefit from a big boost to their brand and reputation by embracing the power of everyone. According to the creators, media coverage of the advert around the world generated PR worth about $100 million for TV2. Within a few months of release, over two-thirds of Danes were familiar with the station's message. Viewers translated it into more than thirty languages. Each time people in another region of the world began sharing the film, this revived attention in Denmark.[21]

The marketing narrative was experimental and bold. But what is crucial here is that it was not just a "nice to do." It arose directly out of a new strategy of inclusive programming and was a test of whether that strategy would succeed with viewers. TV2 connected its purpose—to be a channel for everyone—with its strategy and its advertising output. And the results were staggering.

Building Coalitions for Faster Progress

Given the scale of the challenges that organizations face, they are likely to make faster progress through collaboration. This is also a powerful way to demonstrate collective leadership. Coalitions for change make it easier for companies to hold themselves and each other to account.

Here is an example from the technology sector, the industry that is shaping and influencing the future of work more than any other. For all its promise, the industry risks being held back, and making mistakes, because of the lack of diversity that I have highlighted in its leadership and workforce. For example, women make up only 26% of the computing workforce, and hold only 5% of leadership roles in the technology industry.

In early 2019, a coalition of tech CEOs wrote an open letter to every leader in the tech sector, published in the *Financial Times*, calling on men to take responsibility for accelerating gender equality.[22]

The Male Champions of Change Global Technology Group advocates a strategy of systemic change, identifying ten areas for action, both inside and beyond their companies. These include workforce solutions such as closing the gender pay gap and making all roles flexible, as well as societal interventions such as tackling everyday sexism and taking action on domestic violence.

There is a clear business case for the sector to attract talent from a wider pool, increase innovation through diverse perspectives, and better serve its customers. But the group recognizes that tech leaders can only make change by touching hearts as well as heads. They committed to "listen, learn, and lead through action," which requires openness and vulnerability. And they demonstrated a wider social purpose by their willingness to contribute to gender equality across society as a whole.

Others are also beginning to forge links between inclusion, on the one hand, and social and environmental sustainability, on the other. B Corp is a community of nearly 3,000 companies in sixty-four countries that are committed to balancing "purpose and profit" and using business as a force for good. Their focus is on sustainability. In a recent blog, Ryan Honeyman, author of *The B Corp Handbook*, said B Corp companies now had to get serious about diversity, equality, and inclusion (DEI). "Siloing DEI into something separate is one of the main barriers facing our movement to create a more equitable society," he wrote.[23]

Combining these two—inclusion and sustainability—as central pillars of business strategy is likely to be a defining principle of responsible companies in the future.

In Conclusion

Organizations that place inclusion at the heart of business strategy are developing the skills their people need to thrive in the new world of work. They are forging stronger links with employees and with the growing independent workforce, as well as with customers, investors, suppliers, regulators, and other external stakeholders. They are making a smart choice to enhance business performance and growth.

They are also better placed to make interventions to bridge divides, enhance human connectedness, counter exclusion, and draw on collective wisdom in pursuit of innovative solutions to our most pressing challenges.

For businesses, harnessing "the power of everyone" builds trust and reputation and promotes sustainable results. For societies, whose health and prosperity are threatened by inequality and division, the prize is even greater.

Alison Maitland is an international writer, speaker, adviser, and coach. Her key areas of expertise are: the changing world of work; building inclusive organizations; new models of leadership; and the importance of gender balance in business. She is a former long-serving *Financial Times* journalist, and is coauthor of the books *Future Work* and *Why Women Mean Business*. Alison is a Senior Visiting Fellow at Cass Business School, London, and chairs the Executive Board of the Cass Global Women's Leadership Programme. She is Vice-Chair of the International Women's Forum UK and a Senior Fellow in Human Capital with The Conference Board. She wrote a chapter on gender in the BBVA OpenMind book *Reinventing the Company in the Digital Age* (2015). A coach to clients who want to make positive change in their lives and the world, Alison is trained in Co-active® coaching and Conversational Intelligence®, and is a member of the International Coach Federation.
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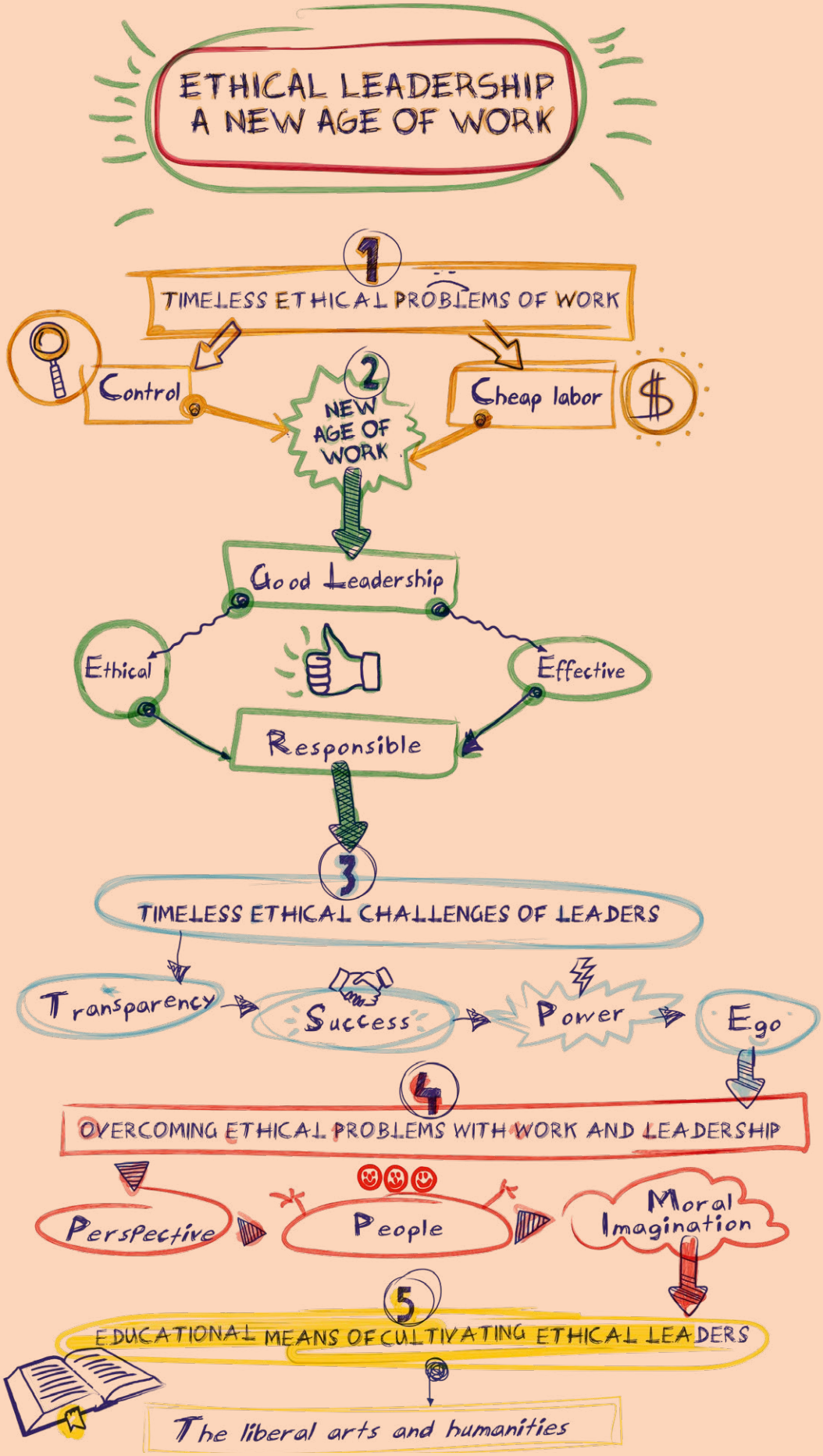
ETHICAL LEADERSHIP
A NEW AGE OF WORK
1
TIMELESS ETHICAL PROBLEMS OF WORK
Control
2
NEW AGE OF WORK
Cheap labor
$
Good Leadership
Ethical
Effective
Responsible
3
TIMELESS ETHICAL CHALLENGES OF LEADERS
Transparency
Success
Power
Ego
4
OVERCOMING ETHICAL PROBLEMS WITH WORK AND LEADERSHIP
Perspective
People
Moral Imagination
5
EDUCATIONAL MEANS OF CULTIVATING ETHICAL LEADERS
The liberal arts and humanities

Ethical Leadership in a New Age of Work

Joanne B. Ciulla

This chapter looks at the past as a means for understanding the future. While new technologies change the context of work, they do not always change the ethics of leaders who make decisions about business and what transpires in the workplace. By focusing on the ethical challenges of leadership that must be overcome to develop ethical leaders, it argues that a new age of work requires a new age in which leaders really are ethical and effective. The chapter begins by examining some of the recurring ethical problems with work. It then explores the ethical challenges of being a leader and concludes with a discussion of three essential qualities for ethical leadership.

What would it take to create a new age of work? For some, the first thing that comes to mind are machines—robots and computers that would serve our every need. We might imagine all sorts of wonderous inventions that make work easy and efficient. Moreover, we could also envision machines, like self-driving cars, which make life and death decisions for us. All devices and computer programs require a human touch, even if it is only from the fingers that create an algorithm. As artificial intelligence matures, the distance between the human touch and the activities of machines increases. Nonetheless, all work, like technology, requires someone to make final decisions, initiate processes, and organize people, and ponder what, why, and how things should be done. Herein lies the problem: technology changes but human nature stubbornly remains the same. We can still have leaders with medieval personalities and dispositions running workplaces in a high-tech future. While the context of work and society may be different, the basic ethical and unethical behavior of leaders is often no different than it was in the past.

To comprehend the complexities of ethical leadership yesterday, today, or in the future, we must examine the relationship between leadership as a social construction, based on contextual factors such as history, culture, values, ethical norms, technology, and so on, and human nature. "Are leaders born or made?" is a fundamental question in leadership studies. In other words, do exceptional people step on to the stage of history and reshape it, or does history set the stage for someone to enter from behind the curtain and play the role of a leader? Like all such questions, the answer is usually a bit of both. Who becomes a leader, how they lead, and how others follow, is embedded in personality traits and shaped by the context in which a person lives and works. The new age of work may show progress in science and technology; however, will that progress extend to us as human beings? Are leaders and followers better today than in the past? In the Western world, the bright, promising eras of the Enlightenment and modernity have given way to a darker, post-modern world. Today, truth is a contested terrain and growing social and economic inequality and environmental destruction compel some people to long for the past rather than embrace the future. Not all people believe that a new age of work will be better than

the old one. For some, the new age of work only looks like unemployment.

This chapter looks at the past as a means for understanding the future. While new technologies change the context of work, they do not always change the ethics of leaders who make decisions about business and what transpires in the workplace. By focusing on the ethical challenges of leadership that must be overcome to develop ethical leaders, it argues that a new age of work requires a new age where leaders really are ethical and effective. The chapter begins by examining some of the recurring ethical problems with work. It then explores the ethical challenges of being a leader and concludes with a discussion of three essential qualities for ethical leadership.

The Ethical Problems of Control, Technology, and Economics

History tells us that new technologies in the workplace do not always live up to the hope of making work better for people. For example, Aristotle wistfully speculated about the potential of technology to eliminate the need for slaves and servants. He argued that we use everything we own, including tools or instruments, to maintain our lives. Slaves, he said, are the living instruments that people possess to work with material instruments. In other words, they are the instruments that use the instruments. That is why Aristotle and other ancient writers referred to salves as *instrumentum vocale*, or talking tools. Aristotle speculated on what would happen if instruments did not need people to run them:

> Suppose that every tool we had could perform its own work, obeying or anticipating the will of others... if the shuttle would weave and the plectrum touch the lyre, the chief workman would not want servants nor masters slaves.[1]

While Aristotle was thrilled with the idea that people would not have to work, today we worry about the workers who are displaced by technology and wonder if work will become so scarce that there will not be enough jobs for those who want and need them. However, Aristotle's comment raises a host of curious questions about the "chief workman" and "masters"—or the leaders of the workplace. Technologies, from computers to robots, to driverless cars, to public safety cameras, reduce or eliminate the need for workers; however, do they eradicate the desire of people in positions of power and authority to want servants or slaves? Talking about slavery may seem like a rather dramatic way to ask a broader question about the inclination that some people in leadership roles have to control others—whether it is control over their work, their buying habits, or their privacy.

From slavery to the Industrial Revolution, making a profit rested on the assumption that one had to get the most labor out of workers for the least amount of money. One aspect of this was having control over employees, which usually meant control over productivity. There has always been a struggle for control in the workplace. In the eighteenth century, Jean-Jacques Rousseau observed that the human race fell from a golden age when they learned they could gain an advantage from the work of others.[2] Often the greater the control over workers, the greater the advantage in terms of things like productivity, quality control, and labor costs.

Slavery was the most extreme example of this advantage. In the nineteenth century, a North Carolina judge named Thomas Ruffin wrote that the end of slavery is the profit of the master. He said: "The power of the master must be absolute, to render the submission of the slave perfect."[3] At the time, some Southern slaveholders in the US maintained that their slaves were better off than the men, women, and children who worked in the Northern factories on the machines that were part of what was then a new age of work called the Industrial Revolution. As historian Eugene Genovese argues, while slaves did not get paid and were not free to leave their masters, their work did not require the tight oversight on the job that the Northern industrialist needed to have over workers to extract maximum profits.[4] Friedrich Engels made a similar point about British industrial workers.[5] These arguments are not meant to downplay the horrors of slavery but to illustrate the significance of control of production in the workplace. Today, new technologies allow employers to see, hear, and monitor what employees do at work and, if they want, at home. One might say that from the *instrumentum vocale* to the "hands" of the Industrial Revolution, what many employers have always really wanted were robots.

I raise the question of control because it encapsulates many of the ethical challenges for leaders in the workplace. Control over workers, the cost of workers, and the quality of working conditions are about employers' respect for human rights and the dignity and autonomy of employees. The desire of employers to keep labor costs low raises questions about fair wages and what constitutes a living wage. All of these things are elements of the moral conditions of work.[6] My point here is that if we really want to usher in a new age of work, the most radical change will require a different kind of leader who is capable of avoiding the worst instincts that come from both holding power over others and the pressures of having to make unlimited profits. I believe that developing leaders who are capable of taking on the ethical challenges of leadership is as important and perhaps more difficult in a new age of work than some of the most sophisticated technologies on the horizon. Before I get to what ethical leadership might look like, I turn now to some of the personal and social elements that have always made it difficult for leaders to be moral.

Ethics, Effectiveness, and Good Leadership

No matter how people become leaders, no one is a leader without willing followers. Tyrants, dictators, and bullies force their will on others—that is coercion, not leadership. The very idea of a leader is normative. We assume that leaders will take responsibility for and promote the well-being of their organizations or constituents. While not all leaders do this, it tends to be what we think of when we describe a leader's job. For example, you would not write an ad for a senior manager this way: "Wanted: a manager who will pursue his or her interests at the expense of the employees and the organization." Leadership is not a person or a position. It is a process and a complex moral relationship that ought to be based on trust, obligation, commitment, emotion, and a shared vision of the good.[7] The central challenge of leading is discovering how to be highly effective in the role and ethical. As mentioned earlier, slave owners and manufacturers can be very effective at "gaining advantage" from their workers, but they traded the ethical treatment of their workers for profits. In all walks of life, some

leaders are effective at what they do, but not ethical, and others are ethical but not very effective.[8] Hence, a straightforward definition of good leadership is leadership that is both ethical and effective. Some leaders equate effectiveness with efficiency, but it is only one aspect of effectiveness and efficiency alone can lead to very unethical behavior. To be both ethical and effective requires leaders who have the imagination and the will to reconceptualize what constitutes effective leadership. However, first, leaders have to come to grips with the challenges that they face as human beings in positions of power.

If a good leader is one who is both ethical and effective, we need to understand the relationship between the two. There are three facets to leadership that form the foundation of this relationship:

1. The ethics of leaders themselves—the intentions of leaders and the personal ethics of leaders;
2. The ethics of how a leader leads or the process of leadership. This includes the means that a leader uses to get things done. It also consists of the relationship between leaders and all those affected by their actions. How leaders do things is related to their competence and ethics;
3. The ethics of what a leader actually does or the ends of a leader's actions.

Hence, ideally, a good leader is someone who does the right thing, the right way, and for the right reasons. By "right," I mean that they do it ethically and competently. Some leaders get only two out of the three of these correct. For example, the legendary hero Robin Hood stole from the rich to give to the poor. He had good intentions and made life better for the poor, but his method of achieving his ends—stealing—is unethical. Some leaders attempt to achieve good ends in bad ways, either because they believe that the ends justify the means or because they are incompetent and do not know how to do something.

Niccolò Machiavelli's book *The Prince* (16th century) highlights the underlying tension between behaving ethically and achieving important goals.[9] Machiavelli concedes that even when his Prince cannot be ethical, it is crucial for him to appear ethical so that he can be effective at doing the tasks at hand. He tells us that leaders have to learn how "not to be good." Whether Machiavelli's Prince is self-interested and power-hungry or selfless and caring, his actions affect the well-being of many people. When you are a leader, the stakes of achieving specific goals are often higher than those of ordinary people. Hence, what is called the "dirty hands" problem is a fundamental ethical problem for leaders. The dirty hands problem is when leaders have to do something bad to carry out their responsibilities to followers. As Michael Walzer notes, no leader leads innocently.[10] It is difficult for leaders to adhere to some of the constraints of morality when, for example, the jobs of their employees are at stake. They may have to lay off employees to save the business; however, it is imperative that they do not take such an action lightly. They should feel bad about actions that harm others. Their conscience should bother them, so that this kind of behavior does not become a habit. Max Weber also acknowledges that leaders sometimes have to use "dubious morality" that has "evil ramifications." He proposes an ethic of responsibility for leaders because there are situations where it is inappropriate and ineffective for them to act like saints. In some cases, acting ethically may save the leader's soul but not serve the interests of followers. However, in these cases, Weber does not let the leader off the hook. He says that if anyone wants to be a leader, he "must know that he is responsible for what may become of himself under these paradoxes."[11]

Machiavelli, Walzer, and Weber realize that the actual job of a leader may require him or her to behave in ways that are harmful to their followers—for example, laying off some workers to save the jobs of others. Leaders might have the attitude of Weber: "I will go to hell because I do what is best for the organization;" or of Machiavelli: "I will not go to hell because I have done what is best for the organization;" or of Walzer; "I will go to hell when my hands stop feeling dirty or I stop feeling guilty about what I have done." Hence, the paradox: we want leaders to be ethical, and we select or elect leaders to make difficult decisions that sometimes entail moral compromises. When leaders do bad things or make those moral compromises to do their jobs, they often disappoint their followers.

The Personal Challenges of Being a Leader

Leaders face several personal moral challenges that are based on factors such as pow-

New technologies reduce or eliminate the need for workers, but do they eradicate the desire of people in positions of power and authority to want servants or slaves?

Control over workers, the cost of workers, and the quality of working conditions are about employers' respect for human rights and the dignity and autonomy of employees

er, success, privilege, and ego. How leaders get and use power is a key source of ethical problems in leaders. Leaders gain power and influence in many ways, such as their position, their ability to control resources and reward and punish, their expertise or ideas, their connections, and their charisma. It is usually the case that the higher the leadership position, the more power leaders have over others and the less power others have over them. In Plato's *Republic*, the story of "The Ring of Gyges" literally and figuratively illustrates the problem of power and morality.[12] It raises the questions: "Would you be moral if you had the power to be immoral?" and "Would you be moral if no one was watching?" Questions concerning power, accountability, and transparency apply as much to followers as they do to leaders, given that followers can enable leaders to misbehave. It is also useful to think about the extent to which institutions, organizations, and groups are responsible for how their leaders behave.

Success is a slightly different problem than power for leaders. When leaders are successful over time, they can become overly confident or inattentive to their duties. Such leaders can fall prey to what Dean Ludwig and Clinton Longenecker call the "Bathsheba syndrome."[13] The Bathsheba syndrome is named after the story of David and Bathsheba in the Bible (Samuel 2: 11–12). In the story, King David, a moral and successful leader, seduces the wife of one of his generals and tries to cover it up by having the general killed. He gets caught and God punishes him. This story has been replayed throughout history and in the news media today. Successful leaders sometimes become isolated, lose perspective and focus on their jobs, overestimate their ability to control outcomes, and become reckless. When this happens, the result may be sex scandals, abuse of funds, or other forms of risky behavior.

Another ethical challenge for leaders is that they usually receive special treatment, which includes tangible privileges such as a luxurious office or intangible ones such as deferential treatment from those who want to curry favor. Research has found that when followers admire and trust leaders, they sometimes grant them "idiosyncrasy credits."[14] These credits signify that in their followers' eyes leaders have earned their status and have their followers' permission to innovate and deviate from some of the norms of the group or organization. Idiosyncrasy credits may lead them to make a variety of moral mistakes.[15] When followers grant privileges and give idiosyncrasy credits to leaders, they make it easier for leaders to believe that they are special and do not have to follow the same rules as everyone else. Some people say that leaders should be held to a higher standard. However, that would imply that followers should be held to a lower standard, which is not true. Everyone should adhere to the same moral standards. If anything, leaders should be held to a higher standard of complying with the moral norms by which everyone is bound. Followers should not allow them to be exceptions to the rules because in leadership, morality and immorality are magnified. When leaders do something good or bad it has a far-reaching impact on others.[16]

Needless to say, because leaders are usually treated with deference and given privileges and perks, their egos are bound to swell, especially when they are successful. We have long understood the dangers of people with inflated egos. The Chinese philosopher Lao Tzu put it succinctly: "He who stands on tiptoe is not steady."[17] Another ancient writer, Tertullian, captures this problem of power, success, and ego when he describes the Roman practice of having a slave stand at the back of a general's chariot when the general makes a triumphant entrance into the city before a cheering crowd.

Demonstrators greet Swedish climate activist Greta Thunberg as she arrives in New York after crossing the Atlantic in the *Malizia II*. The high-speed yacht allowed Thunberg to travel without flying to the Climate Action Summit in September 2019

> Even when triumphing in that most lofty chariot, he [the general] is warned that he is a man, for he is prompted from behind, "Look behind thee–remember that thou art a man." And, in truth, his joy is on this very account the greater, for he glittereth with so much glory, as to need reminding of his proper nature.[18]

Tertullian is skeptical about how effective this is at keeping a successful, powerful leader's ego in check. Cultures vary in terms of how people regard their leaders and expect them to behave. For example, the Globe Project on cross-cultural leadership in sixty countries found that in highly egalitarian cultures, such as Denmark, it is unseemly for a leader to flaunt power and appear special. Whereas in cultures where unequal power is acceptable, such as China, leaders are supposed to appear distant and above everyone else.[19]

Three Qualities of Ethical and Effective Leaders

As we have seen, there are fundamental ethical problems that have plagued the workplace and its leaders throughout human history. Some of these problems are the psychological ones that come with power and greed, others stem from the responsibilities of being a leader. Let us now look at three qualities that leaders need to develop to overcome some of the ethical challenges of leadership. These qualities are not new, but they are ones that leaders have often failed to acquire. The qualities are perspective on themselves and the world, a rich understanding of people, and moral imagination.

While we cannot expect business leaders to foresee the future, it is their job to at least try to anticipate it. Management writer Chester Barnard once said: "Leadership is the art of sensing the whole."[20] Being a leader requires the ability to look at the big picture and how all of its pieces interact; whereas a manager concerns the functional elements of an organization. Perspective is, perhaps, the foundational element of leadership. Perspective applies to the ability to understand complex systems and it also facilitates self-reflection and self-knowledge. The new age of work will take place in the context of highly complex social, political, economic, technological, and environmental systems. Despite the inflated claims of business schools that they are educating leaders, most of them train managers and specialists. The focus of business education is on competency in various aspects of a business. Becoming competent in areas such as finance or marketing may be part of leadership in some organizations; however, work in these areas is often done by specialists, not leaders. So, it is ironic that in an era of complexity, business schools seem determined to churn out narrow specialists.

Students are more likely to develop a perspective about themselves, their ethical obligations to others, and the way the world works, through the liberal arts and, in particular, the humanities, than business courses. As Aristotle once noted, the liberal arts teach people how to make good choices in a free society.[21] It is extraordinary how many MBA students have not formally studied history, religion, literature, and the arts. All of these areas of inquiry tell us about where we stand in relation to the rest of the world. The humanities comprise the study of the human condition and the values, emotions, and aspirations of people. They tell us about the basic similarities of all human beings and the ways that family, personality, and culture shape them into unique individuals. This knowledge is the basis of a foundational principle of ethics—respect for the dignity of all human beings. Moreover, the humanities remind us of human frailty and the mistakes that people have made time and time again. Ancient Chinese and Greek philosophers believed that reverence was the most important virtue for a leader because it made them act as if they were part of some larger whole and, hence, kept them from acting like gods.[22]

Shaped by factors such as immigration, the environment, technology, and political change, the material conditions of the world create a new context for work. Ethical leaders in a new age of work have an obligation to consider how these factors affect people from all walks of life. So, along with perspective, leaders need to understand people and have empathy. While management courses teach students something about human behavior, they often mostly focus on how to motivate workers to be productive. Since leadership is a specific kind of moral relationship between people and all living things, leaders need to apprehend how to treat employees and other stakeholders as

Leaders should not be allowed to be exceptions to the rules, because both morality and immorality are magnified in leadership

The three qualities that leaders need to develop to overcome some of the ethical challenges of leadership are: perspective on themselves and the world, a rich understanding of people, and moral imagination

Phil Schiller, Vice President of Worldwide Marketing, presents the new iPhone 11 Pro at Apple Park in Cupertino, California, September 2019

Business ethics courses offered by business schools are the obvious places to develop ethical leaders. However, relatively few schools in the world are willing to make business ethics a full course in the curriculum or to hire well-trained, full-time faculty to teach them

people with free will who are ends-in-themselves.[23] In other words, as people who are individuals capable of making reasoned decisions about their work and lives. A new age of work would be one where employees are not treated as Aristotle's "talking tools" or "instruments that use instruments" that are used to get work done.

Perspective and an understanding of people also need to be paired with the last quality of ethical leadership, moral imagination, which is part of problem-solving. There are two parts to moral imagination, imagining *how* and imagining *that*. Imagining "how" is practical. It concerns devising new ways to think about and do things. It entails both ethical and effective problem-solving. Imagining "that" is cultivating the ability to see and anticipate ethical issues inside and outside of the workplace.[24] Literature, history, philosophy, and the arts help foster both kinds of moral imagination.

Many business schools have business ethics courses. These are the obvious places to develop ethical leaders. However, relatively few schools in the world are willing to make business ethics a full course in the curriculum or hire well-trained full-time faculty to teach them. A good business ethics course should be somewhat like a humanities course that focuses on business. It has to be much more than a series of cases about companies that did bad things. Such cases help students learn to analyze situations and some problem-solving, but they do not give them the other skills they need to be ethical leaders. Most cases do not lead to self-reflection or offer different ways of seeing business, society, and the world. Studying ethics is an excellent way to learn about leadership because leadership consists of taking responsibility and caring for an organization and its stakeholders. A good business ethics course can, at a minimum, warn students about the personal ethical challenges of leadership.

MBA programs are becoming increasingly compact and the so-called "soft" courses like business ethics are often made shorter or eliminated. Most business schools, and by extension their students, tend to overvalue quantitative skills and undervalue people skills. Since business education is big business, it is unlikely that they will change on their own, unless the business world presses them to do so. The more technical the work-

Students in the library at Nova School of Business and Economics, Carcavelos, Portugal, 2018

place becomes, the more we need leaders who are humanists, who can anticipate the unintended consequences of technology, and think critically about the impact of economic disruptions on employees and society. Technically trained business leaders are often not prepared to think about these big picture questions.

It would be naive to assume that education alone would produce ethical leaders who could usher in a new and morally better age of work for everyone, but it is a start. Other changes might include new forms of corporate governance that help leaders overcome some of the personal ethical challenges of leadership. However, as we have seen, boards of directors often fail to prevent CEOs from engaging in unethical behavior. Perhaps this is partly because members of these boards are too much like the leaders they are supposed to oversee—wealthy (usually white) men. Some of the ethical problems with leaders today also stem from their dogmatic adherence to certain economic assumptions. A question that most business leaders either cannot answer or do not want to answer is: how much profit is enough? Corporate leaders who believe that their primary obligation is to create shareholder value think they should not answer it; whereas other business leaders do not want to. Hence, the idea of potentially unlimited profits creates an ethical challenge to business leaders since one way to squeeze out more profits is to become more efficient, which sometimes harms employees as well as other stakeholders. Getting around these entrenched economic beliefs about cheap and controllable labor that have been around since the time of Aristotle requires the moral imagination about what work is and the relationship between employers, employees, and profits. We need this sort of conversation to devise a new age of ethical workplaces.

The challenge of educating ethical business leaders has gone on since the beginning of business schools. In the early twentieth century, some educators expressed concern about the social and ethical impact of industrial technological innovations and scientific materialism.[25] In 1928, Harvard Business School hired a philosopher named Carl Taeusch to teach its first business ethics course. The course was dropped from the curriculum seven years later because it was unpopular and some people thought that it was nothing more than "Sunday School talk."[26] The requirements for ethical leaders in a new age of work looked the same in Taeusch's time as they do today. Hence, the problem is not lack of knowledge about ethical leadership but lack of institutional values necessary to develop such leaders. In 1926, Taeusch summed up the problem this way in his business ethics textbook:

> The world is in need of two types of men that it does not have in great abundance: those who are experts in technique, who contribute the ninety-five percent of perspiration necessary to carry on well the world's work, and the inspired five percent who are possessed of broad enough vision to see what there is to do. It is the latter who anticipate most of the possibilities and troubles of humanity, and in this group the philosopher should be found. And the philosopher has functioned in the past, and can still contribute his share, by directing human efforts through the channels that a useful memory and a far-reaching imagination alone can discover or construct. And when we in this practical age insist that the philosopher come down from the clouds and the mountaintops, it is not necessary that he lose his sense of direction in the marketplace.[27]

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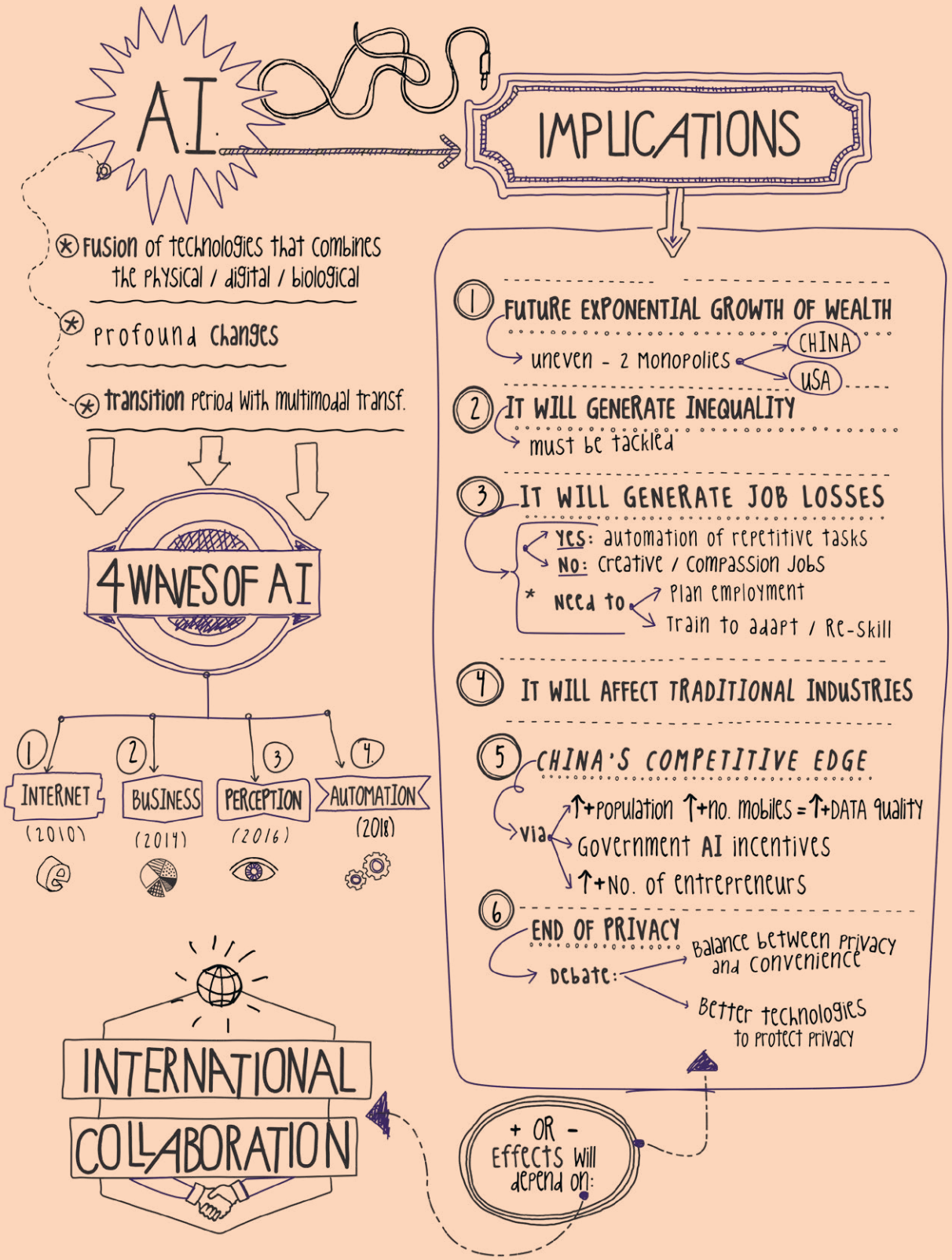

A.I.
IMPLICATIONS
fusion of technologies that combines the physical / digital / biological
profound changes
transition period with multimodal transf.
4 WAVES OF AI
1 INTERNET (2010)
2 BUSINESS (2014)
3 PERCEPTION (2016)
4 AUTOMATION (2018)
INTERNATIONAL COLLABORATION
1 FUTURE EXPONENTIAL GROWTH OF WEALTH
uneven - 2 monopolies
CHINA
USA
2 IT WILL GENERATE INEQUALITY
must be tackled
3 IT WILL GENERATE JOB LOSSES
YES: automation of repetitive tasks
NO: Creative / Compassion Jobs
* need to
Plan employment
Train to adapt / Re-Skill
4 IT WILL AFFECT TRADITIONAL INDUSTRIES
5 CHINA'S COMPETITIVE EDGE
via
↑+population ↑+no. mobiles = ↑+DATA quality
Government AI incentives
↑+No. of entrepreneurs
6 END OF PRIVACY
Debate:
Balance between privacy and convenience
Better technologies to protect privacy
+ OR - Effects will depend on:

Artificial Intelligence and the Future of Work: A Chinese Perspective

Kai-Fu Lee

As with most technological breakthroughs, the hype when it comes to artificial intelligence (AI) has far preceded its widespread application in the real world. This article explores key challenges that need to be overcome over the next decade, at a global level, in order to ensure that AI's potential can be successfully deployed to enhance our working lives and productivity gains. It also places the responsibility for AI advancement firmly in the court of "traditional" industries—radical impact will not come from the technology sector alone, rather from the innovative, timely, and systematic adoption of AI by established companies. While focused on AI's global impact, the article also provides a Chinese perspective on challenges and opportunities of its adoption at scale.

Introduction: The Age of AI

Klaus Schwab, founder and executive chairman of the World Economic Forum and author of *The Fourth Industrial Revolution*, characterized the era we currently live in as defined by "a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres."[1] No previous technological revolution drew upon so many different advancements all at once, and most certainly not at a comparable speed.

The velocity of innovation caused by this multimodal transformation has prompted a heated debate about the future of humanity, asking us to examine the limits of our own capacity to understand and make use of the technological breakthroughs previously never thought possible: can our understanding keep up with the changes at hand? How do we adjust? Will machines eventually rule our lives? What does it mean to be human in the age of the machines?

Our cognitive functions have not kept up with technological advancements. Human relationship with intelligent machines is still perhaps best epitomized by Arthur C. Clarke's and Stanley Kubrick's HAL 9000—something to admire and fear in equal measure—prompting us to defend, while at the same time question, the supremacy of human intelligence. What do we do with the machines whose limits we may not be able to imagine?

If the rate of technological change continues at this pace, it follows that humans will soon be flanked by automatons and robots, automating every aspect of our lives.

Well, maybe someday.

In reality, the science trails considerably behind the futuristic visions of a society where artificial intelligence (AI) reigns supreme. In fact, if I were to make a prediction today, based on the scientific progress at hand, I would say with confidence that true machine intelligence at human level is a very distant prospect, if ever reachable.

Advancements in AI have so far been limited to single-domain tasks. As of today, AI can more efficiently process vast quantities of information about something very specific, such as playing a game, healthcare diagnostics, or speech recognition. But it cannot think laterally to apply learnings to a different domain. It cannot form an opinion about what it is doing. And it most

certainly does not have any feelings about what it is doing.

But, whether we realize truly intelligent machines (often referred to as Artificial General Intelligence or AGI) or not, AI is already transforming how we live and work, finding its way into most domains of human activity. While technologists and pundits debate humans' future relationship with machines, what is not debated nearly enough is the imminent impact of various AI-powered technologies. How do we cope with job loss? How do we ensure our education systems can keep up? What about social services?

Our understanding of ourselves and our role in society is already, if slowly, being challenged. If humans will no longer be required to perform an array of jobs, and if what we have learned at school may soon no longer apply—how do we adjust our course and our expectations of our working lives? Such questions should be front-of-mind for governments, their economic advisers, education ministers, school principals and deans, and business leaders, as well as parents everywhere.

And So It Begins

We are already at the epicenter of synchronous disruption brought upon by AI across all industries. I use a "Four Waves of AI" framework to elaborate AI's impact on the business scenario—they do not come one after the other, but rather simultaneously, transforming the way we live (fig. 1).

The first wave of AI innovation, Internet AI, began around 2010, completely transforming our use of the Internet with the breakthrough brought by the invention of deep learning. Search, online advertising, social media, e-commerce—advancements in these online activities that are now part and parcel of our everyday lives—have all been predicated on advancements in AI.

In 2014, businesses, particularly those where data is readily available, started to embrace AI, creating the foundations for the advancement of industries such as AI fintech, remote education, digitization of public services, and supply chain management. I would call this second, largely software-driven, wave of innovation—Business AI.

Perception AI began to make inroads in 2016, enhancing machines' ability to capture human senses, analyze, and make decisions based on such data. Computer vision technology has become mainstream: machines now recognize human faces, traffic patterns, or even merchandise we select from stores. Speech recognition technology can now analyze and synthesize languages, enabling simultaneous translations and machine-generated news reporting. We will see fast development of AI in software and hardware during this wave.

Most recently, in 2018, autonomous systems saw their first applications across industries, allowing us to imagine the not-so-distant future where autonomous vehicles dominate the roads, and possibly even airways. Automation AI is already transforming traditional heavy-weight players in transportation, logistics, and manufacturing, to name a few.

In what seems like the blink of an eye, we have found ourselves in possession of a multifaceted technology whose application is as pervasive as that of electricity. In fact, it may not be an exaggeration to say that we already may not know what it means to have lived without AI.

What is more, the transformation through AI has only just begun. Leaders across industries have begun to consider AI's application for their own businesses *en masse*. According to Deloitte's "State of AI in the Enterprise" 2019 report,[2] 57% of business leaders believe that AI will have a transformative impact on their own company in the next three years. While fewer, 38%, believe AI will power the same transformation across their industries, the trajectory is clear: AI is permeating most domains of human endeavor. What will separate the winners from the losers is their ability to grasp the magnitude of change and adapt in time.

The fundamental truth of our time is as follows: AI is the greatest frontier facing humanity to date and we must act now to get it right.

How Prepared Are We for AI?

AI's potential to change the way we live and work is so vast that its current uses are a mere scratch on the surface of what is yet to come. Every aspect of our lives will be affected, and every corner of the world we live in will be implicated in the change.

But, will it affect everyone in the same way?

Research shows that AI will enable the creation of unprecedented wealth: PricewaterhouseCoopers (PwC) estimates that the wide adoption of AI will add about $15.7 trillion to worldwide GDP by 2030[3]—barely a decade from now. This growth will continue its exponential trajectory toward the year 2050.

There is tremendous business value to be gained through the adoption of AI, but wealth creation will not be even. As I indicate in my book—*AI Superpowers: China, Silicon Valley, and the New World Order*—gains from early AI innovation are akin to winner-takes-all scenario, with two economic giants—the United States and China—already leading the way, being the homes to all of the world's corporate AI giants. In the PwC predictions I mentioned above, the most significant growth is expected to come from China, not least due to its vast population, which accounts for almost a fifth of all the world's people.

Inequality between countries must be tackled through international diplomacy channels, with the US and China lending their resources and know-how to avoid exacerbating global inequality. But even more pertinently, inequality within countries—stemming from job displacement, skills gap, education inequality, and lack of access—must be made a national priority for governments and businesses across the world.

While it may take fifteen or more years for AI-powered technologies to have an impact across industries, we must act quickly to put in place the infrastructure needed to avoid massive disruption and lessen human hardship that will inevitably come in the form of vast job losses and the uneven distribution of wealth.

AI Infusion

While we are enamored by great AI companies like Deepmind, the $15.7 trillion value will not be realized through them. From today's vantage point, AI's biggest opportunity is infusion into traditional companies. This will be greatly enhanced by the rapid development of AI platforms, so that more and more traditional companies can implement AI, without requiring deep AI expertise.

AI's greatest potential is in infusing existing businesses with new ways of

problem-solving, new levels of speed and accuracy, new efficiencies, and new ways of working and thinking about what is possible. AI can be used to optimize existing processes (such as saving costs by up to 80% on back-office outsourcing or customer service), to improve processes (such as using AI to reshape sales forecasts, logistics, and supply chain), or to disrupt industries (such as using AI to help medical scientists discover drugs many times faster than today).

Business leaders must embrace the long view. Few can afford resistance to change, as businesses must integrate AI as part of their strategy in order to stay relevant. Referring back to the Deloitte study, many more executives believe AI to play a role in offering a more competititve edge to their own companies than that of their industries overall. This suggests that a blind spot is emerging, as the pace of innovation coming from elsewhere may catch businesses off guard. The fact is, no one can remain complacent as AI moves to the top of the agenda across the board.

Anticipating where disruption may come from and upskilling to be ready to take on the level of technological and operational change caused by AI will become a part of the business strategy playbook across all industries.

Impact on Jobs

The impact of AI on job creation and loss is largely misunderstood. The doomsday narrative would have us believe that AI will cause such a level of disruption that it will mark the end of the workplace as we know it. All jobs will be gone, spelling economic hardship for most of us. I am personally against the dystopian view of AI destructing the values of mankind.

A different interpretation of the same scenario holds that AI will spare us the drudgery of work, allowing us, instead, to lead lives of leisure in some sort of utopian state.

The reality is somewhere in the middle. It is true that up to half of all jobs are likely to face extinction or disruption due to the introduction of AI. What may have surprised those in industries already starting to be affected is what kinds of jobs have started to disappear first.

It may seem counterintuitive, but manual jobs, such as those in most manufacturing fields, will not be significantly affected for the time to come.

Today's machines are much better at grasping quantitative reasoning than basic sensorimotor skills. It is extremely difficult to achieve a level of meaningful dexterity and precision in most robotic applications. So, it is repetition-rich white-collar jobs that are already being more readily disrupted than the blue-collar ones.

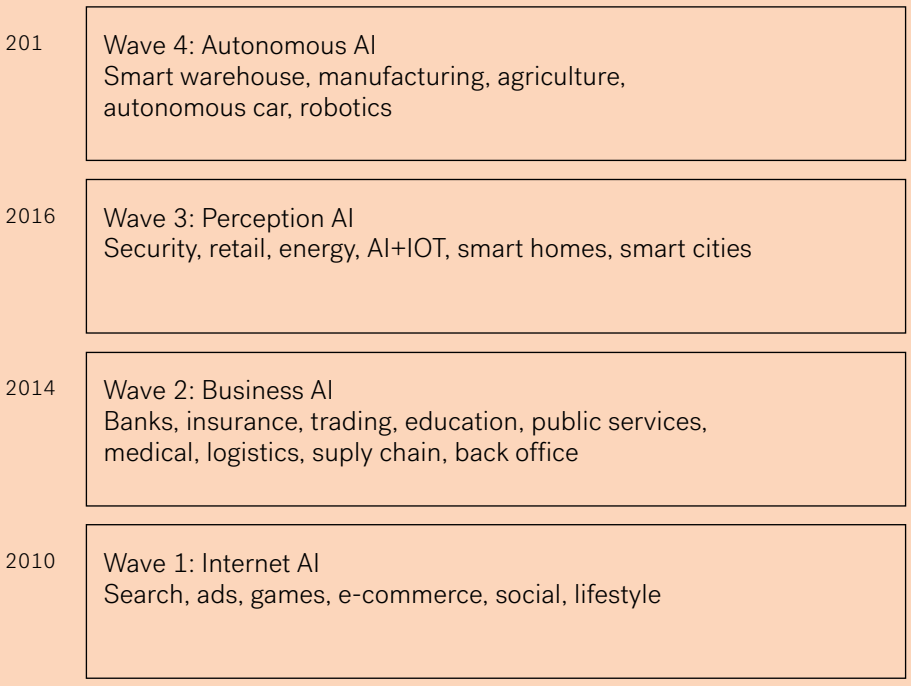


Fig. 1. Four waves of AI

Robotic Process Automation (RPA)

A lot of human activity today is focused on domain-specific tasks that, when injected with a lot of data, can be more efficiently performed by AI. It is estimated that up to one-fifth[4] of all tasks performed by humans at work is spent on repetitive computer tasks that can be automated.

Robotic Process Automation (RPA), with the use of AI and machine learning to process high-volume repetitive tasks, has started to gain traction among companies whose employees spend a significant amount of time on manual tasks, such as query handling, calculations, data entry, or record maintenance. Jobs at the forefront of disruption include those in business process outsourcing: for example, tax examiners filling numbers into cells and tables every day in order to generate data comparison and analysis.

RPA can provide significant value for businesses by freeing up their employees to focus on more complex, higher-value tasks. At the same time, it means companies can now start to reduce the number of people they employ in certain single-domain job positions.

Employers will need to understand the trade-off between efficiency gains and impact on employee morale. Communicating with transparency about the changes in business needs and implementing retraining programs where possible will help both employers and employees transition more successfully.

Is Anyone Safe?

I have established that AI can be used to perform routine work more efficiently.

But AI has no creativity, no compassion, nor the ability to connect with humans and win their trust. The higher the requirement for compassion or creativity in any given job, the less likely it is for AI to replace humans in performing such tasks (fig. 2).

Some fields, such as medical diagnostics, may experience a symbiosis between people and machines. For example, doctors can rely

According to Deloitte's "State of AI in the Enterprise" 2019 report, 57% of business leaders believe that AI will have a transformative impact on their own company in the next three years

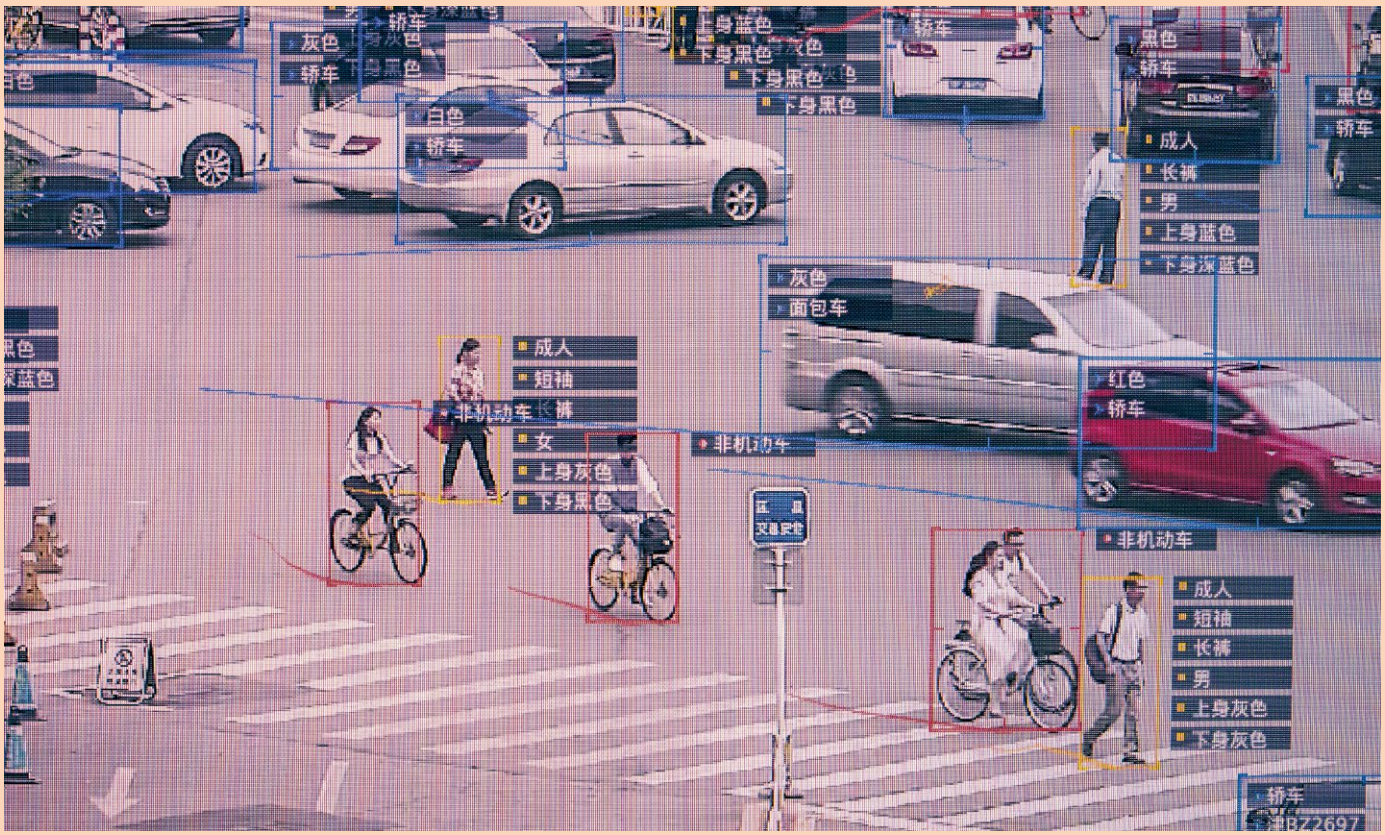
on AI to more accurately diagnose a disease based on data at hand, while they can provide not just the treatment plan, but also the warmth and the trust that are key for human interaction. Research[5] shows that human connection can have a significant impact on the quality of health outcomes. Equally, scientists can use AI tools to discover drugs with higher accuracy. But machines cannot replace the scientists' ability to hypothesize and apply learnings, and communicate to patients with knowledge and trust.

With this in mind, it is critical for governments, businesses, and education institutions to determine what types of jobs will give humans an edge over the machines and make a plan to create more of these. Likewise, understanding where humans will be most needed should have an impact on curricula everywhere: how should we go about preparing children for the future in work? What skills will they need to ensure employability throughout the course of their working lives?

China's AI Competitive Edge

The sheer size of China's population, nearly 1.4 billion, and its embrace of mobile technology as part of everyday life has given China an edge when it comes to quality data crucial for the development of AI. Mobile phones are truly at the epicenter of everyday life in China—from food ordering to peer-to-peer payments to charity donation—the Chinese of all ages rely on mobile payments for most of their transactions. The vast amount of data generated in such a way allows merchants and services platforms to adopt a targeted approach to customer acquisition—causing, in turn, massive disruption of traditional industries.

AI is already omnipresent in China—from mobile payments as already mentioned, to AI-enriched mobile applications, face-recognition authentification, autonomous retail stores, AI personalized news aggregation, to customized product recommendations. The use of AI also plays a growing role in connecting rural school children with so-called "super teachers," who can now be connected to classrooms across the country, offering an immersive, interactive experience for the students and making quality education more accessible even in China's remote mountain villages, given the sheer size and resource disparity between cities and regions.



A screen shows the SenseVideo pedestrian and vehicle recognition system developed by SenseTime Group Ltd at the company's showroom in Beijing

In short, mobile-first consumer demands are fueling AI innovation and digitization of the Chinese economy fast and at scale. Adding to this is the Chinese relentlessly dedicated entrepreneurial culture, significant venture capital funding, and government incentives for the development of AI.

While its size and abundance of data due to mobile technology maturity certainly represent China's fundamental advantage, its rise as an AI superpower has been predicated on painstaking promotion of entrepreneurism and infrastructure development. Readily available funding for AI has attracted a huge number of AI technical talents, providing a crucial advantage in the form of a qualified workforce.

All of these combined have enabled Chinese AI companies to cover competitive ground fast and catch up with, and even surpass, the pace of innovation coming out of Silicon Valley.

AI's Impact on China's Labor Market

Various studies of AI's likely impact on the Chinese labor market illustrate the difficulty in predicting AI outcomes on the workforce with any degree of certainty.

PwC offers an optimistic view of AI's impact on jobs in China, estimating that, on balance, the adoption of AI will lead to a 12%, or 93 million, increase in jobs, an income increase of 38%, and a possible GDP increase of 1.4% per year on top of current rates.[6]

While some 200 million jobs are expected to be lost to automation, there is an expectation that 300 million jobs will be created. However, both job loss and creation are not expected to be spread evenly across all sectors or synchronized in time.

McKinsey and Co.,[7] in turn, ranks China among countries most likely to be affected by automation, with 51% of work activities potentially being affected by automation.

The higher the requirement for compassion or creativity in any given job, the less likely it is for AI to replace humans in performing such tasks

While its size and abundance of data due to mobile technology maturity certainly represent China's fundamental advantage, its rise as an AI superpower has been predicated on painstaking promotion of entrepreneurism and infrastructure development

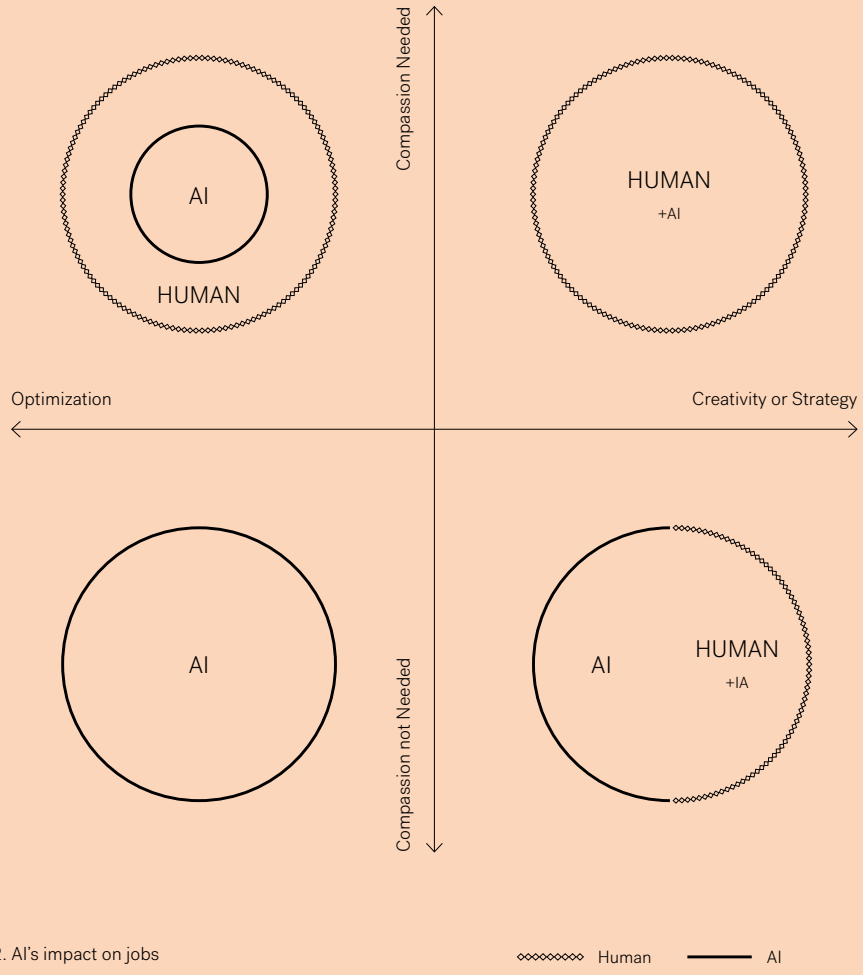


Fig. 2. AI's impact on jobs

On balance, China's economy faces the same challenges as the rest of the world when it comes to AI. While its advantage when it comes to pace of innovation delivered by its AI companies is indisputable, for all countries it is the preparedness for jobs disruption, on the national level, that will be necessary to ensure successful mitigation of imminent job losses.

While having the privilege of talking to leading policy-makers around the world, it is obvious to me that most countries are keenly aware of and deeply concerned about the collective societal impact on the workforce brought by the coming AI revolution. It is also an area where I would advocate for higher international collaboration to share best practices on policy enhancement, social programs, public-private partnerships, and innovations in the public service sector to ensure successful transition to AI across our society.

Conclusion on Jobs

The age of AI, just like the earlier technology revolutions, is expected to lead to significant job creation. But, we do not know for sure what these jobs will look like, nor when they may start to appear.

When the Internet first came into being, no one could have predicted the arrival of Uber and the impact on traditional taxi companies. Or the disruption of the hospitality industry brought upon it by Airbnb. Equally, we cannot predict what innovative ideas are yet to be enabled by AI.

AI will also transform entire business models within existing companies. It is hard to imagine that, once upon a time, Microsoft had an Internet division. Nowadays, of course, the Internet is integrated into every aspect of its business.

The key challenge in dealing with the transition period already underway is the massive job disruption that will precede job creation. Unfortunately, those affected by the former may not be the benefactors of the latter. AI is unlikely to create new routine jobs that would require humans to do them. Thus, retraining will be required to prepare the displaced routine workers for non-routine jobs at a massive scale to mitigate the effects on job losses.

At the moment, very little is being done across the world to account for pending job displacement.

One of the seminal challenges of our time is finding a way to prepare new generations to not only enter the workforce, but also thrive throughout their working lives. This despite the pace of technological innovation and constantly moving goalposts when it comes to demand for skills and specialized knowledge.

Improving education has never been an easy task. Redesigning it entirely to shift the center of gravity away from knowledge transfer and toward self-awareness and self-discovery is a monumental task, yet a necessary one. We must prepare our children for an entirely new relationship between humans and machines.

Training and retraining must be a priority for business and governments, but this alone will not be enough to address the fundamental shift in what will be required to be able to ride the wave of disruption in the job market. As technology continues to disrupt existing processes and ways of working, field-specific expertise will matter less than transferable skills, adaptability, critical thinking, compassion, and self-awareness. These are the skills that will allow young people to navigate the changing world of work. What may constitute a career today may be gone tomorrow, so the ability to reskill and adapt will be more important than any domain-specific knowledge.

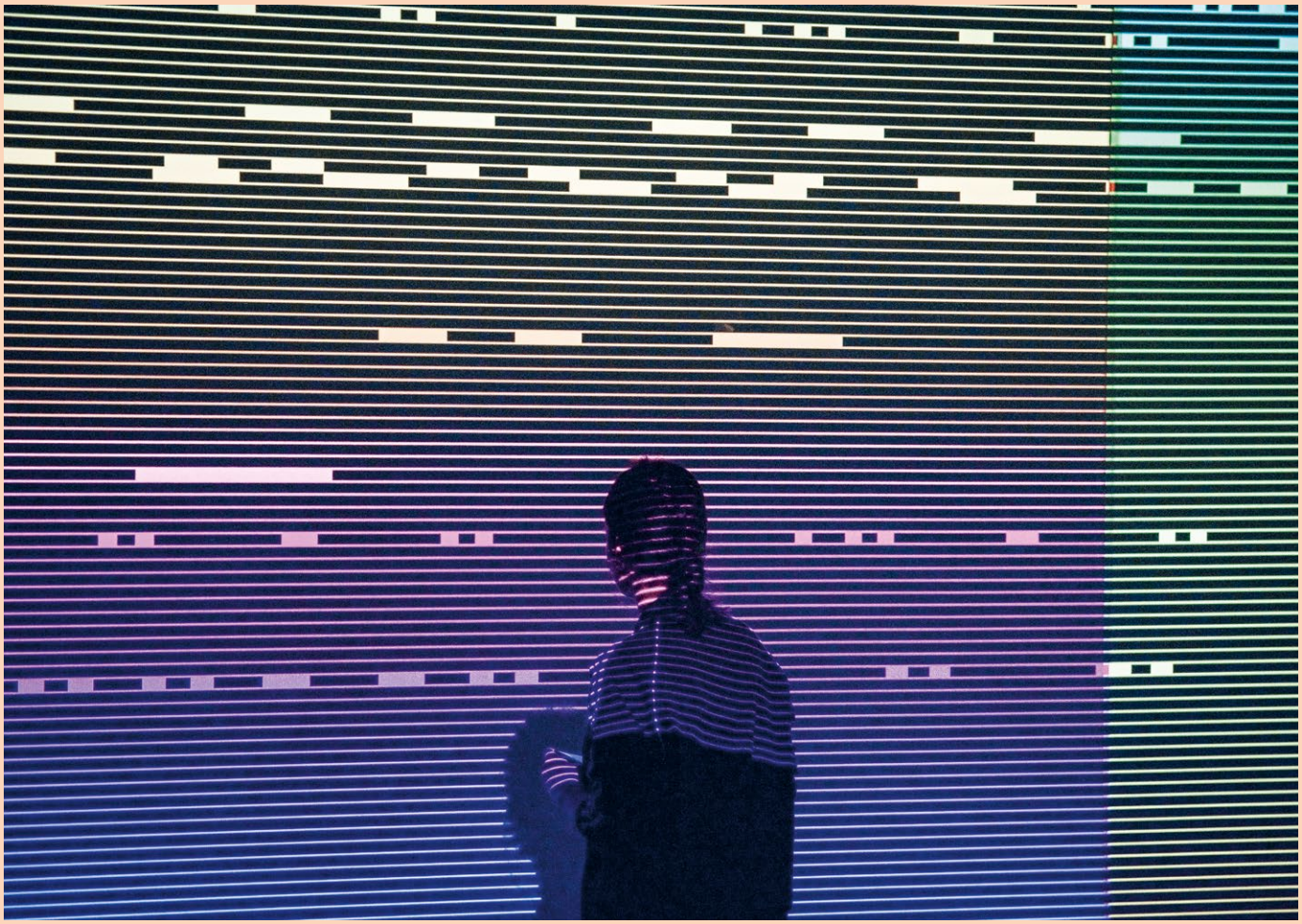
We must attempt to answer questions such as: what constitutes lasting knowledge and what value should we assign to it? What is the role of education in the world where ability to adapt and change ensures our survival more than holding onto what we know?

Ensuring a competitive edge in the global race to lead in AI innovation requires concerted government action: reforming education, job creation, incentivizing entrepreneurship, building the necessary infrastructure to enable innovation to thrive, enabling trustworthy data collection, and training AI application engineers should all be seen as priorities.

The End of Privacy?

It is often said that AI has put an end to privacy as we know it. With millions of digital records that we all leave behind constantly, and technologies that can differentiate our unique features, the danger of misuse is evident.

A customer uses his smartphone to scan a QR code for payment at a pork stall inside the Dancun Market in Nanning, Guangxi province



Every day, a vast quantity of personal data is being collected and stored to drive new AI technologies. On the one hand, these technologies, run by algorithms that improve themselves through consuming more and more quality data, have the potential to make our lives better and more convenient. On the other, we must ensure that personal information does not fall prey to the dangers of misuse.

In response, policy-makers across the world have sought to regulate the transfer of data, hoping to create a more transparent and trustworthy relationship between consumers and companies. Enter Europe's General Data Protection Regulation (GDPR) and California's Consumer Privacy Act, which both stipulate that companies must obtain consumers' consent before collecting their data.

I do believe that these regulations play a role in protecting individual privacy; however, it is both a limiting and a limited way to deal with the issues at hand.

Privacy is not binary. Any privacy regulation must proactively balance considerations of data protection with that of user convenience and value they get in return. This trade-off is largely subjective; it differs among individuals and across countries.

How do we balance the need for scientific progress and the value (convenience, security, social good) brought about by new technologies with the need to better protect personal privacy? Policies alone will tilt the spectrum to the latter, at the expense of the former. So, while regulations are needed, we must also consider technology solutions.

We should question the hypothesis that convenience and privacy are mutually exclusive. We should investigate technologies that protect privacy yet allow the data to be used to improve AI. For example, homomorphic encryption is a method of irreversibly encrypting data to enhance privacy protection. Federated learning, a technology that allows learning to take place in trusted environments, is currently being tested in a number of places.

Consider this scenario: a thousand hospitals are interested in using the power of

New data protection regulations play a role in protecting individual privacy, but it is both a limiting and a limited way to deal with the problem

A visitor at the Onassis Cultural Center in Athens looks at the multimedia project *Data Flux*, in which Japanese artist Ryoji Ikeda challenges the limits of human perception and digital technology

their collective data to train AI-powered diagnostic tools. Due to patient data privacy rules that restrict the use of data within a single health-care institution, patient information cannot be aggregated in one central place—making it impossible to train AI with sufficient data. With federated learning, AI training takes place at each of the hospitals, "federating" the resulting learnings, while "raw data" never leaves the hospital premises. These technologies are not yet perfected, but further research and testing must be encouraged.

AI as a Force for Good

AI's impact is akin to a tidal change morphing the very axis of our lives. I fundamentally believe that AI can act as a force for good across the world. Equally, I am not oblivious to the potential for its misuse.

We have a great responsibility to ensure that AI can live up to its potential—whether it be job creation, medical advancement, transformation of industry processes, access to better education, or making our everyday lives easier through countless conveniences—both big and small.

I hope that we can harness the collective concerns and enthusiasm for AI to start addressing the key questions about its impact on our world. I hope that we can tackle security concerns in a way that is sensitive to regional and cultural differences, while mindful of humanity's future. That, as entrepreneurs, we can start shifting our business mindset from short-term profit to long-term viability by understanding AI's transformative value and its impact on worker training and retraining. That governments can start to scrutinize education to ensure our children are equipped for the changes to come. That we can focus job creation on areas where us people, with our empathy, compassion, and creativity, will remain irreplaceable.

Regardless of global competition for technological dominance, we need concerted action across the nations to ensure that AI can live up to its potential. How we go about engaging with each other on this topic today will decide the nature of the human relationship with AI.

Dr. Kai-Fu Lee is the Chairman and CEO of Sinovation Ventures and President of Sinovation Venture's Artificial Intelligence Institute. Sinovation Ventures, managing 2 billion USD dual currency investment funds, is a leading venture capital firm focusing on developing the next generation of Chinese high-tech companies. Prior to founding Sinovation in 2009, Dr. Lee was the President of Google China. Previously, he held executive positions at Microsoft, SGI, and Apple. Dr. Lee received his Bachelor's degree in Computer Science from Columbia University, PhD from Carnegie Mellon University, as well as Honorary Doctorate degrees from both Carnegie Mellon and the City University of Hong Kong. He is Co-Chair of the Artificial Intelligence Council of the World Economic Forum's Centre for the Fourth Industrial Revolution, a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), Times 100 in 2013, WIRED 25 Icons, Asian Business Leader 2018 by Asia House, and followed by an audience of over fifty million on social media. His *New York Times* and *Wall Street Journal* best-selling book, *AI Superpowers*, discusses US-China coleadership in the age of AI as well as the greater societal impacts brought upon by the AI technology revolution.

Notes

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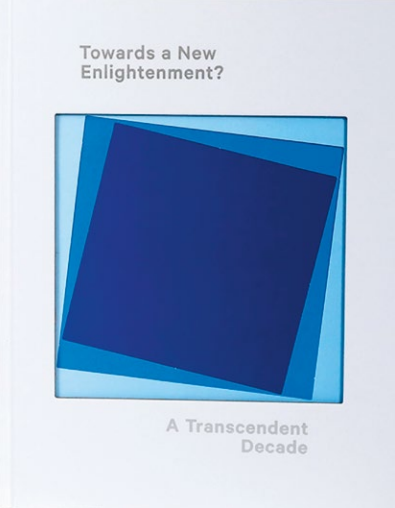
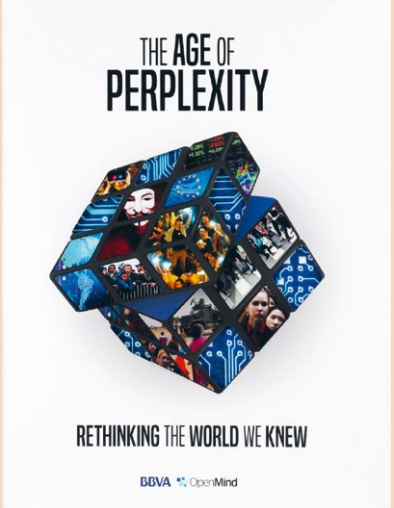


2019
Towards a New Enlightenment?
A Transcendent Decade

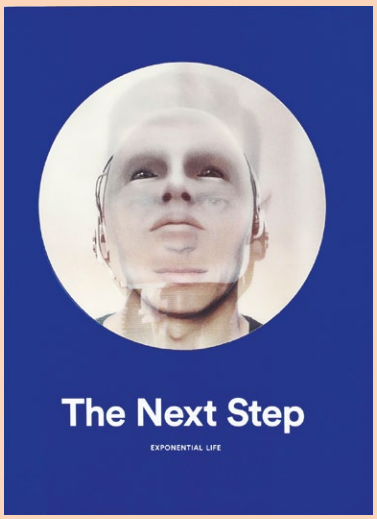
This book examines where the great scientific and technological advances of the last decade are leading us and their impact on how humankind will live in the future.

This impact will depend to a large extent on the decisions we take from now on. In this sense, an important step is to promote what this book calls "a new Enlightenment": a broad dialogue to establish new philosophical and ethical foundations that sustain an economy, a society, a culture and regulations adapted to the new scientific / technological environment with the objective of maximizing growth and well-being while at the same time encouraging the development of collective initiatives to tackle climate change.



2018
The Age of Perplexity: Rethinking the World We Knew

The technological revolution we are living is generating transformations that affect the future of humanity. Those that seemed fundamental constants of the human species: their physical and mental capacities, their longevity ... etc., are now to be defined. All this has opened what this book calls the "age of perplexity". Twenty-three authors analyze the changes that computing and the greater availability of information bring to our perceptions and understanding of our world.



2017
The Next Step: Exponential Life

This book presents a view of the potential of what are known as "exponential technologies", considering their economic, social, environmental, ethical, and even ontological implications.

Emerging technologies will change, and are already changing, what have seemed to be the fundamental constants of human nature: it now seems possible to drastically improve human memory, cognitive processes, and physical and intellectual capacities—even to the extent of extending our life expectancy to such a degree that it may actually change our concept of mortality.

2016
The Search for Europe: Contrasting Approaches

European integration is an issue that affects not only Europeans but everyone in the world. This book aims to analyze and generate discussion on the present and the future of Europe and its integration project.

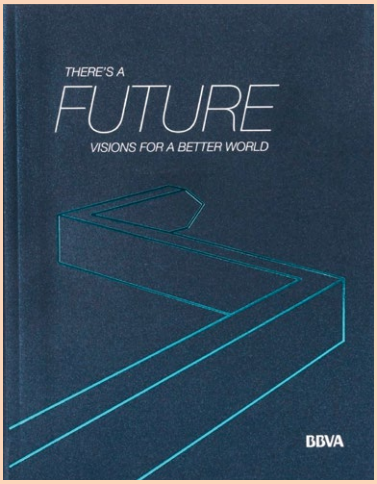
Through 20 articles, 23 leading experts from around the world present their different ideas about Europe, in a simple and accessible way for the lay public.

2015
Reinventing the Company in the Digital Age

The digital era has unleashed a far reaching tsunami that many are still trying to understand and come to terms with. Almost on a daily basis the rules of the game for doing business are changing and we have to struggle to keep up with the fast moving, constantly changing landscape. This has had a colossal impact in the workplace, and nowhere more so than in the so-called traditional sectors: to succeed in this new era, big organizations that up to now have been profitable and leading examples in their areas of business for decades are confronted with the need for swift, radical change.

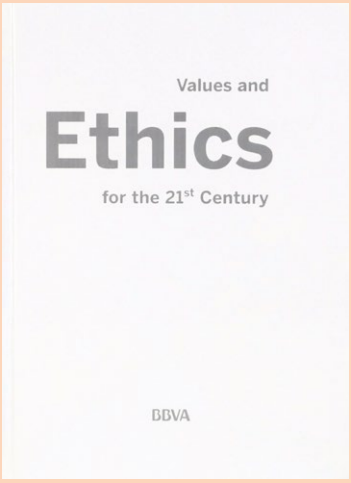
2014
Change: 19 Key Essays on How the Internet Is Changing Our Lives

As a tool available to a reasonably wide public, the Internet is only twenty years old, but it is already the fundamental catalyst of the broadest-based and fastest technological revolution in history. It is the broadest-based because over the past two decades its effects have touched upon practically every citizen in the world. And it is the fastest because its mass adoption is swifter than that of any earlier technology. It is impossible today to imagine the world without the Internet: it enables us to do things which only a few years ago were unthinkable.



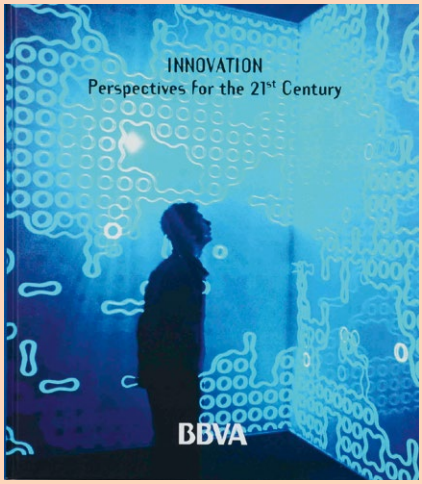
2013
There's a Future: Visions for a Better World

This book seeks to integrate the various elements in the dissemination of knowledge. How do they interact with each other? Where are they leading us? And, more importantly, what can be done to ensure that this path, with all its acknowledged risks, leads us to improve people's quality of life in a sustainable way? The future seems to be hurtling towards us at full tilt. For this very reason, if predicting the future is particularly difficult today, preparing for it is also vital and urgent.



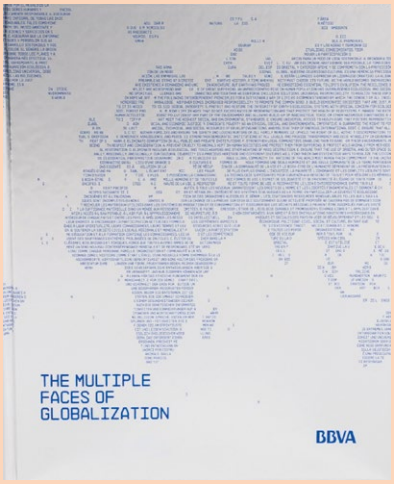
2012
Values and Ethics for the 21st Century

The main topic of this book is ethics and values. That is because shared values and ethics are necessary and vital for the proper functioning of the economic, political and social network and, therefore, for the well-being and development of the potential of every world citizen. The intention of this book is to discuss how we can understand and avail ourselves of universal ethical principles in order to meet the great challenges that the 21st century has placed before us.



2011
Innovation. Perspectives for the 21st Century

The decisive importance of innovation is the most powerful tool for stimulating economic growth and improving human standards of living in the long term. This has been the case throughout history, but in these modern times, when science and technology are advancing at a mind-boggling speed, the possibilities for innovation are truly infinite. Moreover, the great challenges facing the human race today—inequality and poverty, education and health care, climate change and the environment—have made innovation more necessary than ever.



2010
The Multiple Faces of Globalization

The book presents a panorama of globalization, a very complex and controversial phenomenon that is characteristic of present-day society and decisively influential in the daily lives of all the world's citizens at the beginning of the 21st century. Thus, the finest researchers and creators worldwide have been sought out so that, with the greatest rigor and objectivity, and in a language and approach accessible to non-specialists, they can explain and inform us of the advances in knowledge and the subject of the debates that are permanently active on the frontiers of science.

2009
Frontiers of Knowledge

Prestigious researchers from all over the world, working on the "frontiers of knowledge", summarize the most essential aspects of what we know today, and what we aspire to know in the near future, in the fields of physics, biomedicine, information and telecommunications technologies, ecology and climate change, economics, industry and development, analyzing the role of science and the arts in our society and culture.

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- El trabajo en la era de los datos

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