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The Relationship between Technological Change and Social Change: The Case of Egypt

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A nonna Carolina,
grazie a te sono diventata la persona che sono oggi

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Introduction

We are currently living in a period of rapid social change, accompanied by a long-term stagnation with low levels of economic growth and increasing inequality. In addition, the COVID-19 pandemic greatly impacted the economies and the workforce. Incomes are decreasing, savings are disappearing and prices are steadily growing, Nonetheless, "every crisis generates an opportunity", as said by the Egyptian Minister of Economy, Mr. Talaat. In other words, technological change and the Digital Economy can lift restrictions and have a broader effect on inclusivity and widespread progress in many societies and especially in the emerging ones (Wilson Center, 2021).

Therefore, the question is whether technological change is contributing to the creation of a better world and, in the case examined in this thesis, for a better and more innovative Egypt.

The relationship between technological change and social change has always been controversial. Nonetheless, to some scholars it is undoubted that innovation and technological change bring economic growth and social development in several areas, such as health, education, tourism and culture.

As a matter of fact, the Fourth Industrial Revolution can significantly raise the global income levels and improve the social conditions and the quality of life for billions of people in different societal and political contexts. Until today, nearly all countries in the Mediterranean area[1] are pursuing new policies to improve their ability to use new technologies and to speed the process of digitalisation. Hence, those who have benefited the most from technological change have been consumers of those countries, able to access the digital world and to benefit

[1] The region of the Mediterranean Sea includes the following countries: Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia, and Turkey. https://www.medqsr.org/mediterranean-marine-and-coastal-environment

from new products, processes and higher levels of efficiency brought from new technologies (Schwab 2016, 3; Göll and Zwiers 2019, 207).

The argument of this thesis was inspired by the will to answer to the question on how to exploit digitalization and innovation to make people's lives better, especially in emerging countries, such as Egypt. The idea of justice at the basis of this dissertation is a distributional kind of global justice, that operates to share globally the burdens and the benefits of living together. Global justice also means to facilitate the access to international trade and international networks for emerging economies and to make wealthier countries to reduce their emissions and pollution levels (Armstrong 2012, 12-14)

This dissertation aims at investigating on the role played by technological change in the creation of better life conditions and at understanding the nature of the relationship with social change. Moreover, the thesis not only makes an attempt to understand the necessary technological conditions for a social and economic development, but also tries to examine the social, economic, cultural and educational preconditions for a fully-developed technological progress. In fact, the assumption is that technological change can contribute for a more equal society, a redistribution of resources and a further economic, social and cultural advancement. Anyway, this process must be activated by social, economic and political factors and conditions, implemented by the governments helped by other actors. The result is a reciprocal causal process where technological change is both the cause and the effect.

In this thesis, it is assumed and demonstrated that, as intended in the concept of social innovation and "shared value", technological change plays a role in solving societal problems and needs by creating more job opportunities, new markets and by boosting economic growth (El Manouar and El Hilali 2020, 67; Göll and Zwiers 2019, 206). Companies, especially those operating with ICTs, play a fundamental role in coordinating the welfare services and in creating a new welfare model to improve working conditions, personal lives, to increase

family income, to defend health, studies and free time. Hence, it is here assumed that technological change influences culture and social norms, education and values.

It is also evidenced that technological change can markedly shape the welfare services and hence, foster workers' and citizens' wellbeing. Scholars maintain that the diffusion of ICTs has enabled a creation of value which is non coercive, equipotent and equally distributed, allowing cooperation amongst small producers and stakeholders (Mao et al. 2021, 6).

Therefore, in this work it is believed that social equity, the empowerment of women and fragile people and communities can be achieved only throughout the use of innovative systems, products and processes, but also emphasis on building digital skills must be done. In fact, it will be demonstrated that human capital is always at the centre of the digital transformation, and for this reason the Egyptian government has already started its engagement in cooperation with academic institutions and the private sector "to ensure youth are equipped with in-demand ICT skills" (Wilson Center, 2021)

Moreover, the principle followed in this thesis is the principle of distributive justice which maintains that not only economic issues, but also services, such as free basic education and job opportunities are to be ensured on a global basis (Armstrong 2012, 12-16). This assumption follows the Vision 2030 of the United Nations, which for social development and social justice means the need to ensure equal rights and opportunities among all citizens and the elimination of all sorts of social gaps (Bohl et al. 2018, 25) throughout the use of different means, such as the increment of productivity, efficiency, quality of work, new forms of salary and businesses (Bonomi et al 2020, 76-78; Orabi 2018, 1; Mao et al. 2021, 6).

Chapter 1
Technological Change and Social Change

As far as concerns the relationship between the technological and the social change, the two terms appear to be distinct and separated. Since the twentieth century, classic study on social change used terms of "material" and "non-material" culture, assuming that technology, as a part of modern culture, changes faster than other parts of culture, like social heritage, knowledge, moral laws, belief, law, custom. Nikolai Kondratieff in 1925 hypothesized the existence of long waves lasting about fifty years, characterized by the alternation of high and low economic growth. Joseph Schumpeter worked on this assumption and named these waves "Kondratieff waves" assuming that they are generated by innovation. Schumpeter then suggested his theory based on the "creative destruction" process, assuming the existence of alternating periods of growth and decline, stagnation and innovation, deadlock and process, crisis and development (Kavanagh et al. 2021, 2). Ogburn (1922, 200-283) also assumes that there is a "cultural lag" between changes in technology, or material culture, and changes in social, non-material culture. Even though the two concepts are locked into a causal relationship, they are not completely unified, instead it is better to keep the distinction between the two and to understand what social and technological changes are and how they might be measured (Kavanagh et al. 2021, 2-3). A suggested way to measure social change is through the record of social innovations over time but this might be difficult because of the absence of a ready dataset of social innovations. Another – difficult – way suggested by Bauer (1966) and Sheldon and Moore (1968), is to measure social indicators, but also in this case it is difficult to reduce aspects of culture and society to numbers. For these epistemological and methodological difficulties in its measurement, social change has remained largely unexamined and academic articles did nothing more than analysing aspects like technology, energy,

innovation, resources and climate change without recurring to an analysis of social change. In fact, complete research on social changes should examine also trends in families, religion, consumption, leisure, health, social stratification, welfare, education, work, wealth, law and order and other qualitative values present in the society (Kavanagh et al. 2021, 3-4). These categories are extrapolated from studies of Sheldon and Moore (1968) and Caplow et al. (2001) and all of them show changes affecting the society and therefore measure its wealth (Kavanagh et al. 2021, 3-16).

1.1 Technological Change: Origin and Meanings of the Concept

The original meaning of technology was related to "the study of arts and crafts", to what workers had to know to be qualified (Rip and Kemp 1998, 328). In fact, technology is not skill-neutral but favours particular skills while devaluates others (Dachs 2018, 16). In the nineteenth century and after, the concept included inventions and their exploitation. Rip and Kemp (1998, 328) state that "technology is shaped by social, economic and political forces" but at the same time technological change shapes human relations and societies. Dachs (2018, 15-16) talks about skill-biased technological change with particular attention to the application of ICTs, technologies requiring high skills to reach actual benefits in terms of occupation and productivity. Soon after the Revolutions and approximately around the 30s of the twentieth century, the concept of technology set up two related concepts: Technological Change and Technological Innovation. In 1929, the economist Kuznets identified processes like the invention of new machines, the discovery of new sources and new modes of use of goods, classifying them as technical changes and organizational changes (Godin, 2015, 9). An historical example of technological change is the steam engine, while a more recent one is the Internet (Ramadani et al. 2013,

333). Then in 1960, the Report “Goals for Americans” presented to the US President Eisenhower included a chapter titled “Technological Change”, dealing with automation and the concern of unemployment and displacement of workers. Consequently, in 1964 the National Commission on Technology, Automation and Economic Progress has been created with the purpose to deal with the effects of technological change on people. The Commission included the sociologist Daniel Bell and the economist Robert Solow and presented a first study hypothesizing that technological change constitutes a source of unemployment (Godin, 2015, 4).

Due to the controversial existing debate, many questions remain unanswered. What is technological change and which are its effect upon people? What is the difference between technological change and technological innovation? Technological change is “a systematic, on-going, non-reflexive and managed process, one of the key driving forces influencing long-term productivity and economic growth” (Garud et al. 1997). The impact of technological change can assume several faces: It can be understood as the replacement of old processes and products with new ones, the emergence of new firms, sectors and new consumer behaviours depending of different business models and consumers interactions but also as substitution of machinery for repetitive human labour (Bukht and Heeks 2017, 2; Autor et al. 2003, 1284). The Commission on National Goals draw up technological change as “the development of a better way of doing a known job or the discovery of how to do a previously impossible one”, while the Commission on Technology, Automation and Economic Progress as “new methods of production, new designs of products and services, and new products and new services” (Godin, 2015, 4-5). For many scholars, these two definitions correspond respectively to technological innovation and technological change. To some scholars, there is a slight difference between the two terms, while to others they can be used interchangeably. Kennedy and Thirlwall among other few scholars, hypothesised that technical change refers

either to effects of changes in technology on the economic growth, or to changes in technology itself. In other words, technical change represents either changes in society and economy due the technology, or changes in technology (Godin, 2015, 4-5). However, in all definitions, the term *change* is understood as a synonym of improvement, progress or advance (Godin, 2015, 5).

For anthropologists, the concept is linked with new technologies and their impact on society, so how people react and adjust their lives and their living conditions to new technologies. For instance, Margaret Mead's definition of technological change (1953) is "the introduction of new tools and new technical procedures" while for Margaret Hodgen (1952) is more about "alterations in the customary occupational habits of a group, expressed in the willingness of one or more individuals to adopt new tolls or techniques, to improve old products, or to manufacture objects hitherto not made in the local community". Others intend the concept in a wider sense, as Everett Rogers (1958) that defines technological change as "the degree to which individuals accept new technological practices" in the agricultural sector. Those scholars do not make a distinction between technological change and innovation but understand the former as the result of the latter and vice versa (Godin, 2015, 6-7).

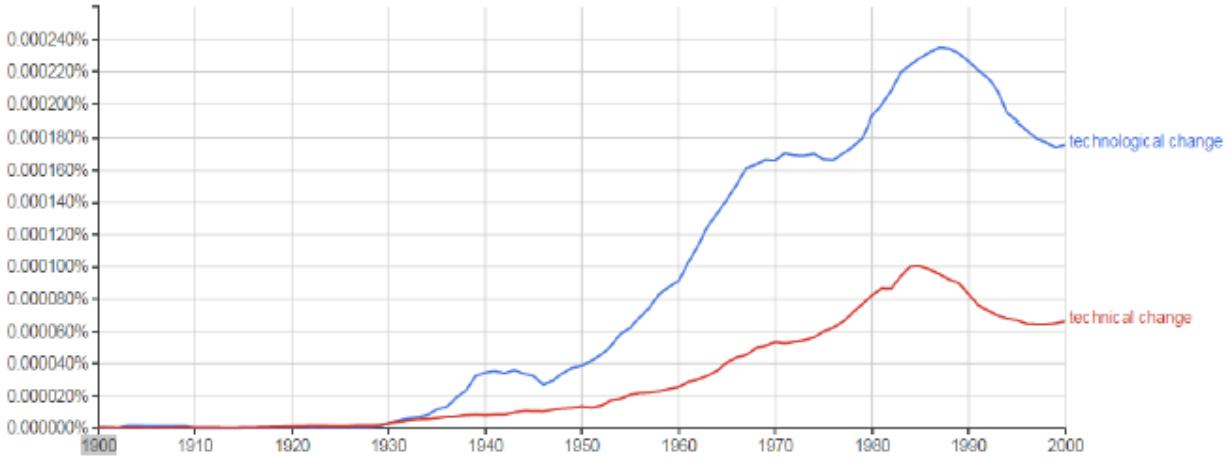
Economists such as Jerome, Kaldor and Robinson, accept a narrower meaning of the concept that focus more on factors of productivity, so they refer to technological changes as to changes in production processes and techniques, in the methods of production resulting from discoveries (Godin, 2015, 7). On the contrary, according to Hekkert et al. (2007, 414), this concept is not a narrow one, but it refers to "the development of technology in interaction with the system in which the technology is embedded". They call "innovation process" this system of interaction.

Finally, mathematicians use to look at the concept as change in productivity (output) resulting from changes in labour and capital, so in factors of production (input). May (1947) compares technological change to "a schedule which gives

the outputs corresponding to different factor inputs, such as changes in the production function", or in other words as a *shift* in the combination of factors of production, not a movement along the production function nor a simple growth in the quantity of factors. Similarly, Brozen (1953), assumes that changes in production methods correspond to changes in the ratio to combine resources (Godin, 2015, 8-9, 13). Brozen has been also one of the few scholars that paid attention to the impact of technological change on the society, on ideology and public policies in emerging countries. In other words, Brozen did not just study technological change as a separate phenomenon, rather as linked to history, sociology and economics (Godin, 2015, 13). Furthermore, another distinction is made among technical and technological changes: The first establishes changes in techniques or practices as the final result of technological change, (Schmookler 1966, 2), where a technique is "a utilized method of production" (Mansfield 1968, 3-11), while the second determines an "advance in knowledge or technology to the industrial arts" (Mansfield 1968, 3-11). Mansfield (1965, 136) defines technological change as the "process by which new processes and products are invented, developed, commercialized, and accepted". To Feller (1972, 155) technological change "involves the creation of a new set (which includes the old one) of production alternatives" and technical change is "a change in production method out of the existing (technological) set of alternatives". Conversely, Freeman (1974, 18) identifies technical change as "the commercialization and spread of new and improved products and [industrial] processes in the economy", and technological change to techniques or "advances in knowledge". Finally, Maclaurin (1953) describes technological change as a progress in technology done by the firms whose inventions come from the application of Research&Development (R&D) activities (Godin, 2015, 13). As revealed by the literature, a difference is not always made between the two concepts. However it is important to keep in mind that technical changes are about industrial processes, while technological change is about products (Godin,

2015, 8). In the light of these definitions, Godin (2015, 10-11) reports a graph that retrieves data from Google and gives an idea on how technological and technical changes progressed in a time span between 1900 and 2000.

Figure 1. Technological and Technical Change Progress (Godin 2015, 10-11)



The debate on the definition of technological change continued thanks to two committees, the Committee on the Social Implication of Technological Change and the Committee on Economic Growth chaired by Kuznets. They shared a widespread enthusiasm among scholars interested in technological change. Reunited in a Conference in 1952, these scholars collected an amount of thirteen papers on the topic of a very explanatory character and offering useful analyses, methodologies and data to define and prepare the research that would have come afterwards (Godin, 2015, 14-15). At the Conference, academics, scholars and researchers gave their contribution to assess an accepted definition of the concept of technological change. Again, new definitions emerged. To Fisher and Gilfillan (Fisher 1953, 57; Gilfillan 1946, 172) technological change is the adoption of new technologies coming from inventions. To Schmookler (1952, 214) the concepts should be defined in terms of "the index of output per unit of total input". Similarly, Leontief asserts that it can be described "in terms of quantitative input-output relationships", while Kuznets gave his definition of

technological change as "change in production practices", most of them caused by addition of knowledge (Godin, 2015, 16). The works of the Conference continued and in the 60s, critics from Schweitzer and Ruttan among others started to undermine the past understanding of the concept. They assumed that is not always true that technological change produces a change in the production function but it should be seen in a "more functional sense, so to designate changes in the coefficients of a function relating inputs to outputs resulting from the practical application of innovation in technology and in economic organization" (Ruttan 1959, 606). Subsequently, the approach that has been followed by every mainstream economist is the one that compares technological change to changes in the production function, leaving behind every approach based only on inventions and factors of production. It is assumed that a firm has at their disposals an number of inputs and a series of techniques that allow the firm to create the maximum amount of output with a lower combination of inputs. The production function is "the technological relation that exists between the quantity of product and the quantities of the 'factors' that co-operate in varying proportion to produce it" (Schumpeter 1954, 260; Godin 2015, 17). Nevertheless, this approach has been criticized by arguing that the focus on the production function could prevent to pay attention to the factors supplies and the consequences in terms of changes in technology (Godin, 2015, 24). Joseph Schumpeter also does not include inventions in the definition of technological change, nevertheless he understands technological change and innovation as a same thing. Thus, to Schumpeter, innovation is "the setting up of a new production function" depending on changes in factors of production. As a result, Schumpeters's theory of innovation[2] emerges from the Schumpeterian definition of technological change as "historic and irreversible change" which also

[2] Schumpeter's theory of innovation is based on the idea that a given quantity of output costs less to produce than the same or a larger quantity did cost or would have cost before that there has been innovation somewhere, if prices of factors have not fallen (Schumpeter 1939, 89).

corresponds to the definition of innovation (Schumpeter, 1939, 87-192; Godin, 2015, 18). Schumpeter has always been at the forefront in the study of innovation so that he still influences the whole literature on the topic, together with economists like Robert Solow, Paul Samuelson, Rupert Maclaurin, Yale Brozen, Zvi Griliches, Vernon Ruttan (Godin 2015, 19-20). Nevertheless, Schumpeter's theory has been not recognised by some authors such as Rosenberg and Leontief that considered the production function as a "fiction", a mathematical analysis that does not explains growth and does not provide a useful analysis based on empirical data (Godin, 2015, 25).

Later, thanks to the National Bureau of Economic Research (NBER) conference of 1962 not only economists started to research on the topic of technological change, such as the group "Inter-University Committee on the Microeconomics of Technological Change", but also engineers that started to show their interest in a process that has never been on the top of the chart for research purposes (Godin, 2015, 20-21). As of the 70s, Rosenberg, Nelson and other academics, inspired by the meeting on Economics and Technical Change held at the Annual meeting of the British Association for the Advancement of Science in 1968, published some articles in the field, arguing that technological advance could result in an increase of output. The discussion about technological progress and its impact on output levels is characterized by different and contrasting contributions that can be summed up with Solow's assumption that "no way has been found to measure directly the contribution of technological progress to the growth of output" (Godin, 2015, 25).

1.2 Technological Change, Innovation or Invention?

Economists found hard to disentangle technological change in all its component factors nor they succeeded in estimating statistically the impact of technological

change on the output. Concepts like technological and technical change, innovation, inventions, science or creativity have been treated for long time as synonyms. Irwin Feller criticized to unifying all those concepts in a single one, nevertheless many scholars continued to use technological change, technological progress and innovation interchangeably or sometimes they also substituted the former terms with the latter (Godin 2015, 22-26; Ramadani et al. 2013, 325). Then what is an innovation and what is an invention? In earlier times, the concept of Innovation was coinciding with "Induced Innovation"[3]. This term was related to "Induced Invention" as "change in the relative prices of factors of production" (Hicks 1932, 22) that lead to inventions, able to save labour and capital and therefore increase the profit. Overall, innovation and invention were both used to define innovations allowing to save labour and capital along the production process. Only afterwards, Schumpeter and then Weil Brown used the term "Induced Innovation" with a completely different meaning (Godin 2015, 27). In the context of the NBER Conference, Jora Minasian defined invention as "a factor or input to economic growth and productivity" that can come from research and development and finally impacts profitability. To other scholars, such as Zvi Griliches, the relationship between technological change and economic growth is very thin (Godin 2015, 24). Following this, invention is when an idea including a new product or process is created for the first time, while innovation coincides with the first attempt to carry out the idea in practice. Innovation is "making new things", and it differentiates itself from creativity, which is thinking about new things, the ability to think about new ways to solve problems which are then applied through the innovation. In a way, creativity, inventiveness and invention are all linked together: Creativity is the possibility to combine input to output to produce something new, be this a product, a process; innovativeness is the process itself to create something new that

[3] Changes in input prices which induce changes in capital-labor ratios (Godin 2015, 22).

improves in a way the overall mankind knowledge; innovation is the final result of Inventiveness, so the definitive marketing of a new product or process or service (Ramadani et al. 2013, 325). In recent studies, the concepts of innovation and technological change coincide. Technological change is not defined anymore as "change in techniques" but as changes in the way of production through new methods of production, the introduction of new products or the boosting of existing ones in order to increase the production (Robinson 1952, 33-34; Ramadani et al. 2013, 324). To this view, technological change stands for "the rate at which new knowledge is put into physical forms and diffused for use in the economy" (Ramadani et al. 2013, 333). Robinson (1952 33-34, 42) states that an innovation "involves stepping from one combination [of factors of production] to another" and that "all types of innovations can be described in terms of the changes in the quantities of labour and capital required to produce a given rate of output" (Godin 2015, 26). To Lionnet, innovation is a "dynamic technical, economic and social process" that allows to earn money from a new idea. Through this process new products or services are created while others are modified and modernized, new technological processes are introduced and new organization models are applied within firms (Ramadani et al. 2013, 325). Ramadani et al. (2013, 325) use a definition from the UK Department of Trade and Industry, which understands innovation as "the successful exploitation of new ideas and involves investment in new products, processes or services and in new ways of doing business". The last definition implies that exist several types of technological innovations that complement one each other to reach their full potential. Schumpeter classifies them as follows:

1) Innovation of product: the production of new goods that never existed in the market and are likely to be sold.
2) Innovation of process: the creation of new methods of production or the implementation of existing ones that increase the output by a certain mix of new or existing input that will lead to a lower cost of production.

3) Innovation in services: the production of services that never existed in the market and are likely to be sold.
4) Innovation in management: this entails new ways to organise work, new conditions that allow a firm to take the monopoly position in the market where before has never been competition.
5) Marketing Innovation: changes in the marketing features of a product or a service (Ramadani et al. 2013, 332; Dachs 2018, 10; McDaniel 2002, 57-58).

Although the term innovation has been widely used not only by economists but also by sociologists and in fields other than the pure economics or statistics, a unique definition and understanding of the concept is still missing. Innovation has been recognised as a "too subjective category" that led to different ideas and perceptions on its core identity, leading to a widespread scepticism towards the several different interpretations given (Godin 2015, 27). Today a possible definition can be "the successful combination of hardware, software, and orgware, where orgware refers to the various components of the innovation system" (Hekkert et al. 2007, 414). The higher the speed of innovation, the more it is assumed to increase economic growth, firm performance, development and societal benefits (Hekkert et al. 2007, 41; Ramadani et al. 2013, 326). Robert Solow was indeed the first to empirically prove the relationship between innovation and economic growth in the 87% of US firms between 1909 and 1949. Solow hypothesizes that technological change is the factor through which innovation operates, hence the "rate at which new knowledge is put into physical forms and diffused for use in the economy" (Ramadani et al. 2013, 326).

Schumpeter also argues that innovation plays an important role to create a better position of firms in the market and to better compete with other companies. The higher the competition, the more the companies are encouraged to adopt innovation and new ideas. When the innovation process requires a short time,

companies can benefit from decreasing production costs and their overall ability to better locate in the market increases (Ramadani et al. 2013, 331-332). Then what stimulates innovation? Certainly Research&Development (R&D) is a key factor to stimulate technological change resulting in new goods, services and knowledge and higher economic profit. Nonetheless, the relationship between R&D and innovation is not always stable nor it is the unique stimulus to new technology. In modern economies also other activities are extremely linked to the use of ICT and new technologies coming from R&D (Ramadani et al. 2013, 332-333). To Hekkert et al. (2007, 414) and part of the scientific community, technological change and related innovations are the result of innovation systems[4]. In making this assumption, these scholars state that technological development is not an autonomous process nor it is self-driven, nonetheless it requires a management from national governments and innovation policy programs to be addressed (Hekkert et al. 2007, 414). Those scholars explain through the innovation system, the reasons and the elements that slower technological change and make it difficult to influence. They are:

- Lock-in situations between the incumbent technology, the existing innovation and the new emerging technologies and innovations;
- Rigid technological paths;
- Difficulties in terms of improvements and high costs;
- Low adaptation of the innovations to the socio-economic environment because of "accumulated knowledge;
- Capital outlays;
- Infrastructure;

[4] Innovation systems are "heuristic attempt, developed to analyse all societal subsystems, actors, and institutions contributing in one way or the other, directly or indirectly, intentionally or not, to the emergence or production of innovation" (Hekkert et al. 2007, 414). To Freeman (1987) they are "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies".

- Available skills;
- Production routines;
- Social norms;
- Regulations and lifestyles (Hekkert et al. 2007, 415).

From this brief explanation on the origin of the two concepts of technological change and technological innovation, a difference is not often made but where it is highlighted, it is in the way the technology is treated: In the former case, as an exogenous force, while in the latter, as an endogenous one. Other scholars also differentiate the two terms based on the agent concerned with the effects of technology: The study of technological change put people at the centre of its perspective, while the study on technological innovation is more keen on the role of firms and industries generating new technologies and on the impact these technologies have on the productivity and competitiveness of the firms (Godin 2015, 27-28). To conclude, the phenomenon of technological change is extremely linked with the concept of progress of modern societies through innovation and the introduction of new machines, products, processes, the advent of automation and mechanization (Godin 2015, 29).

1.3 ICTs and the Digital Economy

Technological change is unquestionably the driving force behind the assumption of a dominant role by the Information Communication Technology (ICT) and the birth of the Digital Economy, a phenomenon that started almost two decades ago and is increasing sharply thanks to economic and political forces (Bukht and Heeks 2017, 2; Badran 2019, 2). The roots of Digital Economy can be traced already in the 1990s when the phenomenon of the Internet emerged and soon after the 2000s the development of new Information Communication Technologies hampered economic changes, the way of doing business and to

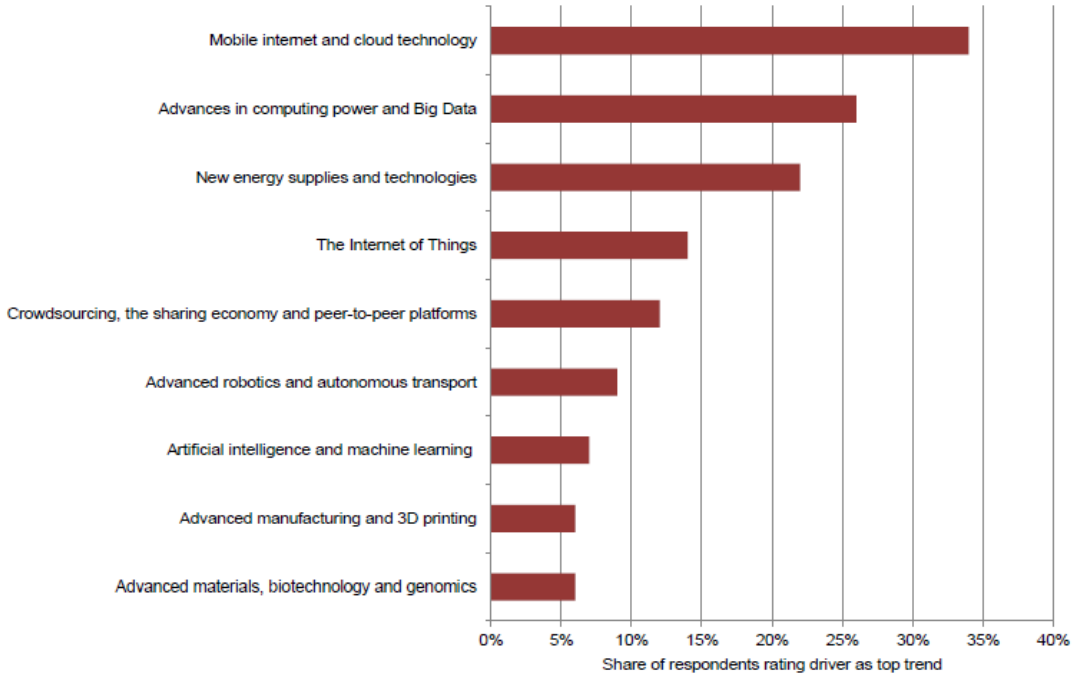
operate transactions. In addition, General Purpose Technologies (GPTs)[5], a small group of technological innovations, were able to accelerate or interrupt the normal pace of economic progress. Together with ICT they have modified the market and the processes within firms, have stimulated complementary innovations and the way to use them, so that influenced the everyday lives of individuals. The development of the Internet stimulated new digital models like the Internet of Things (IoT), cloud computing, digital services and platforms and the increment in the usage of data coming from the web, namely BigData, and its analysis through complex algorithms. All these features and phenomena have been allowed thanks to the advent of new end-user devices like mobile phones, smartphones, laptops, tablets, 3D printers. Indeed, it is hard to think of a world without computer, mobiles and all the benefits related to them. Computers combined with networks create Information Communication Technology, bringing a set of advantages to companies and the economy in general (Bukht, Heeks 2017, 2; OECD 2015; Ramadani et al. 2013, 333; Brynjolfsson and McAfee 2012). Certainly, technology plays a transformative role when it becomes General Purpose Technology and enhances productivity in different economic sectors. The diffusion of GPTs often require long time and complementary changes to adapt in the social, economic or political sectors. The use of ICT to easily communicate is a clear example of application of GPTs, because it contributed to transform an old process into a new one (Bruckner et al. 2017, 5). A new strong ICT expansion started with the digital revolution and the creation of new technologies and capabilities has recently characterized the beginning of a new revolution phase, called the Fourth Industrial Revolution, or Revolution 4.0. (Schwab 2016, 1-2) states that the Industrial Revolution 4.0

[5] A General Purpose Technology or GPT is a term coined to describe a new method of producing and inventing that is important enough to have a protracted aggregate impact. Electricity and information technology (IT) probably are the two most important GPTs so far (Jovanovic and Rousseau 2005).

impacts physical, digital and biological spheres but its changes are different in velocity, scope and system impact. The areas most affected by this new transformative process are slightly different from the past and the exponential speed of the current breakthroughs has never occurred before. The birth of the Internet already brought the possibility to connect from mobile devices with high storage and processing capacity and to access worldwide to knowledge and unlimited contents. Computers could perform processes like storing, retrieving and analysing information that increased human cognition and its efficiency in carry out processes. Today, the importance of the Internet has increased dramatically until it has been incorporated into the organization of work and in processes. The emerging technologies related to the Platform Economy, the Internet of Things, robotics, Artificial Intelligence, Machine Learning and Deep Learning mechanisms are contributing to increase computational power, datasets and the automatic solution of problems and situations in different spheres like the bio-tech, green-tech, nano-tech and neuro-tech (Bruckner et al. 2017, 5; Schwab 2016, 1-2; Autor et al. 2003, 1284; Drahokoupil and Fabo 2016, 1). Many scholars consider the AI to be the driving and central force of the 4IR, both because it is a transformative power of existing and new technologies and because it can mimic the behaviour and the abilities of the human intelligence with its software-based systems (Bruckner et al. 2017, 5). Moreover, digital technologies were the key factor for the creation of social media platforms to share information and create interactions among people. In other words, the Fourth Industrial Revolution impacted customer expectations, product enhancement, collaborative innovation and organizational forms (Schwab 2016, 4-5). Before going in the details of the Digital Economy, it is important to clarify the definition of Information Communication Technologies (ICT). They represent the core of the Digital Economy, a component of technological progress, which are supposed to represent the main determinant for economic change both in developing and developed countries (Bukht and Heeks 2017, 11;

Arendt 2015, 248). ICTs include technologies like autonomous vehicles, additive manufacturing, algorithmic decision-making supporting human decisions based on large data sets and probabilities. Industrial and service robots are also included on the list of new ICTs, as they can perform a number of manual or physical tasks or other activities where humans are not needed anymore. Bitcoins and other technologies that challenge traditional banks started to be in the new ICTs list, together with the technological changes in the production process that allow to create a series of services based on network connectivity and embedded in particular and more customized goods (Dachs 2018, 23). ICTs have increased their impact in today's social and economic life by modifying the way of doing business, the behaviour of consumers and their interaction, together with the way government provide public services. Moreover, ICTs play a crucial role on the productivity and on the GDP growth, even more than any other sector has ever done in the economy (Arendt 2015, 248; Ramadani et al. 2013, 332-333). In fact, ICTs are on the frontline of the new technologies sector while other technology drivers are almost not considered at all from academic research (Dachs 2018, 28). In Figure 2, released from the World Economic Forum (2016) and reported by Dachs (2018, 28), are seen the categories of ICTs having a major impact on employment and overall on the society.

Figure 2. Technological Drivers of Change (World Economic Forum 2016, 7)



The Figure 2 clarifies that ICTs are the protagonist subjects in the study of social change while other technologies do not cover this central position (Dachs 2018, 29).

According to various studies on ICTs, it was shown that their impact on the GDP growth accounted between the 0.5% and the 7.5%, with benefits especially in emerging economies. The European Union encourages its member States to invest in innovation and in competition but encourages mostly companies and small enterprises to rely on the use of ICT and IT, to create a network of services at a regional level and to support eco-innovation (Ramadani et al. 2013, 333-334, 338-339).

As far as concerns Digital Economy, a unique and immutable definition does not exist, rather all the definitions of the phenomenon reflect their times and trends. For instance, at an earlier stage, scholars focused more on the Internet while later contributions on mobiles, sensor networks, cloud computing and big data (Bukht and Heeks 2017, 5-10). Brynjolfsson and Kahin (2000) in Bukht and Heeks (2017, 5) define Digital Economy as "referring specifically to the recent and still largely unrealized transformation of all sectors of the economy by the

computer-enabled digitization of information." This definition follows the one by Tapscott (1996), arguing that the Digital Economy includes "informational basic tasks" together with "interactional activities enabled by the Internet" (Bukht and Heeks 2017, 5). Soon after, other scholars like Kling and Lamb (2000) included e-commerce and the ICT goods and services in the definition of the Digital Economy, becoming aware of the different sectors and components constituting the phenomenon that has no rigid boundaries (Bukht and Heeks 2017, 5). For instance, the definition of Lane (1999) for Digital Economy is "…the convergence of computing and communication technologies on the Internet and the resulting flow of information and technology that is stimulating all of electronic commerce and vast organisational changes" (Bukht and Heeks 2017, 5). The one of Kling and Lamb (2000) "...includes goods or services whose development, production, sale, or provision is critically dependent upon digital technologies" (Bukht and Heeks 2017, 5). In 2013, the European Commission described the Digital Economy as "an economy based on digital technologies", while the European Parliament (2015) as "a complex structure of several levels/layers connected with each other by an almost endless and always growing number of nodes" (Bukht and Heeks 2017, 5). Coming to the recent days, the focus moved to a definition of Digital Economy as a force to improve economic and sustainable growth, including the areas and the activities into which it is differentiated. Dahlman et al. (2016) in Bukht and Heeks (2017, 5) argue that "the digital economy is the amalgamation of several General Purpose Technologies and the range of economic and social activities carried out by people over the Internet and related technologies. It encompasses the physical infrastructure that digital technologies are based on (broadband lines, routers), the devices that are used for access (computers, smartphones), the applications they power (Google, Salesforce) and the functionality they provide (IoT, data analytics, cloud computing)". The Bureau of Economic Analysis belonging to the U.S Department of Commerce also tried to define the Digital Economy. It

found difficult to give a precise definition because of the different activities and the rapid change of the nature of the technologies, that certainly constitute a characteristic of the Digital Economy (Barefoot et al. 2018, 2-3). However, Computer Networks like the Internet, the eCommerce and Digital Media and contents that users can create and access, stand at the basis of the Digital Economy. The existence of the Internet and other Computer Networks is ensured by the following digital-enabling infrastructures, basic materials and organizational patterns:

- Computer Hardware: The manufactured physical elements that a computer system is formed of, such as monitors, hard drives, semiconductors, wireless communications products, audio and visual equipment products;
- Software: Programs and information used by devices, like commercial software of software produced by the firm itself;
- Telecommunication equipment and services: Services needed to transmit information at a certain distance;
- Structures: Buildings where goods or services useful for the Digital Economy are created, including buildings that provide support services to digital products (data centers, semiconductor fabrication plants, fiber optic cables, switchers, repeaters);
- Internet of Things: Internet-enabled devices, such as appliances, machinery, cars with embedded hardware allowing them to connect and communicate with each other and with the Internet;
- Support Services: Services needed for the correct function or reparation of digital infrastructures, like digital consulting services, computer repair services (Barefoot et al. 2018, 5-7).

Digital Media are also considered as a constituent component of the Digital Economy, referring to the digital non-physical content that everyday people create, access, store, view on digital devices. Those media can be direct sold to consumers in exchange for a fee or a subscription or on an item-by-item basis.

Some other can be accessed for free, such as content on Facebook or Youtube, that earn from the advertisements on the margin of the digital products. Some other free content is created from consumers and addressed towards other consumers, known as peer-to-peer or P2P digital media. Finally, Big Data is the large amount of data created from the use of digital media or services offered by the companies that overtime try to collect and gather information on the behaviour and preferences of consumers to improve their performances. Sometimes, those companies well the information coming from consumers to other companies (Barefoot et al. 2018, 6-8). As said before, it becomes even harder to define the limits and the scope of the Digital Economy. Therefore, Bukht and Heeks (2017, 12) better refer to the "Digitalised Economy", following the differentiation of Brennen and Kreiss (2014) between digitisation – the transformation of data from the analogic form into the digital form - and digitalisation – the application of the digitisation to the economic activities and processes (Bukht and Heeks 2017, 11). They would represent the Digital Economy as the result of the production and the application of the digital technologies. In this way, a broader concept can be accepted including the whole digital sector – content, services, retail, good, software and infrastructure – and other emerging phenomena like the Platform Economy, the Gig and the Sharing Economy (Bukht and Heeks 2017, 11-12). This broader definition is useful to include in the field of Digital Economy not only firms that are completely digital, like Google, Facebook etc, but also other firms and eCommerce platforms that sell tangible goods, like Amazon, Alibaba, Uber, Airbnb (Bukht and Heeks 2017, 12).

Digital change and the digitalisation created new services that are provided by "new actors" operating in the market – the Platforms. Platforms became so important in our economy that contributed to name it "Platform Economy". Alongside the benefits of the newly created Platform Economy, it raised issues that have never existed in the old economy, namely regulatory issues and

concerning taxation, social security, inequality, exploitation of law-skilled workforce (Degryse 2016, 26-28). Technology platforms, easily used from smartphones, assets and data, are shaping the way of consuming and buying goods and services, they connected consumers and businesses and changed the working environment (Schwab 2016, 4). As a result of these new phenomena brought by technological change, socioeconomic transformations occurred as a direct consequence, in the economy, society and the labour market. The difference between the past is that old products were obtained through older technologies and processes. Today, new technologies give rise to new and more efficient processes that allow the creation of new types of jobs, new ways of work and an increased demand that stimulate the production and the economic and social prosperity (World Economic Forum 2020, 9). Nevertheless, the Covid-19 pandemic hampered the already existent negative trend both in the economic and in the social sector. The great instability and inequality levels existing since the first financial crisis of 2008 became greater when automation, technology and globalization gained a central role adding some more risks to the already existent economic instability. Disruption of labour market, unemployment and income inequalities are now bigger challenges every economy and government have to deal with (World Economic Forum 2020, 9). To understand the actual impact of the Digital Economy on the well-being and on the economy, Arendt (2015, 249) presents two ways to measure the Digital Economy of a country. The author talks about two indexes: NRI – Networked Readiness Index - and DESI – Digital Economy and Societal Index - related to DAE, Digital Agenda for Europe, an EU initiative of 7 pillars adopted in March 2010 as part of Europe 2020 Strategy. The first one comprehends four sub-indexes (environment, readiness, usage, impact) that form an overall averaged value between 1 and 7. The index works by assigning a value to each country that form a ranking and shift from a place to another improving or worsening their performance and showing the real changes. In 2015 it has been observed

that the NRI value in average of the European central and eastern developing countries (around 4) was still lower compared to the EU average (around 5), with the only exception of Estonia that exceeded 5 points. This showed a slow economic performance linked to ICTs of these countries (Arendt 2015, 249-253). The second index was adopted in 2015 by the European Commission and includes 30 indicators describing the EU countries digital performance in the context of 5 other pillars: connectivity, human capital, use of internet, integration of Digital technology and Digital Public Services. From the studies using these indexes resulted that even though EU developing countries are putting their effort for reaching a digital standard translated into economic and social benefits, some differences remain with other EU countries in their digital performances (Arendt 2015, 249-253). In particular, the research explains in detail that when a country places itself on a good place in the ranking of its advancement in the use of digital public services and the Internet, then they are more likely to be classified as high-performing countries, on the contrary, these features are translated automatically into a low economic productivity and low well-being indexes in the country (Arendt 2015, 254). Therefore, the Digital Economy is the future of the economy and the society. Dachs (2018, 21) estimates that it will employ highly skilled experts as well as low-skilled workers bringing a better working balance and more opportunities to the second category. Another consequence of the advent of Digital Economy is likely to be the gradually shift towards more self-employed contractors and independent experts able to offer products at lower prices. The tasks performed outside the firm will increase progressively because of the crowd-working, the division of tasks to produce a good and the offshoring of steps of the value chain. All these new features of the economy will affect profoundly the society and peoples' lives (Dachs 2018, 22). Many of the traditional companies are now operating in the context of the Digital Economy by investing in digital platforms, marketplaces where good and services are more easily sold and bought at a

lower transaction cost, that allow to decrease the labour outsourcing costs. The Platform Economy contributed to make easier to enter the market by lowering the costs of access and boosting the competition in the market. Moreover, digital platforms guaranteed an expansion of the economy in informal markets where there was no regulation nor organisation of labour. As a result, the Digital Economy and the use of ICTs permitted to re-organise activities based on the employment relationship into self-employment activities and brought several benefits both from the consumers side and from the suppliers' side (Drahokoupil and Fabo 2016, 2-4).

Chapter 2

The Social Costs of Technological Change in the Short Run

This chapter deals with the current discussion on the effects of new technologies on society and daily lives. The focus is on the impact of information communication technologies as an opportunity to change political, economic and social structures and to shape society for societal needs (Dachs 2018, 23; Mao et al. 2020, 2).

Many authors investigated over time on the role of technological progress and its relationship with productivity changes, the creation of job opportunities or losses and its effect on social welfare. More attention has been paid recently since further progress has been reached in the development of Artificial Intelligence and other digital transformations that paved the way to what is called the *Fourth Industrial Revolution*. In a European Commission communication of 2021 (2), scholars like Barnhizer (2017) and Geels (2005) maintain that technological innovations influence not only the nature and the quality of work and the economy, but more important that have an impact on the structure of the society, shaping forms of social inequality and the creation of social classes. For this reason, it could be the driving force for a digital society where no-one is left behind (European Commission 2021, 2). Some scholars expect from technological innovation a direct positive effect on the labour market through the opening of new markets, new products and processes, the improvement of a country's economic growth, financial and sustainable development, a more efficient exploitation of resources, higher wages and more job opportunities due to higher demand and overall societal benefits. In fact, for many, it is likely that technological innovation will lead to a supply-side miracle characterised by long-term profits in efficiency and productivity, hampered by lower transportation and communication costs. In fact, one of the key lessons from the Covid-19 pandemic has been that the digitalisation and the ICTs can

bring millions of people together independently of their geographical location to create digital networks with social or economic aims and therefore, new opportunities (European Commission 2021, 2). These scholars also predict that the cost of trade will diminish thanks to the better logistic and improved supply chains that will finally lead to open new markets and increase economic growth. Mostly important, a good developed digital infrastructure can become a good enabler for rights, freedoms, to allow people to empower themselves and to get them access to knowledge, culture and health services, to receive more opportunities in terms of jobs, fun, learning, participation to the democratic life also from remote areas. A clear example can be the birth of telemedicine and the remote care and robotics solutions to protect patients at their homes by allowing medical staff to support them and to monitor their status from remote. Moreover, technological transformation also helps in the fight against environmental pollution and the reaching of sustainable objectives. Digital solutions allow the transition to a circular and more sustainable economy where business travels can be easily substituted by videconferences and where digital technologies allow for greener processes in many fields, such as agriculture, energy, city planning and services (European Commission 2021, 2).

Other scholars predict a negative effect of technological change, for instance greater inequality, unemployment, job losses, environmental challenges. The risk for those scholars is the differentiation between high-skill/high wage and low-skill/low-wage segments that can end into social tensions and differences. The type of impact of technological breakthroughs can depend on the type of technology, the speed and the conditions of its diffusion and the institutional engagement (Wang 2020; Matuzeviciute et al. 2017; Hekkert et al. 2007, 414; Bruckner et al. 2017, 7; Schwab 2016, 2-3). The greatest risk coming from the Fourth Industrial revolution is inequality. Since technological innovation is often owned by innovators, shareholders and investors, they tend to be seen as "providers of intellectual and physical capital", endowed with higher levels of

wealth in comparison with those dependent on labour. Hence, technology also represents the reason of the stagnation of incomes and the key factor that increased the demand for highly-skilled workers while letting the demand for lower-skills and lower-education workers to decrease. The new face and need of the market worry millions of workers that fear to be displaced and suffer for dissatisfaction, unfairness and for the stagnation of their wages (Schwab 2016, 4).

Klaus Schwab and Saadia Zahidi, respectively the Executive Chairman and a Member of the Managing Board of the World Economic Forum are concerned about the status of the current economy. The income inequality rates are growing together with the disrupted labour markets. The economic shock following the Covid-19 pandemic of 2020 contributed to stimulate more concerns about technology-driven displacement of jobs and that the current social contracts and social prevention norms are showing themselves as inadequate (World Economic Forum 2020, 2-3). In this crucial situation, technological innovation can be of impact to "unleash human potential, to reskill and upskill individuals in unprecedent numbers, to deploy safety nets which protect displaced workers from destitution, and to orient them toward the jobs of tomorrow" (World Economic Forum 2020, 2-3). The crisis brought by the Covid 19 pandemic exposed the vulnerabilities of the digital space and infrastructures with a clear dependence on a few big tech companies and a few technologies that increased the impact of disinformation in some societies. Another aspect hampered by the Covid 19 pandemic has been the digital divide between urban areas and remote areas and the differences between their inhabitants in the access to secure digital space and a range of services. This also put the light on a new "digital poverty" so the fact that not every citizen and business have the same chances for a better life thanks to technological transformation (European Commission 2021, 2).

Conversely, Innovations and new technologies may impact positively on the social economy and the third sector. Technological change may improve communication and co-operation within groups and people, may also help to deal with social issues throughout mobilisation, crowdfunding, new forms of organisations, a more democratic decision-making process (Dachs 2018, 40-41). In light of these development brought by the impact of technological change on the society, the concept of Social Economy was created to define the union of firms, organisations and other entities organised as co-operatives, associations and foundations. Social Economy does not carry out only economic activities, rather it places services for members of a community for free, manages itself autonomously, has a democratic decision-making process and put people and work at its centre and over capital and revenues. The concept of Social Economy is strictly linked to the one of Social Innovation[6], considered to be the social aspect of technological change and a sort of innovation in developing economies and context (Dachs 2018, 38). For instance, aim of Social Economy is the growth of employment especially among vulnerable groups. In the EU, the Social Economy employs about 14 million of people, soon after the Manufacturing and Retail sectors, at the same level of employment of the Construction sector. Social organisations are active mostly in social assistance sectors, education and training sector, work integration, culture and recreation and health sector, so sectors that require high levels of social interactions and therefore, are less likely to be automatized from new technologies (Dachs 2018, 39). Therefore, the concern here is about the possible opportunity that technological change can bring to the well-being of the citizens and whether the economy can be negatively or positively affected by new technologies, as ICTs.

[6] Caulier-Grice et al. (2012) define Social Innovation as new solutions, including products, services, models, markets, processes, that involve at the same time an improvement of capabilities and a better use of assets and resources, and that meet social needs (Dachs 2018, 39).

2.1 Economic Growth and Labour Market

Many scholars asked themselves on the economic relationship between technological change in terms of progress in ICT, economic growth and changes in the labour market. Which kind of impact do they have in the short run on the economy, the labour market and the national productivity? How do they affect our social lives? Over time, scholars and academics tried to answer those questions by building an economic theoretical literature on innovation and its impact on productivity, which became quite vast and reliable, although the evidence of research is sometimes contrasting. Before investigating in detail the effect of technological change and ICTs on productivity and economic growth, it is better to give a definition of productivity. Productivity refers to the ratio between factors or production, or input, and the effective production, or output. When productivity increases, then it means that the output increases by using the same inputs. As some noted, productivity, innovation and employment growth are linked to each other, especially in technological sectors. Innovation may lead to different levels of productivity that stimulate employment. This final effect differs based on the type of innovation and other variables but according to some theories, innovation and technological change enhance speedy economic, inclusive and sustainable growth and development (Dachs 2018, 10-11; Oladipo and Grobler 2020, 1394). Dachs (2018) reports two different effects, in the short and in the long run, that innovation has on employment growth.

On the one hand, in the short run, process innovations allow firms to produce the same or even more amount of output by reducing at the same time the number of inputs (capital and labour) thanks to the substitution of inputs and the progressive technological change. The consequence in the long run is an increase in the productivity levels and a decrease in employment levels. On the

other hand, in the short run, innovation of product stimulates the demand from the consumer side and, if prices are elastic and there are no competitive products, it stimulates employment growth in the long run. Dachs (2018) calls the former effect "productivity effect" and the latter "demand effect" (Dachs 2018, 10-12). Moreover, if the market is quite competitive and there are no monopolistic firms producing goods, a "price effect" can operate; it describes the reduction of prices of goods and services when the costs of production are reduced due technological change as well by leading to a higher demand, market expansion and growth in employment (Dachs 2018, 12). In order to analyse and assess the economic impact of ICTs on economic growth and productivity, Arendt (2015, 249-261) suggests Solow's "Growth Accounting Model" of 1957, the first that aimed at calculating the aggregate production function by following this formula:

$Y = Af\ (K^{NOICT}, K^{ICT}, L^{U}, L^{S})$

Where:

Y, Gross Domestic Product

A, index of the aggregate state of technology (Total Factor Productivity – TFP)

K, input of physical capital formed by K^{NOICT} – non ICT – and K^{ICT} – ICT capital

L, input of labour formed by L^{U} – unskilled labour - and L^{S} - skilled labour.

According to Solow's formula, Gross Domestic Product increases either when capital or labour inputs grow, or when the TFP is included. Changes in TFP are assumed to be caused by changes of technology and regulate the relation between inputs (K and L) and output (Y). Solow assumes that investments in ICT (software, hardware, infrastructure) may influence GDP by deepening the capital and augmenting the ICT-capital that corresponds to a better quality of labour resources and finally, to an increment in labour productivity. Then, according to the Skill-biased Technical Change hypothesis, investments in ICT lead to an increase in the demand for high-skilled and qualified personnel: the

increased demand stimulate the structure of the labour force to change towards higher quality of human capital. As a result, also the stock of labour and the TFP will be influenced. Moreover, technological changes and improvements in the ICT-producer sectors is likely to influence other sectors, like the ICT-users sector by lowering prices, improving efficiency of the production factors and stimulating the TFP to grow. Fourthly, Solow states that ICT as General Purpose Technology (GPT) generates sharp spillover effects, like non-financial external effects, that impact positively the TFP (Arendt 2015, 249). In addition, Ramadani et al. (2013, 326) assume that technological change and Innovation, not only in terms of ICT, is the main stimulus to an economic growth. They confirm a positive impact of Innovation on living standards, productivity, income per capita and consumption in the long run thanks to the improvement that Innovation brings to goods, services, processes and economy's capacity for invention and innovation.

Innovation as information technology and creation of knowledge increases creativity and discovery. Studies conducted in the USA and Japan demonstrated that ICT investments and overall investments in Innovation, have contributed to increase the performance and the economic productivity and they ensured great benefits for the companies. USA and Japan are known for investing a huge amount of their resources to create innovation. For instance, USA invest the 50% of its resources to create new products, processes and services. As a result, in the long run, innovation processes made firms and people more productive, by increasing wages and benefits at a rate of 2% per year (Brynjolfsson 2011, 74; Ramadani et al 2013, 327).

In the 27EU countries, almost all showed an improvement in innovation performance, translated into a higher economic growth in a longer timeframe. The enforcement of property protection, a dynamic competition and a serious commitment in sustainable Research&Development activities enabled the advent of Innovation in European countries. Moreover, investments in

Information Communication Technology further stimulate the innovation levels (Ramadani et al 2013, 329).

Nonetheless, not every study nor empirical data confirm the positive impact of innovation on the economy: negative economic effects are also associated to technological development (Bruckner et al. 2017, 5). This is what Solow called the "productivity paradox", the fact that the full potential of the ICTs can only be exploited together with investments at the micro and macro level, for instance investments in workers skills and business processes or increment in the stock of human capital, policies focused on the flexibility of the markets, the diffusion of new technologies, and are to be seen in the long run. Complementary changes at the micro and macro level are necessary to hamper the economic impact of the ICTs (Arendt 2015, 249-259). Technological progress and its modern technologies require high-skilled labours and people strongly qualified in science and technology. From this assumption, rises the concept of HRST – Human Resources for Science and Technology – that play a complementary role together with ICT investments. CEE developing countries did not perform in an exemplar way: none of the economies reached knowledge standards for their workers and their share of individuals working in the Science and Technology with a completed tertiary education was still very low compared to EU-15 countries. This leads to phenomenon like underemployment or overemployment, when respectively people who do not possess tertiary education are hired for positions that require higher skills. Anyway, the quality of human capital in the CEE countries improved in recent years and results in an increase of labour productivity and consequently in GDP growth (Arendt 2015, 258). As a result of Arendt's study, it can ultimately be stated that there is a clear relationship between growth in ICT capital and human capital, as a complementary element for a consequent growth in labour productivity and in terms of GDP. Complementary micro and macro adjustments contribute to create a "digital friendly environment" that facilitate the full and efficient use of ICT to stimulate

GDP and productivity (Arendt 2015, 260). In conclusion, can be assumed that CEE developing countries benefited the most of investments in ICT capital and the spillover effect related to it in comparison to EU-15 countries (Arendt 2015, 260-261). Brynjolfsson (2011, 61) argues that in the long run, social and living standards depend on economic productivity and economic growth, which depend on innovation. According to Brynjolfsson, if managers, economists and governments aim at improving the social standards of the population, they should before look at the productivity and the level of innovations in the economy.

This view is based on the assumption that digital innovations have an impact on productivity and economic growth in three ways:

1) Digital Innovations increase productivity through growth accounting. The price of ICT has dropped significantly over time and it declines even more if taken into account that an increase in governmental expenditure in ICT is associated with an increase in national productivity;
2) Firms usually invest more on innovative management techniques than in ICT, so that those practices can amplify and widen the ICT investments;
3) Digitalization is becoming the central element of the innovation process both in the economy and in industries (Brynjolfsson 2011, 61).

Brynjolfsson (2011, 61-65) takes in consideration three facts on innovation to summarize the economic literature of innovation. First, it should be kept in mind that input to innovation do not correspond to the output in terms of growth rate, measured through the Multi Factor Productivity (MFP) rate. Some researches show that in 1950, an R&D worker was associated with seven times as much Multi Factor Productivity Growth as in 2000. This trend is worrying but it may be the result of mismeasurements of the productivity statistics: since the growth rate in MPF comes from the national accounts, it should be converted into real values considering price deflators. Moreover, in the digital world are increasing contents and goods delivered for free, for instance YouTube, Facebook, Twitter,

Instagram, that have no weight in the GDP statistics. As the usage of those contents is not reflected in the productivity statistics, neither the increasing product variety and does. According to the same research, the declining ration of MPF growth to R&D investments is hypothesized to depend on the increasing age of innovators, forced to retard their first innovation because of the need to specialize more; moreover, they are not likely to change their field because the need to learn more knowledge before their first innovation.

Secondly, differences among regions and countries have a wide impact in the generation of innovations. For instance, limited geographical regions produce an enormous number of patents and innovations because they follow different innovative paths and business innovations. The ICT and Internet sector has conducted a series of business innovations that are modifying completely industries and their way of producing and retailing their products.

Thirdly, the social impact of innovation on the society depends on the size of the economy it is affected by it. In other words, when technological development allow the reduction of costs of production of a good or a service and therefore its costs, then the share of GDP related to that good or service will be reduced as well if the good or service price is inelastic, ultimately causing the reduction of the economic benefit on he economy. Although there is no economic law predicting this event, it is likely in the ICT sector that when prices of goods are elastic to the demand, then the share of expenditure grows, leading the national productivity to grow as well (Brynjolfsson 2011, 61-65).

Evidence of the US economy given by Oliner at al. (2007) and Jorgenson et al. (2004) in Brynjolfsson (2011, 61-65) is the increase in the economic and productivity growth rate as a result of ICT-enabled innovations, although other nations have not experienced the same. Brynjolfsson (2011, 66) reports the findings of Stiroh (2002) assuming that firms using ICT are more productive and faster than others.

According to many economists, information technologies have always had an impact on business models, business process innovation and on the activities of the organizations. Schwab (2016, 4) states that on the supply side, many firms using new technologies and innovative processes can disrupt existent industry value chains in the long run. The access to global digital platforms for different purposes (research, development, marketing, distribution, sales) is the key force to improve the quality, the speed and the price at which innovative companies replace other non-innovative competitors. On the demand side, in the long run, the change in the consumer behaviour, increasingly engaged and influenced from data coming from the internet, leads companies to adapt their design, markets and the delivery of products and services (Schwab 2016, 4).

In the last three decades, so in a long-term view, the process of digitization of the economy and its activities impacted in several ways. Brynjolfsson reported four of the implications of digitization on innovation and on the economy, which are:

1) Improvement on the real-time measurement of business activities;
2) Faster and cheaper business experimentation;
3) Easier sharing of ideas;
4) Faster and easier replication of innovations of product and process (Brynjolfsson 2011, 68).

It is unquestionable that technological change and innovations like ICTs allowed collecting an enormous amount of detailed data and information on customer activities and relationships that give real-time insights on their behaviour, preferences, allow targeting and personalising products advertisement to gain the highest productivity. The access to the World Wide Web is the key to have available billions of searches, keywords, information of purchases and economic activities that are easily instrumented and used for analytical purposes in order to increase, modify and target business processes. The data stemming from the use of Internet is free and has been recently used to form possible business

innovations suited for the needs of a particular company and its products (Brynjolfsson 2011, 69).

Testing and experimenting products, goods, design, ideas is much easier since the advent of digitization. Industries also increased their cooperation and the technological tools they possess permit them to share ideas, information and good practices. Together with increasing economic productivity levels, the biggest benefit brought by Information Communication Technology in the long run is the creation of knowledge, that has a central role in the creation of non-tangible value, like discovery and creativity. Hence, knowledge, discovery, creativity, high-skills and technological capabilities deriving from the penetration of new technologies in the market, are likely to become the most important elements for the future of the companies (Brynjolfsson 2011, 69-74).

2.2 Job Destruction and Job Creation

Unemployment all over the world and especially in the EU rose from 2008 to 2012. This rise just stopped in 2013, when the peak reached 10.9%, corresponding to about 22.872 million people without a job, and in some cases started to slowly decrease, like in 2015 when it reached 9.4%. In EU the people most affected by unemployment were those with lower education levels, such as primary or secondary education or even less. The unemployment rate affecting this group of people doubled during the crisis, going from below 10% to more than 18% after 2013. It is worthy to notice that the group of people possessing tertiary education increased their employment rate reaching a peak of 59 million people employed in 2015, but the group of people with upper secondary and post-secondary education still holds the maximum share of employment, corresponding to the 50% on the total EU employment. The World Economic Forum (2020) releases trends in the USA labour market between 2007-2018.

The research gives evidence that the demand for employment of "nonroutine analytics jobs" was already increasing while the demand for routine and manual jobs were facing a gradual decrease (World Economic Forum 2020, 9). As a result, 2.6 million workers dealing with technologies and processes have been displaced when these technologies became obsolete (World Economic Forum 2020, 9).

Moreover, many of the most severely affected countries by the crisis of 2008 were the countries that faced a more rapid decrease in the levels of unemployment, with the exception of Italy and France. Even though unemployment rates in the EU decreased after the 2008 crisis, it is still in average 2.4% higher than before the crisis among all the countries. The quality of unemployment, which is not limited in time, is often long-term lasting (for instance 1 year or more), compared to times before 2008. In the EU market, youth unemployment is widely diffused, reaching a peak of 23.7% in 2013 (Dachs 2018, 7-9, 15-16).

Especially after the Covid-19 pandemic, the future of work and the labour market became more uncertain than it was before. In the timeframe between the first and the second half of 2020, real unemployment jumped to 6.6% (World Economic Forum 2020, 10). The World Economic Forum (2020) predicts that it could increase reaching 8.9% by the end of 2021, while the International Labour Organisation (ILO 2020) estimates the reintegration of 195 million of displaced workers and transformation of jobs from the second quarter of 2020 but it is still uncertain whether unemployment can increase over time. The crisis provoked by the Covid-19 pandemic clarified that new ways of working are necessary. More scholars think that it is needed to think to live in a "new normal" era, characterised by digitalisation, automation and remote work. The questions whether the changes of the labour market towards a wider digitalisation contribute to the displacement remain unanswered (World Economic Forum 2020, 10).

Soon after the Great Depression in 1929, a debate on the impact of mechanization on employment emerged. Scholars assumed either optimistic or pessimistic positions. To scholars in fact, technological change may have an impact on the labour market and it can be different among sectors. As of this discussion, other debates and scientific measurements of the effects of technology began (Godin, 2015, 10). For instance, the economist Paul Douglas (1930) stated that in the long run progresses in the machinery and in the efficiency would have not displaced workers nor created permanent technological unemployment, but they may have created temporary unemployment related only to the short run. The effect on technological change is evident both in the industry, manufacturing sectors and service sectors (Degryse 2016, 17-18; Piva and Vivarelli 2017). Degryse (2016, 17-19) notices that this difference becomes less relevant since when industry and services are ever more merged together to produce manufactured products with technological features combined with a series of digital services offered to the purchaser. As said by Rifkin in Degryse (2016, 17-19), the trend is therefore the passage from an economy based on the possess of good, to an economy of services: today's economy is a "cultural production economy" instead of an "industrial production economy", where the access to services is more important than owning items. In other words, scholars found hard to give a definitive assessment of the impact of technological change on the labour market, nevertheless they assume two main positions: on the one hand, technological change is a key force to create jobs, on the other hand, it destructs jobs (Piva and Vivarelli 2017, 4).

This last phenomenon takes the name of "Technological Unemployment", so "unemployment due to technical progress", according to a definition of The Oxford Dictionary of Economics, because it makes obsolete particular types of workers and tasks compared to the changing methods of production (Campa 2018, 58). Already during the First and the Second Industrial Revolution there

has been a shift in the sectors of production, when workers in the agricultural and manufacturing sectors have been displaced and moved to the secondary sector. Campa (2018, 59) calls it a "migration" of the workforce, that happened again from the manufacturing sector to the service sector in the last three decades. Thanks to the free market and ad hoc public policies including industrial policies, unemployment rates, increasing when a new technology was introduced to the market, contributed to keep the labour market stable. When these strategies did not function properly, there have been moments when technological employment assumed bigger proportions and started to be at the centre of the debate (Dachs 2018, 60). It was the 19th century when the Luddites fought against the machines seen as a threat to their jobs in the English cotton mills. They were seeing these machines as the main cause for their and their family's starvation. Ricardo explained that the working classes feared to be replaced by innovation and new technologies while economists afterwards began to be confident in market compensation effects, ensuring that thanks to those machines the productivity could increase and contribute to create new jobs and diminish routine jobs (Piva and Vivarelli 2017, 4; Campa 2018, 61). Adam Smith and John Stuart Mill shared an optimistic perspective concerning the impact of mechanization on the economy. Mill was believing that the labour class is away from suffering from the introduction of machines while Smith believes that the only way to increase the production was due technological progress. He states that:

> "The annual produce of the land and labour of any nation can be increased in its value by no other means but by increasing either the number of its productive labourers, or the productive powers of those labourers who had before been employed. […] The productive powers of the same number of labourers cannot be increased, but in consequence either of some addition and improvement to those machines and

> instruments which facilitate and abridge labour; or of a more proper division and distribution of employment (Smith 1776: 455-456)"

Schumpeter (1954) believes that "initial sufferings" would have been compensated by "favourable ulterior effects" (Campa 2018, 63). Afterwards, Ricardo retracted his optimistic opinion on the effects of mechanization and hypothesized a labour saving effect that, in every case, it should have damaged the working class because of the substitution effect perpetrated by the new machines (Campa 2018, 63). After, Marx (1976) observes that machinery brought all but freedom and guarantees for workers. According to his view, men, women and children lost their original income and started to be exploited. The result was a higher rate of unemployment (Campa 2018, 66). At the same time, Keynes (1963) reintroduces the concept of technological unemployment presenting it as a "new disease". He states that technological change will affect positively the labour market in the long run, because the benefits will be redistributed and will lessen the working hours with an increase of the pay per worked hour. Scholars like Paul Douglas, Gottfried Haberler stand with Mill and Ricardo doctrines. Their argument is that technological change does not represent the reason of permanent unemployment, contrarily, Alvin Hansen, Hans Neisser, Adolph Lowe, John Hicks are unsure about the conditions creating unemployment and whether it is permanent or limited in time (Campa 2018, 67-71).

Soon afterwards, Keynesian scholars participated in the debate by rescuing a more standard, neither positive nor negative, position. They were claiming that technological change will displace some workers, not every worker but it will change the labour conditions, working hours and the overall organisation of work. In other words, Keynesians state that in the newly created capitalism regime, short-run unemployment is not caused by technological progress, rather by public policies, because people would enjoy technological change by earning more and working less (Campa 2018, 72-73).

Starting from the twentieth century, the econometric literature at the macro and micro level concentrating on the nature of technological change, gave different results: some classified technologies as capital-saving, others as labour-saving, others more as neutral. For instance, Van Reenen (1997), Entorf and Pohlmeier (1990) considered the impact of technological change on employment rates as small and not significant (Dachs 2018, 12). Soon after the optimistic approach of the 80s, the idea of involuntary unemployment due technological change and automation began to exist again. Nevertheless, some jobs benefited from technological progresses in terms of costs and efficiency. The tertiary sector for instance went fast in the direction of the digitalisation. This brings potential benefits as well as potential threats from different sides (Campa 2018, 73-76). For instance, an attempt to highlight the impact of innovation and technological change on the labour market, has been through looking at intellectual property rights (IPRs) including patents, trademark copyrights, registered industrial designs, and integrated topographies. The IPR system of a country plays a crucial role in the promotion of innovation, entrepreneurship and economic growth in that country. According to some scholars, both in 20th and 21th century IPRs combined to market liberalization contributed to economic growth (Ramadani et al. 2013, 329-331). Van Roy et al. (2018, 1765) contributed to the discussion with their research on the relationship between innovation and employment on a dataset on European patenting firms in the manufacturing and service sector for the years 2003-2012. They used heterogeneous data from the European Patenting Office (EPO) and the Office for Harmonization in the Internal Market (OHIM) representing the 27 EU countries and 23.111 firms. The main finding was that innovation has a labour-friendly impact (Van Roy et al. 2018, 1764-1765). The dependent variable included in their study was the number of employees of the company while differently from past studies, they decided to consider citation-weighted patents rather than R&D expenditures or innovation dummies to assess the impact of innovation on labour demand. The

key impact variable chosen from Van Roy et al. (2018) had more advantages than the other approach, because patents better proxy product innovations that are more easily appropriated by others. In fact, while process innovations are often embodied in machines or products to be kept secret and to avoid imitation, process innovations are often patented because they can be more easily copied. The study considers 73% of firms which operate in the manufacturing sector, 53% of which are part of high-tech sectors. The evidence from this study is that service firms and low-tech manufacturing firms show the lowest rate of employment and value added but highest wage level. On the contrary, high-tech firms have the highest level of employment, value added, weighted patents and growth in investments (Van Roy et al. 2018, 1764-1766).

The model followed by Van Roy et al. (2018) is the following:

$l_{i,t} = \chi\, l_{i,t-1} + \alpha y_{i,t} + \beta w_{i,t} + \gamma\, invest_{i,t} + \delta\, innov_{i,t-3} + (\varepsilon_i + \nu_{i,t})$

where small letters are natural logarithms

l = labour

y = output

w = wages

invest = gross investments

innov = innovation in terms of citation-weighted patents

ε = individual and time invariant firms's fixed effect

ν = usual error effect

The results achieved by Van Roy et al. (2018) are quite stable and reliable, showing no labour-saving effect coming from technological change and innovation processes but the domination of capital formation and the decrease in the labour cost per employee on labour demand. In other words, the impact of technological change over employment seems to be positive, although not slightly. Moreover, innovative activity seems to have a significant positive impact on employment in the manufacturing sector and a lower positive impact in the service sector. To go more in detail, the positive impact of technological

change on the labour market is more consistent in the high-tech manufacturing sector rather than in the low-tech one, that is to assess that the labour-friendly effect of new technologies is concentrated the most in the advanced, high- and medium- tech manufacturing sectors, characterised by higher demand elasticity, higher technological opportunities and the dominance of the "welfare effect" over the "substitution effect" (Van Roy et al. 2018, 1766-1769). On the contrary, manual routine tasks, so tasks that "can be accomplished by machines following explicit programmed rules" because "require methodical repetition of an unwavering procedure" can be more easily replaced by innovation and technological change (Autor et al. 2003, 1283).

Autor et al. (2003, 1280-1302) built an empirical model trying to find an answer on the topic. The model is based on changes in occupational tasks in the period between 1960 and 1998 and predicts that after investments in computer capital - because of its lower price -, firms will use it to reduce labour inputs employed to carry out routine tasks and simultaneously they will demand for highly educated workers[7]. The evidence was found in the data, showing a decline in the share of labour force employed in intensive routine tasks (either manual or cognitive) in favour of nonroutine cognitive tasks. This data is confirmed by the fact that educational levels became higher within industries because of the increased demand for educated labour force. In other words, according to Autor et al. (2003, 1320-1324), computerization processes in firms stimulated the growth of graduate employment of around 3.7% from 1980 to 1998. Then, task shifts are

[7] For an extensive definition of the existing types of tasks, Acemoglu and Autor (2011) classified them in four groups:

1) analytical and interactive non-routine tasks;
2) analytical and interactive routine tasks;
3) Manual non-routine tasks;
4) Manual routine tasks (Dachs 2018, 18).

associated with the adoption of computer technology both within gender, education and occupation groups and between them. Then the rule in the short run follows that as technological progress increases, productivity and real wages increase as well. Therefore, the income for labour and capital rises and stimulates greater demand both for goods and services that lead, finally, to a greater demand for labour (Degryse, 2016, p.21).

Schumpeter was the main scholar arguing that technological innovation leads to job creation. Contrarily to other scholars, he maintains that technological change stimulates not only process innovation but also product innovation. Then, both further stimulate new jobs.

Dachs (2018, 9) analyses an EU-funded study, also quoted by Peters et al. (2014), which considers the impact of innovation on employment growth at a firm level in different European countries in the period between 1998 and 2010. From the research, it results that innovating companies, and therefore innovating countries, show higher rates of performance than companies and countries whose innovation levels are not satisfying. This leads to higher levels of unemployment in those countries (Dachs 2018, 9).

Piva and Vivarelli (2017, 1) find that R&D expenditures associated to product innovation have a "significant labour friendly impact" mainly in the medium- and high-tech sectors. Despite this, in the low-tech sector, the same type of innovation is likely to slow down employment rate growth, while process innovation related to capital formation and gross investment may reduce employment rates because of the "labour saving effect due to the embodied technological change" (Piva and Vivarelli 2017, 1).

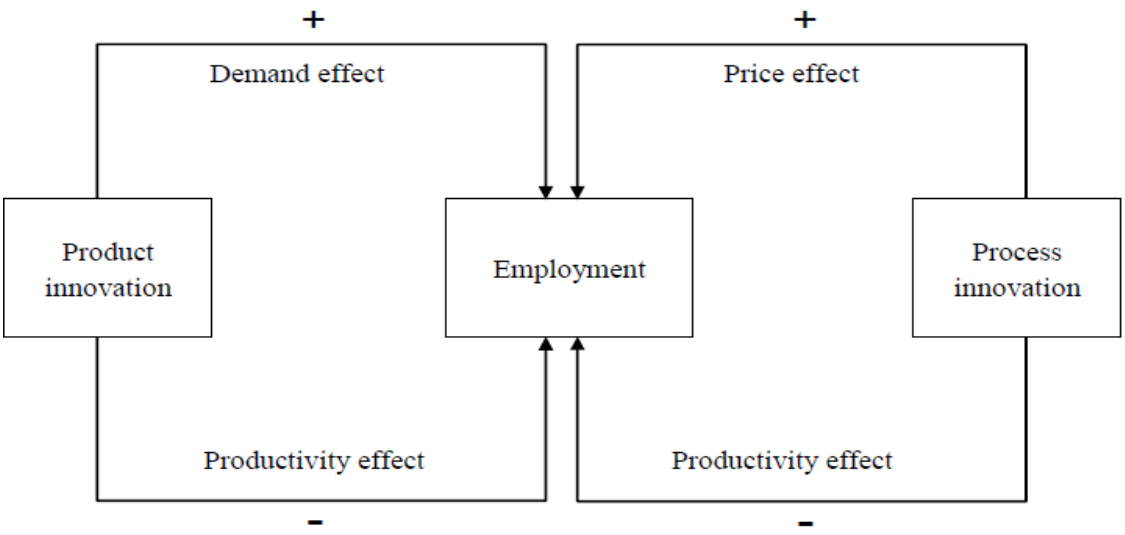
In the same way, Bukht and Heeks (2017, 18) share the idea that the Digital Economy and the progressive digitalisation of the economy creates more jobs: the IT and ICT sector account for around 1% on the total of jobs in emerging economies, while around the 4% in the developed economies. Bukht and Heeks (2017, 18) support the argument of Nottebohm et al. (2012), which demonstrates

that the proportion of job created and jobs destroyed by the Internet is 3.1 versus 1. Despite this, there is still a difference between Northern and Southern regions, where respectively an average of 3.2 and 1.6 jobs are displaced by the Internet (Bukht and Heeks 2017, 18). Equally, El-Darwiche et al. (2012) estimate that the Digital Economy contributed to create 17 million jobs in emerging countries in the period between 2009-2011 and there is a high probability that the data is underestimated (Bukht and Heeks 2017, 18). As revealed by the Boston Consulting Group (2015), ICTs have a positive impact on productivity and employment so to increase jobs of 6% until 2025 (Dachs 2018, 25). Alternatively, Wolter et al. (2015) hypothesise that new technologies will affect industry in its structure, resulting in a loss of some types of jobs in the manufacturing sector and the gain of the same number of new jobs in the service sector (Dachs 2018, 25). Bruckner et al. (2017, 17-18) is of the view that the introduction of new technologies brings productivity at higher levels, decreases costs and consequently rises the demand. Notably, the increment of productivity through technological change is done at the expenses of the traditional workforce and capital labour, replaced by machines performing the same tasks in a shorter frame of time. Nevertheless, this general rule is not always valid, for instance Bruckner et al. (2017, 17-18) show that only one of 270 types of occupation existing in 1950 in the US Census have been replaced by automatic processes, and it was the elevator operator. Therefore, technological change does not substitute jobs, rather it changes the type of jobs and how they are performed. Besides the traditional manual, cognitive, routine and non-routine tasks, other types of jobs will be created, such as teleworks (Mao et al. 2021, 10). Hans Boeckler Foundation study (2015) supports this argument and clarifies that technological change surely has an impact on the nature of jobs, nonetheless this can not directly be associated to job losses, but to a shift of the tasks that today belong to men and that will, probably, belong to machines in the near future (Degryse 2016, p.25). Even though technology may destroy jobs,

there is undoubtedly a counter effect of job creation operating through several ways. First, technology and automation make the operations more specific and precise, therefore more productive and valuable. This leads to an increase in the demand of workers performing non-routine cognitive tasks, such as consultants, IT managers and high-skilled workers. Secondly, technological innovations create new products able to fulfil human needs and increase employment levels (Bruckner et al. 2017, 17-18). In addition, ICT and the use of Internet improve and allow the access to education services, resulting in important effects on the society in terms of overall education levels and work expectancy levels (Mao et al. 2021, 10). In the same way, Marx shared the theory predicting that new machines and investments, lower wages and prices can compensate the "labor-saving effect" of innovation. To Marx, compensation of unemployment is done through investments in new structures and machineries for digitalisation. Moreover, an increment in the number of new products can stimulate the product demand and therefore the demand for labour force (Matuzeviciute 2017; Dachs 2018, 27). Despite this, the compensation effects may work in a condition of perfect competition and demand and supply elasticity (Emara 2020, 263; Blien and Ludewig 2017). Greenan and Guellec (2000) and Lachenaier and Rottam (2011), quoted by Dachs (2018, 10-13), confirm the positive effect of process innovation on employment growth, even more positive than the impact of product innovation. In fact, product innovation brings two types of effect, namely the "cannibalisation effect" and the "business stealing". These effects refer to the fact that new, more technological products are likely to replace other "old" products already existent in the market. New products are endowed with an increased functionality and more technological features so that they can negatively affect sales of older products of the same company (cannibalisation) or products of other competitor firms with lower functionality or with higher prices (business stealing). The only exceptions are when a new product released on the market aims at completing an existing one or extends the range of

products of a firm in a certain sector (Dachs 2018, 13). The mechanism explaining the positive/negative effect of innovation on employment can be summarized as in Figure 3, released by Peters et al. (2014) and used by (Dachs 2018, 13). Figure 3 explains that both product and process innovation lead to employment, either thanks to the price and demand effects or thanks to the absence of productivity effect

Figure 3. Effects of Product and Process Innovation on Employment (Peters et. al 2014)



Overall, it is not true that the technological progress brought unemployment. Rather, since the 19th century the employment of machines contributed to create more jobs in the long run, although in the short run job destruction dominated. This is explained by the fact that the disruptive effect of technological progress often takes place in the immediate time after the introduction of the new technology, while counter effects, including changes in the types of jobs, a progressive job-polarization, offshoring of jobs and the disappearance of medium-wages jobs, may take some time and therefore, be the result in the long run (Bruckner et al. 2017, 19-20).

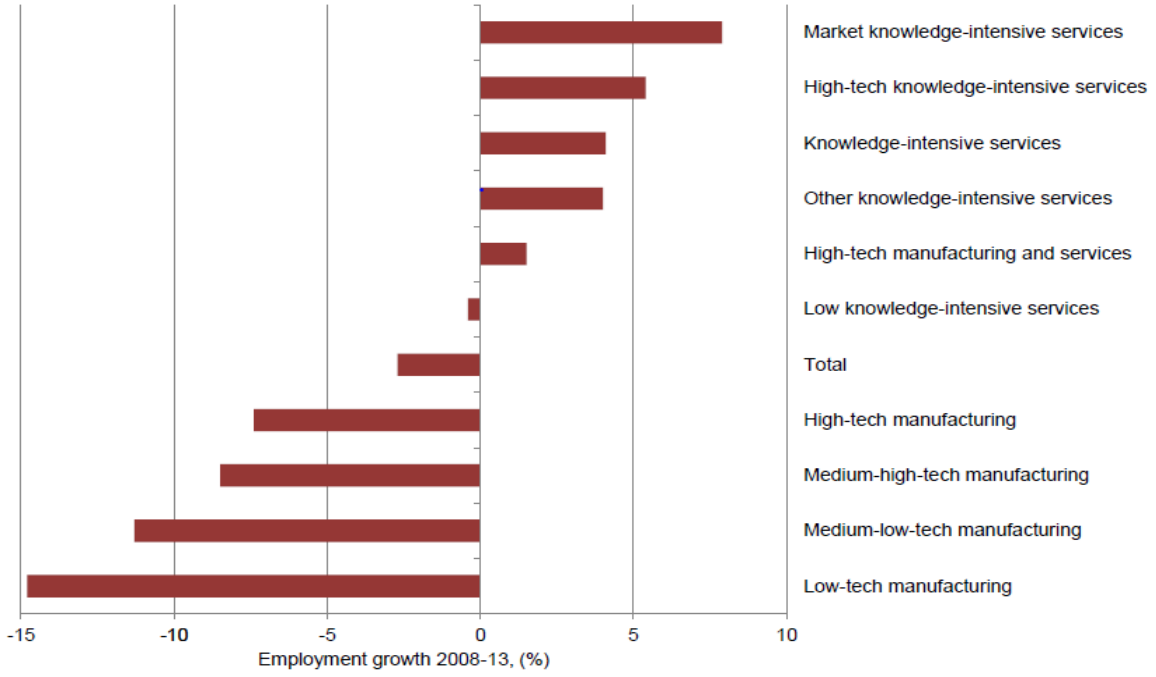
Other scholars believe that employment crisis and stagnation come cyclically after a crisis, like in 1929 or 2008. Nonetheless, stagnation and job losses are not

just related to economic crises but also provoked by the inability of a country to innovate and to increase productivity. In this discussion, "stagnationists" maintain that only innovative ideas and technological progress can lift an economy. This argument is criticized by scholars like Brynjolfsson (2012) and McAfee (2014), stating that technology and innovation negatively affect employment and bring stagnation and job losses, although they can increase productivity. They believe that innovation is developing so fast that it has left behind many people, the "losers" of the race against the machine, whose wages and quality of life has been affected since the process of digitalisation and technological change. Besides innovation as lifter of productivity, it should also stimulate economic growth and social wellbeing as a consequence. Some scholars, such as Matuzeviciute (2017), Brynjolfsson and McAfee (2012), follow this view and believe that process innovation stimulates unemployment by reducing costs of production and consequently replacing labour with new equipment and productive technology, with the aim to improve productivity and efficiency of firms. They support the argument by stating that institutions have not followed the rapid pace of technological innovation, therefore innovation benefited only a portion of the population, namely high-skilled people, while it has displaced workers belonging to other sectors, like the agricultural one. Dachs (2018, 18) further points out that the demand for jobs based on routine tasks has sharply fallen while workers with higher education levels and high-skills has risen. Hence, as a result of the so called "job polarisation" and "routine-biased technological change", workers belongings to sectors affected by technological change were forced to reskill and to move to different sectors, like service and manufacturing, where employment opportunities have been improved by technological change (Brynjolfsson and McAfee 2012). Moreover, globalisation boosts job polarisation because it allows firms to offshore routine jobs to other countries where the production costs are lower. It is estimated that job polarisation accelerated since 2008 and affected medium-paid jobs in

comparison to high- and low-paid jobs (Dachs 2018, 18). Frey and Osborne (2013) show that the 47% of total US jobs are "at risk" to be replaced by skills of robots. In Europe the 54% of jobs are at risk of automatization. For instance, the highest percentage of jobs will be displaced among peripheral European countries, such as Romania (61.93%), Portugal (58.94%), Bulgaria (56.56%), Greece (56.47%), while other central countries will be less affected – Germany (51.12%), Belgium (50.38%), France (49.54%), the Netherlands (49.50%), the United Kingdom (47.17%), Sweden (46.69%) (Degryse 2016, p.24). This data is supported by the fact that today's technologies are more powerful than those brought by the First and the Second Industrial revolution. They are able to carry out complex routine tasks, both manual and cognitive operations, that do not require any judgement, intuition or persuasion. These tasks are likely to be fully automatized in the next future thanks to Big Data and Artificial Intelligence. Nonetheless, this does not mean that low-skilled jobs will be completely displaced, rather will be kept as complementary to high-skilled tasks and jobs (Dachs 2018, 18). The sectors most likely affected by new technologies are the ones relying on routine tasks, such as the manufacturing one, the service sector, retail, administrative services and storage, the transport sector, logistics, construction, sales and commerce and some type of services like the financial ones. Other sectors relying on social capabilities and interpersonal relations, such as education and training, arts and media, legal services, business, engineers and scientists, social works, health, agriculture, forestry and fishing, are less likely to be impacted by automation (Degryse 2016, 23; Bruckner et al. 2017, 28-30; Brynjolfsson and McAfee 2012; Dachs 2018, 25-26). Summarising, on the one hand, workers with lower levels of education are the most affected by new technologies, because they perform tasks based on routine and automatic activities, such as entry keyers, library technicians, photographic process workers, tax preparers, cargo and freight agents, watch repairers, insurance underwriters, title examiners, searchers etc. On the other hand, more

educated workers perform tasks and duties that are difficult to replace since they require high level of social and creative intelligence, requirements that cannot be substituted from any technology. Examples of these jobs are recreational therapists, installers, management directors, mental health and social workers, audiologists, doctors, dieticians and nutritionists, lodging managers (Bruckner et al. 2017, 30; Dachs 2018, 25). As a result, Figure 4 from the European Commission (2016) showed by Dachs (2018, 14), summarizes the employment level per sector in the EU countries.

Figure 4. Employment by Technology Intensity of the Sector (European Commission 2008, 2013, 2016)



From this study, it is evident that market knowledge-intensive services and high-tech knowledge-intensive services are the less affected by unemployment due to technological change. The former category includes professional, scientific and technical activities like water and air transport, legal and accounting activities, marketing and consultancy, architectural and engineering activities, security and investigation activities. The latter category includes ICT services, television,

music and film industry, telecommunications and commercial R&D services. The big gap stands between services and manufacturing sectors. The higher employment rates in the services sector are explained by the income elasticity of services and the possibility of offshoring in the manufacturing sector, so to move the manufacturing step to countries that guarantee lower costs of work (Dachs 2018, 14). Moreover, innovation applied to the service sector is non-technical, that means based on social and interaction skills. Then, knowledge spillovers in the services sector are lower than in the manufacturing one, where innovative ideas could be easily imitated and copied (Dachs 2918, 14-15). These are some of the reasons why scholars believe that technological change may rise productivity levels in the manufacturing sector, although at the expenses of traditional jobs. Despite this, Dachs (2018, 15) still maintains that innovation and new technologies can move capital among sectors and therefore can reallocate employment. On the contrary, Bonin et al. (2015) and Arntz et al. (2016) support the idea that ICTs have an overall negative impact on employment, regardless of the sector (Dachs 2018, 27). Likewise, Matuzeviciute (2017) reports Malthus theory, stating that if companies invest in capital-intensive technologies, they will obtain not only lower costs of production, but also lower prices and therefore a rising demand of products. Nonetheless, this leads to a decrease on the demand for labour force. Certainly, companies are not encouraged to hire new employees because of the reduced demand of products together with the prospect of lower wages. Thus, as a consequence, technological unemployment rises (Matuzeviciute 2017). This view is shared also by Blechinger and Pfeiffer (1999), stating that process innovation causes job losses and unemployment, although officially there is no unanimous answer to the issue but contrasting contributions. In fact, besides some companies gaining from technological change, there are others who lose from this process. Among the possible reasons there is the unaffordable cost of innovation, much higher than the traditional way of working, that include the costs of new

materials, new processes and organisation, training for employees and production shutdowns. Moreover, it is hard to predict exactly the gains in terms of employment due to technological change since a model on actual data does not exist. (Bruckner et al. 2017, 31; Dachs 2018, 27).

To sum up, although it is problematic to assess the relationship between technological change and employment levels, it can be stated that employment losses due to technological change are more than compensated and that innovation contributes to create enough jobs to counterbalance technological unemployment. Anyway, the debate on the prevailing effect between the "welfare effect" and the "substitution effect" is still open. Hence, a possible answer is given when looking at the balance between product and process innovation together with the social and institutional context (Piva and Vivarelli 2017, 11; Dachs 2018, 27).

2.3 Inequality and Regulatory Concerns

A crucial aspect related to technological change is its impact on wages, so its role as a driver of economic and social differences or, contrarily, as a way to solve the gap between the poorest and the richest. The Covid-19 pandemic hampered the effects of the Fourth Industrial Revolution and showed not only that a digital world and society is possible but also that it is sometimes more productive and efficient. The question remains whether technological change can stimulate the wellbeing of the world's population or if remains a driver of economic and social inequalities. Existing social and economic challenges became harder to tackle, extreme poverty and the exclusion of social classes on the basis of race, gender, age, generation, mental and physical abilities, education level, health level, geographic location are just some of the growing issues that the progressive technological change has brought since its

development (World Economic Forum 2020, 19). In this context, the concept of inequality is related to the concept of monetary or income inequality. Inequality can be measured by looking at the households income before and after public transfers and taxes. Wealth inequality, on the contrary, aims to assess wealth distribution throughout several data, referring to real estates, debts, social security (Dachs 2018, 29).

The main argument on the issue is given by Bruckner et al. (2017, 20-21), which believe that the job polarization caused by technological change brought a rise in wage inequality in developed countries. This is the result of the "strong complementarities" between information technologies and cognitive non-routine activities, that played a role in increasing the marginal productivity of already high-skilled workers. Moreover, the labour supply of low-skilled workers is more elastic than the one of high-skilled workers, workers with high degrees or diploma, which contributed to hamper the gap between the wages. From the 70s, wages of high-skilled workers have rapidly increased, faster than the medium- and low-skilled ones. At the same time, the gap between the top 10^{th} percentile and median wages increased and medium-wages occupations declined from 47% to 38%. To some scholars, wage inequality in developed countries is measured by the 90:10 ratio, but it seems to be higher today than five decades ago. The countries that experienced the higher wage inequality were the United States and rich countries, such as Australia, Canada, Germany and Nordic countries. In countries like Japan, Italy or France it remained quite stable. Anyway, there is not a unique trend in developing economies: from the 80s until the late 90s, Latin American countries experienced an increasing wage inequality, while East Asian countries including Korea, the Philippines, Indonesia, Vietnam saw a steady increase in wage inequality (Bruckner et al. 2017, 20-21). The increasing income inequalities depend on the market structure and its changes. In fact, it creates monopolistic rents and the polarisation of profits in the hands of few firms. New firms operating with the Internet and new

technologies are likely to benefit from network effects due to demand-side economies of scale. Moreover, those firms show themselves ready to grow more than their competitors. Hence, they focus on putting onto the market new products and processes so to keep gaining a bigger share of the market revenues. A possible effect is the one called “the winner takes most”, indicating when few firms dominate the market and gain the largest share. By employing only high-skilled workers, these firms contribute to increase the gap between the income of the high-skilled and low-skilled workers (Bruckner et al. 2017, 21-22).

On the other hand, a support to this argument is that new technologies might change the market needs by increasing the demand for highly-skilled workers. These workers, able to work with new technologies, may replace low-skilled workers performing routine tasks. Furthermore, the new structure of the market may prevent the shares belonging to a certain sector to be evenly distributed. As a consequence, only firms operating in the technological sector and possessing innovations patents may benefit from the revenues. The result is a widespread inequality because of the impossibility to spread the shares of the technological sector across the whole market (Dachs 2018, 30). Schumpeter (1911) introduced first this theory when he argued that the reward of gaining market power and monopoly rents are the only factors letting entrepreneurs to introduce new products on the market. Also, Mankiw (2013) shares the idea that even though individual incomes grew faster since the 70s, high earners contributions should be redirected towards the rest of the workers, or they will earn more than all the rest with negative consequences of the overall wellbeing (Dachs 2018, 30-31).

On the other hand, scholars argue that technological change helped in reducing inequalities by providing the society with more types of products available for a larger part of the population, that before were just for a few. If this is the case, new technologies were beneficial for the wellbeing of the society because acted as “catalyst for social change” (Mao et al. 2021, 10). For instance, technologies like mobile phones reduced communication costs and information asymmetries

among societal groups and different regions of the world. These technologies were “value driven” of people and freed up time that were used to carry on different activities (Dachs 2018, 30; Mao et al. 2021, 10). Moreover, ICTs represented an important means to advance women empowerment. They allowed them to invest in political, social and monetary fields, to be reinforced in their role not only as mothers and wives but also as workers in their own network. To achieve this result of gender equity, ICTs played an important role because included women in administration and the leadership of businesses. For these reasons, ICT ventures tried overtime and in different geographical contexts to engage ladies for their internet businesses, e-governments and business improvements in order to improve their work. These experiences demonstrate that an effective and productive use of innovation contributes to recognize not-sexually-biased advancements, to strengthen the elimination of sexual discriminations, underestimations and social distinctions (Orabi 2018, 2-4; Orabi et al. 2020, 785). In other words, to this argument ICTs and technological change progressively advance the development of the society, both in developed and developing countries, destitute annihilation, strengthen disadvantaged gatherings and minorities in the Global South (Orabi 2018, 2).

To conclude, even though to the routine-biased approach, technological change displaces jobs and creates “lousy” jobs, to the skill-biased theory, technological change can really create more and better jobs in the future, relying on its avant-garde technologies and larger shares on the market (Dachs 2018, 31).

Another issue related to inequalities on the labour market and the exploitation of workers is linked to the capacity of technological change to create new forms of jobs, as seen below (Degryse 2016, p. 27). However, digitalisation creates “new forms of employment” which still need to be defined and investigated through an examination of the intensity and the type of relationship between employers and employees, the status of workers, their working conditions and the impact they have on the labour market (Degryse 2016, p. 33). Degryse (2016, 34)

identifies nine new forms of employment created since the advent of technological change. They are: employee sharing, job sharing, interim management, casual work, ICT-based mobile work, voucher-based work, portfolio work, crowd employment and collaborative employment. In common, all these new forms of employment have the absence of working schedule, the absence of working hours and the absence of contracts including terms of employment and wage. For instance, Uber, one on the most famous platforms operating in the transport sector, does not bind the riders with any contract establishing their form of employment, there is no company responsible for their health care or their pensions and all risks are borne by workers themselves (The Economist 2015). Many agree on the fact that the introduction of ICT and new technologies in the market is going to undermine the rights of the workers, which become more precarious than before. According to this view, the worker becomes a good, a commonality that needs to offer itself in the best way to be chose from the range of clients (Drahokoupil and Fabo 2016, 5). The question here is also whether it exist a regulatory framework able to protect the health and the right of the workers (Degryse 2016, 35). Undoubtedly, technological change impacted the organisation of work. Companies working with new technologies, hi-tech firms and digital platforms are more likely to cooperate among them, especially the small ones. These companies adopted new organisation methods thanks to changes brought by technological change. Nonetheless, even though on the one hand these changes permitted more flexibility and part-time shifts, helpful especially for women, on the other hand, non-standard work relations are leading to precarious working conditions and many other issues are coming into existence, such as matters related to the income, occupational health and safety risks (Bruckner et al. 2017, 23). It is beyond questions that workers operating in the new Digital and Platform Economy should be protected through contracts and relations of self-employment, but also they must be added to a category of workers. This could

help in the monitoring of the development of these jobs and the sources of their revenues (Drahokoupil and Fabo 2016, 5).

However, one of the most positive effect of technological progress on the organization of work is the way it is going to transform the role of woman's labour force in the market. An overall increase in the women education levels and school attendance has already improved both in developed and developing countries over time. Consequently, technological change is progressively increasing the opportunity cost for firms that allow women to enter the labour market. Thanks to incentives from technology, firms are more pushed to include women in their activities. Hence, women may now cover positions which have historically belonged to men and are present in sectors that have never seen them before. For instance, the agricultural sector, the industrial and manufacturing ones and the use of capital-intensive technologies have always been matter of men. Today, the introduction of light manufacturing and electronics allows women to have a comparative advantage on men to carry out particular tasks. In fact, women are even preferred to men to carry out non-routine tasks which require cognitive and soft skills. The result is the progressive reduction of the gender pay gap by increasing the wages of women relative to men. As a consequence, the general trend is an increment in the female labour intensity in the manufacturing and in other sectors. Furthermore, the shift towards new work arrangements and more flexibility provided to workers may give women the possibility to carry out together "reproductive and productive responsibilities". However, if technological change is introducing new forms of work into the market and is sharing the benefits coming from the digitalisation on the society, still an effort from the political and social community is required. Hence, the priority should be to finally equalize pays and benefits related to maternity and paternity and to ensure to the two sexes and all types of workers an equal treatment in work opportunities and working conditions (Bruckner et al. 2017, 24-26).

Chapter 3
Technological Change for Socio-Economic Development in Emerging Economies: The Case of Egypt

The literature dealing with the effects of technological change and innovation on the economy and the society is much more consistent for developed countries while a little research has been made for emerging countries. Surely, technological change brought a revolution in developed countries both at the social and economic level, it has substituted the way of delivering services and transformed traditional societies into knowledge societies all over the world (Orabi et al. 2020, 785). It is also believed that technological change can have the same positive impact on emerging economies. For instance, studied made in Costa Rica and India showed the positive relationship between ICTs and socio-economic growth. Nevertheless, this never turned into a proper and accredited theory. The biggest concern remains whether innovation and new technologies bring benefits or instead, unemployment and inequality in these countries, already facing other problems related to health, water, education, food, infrastructures and telecommunications (Emara 2020, 260; Kamel et al. 2009, 2). In fact, developed economies adopt technology and become "skilled labour abundant". This means that they use skilled labor in a more efficient way than emerging economies, that remain "low skilled-labor abundant". However, the arguments on the positive relationship between ICTs and productivity have been confirmed in developed countries while not in developing ones.

3.1 The Relationship between ICTs and Socio-Economic Development in Emerging Economies

Recently, scholars pointed out the positive contribution of ICT improvements on the GDP growth and labour productivity between 1995-2001 in developing countries of Central and Eastern Europe (Kamel 2009, 2; Oladipo and Grobler 2020, 1395). In addition, Kamel (2009, 2) argues that, on the basis of several projects conducted in developing countries, ICTs contributed to the development of these nations and improved their competitiveness on the market. Similarly, Dimelis and Papaioannou (2010) and Jorgenson and Vu (2010) theorised that the GDP growth is a result of the TFP growth, while Asongu and Le Roux 2017, Bahar 2018, Ghosh 2017, Haftu 2019, Kumar et al. 2016, Vu 2017 and Wamboye et al. 2015 proved the causal relationship between ICT and growth thanks to telecommunications (Oladipo and Grobler 2020, 1395). The same authors believe that telecommunications, ICTs, Research and Development are the essence of growth in the direction of a smart society, where technological change operates to lessen inequalities and disparities in the region (Oladipo and Grobler 2020, 1395). Bahar (2018) hypothesizes that there is a nexus between the ICT penetration and financial and economic development in lower and middle-income countries. As an evidence, it has been hypothesized that ICT is the driving factor to support development in emerging economies and that it narrows the productivity gap with other nations through the introduction of elements like the Internet, digital platforms and mobiles (Orabi et al. 2020, 787). Also, Cecchini and Scott (2003) in Orabi et al. (2020, 787) confirm that ICT can reduce poverty by improving the access to education, health services, government and financial services for poor people, although only potentially (Orabi et al. 2020, 787). Anyway, the positive effect of ICT on economic development, employment and export has been confirmed but the equality of the diffusion of the wealth produced, the penetration of ICT and the social protection of workers in this sector are still issues that need to be addressed (Kamel 2009, 3-4). Moreover, the digital economy growth rate is often faster than the growth of national GDP. For instance, developing economies show a

slower growth than their growth in the e-commerce or in the mobile and internet sectors (Bukht and Heeks 2017, 18) and they often show several barriers for the adoption of technology.

Furthermore, many emerging economies do not need to save on cost of labour because they already rely on cheap labour. Especially in the service sector, automation and job displacement levels are quite low (Bruckner et al. 2017, 31).

In the light of these findings, technological change could represent a driven force for economic development in Egypt. Egypt, like other developing countries like India, benefited from the application of ICTs that increasingly promoted key solutions for comprehensive development, poverty eradication and the empowerment of disadvantaged groups, such as minorities and women (Orabi et al. 2020, 785). In such countries, ICTs contribute to the process of information dissemination and provide women and other disadvantaged people with capabilities, knowledge and technological skills, which constitute the most negatively affected people in emerging economies. In fact, since the advent of ICTs operating as a "great equalizer" as defined by Drucker (2001), these categories of people are less discriminated and included in the Egyptian economy (Orabi et al. 2020, 785-787).

Oladipo and Grobler (2020, 1396-1409) base their research not only on the real gross output in the African region, which measures economic development, but also on the human development index (HDI), as suggested by Hub (1996) in the United Nation Development Program (UNDP)[8]. Egypt had an average HDI of 0.66 in 2018 together with other 22 African countries, while others had lower human development indexes. Following this criteria, Oladipo and Grobler (2020, 1412) found a correlation between an increase in the telecommunication

[8] The HDI value has to be between 0.70 and 0.80 to reflect very high human development, between 0.55 and 0.69 for medium human development and if the value is less than 0.55 then it means low human development levels

operations and an increasing economic growth and development in countries like the African ones.

Similarly, Arendt (2015, 254) applied the measurement of the ICT impact in the CEE countries, classified as developing countries. He measured the economic growth in those countries in two periods, the first going from 1994 to 2003 and the second from 2004 to 2014. It resulted that emerging economies are keen on investments in ICT infrastructures and that from 1995 to 2003 TFP was the major source of GDP growth: This means that thanks to spillover effects linked to ICT investments, CEE economies, as well as other developing countries, experienced an important economic growth, although not evenly distributed. In the second period between 2004-2014, TPF did not contribute to the GDP growth as in the past years but still ICT capital played an important role to GDP growth together with non-ICT capital. This rule could be valid also for Egypt.

Even though the positive economic effects, it is to ascertain the type of development ICTs will bring in the society, whether horizontal or vertical, and whether it will solve already existing challenges, such as the access to basic services and the covering of everyone's basic needs in a social justice optic. This theory is advanced by other authors like Mbarika (2003), arguing that an overall development could be only reached if other socioeconomic instruments are used together with investments in ICTs. Hence, scholars maintain that ICT improvements should be accompanied by macro changes in the institutional and regulatory framework, in the structure and organization of the companies at the micro level and by investments in ICT infrastructures made by the governments (Arendt 2015, 249; Oladipo and Grobler 2020, 1398). For this reason, since 1999 the Egyptian Government approved several projects to boost not only economic growth but also social opportunities, such as the creation of job opportunities, the delivery and access to health and education services, the free access to information and knowledge. All these elements create a welcoming social environment where ICT gains the potential to improve it (Kamel 2009, 3).

3.2 The Egyptian Economy in the Context of the Euro-Mediterranean

Egypt is the most populous country in the Arab world and is estimated to grow around 24% by 2030. With this growth, also the young population will grow proportionally, covering the 60% of the population and being able to work. Hence, the Egyptian economy is expected to reach a total GDP of $571 billion by 2030, growing of 5-6% and stimulating the GDP per capita to reach $14.270 (Bohl et al. 2018, 11). Egypt has been profoundly changed from the 2011 Revolution that attested all the limits of the economic and political model on which the country was relying since ever. State institutions, the legislative, judicial and financial branches, including the tax and regulation bodies were not robust, and this is the reason why they have been sharply changed by the new constitution of 2014. Since before this date, Egypt was suffering from political, social and economic challenges, such as informality, unemployment, low female labour force participation, requiring the need of generating more growth, more jobs, improving workers capabilities in many sectors (Luciani 2017, 184-186, 192; Bohl et al. 2018, 11). The gap between the official policy and the actual performance of the economic management is huge. The World Bank's 2015 annual Doing Business Report reported the poor state management of the economy in Egypt and its conditions remained essentially unchanged over the period. The country, which in the past relied heavily on rents -particularly those from the hydrocarbon sector -, and on foreign direct investments (FDI) from oil and gas companies, real estates in residential/commercial buildings, is now trying to lessen its dependence on those rents and its mere interest in economic growth, by preferring other elements, such as human capital, quality of institutions, infrastructures and digital infrastructures and openness of the country. Hence, the net import of gas and oil lessens the export profits of its oil

and gas (Luciani 2017, 184-186, 192; Bohl et al. 2018, 11). In the documentary released by Al Jazeera "*Egypt's Lost Power",* it is alleged that the country lost billions of dollars of revenues as a result of commercial transactions with Israel. The country, already strongly relying on rent seeking, has worsened its performance in several economic sectors. For instance, tourism is flourishing because of its proximity with land activities and the rents to the military, the largest owner of land in Egypt. The share of formal wage employment is progressively replaced by higher levels of informal wage employment provided by small and micro enterprises characterized by lower productivity that account for more than two-thirds of the new entrants in the market (Emara 2020, 267; Luciani 2017, 198). Egypt is the fourth largest country for Gross Domestic Product (GDP) and lies at the 15th place in the rank of GDP per capita in the Middle East and North Africa region (MENA). The country presents still a strong cultural, political, economic and military influence. However, Egyptian GDP is not well distributed across the population and the overall well-being indexes are quite low because of a high concentration of wealth in the hands of a small percentage of population (Fakoussa et al. 2018, 696; Seda and Mamdouh 2020, 162; Luciani 2017, 184-186). The inequality levels are relatively low, according to traditional measures, such the Gini index, but the perception of inequality and the stagnant social situation are growing depending on the geographic location (Bohl et al. 2018, 13). A study from Assad et al. (2017) demonstrated that between 1988 and 2012, wages and incomes of middle-classes converged towards wages of poor-people, while wages of most privileged people remained quite unaltered (Bohl et al. 2018, 13). This is the main reason why poverty is progressively growing and already in 2013, the 25% of population appeared to be under the poverty line, living with only $2 per day (Fakoussa et al. 2018, 696; Seda and Mamdouh 2020, 162; Luciani 2017, 184-186). At the same time, over the past decades, extreme poverty has declined and the population living under the poverty threshold have declined as well.

Nevertheless, by 2030 still 16.7 million people in Egypt may live with less than $3.10 per day and over 340.000 may be living in extreme poverty conditions (Bohl et al. 2018, 12). This is also known as “economic inequality” in Egypt and it represents one of the most difficult socioeconomic challenges to deal with to ensure an homogeneous and even growth in Egypt. In addition, other socioeconomic issues that slower the growth and the innovation impact on the society are related to high illiteracy rates, insufficient healthcare services, youth unemployment, bad public education system, emigration to western countries and the Gulf countries. Besides this, some less developed, rural and remote areas of the country lack of important and basic products and services. Unemployment and education are strongly connected and female participation rate in education, political and working environments has progressively dropped, being added to the already high unemployment rates (around 13%) and youth unemployment rate (around 35% in 2015) (Bohl et al. 2018, 12). To give an example of the size of the issue, in 2011 800.000 jobs were required to solve the unemployment problem (Fakoussa et al. 2018, 696; Seda and Mamdouh 2020, 162; Luciani 2017, 184-186). The most important source of employment in Egypt, also for people living in rural areas, is government employment and agriculture (Luciani 2017, 187). This status of things found its beginning already in the Mubarak era, when the achieved economic growth helped to mitigate the lack of jobs but at the same time, the private sector failed to expand itself rapidly to absorb new entrants to the labour market and the Government continued to hire thousands of workers. Moreover, the Government spent his finances and budget in consumer subsidies, such as subsidies for energy, but it has not increased taxes to absorb the costs, that were approximately one fifth of the government expenditures. The budget was also largely used to cover the public debt and the interests of the state. Therefore, savings and investments declined simultaneously, the GDP dropped and let Egypt to be one of the less growing countries in the world in 2010. The military interventions in the economy exacerbated the already bad

situation, from their already strong position of who benefited from subsidies and preferential treatments, like free-tax status. The status of things during the Mubarak era has been subsequently inherited by the Al-Sisi Government, that faced a deep fiscal crisis with the need to empower an elite in order to create jobs for young workers and women and to stimulate growth through various sectors (Luciani 2017, 187-190). Although all these developments, as far as the financial situation concerns, Egypt went from an emerging economy to a frontier economy, as stated by Russell's Annual Index in 2014. The reason why Russell gave this definition was the currency control by the central bank to slow the devaluation of the currency and to protect the foreign currency reserves. Anyway, these actions ended to damage the Egyptian market, with enormous losses from the side of some Egyptian companies as of 2014 because of the lack of foreign currency due to the finance regulations. This provoked a severe fiscal crisis from 2014 in Egypt that required a financial stimulus by Saudi Arabia and the United Arab Emirates and that have not particularly encouraged the economic growth. Inflation also increased and the GDP levels were the lowest ever, the currency has fallen 15% against the dollar and the euro, unemployment rates increased steadily. The Al-Sisi Government response was the increase of taxes and the lessening of subsidies, which brought onto a more stable situation (Luciani 2017, 190-191). The result has been the loss of jobs and the moving of millions of Egyptian workers to other Arab countries, especially the Gulf countries. which account for about one half of all remittances to Egypt. The weakening of the Egyptian labour market is the natural consequence: the remittances of Egyptian workers back to their country account for one half of the total remittances, therefore the decision to expulse foreign workers from the Gulf countries could be an external shock for the Egyptian labour market (Luciani 2017, 192).

As can be noted, the Government has failed to address the hardest social and economic issues of the Egyptian society in a sustainable and long-term manner.

Its large and centralized structure is also not endowed of enough financial resources and expertise to tackle those challenges affecting the country after the political and economic turmoil of 2011, which negatively affected the private sector as well. Although the negative developments of the past years, human development in terms of health and education levels, is expected to improve, as measured by the average Egyptian's years of schooling, going from 7.1 to 8.5 (as projected by 2030). As far as women attainment concerns, it is still at low rates (Bohl et al. 2018, 11)

In the light of this situation, it seems that technological change and the progressive digitalization of the society could improve living standards if the middle class rise as well. The middle class is expected to triple by 2030. The 8.8 million of Egyptians that today are filling the middle class are ones willing to benefit better public services, greater transparency, inclusion and quality of governmental services (Seda and Mamdouh 2020, 162-165; Bohl et al. 2018, 11). However, the transparency levels in Egypt are progressively increasing. It has been forecasted a change of the Egyptian transparency levels from the 115th position to the 109th by 2030 but the standard is still not satisfying (Bohl et al. 2018, 11). Furthermore, the current crisis related to the Coronavirus pandemic have further worsened the economic situation. The current needs of the government are to recover from the crisis and to re-launch the economy, following the global recovery, and to provide a decent life for all Egyptians, especially the ones who suffered during the recent crisis (ECES 2020, 1). The worsening of activities in other sectors made Egypt to invest in the telecommunications sector, digital infrastructures and tourism related services. The explanation of these investments is the Government's necessity to replace, in a sense, the services that it failed to offer to the population and that provoked the dissatisfaction of the society (Bohl et al. 2018, 15). In other words, the Egyptian economy is progressively changing and its recent adaptation to free trade has been the stimulus to develop new technologies and to benefit from the

social and economic revenues of the Internet and of technological change (Fakoussa et al. 2018, 697-698). In details, as far as the entity of technological development in Egypt concerns, it is explained by the composition of its ICT sector and its total revenues. Overall, the telecommunication and ICT sector counted of around 35 billion EGP of total investments value in 2019, showing a growth of 7 billion EGP from 2018 (ECES 2020, 2-4). According to the report of ECES (2020, 2), the ICT sector in Egypt is divided in the telecommunications sector and the IT sector. The telecommunications sector is divided in two levels: the first comprehends a few companies that control the sector, like big operators and mobile companies. The IT sector is made up of many small companies that work with applications and outsourcing services, where Egypt has a comparative advantage. The IT sector is composed of four sub-sectors: hardware, IT services, software development and IT-enabled services. In Egypt, companies that operate in this sector do not need a certain license but they must follow some procedures to start their career. The Egyptian Government accounts for the 60% of clients in the IT sector.

Both sectors have developed since 1985 when the Egyptians' government put its effort to introduce ICTs to attract businesses and firms. As of 1995, telephone operators like Mobinil and Vodafone Egypt started their business and they lead to the privatization of the Internet. Such companies required licenses and permits from the government to operate in the market. From 1999 to 2004, the several investments in ICT infrastructures required the creation of a new Ministry of Communications and Information Technology (MCIT) with the aim to approve an institutional framework to boost an export-oriented ICT industry, with the aim to increase the regional and global marketplace. The plan for the newly created MCIT was to work in synergy with other Ministries to improve the socioeconomic situation in Egypt by creating a comfortable environment for investments. However, the path was requiring other insurances, such as a stable, transparent and independent regulatory environment to attract investors willing

to realize big profits. From this point onwards, the telecommunications sector witnessed a process of reform with the state trying to delegate the regulatory functions among two introduced institutions (Kamel 2009, 5, 11). The National Telecom Regulatory Authority (NTRA) and the Information Technology Industry Development Agency (ITIDA) are the institutions endowed with the power to regulate the telecommunications and the IT sectors. The difference between the two is that the ITIDA's work is limited to developing ICT for the local industry by using "specially-designed highly-efficient programs" to provide advice and to boost trade and foreign investments both in local and international markets. This makes the IT sector less regulated than the telecommunication one (ECES 2020, 5; Kamel 2009, 8). The Government's effort was also translated into the creation of another institution called Cabinet of Egypt Information and Decision Support Center (IDSC), established already in 1985 to raise awareness of ICT and build a "comprehensive information infrastructure-infostructure". The MCIT together with the IDSC were engaged in organising a number of projects to realize an integrated information society, including also other projects under the name of Information Society Initiative (EISI) that aimed at expanding the telecommunication infrastructure and the pool of IT skilled workers at the public and private level. For instance, IT training centres have been established to narrow the digital divide between Egypt and other technologically advanced countries (Kamel 2009, 5).

In fact, in the last decades, the engagement of the Egyptian Government to transform the country into a developed digital economy was quite intensive.

The Egyptian Government started to invest in ICTs around the 80s, when these infrastructures were produced to be used in different sectors of the economy. Already in the Third Industrial Revolution, microchips, computers and the Internet became so important in the digital environment to be classified as General Purpose Technologies. Those technologies were considered able to address some economic and social challenges considering their fast

development. Nonetheless, some other challenges remained active, for instance the digital gap between man and women and the inequality in the digital knowledge among the population. (Badran 2019, 2; Sicat et al. 2020, 12). The introduction of ICTs in the economy had a great impact, also bigger than in the industrial revolution, but it stimulated some questions around the socioeconomic effect of ICTs and its role in the development of the country. To transform the society and its living standards, it is necessary to transform simple ICT into services, applications and contents that can create new markets, decrease costs and increase the productivity. The most important thing in this process is the role played not only by the government, but also by the private entities and the civil society, which must cooperate and make partnerships aiming at ensuring a "fully developed information society". Egyptian expansion of telecommunications has been a national priority since ever when Egypt was the first in the Arab region to invest on basic digital infrastructures and the fixed network and to expand national broadband to increase the internet penetration in the country. The national strategic plan adopted by the Government was to encourage private ICT investments to allow Egypt to cover a competitive position both at the regional and at the global level. The plan was adopted to improve the living standards using ICTs and the creation of an information society, with the final aim to improve the distribution of goods and services to address poverty, to create jobs and stimulate economic growth in a more serious welfare state (Kamel 2009, 8; Luciani 2017, 204). Thanks to the financial support of several stakeholders such as local and multinational companies, research institutions, universities, the Ministry of Higher Education and Scientific Research, the Government worked with the final aim to improve the quality of life for citizens and to reduce the digital divide between rural and urban areas, sometimes characterized by different levels of services quality (Kamel et al. 2009, 1,10; ElShenawy 2017, 3). In other words, the pillars used by the Egyptian Government for these reforms were:

- Emphasizing R&D, development of ICT and competitiveness;
- Provide universal access to the Internet;
- Maintaining a regulatory framework that makes Egypt attracting foreign investments (Kamel 2009, 6).

Also recently Egypt invested on the country's digital and ICT infrastructures, on digitalized start-ups, global innovative hubs, big data centers and companies operating in the IT and eCommerce to provide its citizens with new investments and new job opportunities. Moreover, Egypt invested in smart infrastructures, such as Fourth Generation (4G) services, a regulatory framework to allow mobile operators to offer the same service to end users. The evidence of this effort can be found in the increase by more than 500% of the internet bandwidth from 2011 to 2016, reaching 1,134,25 bit/s in 2016. In 2018, Egypt covered the 7th place among other 46 African countries for its penetration index of population with internet access (around 48%) and the third place among other 46 African countries for the penetration index for mobile telephone lines subscription (55%) (Oladipo and Grobler 2020, 1402-1405; Kamel 2009, 10-13; ElShenawy 2017, 2).

The effect is that many young Egyptians have been abandoning traditional careers and starting innovative businesses, careers in multi-national enterprises and they are establishing digital platforms that now characterizes a potential ecosystem in Egypt (ElShenawy 2017, 2-3; Seda and Mamdouh 2020, 166). Furthermore, in the period between 1990-2018, the industrial employment rate in the Egyptian labour market decreased to 40-45%, which means that the service sector increased its dimension and number of workers as a result of the de-industrialization starting in Egypt from the 90s. Emara (2020, 263) researched on Egypt's position in the context of innovation using the Global Innovation Index (GII). The Index considers innovation inputs like institutions, human capital and research, infrastructure, market and business sophistication with the aim to "capture the multidimensional aspects of innovation and offer

tools that can help in designing policies to promote output growth, improve productivity and job growth in the long-term". According to this study, in 2019 Egypt seemed to occupy the 74th position in the GII's ranking for innovation output, gaining 23 positions from 2017 (when it was the 97th). This change showed Egypt efficiency in converting its innovation inputs into outputs. Nevertheless, Egypt's innovation input and output levels is still low in comparison to other North African and Western Asian Countries.

However, R&D activity increased because of the government's investments on scientific research, a key determinant of a country's innovation potential, going from 27% in the period between 1996-2008 to 40% between 2009-2017 (Emara 2020, 265-266). ECES (2020, 5) lists Egypt as the 58th out of 79 countries listed in the Global Connectivity Index with the possibility to advance in the ranking because of the positive trends in the number of mobile users, internet users and subscribers to mobile payments. For instance, until 2000 the telephone lines averaged around 15% but already in 2015, the percentage of ownership of mobile phones reached 84,4% (Kamel 2009, 10; ElShenawy 2017, 3). Nonetheless, Internet users are still less than the 50% of the total population and the number of active subscribers to mobile payment services are not more than the 5% of the 13 million total. The reasons why internet penetration is still low are multiple, including cost, language, literacy rates, infrastructures' nature and low skills (Kamel 2009, 11-12). The Government showed its interest in investing in the sector with the aim to spread wider the Internet among the citizens, to expand the network and the coverage of operators, so to lower the prices of entry packages that should automatically bring an increase in the number of internet users (Kamel 2009, 10-13; ElShenawy 2017, 2). The Government on its side, invested in high-speed internet, which is still slower than the world average (27MB vs 60MB) and introduced it in 2530 public schools. In 2019, the 29% of students and the 27% of teachers were using Internet for educational purposes. The result was the increased number of users

which overhauled the fiber optics, that being not supported by appropriate infrastructure, seems to be work slowly. In addition, the Egyptian software sector is growing fast in many market segments and employed more than 300 industries, making Egypt to be the main exporter of software in the whole Arab Mediterranean Region. Video and audio contents, cultural, educational and artistic entertainment are the categories most exported from Egypt (Kamel 2009, 10-13). Even though the development achieved by the Egyptian Government on the way of a complete technological change and digitalisation, the unsolved question remains whether these reforms have been correctly implemented and which social class of the national population they influence the most.

3.3 Challenges and Opportunities of Technological Change in Egypt

What opportunities can technological change bring to the development of the Egyptian society? What challenges are expected to be solved thanks to technological change?

The most plausible argument hypothesizes that investments in new technologies and ICT bring more efficient production methods, increases productivity and enlarge the access to social goods and services. This argument establishes that technological change and the progressive digitalisation of the society is more than necessary for a social change in the Egyptian society, which requires “equal rights and opportunities among all Egyptians and [the] effective elimination of all sorts of social gaps” (Ministry of Planning, Monitoring and Administrative Reform 2016, p. 143). According to an inclusive approach, a social change requires poverty to be tackled to reach a “World Free of Poverty”, to quote the World Bank. To be successful and the most even and widespread, the process should be managed in a co-created way and include many stakeholders in the process (Fakoussa et al. 2018, 694).

However, some developing economies, including Egypt, still face several obstacles in responding adequately to the demands of digital transformation and cannot use it as a mean to endow its citizens with more economic and social chances. These countries, for instance, are challenged by the inadequate access to the latest technology, lack of sophisticated telecommunication infrastructures, low computer literacy levels. These causes together with other economic and cultural factors prevent developing economies from reaching a full technological change and, therefore, to exploit its social benefits on the market and the society (ElShenawy 2017, 1). Nonetheless, what are exactly the opportunities which technological change and the digitalization may bring? What do they may really improve in the society and for who?

To some scholars, poverty in developing countries can be tackled by increasing economic growth. Technological change plays a role in this mechanism by creating job opportunities, positive savings and contributing to transform the local economy into a global digital economy (ElShenawy 2017, 6). For instance, only in the period between 2016-2017, the technological sector has contributed to the 3,2% of the Egyptian GDP and has provided between 90.000-95.000 new jobs just in the industrial sector. The growth in the share of the telecommunication and IT services reached a rate of +16% accounting respectively 20 billion and 7.9 billion Egyptian pounds. Innovation and technological change constitute a source of competitiveness for business since they reduce production costs, enhance the production of new products and their better allocation of the market thanks to the ICT infrastructures that in Egypt are growing fast (Kamel 2009, 13-15; ElShenawy 2017, 6). The current situation in the labour market has worsened because of the current crisis provoked by Coronavirus pandemic. In this context, the development of digital economy and ICTs are progressively seen as a mean to solve the unemployment among young generations and accelerate development and the modernization of economy, as confirmed by Makhtar Diop, World Bank's vice president for Infrastructure in

an interview for the journal “Today Egypt”. Then, the digital economy could impact positively in the market by creating new jobs in the field of the ICTs thanks to the developments brought by the digital economy (UNCTAD 2019, 58; Egypt Today, 2019). OECD (2020, 61) reports that the 60% of firms operating in the digital and ICT sector offer high-skills job positions, most of them looking for software developers, while the 40% of firms look for mathematicians, statisticians, database managers, software engineers, data analysts and scientists. These are currently the most required positions in the Mediterranean area. For this reason, investments in technological change lead the unemployment rate to decrease by increasing the number of innovative and high-skill jobs, their economic incomes and the benefits for the young generation. In addition, technological change plays a role in mitigating women and youth unemployment rates. Arab women between 15 and 29 years are the less employed in the world rankings. Especially in digital fields, women own only the 4% of businesses, while men are the owner of the 96% on total businesses (UNCTAD 2017; Colella 2017, 8). The higher the education opportunities and the investments in technological skills, the more the work opportunities for women with a large share of benefits to the national GDP (Colella 2017, 8). In fact, women would become *de facto* part of the labour market, they would be integrated in the value chain and included in the working class and in the market. As a result, the gender gap between men and women in the occupation sector would decrease and the latter would be able to share their voices and their needs by participating in public spaces through official women working movements. For instance, in the cities of Aswan, Cairo, Alexandria and Sohag, only few women on a group of 100 women involved in the informal sector were familiar with the concept of eCommerce and digital technologies. This is caused by the fact that only the 9% of women living in remote areas have the possibility to possess a mobile phone, against the 25% of men (World Bank 2018, 8; Sicat 2020, 12). Furthermore, the newly created jobs for women and

young graduates would be “future proof”, so keener to be adapted to new technological needs. Compared to other older jobs, they would be more flexible, so allowing more flexible time schedules and working place, such as in the work from home case. The advantages of the new technologies in the flexibility of work have quite an important influence on the young generation, women, isolated or fragile communities that, unlikely from the recent past, see themselves endowed with more working opportunities (Strategy& 2017, 8; UNCTAD 2017; Colella 2017, 8; Egypt Today, 2019). Technological change and ICT diffusion also enable social development as a further vehicle for innovation and education, health services, improved government services and empowering the private sectors. In this context, technological change reflects the government’s objective to develop social and economic insurances for people (Kamel 2009, 15). Booz Hamilton (2005) listed several sectors that benefit from ICTs and contribute to socioeconomic development, such as transportation, education, manufacturing, trade, finance and tourism. Among them, transportation, education, health, manufacturing and trade constitute the most influential sectors to increase basic rights and income opportunities in Egypt (Kamel 2009, 17). Moreover, the use of new technologies applied in the trade sector will solve some problems related to the pollution of atmosphere and the environment, traffic congestion and traffic flow which constitute an issue in the Egyptian society. Digitalized health care services are also helpful to mitigate inequalities and to improve communication and data connection through automatic procedures (Kamel 2009, 17; ElShenawy 2017, 5). ElShenawy (2017, 5) further maintains that the strategy pursued by the Egyptian government to boost eCommerce is another way to increase internal trade, export levels and the creation of new job opportunities, by stimulating creativity, new skills and useful knowledge. Furthermore, the youth generation is supported by the government that equips them with digital skills and knowledge through trainings, human capacity building programs for young graduates and students

to develop and transform their ideas into digital businesses and start-ups. On the one hand, the expected result is an improvement in the communication between central and remote areas and the possibility for marginalized communities to reach higher levels of technological skills and therefore to participate in the economic and social life of the country (ElShenawy 2017, 5).

On the other hand, technological change in the context of the Fourth Industrial Revolution did not bring benefit to the Egyptian society as it did in the British context some centuries ago. New technologies did not stimulate social entrepreneurship as expected nor ended to satisfy people's needs. Nonetheless, technological change, stimulating the globalisation of businesses, had a negative impact on the employment levels of some local citizens communities in Egypt. Digitalisation of the society has not been accompanied by a social change as expected but still several social initiatives are waited to happen to change the society (Fakoussa et al. 2018, 697-700). For instance, technological change caused the "polarization effect" on the Egyptian labour market. This caused, in turn, the boost of some occupations and the decrease of some others when network effects benefit first movers assuming new technologies and was associated to a growth in certain occupations in fields related to science and engineering while other occupations faced a rapid decrease, such as in the agricultural sector fishery, forestry, and other administration workers. Also, gender is a factor that shape the employment levels in Egypt because males are generally more employed than females (Emara 2020, 268; Badran 2019, 2-10). Emara (2020, 268) reports a model to understand the link between innovation and technological change and employment, economic growth and education. The Vector Autoregressive Model (VAR) presented by Emara considers the following endogenous variables: employment, innovation in terms of patents, gross domestic product growth, domestic investment, education and demand. These variables are part of a system where they affect each other, at the same or different times and also the whole system. The model explains that the rising

employment intensity as of the 1980s can be explained by the rising informal employment in Egypt. Moreover, investment and employment stimulate each other, while education stimulates the demand to employment. Emara shows that Egyptian employment reacts to shock in all the variables, especially to shocks in patents, which express innovation, and are likely to have a negative impact because of the substitution effect between technology and labour. At the same time, technological progress, expressed by patents, stimulates employments and helps the workforce to develop their skills to produce and use technology, so that they can use it in order to gain only benefits. The effect of changes in GDP on employment is different because is firstly positive, then becomes negative after seven years, as showed for the recovery after the crisis of 2008, which has been defined by Emara (2020, 273) as a "jobless recovery". The relation between investments and employment or negative, as far as major investments are linked to a labour-saving effect especially in the low-tech sector, where costs become even lower. Nonetheless, the model shows that in the long-run, this impact becomes positive because the new investments stimulate new projects in different sectors that require a number of workers and employees. The same type of relation links education and employment. In fact, only in the long run the government sees the benefits of its investments in education, so when scholars graduated and enter the labour market. However, in the short period, innovation provokes an increase in the product demand. This is motivated by the fact that thanks to innovation, production costs and therefore final prices are lowered. Nonetheless, production costs and final product prices increase again in the long run, with negative consequences for employment and therefore product demand. According to this model, it is expected a long-run decrease in incomes and human capital investments with a consequent decrease in the demand for employees and the overall employment rate. Emara's economic model is based on the "shock of a variable" ratio. This means that shocks of the aforementioned variables lead to different results according to the timeframe considered. In

general, there is a positive correlation between the implementation of new technologies and human capital. For this reason, the Egyptian government kept investing in human capital throughout education (tertiary schooling and adult learning) and innovation. Its final aim is to endow the workers of tomorrow with advanced cognitive, communication and socio-behavioural skills. Furthermore, such investments help the Egyptian government to attract international entrepreneurs and innovators who can finance projects in the country in exchange of expertise, high performance and quality (Emara 2020, 273-275).

Although the desired goals from the Egyptian government are quite ambitious, the outcome of the research released by ECES in 2020 (9-19) was not reassuring. ECES examined the role played by ICTs, the Internet, innovative infrastructures and services to overcome the current crisis for Covid-19. The research also included an analysis on the social and economic impact of investments in ICTs infrastructures for purposes of distance learning and work approved by the governments to overcome the pandemic crisis. What resulted from ECES study is that the Egyptian Government still cannot rely on a proper and functioning IT sector able to meet citizens needs during the Covid-19 crisis. The major challenge facing technological change in Egypt is the lack of modern infrastructures, trust, security and notably legislations on cybercrime, data protection and ecommerce (ElShenawy 2017, 6). Moreover, the problematic access to energy is an obstacle for the development of the digital economy and the advent of a proper technological change. Menara (2018, 18) argues that the primary energy demand in the Mediterranean area is expected to increase at an annual rate of 1.9% by 2035, considering the growing population and the change of their businesses activities. Until 2021, the energy demand grew at a rate of 7.4%. For this reason, scholars believe it is necessary to turn to a major diversification of the energetic sources to satisfy the demand. To pursue this objective, ICT and technological change are essential. ICT would operate in this sector by creating the so called “Internet of Energy” (IoE), which represents the

application of the Internet of Things to the energy systems. The desired result is the optimisation of the energetic infrastructures, a better use, generation and transmission of energy and the general creation of more secure and sustainable energy networks (Williams 2017). However, the daunting challenges of the Egyptian Government concern its lack of an inclusive national strategy for digital transformation involving all or most civil parties and a weak monitoring and implementation phases executed by the national body in charge. Moreover, the uneven distribution of high-speed internet across the country and governorates is still an enormous issue. Investments in landline networks and the access to the central network are badly needed to permit the good functioning of the internet even with a huge amount of data. To ECES (2020, 9-19), a serious regulation of the sector is required, to monitor the adherence to quality standards and to treat information with confidentiality. In other words, the sector has never really relied on a fix and solid order. The evidence is given by the fact that during the Covid-19 pandemic crisis no automatic and innovative mechanism of data collection and analysis has been empowered. This means that useful data to avoid new crisis and for research purposes has not been collected (ECES 2020, 19-22).

To sum up, technological change has surely an impact on the society. However, the type and nature of its consequences are still uncertain, its related challenges and opportunities remain “context-specific”, so they depend on the countries and sectors considered (Badran 2019, 2).

Chapter 4

Long Run Policy Recommendations: Technological and Social Conditions for Social Change

In the light of what discussed in this work, it is believed that when reached the technological conditions, digitalization can "make life easier for citizens and consumers, raise the productivity for workers and firms and help governments to extend their key services to people in need" (ElShenawy 2017, 2). As in a mutual game where every variable is the cause and the effect at the same time, countries need to invest on a more efficient management of resources to stimulate future developments, a better communication and education levels, more transparency, higher citizens empowerment levels (Göll and Zwiers 2019, 236). To the "UNCTAD's ICT Policy Review Integrated E-Commerce Enabler and Assessment Framework" (2019), the ICT infrastructure and its services constitute the precondition to the well-being and the equality of the population in a country. These infrastructures – among all a good and stable internet connection - further stimulate a series of other changes, which, in turn, create the right conditions for more social and economic development. For instance, the elements and aspects positively impacted are the development of an integrated network of innovative start-ups and industries, logistics and trade facilitation, e-payments, legal and regulatory environment, e-platforms, new innovative skills, building talents, more awareness levels among entrepreneurs and consumers, e-services. ElShenawy (2017, 1) and Geiger (2015) point out four critical variables to evaluate the digital economy performance. These variables define the readiness of the country to exploit new technologies and are:

1) Investments in smart infrastructure, affordability and skills
2) Empowerment of society, social and economic impact
3) Usage by businesses, individuals and governments
4) Delivery of growth and jobs

To these scholars, when a country shows good performances according to these variables, then it is ready to exploit the benefits coming from innovation and investments in new technologies. For instance, they can use technological change as a driver to stimulate social justice, inclusive and sustainable growth. UNCTAD's review, for instance, strongly reports that women and disadvantaged people might use the new technologies to access the employment sector, to enter the global value chain, to rely on not-discriminatory laws and regulations to support their businesses, to work as freelancers in the digital economy, to build their talents and education, to attend trainings and participate in incubation and acceleration programs (Sicat 2020, 26-27).

4.1 Socio-Economic and Political Requirements for Innovative Growth

Taken for granted the positive nature of the impact of technological change, both in Egypt as well in other countries, it is still necessary to understand the path to follow to create a good environment for technological change and, therefore, for the wished social change. In fact, the research focuses itself not only on the necessary technological conditions for a social and economic development, but also it is important to examine the social, economic, cultural and educational preconditions for a fully-developed technological progress. Hence, it is assumed that technological change can contribute for economic, social and cultural advancement, but it is also believed that this process must be activated by the presence of social and economic factors or conditions, implemented by the governments in synergy with other civil actors. The result is therefore a mutual causal process where technological change is both the cause and the effect, where it is linked with social change in a causal and causal relationship and where it is both aim and mean. For instance, technological change in developing countries, and in particular in Egypt, is inextricably linked

not only with the availability of fixed and wireless broadband networks infrastructures on the supply side, but also of educated and expert individuals on the demand side. In the emerging economies, especially in the African region, the lack of these infrastructures prevent a fully technological development since it cannot rely on trends such as mobility, cloud computing, social networking, big data analytics. These features are the "smart" drivers for the creation of a Digital Economy that lead to an empowerment of businesses, consumers and society (Badran 2021, 1; ElShenawy 2017, 1). Moreover, there are several states in the Mediterranean region that do not meet the necessary social and economic preconditions for an innovative development of the society. Their features are diverse depending also on their political situation and the role of external and internal actors operating in the country, such as multinational corporations (e.g., Samsung, Google, Facebook) and supranational institutions (World Bank, FAO, UN, EU) (Göll and Zwiers 2019, 208). Hence, the political conditions in a country and the status of the democratization process are to be seen as signal of the capability of that country to bring forward policies for an innovative growth. Unfortunately, a deeper analysis of this aspect must be treated in a separated and wider work, so it will be left out on purpose in the present work.

In this section, a series of hypothesis is made. Fakoussa et al. (2018, 700) hypothesize that globalisation, that can also count on technological change, helps to create more opportunities for Egypt. Nonetheless, it must be accompanied by a specific national political effort to reach a social change. For instance, the Egyptian Government established the Technology, Innovation and Entrepreneurship Centre (TIEC) and the Industrial Modernisation Centre (IMC) with the specific aim to support social change and to lessen the high inequality levels in the Egyptian society (Fakoussa et al. 2018, 700-701). What still could be done by the Egyptian government and in particular by the Egyptian Ministry of Communication and Information Technology (MCIT) is for instance to foster the already existing initiative in cooperation with the United Nations

Development Program (UNDP) aiming at the creation of an online portal, the "Kenana portal", that facilitates the communication between people from remote areas and the government. This measure could improve the communication levels within the countries and the spread of information and awareness of non-governmental services useful to penetrate the labour market (Orabi et al. 2020, 791). Furthermore, the government could provide itself more information in local language, so Egyptian Arabic, together with products and services of livelihood domains, such as agriculture, health, primary education, energy and social welfare. This could constitute an attempt to achieve the empowerment of the poorest and under-served people which are sometimes excluded from the official governmental communications. In addition, it is hypothesized that the provision of more inclusive and participatory foresights could be beneficial for a social change in the country and it can be done with the useful help of new communication technologies. This would create the possibility to discuss with several stakeholders on societal needs at large and on the role played by innovation and technological change. In other words, the engagement of citizens groups and associations in the decision-making process is inevitable to deeply understand which direction to follow to have a better life and society (Orabi et al. 2020, 788; Mao et al. 2021, 12).

Starting from the premise that social inequality is influenced by cultural and economic factors, a hypothesis to achieve more social equality could be to increase public and private funding to develop innovative ideas. A second premise concerns the innovative and digital endowment of a country which must possess basic sustainable digital infrastructures to permit economic development and a social change, like happened in the 19th century for some European countries such as United Kingdom. The need of general digital infrastructures seems to be necessary to overcome the social issues afflicting the country. Taken these premises for granted, according to this hypothesis, these innovative ideas can foster and support social initiatives under the name of "social

innovation" to achieve higher social protection levels. In fact, social innovation covers a sector whose issues are not being addressed by the public sector. The public sector is normally engaged in solving social challenges, including poverty, inequality and unemployment sometimes with unsatisfying results. Therefore, if the private sector is more engaged in financing innovative initiatives with social or environmental aims, it can sharply contribute to solve the major national issues, where the national government seems to be reticent to do so. For instance, funding private innovative initiatives to achieve wage equality, safe and not discriminatory working conditions, the respect of the environment is what the society may need to see a faster social change. Also non-profit organisations can play a role in tackling social issues by investing their funds in innovative projects that are able to reduce inequalities, poverty and to make some products and services accessible and affordable by everyone (Fakoussa et al. 2018, 700-703). Furthermore, it is hypothesised that only by enabling digital infrastructures regarding connectivity, microelectronics and data process, the Egyptian digital industry can really grow. Evidence lies in the path followed by the European Commission, which announced to be wishing to cover the entire population by a Gigabit network. In fact, only if Egypt invests in digital communication it can concur in the world market. To give a more precise idea, it is assumed that investments in such infrastructure - like high-precision features, holographic media, digital senses, data infrastructures for cloud computing and data processing – will make Egypt to create new data processing technologies that move away from centralised cloud-based models and that rely on a decentralized data processing method. Moreover, it is recommended for Egypt to follow a path towards a better computing capacity. This could eventually be possible by establishing a sort of Joint Undertaking, as also the EU Commission did, to deploy the *quantum computing data infrastructure*[9]

[9] Quantum computers are fully programmable and accessible from everywhere in Europe

(European Commission 2021, 4-7). Furthermore, energy access is a prerequisite for supporting the development of the digital economy in the country. Egypt is not among the biggest oil and gas producers, so it is believed that the achievement of greater energy efficiency can make Egypt to benefit even more from technological change. Investments in renewable energy and in ICTs are mutually dependent and influence each other. For instance, a deployment of ICT can be done in monitoring, controlling and protecting structural changes in the energy sector and investments in sustainable and renewable energy sources can ensure a more fair and secure distribution of energy. 2014 was estimated that the 2% of all energy consumption in Egypt was the result of ICT use. Therefore, it is hypothesized that Egypt can foster its energy efficiency only through investments in ICTs. Energy security, economic growth, health and well-being improvements are some of further indirect effects of ICTs investments, at the condition that investments in human resources and professional skills are also made (Göll and Zwiers 2019, 207-208, 227-231). The assumption followed by Kamel (2009, 17) suggests that technological change have the best impact on the Egyptian society only if Egypt considers the opportunities coming from alliances with other countries. He hypothesizes that international alliances create the right environment to attract foreign investments after the lessening of trade barriers already existing among Arab countries. To Kamel, this would create economies of scale and extend the Egyptian market (Kamel 2009, 17).

Because humans remain able where computers cannot operate, the recommendation is to reach maximum utility from the use of new technology and together to improve the quality of organizational innovation and human capital. Innovation can bring growth only if workers possess enough skills and capabilities. Therefore, new organizational structures and business models are

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while being highly energy efficient. They are able to solve in hours what is currently solved in hundreds of days or years (European Commission 2021, 8).

required to be careful about the knowledge component of workers: on the one hand, attention should be paid on firm-specific characteristics, such as academic qualification and knowledge; on the other hand, on cluster-specific variables, such as the presence of trainings and internal technological support for companies and institutions (Menara 2018, 13; Göll and Zwiers 2019, 208-210). The academic component is extremely linked to economic and social change. The main assumption here is that it is necessary to stimulate young Egyptian students to choose mathematic, scientific and engineering subjects that meet the requirements of the digital economy and its job calls. In fact, fresh graduates often lack necessary skills to deal with technological and digital machines and processes. Then, according to this dissertation, it is here recommended to the Government to invest more in the alphabetization and education of Egyptian population (Menara 2018, 13). The Egyptian school system is not able to educate young students and to endow them with the needed skills by the digital economy. Furthermore, there is an insufficient connection between academic environments and businesses. The lack of technologically educated teachers, a scarce and unproductive provision of scholar services and a low performance of both teachers and students worsen further the situation (ECFR 2020, 1; Strategy& 2017, 15). Informatics skills are necessary to allow a change in the Egyptian society. Therefore, it is believed that an education reform is now a national priority in Egypt, so that students acquire competences to enter the new digital market. In other words, the educational sectors must become digitalized and rely on different approaches that stimulate the learning and the use of the digital technologies (Brynjolfsson and McAfee 2012). ECFR (2020, 4) points out that the internet penetration rate in Egypt is not adequate. Smartphones and the Internet are mostly used to navigate for entertainment purposes rather than to develop businesses and launch new enterprises. For instance, it would be possible to turn universities into innovation hubs, places where to develop ideas and start-ups with a wished impact on the wellbeing of the society (Aljuwaiber

2020, p. 15). As far as the women work concerns, it is here believed that only through a more inclusive work model, women and young workers can reach a total engagement in the market. In fact, their participation in the economic activities also thanks their technological skills can be an attraction for new investments and the establishments of start-ups and innovative enterprises. Technological change and investments in ICT could lessen social barriers and reduce the gender gap between men and women. If women are allowed to start their own business a tangible change in the society could be achieved. Nonetheless, this could be done only with a synergic engagement of the public spheres and the civil society that should approve educational reforms and new agreements for a higher protection of the working class in order to satisfy everyone's needs (Strategy& 2017, 18). This argument is supported by Badran (2021, 13-14), urging the Egyptian government to undergo a series of national policies for social change. He maintains that a good business environment must be created to facilitate the digitalisation process. Moreover, it is believed that policymakers must work seriously on data protection and new regulations. The aim is to increase the quality of the services provided to end users (Badran 2021, 13-14). To conclude, following UNDP's argument (2012, 144), developing societies should be encouraged to create an attractive environment for innovation and, consequently, for social development. For instance, they could start with the following measures:

- A review of institutions management and their readiness to use technology, especially in the field of education and training;
- The improvement of the legislation dealing with property rights and technology;
- The improvement of investments on trainings for a better use of new technologies;
- The improvement of investments in ICTs infrastructures;

- The development of projects to produce and employ technology in schools, universities, public institutions.

This argument is supported by other scholars that also individuate the increase in the education levels with the means to increase the Egypt's global HDI ranking. For instance, they also recommend moving a step towards a wider, more actual and qualitatively higher education system that could offer the same chances to students coming from public as well as private universities. The final aim would be to give children a proper education, in line with the requirements of the digital economy and the new job positions (Seda, Mamdouh 2020, 171-178; Bohl et al. 2018, 25).

4.2 How can ICTs Strengthen Income Equality and Fair Distribution?

After the analysis of the positive impact of technological change to the economy of a country and to its social conditions, and after pointing out the path to follow to start the technological change process in a country, it is essential to practically examine what ICTs and digitalization did and can do for people's lives.

The possible opportunities coming from technological change in favour of the economic and social empowerment have been already widely discussed. Many NGOs are already at work along the Egyptian government, to tackle social issues also by recurring to new technologies. The public and the private efforts are therefore aimed at contrasting the major societal issues present within the Egyptian society: income inequality, women empowerment, the removal of trade barriers for women and for micro, small and medium businesses, the reduction of mobility constraints, discrimination and violence. The number of female entrepreneurs is still not successful and digital technologies have the potential to make women to access to services, networks, trainings, internal and informal financing and markets, to lower the interest rates on women – which

are higher than for men - so that they can have the same possibilities as men entrepreneurs. Women, as well as weak categories of people, benefit from the digital technologies, which allow overcoming mobility and timing constraints. This creates a "global brain" able to put the workforce together between different countries, helping them to easily access information, make the working hours more flexible and to advance the manufacturing techniques. For instance, online marketplaces like Upwork and Airbnb see the engagement of women between 44%-55%, sharply higher than in other traditional sectors (Sicat et al. 2020, 1; Göll, Zwiers 2019, 216).

Hence, Egypt must invest on social skills and female-specific skills to reduce the wage gender gap. The social skills create a comparative advantage in the age of digitalization and in a labour market where high-paying jobs – mostly non-routine analytic and interactive tasks - require social, cognitive and interactive skills (Sicat 2020, 16). In other words, the flexibility provided by the use of digital technologies can help women and other fragile people to work from different locations, in flexible hours and using alternative means of communication –email, video calls, telephone, instant messaging – balancing the working and the private and family life and obligations. Therefore, Egypt, as well as other developing countries, should invest on those technologies, that can narrow the gender gap and can allow women and other fragile people to save their time, to accept jobs before considered as "men's jobs and to engage them in economic activities (Bohl et al. 2018, 24; Emara 2020, 275).

In recent times, also the digitalisation of public services plays a large role in the fight against inequality among genders and social classes. For instance, public services provided by using digital methods ensure better levels of efficiency and improve the quality of everyday life for citizens. Examples digital services offered are the smart parking, smart energy, lighting solution and resource optimisation services. Furthermore, the information-gathering-role played by Social Media can create awareness on "solidaristic practices" to fight labour

exploitation and to improve capital allocation. (European Commission 2021, 11). Social Network and the Internet also facilitate the matching between buyers and sellers and create mutual trust among them thanks to online rating systems and e-payment solutions. Then, by reducing face-to-face interactions, Internet facilitates women and weak social categories to open their own businesses, it decreases violence and discrimination events which are still common in Egypt (Sicat et al. 2020, 5-8, 14; El Manouar and El Hilali 2020, 70). Nonetheless, there is no social change following technological change without good redistribution policies from the government side. Thus, to avoid the counter effects deriving from the application of innovative strategies, it is important to invest in other fields, such as resources for adult education, not only for basic education, a strategic redistribution plan to ensure the resources and the newly created jobs are evenly distributed across the economy (ElShenawy 2017, 2). However, also the online teaching sector is rapidly increasing thanks to technological change. The number of female instructors had increased dramatically in the recent years, especially after the start of the Covid-19 pandemic, giving the chances to women and other jobless people to earn at zero costs, helping to reach a more equal society (Sicat et al. 2020, 8-10). Also in this case, the effort must go towards women and fragile people who must be endowed with digital technologies and digital skills to become effective "digital users". Therefore, it is necessary to educate people at all levels to technological change and to the digital environment. Measures can include for instance peer-to-peer learning initiatives, ongoing trainings, mentorships and the effort of high-growth digital entrepreneurs (Sicat et al. 2020, 10-12). The Minister of Education must keep investing on the change of the public educational system adding the teaching of skills such as critical thinking, innovation skills, creativity, technological skills. Broad-basic digital skills should build a society where also children learn how to navigate through the thousand information they are exposed online, how to trust digital products and online services and to

identify disinformation and fraud attempts (Seda and Mamdouh 2020, 167-170; European Commission 2021, 4). The government must rely on digitally empowered and capable citizens able to perform on the high-performing digital education ecosystem (European Commission 2021, 4). Only Egyptian graduates possessing these skills will be able to be part of the new digitalised context, acting the digital skills as a prerequisite to participate actively in the digital decade. Hence, companies and universities must develop training programs for students so that graduated talents have the possibility to find satisfying job opportunities and so that a pool of talented workforce is created (El Manouar and El Hilali 2020, 70). Good examples are the American University in Cairo, the German University and the British University which are progressively modifying their teaching methods and programs so to prepare graduates to start an innovative business and to encourage students to think and behave more critically and entrepreneurially (Seda and Mamdouh 2020, 167-170). Another way could be the establishment of collaborations with international top schools that can offer training workshops to Egyptian teachers on how to use new technologies and how to develop innovative ideas (Seda and Mamdouh 2020, 167-170). All these measures help to accomplish the UN Sustainable Development Goals (European Commission 2021, 4). Other best innovative practices for the society are presented by Seda and Mamdouh (2019, 166). These scholars report innovative enterprises that are currently facing some of the major challenges of the Egyptian society. The common feature to these companies is their will to tackle social issues by using new technologies. For instance, *Alashanek Ya Baladi*, an initiative seeking to alleviate poverty, youth unemployment and to empower underprivileged youth in Egypt, is operating through technical-, vocational- and life-skills trainings to support young generations to find a suitable and secure job. Also, *Nahdet El Mahrousa* is the first incubator of innovative social enterprises in the Middle East, aiming through an innovative platform, to build a network of people supporting other

people to address some social problems affecting the Egyptian society. Then, *Ashoka* through its innovative platform is seeking to create the largest network of social entrepreneurs in the world. Moreover, *Fekratek Sherkatek*, a nationwide initiative patrocinated by the Ministry of Investment and International Cooperation (MIIC), seek to improve the socioeconomic development of Egyptian society by supporting innovative business in today's competitive economy (Seda and Mamdouh 2020, 166-168). For the purposes and the possible positive effects of technological change on the society, the Egyptian Government might be the best supporter of innovative enterprises. Hence, the Egyptian government can ensure incentives and fiscal benefits to medium enterprises operating in the IT sector and especially to those supplying welfare services. For instance, in Europe, innovative platforms have been created that focus on the well-being of employees, their families and that supply welfare services according to the workers needs. Thus, workers can receive services offered by their company, such as voucher meals (Bonomi et al. 2020, 84). At the same time, it is necessary to fund those initiatives which often lack of secure funds for their core operations. In fact, funding is one of the biggest problems in the context of tackling social and economic issues in Egypt. For this reason, innovative social enterprises should be to rely on an established financial standard, a long-term funding or governmental awards established by the Ministry of Social Solidarity. In fact, this, seeking partnerships with foundations and corporations, should support technological change and simultaneously spend on health, infrastructures, education and social services (Seda and Mamdouh 2020, 166-168). Luciani (2017, 192) defines banks as "zombies", who net profits by collecting deposits on behalf of the government but do not contribute to the private sectors' financial needs. To Luciani, this motivates the needs of a long-term planning instead of short term financing of innovative enterprises and initiatives. This would end the economic decline caused by the public and private sectors blocking access to credit (Luciani 2017, 191). Hence,

it is recommended to provide assistance and consulting services to newly created incubators, accelerators, multiplications and co-working spaces (Seda, Mamdouh 2020, 166-168). In other words, financial subsidies and technical support are necessary to benefit the poorest part of the population (Luciani 2017, 192). However, it has to bear in mind that the amount of funding of capital and know-how still depends on the attractiveness levels of the country for international corporations, banks and institutions. According to "The Economist" (2017), the bureaucracy and the government situation are some elements that may lead foreign investments on start-ups to decrease. For instance, the bill that recently introduced from Egypt abolishing imprisonment for company owners whose business fails, will surely have positive effects of the foreign presence in the country (Göll and Zwiers 2019, 211).

In this context, Seda and Mamdouh (2019, 170) explain that normal initiatives do not attract enough foreign funding and investments because it is believed they do not pay the investment back. On the contrary, innovative entrepreneurial or economic initiatives are more attractive for investors. Thus, the money they will raise for the projects themselves will also have positive indirect effects on the whole economic environment and society. To conclude, Seda and Mamdouh (2020, 171-178) and Bohl et al. (2018, 25), recommend to support and coordinate initiatives that put innovation and technological change at their core. This would also play a role in addressing socioeconomic problems that often social enterprises and NGOs lack to tackle because of lack of funding and monetary problems. It is furthermore extremely necessary to encourage innovative activities in general, especially those that go under the definition of "social innovation activities". In fact these activities can help to reduce the poverty gap, the gender gap, youth unemployment levels and inequality among classes and individuals.

4.3 Policies to Mitigate Job Destruction

Starting from the assumptions considered in this dissertation, it is now time to individuate which policies are to be approved to experienced a fast growth in ICT and then to increase employment levels among men and women in the Egyptian society (Sicat 2020, 15). First, Badran (2019, 2) believes that the building of a "long-term pool of talents" in Science, Technology, Engineering and Maths fields will stimulate labour market. He states also that this would accelerate the birth of Internet-Based-Companies that generate income also for people living in remote areas thanks to the Digital Economy (El Manouar and El Hilali 2020, 70). Digital Economy plays a role in helping SMEs to connect with other firms across the world and to find new opportunities, also remote, for trade and development. Digital Platforms allow now to access and store data through the IT and big data tools. They are allowed to analyse the data collected to have predictions thanks to new technologies (El Manouar and El Hilali 2020, 71). This is proved by the McKinsey Global Institute (MGI), reporting that technological change is about to transform work instead of replacing it. In this context, Egypt and other developing countries should invest on skilled workers and cognitive capabilities to adapt their workers to technological needs of companies (Badran 2019, 2). In fact, McKinsey Research demonstrates that technological change will contribute for an increase of wages of around $366.6 billion in the whole MENA region. In other words, this brings an increase in the number of job opportunities in the Egyptian labour market. $88.8 billion of wages in Egypt come from technically automatable activities, a considerable amount compared to other Middle Eastern countries. Thanks to the global-ICT enabled services and ICT outsourcing, Egypt currently supports 90.000 related jobs and is growing at a rate of 7.5% per year, partially driven by businesses from Saudi Arabia and the Gulf countries. By increasing the Internet access, new opportunities for new business models will be created. Between these,

adequate opportunities of remote work and new digital formats will engage a wider audience, including woman and people living in remote areas, and will improve their skills and knowledge with a positive impact on unemployment rate (Badran 2019, 10-13; Göll and Zwiers 2019, 219-221). Therefore, it is recommended for Egypt to invest more on ICTs to create a second wave of technology disruptions. The aim is to involve the population into the Digital Economy and consequently to improve the business environment, attract foreign investments in research and development (R&D), adopt digital technologies and products with lower environmental impact but higher energy and material efficiency for a more efficient resources use. Small and Medium enterprises play an important role in this transition because they represent an interesting source of innovation. Therefore, the Egyptian government should accelerate this process by stimulating the activities of private industries and companies and fostering their digital transformation (Badran 2019, 10-13; Bohl et al. 2018, 24; European Commission 2021, 9). In a condition of elasticity of demand, automation will increase consumer demand, trade will increase as well with consumer needs. As a result, job opportunities will rise and unemployment will decrease, going from a rate of 12.6% of today to 4.6% by 2030 (Badran 2019, 10-13; Bohl et al. 2018, 24). Furthermore, it is needed that the public sector invest more on mobility across jobs, tasks, occupations and industries through Lifelong Learning (LLL) and a vocational enrolment model. This model represents the way to tackle the unemployment issue by providing the required skills and education to workers so to facilitate their replacement and to increase their proficiency, productivity and profitability. In fact, job seekers look for certain skills instead of qualifications and experience. For this reason, the model should follow the “skills map” that highlights the kind of skills that meet the needs of job givers. The point is not to compete against technological change but to complement workers with technological skills required to cooperate with new technologies and new machines. Thus, only under these circumstances Egypt

can keep its brains, it can encourage young people to invest their human capital in the Egyptian market and to develop R&D initiatives for a faster technological change (Badran 2019, 10-13). As far as displaced workers concerns, it is believed that a social safety strategy can support their re-allocation in the market. Moreover, the Egyptian government shall consider the improvement of social protection mechanisms for low-skilled displaced workers. For instance, the Egyptian government could provide them not only with a basic income – through monetary transfer programs or unemployment insurance - but also engage them in digital training courses to be employed in the new Digital Economy. A new regulatory framework and protection measures for these workers are also needed. These new measures would increase the labour productivity, the expansion of the tax base and government revenues. In other words, the Egyptian government would be able to spend more in social services and physical infrastructures (Bohl et al. 2018, 24; Emara 2020, 275). All what has been considered is an evidence of the labour-friendly impact of technological change in high- and medium- tech manufacturing sectors. What the government can do is to invest on the application of new technologies in the service sector, so that citizens can benefit of the advantages of ICTs (Van Roy et al. 2018, 1764-1766; Sicat 2020, 17). Furthermore, the tourism sector should be at the forefront in the application of new technologies for its activities. The tourism sector represents one of the biggest and most producing sectors in Egypt. More ICTs should be used for touristic purposes. Some best practices are already been developed and waiting for the application. For instance, the Second Life (SL) virtual platform was made for the ancient area of Giza to offer a virtual experience throughout an educational tool with social networking capabilities. The reachable aims are several: On the one hand, this project can save the Egyptian cultural heritage, on the other hand, millions of remote tourists can discover places and visit areas normally hardly accessible in real, because of their structural characteristics or their prices. The most interesting

feature is the possibility to socialize having a complete and real touristic experience, which can encourage tourists to visit the actual site. There are many best practices all around the world of companies, institutions, governments or ministries, museums and galleries that invested in digital tools for increasing their tourists' visits, such as the Second Louvre Museum in Paris or the Mauritius Islands, that offer visitors their tropical paradise, their culture and their diving treasures in a virtual manner. Also the Mecca Pilgrimage is now possible in a virtual way (Rateb et al. 2020, 511-512). The most interesting aspect of these projects is their socio-economic impact, which confirms the main argument of this dissertation. The beneficiaries of the application of such virtual projects in the touristic sector are the local communities. For instance, as far as the virtual projects in Egypt concerns, the surrounding area of the Pyramids of Giza and the overall local areas is the potential beneficiary of the new virtual tool. Also the academic community, researchers and scholars working on the virtual tool, the private and public sector and the local tourism industry at large will benefit from the revenues. In other words, the application of ICTs in different sectors surely contributes to create new job opportunities and higher wealth levels for the local population. Moreover, the same virtual tools have also educational purposes. In fact, they offer virtual learning opportunities for local pupils, including interactions and group projects, following new pedagogic-technical approaches of education. The overall Egyptian educational system could definitely benefit of the new technologies in the context on a new digitalized world, developed even faster after the challenges brought to the traditional system from the recent Covid-19 pandemic (Rateb et al. 2020, 513-524).

To sum up, a research from the European Commission (2021, 9) shows the sectors which benefit the most from technological transformation whose potential is able to mitigate job destruction processes. Among them, there is the manufacturing sector, because thanks to 5G connectivity, devices in firms will

be more connected and able to collect industrial data, improving workers job, safety, productivity and demand and therefore wellbeing. In the health sector, the introduction of online interactions and electronic documents make the government expenses to decrease and the wellbeing of persons with diseases and disabilities to benefit from the possibility to receive care from home. In fact, telemedicine is a way to lessen the long queues in the hospitals and to have a live monitoring on all patients. In the construction and agriculture sectors, digitalisation can be the driver of change to produce more tailored and efficiently, thus increasing competitiveness and sustainability performance. Moreover, also in the mobility sector digital solutions have the potential to improve the efficiency of the transportation systems and to its environmental footprint and traffic accidents and (European Commission 2021, 9-10). Even though the Digital Economy still needs to tackle several issues and effective framework measures are to be addressed, it is playing an important role in creating new forms of employment, new entrepreneurial opportunities and new forms of wealth. Doubts remains about the replacement of low- and medium-skilled jobs with high-skilled jobs, the inequitable access to key resources in developing countries, the uneven distribution of profits and education opportunities, the unequal access to digital infrastructures, the gender and racial discrimination at work. However, the debate is still ongoing and new horizons are to be defined in the near future (Sicat 2020, 28-30).

Conclusions

The outcome of the present research clarifies that digital technologies are now imperative for working, learning, entertaining, socialising, shopping and accessing services and culture. Although it was found hard to give a definitive assessment of the impact of technological change on the labour market, scholars contested the idea that it destructs jobs. In fact, this general rule is not always valid. It has been demonstrated as incorrect that the increment of productivity through technological change is done at the expenses of the traditional workforce and capital labour, replaced by machines performing the same tasks in a shorter frame of time. Contrarily, scholars gave evidence of the fact that technological change does not substitute jobs, rather it changes the type of jobs and how they are performed. Besides the traditional manual, cognitive, routine and non-routine tasks, other types of jobs will be created, such as teleworks (Mao et al. 2021, 10). In other words, technological change cannot be directly and fully associated with job losses, but instead to a shift of the tasks that today belong to men and that will, probably, belong to machines in the near future

The ambition of every government, especially for those facing economic and social issues, is to approve digital policies to empower people and businesses and to create a more sustainable and fair digital future for everyone (European Commission 2021, 1). As announced from the President of the European Council, Ursula Von der Leyen, European Union is already working to improve its leadership on digitalisation, artificial intelligence, a good monitoring system and a secure digital identity for all. In fact, in Europe the call for action implies now to accelerate the digital transformation and to work towards a Digital Single Market and an integrated regulatory framework to achieve solidarity, prosperity, sustainability and people empowerment in a digital and secure ecosystem (European Commission 2021, 1). Similarly to Europe, also emerging countries and especially Egypt must develop an economy based on

Research&Development and innovation. Egypt has great opportunities in pursuing this path since its rapid technological adoption, its capacity to learn from other countries and the existence of several routine occupations (Badran 2019, 10; Van Roy et al. 2018, 1764-1766).

It has been demonstrated that technological change in the long period improves the economic performance of countries and continents in terms of job creation, quality of work and life conditions. Nonetheless, as it has been showed, it remains extremely linked to human development, education and qualifications (El Manouar and El Hilali 2020, 67; Göll and Zwiers 2019, 213). In other words, it is assumed that technological change can contribute for economic, social and cultural advancement, but it is also believed that this process must be activated by the presence of social and economic factors or conditions, implemented by the governments in synergy with other civil actors.

In fact, technological change in developing countries, and in particular in Egypt, is inextricably linked not only with the availability of fixed and wireless broadband networks infrastructures on the supply side, but also on the political conditions present in the country and the rates of democratization.

Therefore, it has been suggested that the Egyptian government and its institutions should foster further innovative initiatives and projects, in cooperation with non-state actors, such as international organizations and non-governmental organizations. This would create the possibility to discuss with several stakeholders on societal needs at large and on the role played by innovation and technological change. In other words, the engagement of citizens groups and associations in the decision-making process is deemed inevitable to deeply understand which direction to follow for a better life. In fact, as it has been maintained, this cooperation can bring a successful result in the empowerment of the poorest and under-served people in the country, throughout the use of new technologies and the creation of widespread wealth. What seems to be certain, it is the need of digital infrastructures to overcome the social issues

afflicting the country, such as poverty, illiteracy rates, income inequality, women empowerment, trade barriers for women and for micro, small and medium businesses, the reduction of mobility constraints, discrimination and violence.

Internet access, the wider use of mobiles and digital services play a large role in facilitating the energy access, in the lessening of trade barriers already existing among Arab countries, in the introduction of under-served people in the labour market. By increasing the Internet access, new opportunities for new business models will be created. Between these, adequate opportunities of remote work and new digital formats will engage a wider audience, including woman and people living in remote areas, and will improve their skills and knowledge with a positive impact on unemployment rate. Digital Economy helps SMEs to connect with other firms across the world and to find new opportunities, also remote, for trade and development. Therefore, maximum utility has to be taken from the use of new technology to improve the quality of organizational innovation and human capital.

Nonetheless, it has been stated that innovation can bring growth only if workers possess enough skills and capabilities. The academic component is extremely linked to economic and social change. It is needed to endow students with digital technologies and digital skills to become effective "digital users". Therefore, it is necessary to educate people at all levels to technological change and to the digital environment. Measures can include, for instance, peer-to-peer learning initiatives, ongoing trainings, mentorships and the effort of high-growth digital entrepreneurs (Sicat et al. 2020, 10-12). The Minister of Education must keep investing on the change of the public educational system adding the teaching of skills such as critical thinking, innovation skills, creativity, technological skills. The government must rely on digitally empowered and capable citizens able to perform on the high-performing digital education ecosystem.

Moreover, it has been showed that only through a more inclusive work model, women and young workers can reach a total engagement in the market. In fact, their participation in the economic activities, also thanks their technological skills, can be an attraction for new investments and the establishments of start-ups and innovative enterprises. Technological change and investments in ICTs could lessen social barriers and reduce the gender gap between men and women. Only if women are allowed to start their own business a tangible change in the society could be achieved. Hence, is here stated that a good business environment must be created to facilitate the digitalisation process. Moreover, it is believed that policymakers must work seriously on data protection and new regulations. In fact, there is no social change following technological change without good redistribution policies from the government side. Thus, to avoid the counter effects deriving from the application of innovative strategies, it is deemed important to invest in other fields, such as resources for adult and basic education, a strategic redistribution plan to ensure the resources and the newly created jobs are evenly distributed across the economy.

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Summary

Chapter 1: The first chapter deals with the relationship between technological change and social change. This section tries to understand the relationship unifying the two terms and the way of measuring them. The biggest difference lies in the epistemological and methodological difficulties to measure social change which appears to remain largely unexamined. Technological change, contrarily, have been more deeply studied by several researchers which try to understand it change can shape the welfare services and hence, foster workers' and citizens' wellbeing by creating more job opportunities, new markets and by boosting economic growth.

The first part deals with the academic definition of technological change and its different meanings over time according to different academic factions and commissions, beginning from the 30s of the twentieth century, when the concept of technology set up two related concepts: Technological Change and Technological Innovation. The opinion of the scholars was discordant about the interchangeability of the use of the two terms. Nonetheless, they all understood the term *change* as a synonym of improvement, progress or advance. Later in time, a second difference were made between Technical and Technological Change.

The second part explains deeply the characteristics of these concepts and the differences between them: technological change, innovation and invention with a particular attention to the types of technological innovations pointed out by Schumpeter.

The third part focuses itself on the definition of Information Communication Technology (ICT) and its central role played in the Digital Economy. In fact, the importance of Internet has increased dramatically until it has been incorporated into the organization of work and processes as it is one of the biggest variables for the GDP growth. Today, the Artificial Intelligence, General Purpose

Technologies and several other innovations in the digital environment have a transformative power in favour of the wellbeing of citizens in urban and rural societies.

Chapter 2: The second chapter deals with the current discussion on the effects of new technologies on society and daily lives in the short period. The focus is on the impact of information communication technologies as an opportunity to change political, economic and social structures and to shape society for societal needs. The main belief is that technological innovations influence not only the nature and the quality of work and the economy, but more important that have an impact on the structure of the society. On the one side, the assumption is that technological change could be the driving force for a better economy, labour market, trade and society, through the enabling of rights and freedoms, culture and health services. On the other side, it is maintained that technological change can have a negative impact on the labour market and the economy, but also can shape forms of social inequality and the creation of social classes.

The first section of the chapter explores the type of relationship between technological change and changes in the labour market and in the economy. To assess this aspect, the notion of productivity is introduced. The most valuable argument explains that the final effect of technological change and the digitalization on the economy depends on the type of innovation and other variables but mostly it enhances speedy economic, inclusive and sustainable growth and development. A difference is made between the impact in the short and in the long run.

In the second part it is assumed that in the short run, innovation of product unemployment and job losses but then stimulates the demand from the consumer side and, if prices are elastic and there are no competitive products, it allows the employment growth in the long run. Hence, the consequence in the long run is an increase in the productivity levels and a decrease in employment levels.

Overall, the productivity levels of innovative firms are seen to be better than the ones of old firms.

Then, the argument is deeply researched through the analysis of cases and it is assumed that technological change plays a considerable role in reducing the gender gap and the inequalities in the labour market.

Chapter 3: The third chapter tries to answer some questions about the impact of technological change and innovation in emerging countries, already facing problems related to health, water, education, food, infrastructures and telecommunications. The focus is made on Egypt and its opportunities and challenges deriving from investments in new technologies together with an effort in the social, economic and education spheres.

The first section of the chapter investigates the relationship between the application of ICTs and the economic growth. Hence, it is here hypothesized that the ICT is the driving factor to support development in emerging economies, including Egypt, in challenges such as poverty eradication and the empowerment of disadvantaged groups. Moreover, it narrows the productivity gap with other nations through the introduction of elements like the Internet, digital platforms and mobiles.

The second part of the chapter focuses on the Egyptian economy, its labour market and the challenges it is facing. Among these, the Egyptian GDP is not well distributed across the population and the overall well-being indexes are quite low because of a high concentration of wealth in the hands of a small percentage of population, giving birth to high levels of economic inequalities in the country. Thanks to the new reforms adopted by the Egyptian government, the Egyptian economy is progressively changing and its recent adaptation to free trade has been the stimulus to develop new technologies and to benefit from the social and economic revenues of the Internet and of technological change.

In the last section it is assumed that although its economic and political issues, Egypt can benefit from investments in new technologies to increase productivity and enlarge the access to social goods and services in order to reach a "World Free of Poverty", but only if an inclusive national strategy and a serious implementation phase are applied.

Chapter 4: The fourth chapter discusses the policy recommendations to set forth and strengthen the preconditions for a successful technological change and therefore, a social, economic and cultural advancement.

As assumed in the first section of the chapter, the policy reforms do not only include technological and innovation aspects but also and foremost they must act in the economy, in the cultural and education sectors to pave the way for a serious social development in Egypt, since the process must be activated by the presence of social and economic factors or conditions, implemented by the governments in synergy with other civil actors. Here it is maintained that when a country shows investments in smart infrastructure, good empowerment levels, the exploitation of new technologies by businesses and the delivery of growth and jobs, it is ready to complete the digitalization process. In other words, it is believed that when reached the technological conditions, digitalization can "make life easier for citizens and consumers, raise the productivity for workers and firms and help governments to extend their key services to people in need. In fact, some best practices are presented to show that technological change in Egypt has benefited many businesses in many sectors, such as agriculture, health, primary education, energy, social welfare and widespread empowerment. Then, it is suggested to encourage an attractive environment for innovation and, consequently, for social development through a review of institutions management and their readiness to use technology, the improvement of the legislation dealing with property rights and technology, the improvement of investments on trainings for a better use of new technologies.

This argument is wider discussed in the second section, where it is deduced that countries like Egypt must invest on the reduction of the gender gap and disadvantages present in the society also by investing in new technologies to engage them in economic activities. In recent times, also the digitalisation of public services plays a large role in the fight against inequality among genders and social classes. Moreover, technological change with good redistribution policies from the government side will avoid the counter effects deriving from the application of innovative strategies, providing a strategic redistribution plan to ensure that resources and the newly created jobs are evenly distributed across the economy. Other best innovative practices for the society are presented, showing how some innovative enterprises are currently facing some challenges of the Egyptian society with the aim to tackle social issues by using new technologies.

The third part of the chapter individuates the policies to experience a fast growth in ICT and then to increase employment levels among men and women in the Egyptian society. In fact, it is concluded that Egypt and other developing countries should invest on skilled workers and cognitive capabilities to adapt themselves to technological needs of companies. It has been also demonstrated that this will bring an increase in the number of job opportunities in the Egyptian labour market for the labour-friendly nature of technological change in high- and medium- tech manufacturing sectors.