

The world of work is undergoing major changes that will continue, and potentially intensify, in the future. To better understand and in order to respond effectively to these new challenges, the ILO has launched a “Future of Work initiative” and proposed four “centenary conversations” for debates in the years leading up to its centenary anniversary in 2019: (i) work and society; (ii) decent work for all; (iii) the organization of work and production; and (iv) the governance of work. This Issue Note Series intends to provide an overview of key trends and issues in selected thematic areas of particular relevance to the “conversations” with a view to informing and facilitating dialogue and debates at the national, regional and global levels.

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TECHNOLOGICAL CHANGES AND WORK IN THE FUTURE: Making technology work for all*

This note analyses the effects of technological changes on the quantity and quality of jobs and discusses policy challenges in developing a skilled workforce, avoiding job polarization and assuring equal distribution of productivity gains.

** This note is based on contribution from Irmgard Nübler.*

1. Setting the scene: Key issues and overview

Technological change is recognized as a major driver of growth and development. In economic thinking, for instance, it is common to assume that long-term growth can be explained largely by technical progress. Robert Solow who received a Nobel Prize in economics for his growth theory once estimated that technical progress accounted for around 80 per cent of US economic growth in the first half of the 20th century (Solow, 1957).

Technological changes are also inevitably dynamic processes which involve: (a) both job destruction and creation; and (b) transforming existing jobs, particularly in how work is organized. Both aspects have critical implications for workers, employers and their families. The extent and speed of technological changes have always been subject to economic and social debates, typically with diverging views between optimists and pessimists.

The recent wave of technological change within the digital paradigm is once more garnering wide-spread attention. While there is a broad consensus on its productivity potential, recent years have witnessed growing concerns – not entirely unlike those of the past – about the “labour replacing potential” of this kind of technological change (ILO, 2015a). Some believe that the current wave has already reached a tipping point so that a jobless digitalization of the economy (or society) could be a reality in the near future. Others disagree. Some are more optimistic, noting the sequential process of job creation which is often stronger than job destruction. Still others admit that technological innovation puts jobs at risk, but that this is not inevitable. In the latter view, the future impacts of technology on the labour market will depend on social choice and policy actions and thus a job-rich digital economy is deemed to be an attainable future (Nübler, 2016).

This issue note reviews recent analysis and debates on the possible impacts of ongoing and recent technological innovations on work in the future. Given the breadth of the subject

area – and the huge cross-country variations, especially between industrialized and developing countries – this note concentrates on major trends, the forces shaping these trends, and issues most commonly observed globally. Based on the selective review, the note will identify key questions which merit, and should lay the groundwork for further in-depth analysis and policy discussion in the coming years.

Technological change is a complex, non-linear, evolutionary and resource-intensive process which is driven not only by economic, but also by social and political forces. Moreover, technological change is not homogenous, and is defined broadly to take into account different forms of change and innovation that affect the quantity and nature of individual tasks in different ways (Nübler, 2016). Technological change is reflected in the creation of new knowledge, the implementation of an original or significantly improved product, or a different production technique, workplace, or business model, and in the wide diffusion of these innovations within the economy.

The note is structured as follows: as technological change is not new, Section 2 looks back at the past role of technological change and its effect on the world of work, and the debates that have accompanied it, which show that techno-pessimism has often failed to materialize.

However, history does not always repeat itself. So the question is: will this time be different? Section 3 examines this critical question by looking at distinctive features of the current wave of technological changes (often called the Fourth Industrial Revolution) with a historically unprecedented potential of job destruction. We then examine the opposing case which argues that technological change is associated with strong job creation and net gains in total employment. The most recent studies in this area, including a variety of projection results, are reviewed for each of these contrasting views.

Obviously, only time will tell which trajectory the future will take, and, as discussed below, policies will also matter in shaping the future. However, there are other important dimensions which go beyond employment volume. It is well known that technological changes have significant distributional consequences, with winners and losers. Section 4 looks at three issues of particular importance in the current economic and social contexts: (a) impacts on job quality, especially given the ongoing trend towards job polarization; (b) social and economic adjustments driven by technological changes (e.g., new skill requirements, geographical relocation); and (c) (re)distribution of productivity gains between different economic and social groups, given the global trend of widening income inequality.

Section 5 concludes the note with a short summary and proposes a list of major questions for further in-depth analysis and debate.

2. What does history tell us?

While technological changes may have eventually led to new job creation, they typically began with “labour-saving” efficiency gains (i.e., job shedding) and the speed of such technological efficiency enhancement was often faster than that of creating jobs for displaced workers. In a sense, job destruction comes first and compensating actions follow, typically at a slower speed. Thus, historically, technological changes have been the source of anxiety and even discontent. The early 19th century saw the massive introduction of textile machines which provoked the well-known Luddite movement. Since then, the overall response to technological innovation has become less negative, but it has continued to be viewed with considerable apprehension as the job losses stemming from these changes have been a reality for many firms and workers. As early as 1930, John Maynard Keynes called such job loss “a new disease” and introduced a new term, technological unemployment: “unemployment due to our discovery of means of economising the use of labour outrunning the pace at which we can find new uses for labour” (Keynes 1930).¹ Debate on this persists.

1. But Keynes added “this is only a temporary phase of maladjustment. All this means in the long run that mankind is solving its economic problem. I would predict that the standard of life in progressive countries one hundred years hence will be between four and eight times as high as it is to-day. There would be nothing surprising in this even in the light of our present knowledge” (ibid).

Since its inception in 1919, the ILO has provided a global avenue for discussing the employment impacts of technological progress. For instance, in response to emerging doubts about the employment impacts of rapid mechanization and automation (i.e., standardization of products and production processes which allows jobs performed by workers to be encoded in algorithms which could be performed by machines) in the 1950s, the ILO Director General submitted a report which stated “past experience shows no reason to believe that technological innovation led to a decrease in the global volume of employment. On the contrary, it suggests that such innovations, while they may cause declines in some areas of employment, led in the long run to an expansion of employment by creating increases in other areas” (ILO 1957, p. 29). However, techno-pessimism gained strength in the 1960s, which led the ILO to discuss the “labour and social implications of automation and other technological developments” at its 1972 annual International Labour Conference (ILC).

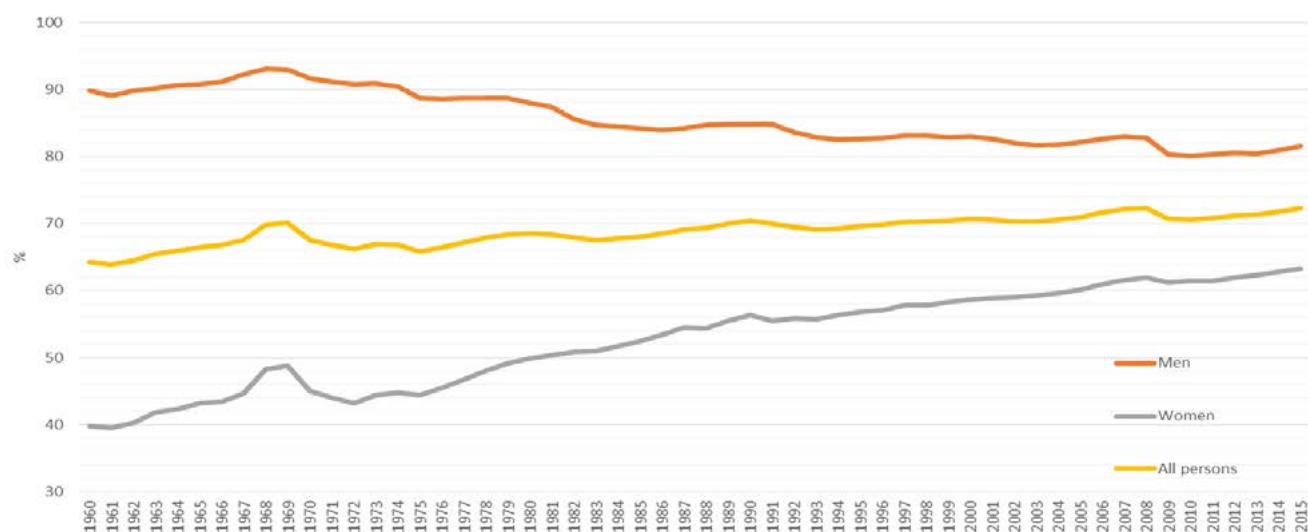
It is interesting that the ILC report of 1972 began by examining the latest trends in reference to “the opinions expressed during the 1950s and the early 1960s” which were predominantly pessimistic (the ILC report referred to it as “automation scare”). Noting that “much of the discussion was of a theoretical nature and was based more on opinions than on facts”, it concluded that the consequences of technological changes were “in most respects much less dramatic than had earlier been feared”. It added:

Many of the forecasts made in the early fifties have been clearly disproved by the real course of events. Probably one of the most striking was the prediction made by Norbert Wiener, an authority on cybernetics, when he said in 1950 that automation deriving from computers and cybernetic feedback controls would result within twenty-five years in a depression which would make that of the 1930s seem like a “pleasant joke”. Twenty-two years later, it does not seem likely that his prophecy will come true either by 1975 or – fortunately – even during the following twenty-five years” (ILO 1972, p. 4).

Similar debates were observed in the 1960s in the US where concerns about “the automation jobless” led President Johnson to set up a national commission which eventually concluded that these concerns were not grounded (Autor, 2015).

Technological innovation gained further momentum after the 1970s, with the usual cyclical up-downs, but overall employment volume in both absolute and relative terms expanded. As a simple illustration, Figure 1 shows the employment-to-population rate in OECD countries between 1960 and 2015. The rate for men declined significantly but such decline was more than offset by the rapidly increasing employment rate for women. This contrasting development between men and women, in part, reflects technological changes which shifted the economy away from the male-dominated manufacturing to service sectors. Overall, the employment rate has increased by around 10 percentage points over the last 55 years. In fact, ILO’s World Employment Reports (1996/7, 2001) concluded that aggregate data do not support the fear of massive technological unemployment (“the end of work”).

Figure 1. Expanding employment in the era of technological innovation: Employment-to-population rate, 1960-2015
OECD countries



Source: ILO and OECD, age group 15-64

3. Will this time be different?

Job destruction: how bad will it be this time?

Our historical experience to date tends to discredit techno-pessimism when it comes to the overall employment outcome, but history does not always repeat itself. The question, therefore, is: will this time be any different in terms of net job destruction; and if so, how?

Some observers believe that we are witnessing a critical departure from the historical pattern to date, highlighting the unique nature of the current wave of technological changes, sometimes referred to as “the Fourth Industrial Revolution” (Schwab, 2015). One of the arguments underpinning this view is that this round of revolution builds on the achievements of the previous waves of technological change (including information technology (IT) and automation) and brings them all together to produce an unprecedented – and exponential – pace of productivity growth.

Automation has also intensified, resulting in much stronger job-replacement effects. The new manufacturing technologies leading to Industry 4.0 are expected to introduce a new wave of automation of jobs in logistics, coordination and communication. The move towards automating the full value chain by manufacturing and integrating autonomous robots equipped with sensors that collect and analyse data, into a data network that boosts inter- and intra-firm connections could increase productivity exponentially. Indeed, some expect increasing and persistent technological unemployment due to the disruptive effects of the innovative use of information and communications technology (ICT), the diffusion of learning robotics, the Internet of things and 3D printing (McAfee and Brynjolfsson, 2014), and some foresee a jobless future (Ford, 2015).

This growth in automation is combined with ongoing competitive pressures in the context of globalization. Enterprises are under strong pressure to enhance productivity and to reduce costs. Competition induces firms and the research and development (R&D) sector to search for new production technologies in order to create opportunities for enterprises to enhance productivity and competitiveness. These competitive pressures have been driving automation and the fragmentation of production systems as two long-term trends in process innovations that enhance productivity by saving labour and thereby destroying jobs.

As a result, the pessimistic perspective argues that the unprecedented nature of current technological change is essentially biased to “labour-saving” even in the long term. The question becomes: how bad will it be this time?

A variety of efforts have been made to estimate the potential magnitude of job destruction. For example, Frey and Osborne (2013) explored the potential automation of occupations, that is, the technical easiness or feasibility of computerizing occupations. They estimated that 47 per cent of total US employment is technically in a high risk category “over the next decade or two”. The comparable estimate for the UK is 35 per cent, and studies for Germany and France produced similar results. An ILO study has recently produced a much higher estimate for ASEAN countries: about three in five jobs face “a high risk of automation” (Chang and Hyunh, 2016), thus raising important questions about regional variations in job destruction.

Critics, however, argue that future automation is unlikely to destroy complete occupations; rather, jobs within occupations will vary, and while some jobs may disappear, others will only change (Autor and Handel, 2013). Studies analysing jobs rather than occupations find significant lower risks for job losses. Arntz, Gregory and Zierahn (2016) find that automation will replace some tasks which will fundamentally change the nature of jobs workers will perform, but the jobs themselves are not at risk. They conclude that in OECD countries on average about 9 per cent of jobs are at high risk of being automated, ranging from 12 per cent in Austria, Germany and Spain to around 6 per cent or less in Finland and Estonia.

In addition, recent technological changes have often facilitated outsourcing/offshoring and made the production process more fragmented, with the potential of making job losses more severe in developed countries. New technologies in transport, information and communication technologies as well as new institutions such as trade agreements and free trade regimes have enabled increasing fragmentation in order to enhance productivity. Initially, jobs of workers were routinized, with a specialization on a narrow sequence of tasks. The search for productivity increase with economies of specialization and agglomeration has motivated firms also to specialize in particular tasks within countries, and finally to specialize in specific tasks within global value chains. Outsourcing of labour intensive production tasks has resulted in the fragmentation of production processes across borders, and the relocation of low- skilled jobs from developed countries to low-wage countries. During the past decades, developed economies have specialized in high-skilled tasks such as R&D, design, finance and after-sales services, while developing countries have attracted many of the low- wage and low-skilled jobs which could not yet be automated.

Overall, it is widely expected that high competition in global markets will continue to drive automation and fragmentation, though the new wave of specialization may be driven more by the service sector than by manufacturing. On the one hand, new production technologies requiring sophisticated skills are expected to re-shore or in-source jobs and disrupt value chains. For example, new robots can perform sewing tasks which so far had remained a job for “nimble fingers” in low- wage countries (The Economist, 2015, May 30). On the other hand, the spill-over of digital technologies, powerful algorithms and learning software (artificial intelligence) will result in the decomposition of professional jobs, and relocation of jobs from developed to developing countries. Brown, Lauder and Ashton (2011) foresee a process of “digital Taylorism”. Enterprises will divide office services into specialized tasks similar to the process of Taylorism in manufacturing. Digitalization allows relocation of these tasks to developing countries. Even complex service tasks will be outsourced to developing countries due to the growing number of high-skilled workers there along with wages that are two-thirds lower than in developed economies.

Yet new jobs will also be created: Mechanisms and magnitude

The gloomy picture has been questioned by many other researchers who point to the potential of new job creation. While the direct impact of innovations aimed at the productivity enhancing process is job-destroying, these innovations and their intended consequences have the potential to trigger new economic activities and create jobs (with the potential of net positive job creation at the aggregate level). There are indeed various mechanisms, outlined below, which can channel such changes (Vivarelli, 2007).

First, there are complementarities between new technology and employment within a given sector. For instance, as Autor (2015) explained, the introduction of ATMs reduced labour demand for tellers but this was offset by large expansions in the number of branches. In addition, the new technology itself enables the banks to broaden the range of their services, particularly through “relationship banking” in which bank staff members introduce various banking services to the customers in person.

Second, the technological spill-over effect creates jobs. The same process innovations which displace workers in the user industries create demand for workers in the producer industries. New robots and smart machines need to be developed, designed, built, maintained and repaired. Furthermore the fragmentation of production systems, the Internet of things, Industry 4.0, digital Taylorism, driverless cars and other phenomena will increase demand for the construction of new infrastructure, transport equipment and IT equipment as well as increasingly complex software and new institutions. Many developing countries will need to construct a reliable supply of electricity, transport and IT infrastructure.

Third, technological innovation leads to other innovations. New scientific knowledge opens “exploitable opportunities” not only for process technologies but also for the development of new products. Creative entrepreneurs design and develop fundamentally new goods and services, develop new business models and create new jobs. The Industrial Internet of Things (IIoT) and Big Data have created a new business model – manufacturing-cum-service – where firms combine manufacturing with data creation that leads to additional product innovations. For example, Michelin has developed tires with sensors to collect information on road conditions, temperature and speed, which provides the opportunity to provide services to truck fleet managers in order to reduce fuel consumption and costs. At the same time, software enterprises such as Google combine new technologies to expand into manufacturing by developing a driverless car (Accenture Technology, 2014).

Fourth is the price and income effect (Acemoglu and Restrepo, 2016). Technology-induced productivity growth, if translated into higher wages, income, purchasing power and reduced prices, will enhance demand for domestic products and expand output. Furthermore, lower costs will enhance competitiveness, while higher profits will stimulate investment. This will lead to further productivity gains through innovation and scale economies. These income and market expansion effects have the potential to compensate for the loss of employment (Vivarelli, 2007). For instance, technological advances in health care can reduce health costs which then increase demand for more sophisticated medical services.

Fifth, the implementation of labour saving process technologies has resulted in declining working hours. This has led to increasing demand for leisure related activities, a wide range of product innovations, entire new leisure industries and services, and the creation of new jobs. Sports, health, recreation, tourism, music, TVs, computer games, restaurants, fairs and museums, and the do-it-yourself movement starting in the 1980s are examples of this phenomenon. Evidence also shows that leisure industries have become increasingly technology intensive, and hence, jobs have become increasingly complex (Posner, 2011). The potential of increased future demand for leisure activities depends on the translation of technological advances into reduced working time rather than unemployment. Thus, the distribution of productivity gains arising from new production technologies to consumers is critical to ensure rising purchasing power and demand.

If these mechanisms all exist, then, “technology eliminates jobs, not work” (Bowen 1966, cited in Autor, 2015).

Will this time be different? It is hard to predict but further research and well-informed debates will be necessary in the coming years. One important point in this debate is the recognition of country variations with respect to the impacts of new technologies on job destruction and creation processes. Empirical evidence shows that countries differ significantly in innovation activities, growth of robotization and integration into the global value chains (GVC), and in the impact of these process innovations on net job creation. Even more interesting is that the correlation between these new process technologies and employment is not clear cut and indeed

both the job-destruction and job-creation effects differ across countries (Timmer et al, 2015; Graetz and Michaels, (2015). For example, despite the fact that Germany had the highest rate of growth in robot density, far surpassing the rate in the United States, the net job loss in manufacturing employment as a share of total employment was much lower when compared to the US (Nübler, 2016).

More generally, we need to better understand the country-specific forces that allow some countries to rapidly adopt new technologies, gain competitiveness and create product innovations as part of the economic adjustment process. The compensation effects are created by markets, but markets do not work in a vacuum. Rather, they are embedded in societies, whose capability to innovate, mobilize resources for new economic activities, and to learn to compete have shown to be important determinants of product innovation and job creation (Cheon, 2014; Nübler, 2014; Paus, 2014).

4. Beyond employment volume: Job quality, economic and social adjustment, and distributional challenges

Our analysis thus far shows that the outcome of the Fourth Industrial Revolution may not be as negative as some pessimistic observers have suggested. Creating more jobs than destroying them is a possible trajectory in the near future. Even in this positive scenario, however, there are many other issues which deserve serious policy debate, and the economic and social outcomes of technological changes tend to depend much on how countries address these issues.

More specifically, there seem to be three broad issues:

- First, technological changes will transform the nature and quality of existing and new jobs. Simply put, the key concern here is whether and how we will be able to avoid the destruction of good jobs and the creation of bad jobs, even though total employment increases. The point is well captured by Gordon (2016, p. 604): “The problem created by the computer age is not mass unemployment but the gradual disappearance of good, steady, middle-level jobs that have been lost not just to robots and algorithms but to globalization and outsourcing to other countries, together with the concentration of job growth in routine manual jobs that offer relatively low wages.” In developing countries, the key concern is to generate patterns of diversification that generate more and better jobs.
- Second, the dynamic process of job destruction and creation involves significant changes and adjustments for workers and companies as well as communities, which are often painful and costly. The outcome of technological changes depends on how these adjustment processes are managed. This is not just about market processes but also the social and political choices that communities make and the policies they implement.
- Third, technological changes can bring about significant productivity gains. Again, the impact on the world of work within countries and across the globe will depend on how such gains are distributed between economic and social groups. This point is particularly important as today’s technological innovation is taking place when overall income inequality has already reached a historic high (Piketty, 2014).

Will technological changes destroy middle jobs and exacerbate job polarization?

Technological change not only affects the quantity of jobs, but also the nature and quality of jobs. While there are various ways of describing the quality of jobs, the ILO (1990) defines a job as “a set of tasks and duties, performed, or meant to be performed, by one person, including for an employer or in self-employment”. This defines a job by the scope, nature and profile of tasks and these job properties determine the occupational profile. Autor et al. (2003) describe the tasks of a job both as routine or non-routine and as manual or cognitive. They show that automation first replaced manual routine tasks and increasingly has replaced non-routine

tasks; while recent multiple new technologies have allowed the automation of increasingly complex tasks, in particular routine and non-routine cognitive tasks.

Many of the emerging mobile robots will not replace humans, but will augment their cognitive, collaborative and physical capabilities. Workers will increasingly focus on those tasks that cannot be performed by computers and as a result, jobs will become more complex. Collaborative worker-machine interaction requires a higher level of autonomy of operators and designers, shifting focus from rule-following to value-finding. Managers working with smart and connected machines which will support day-to-day management decisions, and take over routine decisions, require more soft skills acquired mainly through experience, such as good judgement, creativity and problem solving. Managers will have to frame the questions which computers have to answer, address exceptional circumstances highlighted by increasingly intelligent algorithms, and learn to cope with ambiguity. Furthermore, the nature of jobs in research, development, and design will become more experimental as digital modelling and simulation make experiments less expensive, and work processes will increasingly be structured around “design-build-test” cycles.

Moreover, product innovations driven by the Internet of things, Big Data, Industry 4.0 and digital Taylorism have the potential to create jobs in a wide range of new knowledge-oriented occupations. New occupations will emerge, in particular at the intersection of professions, software and machines, such as big data architects and analysts, cloud services specialists, software developers and digital marketing professionals (Frey, 2016). Susskind and Susskind (2015) predict that a range of new legal roles will be created at the intersection of software and law, such as legal knowledge engineer, legal technologist, project manager, risk manager, and process analyst.

An important issue in this context is whether the demand for higher-skilled occupations comes at the cost of middle-skilled jobs, i.e., whether it will create the polarization of jobs or a “hollowing out”. For example, Autor, Levy and Murnane (2003) found that since the 1980s, the share of middle-skilled routine jobs in the US decreased relative to low - and higher-skilled jobs. However, recent studies by Graetz and Michaels (2015) and Timmer, Los and de Vries (2015) estimate the impact of robotization and globalization on jobs during the 1990s and 2000s and confirm the results for the US but find limited evidence of widespread job polarization elsewhere.

Job polarization can also be observed at a global level, especially when technological progress occurs unevenly with low-income countries lagging behind. For instance, most African countries still face low levels of technological advancement, and only a small number of them have managed to transform their economies by generating economic dynamism through technological upgrading. Evidence shows that patterns of change in occupational composition differ widely across countries. While some countries increase the share of high-skill intensive and middle-skill intensive jobs, others demonstrate job polarization as defined above, and some countries simply increase the share of medium-skilled jobs (ILO, 2015b).

How can we manage economic and social adjustments for technological upgrading?

The dynamic process of technological change and innovation does not happen in a vacuum or in a predetermined way and results in a wide range of economic and social adjustments, which can disproportionately affect certain workers, firms and communities (in some cases countries and regions). Experience shows that the outcome of technological changes depends on how these adjustment processes are managed and whether or not they include support for communities and displaced workers (including training and income support) and start-up incentives for firms. These processes tend to be complex and resource-intensive, but it is often taken for granted that such adjustments will take place.

New task profiles for jobs and new occupations can significantly alter the nature of skills needed for production and innovation. This challenges education and training systems, enterprises and families to provide the skills needed in the future, and to promote the development

of diverse and complex sets of competences in the labour market. First, workers need to acquire the right set of skills to be employable and to respond rapidly to changing skills requirements. Such competences relate to technical, but also to core skills such as creativity, imagination, openness to new ideas, social and communication skills. Yet, during phases of rapid technological change many of the specific skills sets which will be needed in the future are unknown or uncertain. Education and training systems face the challenge of reducing this risk and enhancing the flexibility of workers and the portability of their skills.

Productive transformation policies are also needed to drive the diversification of enterprises into new products and industries. The recent debate on productive transformation highlights particularly the role of industrial dynamics, macro-economic effects and innovations on structural change in driving the creation of good jobs (Salazar-Xirinachs, Nübler, Kozul-Wright, 2014). Economic models also show that sustained growth in productivity and good jobs requires diversification of the economy, the expansion of high-tech activities, and a dynamic growth in domestic and international demand (Astorga, Cimoli and Porcile, 2014).

A fundamental message is that markets alone cannot trigger this complex adjustment process in conjunction with technological changes and that proactive and deliberate government policies and institutions are critical to support such processes. Evidence shows that successful Asian catching-up countries transformed their industrial structure in favour of high-tech sectors and higher demand elasticity sectors. To achieve this they implemented industrial, trade, investment, education, training, macroeconomic and labour market policies to generate learning, productive transformation and job creation processes. Many Latin American countries as well as African countries have been unable to generate productivity and job enhancing dynamics of structural change. Recent experience shows once more that Asian countries have used integration into global value chains as a means to increase the complexity of their economy while Latin American countries followed a strategy that reduced their economic complexity (Nübler, Kümmitz and Rubínová, 2016).

It is also important to note that technological change comes in long waves, and that phases of productivity-enhancing innovations and job destruction are followed by phases of product innovations that create fundamental new goods and services and trigger what Perez (2013) has called a “Golden Age of job creation”. This second phase has led each time to interconnected innovations - “... technical and organizational and managerial innovations, ... opening up an unusually wide range of investment and profit opportunities”. This is the phase where enterprises create value by developing new products and markets, and where new industries replace incumbent industries as drivers of growth. Again, markets cannot achieve this transition; history shows that this is a socio-political choice. Creating a Golden Age phase requires a fundamental transformation of economies and this can only be achieved by transformation of societies, which is essentially a process of collective learning (Nübler, 2016). Based on her framework of historical recurrences, Perez (2013) argues that countries are currently at the turning point at which they need to make social and political choices, forge a new social consensus and develop new institutions to drive the path towards new consumption and production patterns (Nübler, 2016).

Distributional challenges of technological changes and productivity gains: How real, and what policies?

Productivity gains from technological innovation are substantial and may continue to be so. In the era of wider IT applicability and globalization, economies of scale (and productivity gains) are likely to be even larger. However, because these gains have gone primarily to the owners of such innovation, recent technological changes have contributed to widening inequality (ILO 2014). The job polarization noted above has led to a rise in inequality in many countries, due to the unequal distribution of high productivity gains arising from innovations among capital owners, skilled and unskilled workers and consumers. Moreover, the expected increase in the skills of managers, and in particular the important soft skills that can only be acquired through experience, may contribute to rising inter-generational inequality. Thus, with continued technological advancement, inequality will likely increase further.

However, the current level of inequality is already high, posing serious economic and political risks and a global consensus has emerged for the need to tackle this divide (G20, 2016). In addition, it is important to note that technological innovation, as discussed above, is the result of collective and cumulative effort by individuals and companies over generations, and therefore its benefits should be shared widely.

This is also an important economic issue. The concentration of productivity gains among certain economic groups (hence, widening inequality) can depress overall consumption and thus constrain economic growth. If this is combined with technological unemployment, it can create significant shortfalls in aggregate demand, which in turn could be a serious blow to the global economy, given the persistent weakness of aggregate demand since the beginning of the Great Recession. As Ford (2015, p.190) put it:

“Accelerating technology is likely to increasingly threaten jobs across industries and at a wide range of skill levels. If such a trend develops, it has important implications for the overall economy. As jobs and incomes are relentlessly automated away, the bulk of consumers may eventually come to lack the income and purchasing power necessary to drive the demand that is critical to sustained economic growth”.

For this reason, some commentators have suggested basic income as a counter-policy measure. This would guarantee minimum living standards for all, irrespective of employment status, thus maintaining the consumption demand. This idea is not new. In the 1960s when technology pessimism was strong, the commission set up by President Johnson observed that the “cybernation revolution” resulted in “a system of almost unlimited productivity capacity which requires progressively less human labor” and “the traditional link between jobs and incomes” was broken. It therefore proposed that “society, through its appropriate legal and governmental institutions, undertake an unqualified commitment to provide every individual and every family with an adequate income as a matter of right”.

More broadly and historically, productivity gains tend to be shared with workers in the form of higher wages and/or shorter working hours. However, in recent years, wages have tended to stagnate in many parts of the world and only modest progress in reducing working hours has occurred, especially for full-time workers (ILO, 2014). For this reason, hourly wages, which could increase as a result of higher hourly rates or shorter hours, have lagged behind labour productivity.

Overall, an important feature of the current wave of technological innovation which may distinguish itself from the previous waves is that the pace is progressing while inequality is already high, jobs are increasingly polarized, and the labour market is deeply segmented. Given the significant risk of worsening these trends, debates should focus more on policy actions to tackle the distribution of productivity gains.

5. Wrap-up: Key questions for future debates

Technological changes have been a defining character of market economies, often inviting opposing views on their impacts on work. Employment volume has defied techno-pessimism repeatedly, but history does not always repeat itself. Indeed, the current wave of technological changes (i.e., the Fourth Industrial Revolution) includes various elements which could make this time different. However, studies have also identified new sources of job creation which could potentially offset job losses. Understandably, projections on employment volume in the coming years differ sharply. In light of this, debates are needed, with new empirical analysis using a variety of methodologies, with a focus on this overarching issue:

- How can “full employment” be achieved in the context of current and future technological changes?²

² The ILO Philadelphia Declaration (1944) explicitly recognized achieving “full employment” as ILO’s solemn obligation. This is reflected in the Employment Policy Convention (No. 122) which commits future ratifying States to “declare and pursue as a major goal an active policy designed to promote full, productive and freely chosen employment”.

- In addressing this question, the following specific questions will need to be examined:
 - Which jobs and occupations are at the risk? At the same time, what are the new potential sources of job creation?
 - If net job loss is inevitable, how can society find complementary ways of creating jobs that help achieve full employment (e.g., the care economy)?
 - How are these dynamics of job destruction and creation played out at the global level?
 - What policies, at both national and global levels, can be helpful in realizing the full potential of new job creation?
 - The transition of economies into new and dynamic industries with a huge job-creating potential requires transformative technological change, mission-oriented innovations, and a new social consensus. How can social dialogue play an instrumental role in shaping this process?

In addition, technology has critically important effects on job quality, economic and social adjustments, and distributional challenges.

First, some evidence indicates that the current technological changes may exacerbate the ongoing trend towards job polarization; this has the potential of further segmenting the labour market, crowding out the middle class, and widening wage inequality. In light of this, debates must also focus on questions such as:

- Is technology-driven polarization inevitable? What policies and institutional changes are needed to tackle job polarization and, more broadly, the deterioration of job quality? Will education and skill policies be sufficient?
- How will new technologies change the nature of jobs in different occupations and different levels? What will be the defining properties of new jobs, and most importantly, will they be perceived as quality jobs?

Second, technological changes do not happen in a vacuum or in a mechanical way but require a wide range of economic and social adjustments. Experience shows that the outcome of technological changes and the nature of innovations depend on how these adjustment processes are managed. In light of this, debates are needed, with a sharpened focus on:

- What are good practices and what capabilities are needed in managing this adjustment process? What are the key elements of success, especially in terms of articulating a wide range of labour market policies, education and training policies, industrial policies and macroeconomic policies?
- How should we redistribute work within the labour force and adjust working time in the light of net jobs destruction? What are innovative models and what can we learn from past experience?

Third, current technological changes have created huge productivity gains which, to date, have exacerbated income inequality. Given the already visible economic and political risk of widening inequality, how to address the distributional challenge of productivity gains will be an important factor in shaping the future of work and society. In light of this, critical debates are required, with a focus on:

- How can we manage the (re)distribution of productivity gains to reduce inequality while maintaining purchasing power and demand in order to strengthen compensation effects, sustainable economic growth and job creation?
- How can fiscal and wage policies become effective instruments in sharing productivity gains with consumers and creative entrepreneurs?
- Do we need a new “paradigm-shifting” way of thinking about income distribution (e.g., basic income)?

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