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YÜKSEK LİSANS TEZİ

**THE IMPACT OF TECHNOLOGY ON
EMPLOYMENT**

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ÖZ

Bu çalışmanın temel amacı, teknolojiler ile istihdam düzeyi arasındaki ilişkiyi incelemektir. Çalışma, teknolojinin istihdama olan etkisini iki kategoride değerlendiriyor: firma düzeyindeki etki ve sektörel etki, aynı zamanda, bu etki istihdam ve ücretler bağlamında incelenip, yüksek teknoloji imalat sanayilerindeki istihdam ve ücretlerdeki genel artışı ve diğer yandan düşük vasıflı ve rutin temelli mesleklerde çalışan işçi sayısında önemli bir azalması gözükümüştür. Analizin sonuçlarında, otomasyonun etkisinin her koşulda aynı olmadığını, ancak devlet gelişimine (gelişmiş veya gelişmekte olan), endüstrinin türüne (üretim veya hizmet), sektörün yapısına (yüksek teknoloji veya düşük teknoloji), işçilerin niteliğine (yüksek vasıflı veya düşük vasıflı), teknoloji türüne (emek yoğun veya sermaye yoğun), teknolojinin özelliği (ikame edici veya tamamlayıcı), yenilik yöntemine (süreç veya ürün), süre etkilerine (kısa vadeli veya uzun vadeli) ve küreselleşme gibi bazı ilgili önlemlere göre değiştiğini göstermiştir. Yukarıda belirtilen özelliklere dayanarak, VAR modeli üzerinden, ABD ve Türkiye'nin imalat ve hizmet sektörlerinde teknolojinin ve yüksek vasıflı işgücünün istihdam ve ücretler üzerindeki etkisini analiz ettik. Sonuç, imalat sektöründeki istihdam kategorisi hariç, Türkiye için, 4 sıralamadan on yıl boyunca uzun vadeli ve nedensel bir ilişkinin olmadığını, ancak, ABD için, imalat sektöründeki ücret kategorisi hariç, 4 sıralamadan 3'ünde açıklayıcı gücün nedensel ve uzun vadeli olduğunu gösterdi. Bu, gelişmiş ülkelerde teknolojinin istihdam ve ücretler üzerindeki etkisinin açıkça olumlu, gelişmekte olan ülkelerde ise belirsiz olduğunu göstermektedir. Ayrıca, ABD tekstil endüstrisini istihdam ve ortalama ücretler açısından bir analiz yaptık. Sonuçlar, mutlak anlamda teknolojinin pozitif etkisini düşük vasıflılardan çok yüksek vasıflı mesleklerde daha büyük olduğu elde edilmiştir ki, ve bu da mesleklerin kutuplaşmasını doğrular.

Anahtar Kelimeler: Teknolojiler, İstihdam Düzeyi, Ücret Düzeyi, İşçilerin Nitelikleri, ABD ve Türkiye İmalat ve Hizmet Sektörleri, ABD tekstil endüstrisi.

ABSTRACT

The main purpose of this study is to examine the relationship between employment level and technologies, where the study assesses the causal relationship in two categories: at the firm and sectoral basis, in the context of employment and wages, where was seen overall increases in employment and wages in high-tech manufacturing industries and a significant reduction in the number of low-skilled workers and in the routine-based occupations. The results showed that the effect of automation is not the same in all conditions, but it varies depending on the state development (developed or developing), the type of industry (manufacturing or service), the structure of the sector (high-tech or low-tech), the qualification of the workers (high-skilled or low-skilled), type of technology (labor intensive or capital intensive), the feature of technology (substitutional or complementary), the method of innovation (process or product), the duration implications (short term or long term) and some related measures such as globalization. Based on the aforementioned characteristics, we analyzed the impact of technology and a highly skilled workforce on employment and wages, in the manufacturing and service sectors of US and Turkey using the VAR model. The result showed that for Turkey, except for the category of employment in the manufacturing sector, out of 4 rankings, there was no long-term and causal relationship throughout the decade, however, for the USA, except for the category of wages in the manufacturing sector, out of 4 rankings, the explanatory power in 3 of them was a strong long-term and causal relationship, indicating that the impact of technology on employment and wages in developed countries is clearly positive compared to developing countries where it is ambiguous. Moreover, we analyzed the US textile industry in terms of employment and average wages. The results demonstrated that the positive impact of technology in absolute terms in a high-skilled occupation is higher than in a low-skilled one, which confirms the polarization of professions.

Keywords: Technologies, Employment Level, Wage Level, Qualification of the Workers, US and Turkey Manufacturing and Service Sectors, US textile industry.

ACKNOWLEDGMENTS

This work was written with the aim of providing a new perspective on trends in employment patterns influenced by innovation in organizational and sectoral levels. Dedicated to the master's thesis, the work demonstrates the positive and negative results, in terms of employment and wages, of modern technologies and machines, introduced instead of the labor force.

The thesis is divided into four parts. The first part is a review of a brief history of technological development, in the context of the first seeds of technology and the approach of economic schools in relation to it. The second part demonstrates the emergence of new business structures as a result of the introduction of technologies. The third part illustrates the analysis of technological effects at the firm and industry levels, that is, based on the organizations and sectors, respectively. The last part shows empirical results obtained from our own calculations for a causal relationship between technology and employment.

I am sincerely grateful to my supervisor Asst. Prof. Dr. Önder YERLİKAYA, for all of his support, guidance, critiques, and vision throughout the work. I would also like to express my gratitude to Prof. Dr. Muhittin KAPLAN and Asst. Prof. Dr. Guzin Emel AKKUŞ for their assistance. Finally, I am proud to express my gratitude to my family and friends.

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LIST OF ABBREVIATIONS

AAL	: Active Assisted Living
AI	: Artificial Intelligence
ATM	: Automated Teller Machine
BCG	: Boston Consulting Group
C	: Intercept
C&T	: Trend and Intercept
CMS	: Content Management System
CD	: Creative Destruction
DEU	: German'
Ed.	: Edited
Ede.	: Education
EDCUSA	: The Number of People with Tertiary Education Level in USA
EDCTR	: The Number of People with Tertiary Education Level in Turkey
EMPUSAMAN	: Employment in the Manufacturing Sector of USA
EMPTRMAN	: Employment in the Manufacturing Sector of Turkey
EMPUSASRV	: Employment in the Service Sector of USA
EMPTRSRV	: Employment in the Service Sector of Turkey
EU	: European Union
GE	: General Electric
GM	: General Motors
HEGY	: Hylleberg, Engle, Granger and Yoo
HRM	: Human Resouce Management
H-S	: High-skilled
Ibid.	: A source mentioned in the previous endnote
ICT	: Information and Communications Technology
IFR	: International Federation of Robotics
IRF	: Impulse Response Function
IMF	: International Monetary Fund

IT	: Information Technology
IWMA	: Industrial Waste Management Association
L-S	: Low-skilled
LR	: Long-run
OECD	: Organisation for Economic Co-operation and Development
PED	: Price Elasticity of Demand
PM	: Profit Maximization
p.	: page
pp.	: pages
RBTC	: Routine-Biased Technological Change
RPA	: Robotic Process Automation
R&D	: Research and Development
RDUSAMAN	: R&D Expenditures in the Manufacturing Sector of USA
RDTRMAN	: R&D Expenditures in the Manufacturing Sector of Turkey
RDUSASRV	: R&D Expenditures in the Service Sector of USA
RDTRSRV	: R&D Expenditures in the Service Sector of Turkey
SBTC	: Skill-Biased Technological Change
SL	: Short-run
STOA	: Science and Technology Options Assessment
TFP	: Total Factor Productivity
US	: United States of America
VAR	: Vector Autoregression
W.Date	: Date not specified
WEF	: World Economic Forum
WGUSAMAN	: Average Earnings in the Manufacturing Sector of USA
WGTRMAN	: Average Earnings in the Manufacturing Sector of Turkey
WGUSASRV	: Average Earnings in the Service Sector of USA
WGTRSRV	: Average Earnings in the Service Sector of Turkey
W.Place	: Place not specified

INTRODUCTION

Technology is a tool that profoundly changes our lives from different sides of daily life and has become our necessity. The changes that occur in the environment with technology, forcing all people to join this cycle, as people's professions change with the change in technology. In the modern world, there are professions that were not in the past, as well as professions that existed in the past, but have disappeared today. Technology is one of the central factors to all these changes.

One of the main differences between humans and other living things is their ability to innovate. Humanity has spent many millennia to accumulate abilities, improve, acquire new skills and technologies. Technology is a reformation of humanity for better survival. The power that forced people to such changes is nature itself. From time immemorial to the present day, one of the main reasons that forced people to modernize is the desire to stay alive in nature. In this way, the accumulated information that was written by people is called knowledge. This knowledge during the period was improved, changed, and also criticized, and knowledge that was distinguished by its truthfulness (science) was passed on to future generations.

Today, ongoing scientific discoveries are based on knowledge that has been accumulated and passed on to us over tens of centuries, are the main factors of modern technological innovation. Science and technology are an integral complement to each other, since with the help of science, modern technologies are invented and, in turn, the latest technologies have become the main factors in the development of science in the modern world. It is determined in Liebermann's study that science and technology develop significantly dependent on each other. He says that the papers of scientists who actually work in electronics industry firms are found to be much more cited in leading scientific physics journals than their university colleagues.¹ Technology and science,

¹ F. Chris and S. Luc, **The Economics of Industrial Innovation**, Trans. by Ergün Türkcan, 2, Tubitak Yayınları, Ankara, July 2003, p. 18

which are the basis for each other, are the main factor in the development of economic science and its empirical basis in modern countries.²

The beginning of the XXI century was also the beginning of a new technological revolution. Smart factories, the internet, information and communication technologies are actively entering our lives. The scientific community is beginning to realize that qualitative changes are taking place in material production. The transition to a qualitatively new stage is always associated with the accumulation a qualitatively new level of knowledge-capacity, that occurs in leaps and bounds and changes the proportions between the material and knowledge parts in favor of the latter. However, it's important to highlight that technology and innovation do not represent the same meanings. Innovation can be described as a human-oriented look and process. This approach necessitates repetition and experimentation, as well as a varied staff and a commitment to learn while failing. New technology may come from innovative approaches, but innovation does not mean technology.³ In contrast to technology, which is physical, innovation might be intangible.

Today, under the influence of accumulated knowledge, we are witnessing a process of erosion of industry divisions. A turner who works on a five-axis machine must, in fact, be a software engineer. Innovation also leads to equality by allowing people to save time and resources on other purposes. Since it freed female and help them to avoid from time-consuming domestic tasks, such as the washing machine which is probably the perfect example of how time-saving leads to equity.⁴

Information and communication technologies are becoming an integral part of modern humanity. Growing economic activity is currently supported by these technologies. These technologies provide quick access to a variety of information from

² Muhammed Göktürk, "Teknolojinin İstihdam ve İşsizlik Üzerindeki Etkisi: Türkiye Örneği", **Nevşehir Hacı Bektaş Veli Üniversitesi**, Nevşehir, August 2015, pp. 16-19.

³ Margaret A. White and Garry D. Bruton, **The Management of Technology and Innovation**, South-Western, Cengage Learning, USA, 2011, p.19

⁴ Emanuela Cardia, "Household Technology: Was it the Engine of Liberation?", **Universite de Montreal and CIREQ**, w. Place, July 2008, p.2

anywhere 24/7. Currently, more than 2 billion people have phones and by the connection of Internet, and innovations now allow people to regulate their household equipments, kitchen timers, health routines and systems of car; these technologies are also increasing the scale of the practices and effectiveness of companies and governments.⁵ With better innovation, companies in the private sector can regulate energy consumption in a building, they can find deficiencies in production and gain the ability to robotize routine jobs that used to be done by humans.

The extension of implementation of technology is projected to impact the quantity and quality of jobs. The innovative types of job and employment are transforming the appearance and requirements of work, changes the skill demands and substituting the former types of job organisation. Technologies offer potentialities, mostly in developing states, for new entrants and to be able to compete with developed countries. Moreover, innovations are impacting the mechanism of labor market and calling into question the efficiency of current labor market policies, with great implications for the quantity of positions, as its quality and the variety of potentialities associated with them. Science, which is at the heart of innovation, opens up new places and industries to work. This means that no society can grow and compete in today's world without investment in science and technology.

In the subject of economics, technology means - the use of all types of industries to generate new items or perfect the current item's quality on the market. The use of technology is essential for growth, development and competitiveness. This approach is well described in three words: Science-Technology-Development.

In the 19th century, with the industrial revolution, the link between science and technology became stronger. The steps taken during that period became important for the inevitable change in a human life. Changes have occurred in a short time. The German philosopher Friedrich Nietzsche said: " A snake which cannot cast its skin has

⁵ Martha Garcia-Murillo, "The impact of ICTs on employment in Latin America: A call for comprehensive regulation", **Barcelona Institute of International Studies (IBEI)**, 48, Barcelona, 2017, p.2.

to die."⁶ In economic terms for our topic, we can say that if countries resist the introduction of new technologies, they will lose their competitiveness in the international market. This means that if the world around us develops faster than we do, then our end is near. All these changes became the basis of a new civilization. Today, innovation has become one of the main indicators of economic and social development, as the demand for high technology is growing rapidly with impacting employment, education, health care and other sectors.

Obviously, the existing areas welcome the active development of these technologies, but there is an area in the economy that has undergone some changes in dynamics in certain periods of time, starting from the 19th century, has been influenced, and in certain places has been strongly negatively influenced by constant technological innovations. This is employment. The economy today is undergoing significant changes. One of the most significant reasons for this change is the fourth industrial revolution and the ubiquity of digital technology. Technologies such as artificial intelligence, cloud computing, robotics, nanotechnology, and 3D printing technologies are developing. A variety of industries and types of activity are undergoing transformation, new ones are being formed, built exclusively on the use of modern technologies, however some industries with the implementation of technologies on an irrational scale in some sectors adversely affects the employment of certain segments of the population.

The introduction of technology into industry is contributing to structural change in existing professions and becomes an important factor in the disappearance and transformation of jobs. With the Industrial Revolution, non-living machines were used in manufacturing, with which companies began to produce huge quantities of products in a short time, which led to less use of human labor in industry. In the last quarter of the

⁶ Jan Bouwens, "Auditors: their mindset and their decisions", **Accountantscontrole, MAB**, 90 (10), w. Place, Oktober 2016, p.390

20th century, technology that contributed to high productivity, did not surprise by causing high unemployment in some sectors.⁷

The consequence of the transition in industry from human labor to a wider use of machines and capital is the technological unemployment. As international competition intensifies and becomes fiercer in the world, capital owners who want impeccable production and cheap labor are moving their investments to where they can be realized.⁸

Economists often consider the global impact of technologies, such as automation, robotics, on the economy and human, but at the same time they have very different points of view. On the one hand, it is said that technology will reduce workload, fire workers, or end work by transformation. Another important point is that technology will create great opportunities for workers and will contribute to economic growth.

Many policymakers are concerned about how to generate productive employment at a fast enough level and to lower current levels of unemployment as a consequence of rapid population growth. The typical answer to this dilemma is to use a labor-intensive and capital-saving production method. If there is a labor surplus, it is preferable to employ a low capital (K) to labor (L) ratio so that the extra labor may be utilised in the manufacturing process. Using a greater K/L ratio would imply that less labor could be used, which would lead to increase in unemployment levels. However, there are grounds of assumption, contrary to popular belief, using a greater K/L ratio would not automatically result in higher unemployment levels, in the long-run. Instead, a higher K/L coefficient might result in more job possibilities as a result of faster production growth brought on by technical advancements reflected in new capital expenditures. As a result, the greater the percentage of capital investment, the greater would be the technical development, which in turn results productivity growth and increased labor demand, in the long-run. However, this mechanism is not applicable in

⁷ Daron Acemoglu, "Technology, unemployment and efficiency", **European Economic Review**, Elsevier, w. Place, 1997, p.525.

⁸ Zeynep Erdiñ, "Küreselleşmenin İstihdama Etkileri", **Dumlupınar Üniversitesi Sosyal Bilimler Dergisi**, w. Place, 1999, p.116.

practice for most developing countries, where there is no market for perfect competition, and the entire market is in the hands of oligopolistic powers. Consequently, in such a labor market, the accelerated and cumulative transition to technology does not compensate for the former laid off workers, which will lead to high unemployment in the long term.

In this context, the aim of the study is to show the impact of technology on employment and identify positive trends and bottlenecks, analyze empirical data in terms of employment and wages.

PART ONE

A BRIEF HISTORY OF TECHNOLOGICAL DEVELOPMENT

1.1. Technological Development Before Classical Economics

The history of the expansion of innovations isn't independent from to the history of mankind socio-conditional growth. The first seeds of science emerged 3000 BC, originated in the Mesopotamian civilization, where the brilliance of civilization manifested itself. Thus, science embarks on its first journey from the Eastern civilization. Science, which after the Egyptian civilization moved to the West, first goes to Ionia, then to Athens, southern Italy and again returns to Alexandria. With the fall of the Roman Empire and the burning of the magnificent Alexandria Library, by medieval fanatics, science revived and began to develop with the rise of Islam.⁹ From the 7th century to the end of the 13th century, science, which developed under the auspices of Islam and the seeds of which were sown in the modern sense, began to revive again in Europe. The science that travels from Europe to America before embarking on this journey backs up its hands with technology.

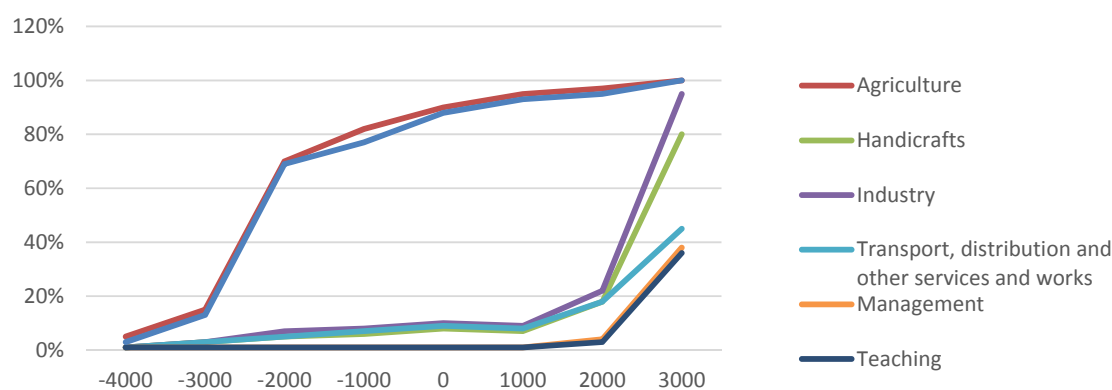


Figure 1.1: The Evolution of Operation Types in the Past and Future (*“The Economics of Industrial Innovation”*, 2003)

⁹ Misbah Deen, *Science Under Islam - Rise, Decline and Revival*, LULU Edition, w. Place, 2010, p.14

Generally, the first steps of technology that began in the 1650s and accelerated with the use of steam as an energy source, created the first realities of the industrial revolution.¹⁰ If we look at it as a transitional period, the mechanization that follows the industrial revolution begins with the transition from agriculture to industry, when a culture of urbanization emerges, which continues with the emergence of capital ownership, in which increasing mechanization of production creates mass production in factories and where we can observe the emergence of new disciplines.

The First Industrial Revolution is credited with being the first time in history that a country transitioned from agriculture - based to industrial dominance. The Industrial Revolution describes a set of technological advances that, by compensating machinery for man's ability and nonhuman control for man's and animal's force, result in a transition from handiwork to manufacturing and, as a result, the birth of a new economy.¹¹ This isn't to suggest that there hadn't been significant technical advancements prior to the First Industrial Revolution. China, on the other hand, was likely much more progressed than Europe in the 14th century. However, a massive transformation towards technological concepts took place in the seventeenth century with a revolution that would then be the beginning of great global changes.

1.2. Technological Development in the History of Economic Thought

The economic model, which begins with *The Wealth of Nations*, published by Adam Smith in 1776 and explains how economics worked till the Great Depression in 1929, is what economists call the classic model.¹² Although the classical economic model lost its meaning for a period after the 1929 crisis, it gained importance again after the 1960s.¹³ The classical school viewed technology as an approach to the production

¹⁰ Min Xu, Jeanne M. David, Suk Hi Kim, "The Fourth Industrial Revolution: Opportunities and Challenges", **International Journal of Financial Research**, 9 (2), USA, 2018, p.90

¹¹ Jurica Simurina and Josip Tica, "Historical Perspective of the Role of Technology in Economic Development", **FEB-Working paper series**, University of Zagreb, 6 (10), Zagreb, 2006, p.4

¹² Miljenko Antic, "Reexamining Role of the State in Promoting Development", **Politicka misao**, 5, Zagreb, 2003, p.18

¹³ G.G. Muhammed, *Ibid*, p.10

function within the framework of economic theory, and technology was adopted as external to the production function. Adam Smith, David Ricardo and Karl Marx, who were the first representatives of the classical school, focused their attention on various phenomena, although they knew about the importance of technological innovation and R&D in the development of countries.

Table 1.1: Successive Technological Revolutions (*“The Economics of Industrial Innovation”*, 2003)

Long waves or cycles			Important features of predominant infrastructure		
Timing	Waves	Science, technology, education and retraining	Transportive communication	The means of energy	Global and cheap important points
First 1780s- 1840s	Industrial Revolution: textile factory production	Learning by doing, dissent academies, and scientific organizations	Canals and carriageways	Power of water	Cotton
Second 1840s- 1890s	Period of steam factor and railroads	Professional engineering, technological institutes, and public primary education	Telegraph and railroads (iron)	Power of steam	Coal and Iron
Third 1890s- 1940s	Period of stell and production of electricity	State and standardized laboratories, Industrial, chemicals and electrical	Telephone and railroads (steel)	Electricity	Steel

		RD laboratories			
Fourth 1940s- 1990s	Period of mass production (Fordism) of cars and synthetic materials	Massive industry and government research and development, as well as mass tertiary education.	Airlines, highways, Tv and radios	Oil	Oil and Plastics
Fifth 1990s-?	Period of microelectronic s and computer systems	Information networks, worldwide RD connections, and perpetual learning and training	ICT highways and digital systems	Oil/Gas	Microele ctronics

One of the main engines of technological improvements is the spendings on research and development. There were state and university laboratories in earlier periods, but the first specialized R&D laboratories of the industry itself were created in the 1870s.¹⁴ Professionalized R&D is associated with three key changes: The increasing scientific nature of technology, technology is gradually giving priority to "continuous and mass" production lines instead of "cluster and one-piece" production systems and the tendency towards division of labor, also emphasized by Adam Smith, gives an advantage to private research laboratories with highly trained personnel, information services, and scientific instruments. The real change had occurred, especially in the American economy, between the two world wars, with the sudden boost of military equipments and the rapid development of industrial R&D activities in large companies during this period. At the outbreak of the Second World War, there was a widespread system of professionally staffed research laboratories and related institutions run by the

¹⁴ Mark Lehrer, Phillip Nell and Lisa Garber, "A national systems view of university entrepreneurialism: Inferences from comparison of the German and US experience", **Elsevier, Research Policy**, 38, w. Place, 2009, p.272

state, universities, and industry.¹⁵ So, the aforementioned sayings clearly show that the classical school viewed technology as an external factor in increasing labor productivity, as well as the growth and development of the economy.

1.2.1. Adam Smith and Technology

At the initial stage of economic development, the term "machine" usually meant the widespread introduction of the division of labor. As Adam Smith wrote, the greatest progress in the development of the productive power of labor and a significant proportion of art, skill and ingenuity with which it is directed and applied, were, apparently, a consequence of the division of labor.¹⁶

Adam Smith's concept of division of labor states that employees learn new abilities while working on a project.¹⁷ When assessing the economic development, it becomes clear that the notion of economical improvement was constructed correlated to the mechanism of the growth preconditions of that time-interval. Taking this into account, changes in productivity that affect the profit target are highlighted in Smith's work of capital collection and economic boost.¹⁸ It can be seen that its effectiveness is investigated depending on conditions, for instance: geositions of countries, the availability of natural resources and the fundamental mechanism of the country, the division of labor and the process of technological enhancement.

Tesel also emphasizes Smith's idea that "there is a natural upper limit to economic growth."¹⁹ In other words, long-term growth is limited. Adam Smith also believes the development of technology will always push the boundaries of economic

¹⁵ Richard Rowberg, "Federal R&D Funding: A Concise History", **CRS Report for Congress**, w. Place, August 1998, p.1

¹⁶ Adam Smith, **The wealth of nations**, Ed. by S.M. Soares, MetaLibri Digital Library, New York, May 2007, p.8

¹⁷ Allen J. Scott, **Metropolis: From the Division of Labor to Urban Form**, University of California Press, Los Angeles, 1988, p.30

¹⁸ Rabiul Islam, Ahmad Bashawir, Abdul Ghani, Bobby Kusuma, Belinda Theseira, "International Journal of Economics and Financial Issues", **Econjournals**, 2016, 6(4), pp,1722-1728.

¹⁹ Barış Aytekin, "Adam Smith'in Ekonomik Büyüme Düşüncesinden Günümüze Bakmak: Krizlerin Sürekliliği", **Kırklareli University, İşletme ve İktisat Çalışmaları Dergisi**, 5 (1), w. Place, w. Date, p.31

opportunity. Because he lived in a period when the agricultural sector dominated, limited by the availability of land and climatic conditions, and this thought prevailed in Smith. According to Rostow, the key forces influencing the engine of economic development are population development, capital growth, the division of labor (technological progress), as well as the economy's structural system (competitive and free market economy).²⁰

Summing up the work of Smith, we can conclude that he was the first economist who considered production technology as a condition for growth.

1.2.2. David Ricardo and Technology

By 1821, nevertheless, Ricardo had been convinced that the replacement of equipment for human labor, is always quite injurious to the needs of the class of laborers, and that the opinion held by the working class, that the implementation of technology is often unfavorable to their passion, is not formed on preconception and mistake, but is appropriate to the standards of policymakers.²¹

Ricardo's early work on mechanization confirms the Say's law.²² Namely, in the studies, Ricardo remarks that using machines will not lead to permanent unemployment. Moreover, Ricardo did not emphasize entire layoffs due to technological development. Thus, Ricardo believes that workers temporarily exposed as a result of the use of the equipment, can be re-hired. That is, technological development will not cause permanent unemployment.²³ This assumption that as profits rise, so will the demand for labor, which led him to conclude that the use of machines benefits all classes.²⁴

²⁰ Ayhan Uçak, "The sentiments of Adam Smith relating to economic growth as an inspirer to modern growth theories", **Trakya University Journal of Social Sciences**, 15, Turkey, June 2013, p.34

²¹ Samuel Hollander, "Ricardo on Machinery", **Journal of Economic Perspectives**, 33 (2), Toronto, 2019, p.230

²² Margherita Russo, **Economic Policy, Crisis and Innovation**, Ed. By Maria Cristina Marcuzzo, Antonella Palumbo, Paola Villa, Routledge, London, December 2019, pp.1-302

²³ Mario Amendola and Jean-Luc Gaffard, "Revisiting the 'machinery effect': from Ricardo to Hicks and ahead", **OFCE**, w. Place, 2009, p.6

²⁴ S. Hollander, *Ibid*, p.230

1.2.3. Karl Marx and Technology

According to the understanding of capitalist economics, although it is argued that the trio of capital, technology and labor constitute the contribution of production, according to Marx, this discourse is an ideological discourse designed to disguise the exploitation of labor.²⁵

In *Capital*, in his most comprehensive study of capitalism, Marx devoted an entire section longest to technology and its effect on the working class. Machines, according to Marx, are the most effective tool for suppressing attacks.²⁶ Indeed, he indicated that it'd be possible to generate quite a history of the developments produced since 1830 solely the aim of supplying capital with weaponry targeting working-class rebellions.²⁷

Every innovation or improvement in an equipment throws out many workers out of work, and as the innovation movement continues, the army of people who are unemployed, which Karl Marx names as The Reserved Army of the Capitalists, will grow, leading to additional suffering, poverty and hunger.²⁸ In fact, Marx derived this system from an analysis of Ricardo about tools and their impact on the life of the worker. Marx was one of the economists, who think that technology regulates our “metabolism” with life, or our positive transformation of nature.²⁹

²⁵ Zafer Demir, “Karl Marx’ın bakış açısından kapitalist toplumda yabancılaşma ve sonuçları”, **Abant Kültürel Araştırmalar Dergisi**, 3(5), Ankara, 2018, p.66

²⁶ Andrew Feenberg, **Transforming Technology**, Oxford University Press, New York, 2002. p.48

²⁷ Nathan Rosenber, "The Direction of Technological Change: Inducement Mechanisms and Focusing Devices", **Economic Development and Cultural Change**, 18 (1), w. Place, 1969, p.13

²⁸ Muhammad Baqir As-Sadr, **Our Economics**, World Organization for Islamic Services, Tehran, 1994, pp.194-195.

²⁹ John B. Foster, “Marx’s Theory of Metabolic Rift: Classical Foundations for Environmental Sociology”, **The University of Chicago**, 105 (2), w. Place, September 1999, p.390

One of the most important things, according to the framework of Marx, by which one can define his approach is that laborers were more dependent on the system of capitalists since they could not own the instrument of manufacturing anymore.³⁰

1.2.4. John M. Keynes and Technology

The main direction of the analysis and normative conclusions was the technological development of the real sector of the economy and its diversification and structural restructuring.

Keynes was long-term pessimistic about developed countries.³¹ Keynes's idiom proves this: "In the end, we will all die."³² He stated that one of three factors, which he cited as the reason for this, is a slowdown in technological progress.³³ Both the post-World War II experience and rapid technological development and growth have clearly demonstrated how erroneous Keynes's long-term pessimistic views were. For Keynes, the long-term balance is not very important, he explores how to achieve a full employment balance with the inputs (data, technology and labor) in the short term.³⁴

The definition of "technical unemployment" has been further discussed by J.M.Keynes, who described it as unemployment caused by the invention of ways of economising the use of labor; and who claimed that "the rise in technical productivity has been actually occurring faster than we could cope with the issue of labor application."³⁵ According to him, when machines and other modes of innovation become more productive than labor, businesses can raise capital and reduce labor, in consequence of which the unemployment will grow. Many impacted by this transition

³⁰ Martin Griffiths, **International Relations Theory for the Twenty-First Century**, Routledge, New-York, 2007, p.42

³¹ Vincent Barnett, **John Maynard Keynes**, Routledge, London, October 2012, pp.1-324

³² Sema Y. Genç, Keynesyen İktisadi Düşünce, w. Place, w.Date, p.5

³³ Ozlen Hic, "Keynesian System, Keynesian Policies and an Evaluation of What Keynes Might Have Advised Today", **International Conference on Eurasian Economies**, Istanbul University, Turkey, 2015, p.221

³⁴ Levent Aksu, "İktisat Ekollerinin İktisadi Büyüme Konusundaki Düşünceleri Ve Modellerinin Analizi", **Türk Dünyası Araştırmaları**, 208, w. Place, February 2014, p.363

³⁵ Jordi Gali, "Notes for a New Guide to Keynes (I): Wages, Aggregate Demand, and Employment", **National Bureau of Economic Research**, USA, December 2012, p.12

would be unemployed in the short to mid term, but Keynes remarks, that this is only a "temporary period of maladjustment."³⁶

Intensive development of technologies and severe consequences of the world economic crisis of 1929-1933. rekindled a lively debate on technological unemployment. Keynes examines the difficult period of the Great Depression and makes the following prediction that have captured by a problem that certain reciters might not have encountered, but it will be analysed a lot in the future periods with the topic named by technological unemployment. It is growing as the acceleration rate of human-saving innovations exceeds the possibility to discover new uses for the freed labour.³⁷

1.2.5. Joseph A. Schumpeter and Technology

Joseph Schumpeter mainly attributes the growth to technological innovation,³⁸ and highlighted that this is an inalienable condition of growth. In the concept "Creative destruction" he shows in detail the process of destruction and creation of new jobs. He believes that this is a necessary precondition for per capita income growth in the long term.³⁹ He views technology as an "external element" and emphasizes the line of uncertainty.⁴⁰ The organisations pursue technical improvements and acquire innovations which are matching for their needs. In contrast to the neoclassical vision,⁴¹ Joseph Schumpeter elevated the dimensions of the approach of technologies not just like a contemporary method in the manufacturing procedures; At the same time, it was defined as a concept based on 4 main ideas, which include procedures kind of the manufacturing of a new item, the discovering of new commerces, the creation of new regulations inside

³⁶ Peter Wilson, "Did the Luddites Get it Right? Automation and the Labour Market", **The Student Economic Review**, 31, w. Place, p.26

³⁷ Bruno, Hans-Joachim, "Rage Against the Machines: Labor-Saving Technology and Unrest in England, 1830-32", w. Place, October 2018, p.2

³⁸ Elias Dinopoulos and Fuat Şener, "New Directions in Schumpeterian Growth Theory", **Horst Hanusch and Andreas Pyka**, Cheltenham, February 2007, p.2

³⁹ Gregory Tasse, "Beyond the business cycle: The need for a technology-based growth strategy", **Science and Public Policy**, Oxford University Press, 40, 2012, p.309

⁴⁰ A.Levent, Ibid, p.364

⁴¹ James Harrigan, "Technology, Factor Supplies and International Specialization: Estimating the Neoclassical Model", **NBER Working Paper Series**, National Bureau of Economic Research, Massachusetts, August 1996, p.3

the commerces and markets, the search for new raw materials, and the idea of technological innovation was formed.⁴²

Joseph A. Schumpeter in his work "Theory of Economic Development" first introduced this concept into economic circulation, including among five new combinations: the implementation of contemporary innovations, new technical procedures or new commercial assistance for manufacturing; the creating of a new item or a familiar item with additional properties; the acquisition of modern kinds of raw fabrics or semimanufactured products; modifications in the regulation of manufacturing and its various methods and assistances; pervasion into a new sales businesses.⁴³ J. Schumpeter understands innovation as changes to generate and utilize new methods of manufacturing of output, contemporary manufacturing and transportation tools, markets and forms of organization in industry, focusing on the economic impact of these changes.

⁴² Karol Sledzik, "Schumpeter's View On Innovation and Entrepreneurship", Ed. By Stefan Hittmar, **University of Zilina & Institute of Management by University of Zilina**, w. Place, 2013, p.90

⁴³ Farrokh Langroodi, "Schumpeter's Theory of Economic Development: A Study of the Creative Destruction and Entrepreneurship Effects on the Economic Growth", **Journal of Insurance and Financial Management**, 4 (3), Canada, 2021, p. 69

PART TWO

TECHNOLOGICAL DEVELOPMENT AND NEW BUSINESS STRUCTURES

With the development of the Internet, smartphones and computers, communication between people at a distance has increased significantly. Today, we can freely cooperate with an employer while being in another city or even a country. Tele-access clearly delineates the range of relationships between an employee using access from distance. The working place can be switched straightly out of the office to the home atmosphere, while providing a "virtual" presence at work. With tele-access, there is a practical linkage between a worker who is working from home with his associates who can be both outside and inside the office. Moreover, the working place itself, in the event that all its employees move from the office to the home environment, might be virtually connected and be substituted through a single communication forefront. Telecommuting has been proven to be family friendly, allowing flexibility in responding to the needs of children or elderly parents.

Table 2.1: Comparison of Classical Economy and New Economic Structure
(*“Teknolojinin İşsizlik ve İstihdam Uzerine Etkileri: Türkiye Ornegi”*, 2015)

Changed element	Classic economic structure	New economic structure
1. Production and competition area	National	Global
2. Determinant Factor of Economic Growth	Capital and labor	Knowledge and innovation
3. Technology determining factor	Mechanization (equipment)	Digitalization (hardware and software)
4. Importance of	Low or medium	High

R&D		
5. Employment structure	Stable	Risky and full of opportunities
6. Labor structure	Certain specialty	Knowledge, skill, versatility, master of experience and innovator

Since the beginning of the XXI century, the number of home workers is increasing. Polls of Americans show that for the period from 2005-2017 the percentage of employees that worked remotely as minimum half of the period increased by 115% to about 3% of the total workforce.⁴⁴ The Gallup Institute estimates that the proportion of workers who have ever worked remotely increased from 9% in 1995 to 37% in 2015.⁴⁵

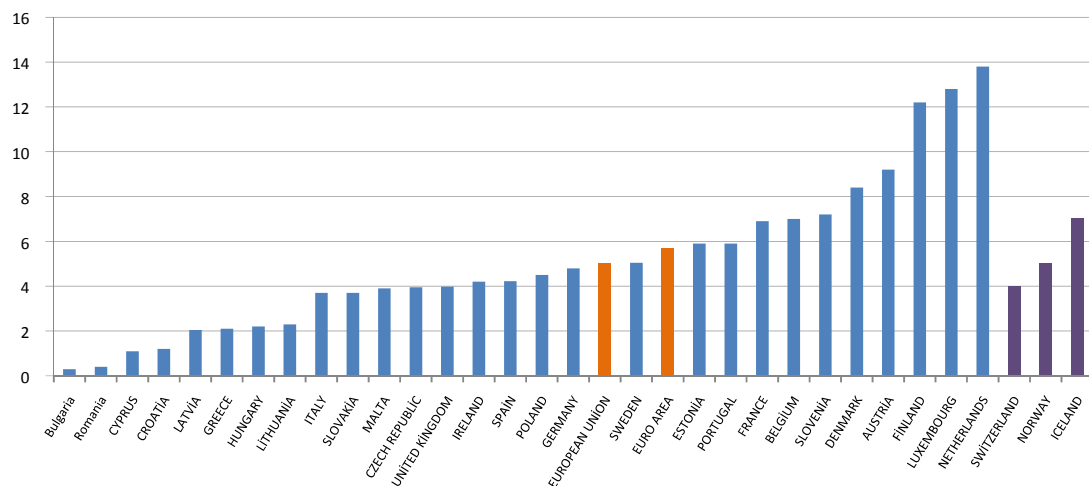


Figure 2.1: Workers whose Ages are between 15-64 Who Mostly Work Remotely in the EU, 2017 (*“The Journal Contemporary Economy”*, 2019)

According to McKinsey, the occupations that have the greatest possibility to be turned to the remote in a few years, among the 2 thousand tasks and 8 hundred positions,

⁴⁴ Harley Frazis, “Who Telecommutes? Where is the Time Saved Spent?”, **BLS Working Papers**, w.Place, April 2020, p.1.

⁴⁵ Jeffrey Jones, “In U.S., Telecommuting for Work Climbs to 37%”, **GALLUP**, USA, August 2015, p.1

are the finance, managerial-qualificative services, and information sectors, with 80%, 70%, 65% indicators, respectively.⁴⁶ Remote work allows you to more effectively use the time that was previously used on the road to work. Telecommuting varies greatly by occupation and industry. Based on the positive experience of remote work, some large companies have, in fact, decided to leave some of their specialists remotely. These parameters are especially important in companies, since a high degree of autonomy is effective only when there is an equally high degree of consistency within and between teams, and the importance of this consistency only increases when working remotely.⁴⁷ The highest rates are noted among middle managers and specialists. In the field of information, finance, as well as in the field of professional and business services, telecommuting rates exceed 25%, while in most other industries the rates are below 10%.⁴⁸

The percentage of people in the age between 15 and 64 in the European Union (EU) who are working from distance was 5.0% in 2017. This rate was on the top in the Netherlands (13.7%), which was followed by Luxembourg (12.7%) and on the third stage Finland with (12.3%), the number of people who work from home was the lowest in Bulgaria and Romania, with 0,3% and 0,4% respectively.

As a result of modern technological advances, working from home has acquired new content. In particular, these developments are based on the use of innovations in the field of computer technologies. The incorporation of telecommunications networks into business is one of the most important developments in the twentieth and twenty-first centuries. Indeed, telecommuting means expanding the original meaning of the word "home office" and moving it towards more complex systems of organizations. Definition

⁴⁶ Susan Lund, Anu Madgavkar, James Manyika, and Sven Smit, "What's next for remote work: An analysis of 2,000 tasks, 800 jobs, and nine countries", **McKinsey Global Institute**, w. Place, November 2020, p.5

⁴⁷ Jochen Wirtz, Werner Kunz, "Service Robots, Customers, and Service Employees: What Can We Learn from the Academic Literature and Where are t...", **Journal of Service Theory and Practice**, ACADEMIA, w. Place, January 2020, p.13

⁴⁸ Alexander Bick, Adam Blandin and Karel Mertens, "Work from Home After the COVID-19 Outbreak", **Working Paper 2017**, Federal Reserve bank of Dallas, w. Place, June 2020, pp.3-15

of remote work associated with different applications, complicates the task. Accordingly, remote work, it can be defined as a form of employment in which an employee is unable to establish personal relationships with employees who work in the head office or production department and who are actually his / her colleagues in the business environment and can only communicate using new technologies.

Pandemic and other cataclysms are also pushing for transformation of employment of the population. Due to the situation around the COVID-19 pandemic, there has been a quantum leap in the use of technology around the world. More organizations have found the opportunity to organize the work of their employees remotely. The emergence of digital online labor platforms has become one of the key transformations in employment. The emergence of distance relations between workers and employers leads to the formation of a flexible and virtual labor market.⁴⁹ There was a gradual growth in individuals opting to work remotely long before the coronavirus outbreak, and many firms have switched to more mobile workspace models. Before the recession hit, there was a rise for employees working from home from 2013 to 2018.⁵⁰ According to statistics, the self-employed people start working remotely during a recession increased. Although most of these individuals will return to the workplace after normality has recovered, it is doubtful that the percentage of people operating remotely will go down to pre-COVID-19 levels. According to Mercer's 2020 Global Workforce Trends Survey, only 44 percent of companies systematically analyze the feasibility of shifting jobs to remote work, instead of giving the worker some degree of freedom depending on his circumstances.⁵¹

⁴⁹ Nishonqulov Shohruhxon and Rajabboyev Botir, "In The Context of Developing the Digital Economy Modern Forms of Employment", **Eurasian Scientific Herald**, 1 (1), w. Place, August 2021, p.12

⁵⁰ Matthew Clancy, "The Case for Remote Work", **Economics Working Papers**, Iowa State University, w. Place, April 2020, p.23

⁵¹ "An employers' guide on working from home in response to the outbreak of COVID-19", **International Labour Organization 2020**, w. Place, 2020, p. 7

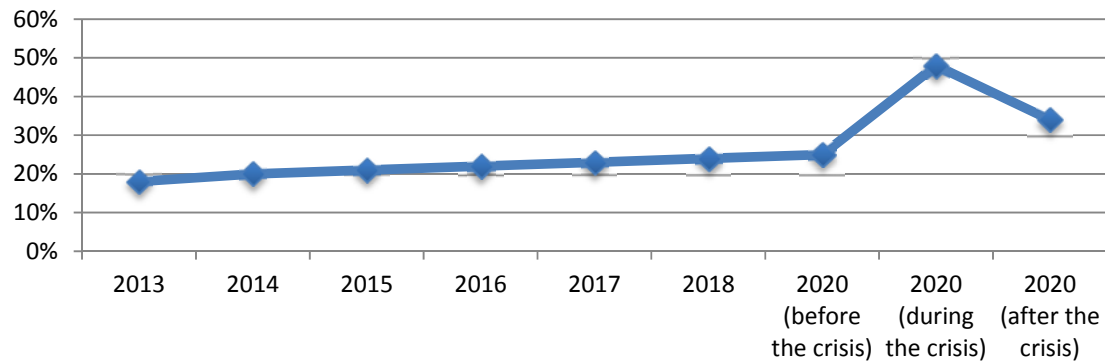


Figure 2.2: The Percentage of Swiss Employees Working Remotely a Minimum Half a Day Per Week (<https://www2.deloitte.com/us/en.html>, 2021)

The growth would have a huge effect on companies, and many will likely shift to more agile models in the workplace. Boosted by the COVID-19 epidemic, the transition into more flexible working structures had a positive influence on society in general, allowing people more choice in terms of location and management of time, while reducing the pressure on roads and railways.

There is a possibility that for some people it is preferable to work in an office rather than remotely, in terms of productivity. Some people find it convenient to perform company orders more efficiently when they are not working in a noisy office.⁵²

It is also important to note the positive and negative aspects of teleworking. The most important factor in the widespread use of remote work in different places is the development of technology. Moreover, we cannot ignore the demand from employers. In fact, employers are increasingly organizing teleworking, although communication costs are very high, and this creates various problems associated with daily supervision, management and organization. One of the main reasons for this is the expectation that working remotely will increase productivity of company. Employers believe that doing remote work without much interruption and focusing more on work will increase the

⁵² Alladi Venkatesh and Nicholas P. Vitalari, "An emerging distributed work arrangement: an investigation of computer-based supplemental work at home", **Management Science**, ACADEMIA, 38 (12), California, December 1992, p.18

level of productivity. In addition, teleworking is expected to increase productivity of work through greater job satisfaction and motivation as the worker gains control over their work. Another factor that is expected to improve efficiency is time saving factor. Teleworking helps prevent the wasted time that occurs when instructions are given using traditional methods inside the company. Another reason, employers prefer telecommuting is because it helps in flexibility and cost savings in terms of work organization and production. As a result of the implementation of this method in some organizations, the efficiency was estimated at tens of thousands of dollars.⁵³ Businesses can increase flexibility by hiring remote employees with different types of contracts.

On the other hand, teleworking also allows the hiring of skilled workers who live far away. In addition, the employment rate increases with creating new human resources, enabling the employment of people with disabilities. Another reason for the shift to telecommuting that should be remarked is that it offers a variety of conveniences in hiring and maintaining a skilled workforce. In this sense, teleworking can be achieved to keep women who plan to leave their maternity jobs and older workers retired to continue working. While telecommuting requires additional hardware costs and thus increases operating costs, it balances this increase with the savings that it provides through overhead costs. Employee reasons for preferring remote work: It can be described as providing control over work, allowing more flexible programming of family life, facilitating harmony between work and home and saving on costs such as food, clothing and transportation. However, it is very important that the person who will be engaged in remote work has a period of adaptation. Because moving to telecommuting requires new habits. The adaptation period takes place even for those who have the habit of planning their time in the best way. At the same time, telecommuting should ideally be accepted and highly desirable for work from home. In this work style, in which personality traits play an important role, those who do not like home life, who cannot establish harmonious relationships with the people with whom they live at home, or who prefer to

⁵³ Ralph D. Westfall, "Does Telecommuting Really Increase Productivity?", **Communications of the ACM**, 47 (8), w. Place, August 2004, p.93

participate in the social environment in the office instead of working on their own, do not prefer work based on remote work.

2.1. Freelance Work

The proliferation of computers, internet and related types of work has led to the emergence of a new way of employment - freelancing. A freelancer is an employee who is not on the staff of any company and who independently chooses the conditions, schedule and amount of remuneration for his labor.⁵⁴ In order to improve the efficiency of business processes, many companies prefer to hire employees from outside (contractor organizations or individuals, both directly and through recruitment agencies), instead of hiring them on the staff.⁵⁵ This kind of "platform" or "gig economy" might be a cause for workers for better self-control and a great social relationship, and might contribute to enhanced uncertainty and times of unintended unemployment.

According to a study by Edelman Intelligence, the number of freelancers in the United States increased from 53 million in 2014 to 55 million in 2016, and this is about 35% of the total workforce in the country.⁵⁶ Basically, this type of employment is chosen by young people, as older people prefer traditional employment with guaranteed social benefits.

The key assumption is that individual activities conducted by humans would turn to more tradable through the global network. Firstly, as markets for these activities ('platforms') get more popular, the proportion of freelance individuals that supply similar services through the platform will grow. Second, businesses increasingly focus highly on freelance workers and free specialists rather than stabilized system, which sometimes might show the worries of certain segments about the new economy and the 'atomization' of platform work interactions. In addition, due to problems encountered in

⁵⁴ Errol Salamon, "Digitizing freelance media labor: A class of workers negotiates entrepreneurialism and activism", **New Media & Society**, 22 (1), USA, 2019, p.105

⁵⁵ Gerald Friedman, "Workers without employers: shadow corporations and the rise of the gig economy", **Review of Keynesian Economics**, Edward Elgar Publishing Ltd, The Author, 2 (2), w. Place, 2014, p.184

⁵⁶ "Freelancing in America: 2018", **Edelman Intelligence**, Commissioned by Upwork And Freelancers Union, w. Place, 2018, p.11

online platform freelance works, the demand for cybersecurity is growing, which is driving the demand for information security professionals, which also leads to the creation of other future possible professions.⁵⁷ A lot of things would also depend on how and in which way policymakers of government monitor the system of crowd working and related innovations.

2.2. Outsourcing

Outsourcing has become popular much earlier than commonly believed. This approach made it possible to spend less money on the production of goods, increasing the profits of companies using cheap resources.⁵⁸

Outsourcing allows you not only to save money, but also to efficiently use the resources of your company, including maintaining an efficient structure of systems in the company. Why is outsourcing going to be popular? Because companies will look for ways to optimize operating costs due to the rising cost of raw materials, energy and transportation services. More and more companies will use cloud-based outsourcing services.

Outsourcing (working with employees from outside in replace to the professionals from local places), that is hugely implemented in IT organizations, in most instances causes a remarkable growth in unemployment. In the United States, over millions of jobs are outsourced.⁵⁹

⁵⁷ Sehun Kim and Myeonggil Choi, "Educational Requirement Analysis for Information Security Professionals in Korea", **Journal of Information Systems Education**, 13(3), w. Place, 2002, p.237

⁵⁸ Adrien Bilal and Hugo Lhuillier, "Outsourcing, Inequality and Aggregate Output", **NBER Working Paper Series**, National Bureau of Economic Research, Massachusetts, October 2021, p.2

⁵⁹ Ashok Deo Bardhan and Cynthia Kroll, "The New Wave of Outsourcing", **Fisher Center Research Reports**, November 2003, p.7

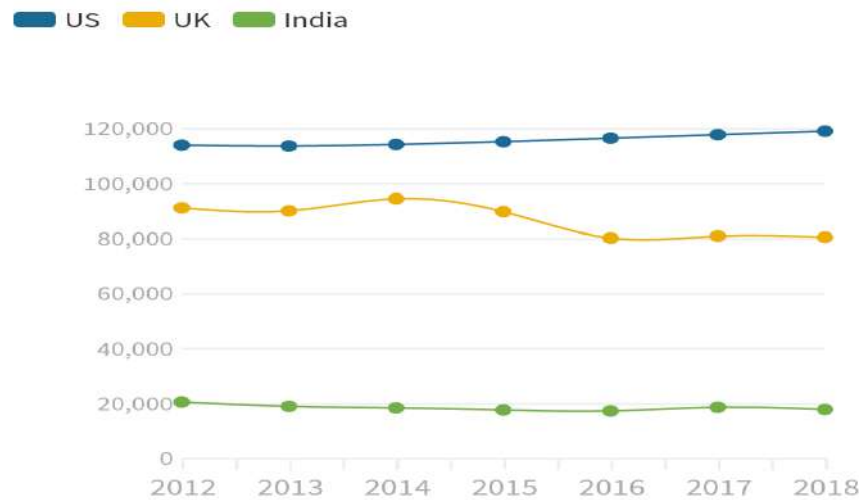


Figure 2.3: Average Salary for IT professionals (*Flourish, 2021*)

For example, while domestically in US, the salaries of IT specialists were more than \$ 100 thousand per year, the salaries of high-level IT specialists in UK and India were 80 thousand and 20 thousand dollars, respectively. That's why, it'll be beneficial for US organizations to support their competition in the worldwide institutions to implement the work of instructed professionals at a reduced cost. Several authors highlighted that the processes of globalization of the global economy can't usually witness a positive impact on the organizational system of employment inside the state. In the analyses of Forrester Research, 300 thousand out of 2.7 million IT positions have disappeared in the US because of outsourcing, from 2001 to 2004.⁶⁰ All this deep impact of information technology on a variety of industries became the reason to make a better case for multidisciplinary scholarly study that connects topics, problems, and important debates.⁶¹

As long as companies strive for optimization, outsourcing will also exist. Changing and adapting to the needs of the clients, it is possible to provide partner

⁶⁰ Joey F. George, Joseph S. Valacich and Josep Valor, "Does Information Systems Still Matter? Lessons for a Maturing Discipline", **Twenty-Fifth International Conference on Information System**, AIS Electronic Library, w. Place, December 2004, p.1042

⁶¹ Wendy L. Currie and Thomas S. Lagoarde, "Financialization and information technology: themes, issues and critical debates, part I", **Journal of Information Technology**, 2017, 32, p. 212

support and help find ways out of difficult situations. Outsourcing is able to provide the main thing for the continuous development of a business - rational load distribution and effective resource management.

2.3. Offshoring

Offshoring compared to outsourcing is a strategy that is described as getting an end product existing in a given country that was produced in another state.⁶² In this case, businesses are trying to find a supplier in a state of low economic power, for example, American companies offshore tasks and jobs to companies or individuals in South Africa. Since the economies in these countries are weaker, this situation inevitably leads to a decrease in the production costs of the company that organizes offshoring, and producers in weak countries receive a decent profit for them due to the strong exchange rate difference. This system actually brings together companies or individuals from different countries with an affordable price and high experience.

In the case of offshore, since the company operates with other countries, time has a special factor in production. When using the offshoring method, the process slows down, the final product reaches the country of the main company later than in natural methods of production, new transport costs appear (if the distance is long, then transport costs double), there are also costs for customs and for the registration of products produced in other countries. All of these are elements that directly affect the cost of production. We do not yet consider that the quality of the final product after these long processes may not be desirable.

There are other factors that contribute to the decline in employment opportunities for low-skilled persons.

⁶² Farok J. Contractor, Vikas Kumar, Sumit K. Kundu and Torben Pedersen, **Global Outsourcing and Offshoring**, Cambridge University Press, New York, 2011, p.XXVI

Globalization is one of the main reasons why low-skilled workers living in one country are being replaced by workers in other countries with the same skill level⁶³, for example, in the case when the companies organize production according to the method of offshoring and prefer to import the production produced in other countries instead of their own. These management tools became widespread in the late 20s and early 21st century with the processes of globalization, growing competition and "exponential" development of computer systems, technology and communications.⁶⁴ With the development of this method, sectors and countries want to receive more intermediate goods. But this trend is not an indicator of the disappearance of the local low-skilled labor and the beginning of a full-sector use of low-skilled labor in other countries. It was shown that for the automotive industry in Germany, the percentage of decrease in the use of low-skilled labor in value added was determined by 3% over 13 years (from 7% to 4%, from 1995 to 2008), while the overall proportion of foreign resources in the German auto sector's final production rose from twenty one % towards thirty four % throughout the decade, and the proportion of low-qualified employees from outside in the production process remained constant at 4%.⁶⁵ capital and high-skilled workers are continuously producing additional value, as well as the amount of domestic and imported low-skilled work in production and additional value is declining.⁶⁶

According to the Crino, either technology and globalization do have affect on the imbalance we are seeing in the data on work.⁶⁷ Furthermore, short-term and long-term consequences must be distinguished: if businesses start relocating low-skilled workers

⁶³ Martin Rama, "Globalization and Woirkers in Developing Countries", **Policy Research Working Paper 2958**, The World Bank Development Research Group Public Services, Washington, January 2003, p.12

⁶⁴ Vasil Tanev and Anton Nedyalkov, "Outsourcing, Offshoring and their derivatives as management tools: what works and what doesn't?", **Proceedings of University of Ruse**, 59, w. Place, 2020, p. 99

⁶⁵ Marcel P. Timmer, Erik Dietzenbacher, Bart Los, Robert Stehrer and Gaaitzen J. de Vries, "An Illustrated User Guide to the World Input–Output Database: The Case of Global Automotive Production", **Review of International Economics**, John Wiley & Sons Ltd, Academia, 23 (3), w. Place, 2015, p.584

⁶⁶ Bernhard Dachs, "The impact of new technologies on the labour market and the social economy", **European Parliamentary Research Service**, Brussels, February 2018, p.23

⁶⁷ Rosario Crino, "Service Offshoring and White-Collar Employment," **Review of Economic Studies Limited**, 77(2), w. Place, 2010, pp.595-596

overseas, offshoring can raise salaries abroad and could shift the course of technological change. Acemoglu expect that in less professional sectors, more offshoring will quickly stimulate progress, leading to less inequalities (globally).⁶⁸

There has been a lot of controversy about the relocation of manufacturing from developed countries to certain other countries, especially developing economies, to the point that, over time, the negative connotation of offshoring has become prevalent in popular perception. This develops the claim that, in many developed countries, this trend is primarily responsible for the decrease in employment levels, especially in the case of unskilled labor, while providing huge benefits to companies and consumers. There are studies by several authors that have different results regarding the impact of offshoring on employment in the context of the labor market.

Table 2.3: The Impact of Offshoring on Employment (*“The Impact of Offshoring on Home Country’s Employment”*, 2019)

Author and year	Period	Example/Country	Dependent Variable	Ratio of indicators	The impact of offshoring on demand of labor
Feenstra and Hanson (1996)	1972-1992	435 industries (US)	Yearly shift in the proportion of non-productive wages	The amount in the net purchases of non-energy products of the imported intermediate goods	Positive impact on skilled labour demand
Strauss-Kahn (2004)	1977-1993	50 sectors from manufacturing industry (France)	The amount of unskilled employees	The amount of import sources represented	Negative impact on skilled labour

⁶⁸ Daron Acemoglu, Gino Gancia, and Fabrizio Zilibotti, "Offshoring and Directed Technical Change", *American Economic Journal: Macroeconomics*, 7(3), w. Place, 2015, pp.84–122

			in the manufactur ing sector	in manufacturi ng	demand
Amiti and Wei (2005)	1995- 2001	69 manufacturing companies and 9 sectors from service (UK)	Employe ment (thousand)	The amount imported intermediate goods in the net purchases of non-energy products; Broad offshoring	No indicator showing the negative impact of offshoring on employment
Geishecker (2006)	1991- 2000	23 manufacturing industries (Germany)	The amount of expenditure s for low- skilled labor (indicator based on relative employmen t and relative wages).	The amount imported intermediate goods in the net purchases of the industry – narrow and broad	The offshoring has an impact on the demand of low- skilled workers in the indicated sectors, that leads to grow the level of qualification s
Hijzen and Swaim (2007)	1995- 2000	17 high income states of OECD	Employe ment evaluated from total employed	The amount imported intermediate goods in the additional value of the industry – narrow and broad	No impact (positive or negative) on employment in the indicated sectors

2.4. Reshoring

Employment in the economy is also influenced by one of the new tendencies that has emerged recently and is called reshoring (reshoring - the return of production to the country; a process opposite to offshoring,⁶⁹ when production moves to other countries with cheaper labor). Walmart, GE Appliance Park, and others were the first to take such steps in the United States. According to the Lindsay Oldenski, from 2010 to 2012, a significant number of reshoring companies returned to the United States from offshore.⁷⁰ In the global level, the countries, where a strategy of reshoring, or the return of previously withdrawn production abroad, has been put forward.⁷¹ The emergence of new technologies expands the possibilities for creating geographical value networks. As an instance, investing in manufacturing robotics enables efficient production in industries with relatively high labor costs. The widespread use of robotics can reduce labor requirements and reduce the share of labor in production costs, making offshoring less attractive. OECD manufacturing organizations, which previously took their production facilities abroad, increasingly return them back. A huge number of US firms announced, it is moving some of its manufacturing operations back to the United States.⁷²

⁶⁹ Vida Vanchan, Rachel Mulhall and John Bryson, "Repatriation or reshoring of manufacturing to the U.S. and UK: dynamics and global production networks or from here to there and back again", **CORE**, University of Birmingham, w. Place, 2017, p.4

⁷⁰ Lindsay Oldenski, "Reshoring by US Firms: What Do the Data Say?", **Policy Brief**, Peterson Institute for International Economics, Washington, September 2015, p.4

⁷¹ Luciano Fratocchi, Carmela Di Mauro, Paolo Barbieri, Guido Nassimbeni, Andrea Zanoni, "When manufacturing moves back: Concepts and questions", **Elsevier, Journal of Purchasing & Supply Management**, 20, w. Place, 2014, p.54

⁷² Lindsay Oldenski, "Reshoring by US Firms: What Do the Data Say?", **Peterson Institute for International Economics**, w. Place, September 2015, p.1

Table 2.4: Global Companies that Used Reshoring (*Vladimir Kondratiev, "Reshoring as a Form of Reindustrialization", 2017*)

Company	Number of jobs	Original location	Reshoring product
Wal-Mart	4444	Asian countries	Consumer goods
Ford	3250	Mexico	Automotive components
Caterpillar	1900	Japan	Construction equipment
GE	1900	China, Mexico	Appliances
GM	1800	Mexico	Gas turbines
Apple	1700	Asian countries	Computers
Farouk Systems	1200	China, South Korea	Goods for women
NCR	870	Brazil, China, India, Hungary	Asynchronous data transmission systems
Made in America Seating	510	China	Office furniture

Table 2.5: Reshoring by Industry in the USA between 2010-2015 (*Vladimir Kondratiev, "Reshoring as a Form of Reindustrialization", 2017*)

Industry	Number of jobs	Number of companies
Transport engineering	13823	33
Electrical industry	9240	58
Computer and electronic industry	3483	25
General mechanical engineering	2850	25
Textile industry	2154	46
Metalworking	1721	39
Food industry	1628	10

The digital revolution is expected to create favorable conditions for the placement in developed countries of low-cost and high-quality production, preventing further offshoring and stimulating the reverse process - reshoring. Thus, changes in the cost structure, demand factors and technologies are gradually changing the very nature of production. As a result, in the past few years there have been marked changes in the global manufacturing industry. In the USA, Germany, France, Great Britain and a number of other Western countries, within the framework of the new industrialization policy, outsourcing is being replaced by a strategy reshoring.⁷³

2.5. Crowdsourcing

Crowdsourcing technologies are understood as a way to achieve the goals based on the use of the labor force of stakeholders through information technology.⁷⁴ The increased attention to crowdsourcing activity as a type of labor activity is predetermined by the change in the economic conditions of market entities associated with the transition to the digital economy. In outsourcing, work is transferred outside the company to competent performers for a certain amount, while in crowdsourcing, there is a minimal payment or no need to pay.⁷⁵ The necessary work is done by unpaid amateur professionals who spend time creating content, solving problems, or even doing research.

Characteristically, crowdsourcing uses labor resources that “live” in the global network.⁷⁶ Its basic principle is simple and intuitive. If the goal is to find a solution to a problem, then the chances of finding an original solution are higher when 20 thousand people are involved in the process than when only 20 people are involved. And if the

⁷³ Hamid Moradlou and Chris J Backhouse, "A review of manufacturing re-shoring in the context of customer-focused postponement strategies", **Proc IMechE Part B: J Engineering Manufacture**, Sage, w. Place, April 2016, p.8

⁷⁴ Daren C. Brabham, "Crowdsourcing as a Model for Problem Solving", **The International Journal of Research into New Media Technologies**, Convergence article, 14 (1), Sage Publications, London, 2008, pp.75-76

⁷⁵ Stephen Quinn, Asia's Media Innovators Volume 3: Crowdsourcing in Asian Journalism, **Konrad-Adenauer-Stiftung**, Singapore, 2013, p.7

⁷⁶ Daren Brabham, **Crowdsourcing**, The MIT Press, Massachusetts Institute of Technology, London, 2013, p.1

goal is to benefit from interaction, then the more you involve people, the better for the cause. Since there are millions on the web, any number of performers can be found there. There are crowdsourcing platforms for open innovation. A lot of sites, software packages have been created that provide the ability to use network forms for performing one or another class of tasks.

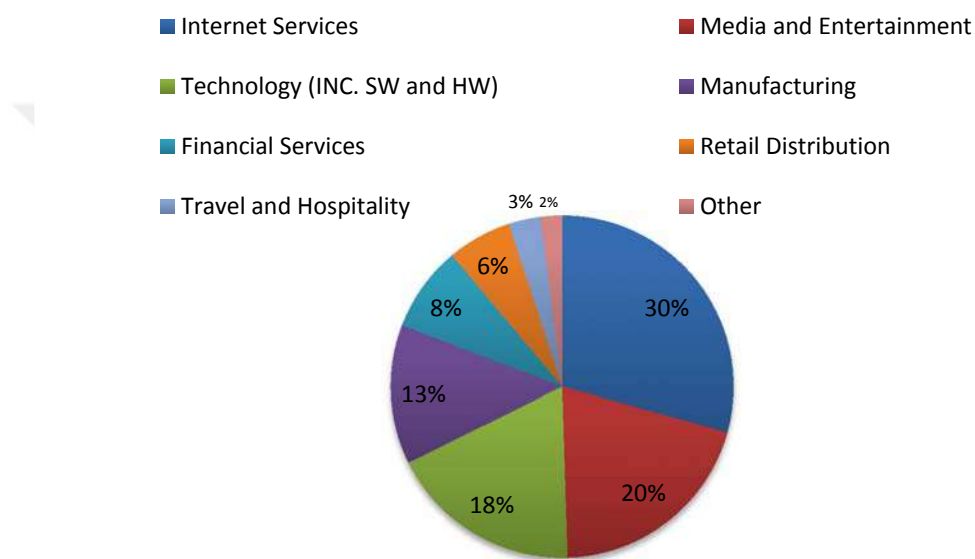


Figure 2.4: Crowdsourcing Activities that are Used in Different Areas
(*“Trustworthiness in Crowdsourcing”*, 2015)

PART THREE

THE IMPACT OF TECHNOLOGY ON THE FIRM AND INDUSTRY LEVEL

The unemployment is a macroeconomic position when a particular percentage of capable people in a country, face difficulties in finding a job which suits their performance ability. Among the types of unemployment, the following can be distinguished:

- A. Voluntary unemployment. This is a group of people who do not want to work with the prevailing wages and conditions. This is more typical for economies with liberal economic policies.⁷⁷ Voluntary type of unemployment rises in the period of increasing in economics and falls when there's a downturn.
- B. Involuntary unemployment. Involuntary unemployment is associated with the ongoing changes in the organization and management of economic activity, in technology and in the sectoral structure of social production.⁷⁸ The economic situation becomes such that workers cannot find work, even if they agree with the current level of wages and conditions.
- C. Cyclical unemployment. This unemployment occurs during a recession.⁷⁹ In the literature, this is called Keynesian unemployment.⁸⁰ This is a type of unemployment that occurs in the labor market due to a lack of demand in product markets.⁸¹ Due to the decrease in the volume of economic activity, this causes a decrease in the demand for labor.

⁷⁷ Jochen Clasen and Elke Viebrock, "Voluntary Unemployment Insurance and Trade Union Membership: Investigating the Connections in Denmark and Sweden", **Journal of Social Policy**, Cambridge University Press, 37 (3), United Kingdom, July 2008, p.433

⁷⁸ Chari, V.V., "Involuntary Unemployment and Implicit Contracts", **Discussion Paper 459**, Econstor, ZBW, Northwestern University, Evanston, 1980, pp. 1-29

⁷⁹, Michael W. Elsby, Ryan Michaels and Gary Solon, "The ins and outs of Cyclical Unemployment", **NBER Working Paper Series**, National Bureau of Economic Research, w. Place, January 2007, p.14

⁸⁰ Lael Brainard and David Cutler, "Sectoral shifts and cyclical unemployment reconsidered", **NBER working paper series**, National Bureau of Economic Research, w. Place, October 1990, p.1

⁸¹ Huriye G. Diler, "İnsan ve Toplum Bilimleri Araştırmaları Dergisi", **İnsan Ve Toplum Bilimleri Araştırmaları Dergisi**, 7 (1), w. Place, 2018, p.35

- D. Seasonal unemployment. This is unemployment that occurs in some sectors of the economy. These are usually tourism⁸², construction⁸³ and agriculture.⁸⁴ In some seasons, economic activity slows down due to social events or natural conditions, and as a result, production decreases.
- E. Demographic unemployment. This is the impact of population growth on unemployment. Demographic unemployment can result from the fact that the number of new employees coming to the labour market for the first time, due to natural population growth or immigration, exceeds the number of workers leaving the labor market due to retirement or emigration.
- F. Hidden unemployment. This is a type of unemployment observed mostly in the agricultural sector⁸⁵. The definition of hidden unemployment should be understood as an estimated indicator of that part of the population that could theoretically be recognized as unemployed.⁸⁶
- G. Technological unemployment The growing unemployment which leads to the layoffs generated through technological change - called technological unemployment. Technological unemployment is associated with the technological principles of the production function, the main initiatives of which are innovation, mechanization and automation of production. There is a perception, that, as incomes increase, the likelihood of adopting automated technology and therefore replacing humans with machines will increase.⁸⁷ This

⁸² Leo Jolliffe and Regena Farnsworth, "Seasonality in Tourism Employment: Human Resource Challenges", **International Journal of Contemporary Hospitality management**, Emerald, MCB UP, 15 (6), w. Place, p.312

⁸³ Alex Tooman, "Tourism and Development", **Journal of travel Research**, w. Place, 1997, p.36

⁸⁴ Rosenstein Rodan, "Disgised Unemployment and Under-Employment in Agriculture", **Economic Development Italy Project**, Center for Internation Studies Massachusetts Institute of Technology, Massachusetts, October 1956, p.4

⁸⁵ Włodzimierz Kolodziejczak, "Hidden Unemployment in Polish Agriculture in 2005-2018 – A Simulation of the Scale of the Problem", **Annals of the Polish Assotiation of Agricultural and Agribusiness Economists**, Poznan University of Life Sciences, 22 (1), Poland, 2020, p.172

⁸⁶ Luke Elliott and A. M. Dockery, "Are The 'Hidden Unemployed' Unemployed?", **The Centre for Labour Market Research**, 6 (2), Australia, w. Date, p.2

⁸⁷ "The impact of technology on the quality and quantity of jobs, global commission on the future of labor", **Global Commission on the future of work**, International Labor Organization, w. Place, 15-17 February 2018, p.5

kind of modifications in most cases comprise the implementation of labor-saving innovations via technical force or greater efficacy “mechanical minds” (mechanisation).⁸⁸ This is the type of unemployment that worries the modern world most of all and is the most important reason affecting economic policy. An analysis of theoretical and empirical works does not give an unambiguous answer to the question of the level of threats to the social sphere in connection with the development of new technologies. In connection with the created unemployment and the change in the structure of demand for labor, this type of unemployment makes it difficult to implement economic policy. There is a substitutional relationship between capital and labor,⁸⁹ which are the factors of production. Due to the progress and development of technology, more efficient machines can be used instead of the labor force. These attempts, made in countries that invest in technology and focus on capital-intensive economies, are causing unemployment, not to mention the absorption of surplus labor. In developing, and, in several cases, in developed countries, mechanization resulting from technological progress and development leads to unemployment for many workers in small businesses and crafts. Therefore, it is necessary to create new job opportunities for the unemployed. If this is not achieved, the resulting technological unemployment gradually turns into long-term structural unemployment.

There is a wealth of empirical research on the effect of innovation on the level of employed. This kind of anatomy might be carried out at some categories – micro - (only companies), meso- (separate sectors) and macro- (state economies).

Among the problems, one of the crucial points considered as essential factor, is the measurement. What's the way that one can calculate the index of progress in

⁸⁸ Hans-Joachim Voth and Bruno Caprettini, “Rage Against the Machines: Labour-Saving Technology and Unrest in England, 1830-32”, **Discussion Paper Series**, CEPR, Centre for Economic Policy Research, London, June 2018, pp. 3-18

⁸⁹ David H. Autor, Frank Levy and Richard J. Murnane, "The Skill Content of Recent Technological Change: An Empirical Exploration", **The Quarterly Journal of Economics**, 118 (4), w. Place, November 2003, p.1

innovations? Looking at the written works, it's possible to see a diversity of indexes that are implemented to examine the degree of innovational modifications - R&D expenditures, the rate of purchasing new machines, principles that determine the utilizing of technologies, and several different indexes.

What do the available empirical evidences suggest? Virtually many micro-category researches illustrate an affirmative effect of innovational improvement on the level of employed. During the last years of 1980s, the implementation of modern innovations provided a yearly growth in the level of employed, for organizations actively participating in the introduction of new technologies, for about 2% in Australia and for roughly 3% in the United Kingdom;⁹⁰ a typical output was received using UK records during 1976-1982;⁹¹ and affirmative linkage betwixt the implementation of modern innovations and the growth level of employed in British organizations was recorded as well, during the years 1998-2011.⁹² A research of a big instance of US production organizations that covered the 40-year time interval betwixt 1963-2002 demonstrated that the greater their patenting practice, the bigger will be the size of their procedure of creation of occupation.⁹³ A typical derivation, that innovative firms have greater growth in the level of employed rates compared to non-innovators, was drawn from the data in the production sector in West Germany over the period 1980-1992;⁹⁴ for the case of France (for the last years of 1980s), the organizations actively participating in the introduction of new technologies were greater active in job creation compared to

⁹⁰ David G. Blanchflower and Simon M. Burgess, "New Technology and Jobs: Comparative Evidence from a Two Country Study", **Conference on Technology**, Firm Performance and Employment at the National Academy of Sciences, Washington, May 1995, p.18

⁹¹ John Reenen, "Employment and Technological Innovation: Evidence from U.K. Manufacturing Firms", **Journal of Labor Economics**, 15 (2), The University of Chicago, w. Place, 1997, p.277

⁹² Guido Matias Cortes and Andrea Salvatori, "Task Specialization within Establishments and the Decline of Routine Employment", w. Place, December 18, 2015, p.21

⁹³ Alexander Coad and Rekha Rao-Nicholson, "The firm-level employment effects of innovations in high-tech US manufacturing industries", **Journal of Evolutionary Economics**, w. Place, 21(2), May 2011, p.260

⁹⁴ Werner Smolny, "Employment adjustment at the firm level. A theoretical model and an empirical investigation for West German manufacturing firms", **CEIS**, Fondazione Giacomo Brodolini and Blackwell Publishers Ltd, Malden, 2002, pp.75-85

organizations which are not innovative.⁹⁵ Quite unexpectedly, this work also led to the conclusion that “process” innovational changes more affirmatively impact the rate of employed compared to “product” innovational changes. The similar reverse output was received for production organizations of Germany (1982-2002): “process” and “product” innovational changes promoted the happening of new occupations, however the impact of the “product” one outweighed the impact of the “process” one.⁹⁶ An affirmative, however not enough powerful relationship betwixt entry companies technology and the rate of employed was identified for Italy (throughout 5 years after 1999).⁹⁷ Another study, also from Italy, shows that roughly half of the growth in manufacturing employment in that country over the time interval 1995-2003, was navigated via ‘product’ innovation, whereas the impact of ‘process’ innovational change kept indifferent.⁹⁸ Similarly, in the Taiwan economy (throughout 4 years after 1992), “product innovation” was correlated with the growth in the amount of labors working in total production industries, while “process innovation” - only in high-tech ones. Looking at the relatively recent works about Spain (throughout 7 years after 2002), where reported that in more pro-technological, little-sized and new companies, the rise of the rate of employed is quicker, compared to companies which are not pro-innovative. Larger companies in the other size groups led proportionally less to job growth than their employment percentage.⁹⁹ But, in more research, again about the Spanish production sector (2000s-2013), lack of powerful linkage betwixt innovation and the rate of employed was found. Complete lack of impact of R&D spending in context of generating new occupations was discovered in the companies dealing with production in

⁹⁵ G. Nathalie and G. Dominique, Ibid, pp.547-590.

⁹⁶ Stefan Lachenmaier and Horst Rottmann, “Effects of innovation on employment: A dynamic panel analysis”, **CESifo Working Paper**, 29, Germany, 2011, p.218

⁹⁷ Mariacristina Piva and Marco Vivarelli, “Innovation and Employment: Evidence from Italian Microdata”, **Journal of Economics**, w. Place, 2005, 86(1), pp.65-83

⁹⁸ Francesco Bogliacino, Marco Vivarelli and Mariacristina Piva, “R&D and employment: An application of the LSDVC estimator using European microdata”, **Economics Letters**, 116, Academia, Elsevier, w. Plate, 2012, p.56

⁹⁹ Paloma, Sergio and Angel, Employment Generation by Small Firms in Spain, **Banco De Espana**, Madrid, 2009, p.16

Norway for the decade after 1982.¹⁰⁰ Moreover, the table below shows a list of the largest Fortune 500 employers in the United States. These are companies headquartered in the United States, but they operate around the world, bringing their innovations to all of their divisions. The management of Walmart is participating in the process of automation activity in shops in a maximum rate. All of these robotic workforces are side of a project purposed at dropping the manufacturing price as well as growing shop efficiency. WalMart shops as well as different large retailers are switching towards innovation for technical activity. Walmart always expressed that their inclination of introduction the new innovations is just because of properly distribute the assignments of workers, and it's not aimed in the declining of positions. Innovations are improving and the features of employees are modifying, occupations are getting updated.¹⁰¹

Table 3.1: List of Fortune 500 US Largest Employers (*“Impact of new technologies and robotics on employment in the United States”, 2020*)

Name	Number of employees	Headquarters
Walmart	2 200 000	Bentonville, Arkansas
Amazon	798 000	Seattle, Washington State
Yum China Holding	450 000	Plano, Texas
Kroger	435 000	Cincinnati, Ohio
Home Depot	415 700	Atlanta, Georgia
Berkshire Hathaway	391 500	Omaha, Nebraska
FedEx	389 500	Memphis, Tennessee
IBM	383 800	Armonk, New York
United Parcel Service	377 640	Atlanta, Georgia
Target	368 000	Minneapolis, Minnesota

¹⁰⁰ Tor Jakob Klette and Samuel Kortum, “Innovating Firms and Aggregate Innovation”, **Journal of Political Economy**, The University of Chicago, 112 (5), 2004, p. 986-1018

¹⁰¹ N. Evgenievna, Ibid, p.85

According to the Portland State University, 200 thousand robots work at Amazon for 2021.¹⁰² Notwithstanding this speed of implementing of robotics, Amazon still acquiring fresh candidates. As it's reported by Amazon, starting from 2012, the organisation has purchased the Kiva Systems, which was named afterwards as Amazon Robotics (Kiva Systems, a new technology organization, was purchased by Amazon in 2012 for \$775 million).¹⁰³ A research written by Andrzej Wodecki has shown that the amount of time and the monetary value of operation introduced by robotics working in Amazon are quite less compared to the human.¹⁰⁴ ¹⁰⁵ However, the robotical technologies are not able to independently activate without getting an administration from personal. According to Amazon, they believe that there's not exist a battle betwixt robotical technologies and labor forces, and the system of activities is formed on the procedure of people plus robotics.¹⁰⁶

However, on the other hand, Amazon created Amazon GG - shops where grocery is selling with no need for checkouts and booking-clerks. Recorded for March 2021 that in US exist 28 magazines.¹⁰⁷ According to Alex, such groceries will cause the elimination of jobs in the market, in terms of service.¹⁰⁸ Many researchers think that this project might be the all-accepted principle for retailment. This project has its inverse effect on the rate of employment in the short-term, since the store is a responsible project, because compared to a restaurant or other sectors (each has its own demand for

¹⁰² Patil Girija, John Mareena, Jin Fenny, Kandula Swapna, Ketsaraporn Kaewkhiaolueang, "Amazon Robotic Service (ARS)", **Engineering and Technology Management Student Projects**, Portland State University, w. Place, 2021, p.12

¹⁰³ David Rotman, "How Technology Is Destroying Jobs", **MIT Technology Review Magazine**, w. Place, July/August 2013, p.4

¹⁰⁴ Andrzej Wodecki, **Artificial Intelligence in Value Creation**, Palgrave Macmillan, Springer Nature Switzerland AG, Warsaw, 2019, pp.1-340

¹⁰⁵ Hryhorak Mariia, **Intellectualization of Logistics and Supply Chain Management**, The Electronic Scientifically and Practical Journal, Viold Limited Liability Company, Kyiv, July 2020, pp.32-50

¹⁰⁶ Sangseok You and Robert Jr, Lionel, "Human-Robot Similarity and Willingness to Work with a Robotic Co-worker", **ACM, HRI '18**, Chicago, March 2018, p.1

¹⁰⁷ Russell Redman, "Report: Amazon has 28 more Amazon Fresh stores in the works", **SNSupermarket News**, USA, March 2021, p.1

¹⁰⁸ Alex Polacco Kayla Backes, "The Amazon Go Concept: Implications, Applications, and Sustainability", **Journal of Business and Management**, 24 (1), Department of Management Information Systems, College of Commerce, National Chengchi University, w. Place, March 2018, p.83

production), typical markets have a demand power (applies to everyone, not for individual consumers), as a result of which it can push other simple markets with full workers out of the sector. That is, if the audience of the company is a certain class of the population, then the existence of other companies with an incomplete transition to technological innovation in this sector is possible, however if the audience of the company is people from 7-70 years old and all classes of the population, then the demand will soon go to the store typical of Amazon Go Grocery, which will not give time for others to adapt gradually (as people will quickly change the market due to good infrastructure and prices) and may even lead to more severe results for other companies.

Evaluation of other empirical results show that the prediction of employed modifications in the UK for the years - 1990s. illustrates that the compensatory system is showing a powerful result to entirely balance the previously employee-laid off impact of modern innovations.¹⁰⁹ It's essential to note that the highly impacting channel is considered the compensatory channel linked with a decrease in prices; in some cases compensation would be only partial and in certain occasions an incomplete compensation for job losses.

Another important point that should be noted, in addition to stable conditions for companies, is the situation when the level in the economy is changing. Which companies manage to successfully get out of the changing level of the country's economy?

¹⁰⁹ R. Kapeliushnikov, Ibid, p.98

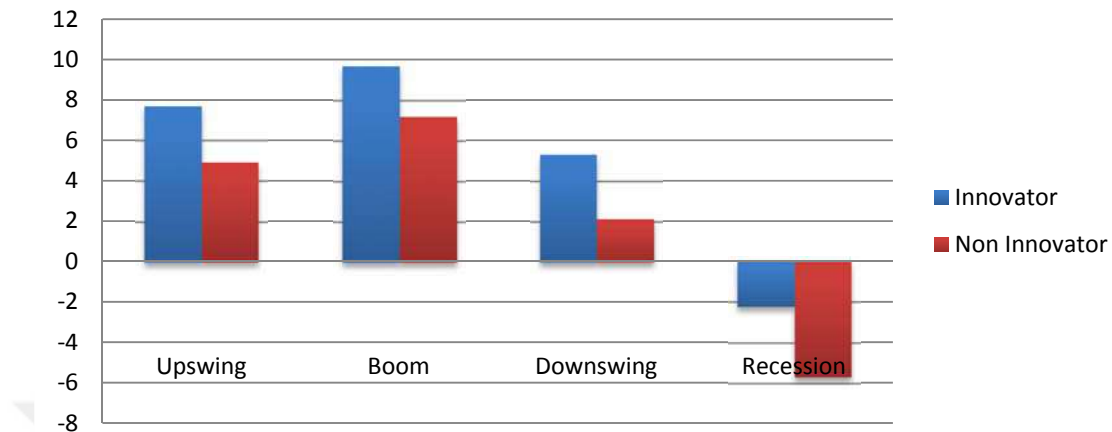


Figure 3.1: The Increase of Employed in the Innovative and Non-innovative Companies during Various Stages of the Economy, 1998-2010 (*“The impact of new technologies on the labour market and the social economy”*, 2018)

It is clear from some empirical datas that there are no specific indicators for all regions and organizations, since the economic structure of the state and the methods of firms do not always coincide, but it is obvious that despite certain negative preconceptions, there are examples that show positive correlation between technology and employment at the firm and industry level.

3.1. Creative Destruction, Augmented Solow Model and Employment

A. Creative Destruction

The emergence of new revolutionary technologies has always contained great economic potential, but at the same time it was destructive for the existing structure of society. Some professions are becoming obsolete, others are emerging; labor must transfer out of locations in which demand for it is falling to locations in which demand for it is growing; non-innovator companies begin layoffs / shut down entirely, while innovator firms share new occupations, so that works begin to spill over out of the former towards the latter. Indeed, such procedure is the illustration of what J. Schumpeter named the mechanism of “creative destruction”. CD is a mutation procedure that continuously reconstructs the system of economics out of inside through

demolishing the old structure and contributing the formation of the new structure.¹¹⁰ The following stages show several conclusions about the mechanism of Schumpeter's "creative destruction" and unemployment:¹¹¹

1. Innovation is a driving force.
2. The neo-Schumpeterian formulation of external growth theory highlights quality-improving technologies that, via Schumpeter's "creative destruction," render old goods and enterprises outdated.
3. The creative destruction mechanism causes employees to be reallocated from old to automated positions, resulting in unemployment.
4. During an upswing, new manufacturing methods are implemented, and investment demand rises, resulting in increased employment. Workers, however, are unable to gain more during this period due to growing prices. However, when new goods become available during the downturn, prices fall, and the preceding boom's commercial profit is converted into greater real incomes for the fundamental inputs of production. An increase in workers' wages during a downturn is far more essential than an increase in their money income during an upswing.
5. According to Schumpeter, the long-term benefits of technological innovation include: In the long run, all durable successes of innovations enhance salaries by producing more than before. All permanent successes are attained through two stages in the long term.
 - By reducing production costs via better organization;
 - Through innovative production methods "with a cost-cutting effect."Both contribute to progress, while the latter lowers labor demand.
6. According to Schumpeter, the scientific discussion over the benefits of labor-saving inventions has yielded no results, and one of the key reasons for the

¹¹⁰ Charles Edquist, **Systems of Innovation: Technologies, Institutions and Organizations**, John De La Mothe, Routledge, Ottawa, 1997, p.184

¹¹¹ Mauro Boianovsky and Hans-Michael Trautwein, "Schumpeter on Unemployment", **Journal of Evolutionary Economics**, w. Place, January 2018, pp. 21-22

ambiguity is a fail to differentiate the "direct" and "indirect" impacts, as well as between short-run and long-run factors.

7. According to Schumpeter, the impact of labor-saving technology in a given industry is determined by the flexibility of the product's supply and demand curves.
8. A drop in real wages boosts the efficiency of old labor-intensive innovation while also allowing employees who have been displaced by the adoption of new technology to re-enter the workforce.
9. Labor-saving technologies may result in permanent decreases in real wages, while job losses may only be temporarily. Employees who lose their jobs as a result of the machines cannot be unemployed forever, because there is no system in which a good's supply does not meet its appropriate demand.
10. Schumpeter highlighted the compensation relying on Say's law.
11. According to Schumpeter, the reduction in labor demand caused by automation cannot be stable because the expense of that portion of commercial profit which is not obliterated by price falls precludes any enduring shrinkage.
12. There's only one method to permanently lowers labor demand: "If technology moves all marginal importance of labor (from various aspects).
13. A labor-saving invention, according to Schumpeter, will decrease real wages by increasing the marginal productivity of capital relative to labor at a particular capital-labor ratio.
14. As most technologies not only save labor but also cause labor-saving adaptations (affecting the whole organizational system), the "relative marginal importance of labor" will decline as the economy develops.
15. Another idea put out by Schumpeter is that modern innovation cannot be accepted by many current occupations, and that the adoption of new technologies necessitates the development of new work positions with new capital goods, resulting in the creation of employment opportunities without the destruction of old jobs.

16. According to Schumpeter, imperfectly competitive markets are another source of long-term unemployment. It happened in Germany in 1920, when the temporary job losses caused by labor-saving technologies became permanent. (As the endogenous growth acknowledges the presence of imperfectly competitive markets, it is feasible to gain a deeper understanding of the economy and the idea of economic expansion).¹¹²
17. Schumpeter understood that a steady pace of technical advancement would have irreversible consequences on the percentage of long-run joblessness.
18. Workers who lose their jobs as a result of the introduction of robots will not be able to stay unemployed forever due to the resulting salary reduction. Instead, widespread adoption of technology and development has the potential to increase labor demand in the long term.
19. The idea that growth must be accompanied by a faster rate of labor emergence appears to be based on Say's rule, which states that increased productivity leads to increased demand for products.
20. While Schumpeter acknowledges that there is a positive relationship between technical development and unemployment, he dismisses the possibility of a positive relationship between productivity growth and long-term unemployment.
21. During upswing and downswing phases, Schumpeter separated employment and wage rates of employees into two categories (when new product is going to produced and sold and the period when prices goes down with the obsolescence of goods).
22. A high wage rate encourages the substitution of work by other innovations by increasing demand for labor-saving technology.
23. Economic policy should not attempt to save "obsolete industries," but also to "prevent their disorder crashing," since such "abnormal depressions" might lead

¹¹² Paul M. Romer, "The Origins of Endogenous Growth", **Journal of Economic Perspectives**, 8 (1), w.Place, 1994, pp.8-15

to bankruptcies and fears during times of crisis. There should be a systematic and accounted transition.

24. Another Schumpeter's macro policy: A broad increase in credit from the government to firms after the crisis would simply worsen the imbalance between old and new enterprises, that's why we clearly identify the evil in the market that should be remedied by restricting credit during the crisis. Schumpeter also pointed out that during the depression, staying without hope, that crisis is inevitable and we have to wait for miraculous, is wrong.

The view of technology, developed by Schumpeter in the name of creative destruction, has been formalized in the seminal creative destruction paradigm developed by Philippe Aghion and Peter Howitt. According to them, the entrepreneurs are making a new investment in R&D activities that improve the efficiency of intermediate (capital) products, utilized in the manufacture of final goods.¹¹³ This kind of productivity-enhancing developments propel technological development and, as a result, constitute an important source of economic expansion. However, as new technologies, developed by the R&D sector, also make old technologies outdated, individuals who invest in this industry incur the danger of their inventions' profitability being short-lived. According to the Richard Blundell, who commented the developed creative destruction by Philippe Aghion and Peter Howitt, pointed out that the innovation by both entrants and incumbents increases top income inequality.¹¹⁴ Through this model several micro questions are getting inferred, such as: How much should we invest in robots, how much in software, how much in AI? Which direction of AI? Are we going to use AI for complementing people or replacing people? Which types of people? Capital-owners? Which types of capital-owners?¹¹⁵ Economy based on policies becomes even more

¹¹³ Mário da Silva, "Teaching Aghion and Howitt's Model of Schumpeterian Growth to Graduate Students: A Diagrammatic Approach", **Australasian Journal of Economics Education**, 9 (2), Portugal, 2012, pp.19

¹¹⁴ Richard Blundell, "Economics of Creative Destruction - Day 1", **The Economics of Creative Destruction**

¹¹⁵ Daron Acemoglu, "Economics of Creative Destruction - Day 1", **The Economics of Creative Destruction**

central than Creative destruction, building on the shoulders of Creative destruction with the diversity of micro directions.

One of the main intuitions that Philippe Aghion and Peter Howitt have made is that they split the population of workers into two groups: production workers and research workers, and these researchers are started to think of new ideas.

In the formula that they represented, the frequency of innovation: $x = \lambda z$ (x - generate the rate of CD on the rate of innovation; z - research labour).

The entrepreneurs endogenously are trying to innovate, and their motivation is the value of innovation: $V = \pi / (r + x)$, (V - the value of innovation; π - The flow of monopoly profit; r - obsolescence-adjusted interest rate; x - the rate of CD on the rate of innovation). The value of innovation is the key ingredient in their model. Normally, if a person come up with innovation, and if he is the owner of it, the present discounted sum of the profit will be equal to the " π /interest rate", but the most important and transformative part is the " x ". Why this is the case, because in the sense of the Schumpeterian reallocation story, whenever there is a new entrant with better technology or product, it replaces the old and unproductive incumbent, and this turnover hurts the incentives of incumbents because the incumbents are enjoying a shorter monopoly duration.

The idea is basically, there's a quality ladder (Firm 1 is the current monopolist producing in that quality ladder), then Firm 2 produces a better quality of it, as a result Firm 2 come in and Firm 1 becomes out. But Firm 2 will not be there permanently, because Firm 3 will produce something better than Firm 2, and Firm 2 will become out. This is basically what's happening in the background of the Schumpeterian CD.

One of the main assumptions of Aghion-Howitt, grounds on the growth theory. The growth is simply equals to $g = \gamma x$, (γ - represents a spillover that each innovation generates, x - innovation frequency). The social planner cares about how much the spillover will be after each innovation, because whenever we raise the quality ladder, the society benefits from this permanently, but as Aghion-Howitt argues in their paper is the

result of the competition or turnover in the economy. So, the incentive of the new entrant is solely to replace the incumbent and make profit until they get kicked out. As a result, they will care less about how long the society will benefit from this, which means that between the social planners' horizon and profit seeking entrepreneurs' horizon we have a mismatch. So, we can see in the Aghion-Howitt model the industrial policy implications emerging from this endogenous creative destruction. Consequently, if the spillover (γ) turns too little, the decentralized economy will spend too much in R&D and if the spillover is too high, the society should spend little in R&D. These implications show us that we should understand the business-stealing dynamics and implement the industrial policies highlighted in the assumption of Aghion-Howitt.¹¹⁶ Thus, each time when there's a higher innovation frequency and an additional quality ladder, the level of employment is modified, as the workers in the incumbent firm should have to be unemployed, because of the new entry. The consequences of those unemployed people will be determined according to the features of new entry (production tools) and the market condition of the country, such as: perfect/imperfect market, the size of R&D investment, the type of technology (labor/capital-intensive) and the qualification of existing workers.

Then this model was extended in the literature. The Aghion-Howitt model is telling us according to the model: $V = p/r + x$, that when there is a new entry, this new incumbent will collect the monopoly rents until another entrepreneur comes and kicks out the existing incumbent, so this model is basically saying that the growth comes mainly from the new entry (however in some cases we can also observe that the big share of R&D comes also from the incumbent, not just from the entry, which also plays a role in growth). Even further, initially, the model was silent to the different dimensions, however, with the expansion of literature, we can even more precisely examine the types, ages, and sizes of the firms and their growth processes:

¹¹⁶ Ufuk Akcigit, "Economics of Creative Destruction - Day 1", **The Economics of Creative Destruction**

Klette-Kortum:¹¹⁷

$$V = \frac{\pi}{r + \chi} + v_{ext}$$

Akcigit-Kerr:¹¹⁸

$$V = \frac{\pi + v_{int}}{r + \chi} + v_{ext}$$

Acemoglu et al¹¹⁹

$$V^S = \frac{\pi}{r + \chi} + v_{ext}^S$$

In terms of wages and employment of high-skilled workers, the Aghion-Howitt model claims that to be compatible with the criteria for labor-market equilibria, the anticipation of greater research of the next period should correlate to a greater demand for skilled workers in the study of the next period, which indicates to the higher salary for skilled workers in the next period.¹²⁰

This work opens the way to several major advances: Winners and losers as in Schumpeter's vision; there can be conflicts over technological change; market structure matters; firm dynamics can be studied and matter greatly; growth and unemployment can go hand-in-hand; policy matters for the right type of growth.¹²¹ The Schumpeter's theory of creative destruction and its development in the writings of Aghion-Howitt provide a model of growth theory that influences employment and wages.

B. Augmented Solow Model

Does the level of unemployment in a state affect its rate of growth? This question can be answered using an Augmented Solow-type model of growth.¹²² In his 1956 paper, "Contribution to the Theory of Economic Growth", Robert M. Solow showed that if the parameter of production technology is softened by allowing the flexibility of the

¹¹⁷ J. Klette and S. Kortum, Ibid., pp. 986-1018

¹¹⁸ Ufuk Akcigit and William R. Kerr. "Growth through Heterogeneous Innovations." **Journal of Political Economy**, 126 (4), w. Place, 2018, pp.1374-1443

¹¹⁹ Daron Acemoglu et.al, "Innovation, Reallocation, and Growth", **American Economic Review**, 108(11), 2018, pp. 3450–3491

¹²⁰ Philippe Aghion and Peter Howitt, "A Model of Growth Through Creative Destruction", **Harvard University**, 60 (2), p.324

¹²¹ Daron Acemoglu, "Economics of Creative Destruction - Day 1", **The Economics of Creative Destruction**

¹²² Michael Brauninger and Markus Pannenberg, "Unemployment and Productivity Growth", Institute for the Study of Labor, **IZA Discussion Paper**, 136, w. Place, March 2000, p.1

capital ratio, sustainable growth becomes not only possible, but also a natural result.¹²³ His own theoretical and empirical studies have shown the importance of scientific and technological progress in accounting for the factors of growth.¹²⁴ In the Classic Solow Model, unemployment has no impact on the long efficiency growth, but, if human capital is valuable, unemployment does have a long-run impact on productivity levels. An example of this tendency we can witness in the work of Arthur Oaken¹²⁵, when unemployment exceeds 1%, the underproduction of GDP is 2.5%. Furthermore, if endogenous increase is allowed, unemployment does have an effect on long-run productivity level.¹²⁶ The primary distinction between endogenous (internal factors) growth model and neoclassical (external factors) growth ideas is the characterization of capital and investment.¹²⁷ The similar approach was mentioned by Kaldor, who stressed the impossibility to enhance labor productivity by lowering the number of employees in respect to current capital equipment.¹²⁸ The basic premise is that savings and educational level help to build physical and human capital. Based on the principle of valuable human capital, the unemployment decreases savings and educational expenses. That's why Paul Romer and Robert Lucas expressed their disagreement with the fact that long-term sustainable growth rate is determined only by an external "technological process."¹²⁹ As a result, unemployment (assuming human capital is valuable) may have an impact on productivity and growth.

¹²³ Robert M. Solow, "A Contribution to the Theory of Economic Growth", **The MIT Press, Quarterly Journal of Economics**, 70 (1), w. Place, 1956, pp. 85-93

¹²⁴ Robert M. Solow, "Profiles Of World Economists", **BIATEC**, Narodna Banka Slovenska, 8, w. Place, November 2005, p.22

¹²⁵ Abdumannon B. Khayitov and Khurshida F. Tukhtayeva, "Employment Increase: Theory and Practice", **Asian Journal of Technology & Management Research**, 10(1), w. Place. 2020, p.45

¹²⁶ Raouf Boucekkine, David de la Croix and Omar Licandro, "Vintage Human Capital, Demographic Trends, and Endogenous Growth", **Journal of Economic Theory**, 104, Elsevier Science, USA, 2001, p.343

¹²⁷ Howard Pack, "Endogenous Growth Theory: Intellectual Appeal and Empirical Shortcomings", **Journal of Economic Perspectives**, 8 (1), Pennsylvania, 1994, pp.55-70

¹²⁸ Ranald J. Taylor, "Can Labour-Savings, CapitalIntensive Production Techniques Reduce Unemployment Rates in Developing Countries? Evidence from Malaysia", **The Accord and Strikes Australian Journal of Labour Economics**, 7(4), w. Place, December 2004, p.516

¹²⁹ Beatrice Cherrier and Aurelien Saidi, "Reflections on the 2018 Nobel Memorial Prize Awarded to Paul Romer", **Erasmus Journal for Philosophy and Economics**, 12 (2), w. Place, 2019, p.57

We assume that unemployment lowers the amount of labor used in production:

$$L = (1 - u) N.$$

Where 'L' stands for Labor, 'N' for labor supply (effective labor), and 'u' for unemployment.

To create a homogeneous output 'Y', firms employ physical capital 'K' and labor 'L', where 'A' - technology level, ' α ' - production elasticity of capital, ' $1 - \alpha$ ' - production elasticity of labor. The production function is considered to become the Cobb-Douglas form:¹³⁰

$$Y = AK^\alpha L^{1-\alpha} \quad (0 < \alpha < 1)$$

The profit maximization (PM) of capital equals the interest rate:

$$r = \alpha \frac{Y}{K},$$

And the PM of an efficacy unit of labour equals the wage for an efficacy unit of labor:

$$w = (1 - \alpha) \frac{Y}{L}.$$

Human capital 'H' is a component of efficacy units of labor. Education and work experience contribute to human capital. Raw labor efficacy units are determined by the workforce size 'N' and the technical status of the economy is 'E'. As a result, labor supply is expressed in efficacy units as:

$$N = H^\beta (E \bar{N})^{1-\beta} \quad (0 \leq \beta \leq 1)$$

As a result, the production function is:

$$Y = (1 - u)^{1-\alpha} K^\alpha H^{\beta(1-\alpha)} (E \bar{N})^{(1-\alpha)(1-\beta)} \quad (1)$$

Three exceptional instances fall under the production function: 1) With $\beta=0$, in the classical Solow growth model, human capital is worthless, and labor efficacy units

¹³⁰ Trkan Turan, **İktisadi Byme Teorisine Giriř**, Yalın Yayıncılık, İstanbul, 2008, pp.45-58

are based just on the quantity of employees and the technical status of the economy. 2) With $\beta=1$, is when raw labor is worthless, and labor supply is solely determined by human capital, yielding an endogenous growth model.¹³¹ We have the augmented Solow model presented by Mankiw/Romer/Weil in the intermediary instance ($0<\beta<1$).¹³²

Productivity, determined as production for each worker, is defined as $P = \frac{Y}{L}$, where “L” is the amount of hired employees. After inserting $L = (1 - u) N$ into the production function, we divide the result by the amount of hired employees “L” to obtain:

$$P = \frac{E}{(1-u)^\alpha} \left(\frac{K}{EN} \right)^\alpha \left(\frac{H}{EN} \right)^{\beta(1-\alpha)} \quad (2)$$

Consider this: After the unemployment falls, productivity and salaries grow. When unemployment decreases, labour supply, capital and labor efficacy rise (in the long-run). Also, when unemployment decreases, the workforce rises with the exogenous rate and exogenous technical development leads to growth in efficacy.

Within every period, physical capital getting augmented via investment $\dot{K} = I$, where the dot indicates to the time derivation:

$$\dot{K} = dK / dt.$$

As we are concerned in the repercussions of long-run unemployment rather than business cycle impacts, we presume that all savings are reinvested $I = S$. The amount of savings proportionate to the amount of income $S = sY$. As a result, by having $\dot{K} = sY$, we divide the first and second sides by ‘K’ and apply (1) to derive the physical capital growth level:

¹³¹ Robert E. Lucas, "Making a Miracle", *Econometrica*, 61 (2), STOR, Academia, w. Place, March 1993, p.170

¹³² Gregory Mankiw, David Romer and David Weil, "A Contribution to the Empirics of Economic Growth", *NBER Working Papers Series*, National Bureau of Economic Research, Massachusetts, December 1990, pp.12-13

$$\hat{K} = s(1-u)^{1-\alpha} \left(\frac{H}{K} \right)^{\beta(1-\alpha)} \left(\frac{EN}{K} \right)^{(1-\alpha)(1-\beta)} \quad (3)$$

According to the Augmented Solow Model, education is the factor that augments the human capital. As the educational expenses are related to income, we get $\dot{H} = zY$, where ‘z’ is the educational expenses level. We are replacing the $\underline{Y}$ with the production function and dividing by ‘H’ to get the human capital growth rate:

$$\hat{H} = z(1-u)^{1-\alpha} \left(\frac{H}{K} \right)^{-\alpha} \left(\frac{EN}{H} \right)^{(1-\alpha)(1-\beta)} \quad (4)$$

It is obvious from (3) and (4) that rising unemployment causes a drop in the growth level of physical and human capital, resulting in a drop in productivity growth.

The economy eventually goes towards the steady state, in which capital and output expand at the same rate. $\hat{Y} = \hat{K}$.

There are two possibilities: 1) the $\beta < 1$, the steady state rate of growth is defined by the external rate of technical development and population increase, and 2) with $\beta = 1$, we obtain continuous returns to the factors which can be accumulated, resulting in balancing endogenous growth.

We must consider the two scenarios ($\beta < 1$ and $\beta = 1$) independently for a long-term productivity evaluation. The rate of long-term growth is unaffected by unemployment (invaluable human capital). As unemployment rises, physical and human capital per unit of effective raw labor decreases. In the long-term (for $\beta > 0$), an increase in unemployment causes a decrease in production. In the long-run (for $\beta = 0$), an increase in unemployment has no impact on output. The model produces endogenous growth rate, if ($\beta = 1$) holds true.

In the short-term, unemployment causes a growth in capital per employee, that leads to increased productivity and wages, as well as a decrease in income, which causes a decrease in savings and educational expenditure, resulting in a decrease in the rate of growth of physical and human capital and (in the long-run) productivity rate

of growth.¹³³ The extent of human capital's impact in the production function determines the long-term impact. In the classical Solow form of growth model, human capital isn't a factor.

The augmented Solow model explains why some states are wealthy while others are destitute. States are wealthy as they invest much in skill acquisition and have advanced technology.¹³⁴ There are certain conclusions made by neoclassical model of growth, where they claim that the production per employee in the wealthiest states in the world is about 40 times that of the poorest states in the world.¹³⁵ This disparity may be split down into variations in physical capital investment level and human capital investment level.

In order to examine the mutual composition of unemployment, the growth rate of physical and human capital, the unemployment in the Augmented Solow Model helps us to perceive the consequences of the modified (augmented) variables.

3.2. Firm Level Effects

The relationship between innovations reveals that the effects of new technologies on employment are not independent of the economic conditions of the period in which they are applied and the way of application in the enterprise. Indeed, consumer demands were determinant on business strategies, and businesses adopted a strategy for increasing sales, aiming to meet this increasing demand in terms of quantity. In this period when the importance of scale economy increased and division of labor developed with the expansion of the market, technical innovations were utilized both as product innovation and process innovation.¹³⁶ Therefore, although there has been an increase in employment, significant changes have occurred in the content and supervision of the work. Short-term fluctuations in the product market led to a slowdown in employment

¹³³ M. Brauninger and M. Pannenberg, Ibid, p.7

¹³⁴ Charles I. Jones and Dietrich Vollrath, **Introduction to Economic Growth**, 3, W. W. Norton & Company, Inc., New York, 2013, p.57

¹³⁵ C.I. Jones and D. Vollrath' Ibid' p.62

¹³⁶ James.M Utterback and William.J Abernathy, "A Dynamic Model of Process and Product Innovation", **OMEGA**, The Int. J1 of Mgmt Sci., 3 (6), Pergamon Press, 1975, Great Britain, p.641

growth and layoffs. Because the balance between product and production process innovations is important in terms of their effects on employment and business relations. However, this distinction is not always obvious. As new products often involve new production processes, product changes are not always employment-generating. However, product innovations emerge as a feature of industries where production is increasing and where price as well as quality are important in competition. Process innovations, on the other hand, are among the characteristics of industries where there is a constant competitive pressure to reduce costs. Resorting to restructuring in the economy, in order to get rid of the economic crisis in the late 1970s and early 1980s, also changed business priorities.¹³⁷ Reducing costs and rationalizing production capacity during the recession has led to the development of what is expected from technological change in the form of process innovations.

In this context, the transition to new technologies includes: not only the reformulation of capital accumulation and its orientation towards production, but also on a personal level; acquiring skills at the business level; new management structures, business organization, a new business relations model, national and / or international level.

In a generalized form, we note some of the opportunities and negative aspects that technologies offer us on the basis of the company and employees.

Positive aspects:

- A. Growth of revenues of employees in the provinces out of info actions because of distance working and a growth in employment. Moreover, there is a decline in the interval betwixt the salaries of employees residing in the center and the labor revenue of employees in the provinces, as the second candidate is more rival because of the reduced monetary value of labor services. By the way, this process becomes a cause to the growth in the wages of information employees in

¹³⁷ "Policy Responses to the Economic Crisis: Investing in Innovation for Long-Term Growth", **OECD**, w. Place, June 2009, p.9

comparison with non-information workers in the periphery and to its relative decrease in the center; pessimistic researchers point to the degree to which high-tech sector for the economic development policies favor local jobs.¹³⁸

- B. One of the wings of technologies is the reducing barriers to the labor market and weakening the strength of singularity of limited professionals. Technologies are becoming a cause in the weakening of in and out barriers to the labor market associated with geographic places, which rises rivalry and decreases the singularity of limited professionals. Consequently, through positive outcomes after this procedures, it's possible to observe a growth in the quality of provided work, and the stimulus of employees to boost labor efficacy and self-improvement. With the introduction of technologies as a process innovation, which actively lowers the cost of production and increases the quality of products, the high-quality companies will drive low-quality companies to decrease their pricing in order to stay competitive.¹³⁹ From this side, technologies, by considering the conditions and circumstances of where those technologies are applied, are stabilizing the price scales and reducing gaps and domination of certain particular market players.
- C. Strengthening production process through extending the trade market. Even A.Smith highlighted the essentiality of scales in the economy in order to extend the production and the process of division of labor.¹⁴⁰ Most of the work categories as well as other services began to be monetarily beneficial just after achieving a particular size dimensions of trade in the market. The virtual based economic structure creates an opportunity to supply different services which initially considered to be non-revenueable in little communities. Moreover, the extend of sales environment in the technology-intensive non-manufacturing

¹³⁸ Neil Lee and Stephen Clarke, "Do low-skilled workers gain from high-tech employment growth? High-technology multipliers, employment and wages in Britain", **Elsevier**, 48 (9), London, 2019, p.1

¹³⁹ Erik Brynjolfsson and Lorin M. Hitt, "Beyond the Productivity Paradox: Computers are the Catalyst for Bigger Changes", **Operations, Information and Decisions Papers**, Penn Libraries, Forthcoming in the Communications of the ACM, w. Place, August 1998, p.5

¹⁴⁰ Ayhan Ucak, "Adam Smith: The Inspirer of Modern Growth Theories", **Procedia - Social and Behavioral Sciences**, 195, Elsevier, Procedia, Edirne, 2015, p.666

sectors launches a structure of effective economies of scale, through which the manufacturing of technology-intensive products is rivalry in little geographical communities, too.

- D. Reducing discrimination in the labor market. The employer's conduct of a discriminatory policy in order to minimize costs has two forms. The first form is monopsony discrimination, in which the employer sets a differentiated wage for each employee, trying to bring it as close as possible to the price of the individual labor supply¹⁴¹; monopsonistic discrimination may have a major contribution to the problem of the overall wage disparity among workers.¹⁴² Moreover, these technologies bring an equalizing access to knowledge for residents of different territories. The second form includes statistical discrimination that occurs in a situation of strong information asymmetry in the labor market.¹⁴³ Under it, the employer, in an effort to minimize costs and risks, in conditions of information uncertainty, sets wages based on information about the average efficiency of an employee in each of the groups. Communication digital technologies, on the other hand, reduce the power of the employer, increasing the choice of jobs for the applicant. Statistical discrimination is also reduced, since in remote employment, the ability to switch to work via the internet, for example by becoming a freelancer, will allow discriminated groups of the population to improve their financial situation and get a fair assessment of the quality of their human capital.

Negative aspects:

- A. Strengthening price competition. On the one hand, workers from the periphery, who have approximately the same skill level with workers from the center,

¹⁴¹ Boris Hirsch, "Gender wage discrimination: Does the extent of competition in labor markets explain why female workers are paid less than men?", **IZA World of Labor**, Leuphana University of Lüneburg, Germany, November 2016, p.1

¹⁴² Erling Barth and Harald Dale-Olsen, "Monopsonistic Discrimination, Worker Turnover, and the Gender Wage Gap", **ECONSTOR**, IZA-Institute of Labor Economics, Germany, January 2009, p.4

¹⁴³ David Dickenson and Ronald Oaxaca, "Statistical Discrimination in Labor Markets: An Experimental Analysis", **Economic Research Institute Study Papers**, Utah State University, March 2004, p.3

benefit from price competition, since they are ready to work for lower wages, but on the other hand, internet technologies allow workers from even poorer territories (for example, from other countries), which unleashes a price war. In addition, in the labor market with price competition, their services are offered primarily by relatively low-skilled workers, whose work is easily amenable to automation. Therefore, having won in wages at first, low-skilled information workers in the future can be replaced by technologies, the creation of which is stimulated by the desire to reduce costs. A striking example is the market for standard services for creating websites, where the standard work of web programmers was gradually replaced by ready-made solutions¹⁴⁴ (CMS systems). Using such systems, an ordinary advanced user can quickly create a rather complex website without the help of a programmer (the creation of CMS systems already requires highly skilled creative work, so the demand for such professionals will only grow).

- B. The Vanek - Reinert effect. E. Reinert, analyzing the consequences of international trade for countries at different stages of economic development, concluded that with relatively open trade relations between a developed country and an undeveloped country, the former will specialize in high-tech production, and the latter - on a resource-intensive.¹⁴⁵ With the emergence of a single labor market and information services, a similar situation may arise for the center and the periphery. The employees of the center will be more competitive in providing services that require creative intellectual labor, and employees of the periphery - in the provision of services related to routine work. As a result, the periphery will specialize in services for which the cheapness of labor is important, and not its quality. Such specialization has negative consequences, especially in the long term, since in the modern economy it is intellectual labor that is the main source

¹⁴⁴ Anna Sabadash, **ICT-induced Technological Progress and Employment: a Happy Marriage or a Dangerous Liaison? A Literature Review**, Joint Research Centre, Econstor, ZBW, European Union, Seville, 2013, p.25

¹⁴⁵ Victor Spirin, "Vanek-Reinert Effect as a Corollary of Ricardo's Comparative "Advantage": A Simple Numerical Illustration", **Munich Personal RePEc Archive**, w. Place, June 2021, p.1

of added value.¹⁴⁶ In addition, this will negatively affect the human capital of the regions and will inevitably cause the migration of highly qualified workers from the periphery to the center.

- C. Other way where technology can exacerbate inequality is the extent to which innovators are able to profit through their developments. Some analysts today observe a trend toward **winner-take-all markets**, in which a limited group of individuals or businesses receive the majority of the profits or revenue available.¹⁴⁷ Since they encourage the gains of one sector to be largely or even completely appropriated by one or a limited list of businesses, winner-take-all markets lead to greater revenue and welfare disparity. This stands in stark contrast to markets in which a single company controls either a small or medium portion of the global economy. Winner-take-all markets are a form of natural monopoly¹⁴⁸ in which innovative developments establish cost structures that result in a single company capturing the entire market.
- D. Another mechanism is the **business-stealing effect** through technology causes inequality. Old goods contend with new technologies, making them outdated.¹⁴⁹ The business-stealing effect causes economic structural transition, resulting in growing and decreasing industries with rising and falling jobs. In the early twentieth century, the motor made horse-drawn carriages obsolete, and we can observe similar examples in other sectors nowadays. As in Shleifer¹⁵⁰, Corriveau¹⁵¹ offers a discrete-time explanation of endogenous growth focused on

¹⁴⁶ Helin Yudawisastra, Daniel Manurung, Fitria Husnatarina, "Relationship between value added capital employed, value added human capital, structural capital value added and financial performance", **Business Perspectives**, Investment Management and Financial Innovations, 15 (2), Ukraine, 2018, p.227

¹⁴⁷ Robert H. Frank and Phillip J. Cook, "Winner-Take-All Markets", **Political Economy Research Group**, 18, The University of Western Ontario, London, 1991, p.1

¹⁴⁸ Herbert J. Hovenkamp, "Antitrust and Platform Monopoly", **Penn Law: Legal Story Repository**, University of Pennsylvania Carey Law School, w. Place, November 2020, p.20

¹⁴⁹ Linus Wilson, "Business Stealing and Bankruptcy", **International Business & Economics Research Journal**, 8 (3), University of Louisiana at Lafayette, USA, March 2009, p.59

¹⁵⁰ Andrei Shleifer, "A Theory of Yardstick competition", **Rand Journal of Economics**, 16 (3), 1985, w. Place, w. Date, p.319

¹⁵¹ Philippe Aghion and Peter Howitt, "Growth with Quality-Improving Innovations: An Integrated Framework", w. Place, September 2004, p.4

cost-reducing technologies, in which the potential of concurrent discoveries produces a new sort of "business-stealing" impact; also, Grossman and Helpman provide a concept of vertical product innovation which explicitly incorporates Segerstrom, Anant, and Dinopoulos' research as well as the findings of this study.¹⁵²

Some analysts believe that the inequality from technical development is equal to the cost that we have to pay for innovational progress.¹⁵³ Some economists had already remarked that holding power in the market and monopoly rents are the key incentives for entrepreneurs to launch new goods¹⁵⁴. N. Gregory Mankiw reports that , since the 1970s, the top 1% of Americans' earnings have risen significantly more than the average and protects the upper 1%, arguing that they have contributed significantly to the rise and wealth of many others.¹⁵⁵

3.2.1. The Impact of Technologies on Firm Productivity

An important stimulator of employment growth should be an increase in demand for products in the context of an increase in labor productivity. Macroeconomic policy, competitiveness, industrial relations, etc. should also be of no less importance. The cost of recruiting is related to productivity since it is more expensive to hire higher productive people.¹⁵⁶

If we summarize the chains that may arise after the introduction of technologies, we can conclude that:

¹⁵² P. Aghion, and P. Howitt, Ibid, pp.325-326

¹⁵³ Robert J. Barro, "Inequality and Growth in a Panel of Countries", **Journal of Economic Growth**, 5, Kluwer Academic Publishers, Netherlands, March 2000, p.9

¹⁵⁴ Zoltan J. Acs and David B. Audretsch, **Handbook of Entrepreneurship Research**, 5, Springer Science and Business Media, Academia, New -York, 2010, p.176

¹⁵⁵ N. Gregory Mankiw, "Defending the One Percent", **Journal of Economic Perspectives**, w. Place, June 8, 2013, p.2

¹⁵⁶ Christopher A. Pissarides, **Equilibrium Unemployment Theory**, MIT Press, Massachusetts Institute of Technology, 2, United States of America, 2000, p.170

- A. All parameters staying equal, innovational shift (as a proxy of R&D intensity) increases efficacy as well as likely to reduce the level of employed in a certain level of need for labor.
- B. Nevertheless, obtained efficiency might be utilized to decline the monetary value relatively, and in this way, promoting demand for this particular item. When the price elasticity is above one, a fall in prices parallel to an increase in productivity will actually increase employment.¹⁵⁷
- C. If the chains are constant, productivity gains can be translated into increases in real wages or profits.¹⁵⁸ Consumption and / or investment will then increase as technological changes take place. When the elasticity of product's price appears to be greater, the loss of working will become offset through additional need for former and newest industries.
- D. However, the key issue must be the proper balance betwixt innovation in processes and innovation in products. When technology in processes develops quickly, then, ceteris paribus, the level of employed will decline. If the rate of innovation in products is comparable to the rate of innovation in processes, then newly emerging demand can provide an increase in employment.

Saez's econometric study of the modification of the level of employed in Spain on the base of sector for the 1980s years, has discover an effective numerical linkage betwixt innovational improvement and employment growth as a result of rise in efficiency and rivalry.¹⁵⁹

Since the mid-1990s., labor demand has shifted significantly from less- and medium-wage professions and capabilities towards greater skilled and highly paid professionals, occupations requiring talent, continuing education, self-reliance or managerial ability. Information and communication technologies (ICT) was one of the

¹⁵⁷ James Bessen, "AI and Jobs: The Role of Demand", **Nber Working Paper Series**, Boston, January 2018, p.12

¹⁵⁸ Langot Francois and Arnaud Cheron, "Real Wage Dynamics in the Labor Market Search Model", **GAINS**, Universite du Maine, Le Mans, w. Date, p.12

¹⁵⁹ M.Castells, Ibid., p.250

main game changers throughout this procedures, as they created a reliable environment for businesses in the expansion via websites, decreasing costs and entering into the global markets. ACIL Tasman in its report investigated the impact of ICT upon the growth of total factor productivity (TFP) and estimated their contribution to TFP growth at 33–65% for the service sector and 45–75% for the manufacturing industry.¹⁶⁰ TFP is a residual part of output growth which cannot be defined by rises in labor and capital.¹⁶¹ Researchers B. K. Atrostic and S. V. Nguyen found that the labor productivity of companies using computer networks is 3.7–7.2% higher than companies that do not get benefit from it.¹⁶² Online activities related to inventory management, order tracking, transportation and logistics have a positive impact on productivity. Moreover, as a consequence of implementing the ICTs, there is not just a decline in demand for labor with less capabilities, but also employees with average level of qualification, in several occupations, cannot compete with ICTs.

According to the results of the analysis, can we say that the assumption: "If labor productivity as a result of the introduction of new technologies increased by X percent, then the demand for labor will also decrease by X percent"? This algorithm is not true, as it proceeds from the notion that the amount of manufacturing products is immobilized and it is not paid attention for the action of different large-scale economical responsive movements. Indeed, with the growth in labor efficiency, the volume of manufactured products isn't stay unmodified: its rise brings a growth in the revenues of business owner (employers), the one that implemented technologies, or employees who start to be assisted with improved innovation, or buyers who get entrance to lower-priced commodities due to lower prices, and most often both those, and others, and the third at the same time. The increased income is translated in the greater amount of buyer as well as demand for investment, and it turns out to be impossible to satisfy it in the absence of extra appealing labor. Afterwards, the linkage betwixt the changes of employee

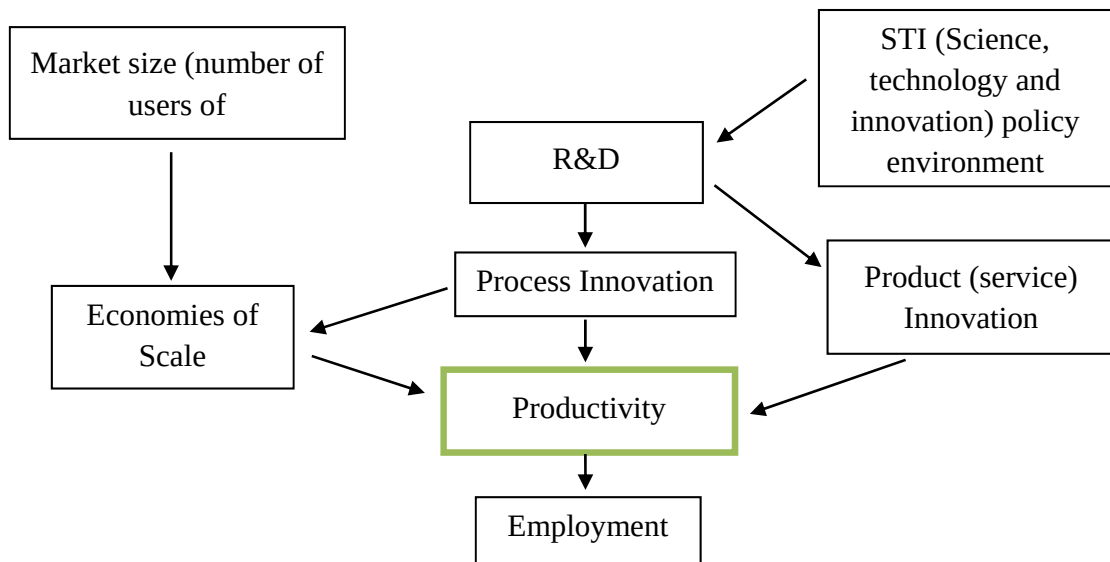
¹⁶⁰ ACIL Tasman, "ICT as a Driver of Productivity", **A White Paper Prepared for Telstra by ACIL Tasman**, w. Place, January 2009, p.4

¹⁶¹ Acil Tasman, "ICT as a Driver of Productivity", **Telstra**, w. Place, January 2009, p.7

¹⁶² M. G. Dubinina, Ibid., p.111.

efficiency and the changes of employee demand become highly complicated and not single directional. Because of to collateral large-scale economic impacts, it might become positive, instead of negative. So, it means that there's not just negative linkage betwixt employment and technologies, but, according to several theoretical and empirical approaches, there are positive relationships as well.

First, firms that integrate technical change, internal change, and ability creation, perform well strategically, affecting overall efficiency and job growth.¹⁶³ Secondly, besides the labor productivity that brings to the growth of employment, the total factor productivity is another factor that creates a positive linkage between innovations and employment level. This gives grounds to believe that in the event of active displacement of people by robots in it, the number of employed in the entire economy will not decrease, as many expect, but will grow. Additionally, it should not be neglected that technology is not the only player that changes the dynamics of employment. The dynamics of population is another important issue that creates huge waves in the labor market.¹⁶⁴



¹⁶³ "The OECD Jobs Strategy, Technology, Productivity and Job Creation: Best Policy Practices", **Highlights**, w. Place, w. Date, p.3

¹⁶⁴ Özgür B. Soylu, İsmail Çakmak and Fatih Okur, "Economic growth and unemployment issue: Panel data analysis in Eastern European Countries", **Journal of International Studies**, Scientific Papers, 11 (1), Foundation of International Studies, w. Place, 2018, p.96

Figure 3.2: Innovation and Productivity in the Technology-based Sector

A. The Role of Technology in Reducing the Cost of Production

Formation of prices for innovative products is an extremely difficult and at the same time important task of a producer. The main feature of pricing for a new, innovative product is that it is created in this form for the first time. So, the objects of innovation are distinguished by their novelty and individual unique character.¹⁶⁵

Technological change modifies the relationship between factors of production, and this change usually occurs in the form of using more capital instead of labor. Therefore, the most important effect of new technologies is labor saving. New technologies reduce labor costs not only through capital replacement, but also through the ability to move personnel between different departments within the enterprise as an organizational technology. The introduction of new technologies into the production process also saves capital costs. Typically, capital cost savings come in two forms. The first stems from the technical, physical and functional properties of microelectronic technologies. Microelectronic systems are information processing systems that are cheap, reliable, complex, and small compared to previous systems. For this reason, even its purely physical properties have the effect of reducing costs in today's world where energy and space savings are becoming more and more important. In addition, the functional properties of microcircuits increase their economic advantages. Flexibility is achieved depending on the programmability of the microcircuits. When these tools are used in robots, the preparation for the production of a new product occurs automatically. In addition, the programming ensured the continuity of product quality; The second feature that leads to capital savings is that microelectronics as an organizational technology provides an efficient flow of information.¹⁶⁶ This provides significant capital

¹⁶⁵ Julia E. Morozova, "Approaches to Formation of Price Policy for Innovative Products", **Institut parlamentarizma i predprinimatel'stva**, w. Place, w. Date, p.197

¹⁶⁶ Yik Ching Lee, "Microelectronics Packaging Handbook", Ed.by Rao R. Tuniniahi and Eugene J. Rymaszewski, Book Reviews, **Journal of Electronic Packaging**, New York, September 1989, p.241

savings in areas such as inventory management, efficient scheduling and automatic ordering, automation of production, design and production control.

According to research by Stewart, during the movement to the manufacturing in the states with low price indexes, economies might preserve till the 65% on employee costs, substituting employees with robotics might decline the costs about 90%,¹⁶⁷ which means that in future, robotization might present organizations very remarkable positivities.¹⁶⁸ Flexible automation has become economically viable with new technologies. Thus, in small batches, a production based on high productivity and a rich variety was achieved. By the 1990s, production costs lost their importance in competition, instead, factors such as product quality, flexibility and innovation capacity came to the fore. This is because, with the application of new technologies, it is not possible to further reduce production costs. Now, for some authors, gaining a competitive advantage depends on the development of new products rather than price reductions. New technology products: having a complex technology and design; inability to avoid high development costs and a high level of demand is required to reduce capital risk.¹⁶⁹ In addition, in the competition conditions based on the development of new products, an effective coordination between production processes and distribution networks becomes imperative in the face of increasing risks. In this case, good management and organization gain a new meaning and importance in maintaining competitive power.

¹⁶⁷ Spartak Keremidchiev, "The Forth Industrial Revolution and CSR", **Economic Alternatives**, 2, w. Place, 2019, p.176

¹⁶⁸ Yuri Odehov and Valentina Pavlova, "New Technologies and their impact on the Labour Market", **Living Standards of the population of the Regions of Russia**, w. Place, 2 (208), 2018, p.62

¹⁶⁹ Tijen Erdut, **Teknolojilerin iş ilişkilerine etkisi**, Türk ağır sanayi ve hizmet sektörü kamu işverenleri sendikası, Dokuz Eylül University, Izmir, October 1998, p.17

Table 3.2: The Cost Diminution due to Technology in U.S. Apparel 1959-1996 (*“The Effects of Technological Change on Productivity and Factor Demand in U.S. Apparel Industry 1958-1996 - An Econometric Analysis”*, 2006)

Year	λ	Year	λ	Year	λ
1959	0,114	1972	0,094	1985	0,071
1960	0,112	1973	0,094	1986	0,069
1961	0,11	1974	0,092	1987	0,068
1962	0,108	1975	0,088	1988	0,067
1963	0,107	1976	0,087	1989	0,064
1964	0,106	1977	0,085	1990	0,062
1965	0,104	1978	0,084	1991	0,06
1966	0,103	1979	0,082	1992	0,059
1967	0,102	1980	0,08	1993	0,058
1968	0,1	1981	0,078	1994	0,056
1969	0,099	1982	0,076	1995	0,055
1970	0,097	1983	0,074	1996	0,053
1971	0,096	1984	0,073	-	-

The effects of technological transition on overall cost of production (λ) in the apparel sector in the United States is measured and shown in the table above. This influence represents the rate of cost savings as a result of technological innovation.

The trend of cost decreasing is positive throughout the time period, indicating that the technological improvement for the United States apparel industry has resulted in a decrease in overall cost. The overall cost of manufacturing in the industry has decreased by 8% on average as a result of technological advances. Furthermore, the table shows that the technological impact on cost declining is obvious; that is, the level

of cost declining because of technical progress is reported over time.¹⁷⁰ It starts at 11.4 percent and ends at 5.3 percent. The following diagram illustrates the feature of technological impact on total cost:

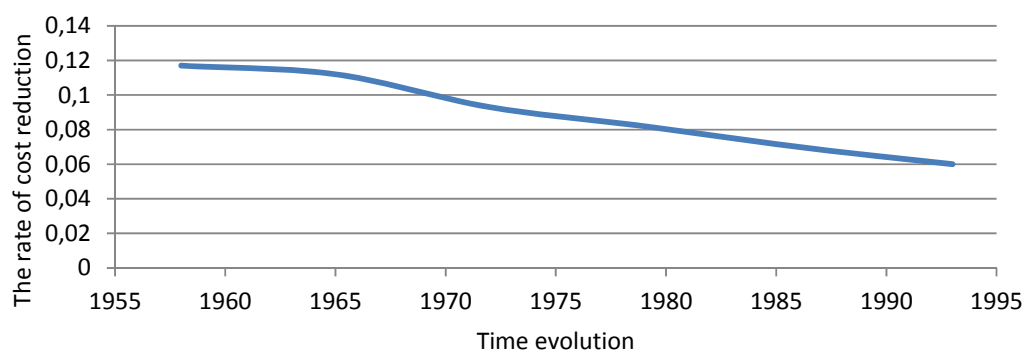


Figure 3.3: Cost Reduction due to Technological Advances in the US. Apparel Industry
(“The Effects of Technological Change on Productivity and Factor Demand in U.S. Apparel Industry 1958-1996 - An Econometric Analysis”, 2006)

In application of innovation to the companies has its negative sides too, some of them are as follows:¹⁷¹

- 1) Expensive charges of the applied program;
- 2) Expensive charges for licenses;
- 3) Expenditures on the infrastructure that ensures the operability of the system;
- 4) Expensive charges of advising of consultation;
- 5) Expensive charges of introduced professionals;
- 6) Great difficulties in adaptation.

It cannot be denied that the percentage of unsuccessful compensation exists to a certain extent if we pay attention to the above negative aspects and their possible

¹⁷⁰ Mahmoud Rezagholi, “The Effects of Technological Change on Productivity and Factor Demand in U.S. Apparel Industry 1958-1996 - An Econometric Analysis”, **Uppsala University**, USA, 2006, p.31

¹⁷¹ Andrey Rudenko and Shild T.A., **Influence of information technologies on process of the cost optimization**, Volgograd, w. Date, p.5

negative results, however, if we focus on the fact that the positive aspects are much more than the negative ones, under the predicted neutral conditions, compensation is expected with various aspects; the main thing is to accurately analyze the processes and to prevent the possibility of side effects on this process. If we summarize all that has been said and associate it with the indirect and long-term influence of technology on employment through changes in the company's costs, then it is possible to identify the compensatory result of the introduction of technology in this section; productivity-focused companies, in modern conditions, seek to reduce costs.¹⁷² Summing up the connection between technologies, the decline in the cost of production and employment, we can say that the process innovations include, from one perspective, the loss of employees; from the other perspective, such technologies themselves contribute to a reduction in item production costs and, in the environment where the competitiveness is strong, to a decline in prices, through which, a decline in prices creates new demand for goods and increase in production and jobs.

B. The Impact of Technological Innovation on Quality and Competitiveness of Product

The main task in developing strategies for the development of enterprises at the beginning of the XXI century is, firstly, the creation of new competitive products.¹⁷³

Quality is a performance dimension that ensures the efficient use of resources, gives products and services suitability for use, and adopts a production approach to meet customer needs.¹⁷⁴ Quality is a concept directly related to business performance. The high quality of products and services will make the business preferable for customers,

¹⁷² Lola F. Popova, "The Impact of Information Technologies on the Formation of Sustainable Development of the Enterprise", **Saratov Socio-Economic Institute**, w. Place, w. Date, p. 74

¹⁷³ Viktor Koval, Ganna Duginets, Oksana Plekhanova, Andrii Antonov and Mariana Petrova, "On the Supranational and National Level of Global Value Chain Management", **Entrepreneurship and Sustainability Issues**, 6 (4), w. Place, June 2019, p.1933

¹⁷⁴ Muammer Zerenler and Güzide Karakuş, "Ürün Ve Süreç Yeniliğinin İşletme Performansına Etkisi: Bir Vaka Çalışması", 19 (2), Dokuz Eylül University – **Sosyal Bilimler Enstitüsü Dergisi**, w. Place, 2017, p.312

and in this case, it will affect the performance of the business positively. The quality indicator was measured within the framework of the following criteria:

- The rate of meeting the product standard;
- Increase / decrease in the number of defective products.

However, the benefit of process innovation to the business can be very high. The new process lowers the cost of the product so much that the business can gain serious profitability or an enormous advantage over its competitors.

The technology used by the manufacturer affects the quality of the product. The choice of production technology affects, first of all, its cost, and here economic parameters and its assessment of competitiveness are already decisive. The desire to ensure the continuity and stability of the reproduction process, making a profit, serves as an incentive for the emergence of new ways of combining production factors in any business entity. Moreover, often the use of such new combinations and, as a result, the emergence of innovations becomes the only possible way to profitably invest capital and meet market demand. The application of these innovations in a complex significantly affects the economic component of competitiveness - it reduces costs, and, as a result, can reduce the price of a product or service. Moreover, it's no secret that updating the design of the product is also a kind of innovation, following fashion and style clearly attracts the buyer. Consumer behavior and desires continue to grow exponentially, along with improvements in the business landscape in which retail businesses operate; this necessitates businesses adapting quickly to changing developments by concentrating on product creativity and evolving innovative designs for producing new fashion trends. It is the same with services - the introduction of new technologies used to provide them, even some originality in the appearance and behavior of the service personnel can be a big plus for the service organization.¹⁷⁵

¹⁷⁵ P.Gazzola, E.Pavione, R.Pezzetti and D.Grechi, "Trends in the Fashion Industry. The Perception of Sustainability and Circular Economy: A Gender/Generation Quantitative Approach", **Sustainability**, MDPI, Italy, 2020, pp.2-3

For the majority of enterprises in the harsh conditions of constantly increasing competition in the market from foreign companies, it is innovation activity and its results that are the main condition for success and efficiency.

Summing up, we can say that the systematic modernization of technology and innovations form the innovation procedure and it's the key precondition for the manufacturing of rival items, cost reduction, promoting demand, competing and assisting the prospects of companies in the market and rising efficiency, as well as the efficiency of the enterprise, which expand the scope of company and the number of positions and occupations. Through the implementation of competitive advantages, innovations help enterprises not only remain competitive in the market, but also take a leading position in the competitive struggle.

Innovations introduced at enterprises are mainly aimed at the following economic, financial and production aspects of activities:

- expanding the list of products;
- saving of conventional trade markets;
- discovering of newest trade markets;
- decline of wage costs;
- reduction of material costs;
- decline of energy consumption;
- improving product quality;
- increasing the flexibility of production.

So, the innovation process and compliance with its laws allow you to create a qualitatively new technique that more fully meets the needs of the buyer. The successful course of this process is ensured under the conditions of its continuity and phasing. The task of providing developers with the information necessary in the development process is solved (or should be solved) by the innovative infrastructure, which consists of a set

of systems, services, data banks, industries, organizations, institutions, etc. The quality of the products created and produced is fully dependent and provided by innovative technology. At the same time, in order to transform a qualitatively new product into a competitive one, it is necessary to ensure an appropriate level of cost, as well as to confirm its compliance with a number of additional requirements, including the market, standards, safety, ecology, health, saving technologies, etc. All these requirements are implemented in products at various stages of development. Compliance of products with these requirements is confirmed by its certification.

A high-quality and competitive product will expand the range of the company and will create demand for products and the opportunity for the company to earn and invest in expanding the range of products, as well as create new projects in which many workers will be involved, which, in turn, will lead to increase employment in this sector, as well as to direct investment in the production of other sectors. This means that under neutral conditions and without side effects during this period, the introduction of technology will have a positive effect on employment within the company.

3.2.2. Process and Product Innovations

Companies might pursue product or process-oriented innovation initiatives. The collection of skills necessary for each and eventual results are not always the same. Product innovation is the introduction of a new product or service to the market, or a significant improvement in existing products and services, and not necessarily based on the use of new technologies.¹⁷⁶ Significant improvement involves the use of new components, materials, the way of providing services. Process innovation is the

¹⁷⁶ Annique UN, Alvaro Cuervo-Cazurra and Kazuhiro Asakawa, "R&D Collaborations and Product Innovation", **Journal of Product Innovation Management**, 27(5), w. Place, May 2008, p.2

introduction of a new or significantly improved manufacturing method for a product.¹⁷⁷ It also includes significant changes to the hardware and / or software used.¹⁷⁸

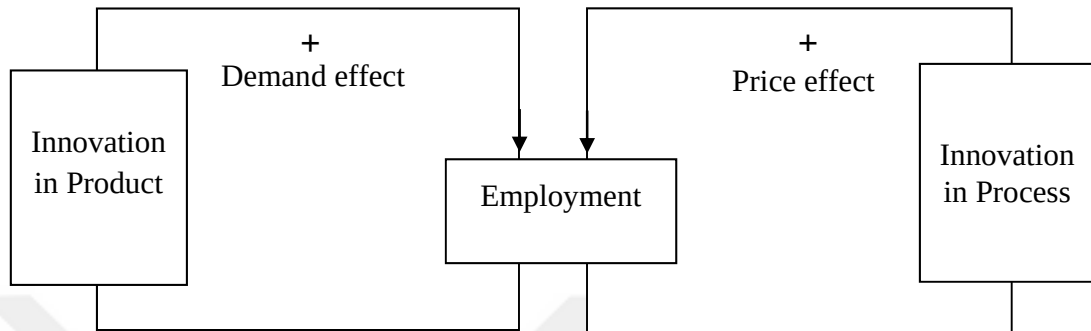


Figure 3.4: The Impacts of Product and Process Innovation on Employment (*"The impact of new technologies on the labour market and the social economy"*, 2018)

Productivity and demand effects. The figure above clearly shows the interaction of product and process innovation and the visualization of change in employment. We'll begin with the impact of the innovation in process on job creation. Innovation in process, such as the addition of modern manufacturing operations, typically enables a company to achieve the same level of production with low level of capital or labor. Consequently, the innovation in process usually leads to increased efficiency while having an adverse impact on jobs, according to some researchers. The scale of the negative impact is determined by the current production technology and the technical change's trajectory. This labor-saving impact differs a lot between industries.¹⁷⁹ An increased level of literature has examined the labor-saving impact of automation in recent years. Due to the introduction of information technology to a broad variety of routine operations in production and services, some writers expect huge possibility for productivity gains and related job losses. Despite forecasts of massive potential job cuts as a result of process innovation, the analytical results about the process innovation's

¹⁷⁷ Thomas H. Davenport and Ernst & Young, "Process Innovation Reengineering Work through Information Technology", **Center for Information Technology and Strategy**, Harvard Business School Press, Academia, Boston, 1993, p.1

¹⁷⁸ Jose-Luis Hervas-Oliver, Francisca Sempere-Ripoll and Carles Boronat-Moll, "Process innovation strategy in SMEs, organizational innovation and performance: a misleading debate?", **Springer Science - Business Media**, New York, February 2014, p.876

¹⁷⁹ B. Dachs, Ibid., p.12

historical work impact is mixed. The effect of process innovations is minor and insignificant, according to the reports of some researchers. In comparison, some authors claim that process innovations have a substantial positive impact on job creation. The new reports also show that process innovation produces more new jobs than product innovation in the frame and level of firm. Process innovation, on the other hand, is found to trigger labor displacement by Blechinger and Pfeiffer, which impact becomes more apparent in larger companies.¹⁸⁰ The demand impact, illustrated in the upper left field of illustration above, seems to be a significant impact of innovation on jobs. When a company launches a new product to market, it can generate new interest if customers and user companies find it useful. The level to which product innovation will produce new jobs is determined by the price elasticity of demand as well as the presence of goods, with the features like: replacement or addition¹⁸¹ Overall, observational evidence shows that the market impact is the most significant positive result of innovation for jobs. The impact under the demand and productivity factors are two of the most important mechanisms by which innovation influences employment; however, they are not the only participants in the system. Process innovation enables a company to produce a new cheaper product compared to the previous one; if the company moves on these lower manufacturing costs to their customers by lowering the product's price, this move will often result in increased business capacity and job creation.¹⁸² The scale of the price reduction, demand's response to price reductions (elasticity of demand), and competitors' responses to the price decreasing, all influence the extent of the price impact. As a result, the price effect demonstrates the competitiveness policy for jobs, as it would be expected the firms in a competitive environment to set prices that are similar to new, less manufacturing costs compared to the marketplace with less rivals. New goods often use new inputs, allowing them to be manufactured with much less inputs

¹⁸⁰ Rolf Sternberg, "Entrepreneurship in the Region", Ed. by Michael Fritsch, Jurgen Schmude, 14, **Springer Science & Business Media**, Germany, 2007, p. 117.

¹⁸¹ Nathalie Greenan and Dominique Guellec, "Technological Innovation and Employment Reallocation", **Labour**, 14 (4), HAL Open Science, Wiley, w. Place, December 2000, pp.4-33

¹⁸² Stefan Lachenmaier and Horst Rottmann, "Employment Effects of Innovation at the Firm Level, **Ifo Working Paper**, 27, w. Place, April 2006, p.4.

and better output than older products. As a result, even though product innovation is not accompanied by concurrent process innovation, it will result in improvements in efficiency. New goods, on the other hand, could assist firms in increasing efficiency by shifting inputs out of the manufacturing of former to the latter items with a larger value, resulting in increased productivity calculated in monetary form. Product innovation is a big factor of job growth, but it comes at a cost. Established goods sold by the company or its rivals would be displaced by new products with greater utility and/or lower prices. As a result, the created demand which will be seen for a new product may outnumber demand for existing 'old' products.

Product innovation can have two kinds of negative consequences: the first one is a negative impact on the innovator (which is known as the 'cannibalisation' effect¹⁸³), and the second one is a negative impact on rivals (which is known as the 'business stealing' effect¹⁸⁴). Each of these effects can minimize product innovation's initial job-creating impact. We've already seen these impacts for cell phones, automobiles, and other goods; if a new product is released, demand for older models of the same company or rivals drops. Furthermore, sales of similar product types such as smartphones, portable cameras, devices, electronic route guidance sensors, and so on could be adversely affected by the introduction of a new smartphone with improved capabilities.

Cannibalization and business stealing effects are common, according to the literature: in reality, some cannibalization is almost unavoidable for companies launching new goods, particularly multiproduct companies. The severity of these non-positive impacts is determined by the presence of replacing factors and competitor responses. There are several exclusions, such as where the new item supplements the current one or in the case if a new item expands a company's product capacity into new areas while also benefiting from the current brand.

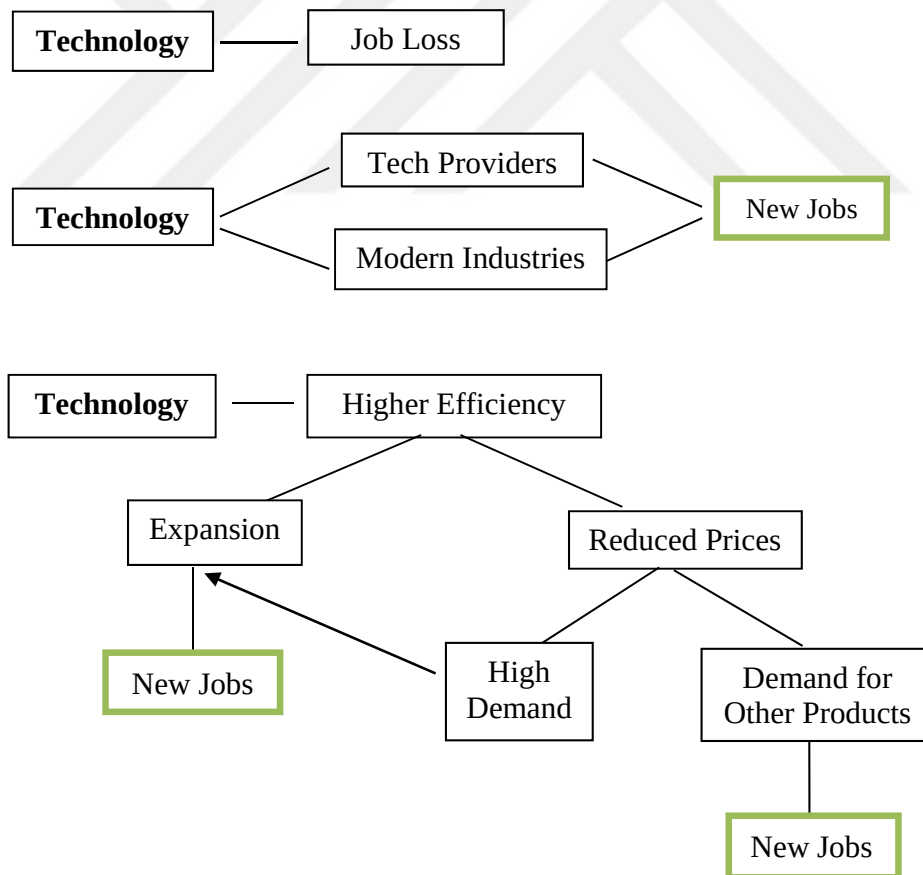
¹⁸³ Charlotte Mason and Kaushik Jayaram, "Don't Get Eaten! Understanding and Handling Cannibalization Risk", 10 (1), **DE GRUYTER**, w. Place, 2018, p.35

¹⁸⁴ Nicholas Bloom, Mark Schankerman and John Van Reenen, "Identifying technology spillovers and product market rivalry", August 2010, p.2

From the above definitions, it became clear that the product and process of innovation have a characteristic effect on employment, despite the fact that the process and product innovations from different directions affect the performance of the company in terms of growth, cost and employment.

3.2.3. Compensation Theory: Critiques and Some Empirical Evidences

Economists introduced a hypothesis that Marx later dubbed the 'compensation theory' during the first part of the 19th century.¹⁸⁵ This hypothesis is based on multiple forms of market compensation caused by technical transition itself, that can neutralise the original labor-saving impact of innovation in process.



¹⁸⁵ Mariacristina Piva and Marco Vivarelli, "Technological Change and Employment: Were Ricardo and Marx Right?", **Discussion Paper Series**, IZA – Institute of Labor Economics, Germany, January 2017, p.5

Figure 3.5: The Process of Creating New Positions Using Technology

The compensation can be obtained in several ways:

A) The process of compensation 'via modern innovations'.

The same process innovations that displace employees within industrial sectors generate new employees in the capital sectors wherein new innovations are manufactured.

B) The process of compensation "via price reductions'.

Process innovations include, from one perspective, the loss of employees; from the other perspective, such technologies themselves contribute to a reduction in item production costs and, in the environment where the competitiveness is strong, to a decline in prices, through which, a decline in prices creates new demand for goods and increase in production and jobs. Non-innovative manufacturing enhancements can be comparable with process innovations, only when it includes the price reductions as a compensation impact.¹⁸⁶

This procedure was established at the early stage of the development of economic thinking. When Say's law had become the subject of classical economic philosophy, this line of argument has become the foundation of compensation theory. In a competitive environment, supply produces its own demand and this self-adjusting mechanism completely engages in technological transition.¹⁸⁷ In the evolution of economic theory, the compensation system "by price reduction" was re-proposed several periods by economists.

C) The process of compensation 'via new investments'.

¹⁸⁶ Angel, Jordi and Cesar, "Innovation and jobs: evidence from manufacturing firms", **European Commission**, w. Place, August 2005, p.29

¹⁸⁷ Mikael Carlsson, Stefan Eriksson and Nils Gottfries, "Testing Theories of Job Creation: Does Supply Create Its Own Demand?", **Sveriges Riksbank Working Paper Series**, Central Bank of Sweden, Econstor, ZBW, Stockholm, May 2006, p.16

The additional revenues might be earned via innovative companies in the time of the interval betwixt the reduction in costs (because of the technical advancement) and the subsequent decline in prices. Such gains are invested and new development and employment are produced in this way.

D) The process of compensation 'through decline in wages'.

In the marketplace, as with most sources of the rate of unemployed, the immediate effects of labor-saving innovations should be rehired. In fact, technical unemployment means a reduction in salaries in a neoclassical system¹⁸⁸ - the open rivalry and complete replacement betwixt employee and capital - and this could contribute to a reverse move back to more labor-intensive technology.¹⁸⁹

E) The process of compensation 'via new products'.

Technological transition isn't just the process innovation, but it could also mean the birth of completely modern and young economic markets with new products where additional employment can be generated.

Different research concluded in the ongoing discussion that product advances have a beneficial effect on jobs as they unlock the door to either the production of whole new products or the key distinction of existing products.

Despite reasonable hypotheses about the existence of compensation, there is also a group of people who do not fully trust this theory. The key critiques of the principle of compensation can be highlighted as follows:

A) Labor-saving innovations have expanded across the capital goods sector; hence, this compensation is an infinite topic that can only be partly told. Eventually, it is possible to implement the new innovations either by added investments or

¹⁸⁸ Sergio Cesaratto, Antonella Stirati and Franklin Serrano, "Technical change, effective demand and employment", **Seminar Paper**, Cesaratto-Eims, w. Place, October 2001, p.4

¹⁸⁹ Yang Liu, **A Critique of the Neoclassical and a Revision of the Keynesian Theories of Employment**, University of Denver, w. Place, March 2012, p.62

literally via replacing the outdated ones (scrapping). In the latter situation - that is by far the most common - no compensation is offered.¹⁹⁰

- B) The efficiency of the process "through price reductions" is dependent on the assumption of perfect rivalry. When an oligopolistic system dominates, as reduction of the cost are not inherently as well as completely converted towards declining indexes of price, the total compensation is significantly diminished.
- C) The "via new investment" compensation process also depends on the assumption of Say's Law that the total revenues (after the technology) are converted into additional investments.¹⁹¹ In addition, the features of new investment acquisitions are important; if they are capital-intensive (instead of labor-intensive), compensation will not happen. For example, the implementation of the jewellery manufacturing has greater labor-intensive impact than the manufacturing of computers. If the new product will not bring labour-intensive innovation, then the compensation will not work.

Beginning with microeconomic research, empirical study of the effects of ICTs at the company level is highly helpful in exposing the real ways in which new products produce new positions in terms of jobs and labor-saving process innovation removes existing ones. Even if the technology is labor-saving, the studies typically indicate a positive correlation between technology and jobs creation because they neglect the substantial impact on competitors that are forced out by the technological companies (named "business stealing" impact). For example, researchers discovered a positive association between technology and jobs creation at the company level by taking data from French industrial areas from 1986 to 1990. (For product and process innovation).¹⁹² But, their findings, on the base of sectors, reinforced the notion that just innovation in

¹⁹⁰ Christopher, John and Luc, **Unemployment and Technical Innovation: A Study of Long Waves and Economic Development**, Frances Pinter, w. Place, 1982, 50, p.160

¹⁹¹ Fabio Petri, "Neglected Implications of Neoclassical Capital Labour Substitution for Investment Theory: Another Criticism of Say's Law", **Review of Political Economy**, 27 (3), Taylor & Francis, Routledge, Siena, 2015, p.310

¹⁹² Nathalie Greenan and Dominique Guellec, "Technological Innovation and Employment Reallocation", **HAL archives-ouvertes**, LABOUR, Wiley, 2000, 14 (4), pp.547-590

product produces new opportunities in terms of positions, whereas the innovation in process creates employment amongst the innovative company, but on account of competitors, resulting in a sector-wide negative impact. When analytical study is performed at the sectoral level, this tendency should be corrected: in this situation, a researcher can consider both the beneficial results of innovative businesses and the negative impact on competitors, and thereby determine the final employment result. However, based on the observation perspective, sectoral findings may be impacted by either a negative or positive prejudgment (service vs manufacturing). Just aggregate macroeconomic analyses will jointly determine 1) the crowding out of the workers by process innovation in certain economic areas (primarily manufacturing); 2) the compensation mechanism that operate sectors (via declining wages and price); and 3) the positive effect of employment of product innovation (primarily services). However, due to the 3 big general concerns that were remarked above, empirical studies are exceedingly difficult to present. With these theoretical concerns in mind, we shall now turn our attention to analytical observations, beginning with input-output models. Input-output formulas were used by Leontief and Duchin to measure the effect of technology on employment.¹⁹³

Although all four models resulted in a rise in employment, the analysis showed that emerging innovations had a distinct labor-saving bias: in fact, rapid technical development indicated lower employment rate of growth. Authors proposed a multisectoral conceptual framework with a compensation system for researching the employment effects of change in innovation. During their first report, the 2 researchers (authors) estimated employment rates for many of economic areas of the British economy in 1990, as well as showed that compensation systems could more than compensate for early work losses through process innovation in their analysis. Amongst these compensatory powers, the process through price reductions was the most powerful, accounting for higher than half of the early labor displaced compensation. In their

¹⁹³ Wassily Leontief and Faye Duchin, **The Impacts of Automation' on Employment, 1963-2000**, New York Univ., NY. Inst. for Economic Analysis, Washington D.C., April 1984, p.57

second analysis, they changed the simulation model to the years 1985-1995, which included workplace automation in office and the public areas. In this situation, compensation was only partly happened, with the net impact of emerging technology resulting in the reduction of 288,000 positions in the British economy; in any case, the system of compensation were efficient in offsetting 280,000 early job cuts, with the most efficient mechanisms through "price reductions" and "new investments".¹⁹⁴ Their modeling of the effect upon the German economy exposed compensatory processes in the workplace, but they were unable to completely compensate for the early labor shift contributed by ICTs spread.¹⁹⁵ The econometric findings confirm the idea that technical innovation contributes to total labor-savings; however, significant sectoral variations emerge: whilst purchased R&D outcomes in job losses in textiles, clothing, and electrical devices industries, in-house R&D increases labor demand in chemicals and information technology industries.¹⁹⁶ On the one hand, several econometric experiments using the "compensation method" sought to assess the reliability of compensation processes in a partial or overall equilibrium context. Latest research, on the other side, has concentrated on either the direct connection regarding growth and employment or macroeconomic models. The first stage of studies includes Sinclair (1981) suggested a macro structure in his first argument, concluding that if demand elasticity and factor substitution elasticity are significantly strong, positive compensation will happen.¹⁹⁷

Using information data of the UK economy, the researchers, according to elasticity ratio, believe that it is adequate to rule out technology as a potential reason of British unemployment, ultimately, researchers investigated how the compensation system "through price reductions" worked in 9 UK two-digit sectors; according to them,

¹⁹⁴ Marco Vivarelli, "Innovation and Employment: A Survey", **Discussion Paper Series**, Germany, February 2007, p.10

¹⁹⁵ Heon-Goo Kim, "Industrial Labor Productivity from IT Innovation: Korea Case 1995-2000", **Korea National Assembly**, Seoul, w. Date, p.4

¹⁹⁶ Nathalie Greenan, Yannic L'Horty and Jacques MAiresse, **Productivity, Inequality, and the Digital Economy: A Transatlantic Perspective**, The MIT Press, Cambridge, London, 2002, p.119

¹⁹⁷ M.Vivarelli, Ibid, p.11

the natural rate of unemployment was 9–11% in 1983.^{198 199} Literature on the second stream shows, that the growth can be labor intensive on the higher or lower levels based on the type of ICT spread (product vs process innovation) and the efficiency of the compensation systems. Boltho and Glyn analyzed OECD states data for sub-periods between 1973 and 1993; their key findings from combining calculations suggest that the employment/growth correlation isn't as good as it seems in terms of theoretical point of view, but it's supported by basic econometric analyses.²⁰⁰ Surprisingly, over the years 1990-1993, the positive relationship between growth in GDP and employment was also verified, contradicting the idea of jobless growth as a consequence of ICT spread in OECD states;²⁰¹ authors could get less positive outcomes, they measured the elasticities of employment for the G-6 plus Sweden from 1980 to 1994, both of them are in aggregate and by economic areas; once the emphasis was changed to the sectoral research, the results emerged: although all of the states had negative elasticities in production, they all had positive elasticity of services;²⁰² between 1970 and 1990, the number of people working in Sweden's public administration and facilities nearly doubled.²⁰³

The researchers found that "through price reduction" was the most efficient compensation strategies by using evidence from the United States, Italy, France, and Japan from 1965 to 1993 (particularly in European states till the 1985). All other mechanisms were found to be less effective and related to the structural frameworks of the various countries; for example, in the flexible labor market of US, the "mechanism

¹⁹⁸ R. Kapeliushnikov, Ibid, p.99

¹⁹⁹ Rod Cross and Dany Lang, "The NAIRU: Still Not an Interesting Rate of Unemployment, Intervention", **European Journal of Economics and Economic Policies**, 8 (2), w. Place, 2011, p.318

²⁰⁰ Karami, Elahinia, Karami, "The effect of manufacturing value added on economic growth: empirical evidence from Europe", **PressAcademia**, 8(2), 2019, p.133-146

²⁰¹ William Seyfried, "A Cross-Country Analysis of the Employment Intensity of Economic Growth", **Southwest Business and Economics Journal**, w.Place, 2007-2008, pp.53-54

²⁰² Steven Kapsos, "The employment intensity of growth: Trends and macroeconomic determinants", **Employment Strategy Papers**, International Labour Office, w. Place, December 2005, pp.8-23

²⁰³ Per-Anders Edin and Robert Topel, "Wage Policy and Restructuring: The Swedish Labor Market since 1960", **University of Chicago Press**, w. Place, January 1997, p.182

through decrease in wages"" was found to be positive. Ultimately, innovation in product exposed its pro-labour ability.²⁰⁴

So, as a result of what mentioned above, we can make a conclusion about compensation theory in the following paragraphs:

The theory of compensation says that the market powers must ensure that the former pro-technological impact of innovation is adequately compensated. When it comes to the empirical proof that is accessible, various levels of research will produce different findings. While the majority of microeconomic studies find a strong link amongs ICTs and employment. When looking at the sectoral level, it's necessary to differentiate between product innovation (in labor-friendly rising sectors like new services of ICT) and process innovation (in labor-saving reconstructive sectors like manufacturing). Various input-output calculations can show opposite impacts at the aggregate stage, based on how different compensation systems operate. Finally, various research findings – regarding the presence of jobless growth in various times and states – are the result of various product and process innovation ratios, as well as various degrees of compensation system efficacy.

3.3. The Impact of Technology on the Sectoral Level

The wealth of technical possibilities, the cumulativeness of the skill set, and the capacity to secure and allocate the economic gains from technology are all aspects that differentiate industries. The fastest-growing field, industry knowledge-intensive facilities, covers a wide variety of operations, including water and air transportation, but also legal and financial operations, head office and management consulting operations, specialists, educational, science, and technological activities. As a result, we can picture a wide variety of factors that have fueled the sector's growth.

In terms of job growth, the analysis shows a significant disparity between manufacturing and service sectors. The difference between production and services is

²⁰⁴ R. Kapeliushnikov, Ibid, p.99

borne out by macroeconomic statistics, which indicate that services have seen higher overall job growth; while manufacturing's percentage of overall jobs has decreased across all European countries.²⁰⁵ There's a lot of controversy about how service and manufacturing technologies are varying. We can deduce from the study that service technology is most usually non-innovational, is focused on the little rate of the implementation of science and standard expertise, involves greater contact accompanied by customers, necessitates higher communication capabilities for connection. When we switch from the company to the macroeconomic stage, another consequence of innovation-driven job transition is the redistribution of labor and capital between industries. Since not all companies thrive in their growth ventures, some businesses and markets expand exponentially, while some stagnate or in some cases decline. Thus, along with firm entry and departure, technology is a significant determinant of economic transition and overall productivity growth. Innovation and the using of emerging technology are pushing this redistribution. Joseph Schumpeter's idea of 'creative destruction' is a well-known example of long-run systemic transformation materialized through significant product²⁰⁶, process, as well as operational technological changes.

3.3.1. Remaining and Disappearing Industries

The main point of the theories of post-industrialism is that people who are already involved in various activities begin to take new positions in the professional structure. Broadly speaking, it has been predicted that as we move towards the information society, we should observe the growing importance of the positions of

²⁰⁵ Reinhilde Veugelers, "Manufacturing Europe's future", 21, **Bruegel Blueprint Series**, 21, Belgium, 2013, p.24

²⁰⁶ John Komlos, "Has Creative Destruction Become More Destructive?", **NBER Working Paper Series**, National Bureau of Economic Research, w. Place, August 2014, p.2

managers,²⁰⁷ professionals and technicians, the decreasing proportion of workers with the middle-skills and routine-based tasks.²⁰⁸

Empirical Observations on the modifications of the level of employed in the “G7” states show several principal similarities that looks like a common feature for economies.²⁰⁹

- Permanent decline in traditional industrial employment;
- Fast growth of organizational, special and mechanical occupations;
- The building, out of collective graduate workers, the office and trade employees;
- Compared to the other sectors, there's a steady state with the enough rate of employed in the retail segments;
- Motivated growth in the top and bottom categories of the professional hierarchy;
- Selective modernization of the professional structure over time, with a higher increase in the proportion of occupations that require higher qualifications and high educational level compared with the growth of the lower-level categories.

²⁰⁷ Mark Doms, Timothy Dunne and Kenneth R. Troske, "Workers, Wages, and Technology", **The Quarterly Journal of Economics**, President and Fellows of Harvard College and the Massachusetts Institute of Technology, w. Place, February 1997, p.253

²⁰⁸ Thomas Kurer and Aina Gallego, "Distributional consequences of technological change: Worker-level evidence", **Political consequences of technological change - Research Article**, R&P, Creative Commons Attribution-NonCommercial, w. Place, January-March 2019, p.3

²⁰⁹ M.Castells, Ibid., p.212, pp.222-223

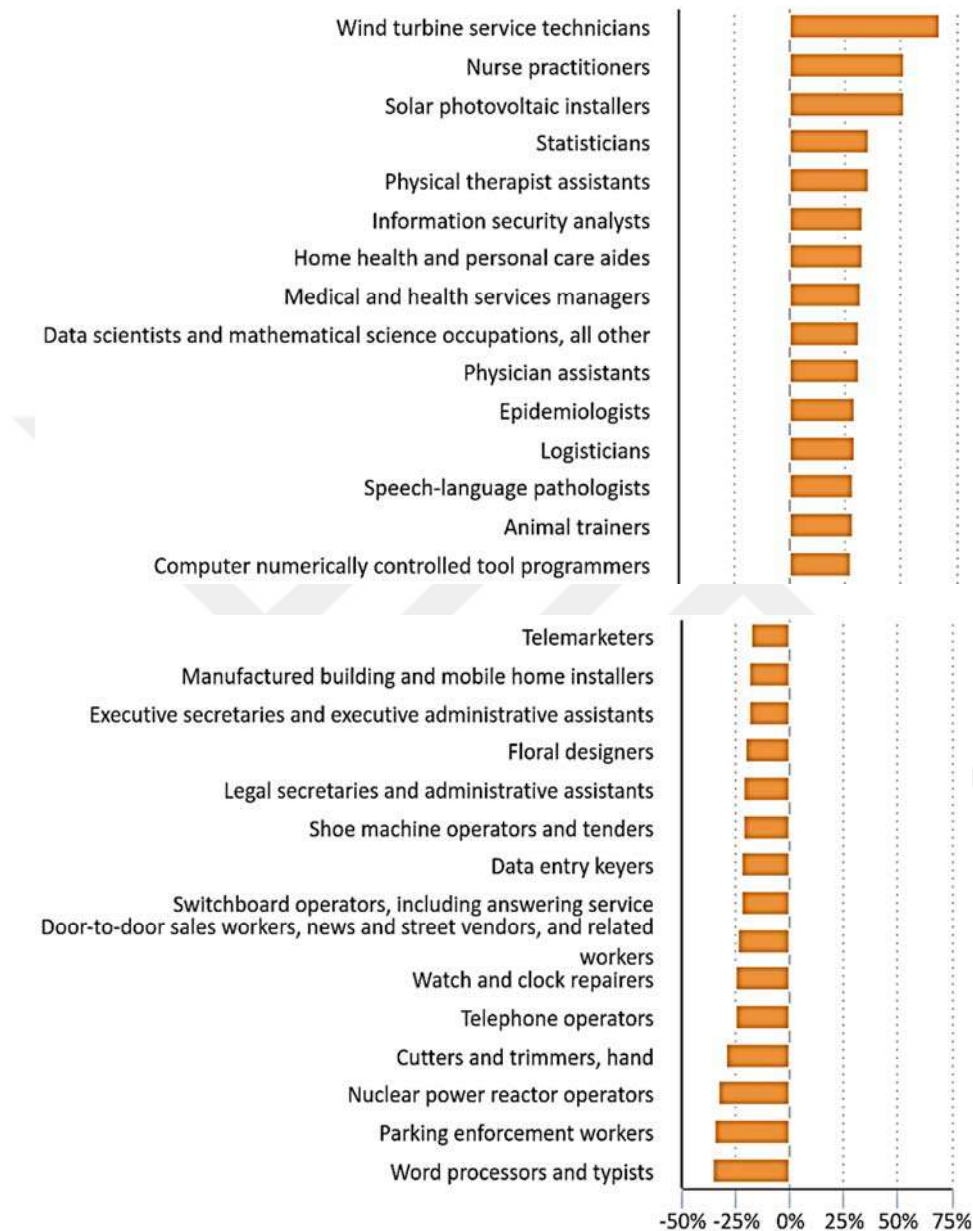


Figure 3.6: Fastest Growing and Decreasing Professions, Expected from 2020 to 2030
(U.S. Bureau of Labor Statistics, 2021)

A. Technological Effect on Employment Expansion in Sectors.

Analyzing the impact of innovations on the labor society and entrepreneurial actions, 2 essential result might be highlighted: foremost, in the virtual economic

system, the efficacy of linkage betwixt a labor and an entrepreneur (also a purchaser and a producer) calms down the importance of physical place; on the other hand, the virtual economic system modifies the strict job timetable acquired in the standard principles of manufacturing, creates an environment where the labor might be utilized in a flexible system of working.²¹⁰

First of all, we are talking about labor and entrepreneurial activity. The special actions of the professionals such as coders, writers, projectors, organizers of virtual shops and internet addressees, virtual marketing specialist, phone operators and i.e., aren't consider the physical places as a factor of work, as these employees are able to work from distance. Slowly, through the improvement of suitable virtual portals and innovations for interaction, doctors, consultants, mentors, analysts and lawyers are switching to the jobs from distance (at least step by step). Moreover, a lot of specialists out of non-technological spheres are starting to supply their services in the portals existed in the internet, where they can earn money through sharing their abilities and advices.

The innovations below that are also explored in a published STOA analysis, are included in a preliminary, definitely non-exhaustive category:²¹¹

- Autonomous vehicles: in personal vehicles, and also passenger and freight traffic, automated cars assist and/or replace car drivers. Automated cars have the possibility to substitute a lot of licensed machinist.
- Additive production (three-dimensional-printing): a method for making 3D objects through leveling raw fabric. The final form of the object was decided through the digital outline. Additional technology is now being used to make a huge list of items.

²¹⁰ Emma Parry and Valentina Battista, "The impact of emerging technologies on work: a review of the evidence and implications for the human resource function", **Emerald Open Research 2019**, w. Place, September 2021, p.1

²¹¹ Lieve V. Woensel and Geoff Archer, "Ten technologies which could change our lives: Potential impacts and policy implications", **European Parliament**, In-Depth Analysis, January 2015

- Calculational solutional techniques: algorithmic codes focused on massive information nets and statistics that substitute for and/or help human decision-making. Credit scores, preparation systems, paper summaries, and other are examples of this. Algorithmic decision making, according to analysts, may be used to replace a variety of office jobs.
- Industrial and service automatons: computers that conduct physical tasks, and do not need for human interaction can replace humans in a variety of manual, repetitive tasks in production and services.
- Bitcoin and blockchain innovations: private-sector digital money based on a blockchain that tracks transfers and guarantees ownership names. This innovation could pave the way for a slew of new entrants to take on established banks.
- Smart housing and Active Assisted Living (AAL): ICTs help people with disabilities by providing support and/or oversight. AAL is associated with home automation, as well as various monitoring technologies and basic decision-making, such as in case of emergency.

Each of these innovations are projected to show a remarkable effect on potential employee demand and innovations can be utilized to substitute repetitive activities. Accountants, as an instance, could be decline or disappear because innovations might now²¹² – as well as would be clearly learn the system of working with papers as well as switching them to the financial standards. This process could put hundreds of accountants around the world out of work.

²¹² Mark A. Dutz, Rita K. Almeida and Truman G. Packard, "The Jobs of Tomorrow: Technology, Productivity, and Prosperity in Latin America and the Caribbean", **International Bank for Reconstruction and Development / The World Bank**, Washington, 2018, p.30

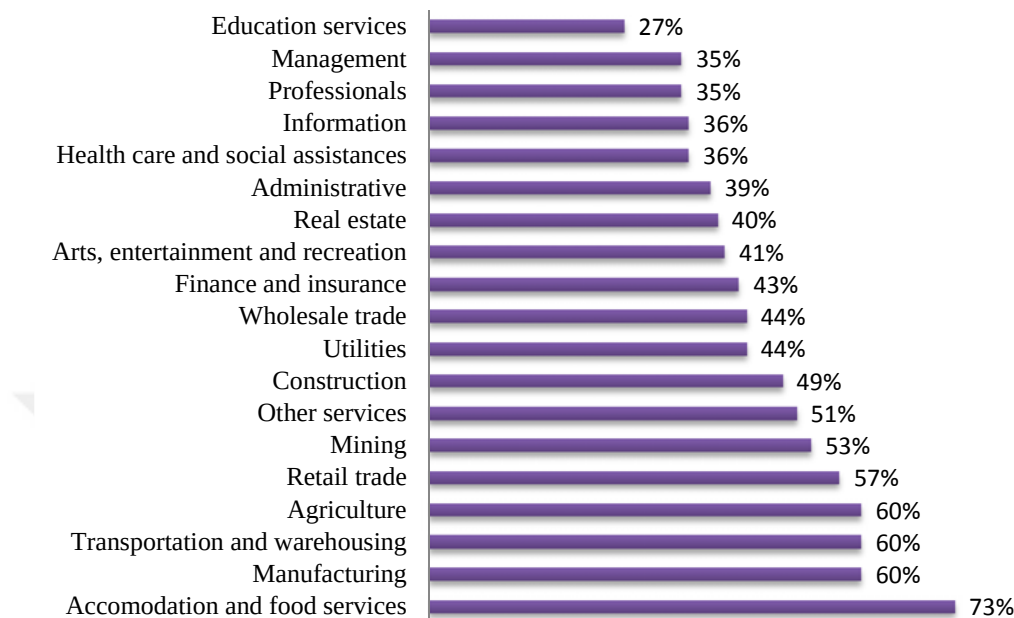


Figure 3.7: Automation Can Replace at Least Some Works in almost All Job Sectors

(A Future that Works: AI, Automation, Employment, and Productivity, 2017)

In the world today, robotic process automation (RPA) is taking over offices; According to Majorel group analysis, in five years, RPA would have taken over 41% of financial office positions, and in ten years, it will have taken over 53%.²¹³ The reasons are:

1. The growth of global competition;
2. Strict market requirements for the speed;
3. Cost reduction of processes;
4. Increase in the cost of labor.

In the 21st century, AI (artificial intelligence) has learned not only to count quickly, but also to see, hear, read and even speak. So, at the international exhibition of information technologies, the guests' special attention was attracted by robots -

²¹³ Sylwia Wojciechowska-Filipek, "Automation of the process of handling enquiries concerning information constituting a bank secret", **Banks and Bank Systems, Business Perspectives**, LLC "Consulting Publishing Company "Business Perspectives", 14 (3), Ukraine, 2021, p.177

humanoids or, as they are also called, software robots - they do not repeat mechanisms on wheels. RPA extracts data from accounts and transfers it to the required fields in the accounting system. In HRM, RPA fills in information about employees, running the cursor over program windows, etc. Summing up, it should be noted that the greatest success will be achieved by organizations that can functionally combine RPA and AI and other modern solutions in this area.²¹⁴

In other words, the arrangement for labor demand on the sectoral base will unavoidably get a greater intensive character. A remarkable position in the arrangement of the labor market will belong to intellectual services (consulting, information mediation, analytics, marketing).

Artificial intelligence is the world's best career driver, according to many industry sources.²¹⁵ While computers and algorithms are projected to displace 75 million positions by 2022, according to the WEF's potential of Jobs 2018 report, it is also expected that they are also produce 133 million new occupations, resulting in more than 58 million completely new positions in over the next several years.²¹⁶ By 2025, the WEF predicts that 85 million positions will disappear and 97 million newest jobs will be generated across 26 countries.²¹⁷

The PwC AI Analysis confirms that artificial intelligence, robotics, and smart technology innovations can provide significant economic growth.²¹⁸ By 2030, these innovations are projected to add \$15.7 trillion to world GDP, a 14 percent increase.²¹⁹ Artificial intelligence is a game-changer in industries such as retail, financial sectors,

²¹⁴Y. Odehov and V. Pavlova, Ibid., p.64

²¹⁵ James Wilson, Paul Daugherty and Nicola Morini-Bianzino, "The Jobs that Artificial Intelligence Will Create", 58 (4), **MIT Sloan**, w. Place, 2017, p.14

²¹⁶ Rudolf M. Oosthuizen, **Theory, Research and Dynamics of Career Wellbeing**, Ed. By Ingrid L. Potgieter, Nadia Ferreira, Melinde Coetzee, Springer Nature Switzerland, Switzerland, 2019, p.17

²¹⁷ Naufal Mahfudz, Arif Satria, Aida Vitayala S. Hubeis, Arif Imam Suroso, Zaim Uchrowi, "The Objective Conditions of the Competency of Labor Social Security Practitioners in Facing Future Jobs", **GATR Journal of Business and Economics Review**, 5 (4), Bogor, 2021, p.19

²¹⁸ "What's the real value of AI for your business and how can you capitalise?", **PwC**, w. Place, 2017, p.9

²¹⁹ Njuguna Ndungu and Landry Signe, "Capturing the Fourth Industrial Revolution: A regional and national agenda", **Foresight Africa**, w. Place, w. Date, p.69

innovation, automobile, shipping & logistics, energy, production, and healthcare. According to the PwC Study, AI technology improves production, product efficiency, and consumption.

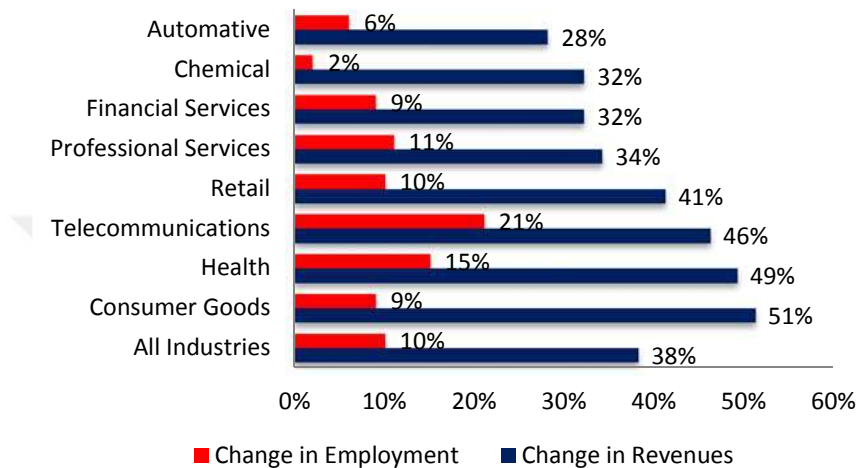


Figure 3.8: Potential Employment Growth in Some Major Sectors ("*Accenture Future Workforce Study*" 2017)

AI adoption in a variety of markets and scenarios leads to increased value-involvement potential and a transition away from conventional occupations toward more evolved positions. The plethora of AI-driven positions and career functions advertised on work boards demonstrates this notion.

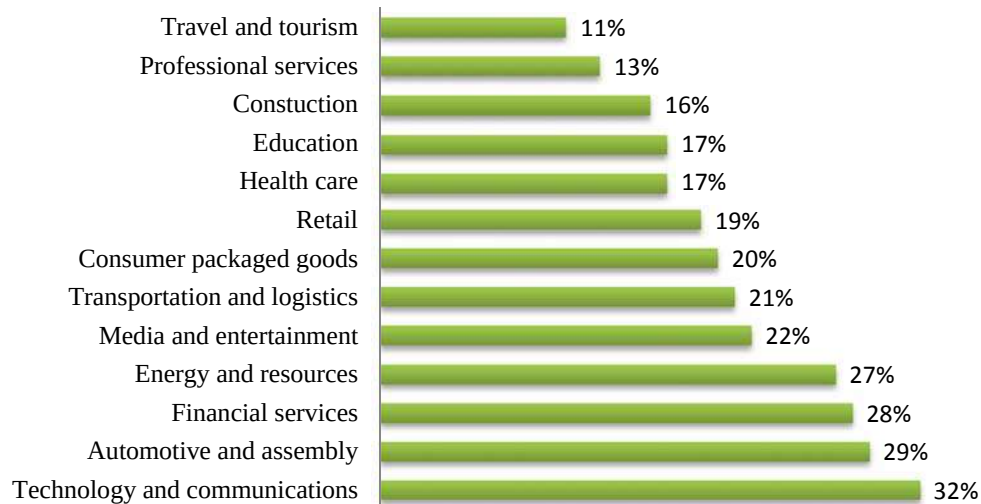


Figure 3.9: Adoption Rate of Artificial Intelligence by Industry (*Artificial Intelligence the Next Digital Frontier, 2017*)

These sectors are on a fast-growing path, with fierce competition for a competitive advantage and shareholder trust. Companies will use AI for innovations and distinction to stay ahead of the competition and focus on market opportunities. Today, no industry or company is immune to the effects of AI. As AI does have ability to change consumer relationships, core company operations are being reinterpreted. In such a situation, businesses invest not just in technologies and data, but also in AI expertise to make use of all the data and use it to expand their businesses.

3.3.2. Empirical Findings of the Impact of Innovation on Sectors

Although the diffusion of new technologies between sectors usually manifests itself in the form of sudden and large-scale changes, it cannot be said that the effect will be the same for all sectors.

In economic approaches, it is accepted that employment increases depending on productivity, and productivity growth is largely due to technological changes. In industrialized countries, since the 1980s, with the spread of new technologies, there has

been an upward trend in unemployment.²²⁰ In fact, while the unemployment-to-active population ratio was 10.4% in the European Union between 1983 and 1985, this rate dropped to 8.3% in 1990, however, the data could not demonstrate why European unemployment rate was higher in 1983, 1984, and 1985 than in 1979-80.²²¹ The unemployment rate, which stood at 9.6% in 1983, fell to 7.4% in 1992.²²² Japan has seen a decline in the unemployment rate from 2.7% in the 1983-1992 periods to 2.2% in 1992.²²³ In the 1950s and 1960s, when it was first put into practice in manufacturing, the debate about the relationship between technology and unemployment came to the fore again. In the previous period, when the capabilities of the computer and the potential of automation were first realized, technical innovations first found application in the manufacturing sector and affected workers in this sector. Technical innovation, on the other hand, has had an impact on those in both the manufacturing and service sectors.

Differences emerging from a country perspective can also be observed in the increase in employment in the service sector. When employment growth is measured on the basis of this “non-industry service category”, employment in this category in the UK increased from 23% to 39% between 1970 and 1990; 30% to 40% in America; In Canada, from 29% to 34%; 15% to 24% in Japan; In Germany, from 20% to 32%; it can be seen that in France it increased from 21% to 30%.²²⁴ We should note, that the ineffectiveness of unorganised national industrial reforms became apparent starting from the mid-1980s, as a result, two significant horizontal methods were established at the EU level: the domestic market and competition policy, which included state assistance.²²⁵ Accordingly, it is proposed that industrialized countries follow two

²²⁰ Lars Ljungqvist and Thomas J. Sargent, "The European Unemployment Dilemma", **IUI Working Paper - No. 481**, The Research Institute of Industrial Economics, Econstor, ZBW, Stockholm, May 1997, p.1

²²¹ Jean-Paul Fitoussi and Edmund Phelps, "Causes of the 1980s Slump in Europe", 2, **Brookings Papers on Economic Activity**, w. Place, 1986, p.492

²²² Gary D. Sandefur and Tom Wells, "Trends in AFDC Participation Rates: The Implications for Welfare Reform", **Discussion Paper no. 1116-96**, Discussion Paper no. 1116-96, Madison, December 1996, p.17

²²³ T. Erdut, Ibid., p.9

²²⁴ Manuel Castells and Yoku Aoyama, "Paths towards the informational society: employment structure in G-7 countries, 1920 - 90", **International labour review**, 133 (1), w. Place, 1994, pp.5-33

²²⁵ R. Veugelers, Ibid, p.163

different paths in employment in the non-industrial services sector. While employment in traditional service industries persists in the United States, England and Canada under the "Anglo-Saxon model", it is expanding in the "Japanese-German model", where the manufacturing sector seems remarkable.²²⁶ Several scholars have attempted to quantify the impact of digitalisation on jobs in recent years. The section below includes a partial list of such studies:

Table 3.3: Studies on the Effect of New ICTs on Jobs across the Economy (*"The impact of new technologies on the labour market and the social economy"*, 2018)

Source	Result	Period	Remarks
Frey & Osborne (2013)	-47%	10 - 20 years	USA, all sectors
Bowles (2014)	-47% to -60%	10 - 20 years	All EU member states; trace the treatment of Frey & Osborne 2013
Bonin et al. (2015)	-12%	-	DEU, all sectors
Boston Consulting Group (2015)	+6%	10 years	DEU, production
Wolter et al. (2015)	less than 1%	25 years	DEU, production, considers also economy-wide compensation effects
Arntz et al. (2016)	-12% to -6%	-	OECD states, trace the treatment of Bonin et al. 2015

•The thesis of Frey and Osborne is arguably the most debated of the reviews, with about 10.000 quotations in Google Scholar. Frey and Osborne classify positions with the most routine jobs and calculate how many workers might be lost due to digitalization. They predict that ICTs will replace about 47 % US jobs. Except three categories, the existing

²²⁶ Stephen Frenkel, Marek Korczynski, Karen Shire and May Tam, **On the Front Line: Organization of Work in the Information Economy**, Cornell University Press, New York, 1999, p.37

jobs: unical ingenuity (as an instance, the potential to illustrate the unique/inventive thoughts in terms of a particular subject or condition); vision & conditioning (for instance, finger dexterity) as well as social intelligence (social thoughtfulness, interpersonal skills, and persuasion). According to the estimation, Frey & Osborne worked on the input which was get out of 702 working categories developed by the US Department of Labor.²²⁷ The authors chose selected 70 professions out of the introduced list and illustarted the writings to the attendants of University of Oxford, with a request to assess how great the risk of complete automation of this kind of occupations starting in the soon future. The obtained examinations were extended to the remaining 632 professions using special statistical procedures. The categories were separated into 3 parts: low rate affected, medium rate affected and high rate affected. The result that they have obtained illustrates that the percentage of 'low rate affected' category is 33%, "medium" - 20%, and high level - 47%, indicating that almost ½ of existing jobs will be lost in a few years. This trend, compared to the popular opinion, points out that the RBTC concept of employment polarization, the highest risk of automation is exposed to workers with low, rather than average qualifications.²²⁸

•However, the way that Frey & Osborne have examined the impact seems to be not fully real. Since Bessen noted, after several years from their estimation, from 37 occupations that as authors promised a quick death (accountants, auditors, bank employees for issuing loans, couriers, messengers), none of them has been automated.²²⁹ Moreover, in the estimation of Bessen, where he analized the 300 occupations and came to the conclusion that in the US, throughout 60 years after 1950, none of the occupation lost, except the lifter, whose work were no longer needed after elevator cars were equipped with automatic doors.

²²⁷ Carl Frey and Michael Osborne, "The Future of Employment: How Susceptible Are Jobs to Computerisation?", **Oxford Martin Programme on Technology and Employment**, United Kingdom, September 17, 2013, pp.1-45

²²⁸ C. Frey and M. Osborne, Ibid, p.42

²²⁹ James Bessen, "How Computer Automation Affects Occupations: Technology, Jobs, and Skills", **Law & Economics Working Paper**, Boston University School of Law, 15 (49), w. Place, October 2016, p.5

- Using the proposed methodology of Frey and Osborne, the result of other researchers looks pessimistic, where they say that a huge number of very different professions will be exposed to a greater risk of complete technological replacement, that considered account in a sum of 35,7% for Finland ²³⁰, 59% for Germany ²³¹.
- Bowles said the same with Frey and Osborne's report for the EU, concluding that in the following years, between 47 percent and over 60 percent of the European Union employees will lose their jobs because of technologies.
- On the grounds of analyst interviews and comparative evidence, the Boston Consultancy Group examines the effects of Industries in the German industrial sector. They expect a 6% growth in workforce, or 390,000 new jobs, from 2015 to 2025.²³²
- Wolter of the German Center for Job Study use a multi-industrial input-output system for Germany, including expanded investments in ICT facilities and machinery, shifting intermediate demand, and modifying demand for different professions.²³³
- Finally, Melanie Arntz adopt Bonin's method to focus on repetitive activities rather than routine professions. They discovered that Germany and Austria (12 percent of the workforce) had the greatest risk of becoming replaced by robotics,²³⁴ whereas the lowest indexes represent Estonia, Finland, and Belgium (6-7 percent).
- From the point of examination method, one of the shortcomings shown in work of Frey and Osborne, was identified in the work of M. Arntz et al. She says that there is no complete disappearing of occupation entirely after innovations, but rather, only certain

²³⁰ Mika Pajarinen and Petri Rouvinen, "Computerization Threatens One Third of Finnish Employment", 22 (13), **Muistio-Brief, Etlä**, w. Place, January 2014, p.3

²³¹ Philipp Frey, "Visions of Automation: A Comparative Discussion of Two Approaches", **Societies**, 11(63), Basel, 2021, p.2

²³² Friedrich Glauner, **Future Viability, Business Models, and Values**, Springer, Switzerland, 2016, p.2

²³³ Wolter I. Marc, **Industrie 4.0 und die Folgen für Arbeitsmarkt und Wirtschaft: Szenario-Rechnungen im Rahmen der BIBB-IAB-Qualifikations- und Berufsfeldprojektionen**, IAB-Forschungsbericht, No. 8, Institut für Arbeitsmarkt- und Berufsforschung (IAB), Econstor, ZBW, Nürnberg, 2015, pp.1-64

²³⁴ Melanie Arntz, Terry Gregory and Ulrich Zierahn, "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis", **OECD Social, Employment and Migration Working Papers**, 189, OECD, Paris, June 2016, p.4

tasks of these entire occupations are subjected to substitution after technologies. Consequently, technologies are not completely removing the occupations, but just replacing certain tasks²³⁵: the interval of time spent on repetitive activities decreases, while the amount of time devoted to non-repetitive activities increases. According to her, Frey and Osborne neglected this point.

According to Arntz, when we shall analyze the impact of technology not on the whole occupation base, but rather, on the task level, then the percentage of disappearing of jobs will decrease to 9% and will not be 47% (estimation of 21 developed economies); for South Korea – seven percent, Austria – twelve percent.²³⁶ She also emphasizes that countries with a more educated workforce are less likely to lose employment when new technologies are introduced.

Three additional researches with a narrower emphasis should also be mentioned:

- First, unlike the studies listed before, Pantea uses firm-base data rather than country-base data in their study. Firm-base analysis has the advantage of providing an overall effect rather than the total impact that might be considered skewed through big or little-sized players. The researchers reached the conclusion that there is no negative association between organization ICT use and increasing in employment.²³⁷
- In the second place, Michaels & Graetz examined the impact of technologies on employment at the sectoral level for 17 states from 1993 to 2007.²³⁸ They discover that increasing the utilization of robotics in manufacturing illustrated a positive effect on efficiency, employment, and, as a result, GDP growth. They see no proof of a negatory effect of robotics on total level of employed, however Michaels & Graetz have provided evidence of a negatory impact on less-capable employees as well as a lesser impact on average-capable jobs.

²³⁵ M.Arntz, T. Gregory and U. Zierahn, Ibid, p.7

²³⁶ M.Arntz, T. Gregory and U. Zierahn, Ibid., p.8

²³⁷ Smaranda Pantea, Federico Biagi and Anna Sabadash, "Are ICT Displacing Workers? Evidence from Seven European Countries", **Digital Economy Working Paper**, European Union, Spain, July 2014, p.1

²³⁸ Georg Graetz and Guy Michaels, "Robots at Work", February 14, 2018, p.3

•In the third place, in relation to Michaels and Graetz, Fraunhofer ISI explores the effect of robotics on work for the duration 2007-2009.²³⁹ They affirm the previous observation, finding no proof of a positive or negative direct job effect. They do, however, demonstrate that companies that employ robotics have substantially better efficiency. A curious side effect is that businesses that employ robotics are much less likely to outsource manufacturing to other countries.

Valuable research was acquired in the writings of J. Bessen, where was highlighted that amongst the alike industries, the linkage betwixt the changes of employee efficiency and the changes of the rate of employed varies: firstly, when it starts, on the initial steps of the improvement of particular sector, the linkage becomes positive (the application of innovation navigates to the growth of new positions), afterwards, when it comes to the last steps, the linkage turns to negative.²⁴⁰ That's why, in case of US, the amount employees involved to the production of cotton manufactories made up 20.000 employees accounted for 1820, grew up to 450.000 employees accounted for 1930 (max) and went back to the initial amount - 20.000 for this period. The similar tendency was seen in the steel and automotive industries (in the automotive industry the amount of labor not fully went back to the initial point, but the tendency is the same).²⁴¹ According to James Bessen, capital investment, especially in the manufacturing sector, is one of the key navigators of production and job growth.²⁴² Moreover, the yearly growth rate of employee efficiency was positive in the mentioned industries during the whole period of time. Why there's a growth and then a decrease in the number of employees, notwithstanding the fact that there was a constant labor productivity throughout the time?

²³⁹ B. Dachs, Ibid, p.26

²⁴⁰ R. Kapeliushnikov, Ibid, p.97

²⁴¹ James Bessen, "Automation and Jobs: When Technology Boosts Employment", **Boston University School of Law**, w. Place, March 7, 2018, p.19

²⁴² James Bessen, "Automation and Jobs: When Technology Boosts Employment", **Law & Economics Paper**, Boston University School of Law, w. Place, March 2018, p.2

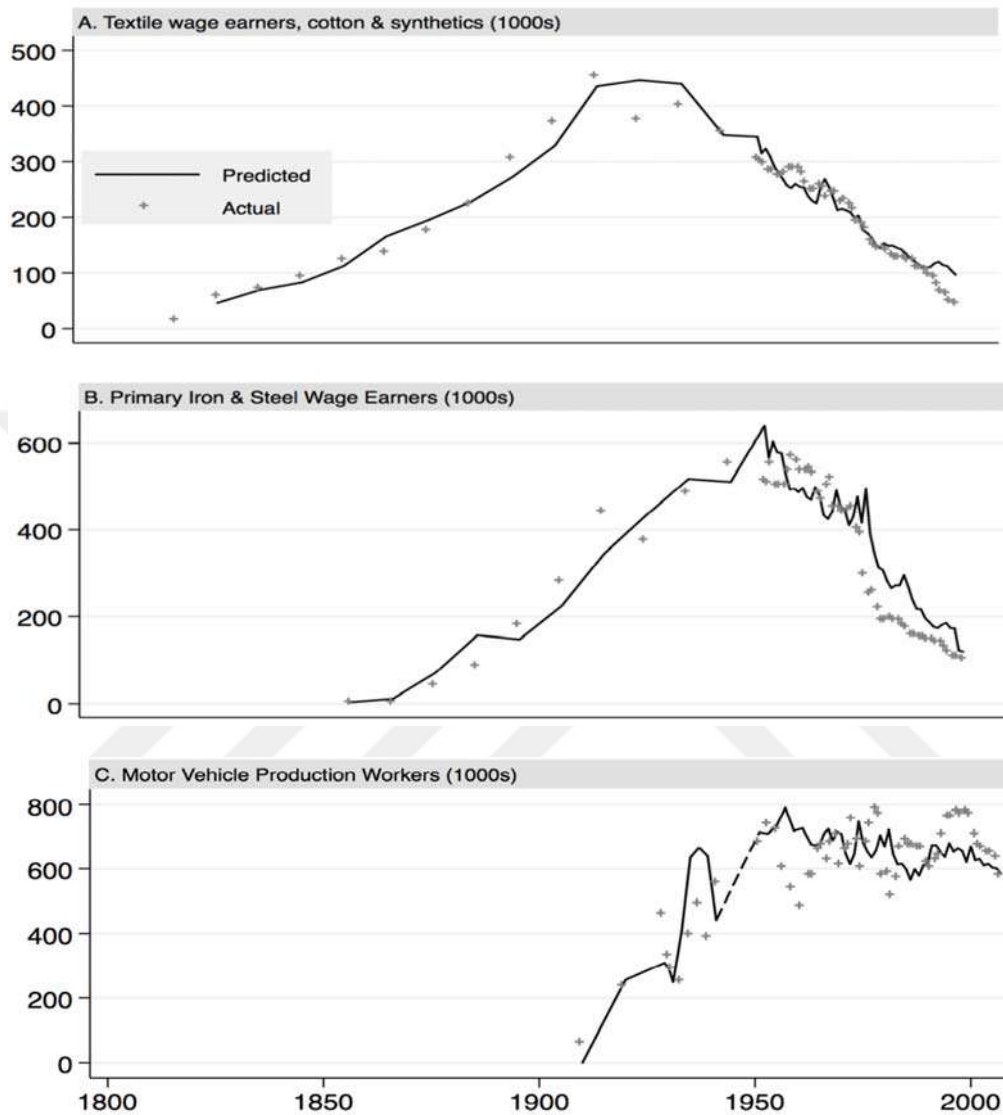


Figure 3.10: Manufacturing Employment Rate in Different Industries (*"Automation and Jobs: When Technology Boosts Employment"*, 2018)

Bessen attributes and link such tendency with the price elasticity of demand, and points out that PED dynamics are changing throughout the time. During the time when an item occurs in the mart, the wealthy people are able to buy this product with the high prices. When, after the cost reduction of product, the price falls, then the number of buyers and demand for this product increase. At the end of the time interval, the price

for this product drops to such an extent that the item becomes available for everyone and price elasticity of demand decreases to the under 1. From this moment, the impact of technology on employment turns out of positivity towards the negative side. So, Bessen, in his work, highlighted that in the growing phase, while the PED is highly greater than 1, the employee productivity leads to growth in the level of employed. Such explanation, according to Bessen, demonstrates, in particular case, why the impact of ICT on employment varied so widely across individual sectors.

There are analyzes, certain forecasts for the coming years. According to Yuri Odehov and Valentina Pavlova, employment in the world due to the introduction of new technologies will be increased each year for fields: virtual network and intangible innovations - 2.47%; areas related to internet - 2.27%; manufacturing technologies - 0.36%.²⁴³

The fastest growing are professions related to health care and related services, as well as professions related to computers and mathematics, and renewable energy sources. These are the indicators which show that the technology, along with an effect on manufacturing industries, has a significant impact on service industries.

3.3.3. An Examination of Employment and Wage Polarization

A. Technology and Skill-based Employment

When we examine the evolution of technology from the past to the present, we see that machines have evolved in such a way that they replaced unskilled labor, not skilled labor. In other words, the capitalist system has always somehow found the cheap labor it needs. Each new technology discovered was developed and implemented in such a way as to save skilled labor. From another side, emerging new technologies reduce the physical labor force of a person (labor) and increase mental workload. It is noted that the fields of employment created by technological progress are gradually shifting from commercial and social activities to a “network revolution” that includes interactive,

²⁴³ Y. Odegov and V. Pavlova, Ibid, p.68

digital and open standards. This situation causes the disappearance of many professions, and in the information sector, which is another sector, the demand for qualified personnel is increasing and is causing the emergence of new lines of business. Surely the need for an adult and skilled workforce will never go away. Trained and graduated individuals will always have the opportunity to work in positions that suit them. In other words, information products are increasingly being included in the total output of the modern economy, and there is a growing need for a skilled workforce that can understand and apply the complex information required to manufacture, process and use these products.²⁴⁴ This helps to conclude that technological change is increasingly driven by skilled labor. Thus, we can say that development, growth, technology and skilled labor complement each other. Technological development first changes not only the structure and production process of a product, but also human labor in this process. In other words, improving the quality of labor causes. This requires a more educated and better quality workforce. Of course, this requires a solid and strong education system.

B. Workers of Low, Medium and High Skill Levels

It's possible to observe several findings in the written works on occurring innovation and employment, namely that technical progress is not skill-neutral. This framework is illustrated in the written works as 'skill-biased technical transition'²⁴⁵. In addition, some researchers have discovered that modern innovations are gradually replacing routine tasks, naming this development as 'routine-biased technological transition.'²⁴⁶ Not just in handheld work, however the office workers and managerial ones, we can find a large share of routine activities. Researchers demonstrate that in the US, demand for routine tasks and assignments has decreased dramatically, without taking into account whether the jobs and assignments have an intellectual or handheld

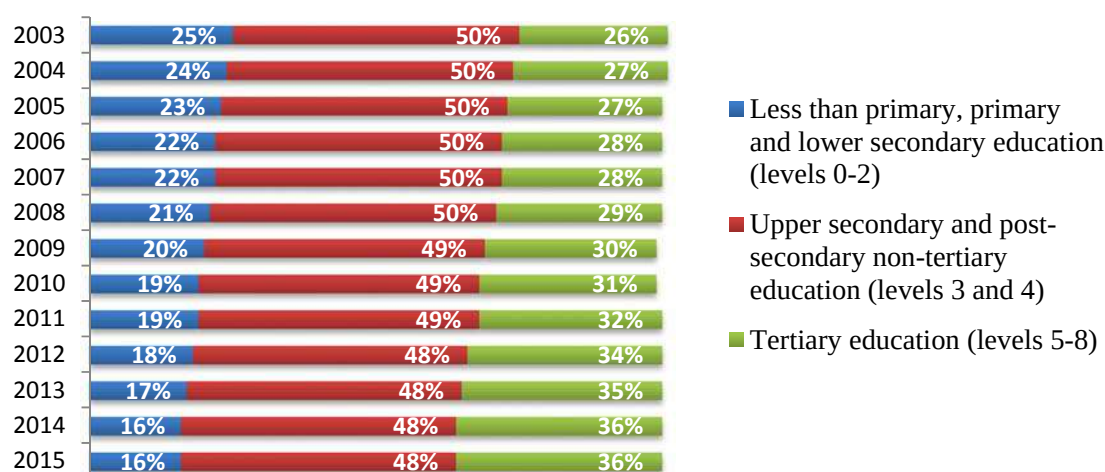
²⁴⁴ G.G. Muhammed, Ibid, p.70.

²⁴⁵ David Card and John DiNardo, "Skill-Biased Technological Change and Rising Wage Inequality: Some Problems and Puzzles", 20 (4), **Journal of Labor Economics**, University of Chicago, w. Place, 2002, p.734

²⁴⁶ Federico Biagi and Raquel Sebastian, "The Routine Biased Technical Change hypothesis: a critical review", **Publications Office of the European Union**, European Union, Luxembourg, 2018, p.5

disposition.²⁴⁷ Consequently, the demand for workers with middle-skill level began to decline, however the demand seemed high for employees with low- and high-skill degrees. This trend has received the name in economics as "polarization of work".²⁴⁸ The growth of the European labor markets has pursued the direction of skill-based technical transition over the past 20 years. The amount of employees and occupations demanding just limited qualifications has dropped gradually. But it is hard to predict that this result is directly related to the use of innovation or globalization. Innovation will establish new jobs with new structures in the future, however it'll be in professions apart from those eliminated through automation and will be distinguished through a small proportion of repetitive activities and a greater proportion of exercises involving analytical and societal skills. This encompasses multiple professions in education, health and social activities.

As shown in the given section, job prospects for individuals with or below elementary and secondary school declined long before the 2008/09 recession. This group's percentage of overall EU jobs declined from 25% in 2003 (the equivalent of about 40 million individuals) to 16% (or 26 million individuals) in 2015.



²⁴⁷ B. Dachs, Ibid., p.4.

²⁴⁸ Jaison Abel and Richard Deitz, "Job Polarization and Rising Inequality in the Nation and the New York–Northern New Jersey Region", 18 (7), **Current Issues in Economics and Finance**, Federal Reserve Bank of New York, w. Place, 2012, p.1

Figure 3.11: Employment and Skills Rate, 2003-2015, EU-28 (*“EUROSTAT, Labour Force Survey”, 2018*)

In comparison, tertiary education employees have grown their fraction EU jobs by 10 percent throughout that time interval, from about forty million to fifty-nine million in a time duration 2003-2015, and the scale showing the complete secondary and post-secondary education of individuals showed almost unchanged in terms of absolute and relative terms, where this group represents a fifty percent fraction EU employment, which is equivalent to around 77 million individuals in 2015. This indicates, that in the medium and long term, skill would necessitate a stronger connection between education and labor market structures, as well as a focus on investments.²⁴⁹

Technology is not skill-neutral, however appears to support those basic talents, whereas other abilities are devalued and made useless. The first representation of the link between the degree of skills and the level of unemployment is described in the following graph. It indicates the proportion of unemployed people with various levels of education as a fraction of the EU-28 active population between the ages of 25 and 64. We find that among individuals with primary and lower secondary education or below, unemployment is incredibly strong. Among all 3 groups, this reported the highest unemployment over the entire period. In addition, as shown in the figure, individuals with little education levels did also encounter difficulties disproportionately from the depression. Over the crisis, unemployment steadily increased in this category. Over the recession, unemployment in this category almost doubled, from below 10 percent to 18 percent in 2013.

²⁴⁹ “New skills and jobs in Europe: Pathways towards full employment, European Commission”, **European Union**, France, 2012, p.39

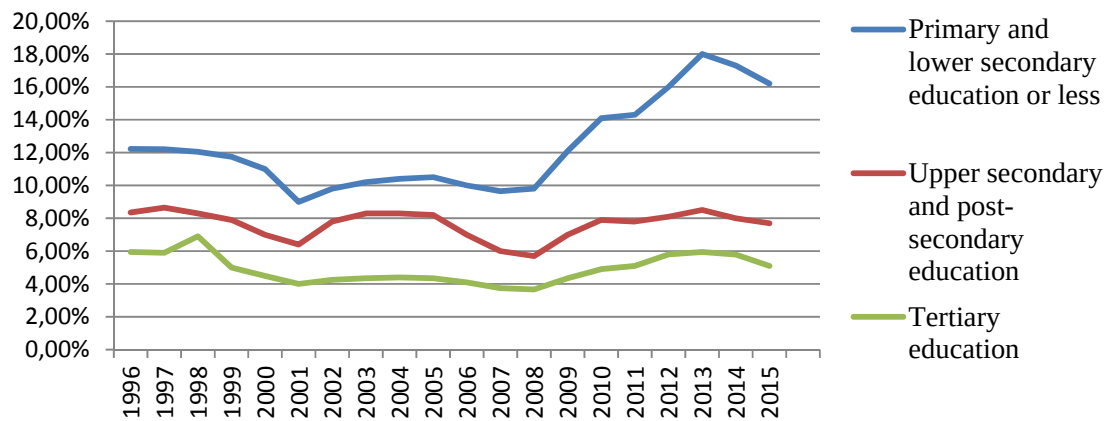


Figure 3.12: Unemployment and Skills Rate, 1995-2015, EU-28 (“*EUROSTAT, Labour Force Survey*”, 2018)

C. High Unemployment Rate among Low-skilled Workers

Progress in the development of electronic computing technology has eliminated millions of jobs for typists, punchers, standard setters, designers, accountants, etc., performing routine work related to calculations according to a certain algorithm. In connection with the expansion of automation, the reduction of the staff of the contact and call centers will begin. According to the researcher, for workers with a low level of education, in the framework of low-skilled employees, the employment-population percentage scale from 1950 to 2010 was declined approximately from 91% to 73%²⁵⁰, as a result, low-skilled workers are less likely to find work nowadays than high-skilled workers.²⁵¹ At the same time, the demand for highly qualified specialists will only grow. According to the Olivier Pierrard and Henri R. Sneessens, the low rate of employment

²⁵⁰ Erin L. Wolcott, "Employment inequality: Why do the low-skilled work less now?", **Journal of Monetary Economics**, Elsevier, w. Place, October 2020, p.2

²⁵¹ Erin L. Wolcott, "Employment Inequality: Why Do the Low-Skilled Work Less Now?", **Middlebury College**, w. Place, December 2018, p.1

level is growing in European Union states was significantly notable for unskilled employees, because of “skill bias” and “crowding-out” factors.²⁵²

Polarized employment - means the interval betwixt the request for high-capable and low-capable employees. There is a risk of further polarization of jobs in the coming years. Against the background of the destruction of jobs in the manufacturing industry and some sectors of the service sector, the employment of both low-skilled and highly skilled workers and specialists is expanding. Research on robotization shows that workers performing routine tasks (i.e., operations that can be easily performed by robots with software) are at high risk of crowding out, including in many service sectors where digitalization and AI came to have a more prominent role. In the lack of efficient switch paths, comprising sufficient potentialities to learn new and in demand capabilities, most of the jobs that undergo the possibility of hazard, might be pushed to take on jobs where skill requirements and pay are lower, further increasing the pressure lower wages in a sector where they are already low.

In an attempt to give a compositive insight into the constructed modifications in professional mechanism, a simplistic stratification system was calculated based on detailed data from another study of the allocation of employment according to their profession, qualification, and wage rates for 1992 (evidence) and for 2005 (projection). Through implementing average weekly wages like the highest straight index of societal stratification, 4 societal categories were built: the highest category (specialists and top managers); average category (technicists and skilled employees); lower middle class (trade workers, office workers and operators); lower class (workers in the service sector and agriculture). After recalculating the data for these categories, it was found that the share of employment for the upper class increased from 23.7% in 1992 to 25.3% in 2005 (+1.6); an insignificant decrease in the average category 14.7 - 14.3% (-0.3); a decrease in the below the average category 42.7 - 40.0% (-2.7); and the growth in the lowest

²⁵² Olivier Pierrard and Henri R. Sneessens, "Low-Skilled Unemployment, Biased Technological Shocks and Job Competition", **Iza Discussion Paper Series**, 784, Institute for the Study of Labor, Econstor, ZBW, Bonn, May 2003, p.1

category 18.9 - 20% (+1.1).²⁵³ So at the same time, there is growth at the highest and lowest deciles of the scaling degrees, however growth is higher at the highest decile.

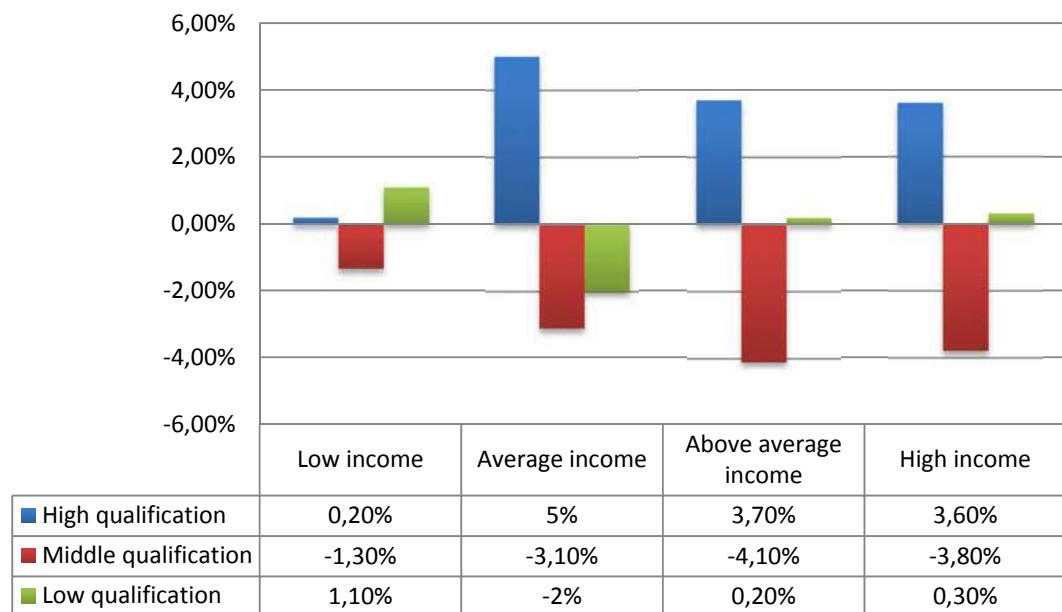


Figure 3.13: Polarization of Jobs Around the World in 2016 (*“The impact of technology on the quality and quantity of jobs, global commission on the future of labor, 2018)*

D. Demand for High-skilled Workers

Technological advances and the impact of these advances on employment have opened up new dimensions in the discussion of employment. New technological changes require higher skills, which significantly reduces the demand for low-skilled workers. The need for manual labor (for “hand work”) has gradually been replaced by the demand for cognitive labor (for “head work”), and now the time is coming for soft skills - “work of the heart”. The ability to make decisions, resolve conflicts and find a common language with clients comes to the fore. Robotics and AI is modifying the character of work, enhancing the "work of the head"; great workers of the future will increasingly engage in non-standard tasks, generate insights and communicate with each other to

²⁵³ Manuel Castells, **The Information Age Economy, Society, and Culture: The Rise of the Network Society**, Wiley-Blackwell, Volume 1, 2010, p.241

make difficult decisions. Historically, schools, universities and workplaces have focused primarily on developing and rewarding technical skills (such as data analysis). Therefore, the offer to work on the development of soft skills outstrips the growing demand.

Many researchers recommend looking at particular tasks instead of skill level. A task means an activity that generates production. Tasks might be implemented via labor (human) or through capital (machinery, technology). Individuals exhibit their skills to perform different tasks. New process technology may make certain services provided by staff, thus improve the importance and usefulness of different activities through improving their efficiency. Such activities cover every aspect relating to the abilities that requires finding solutions, instinct, imagination, conviction, adaptability to circumstances, comprehension of vision and expression and interactions with individuals. New technology will, however, either replace or supplement duties undertaken by employees. According to Acemoglu and Autor, it could be best suited to distinguish between manual versus cognitive and routine versus non-routine occupations rather than skilled versus non-skilled. That's why the authors identify 4 kinds of assignments:²⁵⁴

- Logical non-repetitive activities,
- Logical repetitive activities,
- Handheld non-repetitive activities,
- Handheld repetitive activities.

They demonstrate that demand for routine positions and activities has declined dramatically, without taking into account such jobs or projects might be in a logical or handheld feature. As a result, a need for individuals with average-skilled ranges has lowered, whereas a need for high-qualified and low-qualified professions has increased.

²⁵⁴ Daron Acemoglu and David Autor, "Tasks and Technologies: Implications for Employment and Earnings", **Elsevier B.V.**, Handbook of Labor Economics, 4, Amsterdam, 2011, pp.1043–1171.

This tendency is called 'routine-biased technical transition' and work polarization. Repetitive, average-skilled employees are slowly substituted by ICTs²⁵⁵, however are comparable to lower repetitive - logical activities and low-skilled handled labour positions. These might indicate that businesses highly employ postgraduates from colleges for architecture, creation or administration, however businesses still might require scrubwomen, salespeople, etc. All that involves face-to-face contact is an instance of such a non-routine process. Process of globalization is an alternate cause to work polarisation, since regular workers are expected to become more accessible to offshoring than non-routine positions.²⁵⁶

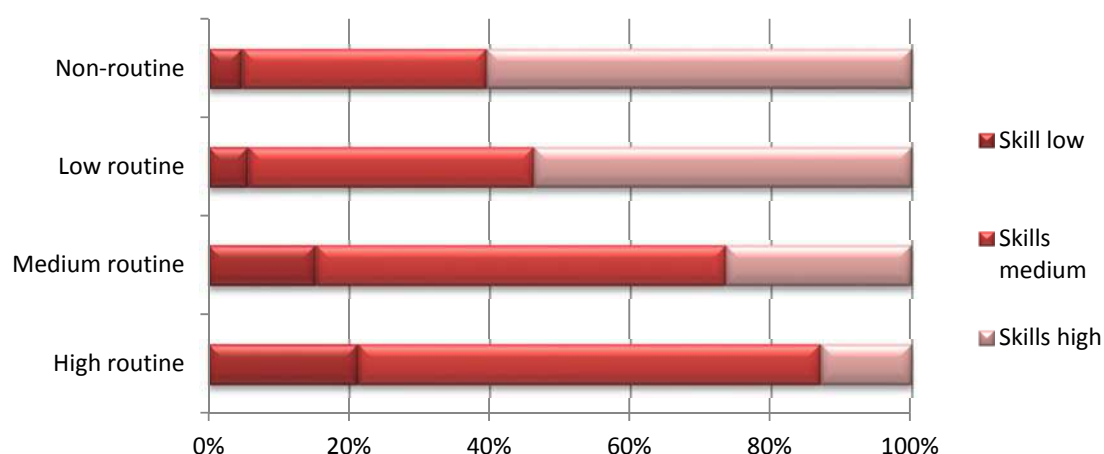


Figure 3.14: Employment Rate Based on Skill Level and Routine Intensity in EU, 2011-2012 (*“European Parliamentary Research Service”, 2018*)

The goal of developing new products is achieved by hiring workers with a wide range of professionals in different positions so that they can replace each other. Accordingly, the flexibility of the enterprise leads to the fact that the production process becomes more flexible and new forms of employment appear.

²⁵⁵ Luca Marcolin, Sebastien Miroudot and Mariagrazia Squicciarini, "Routine jobs, employment and technological innovation in global", **Technology and Industry Working Papers**, OECD Science, Paris, 2016, p.3

²⁵⁶ J. Abel and R. Deitz, Ibid, p.1

Technological innovation may benefit employees by robotics, through labor-increasing technologies, or substitute them. The ultimate impact on labor demand in the industry is unclear in both situations, but can be predicted. Recent technical developments illustrated a greater demand rate for specialists and lower demand rate for repetitive activities of workers. The content of the industry profiles covers the economic situation and trends, the main professions, the qualifications in demand, as well as the qualifications for which the demand is expected in the future. The use of machines has been the core factor guiding improvements in the compensation of professional employees compared to the salaries of unskilled workers. To determine the proportion of jobs at risk from innovation and digitalisation, numerous approaches have been developed. According to these methodologies, in developing states, the calculated share of employment at risk appears to be higher compared with developed countries,²⁵⁷ due to their higher proportion of routine work in employment.²⁵⁸

E. The Impact of Technology on Labor Supply, and on Labor Demand

When we talk about the technological unemployment, it might be possible not to notice that modern innovations might affect not just the rate of demand, however, it is possible that we can encounter the problem of labor supply.

Usually, besides the wastes of money, the laid offs go through the difficulties in terms of mind and sense, as they started to feel they were isolated from the society, but, due to the computers and virtual networks, this kind of negativities have become an order of magnitude lower: now the unemployed are trying to find certain things (spending the day in attraction of internet games) and discovering new friendships in the virtual portals (via virtual networks). Consequently, as the importance of leisure started to grow after technologies, stimulus to find and receive positions in the labor market started to reduce.

²⁵⁷ Simeon Nichter and Lara Goldmark, "Small Firm Growth in Developing Countries", **Elsevier**, 37 (9), w. Place, 2009, p.1453

²⁵⁸ G. Abuselidze and L. Mamaladze, "The impact of artificial intelligence on employment before and during pandemic: A comparative analysis", **Journal of Physics: Conference Series**, w. Place, 2021, p.4

In fact, in the work of Aguiar, it is shown that in the USA, the indexes that show the directions of supply of labor moved to the decline after the impact of information communication technologies, however, most of all - especially the youngsters aged 21-30 years old with less qualification.²⁵⁹ In the years 2000-2015, the share of those who did not work a single hour during the entire previous year grew from 10% to 22%.

In this sense, there is a reason to assert that in these days a significant problem occurred in the labor market and for policymakers besides the labor demand, is the matter labor supply, originated after technologies and innovations.

Early research, dating back to the 1990s, paid attention to the process of how the computer changes as well as the expansion of information technology modified the need for jobs of diverse capabilities. The version of ordinary type, 2 categories of employed were differentiated - low-skilled (people with low level of education) and highly qualified (people with high level of education). Practices illustrate that new innovations are connected to the collection of human capital, as their implementation and utilization needs capable and qualified employees generated through greater official education.²⁶⁰ We can say that technologies (ICTs including) are complementary in relation to highly skilled, but act as substitutes in relation to unskilled labor. This type of technological change has been termed, as we have noted previously, SBTC - skill-biased technological change. SBTC assumes a consistent growth in requirement for qualified and capable employee and a drop in demand for non-skilled employee. As a result of this will occur: development in the system of occupations (in place of “bad” occupations, “good” ones will be introduced); the growth employee efficiency and salaries, for less- and highly-qualified employees; a growth in the pay interval betwixt such categories (i.e, an increase in the “premium” for greater schooling); expansion disparity in labor income.

In fact, as illustrated through the initial work, where the SBTC notion was formulated, in the USA throughout the 1980s. the quantity of highly capable employees

²⁵⁹Mark Aguiar et.al., “Leisure Luxuries and the Labor Supply of Young Men”, w. Place, July 4, 2017, p.1

²⁶⁰ Lawrence F. Katz and David H. Autor, “Changes in the Wage Structure and Earnings Inequality”, Ed. by O. Ashenfelter and D. Card, 3, **Elsevier Science B. V**, w. Place, 1999, p.1534

increased several times per year, however the quantity and the salary rate of low-capable employees have been dramatically declining.²⁶¹ Afterwards, a typical effect was received for different OECD states, with the provision that a low level in the salaries of low-capable employees was seen in states which considered in the group of Anglo-Saxon model, however except the mainland European states.²⁶² Probably, it was happened because of diversities in the organizational types of the labor market. However, the highest switch towards the highly capable employees was observed in organizations and industries greatly impacted via computerization.

But, the sequence of professional responsibilities might differ hugely including those employees who are considered in the same skill category. Such situation was in the system of SBTC, however it began to be the stage of the alternating concept of "technological progress aimed at replacing routine labor" (routine-biased technological change - RBTC).²⁶³

Repetitive labor activities include a given, unvarying, routine character. Repetitive job is primarily typical for professions situated on the average floors of the qualification hierarchy. Professions in the highest deciles of the qualification hierarchy (top managers, professionals, etc.), where you need to have the capability to fix complicated issues, instinct, invention, convincing, etc., lend themselves even worse to codification and programming. It's also important to note that reducing the role of geographic location is a factor of personal demand and supply in the labor market, and, accordingly, a factor that determines the level of the wages.²⁶⁴

²⁶¹ Lawrence F. Katz and Kevin M. Murphy, "Changes in Relative Wages, 1963-1987: Supply and Demand Factors", 107 (1), **The MIT Press**, The Quarterly Journal of Economics, w. Place, February 1992, p.35

²⁶² Daniel Oesch, "Explaining high unemployment among low-skilled workers: Evidence from 21 European and Anglo-Saxon countries, 1991-2006", **Munich Personal RePEc Archive**, Swiss Political Science Association, Switzerland, February 2009, p.24

²⁶³ Rostislav Kapeliushnikov, "The phantom of technological unemployment", **Russian Journal of Economics**, 5, Voprosy Ekonomiki, w. Place, April 2019, p.107

²⁶⁴ Nigel Pain and Isabell Koske, "The Effects of Globalisation on Labour Markets, Productivity and Inflation", **OECD**, June 2007, Paris, p.5

F. Technology and Wage Polarization

In recent decades, there has been an increase in inequality in society in various countries. The debate among economists revolves around the reasons. Innovative instrumentation is emerging to explore in detail the processes that contribute to increasing inequality. One of such processes is “job polarization”, “vanishing middle class”. The polarization of the labor market - the rise in the share of high-paid and low-paid jobs at the expense of middle-wage jobs - has contributed to the rise in income inequality that has occurred in many countries. Sometimes, referred to as the “disappearance of the middle class,” the polarization of the labor market is affecting a wide range of economic policy issues, including employment, education, trade and taxation.

Income inequality has risen sharply in many countries and in the United States since the 1970s²⁶⁵. The United States has seen huge increases in income inequality, but it is not alone in this regard, as many developed countries have experienced some degree of income inequality, even if it is moderate. America, historically, is a country with relatively high levels of inequality, but as the level of inequality remained constant, the standard of living of people increased over the years as the economy grew and the growing economy continued to benefit everyone. The main argument for increasing inequality, as we have mentioned previously, is the growth in demand for skilled labor, directly related to technological change. The difference between the earnings of skilled and unskilled labor is attributed to investment in skilled labor. In the case of inequality in labor income, this inequality includes supply and demand for different qualifications, the state of the education system or the functioning of the labor market, as well as various rules and institutions that affect the determination of wages. Commonly used scales of income inequality combine various phenomena such as inequality in terms of

²⁶⁵ Harry Campbell and Anne Gibson, "Health targets in the NHS: lessons learned from experience with breast feeding targets in Scotland", **Education and debate**, 314, Edinburgh University, Edinburgh, APRIL 1997, p.1039

labor and capital.²⁶⁶ Therefore, it is impossible to distinguish between multiple dimensions of inequality.

Economic growth, globalization and rapid technological change have exacerbated income inequality. While technological development is often seen as the driving force behind economic progress, it has unexpected or unanticipated side effects, such as inequality. The impact of technological development or process of change on income inequality, the impact of technology on inequality levels was also shown in the study of Piketty that gives an evidence that inequality has risen in France in a dramatical rate.²⁶⁷ Between the 1980-2000 years, research provides that Europe's income inequality grew.²⁶⁸

Acemoglu linked the rapid rise in wage inequality in the United States with rising demand for skills faster than supply, skills-oriented technological change, and increased international trade.²⁶⁹ Skill biased technological change means that the productivity of skilled labor is growing faster than that of unskilled labor. This explains the transition between the use of skilled and unskilled labor in favor of skilled. As advances in technology have increased demand, especially for highly skilled workers, the demand for these workers has grown faster when using computers or in more intensive and more innovative R&D sectors. Acemoglu explains why these results have not been obtained in Europe despite similar technological developments, as follows²⁷⁰:

²⁶⁶ Pushan Dut and Devashish Mitra, "Labor versus capital in trade policy: The role of ideology and inequality", **Journal of International Economics**, 69, Elsevier, w. Place, 2006, p.311

²⁶⁷ Thomas Piketty and Emmanuel Saez, "Income Inequality in the United States, 1913-1998", **NBER Working Paper Series**, USA, September 2021, p.33

²⁶⁸ T. Blanchet, L. Chancel and A. Gethin, "Income inequality in Europe, 1980-2017", **World Inequality LAB**, w. Place, April 2019, p.3

²⁶⁹ Daron Acemoglu, "Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality", 113 (4), **The MIT Press**, The Quarterly Journal of Economics, November 1998, pp.1055-1089

²⁷⁰ Hüseyin Özalp, Leyla Firuze Arda Özalp, "Gelir Eşitsizliği Ve Teknoloji: Karşılaştırmalı bir Perspektif", **ASOS Journal**, 5 (59), w.Place, November 2017, p. 343"

- Skills supply grew faster in Europe,
- European wage regulators have prevented the rise in wage inequality (unions, unemployment benefits and the minimum wage have kept the wages of unskilled labor),
- The demand for skills in Europe has grown less than in the US or UK due to technical changes or differences in openness to international trade.

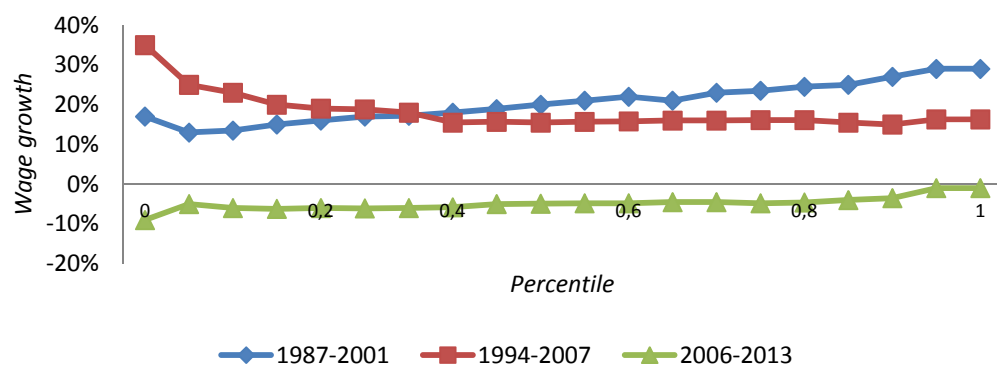


Figure 3.15: Polarization Towards High-paid and Low-paid Jobs Implies Increased Inequality UK (*"Have UK earnings distributions polarised?"*, 2015)

However, the relation regarding polarisation and total inequality is complicated. In a simplistic situation where job division is solely motivated by demand (for instance, as a consequence of automation replacing middle-skilled employees), polarization in wage growth is also likely to occur, as salaries in low-skilled and high-skilled jobs appear to rise at a faster rate than salaries in middle-skilled positions. This is exactly what was witnessed in the 1990s in the US, when lower scale inequality reduced and inequality grew in the upper scale.²⁷¹

²⁷¹ Ioannis Kaplanis, "The Geography of Employment Polarisation in Britain", **Conference Paper**, Econstor, ZBW, 46th Congress of the European Regional Science Association, Volos, 2006, p.4

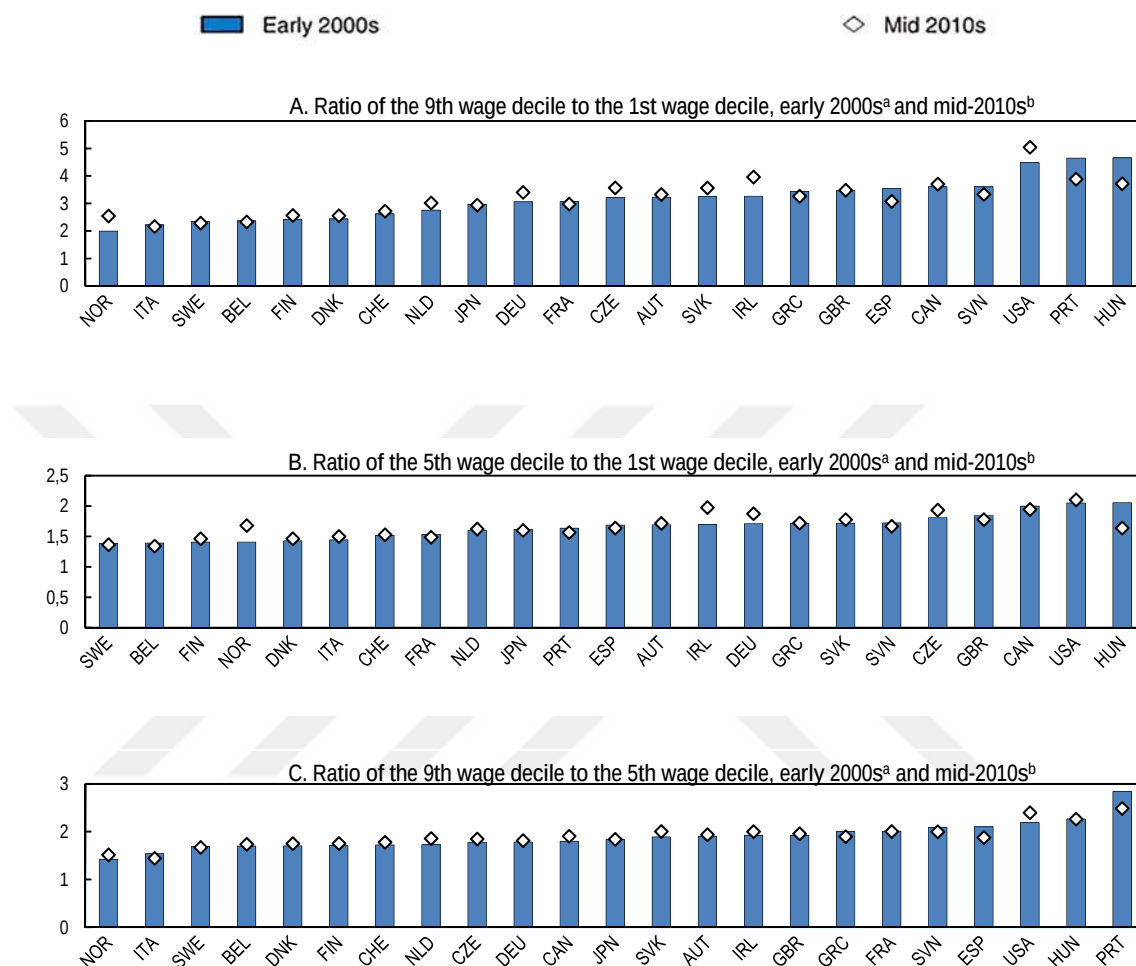


Figure 3.16: Inequality is Growing, Especially at the High Point. Note: The Earning Data Used in the Equations Refers to the Gross Wages of Employees (“*OECD Employment Outlook 2017*”, 2017)

In answering the particular puzzle, the researcher points out that wage growth in lower positions can be hampered by the fact that, considering their low ability requirements, these areas typically do not benefit from substantial complementarities of emerging technology while still experiencing a very elastic supply of labor. In professions that require special thinking abilities, efficiency is usually enhanced by new ICTs. As for middle-skill positions, the researcher focuses that complementarity and replacement may coexist. So, while machines can substitute some employees in the

performance of repetitive activities, they may supplement those who continue in these positions, thus improving their efficiency and, potentially, their salary development.

G. The Impact of RBTC on Wage Polarization

During the first decade of the twenty-first century, a modification of the Skills-Biased Technical Change (SBTC) statement was introduced under the tag "Routine-Biased Technical Change" responding to empirical observations of polarizing.²⁷² The essence of the theory is that the proportion of routine activities (and occupations), rather than the skills, defines their substitutability by machines and modern equipment. Three main predictions follow from the RBTC (routine-biased technological change - RBTC) concept:

Initially, in the total multiplicity of activities fixed by employees, one must be in the expectation of a switch out of repetitive tasks (doesn't matter manual or cognitive) towards non-repetitive ones, as the execution of the previous one is growingly taken up by innovations. Experiential confirmation of the trend towards a decrease in the proportion of repetitive activities was received for the Japan, mainland states and for Anglo-Saxon economies.^{273 274 275}

Second, the RBTC will result in structural polarisation of employment. In the average category of the professional scale, we can observe a dip, however the increase in employment will happen at the top and bottom of the scale, where, on the one hand, the "worst" (least paid) jobs are concentrated, and, on the other hand, the "best" (highly paid) occupations. The typical dimensions have been recorded for several other

²⁷² Enrique Fernandez and John Hurley, "Routine-biased technical change and job polarization in Europe", **Socio-Economic Review**, Dublin, 2016, p.2

²⁷³ John Hawksworthp, Richard Berriman and Euan Cameron, "Will robots really steal our jobs?" **PricewaterhouseCoopers**, UK, 2018, p.3

²⁷⁴ Maarten Goos, Alan Manning and Anna Salomons, "Recent Changes in the European Employment Structure: The Roles of Technology and Globalization", w. Place, September 2009, p.1

²⁷⁵ Nir Jaimovich and Henry E. Siu, "Job Polarization and Jobless Recoveries", **NBER Working Paper Series**, National Bureau of Economic Research, Massachusetts, 2012, p.25

developed states. In the long term, robotization through growth in employee efficiency will be a cause to a growth in income for each individual.²⁷⁶

Third, there's an impact of RBTC, besides the employment level, on the wage rates of employees, resulting in polarisation of salaries. It means that the increase of salaries at the top and bottom of the allocation scale much outpace its increasing rate in the average of the scale. It's considered to be rational, since by declining the need for mid-skilled employees, RBTC must be a cause for the drop in their salaries.

Professionals of the highest level are constantly in demand, but not all companies can pay for their workers. Therefore, more and more firms are investing in training their own employees, increasing the number of lower-level specialists, identifying candidates who are able to grow into highly qualified specialists.

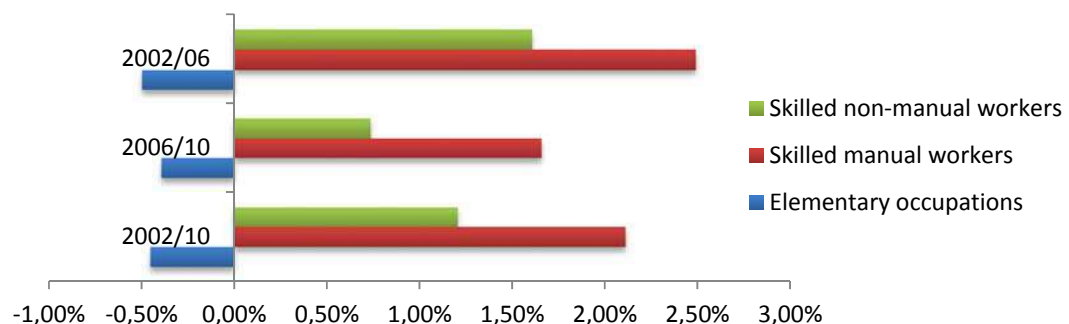


Figure 3.17: The Modifications in the Yearly Mean of Hourly Salaries for 3 Various Occupation Categories (*EUROSTAT, Labour Force Survey, 2018*)

The graph represents there is an inequality between the various occupational groups, and this tendency illustrates yearly average shift in hourly earnings between 2002/06, 2006/10 and the whole intervals 2002 to 2010 for three broad occupations in the business world. Wage dispersion is apparent, with net declines of about 0.5 percent each year for elementary occupations and wage rises for skilled manual and non-manual employees, so that, relative to the average worker, eligible manual workers (e.g. plant

²⁷⁶ Oded Galor and David N Wei, "From Malthusian Stagnation to Modern Growth", **Discussion Paper**, CEPR, London, February 1999, p.5

and equipment operators, craft workers) had a favorable wage development. This can be seen as an indicator of skilled-biased technical transition in the labor markets of Europe.

This kind of various innovations might impact various categories of repetitive professions differently. If computerization in the majority proportions facilitates to the withering away of repetitive cognitive activities, the robotization withering away the physical activities. Consequently, the modifications they introduce in the mechanism of employment are not inevitably match. As a result, in a quantity of works there is a debate that robotization, in contrast to computerization, drives to a drop in requirement for less- and a growth in requirement for highly capable employee, if repetitive tasks are more dense at the bottom of the skills scale, their substitution by computers will just be a representation of routine-biased technological transition.²⁷⁷

H. High-tech Industries of US

High-tech sectors are important to the economy as they account for a significant portion of overall production, employ a huge number of skilled employees, and pay higher salaries to all categories of workers. High-tech sectors can be described in a number of ways, and these concepts can have an effect on studies. The 27 high-tech sectors are listed in the table below. 13 of them are sectors that produce goods that have larger numbers of engineers, and 14 of them are service sectors, that have larger numbers of technology and mathematical workers.

Table 3.4: Employment and Output in High-tech Sectors, 2016 (*“High-tech industries: an analysis of employment, wages, and output”, 2018*)

Industries	Feature	The Rate of Employed (thousands)	Production/Service (billions)
Oil & gas	Production	180.0	\$257.3
Production of compound elements	Production	147.8	\$270.7
Production of medicine	Production	287.0	\$239.1

²⁷⁷ F. Enrique and J. Hurley, Ibid., p.13

Production of sectoral equipment	Production	113.6	\$31.8
Production of business equipment and cameras	Production	89.9	\$25.0
Production of computers and complementary equipment (without cameras)	Production	164.1	\$37.0
Production of interactive technologies	Production	85.6	\$52.6
Production of recorders and videorecorders	Production	19.9	\$3.9
Production of microcircuits and electronics	Production	367.0	\$115.0
Production of estimators, conductors and monitoring instruments	Production	396.1	\$177.7
Production of CD equipments	Production	15.4	\$3.7
Production of technologies for electricity	Production	139.3	\$39.2
Production of space rockets and its complementaries	Production	489.0	\$266.5
Production of a physical channel as a transport	Production	49.5	\$33.5
Operating system supply	Non-production	355.6	\$219.9
Telegraph / telephone operators	Non-production	588.5	\$366.3
Unwire Telegraph / telephone operators	Non-production	120.9	\$265.9
Orbital communication and other methods	Non-production	85.3	\$42.0
Data analyzing and linked services	Non-production	299.6	\$129.5
Extra data services	Non-production	259.3	\$95.5

Sculpting, mechanic, engineering and linkedin services	Non-production	1,410.8	\$282.6
Making of internal computers and linked services	Non-production	1,990.7	\$355.8
Organization, knowledge-based and innovational advice service	Non-production	1,372.5	\$318.2
R&D services	Non-production	682.1	\$219.1
Administration of organizations and firms	Non-production	2,240.7	\$635.5
Government issues without post office	Non-production	2,186.1	\$454.9
Electricity allocation	Non-production	393.6	\$320.7

The median wage within high-tech sectors is greater than in non-high-tech sectors, and high-tech companies pay employees of all types. Majority of people engaged in the profession of sales in the high-tech industries are becoming project / organizational manager or through the interaction with technologies are becoming e-commerce or program-base sellers. However, the same occupation in the low-tech industries are not more than cashiers or traditional sellers with weaker educational and training standards and, as a result, lower salaries.

Table 3.5: Median Salary and Employment Distribution by High-tech Status, 2016
(“High-tech industries: an analysis of employment, wages, and output”, 2018)

Occupation title	The rate of employed		The Middle annual wage		High-tech salary bonus (percent distinction from non-hi-technological)
	Hi-technological sectors (percent)	Non-hi-technological sectors (percent)	Hi-technological sectors	Non-hi-technological sectors	
Summary, all jobs	100	100	\$70,230	\$34,800	101.8
Administrative / managerial	11.2	4.6	\$131,410	\$92,220	42.5

Commerce and financial activities	15.2	4.1	\$76,550	\$62,580	22.3
Numerical and Math	17.5	1.3	\$89,450	\$74,150	20.6
Sculptural and mechanical	11.2	0.7	\$81,900	\$71,640	14.3
Human, material and sociology	3.9	0.5	\$70,400	\$59,100	19.1
Society and public service	0.3	1.9	\$59,350	\$42,740	38.9
Legislative	0.9	0.7	\$115,600	\$76,010	52.1
Schooling, teaching and library	0.5	7.0	\$57,360	\$47,950	19.6
Creativity, decoration, sportive and mass communication	1.6	1.4	\$65,080	\$44,780	45.3
Medical workrs and technological	2.2	6.2	\$75,250	\$63,040	19.4
Medical assistance	0.3	3.1	\$38,700	\$27,800	39.2
Guard security	1.3	2.5	\$51,460	\$37,720	36.4
Kitchener and related occupations	0.2	9.9	\$32,970	\$20,810	58.4
Cleaning and assisting fields	0.4	3.7	\$30,000	\$24,640	21.8
Personal interest and maintenance	0.1	4.1	\$29,520	\$22,690	30.1
Trading and related occupations	4.4	10.5	\$64,690	\$25,710	151.6
Department & managerial	14.4	15.7	\$40,490	\$33,410	21.2

maintenance					
Agriculture, fishing and silviculture	0.1	0.8	\$39,050	\$23,390	67.0
Building and mining	1.1	4.1	\$55,690	\$43,210	28.9
Fixing, assistance and renovation	4.6	3.7	\$59,320	\$41,550	42.8
Manufacturing	6.8	6.2	\$40,920	\$32,260	26.8
Cargo, transport and shifting	1.6	7.3	\$39,890	\$30,570	30.5

In 2016, high-tech companies hired 14.5 million workers, accounting for 9.9% of overall wage and salary of professions in the graph above. From 1996 to 2016, the percentage of people employed in hi-technological sectors increased slightly and doesn't change a lot. The effect of two financial crises, (2001) and (2008), was significant throughout that period. During the first crisis, the high-tech workers dropped for a certain percent, in terms of jobs and wage rate.²⁷⁸ The dot-com crisis struck the high-tech industry more compared to the different groups of mart.²⁷⁹ While the hi-technological industry couldn't restore the rate of employed rates achieved in 2000 till 2013, non-high-tech sectors had stabilized by 2004 from loss of jobs experienced at the time of the first crisis. However, in the time of the second crisis, though, we can see an effect of reverse pattern: hi-technological industries could survive in this period much more successfully compared to the other groups in the market. Furthermore, the regaining of the lost occupations by hi-technological industries was archived by the

²⁷⁸ Brian Roberts and Michael Wolf, "High-tech industries: an analysis of employment, wages, and output", 7 (7), **Beyond The Numbers**, U.S. Bureau of labor statistics, USA, May 2018, p.5

²⁷⁹ Sean Oriain, "High-tech communities: better work or just more work?", **Contexts fall/winter**, w. Place, 2002, p.36

2011, while the regaining of the lost jobs in the non-hi-technological sectors was completed only by the 2014.²⁸⁰

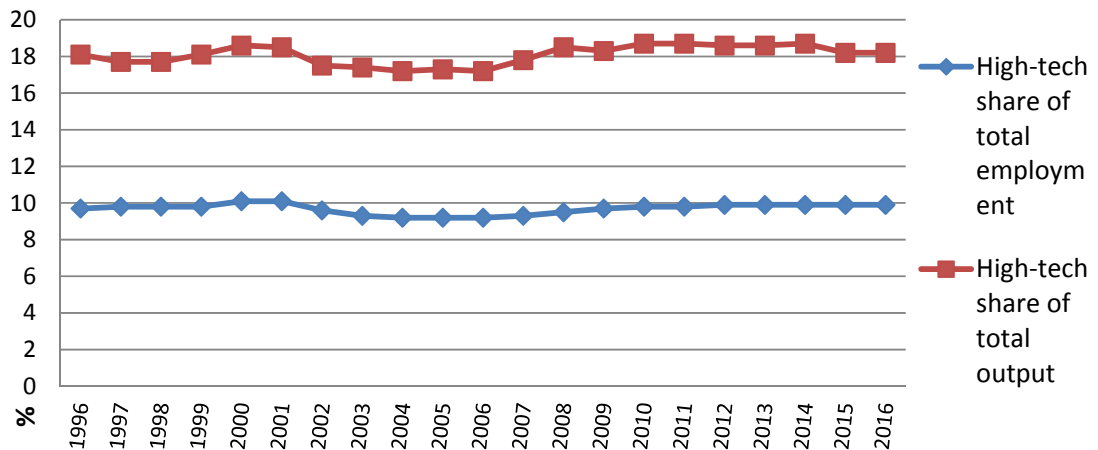
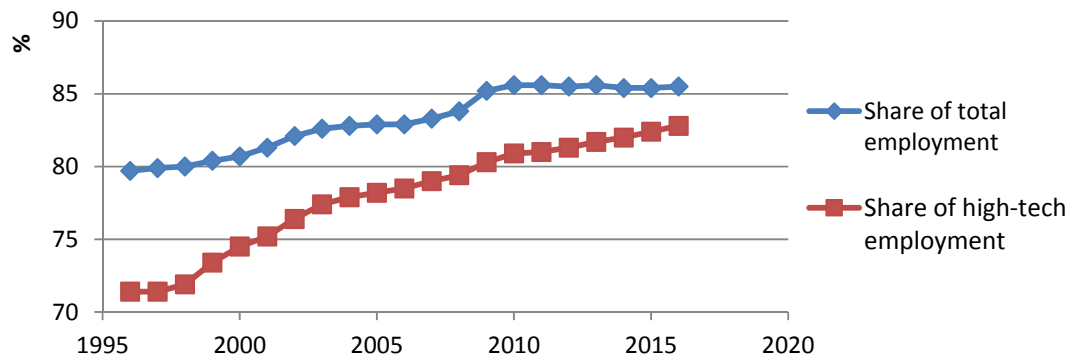


Figure 3.18: The Employment and Overall Productivity of the Economy in High-tech Sectors (*“High-tech industries: an analysis of employment, wages, and output”*, 2018)

The transition of high-tech to service sectors. In 2016, service-providing sectors employed 82.8% of high-tech workers, the all-time high, and goods-producing sectors employed 17.2 percent. For several years, jobs in high-tech sectors, like the society as a whole, has been moving towards service sectors. This workforce pattern (with service-providing businesses) is expected to account for 85.0 % of high-tech jobs in 2026. In 2016, the share of production from service-providing sectors hit an all-time peak, contributing for 71.1 % of the high-tech performance.



²⁸⁰ B. Roberts and M. Wolf, Ibid, p.6

Figure 3.19: Work Share of Service-providing High-tech Sectors from 1996 to 2016
(“U.S. Bureau of Labor Statistics”, 2021)

Throughout a decade after 2016, efficiency in hi-technological manufacturing sectors is expected to rise 34.3%, while efficiency in non-hi-technological manufacturing sectors is expected to rise just 18.6%.

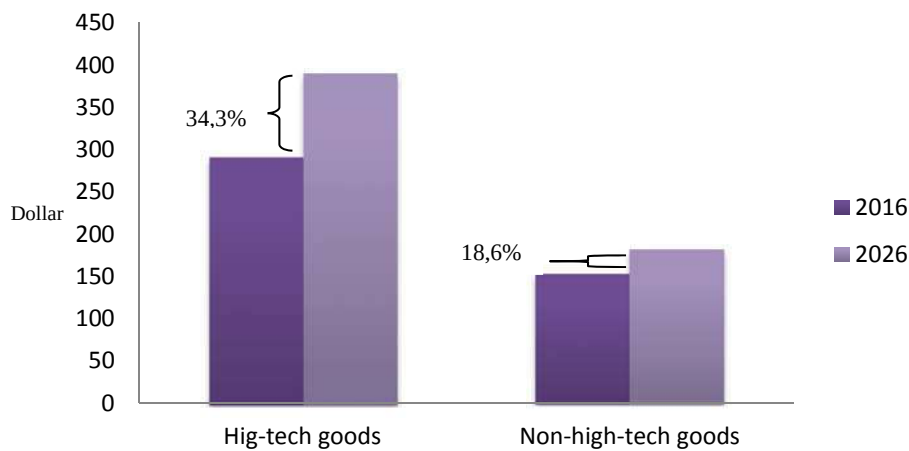


Figure 3.20: Wage and Salary Efficiency through High-tech Classification in Goods-producing Sectors (*“U.S. Bureau of Labor Statistics”, 2021*)

The similar tendency is predicted for service sectors, where throughout a decade after 2016, the efficiency in hi-technological service sectors is expected to rise 26.6%, while efficiency in non-hi-technological service sectors is expected to rise just 24.9%.

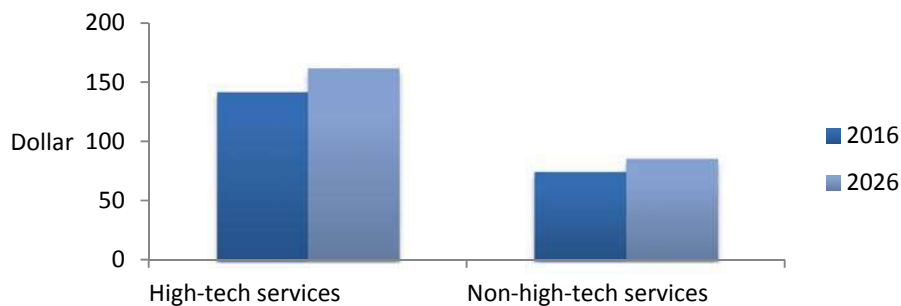


Figure 3.21: Wage and Salary Efficiency through High-tech Classification in Service-producing Sectors (*“U.S. Bureau of Labor Statistics”, 2021*)

Hi-technological companies considered as a vital fraction of the American system of economics, accounting for nearly 10% out of the whole employment and generating greater than 18% out of the total production for 2016 (Figure 3.7). Wages in high-tech sectors are greater for almost any form of occupation, indicating the higher production per worker. Through 2026, high-tech sectors are expected to expand their percentage of overall production while retaining their job share; throughout the next decade (from 2016), jobs in the hi-technological industry is expected to begin to transition into non-manufacturing service sectors, increasing from 82.8 % to 85.0 % in 2026.²⁸¹

The share of the service sector in future service economies or non-industrial societies will be larger than it is today. The reason for the growth in the fraction of service-providing sector will be the trend towards “information production and processing”. The future economy will be an environment in which "services are produced by services."

As Frederick W. Taylor said, "In the past, man came first, in the future, the system will come first."²⁸² No matter how low the wages for labor are, each technology has a workforce that it can handle. In other words, it is the technology that determines the demand for labor.

²⁸¹ Brian Roberts and Michael Wolf, “High-tech industries: an analysis of employment, wages, and output”, 7 (7), Beyond the numbers, **U.S. Bureau of labor statistics**, USA, May 2018, p.10

²⁸² Frederick W. Taylor, "The Principles of Scientific Management 1911", w. Place, w. Date, p.2

PART FOUR

AN EMPIRICAL ANALYSIS OF EMPLOYMENT AND WAGES: US AND TURKEY CASES & US TEXTILE INDUSTRY

In this section we analyze the impact of technology and people with higher education on employment and wages, using the model of VAR. Vector Autoregressive Model is determined through the present and fractionally via the past indexes of the elements. Standard operation in VAR examination is to present the output from Granger-causality analyses, the illustration of impulse-response function, and the determination of decompositions of variance. Since the complicated flow exists within the VAR, these insights are more comprehensive than the evaluated VAR analyses indexes or R-square measurements, which usually go uncited.²⁸³ So, we shall follow the Standard operative system.

The essentiality of VAR application method was recognized and made well-known by Sims.²⁸⁴ This mechanism is accepted as an augmented improvement of the AR system. The VAR approach is highly applicable for illustrating the modified dynamics of macro variables and appropriate to make predictions.²⁸⁵ Before proceeding to our analysis, we present some literature reviews.

This model is widely applied in the field of labor market. Looking at the literature, we can witness the works in the framework of VAR model, such as the research of Peter Summers (2000), where was examined the variations of aggregate job creations and estimation of the linkage among the variables like real wages and unemployment in the OECD states.²⁸⁶ The result concluded that those directions are

²⁸³ James H. Stock and Mark W. Watson, "Vector Autoregressions", 15 (4), **Journal of Economic Perspectivity**, W. Place, 2001, p.104

²⁸⁴ Lawrence J. Christiano, "Christopher A. Sims and Vector Autoregressions", 114 (4), **The Scandinavian Journal of Economics**, Blackwell Publishing, USA, 2012, p.1082

²⁸⁵ Eric Zivot and Jian Wang, "Vector Autoregressive Models for Multivariate Time Series", **Opaque this**, W. Place, W. Date, p.383

²⁸⁶ Peter Summers, "Labour Market Analysis with VAR Models", **Melbourne Institute Working Paper No. 19/00**, Melbourne Institute of Applied Economic and Social Research, Australia, September 2000, pp.2-17

elastic, and enable of applying a big diversity of theoretic and cases related to the policies. In the research of Juan J. Dolado, Gergö Motyovszki and Evi Pappa (2018), where was used the structural VAR model (SVAR), with the variables: manufacturing production, unemployment level, the skill/unskilled index, the comparative employment rate, the inflation in terms of price, and the rate of federal funds.²⁸⁷ They concluded that the estimation of existed inequality, in the market of labour, increases together during the period when monetary policy occurs to be weaker. According to Haroon Mumtaz and Francesco Zanetti (2015), who analyzed the technological improvement, the rate of unemployment, and the GDP indicators, based on estimated VAR, came to the conclusion that the volatility of job finding and job destruction trends has decreased throughout the period.²⁸⁸ However, the research of Murat Sadikua, Alit Ibrahim and Luljeta Sadiku (2015), where was used the economic growth and unemployment rate indexes of Macedonia, based on VAR model and Engel-Granger cointegration test, was concluded that there is no a causal relationship between those 2 variables and the increasing rate of GDP doesn't lead to a growth or decline in the unemployment rate and vice-versa.²⁸⁹ According to the Thorarinn Petursson and Torsten Slok's work (2001), in which was estimated the concept of Cointegrated VAR by using the quarterly data of Denmark.²⁹⁰ Through the evaluation, they came to the conclusion that the essential reason of upward rate of unemployment is the rigidity of real wages. The similar analyses were illustrated by the Karine Raoufina (2016) through using the Bayesian VAR models.²⁹¹ She estimated the indexes in the framework of two variables:

²⁸⁷ Juan J. Dolado, Gergö Motyovszki and Evi Pappa, "Monetary Policy and Inequality under Labor Market Frictions and Capital-Skill Complementarity", **Discussion Paper Series**, IZA – Institute of Labor Economics, Deutsche Post Foundation, Bonn, April 2018, pp.4-37

²⁸⁸ Haroon Mumtaz and Francesco Zanetti, "Labor Market Dynamics: A Time-Varying Analysis", **Oxford Bulletin of Economics and Statistics**, The Department of Economics, University of Oxford and John Wiley & Sons Ltd, W. Place, January 2015, pp.319-337

²⁸⁹ Murat Sadikua, Alit Ibrahim and Luljeta Sadiku, "Econometric Estimation of the Relationship between Unemployment Rate and Economic Growth of FYR of Macedonia", 19, **Elsevier, ScienceDirect, Procedia Economics and Finance**, Kavala, 2015, p.69

²⁹⁰ Thorarinn Petursson and Torsten Slok, "Wage formation and employment in a cointegrated VAR model", 4, **Econometrics Journal, Royal Economic Society**, USA, September 2001, pp.191-207

²⁹¹ Karine Raoufina, "Forecasting Employment Growth in Sweden Using a Bayesian VAR Model", **Working Paper No 144**, National Institute of Economic Research, KI, Stockholm, June 2016, pp.3-11

employment and GDP growth in Sweden, and could get strong evidences in the business and predicted the sales in the trade sectors. In the research of Silvia Fabiani and Diego Rodriguez-Palenzuela (2001), we can observe the Structural VAR Model evaluating the unemployment, real wages and output dynamics for 13 OECD countries.²⁹² They completed their works by indicating that the 15 tools impacting the conditions of temporary workers, existed in the OECD states in 1990s.

In addition to the analysis of the manufacturing and service sectors in the United States and Turkey, we have estimated the US textile industry, to check whether the impact of technology leads the high-skilled and low-skilled employment and wages to the polarization or not. The textile sector in the United States is spending at an unprecedented rate in innovative technology. Textile manufacturing productivity increased at double the rate of overall output growth in more than a decade.²⁹³ As a result of the transition to technological production caused by capital expenditure, the number of workers in the American textile industry has changed. In order to testify the empirical results, we can find the literature where Elena Karpova and Nancy Nelson Hodges evaluate the influence of modifications in the textile sector in the United States on employment framework from 1997 to 2003, where the total number of people employed has dropped by nearly half.²⁹⁴ Furthermore, another work that supports the same conclusion is the study of Anusua Datta and Susan Christoffersen, in which the textile and clothing sectors' total proportion of manufacturing employment fell from 12.1 percent in the 1970s to 8.1 percent in the 1990s.²⁹⁵ The similar results was seen in the research of Robert Woodard, where during 1990-2002 years, the workforce in textile

²⁹² Silvia Fabiani and Diego Rodriguez-Palenzuela, "Model-based indicators of labour market rigidity", **Working Paper No. 57**, European Central Bank, Germany, April 2001, pp.5-22

²⁹³ Lionel S. Johns and Henry Kelly, **The U.S. Textile and Apparel Industry: A Revolution in Progress**, U.S. Government Printing Office, USA, April 1987, p.3

²⁹⁴ Elena Karpova and Nancy Nelson Hodges, "Employment in the US textile and apparel industries: A comparative analysis of regional vs national trends", **Emerald Group Publishing Limited**, Journal of Fashion Marketing and Management, w. Place, April 2006, p.209

²⁹⁵ Anusua Datta and Susan Christoffersen, "Production Costs, Scale Economies and Technical Change in U.S. Textile and Apparel Industries", **Philadelphia University**, USA, w. Date, p.2

mills fell by 40.4%, from 491,800 to 293,200.²⁹⁶ According to the analyses of Cristiano Perugini and Fabrizio Pompei, in 14 EU states, this article presents empirical model of the relationship between technical change and total income inequality. The effect of SBTC on income dispersion: in the first duration, technological advances increase skilled labor demand, which is not encountered by the same supply, resulting wage inequality to expand; afterward, the supply level may reach and stich in the pace with demand, allowing growing demand for skilled labor to be consistent with steady wage inequality.²⁹⁷

In the work of Hernando Zuletaa and Andrew T. Young, the model takes into consideration a number of characteristics of the US economic system, including the fact that in the manufacturing sectors, the grows of more capital-intensiveness is notable and that the labour proportion of manufacturing declines at the sectoral degree. As there is a wage growth, the industrialization process encourages manufacturing enterprises to implement labor-saving advances. As a result, more workers are flowing into service industries.²⁹⁸

In the other research written by the Mark P. Moore and Priya Ranjan, pointed out that although there is a proof about the fact that globalisation as well as SBTC become a cause to the growth in salary disparity, we are presenting that such growing elements might illustrate various effects on the level of unemployed. In case of when the fulfillment betwixt skilled and uncapable employee are powerful, the SBTC decreases the level of unemployed in skilled as well as in uncapable employee categories. Globalisation, from the different side, brings to the decline in the rate of unemployed for

²⁹⁶ Robert Woodard, "U.S. Textile and Apparel Industries", **Bureau of Indian Standards**, September 2011, p.51

²⁹⁷ Cristiano Perugini and Fabrizio Pompei, "Technological change and income distribution in Europe", **Journal compilation**, 148 (1-2), International Labour Organization, w. Place, 2009, pp.123-144

²⁹⁸ Hernando Zuletaa and Andrew T. Young, "Labor shares in a model of induced innovation", **Structural Change and Economic Dynamics**, 24, Elsevier B.V., w. Place, 2013, pp.112-120

the skilled industry however rises it for the industry consisting of incapable employee.²⁹⁹

An empirical analysis of the Mariacristina Piva and Marco Vivarelli is presented, with data collected spanning the manufacturing and service industries for Eleven European states from 1998 to 2011. The following are the two most important outcomes: (1) R&D expenses (mainly associated with product innovation) have a notable labor-friendly effect (in the medium and high-tech industries), whereas there is no detected impact in low-tech sectors; (2) On the one hand, process innovations seems to be a labor-saving, on the other hand, have the potential to compensate for the previous layoffs by lowering cost-price and growth in demand-output.³⁰⁰

David H. Autor et.al shows that the wage disparity in the upper line of the allocation has been on an uncontrolled and rather steady secular climb over the twenty-five years in the history of the US wage system, beginning from 1980. Throughout 1979-1987 years, wage disparity in the bottom line of the allocation rose considerably as well. These tendencies are referred to as the "polarization" of a US employment, in which the system of work is polarized between high-wage and low-wage occupations. They illustrate how a computer technology model can help high-wage workers with non-routine (creative) cognitive activities.³⁰¹

Another study reveals a strong, if tiny, positive association between innovations and employment, based on long-term data of 318 Italian manufacturing enterprises from 1992 to 1997.³⁰² According to the Brad Botwin, between 2012-2016 years, total capital

²⁹⁹ Mark P. Moore and Priya Ranjan, "Globalisation vs Skill-Biased Technological Change: Implications for Unemployment and Wage Inequality" **The Economic Journal**, 115 (503), Wiley, JStor, Malden, April 2005, pp.391-414

³⁰⁰ Mariacristina Piva and Marco Vivarelli, "Technological change and employment: is Europe ready for the challenge?", **Eurasia Business and Economics Society**, Springer, CrossMark, Ebess, w. Place, 2018, pp.1-15

³⁰¹ David H. Autor, Lawrence F. Katz and Melissa S. Kearney, "The Polarization of the U.S. Labor Market", **NBER Working Paper Series**, National Bureau of Economic Research, Cambridge, January 2006, p.1

³⁰² Mariacristina Piva and Marco Vivarelli, "Technological change and employment: some micro evidence from Italy", **Applied Economics Letters**, 11, North West University, Routledge, Taylor & Francis Ltd, w. Place, 2004, p.376

expenditures in the U.S. Textile and Apparel Industry, increased by 90%, from \$1.6 billion to \$3.1 billion.³⁰³

4.1. Data and Methodology

This part of the thesis consists of an empirical analysis of the impact of technology and the number of people with higher education on employment and average earnings in two sectors by evaluating two countries through developing a vector autoregression (VAR) model, as well as the examination of the impact of technologies on textile industry of US via implementing the regression analyses. In the first model, we shall introduce 14 variables and create 8 combinations, by using 61 observations for each of them in a bimonthly interval, which will cover a decade from 2008-2018. All calculations are carried out by Eviews. The data applied in the model were collected from: The World Bank, OECD Statistics, FRED, Trading Economics, CEIC, Döviz724. In addition, for some variables, in order to determine the real change in dynamics, the missing periods were calculated from similar additions that occurred in previous or subsequent years. Moreover, a variable representing R&D spending is shown to be a proxy for technological change.

In the second model, we analyze the impact of technologies on textile industry of US. The aim of this section is to estimate the impact of technology on low-skilled and high-skilled employment and wage rates using 15 observations, taken from U.S. Bureau of Labor Statistics, that are based on annual rate changes observed from 2001 to 2015 in the textile industry of US. All calculations are carried out by Eviews.

³⁰³ Brad Botwin, **Defense Industrial Base Assessment of the U.S. Textile and Apparel Industry**, U.S. Department of Commerce Bureau of Industry and Security Office of Technology Evaluation, w. Place, 2017, P.13

Table 4.1: The List of Variables Applied in the Model (1)

Number	Varibales	Model Version
1	Employment in the Manufacturing Sector of USA	EMPMANUS
2	Employment in the Manufacturing Sector of Turkey	EMPMANTR
3	Employment in the Service Sector of USA	EMPSRVUS
4	Employment in the Service Sector of Turkey	EMPSRVTR
5	Average Earnings in the Manufacturing Sector of USA	WGMANUS
6	Average Earnings in the Manufacturing Sector of Turkey	WGMANTR
7	Average Earnings in the Service Sector of USA	WGSRVUS
8	Average Earnings in the Service Sector of Turkey	WGSRVTR
9	R&D Expenditures in the Manufacturing Sector of USA	RDMANUS
10	R&D Expenditures in the Manufacturing Sector of Turkey	RDMANTR
11	R&D Expenditures in the Service Sector of USA	RDSRVUS
12	R&D Expenditures in the Service Sector of Turkey	RDSRVTR
13	The Number of People with Tertiary Education in USA	EDCUS
14	The Number of People with Tertiary Education in Turkey	EDCTR

For the purpose to know if the connection betwixt the elements subsist or not, we are requesting the Johansen cointegration test. For the purpose to perceive the progress of dependant element as a response to the change existed in the independent elements, we are testing the impulse response function. For the purpose to examine if one of the elements is able to lead another index, we are testing the Granger causality test, as well as for the purpose to know to what extent the elements' explanatory power is able to illustrate a progress on the other variables, we are testing the variance decomposition system.

The concept of VAR model:

$$Y_t = A_1 + B_{11}Y_{t-1} + B_{12}X_{t-1} + U_t$$

$$X_t = A_2 + B_{21}Y_{t-1} + B_{22}X_{t-1} + V_t$$

Matrix Representation:

$$\begin{bmatrix} Y_t \\ X_t \end{bmatrix} = \begin{bmatrix} A_1 \\ A_2 \end{bmatrix} + \begin{bmatrix} B_{11} & B_{12} \\ B_{21} & B_{22} \end{bmatrix} \begin{bmatrix} Y_{t-1} \\ X_{t-1} \end{bmatrix} + \begin{bmatrix} U_t \\ V_t \end{bmatrix}$$

Where ‘A’ – Constant Term; ‘ Y_t ’ – A variable; ‘ Y_{t-1} ’ – Lagged values of the variable Y_t ; ‘ X_{t-1} ’ - Lagged values of the variable X_t ; ‘ U_t ’ – Error term (innovations or shock terms).

Our model consists of 8 combinations of equations, where we determine the possible dynamics of employment in the manufacturing and services sectors, as well as the existing fluctuations in average wages in the same industries, affected by R&D spending (namely technology and innovation) and people with tertiary level of education (namely high-skilled workers), applicable to the US and Turkey, within developed and developing countries.

The formulated representation of variables:

$$\begin{aligned}
 X_{1(t)}^{\text{EMPUSAMAN}} &= a_1 + \sum_{k=i}^{k=i} b_{11} X_{1(t-k)}^{\text{EMPUSAMAN}} + \sum_{m=f}^{m=f} b_{12} Y_{1(t-m)}^{\text{RDUSAMAN}} + \sum_{p=g}^{p=g} b_{13} Z_{1(t-p)}^{\text{EDCUSA}} + u_{1(t)} \\
 X_{2(t)}^{\text{EMPTRMAN}} &= a_2 + \sum_{k=i}^{k=i} b_{21} X_{2(t-k)}^{\text{EMPTRMAN}} + \sum_{m=f}^{m=f} b_{22} Y_{2(t-m)}^{\text{RDTRMAN}} + \sum_{p=g}^{p=g} b_{23} Z_{2(t-p)}^{\text{EDCTR}} + u_{2(t)} \\
 X_{3(t)}^{\text{EMPUSASRV}} &= a_3 + \sum_{k=i}^{k=i} b_{31} X_{1(t-k)}^{\text{EMPUSASRV}} + \sum_{m=f}^{m=f} b_{32} Y_{1(t-m)}^{\text{RDUSASRV}} + \sum_{p=g}^{p=g} b_{33} Z_{1(t-p)}^{\text{EDCUSA}} + u_{3(t)} \\
 X_{4(t)}^{\text{EMPTRSRV}} &= a_4 + \sum_{k=i}^{k=i} b_{41} X_{1(t-k)}^{\text{EMPTRSRV}} + \sum_{m=f}^{m=f} b_{42} Y_{1(t-m)}^{\text{RDTRSRV}} + \sum_{p=g}^{p=g} b_{43} Z_{1(t-p)}^{\text{EDCTR}} + u_{1(t)} \\
 S_{1(t)}^{\text{WGUSAMAN}} &= c_1 + \sum_{k=i}^{k=i} b_{11} S_{1(t-k)}^{\text{WGPUSAMAN}} + \sum_{m=f}^{m=f} b_{12} Y_{1(t-m)}^{\text{RDUSAMAN}} + \sum_{p=n}^{p=n} b_{13} Z_{1(t-p)}^{\text{EDCUSA}} + e_{1(t)} \\
 S_{2(t)}^{\text{WGTRMAN}} &= c_2 + \sum_{k=i}^{k=i} b_{21} S_{2(t-k)}^{\text{WGPTRMAN}} + \sum_{m=f}^{m=f} b_{22} Y_{2(t-m)}^{\text{RDTRMAN}} + \sum_{p=g}^{p=g} b_{23} Z_{2(t-p)}^{\text{EDCTR}} + e_{2(t)} \\
 S_{3(t)}^{\text{WGUSASRV}} &= c_3 + \sum_{k=i}^{k=i} b_{31} S_{3(t-k)}^{\text{WGPUSASRV}} + \sum_{m=f}^{m=f} b_{32} Y_{1(t-m)}^{\text{RDUSASRV}} + \sum_{p=g}^{p=g} b_{33} Z_{1(t-p)}^{\text{EDCUSA}} + e_{3(t)} \\
 S_{4(t)}^{\text{WGTRSRV}} &= c_4 + \sum_{k=i}^{k=i} b_{41} S_{1(t-k)}^{\text{WGPTRSRV}} + \sum_{m=f}^{m=f} b_{42} Y_{1(t-m)}^{\text{RDTRMAN}} + \sum_{p=g}^{p=g} b_{43} Z_{1(t-p)}^{\text{EDCTR}} + e_{4(t)}
 \end{aligned}$$

4.1.1. Unit Root Test

Table 4.2: Kwiatkowski–Phillips–Schmidt–Shin Unit Root Test (1) (“Own Calculations”)

		Asympotic Crit.v	LM-Stat
lnempmanus	level	0.739000	0.613981
	1st difference	0.739000	0.470981*
lnempmantr	level	0.739000	0.927763
	1st difference	0.739000	0.093333*
lnempsrvus	level	0.739000	0.972385
	1st difference	0.739000	0.552345*
lnempsrvtr	level	0.739000	0.936851
	1st difference	0.739000	0.395137*
lnrdmanus	level	0.739000	0.943557
	1st difference	0.739000	0.635368*
lnrdmantr	level	0.216000	0.231989
	1st difference	0.216000	0.068759*
lnrdsrvus	level	0.216000	0.241215
	1st difference	0.216000	0.057661*
lnrdsrvtr	level	0.739000	0.975291
	1st difference	0.739000	0.417137*
lnwgmanus	level	0.739000	0.975518
	1st difference	0.739000	0.178731*
lnwgmantr	level	0.739000	0.960438
	1st difference	0.739000	0.578268*
lnwgsrvus	level	0.739000	0.984345
	1st difference	0.739000	0.229456*
lnwgsrvtr	level	0.739000	0.965814
	1st difference	0.739000	0.424489*
lnedcus	level	0.739000	0.973962
	1st difference	0.739000	0.247172*
lnedctr	level	0.739000	0.982459
	1st difference	0.739000	0.356671*

Stationary, if "LM-Stat" > "Asymptotic Crit.v" (* represents significancy)

The results show that the series variables are stationary at the power of the 1st difference. This output allows us to step forward and run the rest of the VAR model application. In the next section, to test whether the series variables are correlated in the long run, we run the Johansen Cointegration Test.

4.1.2. Johansen Cointegration Test

For the purpose to test the Johansen Cointegration apparatus, it should be defined the matched lag index. In the first part of the tables below, the information criteria of Akaike (AIC) and Schwartz (SC) were taken, where for every element of VAR system we shall move with Akaike (AIC) and will receive for all combination of variables. Consequently, an appropriate lag composition in our case will be as follows:

Table 4.3: Appropriate Lag Selection (1)

	Variables	Appropriate Lags
1	LNEMPUSAMAN	VAR 4:2
2	LNEMPTRMAN	VAR 3:2
3	LNEMPUSASRV	VAR 5:2
4	LNEMPTRSRV	VAR 5:2
5	LNWGUSAMAN	VAR 5:2
6	LNWGTRMAN	VAR 5:4
7	LNWGUSASRV	VAR 5:1
8	LNWGTRSRV	VAR 4:4

Before the interpretation of the results, we shall present the Null Hypothesis of the cointegration test, where we say that the Null Hypothesis (H0) means that there is no cointegration (No long-run relationship). Looking at the output of the test through the “Trace” and “Maximum Eigenvalue”, we conclude that if the “Trace Statistic” is higher/less than the “0.05 Critical Value” at the level of “None” / “At most 1” / “At most 2”, we reject/accept the Null Hypothesis. Again, if the results in the “Maximum Eigenvalue”, the “Max-Eigen Statistic” is higher/less than the “0.05 Critical Value” at the level of “None” / “At most 1” / “At most 2”, we reject the Null Hypothesis.

Table 4.4: Johansen Cointegration Test for LNEMPMANUS (1) (“Own Calculations”)

LAG	AIC-4	SC-2
0	-32.70108	-32.04929
1	-33.02863*	-32.06808*
2	-33.01299	-31.77397
3	-32.94194	-31.39682

Unrestricted Check for Cointegration Degree (trace)		
Hypothesized	Trace Stat.	Crit. Val.
None	51.23697	42.91525
At most 1	22.42805	25.87211
Unrestricted Check for Cointegration Degree (Max. Eigenvalue)		
Hypothesized	Max-Eigen Stat.	Crit. Val.
None	28.80892	25.82321
At most 1	12.83322	19.98704

For Employment in the Manufacturing Sector of USA, we reject the Null Hypothesis, as “Trace Statistic” - 51.23697 is higher than the “Critical Value” - 42.91525, at the level of “None”, and “Max-Eigen Statistic” - 28.80892 is higher than the “Critical Value” - 25.82321, at the level of “None”. As a result, we can say that there is a cointegration, i.e there is a long-run relationship between the variables: “Employment in the Manufacturing Sector of USA”, “R&D Expenditures in the Manufacturing Sector of USA” and “The Number of People with Tertiary Education Level in USA”.

Table 4.5: Johansen Cointegration Test for LNEMPMANTR (1) (“Own Calculations”)

LAG	AIC-3	SC-2
0	-24.57490	-23.86908*
1	-24.78789*	-23.80197
2	-24.69957	-23.53701
3	-24.51044	-23.12497

Unrestricted Check for Cointegration Degree (trace)		
Hypothesized	Trace Stat.	Crit. Val.
None	30.49032	29.79707
At most 1	7.465712	15.49471
Unrestricted Check for Cointegration Degree (Max. Eigenvalue)		
Hypothesized	Max-Eigen Stat.	Crit. Val.
None	23.0246	21.13162
At most 1	6.608362	14.26460

For Employment in the Manufacturing Sector of Turkey, we reject the Null Hypothesis, as “Trace Statistic” - 30.49032 is higher than the “Critical Value” - 29.79707, at the level of “None”, and “Max-Eigen Statistic” - 23.0246 is less than the “Critical Value” - 21.13162, at the level of “None”. As a result, we can say that there is a cointegration, i.e there is a long-run relationship between the variables: “Employment in the Manufacturing Sector of Turkey”, “R&D Expenditures in the Manufacturing Sector of Turkey” and “The Number of People with Tertiary Education Level in Turkey”.

Table 4.6: Johansen Cointegration Test for LNE MPSRVUS (1) (“Own Calculations”)

LAG	AIC-5	SC-2
0	-32.73464	-32.07548*
1	-33.02592	-32.02306
2	-33.07030*	-31.69830
3	-32.87557	-31.28959

Unrestricted Check for Cointegration Degree (trace)		
Hypothesized	Trace Stat.	Crit. Val.
None	44.17424	35.01090
At most 1	15.27969	18.39771
Unrestricted Check for Cointegration Degree (Max. Eigenvalue)		

Hypothesized	Max-Eigen Stat.	Crit. Val.
None	28.89455	24.25202
At most 1	14.57388	17.14769

For Employment in the Service Sector of USA, we reject the Null Hypothesis, as “Trace Statistic” - 44.17424 is higher than the “Critical Value” - 35.01090, at the level of “None”, and “Max-Eigen Statistic” - 28.89455 is higher than the “Critical Value” - 24.25202, at the level of “None”. As a result, we can say that there is a cointegration, i.e there is a long-run relationship between the variables: “Employment in the Service Sector of USA”, “R&D Expenditures in the Service Sector of USA” and “The Number of People with Tertiary Education Level in USA”.

Table 4.7: Johansen Cointegration Test for LNEMPSRVTR (1) (“Own Calculations”)

LAG	AIC-5	SC-2
0	-26.96391	-26.23738*
1	-27.06778*	-25.96011
2	-26.99734	-25.60549
3	-26.82372	-25.22792

Unrestricted Check for Cointegration Degree (trace)		
Hypothesized	Trace Stat.	Crit. Val.
None	27.251454	35.01090
At most 1	9.866157	18.39771
Unrestricted Check for Cointegration Degree (Max. Eigenvalue)		
Hypothesized	Max-Eigen Stat.	Crit. Val.
None	17.38539	24.25202
At most 1	7.356648	17.14769

For Employment in the Service Sector of Turkey, we accept the Null Hypothesis, as “Trace Statistic” - 27.251454 is less than the “Critical Value” - 35.01090, at the level of “None”, and “Max-Eigen Statistic” - 17.38539 is less than the “Critical Value” - 24.25202, at the level of “None”. As a result, we can say that there is no cointegration,

i.e there is no long-run relationship between the variables: “Employment in the Service Sector of Turkey”, “R&D Expenditures in the Service Sector of Turkey” and “The Number of People with Tertiary Education Level in Turkey”.

Table 4.8: Johansen Cointegration Test for LNWGMANUS (1) (“Own Calculations”)

LAG	AIC-5	SC-2
0	-30.30938	-29.65070*
1	-30.49463	-29.53869
2	-30.50397*	-29.22730
3	-30.34318	-28.84353

Unrestricted Check for Cointegration Degree (trace)		
Hypothesized	Trace Stat.	Crit. Val.
None	37.96032	35.01090
At most 1	15.21609	18.39771
Unrestricted Check for Cointegration Degree (Max. Eigenvalue)		
Hypothesized	Max-Eigen Stat.	Crit. Val.
None	22.74424	24.25202
At most 1	12.54216	17.14769

For Average Earnings in the Manufacturing Sector of USA, we reject the Null Hypothesis, as “Trace Statistic” - 37.96032 is higher than the “Critical Value” - 35.01090, at the level of “None”, despite “Max-Eigen Statistic” - 22.74424 is less than the “Critical Value” - 24.25202, at the level of “None”, as we need at least one index that shows the factor to reject the Null Hypothesis. As a result, we can say that there is a cointegration, i.e there is a long-run relationship between the variables: “Average Earnings in the Manufacturing Sector of USA”, “R&D Expenditures in the Manufacturing Sector of USA” and “The Number of People with Tertiary Education Level in USA”.

Table 4.9: Johansen Cointegration Test for LNWGMANTR (1) (“Own Calculations”)

LAG	AIC-5	SC-4
0	-22.54630	-21.80453
1	-22.96286	-21.93846*
2	-22.97220*	-21.66916
3	-22.80476	-21.31272

Unrestricted Check for Cointegration Degree (trace)		
Hypothesized	Trace Stat.	Crit. Val.
None	50.99050	35.01090
At most 1	14.83012	18.39771
Unrestricted Check for Cointegration Degree (Max. Eigenvalue)		
Hypothesized	Max-Eigen Stat.	Crit. Val.
None	36.16037	24.25202
At most 1	12.54157	17.14769

For Average Earnings in the Manufacturing Sector of Turkey, we reject the Null Hypothesis, as “Trace Statistic” - 50.99050 is higher than the “Critical Value” - 35.01090, at the level of “None”, and “Max-Eigen Statistic” - 36.16037 is higher than the “Critical Value” - 24.25202, at the level of “None”. As a result, we can say that there is a cointegration, i.e there is a long-run relationship between the variables: “Average Earnings in the Manufacturing Sector of Turkey”, “R&D Expenditures in the Manufacturing Sector of Turkey” and “The Number of People with Tertiary Education Level in Turkey”.

Table 4.10: Johansen Cointegration Test for LNWGSRVUS (1) (“Own Calculations”)

LAG	AIC-5	SC-1
0	-28.42682	-27.43098
1	-28.65837	-27.73197
2	-28.70734	-27.46360
3	-28.50193	-27.06983

Unrestricted Check for Cointegration Degree (trace)		
Hypothesized	Trace Stat.	Crit. Val.
None	40.35601	35.01090
At most 1	14.92627	18.39771
Unrestricted Check for Cointegration Degree (Max. Eigenvalue)		
Hypothesized	Max-Eigen Stat.	Crit. Val.
None	25.42973	24.25202
At most 1	14.83995	17.14769

Johansen Cointegration for Average Earnings in the Service Sector of USA, we reject the Null Hypothesis, as “Trace Statistic” - 40.35601 is higher than the “Critical Value” - 35.01090, at the level of “None”, and “Max-Eigen Statistic” - 25.42973 is higher than the “Critical Value” - 24.25202, at the level of “None”. As a result, we can say that there is a cointegration, i.e there is a long-run relationship between the variables: “Average Earnings in the Service Sector of USA”, “R&D Expenditures in the Service Sector of USA” and “The Number of People with Tertiary Education Level in USA”.

Table 4.11: Johansen Cointegration Test for LNWGSRVTR (1) (“Own Calculations”)

LAG	AIC-4	SC-4
0	-22.45368	-21.70766*
1	-22.59956*	-21.60487
2	-22.52976	-21.28639
3	-22.40205	-20.91000

Unrestricted Check for Cointegration Degree (trace)		
Hypothesized	Trace Stat.	Crit. Val.
None	37.85210	42.91525
At most 1	16.24935	25.87211
Unrestricted Check for Cointegration Degree (Max. Eigenvalue)		

Hypothesized	Max-Eigen Stat.	Crit. Val.
None	21.60275	25.82321
At most 1	9.335031	12.51798

Significant, if “Trace statistic” and/or “Max-Eigen Statistic” > “Critical Value”

For Average Earnings in the Service Sector of Turkey, we accept the Null Hypothesis, as “Trace Statistic” - 37.85210 is less than the “Critical Value” - 42.91525, at the level of “None”, and “Max-Eigen Statistic” - 21.60275 is less than the “Critical Value” - 25.82321, at the level of “None”. As a result, we can say that there is no cointegration, i.e there is no long-run relationship between the variables: “Average Earnings in the Service Sector of Turkey”, “R&D Expenditures in the Service Sector of Turkey” and “The Number of People with Tertiary Education Level in Turkey”.

4.1.3. Impulse Response Function

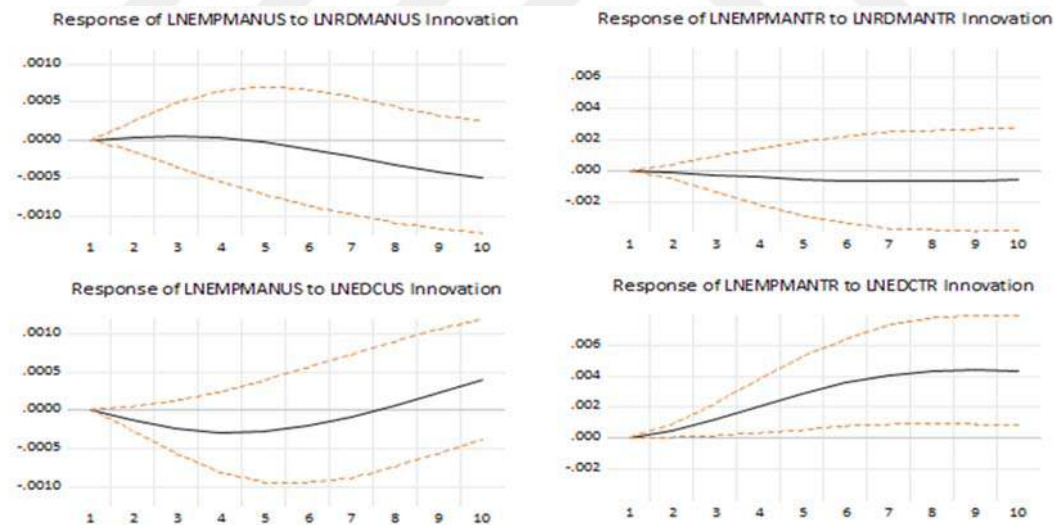


Figure 4.1: The Graphical Representation of IRF for LNEPMANUS and LNEPMANTR (1) (“Own Calculations”)

In the impulse response (IR) mechanism for LNEPMANUS: One Standard Deviation shock (innovation) to LNRDMANUS, initially, has a steady constant impact on LNEPMANUS in the short-run. Starting out of the 4th period, the response

gradually declines until the 10th period, showing a negative trend in the long-run. On the other graph, one Standard Deviation shock (innovation) to LNEDCUS, in the short-run, has a moderate negative effect on LNEPMANUS. Moving from the 5th period, the response keeps increasing, hitting its initial rate in the long-run.

In the IR mechanism for LNEPMANTR: One Standard Deviation shock (innovation) to LNRDMANTR has a gradual negative impact on LNEPMANTR in the short-term and mid-term, keeping steady state in the long-term. On the other graph, one Standard Deviation shock (innovation) to LNEDCTR has a sharp growing effect on LNEPMANTR. Starting from the 7th period, the response keeps constant in the long-run.

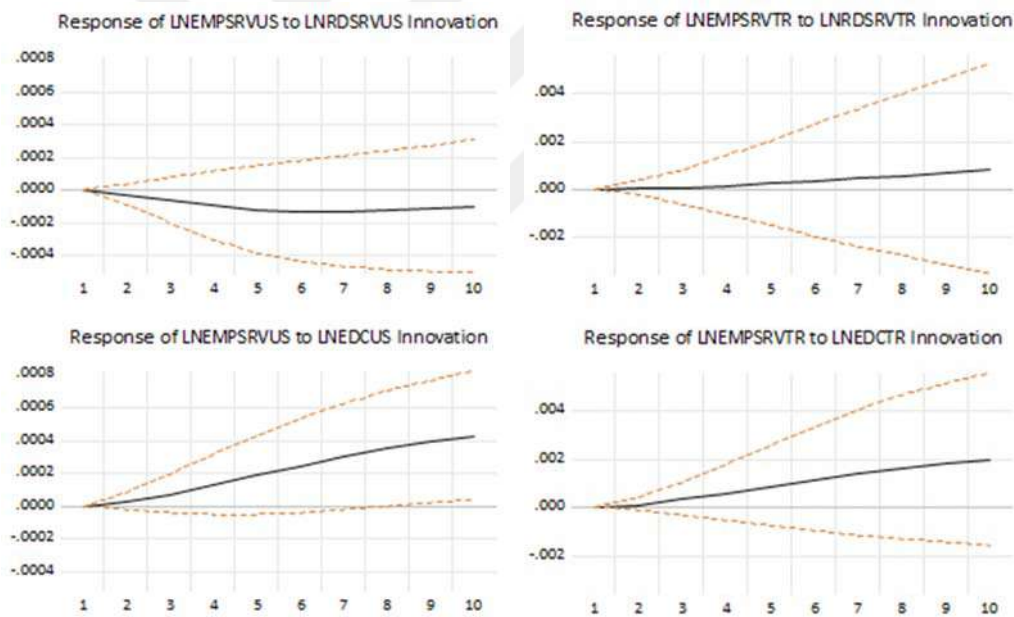


Figure 4.2: The Graphical Representation of IRF for LNEMPSRVUS and LNEMPSRVTR (1) (*“Own Calculations”*)

In the IR mechanism for LNEMPSRVUS: One Standard Deviation shock (innovation) to LNRDSRVUS has a gradual negative impact on LNEMPSRVUS in the short-term, keeping a steady state in the mid- and long-term. On the other graph, one

Standard Deviation shock (innovation) to LNEDCUS has a significant growing effect on LNEMPSRVUS in the short- and long-run.

In the IR mechanism for LNEMPSRVTR: One Standard Deviation shock (innovation) to LNRDSRVTR has a moderate growing effect on LNEMPSRVTR in the short- and long-term. The same with the other graph, where one Standard Deviation shock (innovation) to LNECDTR has a gradual growing effect on LNEMPSRVTR in the short- and long-run.

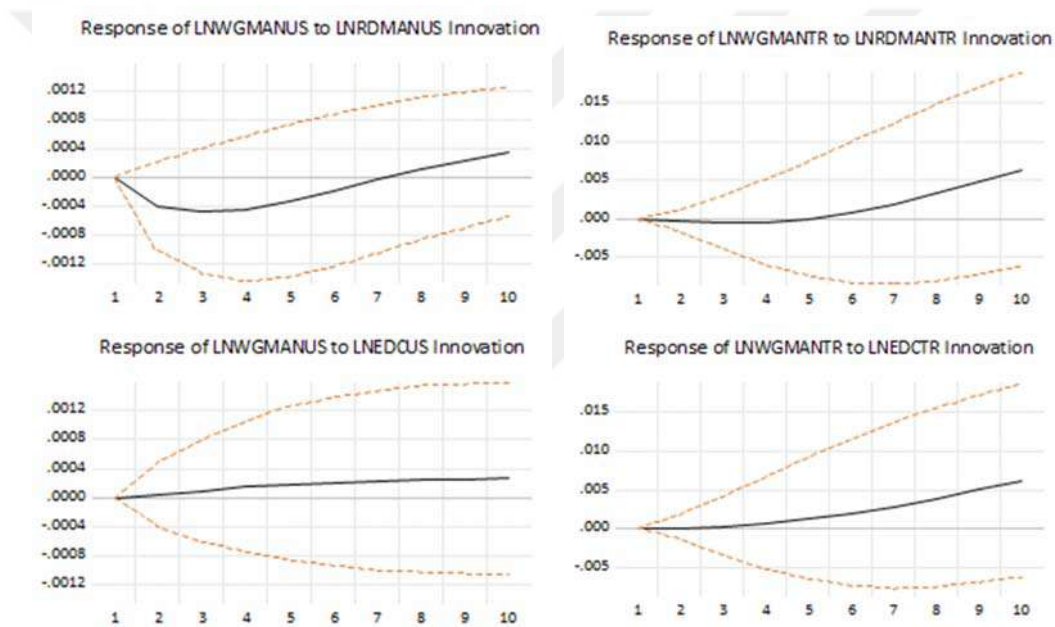


Figure 4.3: The Graphical Representation of IRF for LNWGMANUS and LNWGMANTR (1) ("Own Calculations")

In the IR mechanism for LNWGMANUS: One Standard Deviation shock (innovation) to LNRDMANUS has a slight declining effect on LNWGMANUS in the short-term, and a constant increasing impact in the long-term. On the other graph, one Standard Deviation shock (innovation) to LNECDUS as a moderate growing effect on LNWGMANUS in the short- and long-term.

In the IR mechanism for LNWGMANTR: One Standard Deviation shock (innovation) to LNRDMANTR almost does not have any effect on LNWGMANTR until

the mid-term, however, it sharply rises in the long-term. A similar trend is seen on the other graph, where one Standard Deviation shock (innovation) to LNEDCTR as a moderate increasing effect on LNWGMANTR in the short- and long-term.

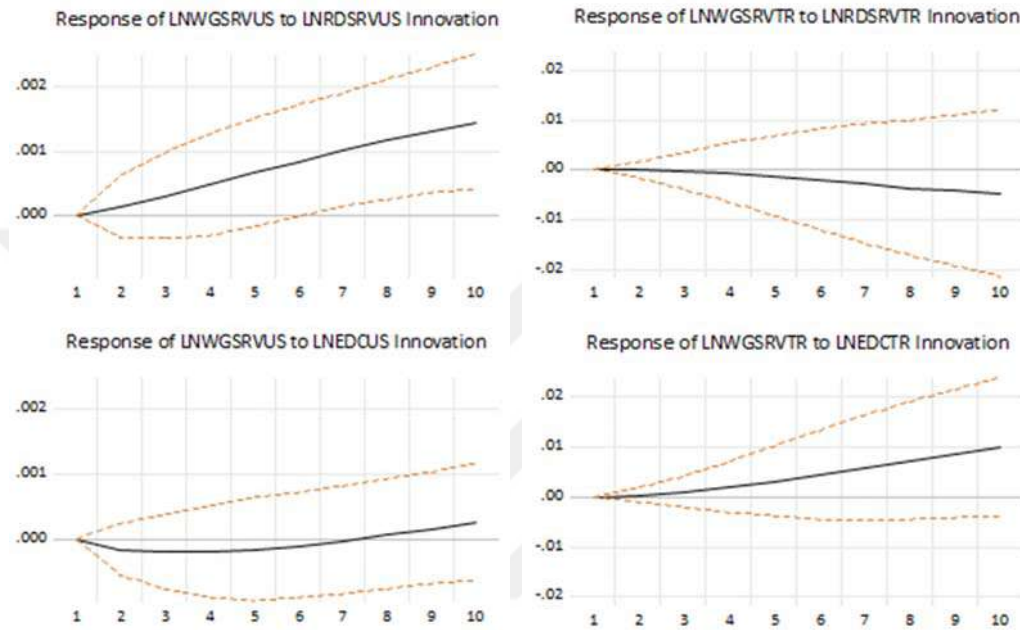


Figure 4.4: The Graphical Representation of IRF for LNWGSRVUS and LNWGSRVTR (1) (“Own Calculations”)

In the IR mechanism for LNWGSRVUS: One Standard Deviation shock (innovation) to LNRDSRVUS has a significant growing effect on LNWGSRVUS, starting from the beginning until the end of the period. On the other graph, one Standard Deviation shock (innovation) to LNEDCUS has an initial slight negative impact on LNWGSRVUS, but the response is gradually increasing in the long-run.

In the IR mechanism for LNWGSRVTR: One Standard Deviation shock (innovation) to LNRDSRVTR has a moderate decreasing effect on LNWGSRVTR for the whole time interval. On the other graph, one Standard Deviation shock (innovation) to LNEDCTR has a straight positive impact on LNWGSRVTR in the short- and long-term.

4.1.4. Variance Decomposition

Table 4.12: The Variance Decomposition (1) (“Own Calculations”)

		Start			Short-run			Long-run		
		Own	R&D	Edc.	Own	R&D	Edc.	Own	R&D	Edc.
1	LNEMPMANUS	100.0	0.00	0.00	98.7	0.08	1.11	93.2	3.35	3.42
2	LNEMPMANTR	100.0	0.00	0.00	96.3	0.16	3.51	59.5	0.98	39.50
3	LNEMPSRVUS	100.0	0.00	0.00	98.3	0.74	0.92	74.5	3.25	22.15
4	LNEMPSRVTR	100.0	0.00	0.00	99.3	0.03	0.61	92.0	0.91	7.01
5	LNWGMANUS	100.0	0.00	0.00	97.8	2.06	0.05	96.5	2.45	1.00
6	LNWGMANTR	100.0	0.00	0.00	99.9	0.06	0.02	95.0	2.26	2.67
7	LNWGSRVUS	100.0	0.00	0.00	98.4	0.88	0.62	68.5	30.4	0.98
8	LNWGSRVTR	100.0	0.00	0.00	99.8	0.01	0.17	90.4	1.76	7.76

In the short-run, that is a row-3, the impulse or innovation or shock to LNEMPMANUS account for 98.7 percent variation of the fluctuation in LNEMPMANUS (own shock), a shock to LNRDMANUS can cause 0.08 percent fluctuation in LNEMPMANUS, a shock to LNEDCUS causes 1.11 percent fluctuation in LNEMPMANUS. In the long-run, that is row-10, a shock to LNEMPMANUS can contribute 96.46 percent to LNEMPMANUS (own shock), a shock to LNRDMANUS can contribute 2.45 percent fluctuation in the variance of LNEMPMANUS, and, finally, LNEDCUS can cause 1.08 percent, meaning that the impulse or shock on LNEDCUS can cause 1.08 percent fluctuation in LNEMPMANUS.

In the short-run, that is a row-3, the impulse or innovation or shock to LNEMPMANTR account for 96.3 percent variation of the fluctuation in LNEMPMANTR (own shock), a shock to LNRDMANTR can cause 0.16 percent

fluctuation in LNEMPMANTR, a shock to LNEDCUS causes 3.51 percent fluctuation in LNEMPMANTR. In the long-run, that is row-10, a shock to LNEMPMANTR can contribute 59.5 percent to LNEMPMANTR (own shock), a shock to LNRDMANTR can contribute 0.98 percent fluctuation in the variance of LNEMPMANUS, and, finally, LNEDCTR can cause 39.50 percent, meaning that the impulse or shock on LNEDCTR can cause 39.50 percent fluctuation in LNEMPMANTR.

In the short-run, that is a row-3, the impulse or innovation or shock to LNEMPSRVUS account for 98.3 percent variation of the fluctuation in LNEMPSRVUS (own shock), a shock to LNRDSRVUS can cause 0.74 percent fluctuation in LNEMPSRVUS, a shock to LNEDCUS causes 0.92 percent fluctuation in LNEMPSRVUS. In the long-run, that is row-10, a shock to LNEMPSRVUS can contribute 74.5 percent to LNEMPSRVUS (own shock), a shock to LNRDSRVUS can contribute 3.25 percent fluctuation in the variance of LNEMPSRVUS, and, finally, LNEDCUS can cause 22.15 percent, meaning that the impulse or shock on LNEDCUS can cause 22.15 percent fluctuation in LNEMPSRVUS.

In the short-run, that is a row-3, the impulse or innovation or shock to LNEMPSRVTR account for 99.3 percent variation of the fluctuation in LNEMPSRVTR (own shock), a shock to LNRDSRVTR can cause 0.03 percent fluctuation in LNEMPSRVTR, a shock to LNEDCTR causes 0.61 percent fluctuation in LNEMPSRVTR. In the long-run, that is row-10, a shock to LNEMPSRVTR can contribute 92.0 percent to LNEMPSRVTR (own shock), a shock to LNRDSRVTR can contribute 0.91 percent fluctuation in the variance of LNEMPSRVTR, and, finally, LNEDCTR can cause 7.01 percent, meaning that the impulse or shock on LNEDCTR can cause 7.01 percent fluctuation in LNEMPSRVTR.

In the short-run, that is a row-3, the impulse or innovation or shock to LNWGMANUS account for 97.8 percent variation of the fluctuation in LNWGMANUS (own shock), a shock to LNRDMANUS can cause 2.06 percent fluctuation in LNWGMANUS, a shock to LNEDCUS causes 0.05 percent fluctuation in

LNWGMANUS. In the long-run, that is row-10, a shock to LNWGMANUS can contribute 96.5 percent to LNWGMANUS (own shock), a shock to LNRDMANUS can contribute 2.45 percent fluctuation in the variance of LNWGMANUS, and, finally, LNEDCUS can cause 1.00 percent, meaning that the impulse or shock on LNEDCUS can cause 1.00 percent fluctuation in LNWGMANUS.

In the short-run, that is a row-3, the impulse or innovation or shock to LNWGMANTR account for 99.9 percent variation of the fluctuation in LNWGMANTR (own shock), a shock to LNRDMANTR can cause 0.06 percent fluctuation in LNWGMANTR, a shock to LNEDCTR causes 0.02 percent fluctuation in LNWGMANTR. In the long-run, that is row-10, a shock to LNWGMANTR can contribute 95.0 percent to LNWGMANTR (own shock), a shock to LNRDMANTR can contribute 2.26 percent fluctuation in the variance of LNWGMANTR, and, finally, LNEDCTR can cause 2.67 percent, meaning that the impulse or shock on LNEDCTR can cause 2.67 percent fluctuation in LNWGMANTR.

In the short-run, that is a row-3, the impulse or innovation or shock to LNWGSRVUS account for 98.4 percent variation of the fluctuation in LNWGSRVUS (own shock), a shock to LNRDSRVUS can cause 0.88 percent fluctuation in LNWGSRVUS, a shock to LNEDCUS causes 0.62 percent fluctuation in LNWGSRVUS. In the long-run, that is row-10, a shock to LNWGSRVUS can contribute 68.5 percent to LNWGSRVUS (own shock), a shock to LNRDSRVUS can contribute 30.4 percent fluctuation in the variance of LNWGSRVUS, and, finally, LNEDCUS can cause 0.98 percent, meaning that the impulse or shock on LNEDCUS can cause 0.98 percent fluctuation in LNWGSRVUS.

In the short-run, that is a row-3, the impulse or innovation or shock to LNWGSRVTR account for 99.8 percent variation of the fluctuation in LNWGSRVTR (own shock), a shock to LNRDSRVTR can cause 0.01 percent fluctuation in LNWGSRVTR, a shock to LNEDCTR causes 0.17 percent fluctuation in LNWGSRVTR. In the long-run, that is row-10, a shock to LNWGSRVTR can

contribute 90.4 percent to LNWGSRVTR (own shock), a shock to LNRDSRVTR can contribute 1.76 percent fluctuation in the variance of LNWGSRVTR, and, finally, LNEDCTR can cause 7.76 percent, meaning that the impulse or shock on LNEDCTR can cause 7.76 percent fluctuation in LNWGSRVTR.

4.1.5. Granger Causality test

Table 4.13: The Granger Causality Test (1) (“Own Calculations”)

Dependent Variable:	Excluded	Chi-sq	Df	Prob.
LNEMPMANUS	LNRDMANUS	4.573453	2	0.1016
	LNEDCUS	8.916689	2	0.0116*
	All	25.73902	4	0.0000
LNEMPMANTR	LNRDMANTR	5.387961	2	0.0676
	LNEDCTR	14.16697	2	0.0008*
	All	17.60263	4	0.0015
LNEMPSRVUS	LNRDSRVUS	0.871992	2	0.6466
	LNEDCUS	13.05934	2	0.0015*
	All	18.05804	4	0.0012
LNEMPSRVTR	LNRDSRVTR	0.454398	2	0.7968
	LNEDCTR	1.149309	2	0.5629
	All	7.773513	4	0.1002
LNWGMANUS	LNRDMANUS	5.918338	2	0.0519
	LNEDCUS	0.390770	2	0.8225
	All	14.06937	4	0.0071
LNWGMANTR	LNRDMANTR	0.949198	2	0.6221
	LNEDCTR	4.928035	2	0.0851
	All	5.355364	4	0.2527
LNWGSRVUS	LNRDSRVUS	11.97300	2	0.0025*
	LNEDCUS	3.293532	2	0.1927
	All	24.05046	4	0.0001
LNWGSRVTR	LNRDSRVTR	0.133072	2	0.9356
	LNEDCTR	2.359662	2	0.3073
	All	5.635692	4	0.2281

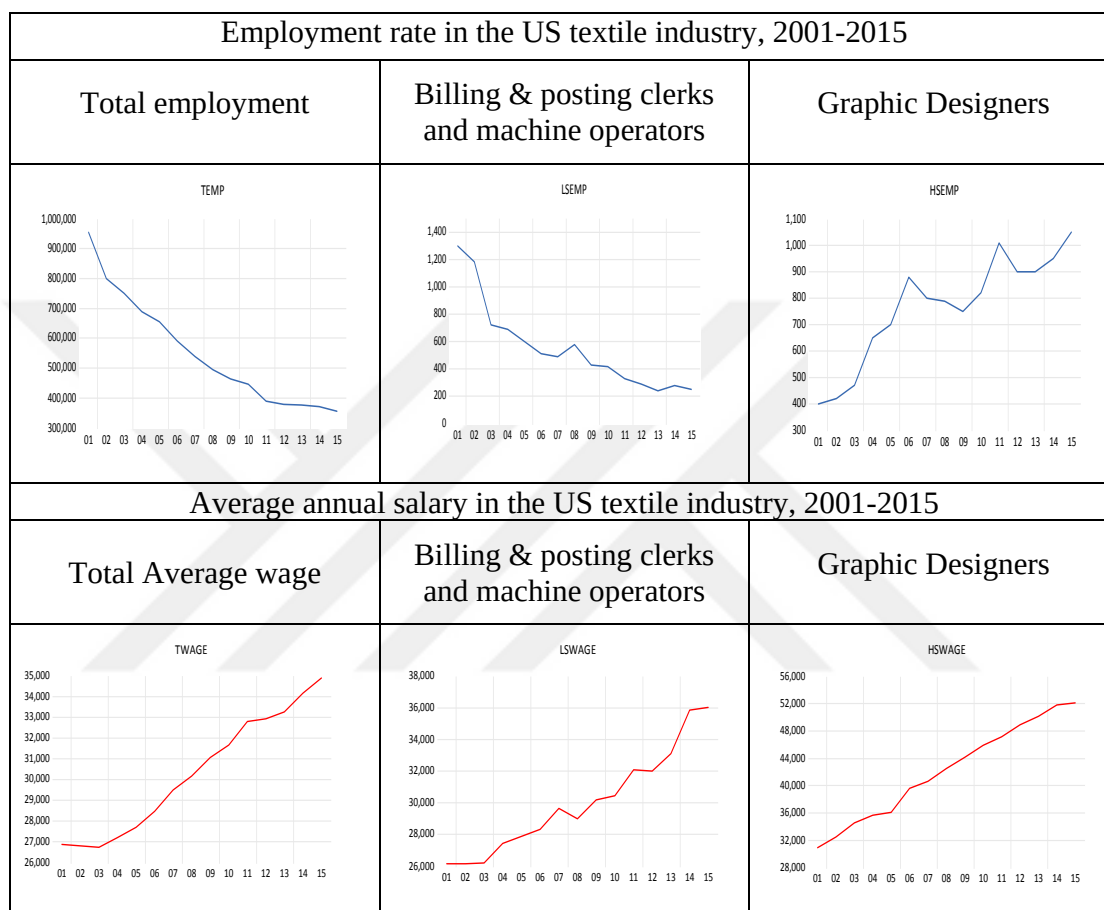
If $0.05 \geq \text{Prob.}$ - Significant; If $0.05 > \text{Prob.}$ - insignificant

When we look at the table of employment, it becomes clear that LNEDCUS does lead LNEMPMANUS, with the probability of 0.0116, where we reject the Null Hypothesis. Likewise, the same scenario is repeated in case of Turkey, where LNEDCTR can cause LNEMPMANTR, with the probability of 0.0008. Similarly, in USA, the LNEDCUS leads LNEMPSRVUS, where we also reject the Null Hypothesis, with the probability of 0.0015. Switching to the market of wages, we can observe that the only case, where the one variable does lead another one, is LNRDSRVUS causes LNWGSRVUS, with the index of probability: 0.0025.

4.1.6. Regression Analysis

In the second model, at the beginning of the elaboration of causal effects of dependent variables (low-skilled and high-skilled occupations), which are "Billing & posting clerks and machine operators" as a low-skilled occupation, and "Graphic Designers" as a high-skilled occupation which affected by the automation, we shall take the P-values of the Unit Root part by using Augmented Dickey-Fuller test, in order to know whether the data is stationary or not. Afterwards, we run the regression test through low- and high-skilled occupations to perceive whether the automation is capable to impact employment and wage rate or not. In addition, for average annual wages for Graphic Designers, in order to determine the real change, the downtrend caused by the 2008 regression was reversed by similar additions that occurred in previous years.

Table 4.14: The Graphical Representation of Variables (2) (*U.S. Bureau of Labor Statistics*)



First of all, we shall look at the outputs of the ADF test, which is precondition that we need to obtain when doing time series analysis since assessing the stationary properties of a time series is a key conducted procedure of models.

Table 4.15: Augmented Dickey Fuller Test (2) (*“Own Calculations”*)

Test	T-statistic			Prob*
	1%	5%	10%	
Low-skilled employment (level)	-4.0044	-3.0988	-2.6904	0.0472*
Low-skilled employment (1st difference)	-4.0579	-3.1199	-2.7011	0.0341*
High-skilled employment (level)	-4.8000	-3.7911	-3.3422	0.4456
High-skilled employment (1st difference)	-4.0579	-3.1199	-2.7011	0.0146*

Low-skilled wage (level)	-5.6046	-3.6948	-2.9828	0.9989
Low-skilled wage (1st difference)	-6.4236	-3.9849	-3.1206	0.0021*
High-skilled wage (level)	-4.0579	-3.119	-2.7011	0.6624
High-skilled wage (1st difference)	-4.0579	-3.1199	-2.7011	0.0013*

If $0.05 \geq \text{Prob.}$ - Significant; If $0.05 \leq \text{Prob.}$ – insignificant

After seeing the probability values we can conclude that the data series of low-skilled employment level is stationary at the first difference (0.0341 are less than 0.05). A similar output was received for the high-skilled employment at the first level, with the result of stationarity (0.0146 is lower than 0.05), where we reject the null hypothesis at the first level. For the annual average salary, we can conclude that the series of data on the level of salaries for low-skilled and high-skilled categories are stationary at the first level (0.0021 and 0.0013 are less than 0.05). So, at the first level, we reject the null hypothesis. From the results of the ADF unit root test, we understand that our series variables are stationary at "1st difference", which confirms that we can perform a regression analysis to test whether and how the independent variable affects the dependent variable.

Table 4.16: Regression Analysis (2) (*“Own Calculations”*)

Variable	T-test	Probability	R-squared
L-S emp.	3.0750	0.0096	0.9261
H-S emp.	-1.9067	0.0808	
L-S wage	2.1686	0.0509	0.9796
H-S wage	4.7514	0.0005	

If $0.05 \geq \text{Prob.}$ - Significant; If $0.05 \leq \text{Prob.}$ – insignificant

The value of the probability of low-skilled employment is 0.0096, that is, less than 5%, which indicates the significance of the relationship between the independent and dependent variables of a particular category, while, on the other hand, the value of the probability of highly skilled employment is 0.0808, which is higher 5%, indicating to

an insignificant connection between highly skilled and total employment. Moreover, the R-squared that illustrates the percentage by which the independent variables can predict the dependent variable is 0.9261 in our case, which obviously tells us that the level at which the independent variables can predict the dependent variable is 93% (high).

For the wage category, the low-skill wage probability value is 0.0509, i.e. higher than 5%, indicating that the relationship between the independent and dependent variables of the wage category is negligible, while, on the other hand, the probability value of highly skilled wages is 0.0005, which is less 5%, indicating a significant relationship between high-skilled and average wages. Also, R-squared is 0.9796, which predicts that the level at which the independent variables can predict the dependent variable is 98% (high).

4.2. The Summary of the Empirical Results

The results of the analysis (1) can be summarized as follows:

1. The impact of R&D spending (technology and innovation) and people with tertiary education level (high-skilled workers) on employment in the US manufacturing sector has a long-run relationship. Despite the explanatory power of LNRDMANUS and LNEDCUS is minimal, especially LNEDCUS is useful and can lead the LNEMPMANUS throughout the decade. Additionally, the shock (growth) in the LNRDMANUS causes the decreasing response of LNEMPMANUS, while the shock in the LNEDCUS leads to an upward trend in the response of LNEMPMANUS.
2. The impact of R&D spending (technology and innovation) and people with tertiary education level (high-skilled workers) on employment in the Turkey manufacturing sector has a long-run relationship. In the short-run, the effect of LNRDMANTR and LNEDCTR on the changes in the LNEMPMANTR is not visible, however, in the long-run, the impact and the explanatory power of LNEDCTR on LNEMPMANTR becomes noticeable, surpassing the influence of LNRDMANTR. Furthermore, the shock (growth) in the LNRDMANTR causes a slight decreasing response of

LNEMPMANTR, however, the shock in the LNEDCTR contributes to the sharp growth in the response of LNEMPMANTR.

3. The impact of R&D spending (technology and innovation) and people with tertiary education level (high-skilled workers) on employment in the US service sector has a long-run relationship. In the short-run and long-run, the effect of LNRDSRVUS on the changes in the LNEMPSRVUS is not visible, while in the long-run, the influence of LNEDCUS is noticeable, as well as, the cause that the LNEDCUS can have upon the LNEMPSRVUS is significant. Furthermore, the shock (growth) in the LNRDSRVUS causes decline in the LNEMPSRVUS, however, the shock in the LNEDCTR contributes to the significant growth in the response of LNEMPSRVUS.
4. The impact of R&D spending (technology and innovation) and people with tertiary education level (high-skilled workers) on employment in the Turkey service sector doesn't have a long-run relationship. In the short-run, the effect of LNRDSRVTR and LNEDCTR on the changes of LNEMPSRVTR is not visible, however, in the long-run, the information that contains the LNEDCTR in order to explain the LNEMPSRVTR is notable. The capability of LNRDSRVTR and LNEDCTR in terms of the impact on LNEMPSRVTR is not significant. Furthermore, the shock (growth) in the LNRDSRVTR and LNEDCTR cause an increase in the response of LNEMPSRVTR.
5. The impact of R&D spending (technology and innovation) and people with tertiary education level (high-skilled workers) on average earnings in the US manufacturing sector has a long-run relationship. In the short-run and in the long-run, the explanatory power of LNEDCUS on LNWGMANUS is higher, compared to LNRDMANUS, notwithstanding the minimal effect. Despite the non-significance of the effect of independent variables, the LNRDMANUS, compared to the LNEDCUS, does have a superior lead upon the LNWGMANUS. Moreover, the shock (growth) in the LNRDMANUS and LNEDCUS cause a steady growth in the response of LNWGMANUS.

6. The impact of R&D spending (technology and innovation) and people with tertiary education level (high-skilled workers) on average earnings in the Turkey manufacturing sector has a long-run relationship (the strength is less than the US case). In the short-run and in the long-run, the explanatory power of LNRDMANTR and LNEDCTR on LNWGMANTR are almost on the same level and insignificant, also, they can't lead and can be a cause for the LNWGMANTR. Furthermore, the shock (growth) in the LNRDMANTR and LNEDCTR cause a moderate growth in the response of LNWGMANTR.
7. The impact of R&D spending (technology and innovation) and people with tertiary education level (high-skilled workers) on average earnings in the US service sector has a long-run relationship. In the short-run the explanatory power of LNRDSRVUS and LNEDCUS upon the LNWGSRVUS is minimal, but when it comes to the long-run period, we can witness the information, that LNRDSRVUS contain to explain the LNWGSRVUS is highly significant. Additionally, the LNRDSRVUS is able to lead and be a cause for the LNWGSRVUS. Moreover, the shock (growth) in the LNWGSRVUS and LNEDCUS cause a moderate increase in the response of LNWGSRVUS.
8. The impact of R&D spending (technology and innovation) and people with tertiary education level (high-skilled workers) on average earnings in the Turkey service sector doesn't have a long-run relationship, with non-significant cointegration. In the short-run, the explanatory power of LNRDSRVTR and LNEDCTR is inconsiderable, however, in the long-run, the information that LNEDCTR contain upon the LNWGSRVTR is notable. Additionally, the LNRDSRVTR and LNEDCTR cannot lead and be a cause for LNWGSRVTR. On the one hand, the shock (growth) in the LNRDSRVTR contributes to a moderate decrease in the response of LNWGSRVTR. On the other hand, the shock (growth) in the LNEDCTR causes the response of LNWGSRVTR to decline.

The results of the analysis (2) can be summarized as follows:

9. If we summarize the obtained results of the second applied model, and interpret them in the context of our pattern, then we can say that the automation that led to a decrease in all employment in the United States textile industry has different effects on low-skilled and high-skilled workers. While the number of workers in the Billing & posting clerks and machine operators of the occupation plummeted due to automation, the overall employment of the high-skilled occupation, in particular Graphic Designers, rose sharply. As a result of these trends, we have been able to observe a polarization between occupations of different abilities, caused by technology.

Moreover, we have determined how the average annual salary of the aforementioned occupation changes. It is important to note that a consistent increase in overall average wages in the textile industry, as we determined through regression analysis, is associated with sequential annual wage increases in the independent variables, i.e., the low-skilled and high-skilled occupations. It's obvious from the output, obtained from data, that automation in any case has a positive effect on the average annual wage of workers, regardless of the degree of qualification.

It is important to note that the absolute downward trend in employment in Billing & posting clerks and machine operators of occupation is becoming greater than the absolute value of employment growth in the Graphic Designers occupation, which clearly shows that the job polarization in the lower steps of occupational qualifications is more intense than on the upper steps. The similar result we can also observe in case of average wages, too, where the positive effect of using technology is more clearly observed in highly skilled occupations than the increase in average wages in low-skilled occupations.

CONCLUSION

In this study, which we have conducted in order to better understand the impact of technology on employment, we have achieved some important results in terms of this aim. On the grounds of the qualifications, we have understood that the introduction of technologies contributes to the polarization of employment, which creates the interval betwixt the demand for high-skilled and low-skilled employee. Moreover, demand for routine tasks and assignments has decreased dramatically, regardless of whether these jobs have an intellectual or handheld disposition. Consequently, we could observe complementary and substitutional features of technologies, when automation can substitute some low-skilled employees in the performance of routine tasks, they may supplement those whose qualifications are high and continue in these positions, by increasing their wages.

On the firm and sectoral levels, we can conclude that in a state of *ceteris paribus*, the technological change increases productivity and is likely to reduce employment. Nevertheless, the obtained benefits out of productivity might be utilized to decline prices relatively, thereby motivating demand for a particular product. Moreover, since the price elasticity is above one, a fall in prices parallel to an increase in productivity will actually increase employment. If the chains are constant, productivity gains can be translated into increases in real wages or profits, which, in turn, will stimulate consumption and investment resulting in additional demand and the creation of new sectors. Also, the research demonstrated that the product innovation was correlated with the growth in the amount of workers employed in all production industries while process innovation mostly in high-tech ones, which shows that the effect of one type of organizational innovation application is relatively positive to another type. However, while positively impacting the firms, product innovation has certain negative consequences, such as the 'cannibalization' effect and 'business stealing' effect, which as we have shown in the work, by adversely affecting the sector, minimize the initial job-creating feature. In addition, we have also analyzed labor-savings and capital-intensive innovations and

could summarize that these technologies have a great effect on employment and wages in the long run, because in order to enhance labor productivity further, a greater K/L ratio is necessary. It's also important to note that in developing countries with relatively low labor costs, such investments (technological) may remain unprofitable. However, as incomes increase, the likelihood of adopting automated technology and therefore replacing humans with machines will increase. In the developed countries, large quantity of production and purchasing degree were able to support efficiency and increase in the level of employed based on increased competitiveness.

Moreover, after the introduction of technologies, if the demand elasticity is significantly positive, the previously laid-off workers will be compensated again. Amongst the compensatory owners, the process through price reductions was the most powerful, especially, when the condition of perfect competition exists. In order to perceive the means of employment increase at the time of economical growth, we have illustrated endogenous growth, which highlights the technical progress and its drivers emphasize topics like knowledge, human capital and R&D. Each additional investment improves not just productivity but also human capital. Through this way, we have demonstrated Schumpeter's theory of Creative Destruction and its development in the writings of Aghion-Howitt, which provide a model of growth theory that influences employment and wages. On the shoulders of the Creative Destruction mechanism, we showed that the economic policy should not attempt to save "obsolete industries," but also to "prevent their disorder crashing". Furthermore, we have shown the explanation of this theory by representing the Aghion-Howitt's model, where was shown the model which illustrates that the growth comes mainly from the new entry. Additionally, in order to keep employment valuable after technologies, we have analyzed the importance of human capital in the framework of the Augmented Solow Model, where was shown the modeling part, that provides a strong theory by introducing the assumption that if human capital is valuable, unemployment does have a long-run impact on productivity levels, and savings and educational level help to build physical and human capital.

At the end of the work, an application was analyzed using VAR model, as a result of which the outputs were obtained where the impact of technology & quality workforce on employment and average wages, is positive both in the manufacturing and in the service sectors. However, this result is not a benchmark for all conditions and countries. On the one hand, in developing countries, namely in Turkey, no simultaneous positive outcome in terms of long-term development and causal nature has been identified, with the exception of employment category in the manufacturing sector, where only an applicable causal relationship was found. On the other hand, with the exception of wage group in the manufacturing sector, practical evidence of the positive impact of technology and the use of highly skilled workers on employment and average wages exists, both by industry and by category, in developed countries, specifically in US.

Finally, was presented an analysis of the US textile industry, where we concluded that automation that led to a decrease in all employment in the United States textile industry has different effects on low-skilled and high-skilled workers. As a result of these trends, we have been able to observe a polarization, in terms of employment and wages, between occupations of different abilities, caused by technology.

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