



CHALLENGES OF THE FOURTH INDUSTRIAL REVOLUTION

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Abstract The article presents the main features of the fourth industrial revolution based on some experts opinions, the most important papers delivered and debated at Davos World Economic Forum in 2016 on the theme of this revolution and some estimation regarding the impact/effects of this last phase of industrial development in the world.

Key words:

Industrial revolution, technology, innovation, jobs, growth, social impact

JEL Codes:

L16, L52, L53, O14, O15, O25, O33

1. The third or the fourth industrial revolution?

Once started in the mid eighteenth century with the invention of the steam engine, the industrial revolution witnessed several phases or steps that allowed the transition from a farming and feudal society to an industrial and capitalist society and then to post industrial or services society, with the gradual release of labor force from physical activity and mental efforts afterwards in favor of more striking creativity. Phases or cycles of industrial revolution entered the literature as the first, second, third industrial revolution and had certain characteristics related to the predominance of specific energy resources, technical achievements with

major effects in economy, means of public transport developed or modernized. This year at Davos it has been much talk about the fourth industrial revolution within the World Economic Forum, but some consecrated authors such as Jeremy Rifkin, had considered previously that we are in front of the third industrial revolution and at the end of the second revolution, that would imply the third phase presented in the Table no. 1 is only an extension of the second phase. In Table no. 1, I made a short presentation of the main features of the industrial revolutions in the period 1760-2015.

Table 1. Main characteristics of industrial revolutions

Period	Transition period	Energy resource	Main technical achievement	Main developed industries	Transport means
I.1760-1900	1860-1900	Coal	Steam engine	Textile, Steel	Train
II.1900-1960	1940-1960	Oil, Electricity	Internal combustion engine	Metallurgy, Auto, Machine Building	Train, Car
III.1960-2000	1980-2000	Nuclear Energy, Natural Gas	Computers, Robots	Auto, Chemistry	Car, Plane
IV.2000-	2000-2010	Green Energies	Internet, 3D Printer, Genetic Engineering	High Tech Industries	Electric Car, Ultra Fast Train

Source: Created by author based on specific literature

Whether it is or not the third or the fourth industrial revolution, this new cycle is based on Internet and green energies, the first allowing easy access to information and easy trade for goods and services and the latest diminishing energy impact on the environment. Combining these two leads in the vision of Jeremy Rifkin in establishing the defining

elements of the so-called new industrial revolution: firstly it would shift from fossil fuels to renewables; secondly it is going to transform the building stock of every continent into green microplants to collect renewable energies onsite; thirdly it would be the use of hydrogen and other storage technologies in every building and entire infrastructure to store intermittent

energy; fourthly it is using the technology of the Internet to transform the electricity network on every continent into an Internet of Energy that acts like the Internet (when millions of buildings generate a small amount of energy from renewable sources at local level, on the spot, they may sell the surplus of green electricity back to the grid and may share it with neighbors on the continent) and fifthly it is the transport fleet that can be passed to electric vehicles and fuel cells, which may buy and sell green electricity on a smart, continental, interactive grid. The project is quite impressive but it belongs to the future and it can be materialized with a broad international cooperation in three or four decades. It is the European Parliament that issued a formal statement in favour of its implementation within the EU and also other countries from Asia, Africa and the Americas have expressed interest and concern for the materialization of such an integrated and interactive system. Strong synergies between the five elements are meant to create a new economic paradigm that may transform the world into a much better place.

Even the Prime Minister of Great Britain, *David Cameron*, came to support Rifkin's ideas announcing that the world is on the brink of "a new industrial revolution," where Internet will allow to ordinary objects to communicate with each other. The so-called *Internet of Things* will transform the world enhancing the labor productivity, making transport more efficient diminishing the energy needs, supporting dealing more effectively with climate change, as due to electronic means offered by Internet one may usually send and receive data from other devices or from individuals. The close interaction between humans and household items, and between cars and many household devices has an enormous potential to change people's lives.

For *Banning Garrett* the new industrial revolution is based on revolutionary technologies, like artificial intelligence, Internet, 3D printing, genetic engineering, all having a strong impact on the inputs and outputs of industrial production but also on social relations and how people relates to production and its results. The question is whether technological progress and strong productivity growth will produce more wealth or more unemployment and social inequality. So far we have a lot of poverty around the globe and a small number of billionaires. Both 3D printing, which can quickly perform a variety of products and components and the new generation of robots and also nanotechnology, genetic engineering, biotechnology can deliver products and services at very low costs and can greatly change production processes and their results.

Other visionary person like *Yves Smith* (*Naked Capitalism blog*) thinks that history provides many lessons and it is better not to repeat the big mistakes made by humanity and she detected five pillars for a

stable society: Food, Security, Health, Prosperity, Knowledge. Between two industrial revolutions there is a transitional period and at the end of each transition Prosperity pillar is threatened, being associated with high levels of unemployment, which could lead to a world war and this was seen after the first two industrial revolutions. Prosperity pillar of human society is in danger now that humanity faces an impending food crisis, a lot of health and safety issues, a serious increase in unemployment and the fall of Prosperity pillar will probably lead to a new industrial revolution. Despite skeptics and alarmists who predict World War III, human society must avoid such a war and opt for a new industrial revolution and for a sustainable economic development based on the Knowledge pillar, having in mind that without good knowledge of the past there will be no stable future.

2. The Davos World Economic Forum and the fourth industrial revolution

During the annual Davos meeting of WEF from 2016 it was intensely debated the issue of the fourth industrial revolution and several aspects of this new phase or cycle of industrial progress were presented by different authors. According to WEF Chairman Klaus Schwab, who introduced the term and theme of the fourth industrial revolution in Davos debates, this phase of industrial development is beginning now, and is "characterized by a much more ubiquitous and mobile Internet, by smaller and more powerful sensors that have become cheaper, and by artificial intelligence and machine learning" and one may see its evolution in a world in which virtual and physical systems are intertwined in manufacturing, services, and other human activities. Much of the discussion in Davos focused on the negative impacts of the new technologies, rather than on their positive effects.

Judith Magyar, from *SAP Community Networks* has identified revolutionary technologies like 3D printer and genetic engineering offering outstanding prospects for industrial development but also presenting some major risks. She has presented some forecasts for the year 2025 included in *Technology Tipping Points and Societal Impact Report* published in September 2015. Sustainable development through technology seems to be a major concern of SAP Community Networks, that is looming an important role played by Internet through hyper-connectivity and the Internet of Things, which determines a new cycle of global economic activity focused on sustainable solutions that may reduce the heavy dependence on fossil fuels. Technology progress enables the reduction of industrial wastes and redesigning of production and consumption systems in order to be more efficient in terms of resource use, but also endangers jobs because of robotics and other innovations. The Internet allows rapid learning and

communication, opens many opportunities for enlarging the knowledge and the best practices, but advanced societies will have the most to gain.

For *Gary Coleman*, from *Deloitte Consulting*, the fourth industrial revolution should not be too long theorized as its impact on business and society is obvious and by digital transformation of manufacturing output one opens wide access to exponential technologies such as robotics, artificial intelligence, sensors, nanotechnology, quantum computer, which are becoming more affordable and easier to manage. Accelerating the cycle of innovation especially in the automotive field can be done by virtual developed prototypes and by installing sensors on cars. New business models are developed using computers, enabling scientific analyzes and forecasts as well as spreading information provided by manufacturers and traders. Technologies based on artificial intelligence may cause the reduction of labor force but Gary Coleman believes that there will not be enough specialists to implement exponential technologies.

For *Mary Barra*, representing *General Motors (CEO)*, technological progress is not a smooth process, but one that occurs in leaps, the same is true for auto industry. Currently major car manufactures are producing more efficient, greener, safer and smarter cars than twenty years ago, and over the next ten years the technological progress will be more rapid and more impressive than in the last fifty years. One may see a transition from autonomous, mechanically controlled, fueled by gasoline or Diesel oil cars to interconnected, electronically controlled, powered by multiple energy sources cars. Besides electric engine one may also see producers installing of cameras, radars, sophisticated sensors that allow the increase of security on several levels. General Motors is a pioneer in 4G wireless connectivity field, which allows a car to act as a Wi-Fi hotspot, which can connect up to seven devices at the same time. The connection can be made with other vehicles and even with the devices installed on the highways, so that the system V2V (vehicle to vehicle communication on a particular Wi-Fi band) enables sharing of important information. The next step is V2I connectivity (from vehicle to infrastructure) that allows avoiding traffic jams. These modern technologies enable the introduction of automated vehicles (without drivers) like Cadillac Super Cruise system, and the increase of safety and speed in the traffic.

For *Xavier Mesnard*, a partner at *AT Kearney*, all revolutionary technologies which drastically change the industrial production may put jobs at risk. The fourth industrial revolution narrows labor demand and imposes new requirements for education. In USA the share of employment from manufacturing industry in total employment decreased from 25% in 1970 to about 10% at this moment. In the next years robots will

eliminate many jobs in the developed countries, especially in the areas of administration and offices, where typically staff is female. Carl Benedikt Frey and Michael A. Osborne estimated that 47% of jobs in the US will be in massive distress because of the introduction of computers, and other developed countries and emerging ones are in a similar situation. Xavier Mesnard raises the question of a challenging transition of Schumpeterian type (theory of creative destruction), as unlike other industrial revolutions that had created jobs, the fourth one does not show the same perspective, but the certainty that the professions will change in a way very difficult to understand and accept. We must take into consideration the exponential nature of digital technologies, so the ubiquitous connection between people and machines, and data, in real time, defining the fourth industrial revolution, would be governed by Moore's Law. This huge transformation is not limited to the manufacturing sector but may also include all jobs related to knowledge and services, thereby inducing a much bigger challenge for society.

Alan Blinder from *Princeton University* considers in his paper *Education for The Third Industrial Revolution* that for adapting to the era of information students need to acquire an education which is not quantitative but specialized and qualitative, focusing on the demands of the moment. Therefore it is necessary a personalized education since we talk of much higher and more complex requisites, requiring innovation, interdisciplinarity, networking.

For *Alain Dehaze*, *Chief Executive Officer, Adecco Group*, technology, economics, demographics, sociological trends and government policies are five major factors influencing labor markets and determining work conditions in the future. Mobility is becoming more and more important for employers and employees and hyper-connectivity is making the location of work irrelevant, employees will take total control over their schedules and work environments. Mobility will no longer mean only the movement of people, but an offer of many new opportunities enabled by the latest technologies and by the new management practices. For companies and countries alike attracting talents will be vital for boosting knowledge and expertise based on their commitment to meritocracy and to recognizing the importance of fast and relevant career development opportunities while for employees will be essential to look for professional and personal development, to find new and challenging job opportunities, to move to locations full of talented people. While for regulators and governments it is important doing structural reforms in labor markets by removing barriers and bureaucracy, by simplification of regulations, by reducing taxes on labor, by boosting education and training, by supporting entrepreneurship and startups.

For Joe Myers, Content Producer at Formative Content, workplaces will change under the influence of automation, their complexity will increase and higher skills, especially creativity, will be demanded. New skills will be needed for transport means, personalized preventative health helpers will be required, also professionals that will provide protection and support for online activity covering fraud and identity theft to social media and reputation management, it will expand rapidly the demand for big data analysts, along with specialisation of analyst roles. More than personal opinions of some participants in the forum debates it counts the assessments made in the report Future of Jobs that predicted the skills that will be needed in a future workplace.

3. The impact of the fourth industrial revolution on economic policy and society

Anders Borg - a Swedish economist and politician - thinks that technological changes in the spheres of digital, connectivity, robotics and big data will have a broad and disruptive impact on the labor market. After the financial crisis, self-employment, short-term contracts, seasonal work and part-time employment dominate in USA and UK. If jobs will be disrupted by robotics and digitalization there will be an impact on tax revenues and tax labor income will be reduced in the long run and public pension funds will also be affected and it is likely that the social costs of taxes in terms of lost employment and lower GDP will increase. On line shopping, goods and services moving freely with the support of Internet and of digitalization of retail sales, may affect tax revenues, like VAT. To better face or adapt to technological challenges one must focus on education and reeducation as income distribution is affected and low income groups are mostly hit, pension incomes will become more unequal, so providing adequate healthcare to elderly people will be more difficult. Long term sustainability of fiscal policy would be undermined by erosion of taxes and need for higher expenditures, requiring a drastically cut of expenditures on social security, finding a quick solution for employment of young people, solving huge problems of social framing of the large number of refugees and migrants.

While currently deflation threatens economic growth seriously, the fourth industrial revolution raises serious challenges related to price stability and inflation rate in the context of high impact of digitization on retail sales and an obvious trend of a higher quality of goods and services. The level of competition, unemployment, wage increases, factor (resource) prices will affect consumer prices and inflation rate and implicitly monetary policy of the central banks. Currency appreciation and depreciation may have different

effects under digitalization process. It is obvious that the fourth industrial revolution will increase labor productivity which recorded a low growth after the crisis due to low resource utilization. When more capital per worker is used, productivity will increase as there is a strong correlation between resource utilization and productivity level, but we must take into account the situation of all resources. Now monetary policy is characterized by low interest rates that could remain very low for a very long time due to liquidity trap and deflation and overestimation of inflation propensity.

Devesh Raj, SVP and Head of Strategy and Planning at Comcast-NBCU and Dries Buytaert, founder of Drupal and Chief Technology Officer of Acquia have investigated how the fourth industrial revolution will help reaching the global goals. The impact of this revolution on jobs will be a relevant one as automation will continue to replace manufacturing or blue collar jobs, while artificial intelligence will do the same for the skilled and high education jobs. Rapid advances in technology may create new jobs, most of which we can't even imagine today as it happened in airplane industry and services. Digitalization will enhance the great inequality existing now in a world where many states and areas have not even passed through the second and third industrial revolution. Robotics and artificial intelligence may drive the "dehumanization" of people lives, affecting unique values as empathy, sensitivity, creativity and inspiration and may also raise moral and ethical challenges. Although the march of technological progress is inevitable, it is obvious that we must avoid or address the negative, unintended outcomes of technological changes.

A major challenge with the fourth industrial revolution that has not get appropriate attention in Davos is the prioritization of technological advances that have the most beneficial impact on society and economy. There is a set of 17 Sustainable Development Goals, also known as the Global Goals, that were adopted by all countries in 2015 to "end poverty, protect the planet and ensure prosperity for all" and they cover poverty, hunger and food security, health, education, energy, water and sanitation, and they are linked to specific targets. Technological advancement may contribute to attaining these Global Goals. It is difficult to prioritize the technologies for meeting the Global Goals and one needs to draft policies and create economic incentives for encouraging the right types of technology advances. The governments and the private sector should involve differently to focus on technology advances which will meet these goals, but it is also needed the energy and creativity of many private entrepreneurs for improving the state of the world. Innovation and technological progress should be directed to the benefit of planet beyond the incentives of commercial returns. Solving

the global needs of humanity is not an anti-capitalist stance but the best direction of capitalist development. Klaus Schwab, WEF founder and executive chairman, believes that we are on the verge of a revolution that will fundamentally transform the way we live, work and interact with each other. Participation in this fourth industrial revolution has to be integrated, comprehensive, multilateral, involving the public sector, private sector, academia, civil society. The first industrial revolution had used steam to set in motion mechanized mass production, the second used electricity for mass production, the third used electronics and Information Technology to automate production, the fourth is characterized by merging technologies that blurs the boundaries between the physical, digital and biological world. In Schwab opinion current transformations are not just an extension of the third industrial revolution but rather the emergence of the four revolution with distinct characteristics: speed, scale and systemic impact. At an unprecedented speed of the transformation, the fourth revolution unfolds with an exponential and not linear growth. It is destroyed the last order of each industry in each country, and great transformations are taking place of all entire systems of production, management and governance (Apostol, 2016).

Thanks to the Internet billions of people are online, have access to limitless knowledge and can accumulate, process and store information, with the significant contribution of discoveries as artificial intelligence, Internet of Things, 3D printer, nanotechnology, biotechnology, energy storage, quantum computing etc. Artificial Intelligence allows cars to drive themselves, using of drones in various activities, offering virtual assistance, using of translation programs, software for trading and investment promotion. Artificial Intelligence has recorded an impressive progress in the last years due to vertiginous growth of computer power and volume of data and information. Nowadays digital fabrication technologies interact with the biological world with the involvement of many experts.

So far the main winners of the the fourth industrial revolution have been the consumers who benefited by the digital world that has brought new products and services. In the future, technological innovation will reinforce the supply side and will bring gains in efficiency and productivity in the long run. Automation will substitute laborforce in many activities but new jobs, safer and better paid, may appear in a large number and compensate the lost jobs.

There are two basic scenarios and it is hard to predict which one will prevail. Klaus Schwab believes the talent, more than capital, will be the critical factor of production. Labor market will be increasingly segregated into segments with top salaries and those

with low salaries based on education level. High social inequality is the biggest concern now and causes serious worries due to its negative economic and social effects (Stiglitz, 2015). Capital providers, be it intellectual, physical, financial, seem to be advantaged at the expense of workers. Is technological progress the source of social inequalities, as Klaus Schwab thinks, or do we have a perverse distribution of income which has hit the middle class, already affected by the deindustrialization process? An economy that destroys the middle class based on the principles *winner-takes-all economy* and *each carries it off well* how can may cause great social convulsions.

4. Conclusions

Revolutionary phenomena may seriously affect society and economy: a) more than 30% of earth population use social-media platforms to connect, learn and change information; b) a lot of new innovative producers/competitors have a rapid access to digital platforms of research&development, marketing, sales and distribution and they may quickly improve the quality, price and distribution of their products/services; c) consumers are more and more involved in the production and distribution chains, they may easily connect to suppliers by means of digital technological platforms. Klaus Schwab sees 4 main effects of this revolution on the business environment through the impacts on consumer expectations, product quality, collaborative innovation and organizational forms.

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