UNIVERZA V LJUBLJANI

EKONOMSKA FAKULTETA

MASTER'S THESIS

TITLE: THE IMPACT OF TEHCNOLOGICAL ADVANCEMENT AND THE EFFECTS OF AUTOMATION ON THE US LABOR MARKET

Ljubljana, July 2018 MARKO NEDZBALA

AUTHORSHIP STATEMENT

The undersigned Marko Nedzbala, a student at the University of Ljubljana, Faculty of Economics, (hereafter: FELU), author of this written final work of studies with the title The Impact of Technological Advancement and the Effects of Automation on the US Labor Market, prepared under supervision of prof. dr. Tjaša Redek.

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INTRODUCTION

The technological contributions to the United States (hereinafter referred to as US) labor market are numerous and complex. There are a lot of technologies that are all having different and sometimes conflicting impacts. The main difference currently with technology as compared to the past is twofold. These types of tasks could be classified as not being cost effective to be automated, or not previously able to be automated. With advanced technologies these barriers are slowly being eroded and the demand for humans in these tasks has greatly diminished. Technology is now able to operate nearly autonomously, and in the very near future could acquire and learn tasks automatically, in a process known as Machine Learning. Machine Learning allows a machine given a minimal set of instructions can learn the tasks needed to perform its job. In the past technology was only at best able to assist humans in their jobs. Now technology is able to perform tasks just as well as humans and in some cases even better than humans. An increasingly number of human's jobs is under threat of automation and could begin to disappear. In the US this is of particular note because of the innovation occurring in universities because companies have easier access to new and improved technologies that grants them a competitive advantage. This competitive advantage is only realized if companies are able to reduce their costs, most notably their labor costs, and reap the rewards of their advancement. The advancements of technology are the gain for many companies and the owners of these companies; however they come at a cost to many individuals whose skills are no longer required as there are machines that can perform the same tasks at cheaper rates. The US is also the world's largest economy and actions felt there have enormous impact on the rest of the world. In this manner it is important to understand the changes that could be felt there, and how they might impact other countries.

The goal of this thesis is to gain a deeper understanding of the impacts of advancement automation technologies on the US labor market. Many experts are divided as to the current impacts of automation in the US labor market. The main research questions of this thesis are to analyze the current situation in the US labor market, gain a deeper understanding of what is occurring, the driving factors of changes and what future trends could emerge.

In order to best analyze these major problems and trends the methodology of this thesis will take two distinct approaches. A theoretical approach based off readings, and an empirical part that looks at the data from those existing papers. Beginning with a review of the various literature available followed by analyzing various different research reports and articles. This enables the development of two different viewpoints to analyze some of the more recent developments by way of news articles. Research reports allow for an in depth analysis of the various factors shaping and defining the US labor market, however while these research articles are well written and carefully researched they take a long time to prepare and achieving their high standard, making them lag a few years behind to trends that are currently happening. In the field of technology, advancements occur at a very rapid pace; things can quickly become obsolete. To counter this limitation newspaper articles, blogs from prominent experts, and shorter papers resulting in a less detailed analysis were used in conjunction with

research papers. This allowed for more recent analysis, because of the short duration of these writings. This combination allowed for an in-depth analysis of the past and an understanding of current events. Using research from many different viewpoints we are able to gain an unbiased viewpoint of what many different experts believe could be occurring in the US labor market. From the literature we next take an empirical analysis based on the secondary research. With this analysis and aggregation of the different viewpoints and research enable a richer viewpoint of the US labor market can be gained and from this a better understanding of what could occur in the future.

Unfortunately there are a number of limitations when conducting a research project of such scale and scope. An economy and country as large as the US it can be difficult to understand all the factors that are currently impacting the economy and the degree of those impacts. Due to the speed at which new technology is being created and deployed it is also difficult to determine the actual implementation of this new technology. This represents a limitation in the methodology of the research as it takes time to analyze what its occurring in the economy and what are the potential causes and impacts. Companies may be waiting to upgrade to newer technologies, so the impact may not be immediately felt or understood. Many other technological lags may also be present, but not very well understood and create a false impression. While it would be ideal to understand each specific technologies impact on the labor market this is simply not feasible and instead we will focus on the technologies seen to cause the largest impact on the labor market. These technologies include: Artificial Intelligence (herein referred to as AI), Machine Learning (herein referred to as ML) and Big Data. While there is an ample amount of time series data available for the US economy this data lacks the impact of more recent technology. The speed of innovation in technology and the impact of newer more powerful technology on the economy are unlikely to be captured. With this analysis of the past it can lead to a misnomer in the understanding of the relationship between technology and the labor market in the US. Because the technologies as mentioned are only relatively recent in their current form the impact may not be fully realized. From this we may get an incorrect viewpoint of the current trends in the economy based off of the short time frame of newer technologies that are causing the impact.

The structure begins with a focus on the previous industrial revolutions and an in depth analysis of the fourth industrial revolution followed by a specific look at the US labor market and how it was transformed during the first industrial revolution to the fourth industrial revolution. After fully understanding the fourth industrial revolution we begin an in-depth analysis of the labor market in the US. Further analysis grants us the ability to understand the current characteristics and the possible future characteristics of the US economy. After understanding the causes and the impacts that could affect the US labor market we look at the possible policy recommendations to help with the problems resulting from the automation.

1 THE FOURTH INDUSTRIAL REVOLUTION

1.1 Major Technological Advances In the Past: First to Third Industrial Revolution

Technology is advancing at such a pace that in recent years machines are beginning to surpass humans in performance in certain tasks (Executive Office of the President, 2016). While rapid progress is being made it is unlikely that machines will be able to surpass humans on a general level of intelligence in the next 20 years (Executive Office of the President, 2016). The current level of AI automation will expand and continue to increase the US economy with opportunities for wealth generation (Executive Office of the President, 2016). Growth generation however will not be without some serious changes and not everyone may benefit immediately with some workers being displaced from their current positions as companies find faster, better and cheaper ways to improve the tasks that they need to get competed. With the AI type of automation the world is experiencing a transition that is greater than the Industrial Revolution of past centuries; one could consider it to one of the greatest changes the global economy is ever likely to witness (Dobbs, Manyika, & Woetzel, 2015). Compared to the past the rate of change that is occurring is 10 times faster at 300 times the scale or about 3,000 times the impact (Dobbs et al., 2015). This current level of technological progress is the result of centuries of improvements, known as industrial revolutions. There have been multiple industrial revolutions each providing a new major technological development that transformed labor.

The **first industrial revolution** took place during the late 18th and early 19th centuries and brought about the benefits of mechanization where animal and human labor was able to be replaced by mechanical labor for the first time in history (Rodrigue, 2017). This industrial revolution was marked by the emergence of mechanization that began the process that would replace agriculture as the foundation of the economy with industry (ICS & Cybersecurity, 2017). The steam engine became the main source of energy, replacing coal as the main source of energy allowing for the development of railroads. With the railroads the acceleration of economy followed by allowing for the rapid transfer of both physical and human capital (ICS & Cybersecurity, 2017). The new machines of this era required a titanic amount labor and energy to be operated, but with this requirement the amount yielded allowed for tasks to be specialized and the divergence between industrial and non-industrial economies begin to develop (Rodrigue, 2017).

The **second industrial revolution** occurred during the late 19th and early 20th centuries and relied on the principle of mass production in assembly lines and the coordination between labor and machines further increasing the specialization of tasks (Rodrigue, 2017). The second industrial revolution once again changed the main energy source from steam power to gas and oil (ICS & Cybersecurity, 2017). With these new energy sources came the combustion engine that was able to use the full potential of these resources (ICS & Cybersecurity, 2017). These inventions enabled research and capital to be centralized

allowing for the construction of large factories enabling mass production and the further ability to lower the cost of previously expensive products paving the way for the likes of Henry Ford to bring the automobile to the working class instead of just the upper class (ICS & Cybersecurity, 2017). Additionally steel become commonplace, chemical synthesis brought synthetic fabric, dyes and fertilizer (ICS & Cybersecurity, 2017). Physical distances became less important with the invention of the automobile allowing people to travel great distances with relative ease and speed, and the telegraph and the telephone allowed for increased speed in communication (ICS & Cybersecurity, 2017). Combined with long range transportation systems manufacturing now had the ability to have a long range impact and was no longer confined to only the cities that the factories were located, these impacts are summarized in table 1 (Rodrigue, 2017).

Table 1. The Main Social Issues of Automation and Solutions of each Industrial Revolution

Main Issues to Consider	How the Issues Were Dealt With
First Decade: 1971 - 1980	
• Impact of automation on employment • Work Ergonomics • Human-computer interaction • Humanisation and dehumanisation of work • Human factors of work in design of systems • Improving cooperation between control engineers and social scientists • Optimisation of human-machine relationships • Need for broader education of control engineers	• Analysis of basic problems • Promotion of problem awareness • Analysis of impact of automation on work and people • Recommendations to control engineers
Second Decade: 1981 - 1990	
• "Ironies of automation" • Skill based automation • Job and Work Design • Division of tasks between machine and people • Workers participation • Human-centered systems (Anthropocentric Systems) • Criteria for appropriate system design • Advanced manufacturing systems (AMS)	• Deeper analysis of problems • Structuring of problems • Quantitative analysis of problems • Basic problem-solving methodologies • "Philosophy" of automation • Recommendations to system design engineers and work psychologists
Third Decade: 1991 - 2000	
• Automation and culture • Education for appropriate automation • Socially desirable automation • Ethics of automation • Gender issues in automation • Complex Systems • Integration in manufacturing (IiM) • Links between ACT and ICT • Effects of globalisation • Networks of systems	• Application of concepts and methodologies • Inter- and trans-disciplinary research • Broader exchange of concepts and methodologies among other research areas • Identification of new problems in developing and implementing advanced technologies • Migration of problems from workplaces into everyday use of advanced technology

Source: Janko Černetič, Stanko Strmčnik, & Dietrich Brandt. *Revisiting The Social Impact of Automation.* 2002. Page 7.

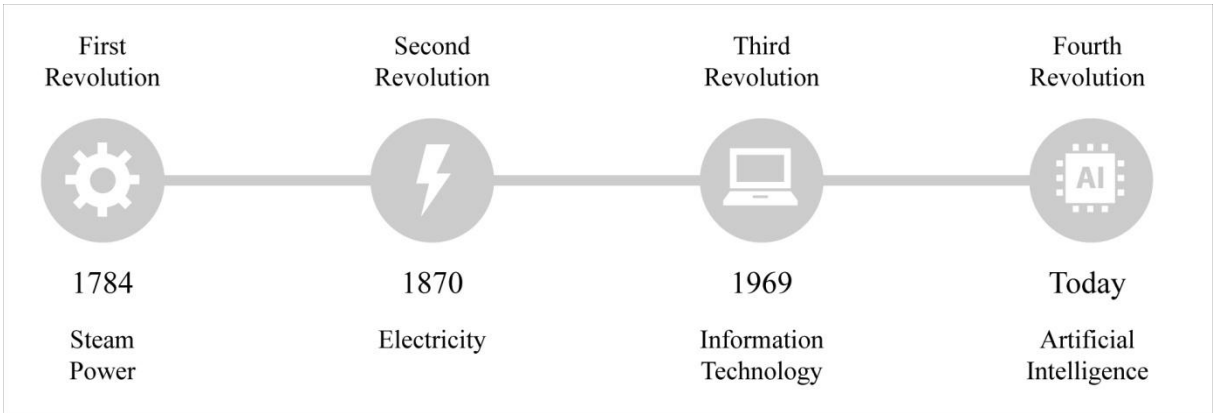
The 20th century saw further automation technologies and the specializing in the manufacturing processes with the arrival of the **third industrial revolution** (Rodrigue, 2017). This revolution was marked by yet another form of energy source; nuclear energy (ICS & Cybersecurity, 2017). The rise of electronics, most notably the transistor and the microprocessor, enabled telecommunications and most importantly the computer led to the miniaturization and new industries in biotechnology, high-level automation (ICS &

Cybersecurity, 2017). This high-level automation made its way to production in two major inventions; Programmable Logic Controllers (herein referred to as PLCs) and robots, technologies that would become of even greater importance later (ICS & Cybersecurity, 2017). Globalization also had a large impact as the ability to transport physical goods enabled the minimization of input costs, particularly labor costs (Rodrigue, 2017). Automation, to some extent, was not fully realized here because with the development of global networks the logistics and transportation enabled many factories to leave developed countries where labor was expensive and move to developing countries where labor was cheap avoiding the expensive costs of automation in creating the products, but still utilizing technologies in disrupting the products around the globe (Rodrigue, 2017). This factor was the result of companies only partly automating their supply chains and automating only the minimal part of the supply that was required. Social issues resulted from the increased usage of automation with each decade creating a specific set of issues.

1.2 Major Technological Advances In The Present: The Fourth Industrial Revolution

The fourth industrial revolution is characterized by merging technology to the point that it blurs the categories of physical, digital and biological to the point that it transforms industries all over the globe (ICS & Cybersecurity, 2017). This revolution began with the emergence of the internet and unlike previous revolutions a new energy source will not be the driving factor of this revolution, but instead the process of digitalization will be the main force behind the changes occurring in this industrial revolution (ICS & Cybersecurity, 2017). Automation goes beyond the mechanization of the past by allowing technology the ability to complete complex tasks to the point that it will soon surpass the flexibility of human labor (Rodrigue, 2017). Interconnectivity will also be a major impact as not only people will be connected with each other every day, but also machines will be able to communicate with each other, without the need for human interaction. This industrial revolution will enable numerous facets of the manufacturing processes (such as, but not limited to locations, the scale and the scope of the output and customization of products) (Rodrigue, 2017). Supply chains are no longer limited to borders, but become part of a much larger global value chain, further combining the manufacturing process with the supply chain (Rodrigue, 2017). This phrase of the revolution has experienced technological breakthroughs at an exponential rate instead of a linear pace as in the past and these changes are occurring at a breadth and depth that is changing entire systems of production, management, and governance (World Economic Forum, 2016). This age will be followed by developments that are so profound and seismic that it will have the potential to change the long-held human-centric status quo (UBS, 2017). Figure 1 briefly illustrates the main technology of each industrial revolution.

Figure 1. The Four Industrial Revolutions and Their Most Important Technologies



Source: UBS. The Evolution of Artificial Intelligence (AI) – A New Dawn. 2017. Page 3.

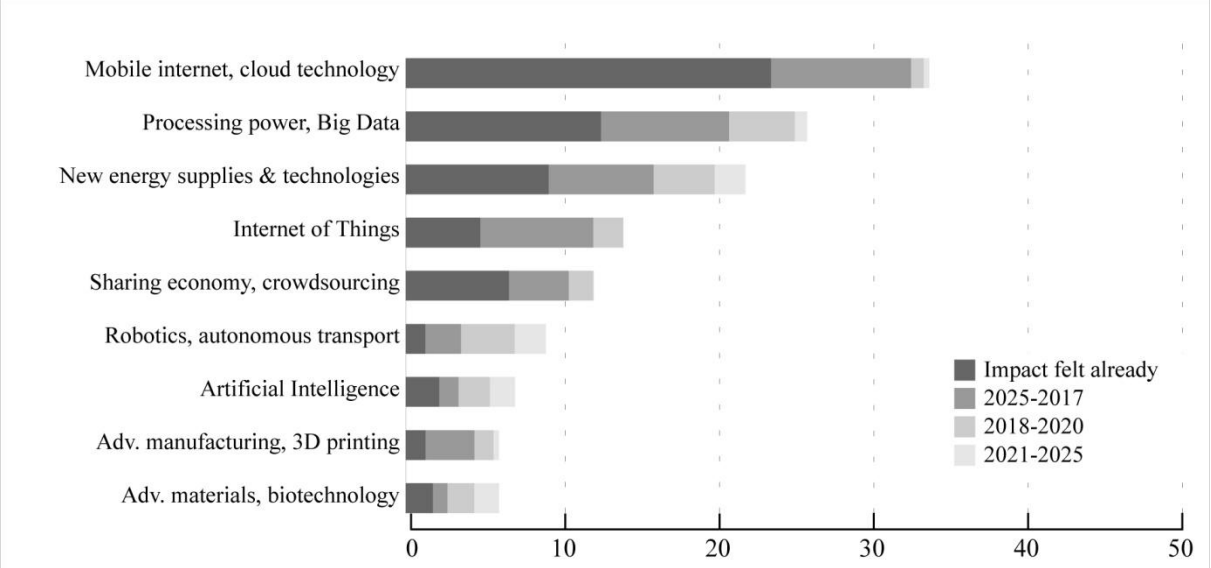
Some of the technologies that are affecting the economy are robots, augmented reality, advanced algorithms, machine-to-machine communications; 3-D printing and autonomous vehicles are just a handful of the new technologies that are affecting the economy and our lives (West, 2015). The impact of each individual technology and the depth of their effects will vary and as further research and development is conducted and there is evidence of what technologies will probably play a significant role (Pluralsight, 2017):

- Wireless technologies.
    - Mobile Internet.
    - Internet of Things (IoT).
    - Cloud technology.
- Technology as a service.
    - Software as a Service (SaaS).
    - Infrastructure as a Service (IaaS).
    - Platform as a Service (PaaS).
- Artificial Intelligence (AI).
- Machine Learning.
- Big Data.
- Virtual and Augmented Reality.
- 3D Printing.
- Advanced robotics.
- Genomics.
- Blockchain (virtual and crypto currencies).
- Supercomputing and quite possibly Quantum computing.

Many of these technologies are impacting the labor market and with their continued development in the future have the potential to further change and bring challenges to the labor market as illustrated by figure 2 an approximate timeline of see these technological changes impacting the labor market.

This current form of automation is being lead by many new technologies, but one technology is likely to have the biggest impact; AI. AI is a deep topic including deep learning, cognitive computing, machine learning, and machine intelligence, the Association for the Advancement of Artificial Intelligence describes artificial intelligence as "the scientific understanding of the mechanism underlying thought and intelligent behavior and their embodiment in machines" (Miller & Atkinson, 2013). These entire technologies combine together to create a new technology that allows the creation of new innovations. AI is a major subtopic of computer science primarily in the creation of computational machines and systems that perform autonomously akin to human learning and decision-making (Miller & Atkinson, 2013). This was once the realm of humans because machines were unable to perform these tasks, and thusly humans had a distinct advantage over the machines. During the Great Recession numerous businesses faced major budgetary constraints and thusly were required to curtail their labor force and were forced to downsize their workforce for budgetary reasons and mange business activity through smaller and more efficient methods (West, 2015).

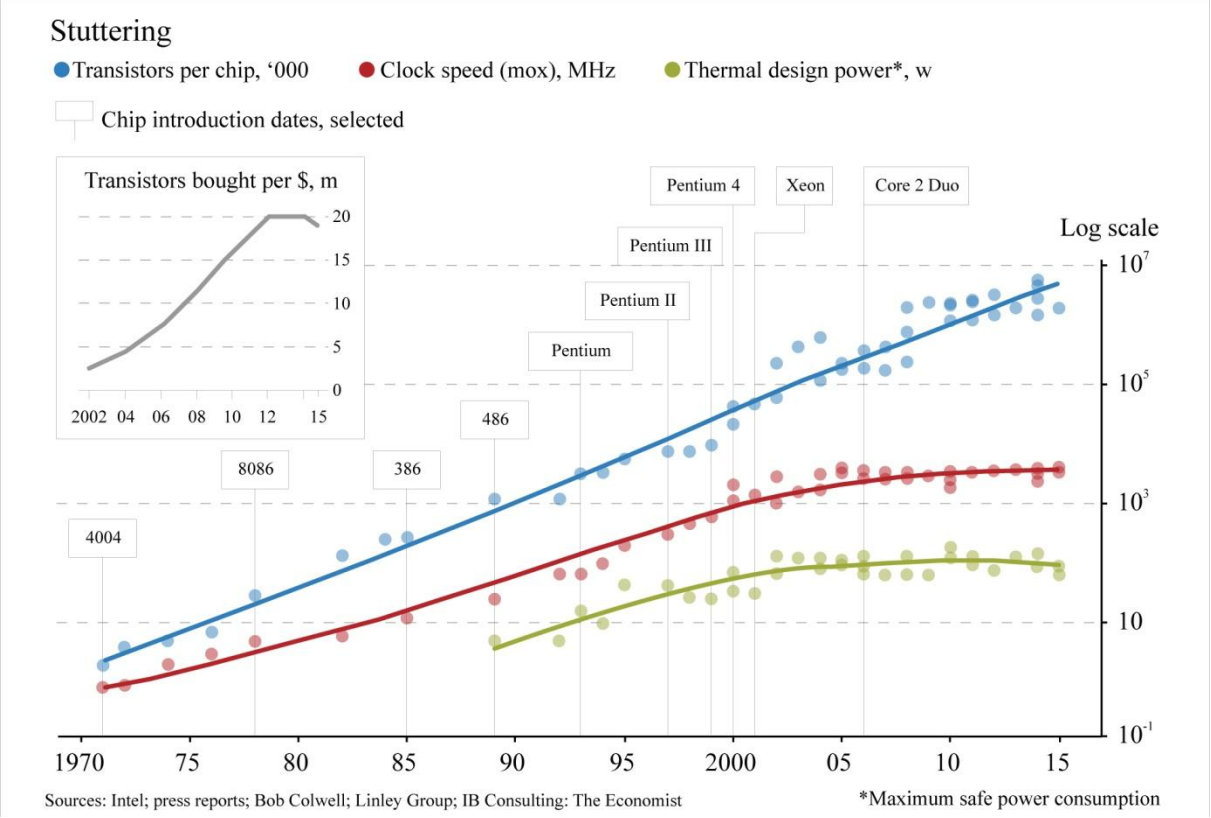
Figure 2. The Technological Changes the Economy is Facing



Source: World Economic Forum. *The Future of Jobs: Employment, Skills and Workforce Strategy for the Industrial Revolution.* 2016. Page 19.

None of these technologies would have been possible had it not been due to Moore's Law. Moore's Law is named after Gordon Moore, one of the founders of Intel, who famously predicted that the speed of computer processing would double every 18 to 24 months even as the price of that computing power halved (Miller & Atkinson, 2013). Moore's Law has continued, not as the same speed as in the past and if continues to grow (even at this slower rate) it will enable many technologies such Artificial General Intelligence (herein referred to as AGI) a reality (Miller & Atkinson, 2013). Technology is increasing at an exponential rate whereas humans are not able to because evolution is a much slower process than engineering as shown in figure 3.

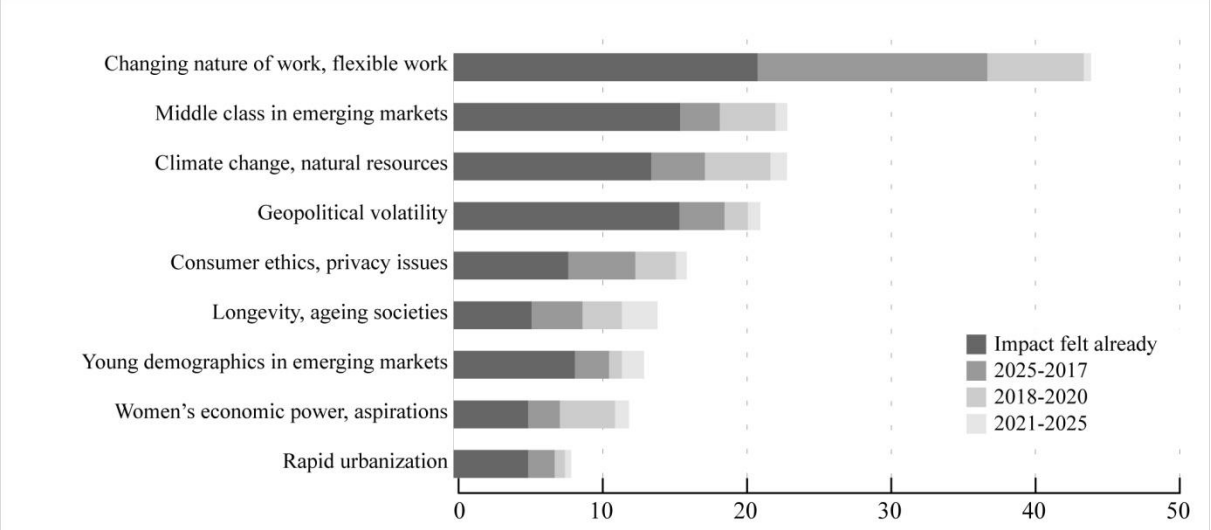
Figure 3. Transistor Technology Progress Throughout the Years



Source: Mikal Khoso & Kamran Khan. *Smartphones: A Supercomputer in Your Pocket.* 2016 Page 3.

The consequences of the fourth industrial are wide and varied with both positives and negatives to look forward to. Positive benefits include: connecting billions of people to digital networks, improve the efficiency of organizations, and assist to regenerate the environment (Schwab, 2016). Negative benefits include: organizations could be incapable to acclimate to this new environment, needed government policy to govern these new technologies, potential security concerns due to interconnectivity, growing inequality and societies fragmenting (Schwab, 2016). The biggest challenge facing the free market will be to understand how millions of people being unable to provide any economic benefit to society will impact the labor market (Davidow & Malone, 2014). Similarly as with the technological timeframe impacts figure 4 illustrates the demographic and socio-economic impacts that are impacting the labor market.

Figure 4. The Demographic and Socio-economic Changes that the Economy is Facing



Source: World Economic Forum. *The Future of Jobs: Employment, Skills and Workforce Strategy for the Industrial Revolution.* 2016. Page 19.

AI is also causing trends to break and is radically changing the world from our youth a world we prospered and formed, causing society great fear and anxiety (Dobbs et al., 2015). A departure from that could lead to a better world or a worse world; it is the unknown that causes us great fear. The decisions and actions that are now taken not only influence our local communities, but also people in other countries. The 21st century world is interconnected at many levels with trade, capital and individuals all able to move freely (Dobbs et al., 2015). Globalization now impacts everyone and decisions cannot be made in a vacuum. From this we need to realize that our decisions and actions can have a larger impact than in the past ensure that there is some sort of plan or framework for the future.

The Whitehouse report released in 2016 titled "Artificial Intelligence, Automation, and the Economy" suggest that policy makers should prepare for five economic effects (Lee, 2016):

1. "Positive contribution to aggregate productivity growth" (Lee, 2016).
2. "Changes in the skills demanded by the job market, including greater demand for higher-level technical skills" (Lee, 2016).
3. "Uneven distribution of impact, across sectors, wage levels, education levels, job types, and locations" (Lee, 2016).
4. "Churning of the job market as some jobs disappear while others are created" (Lee, 2016).
5. "Loss of jobs for some workers in the short-run, and possibly longer depending on policy responses" (Lee, 2016).

Similarly as in the past the fourth industrial revolution is expected to leave a marked impact in numerous ways. This will create many threats as well as opportunities that will lead to strengths and weaknesses in the labor market. Table 2 shows a Strength, Weakness, Opportunities and Threats (herein referred to as SWOT) analysis of the fourth industrial revolution.

Table 2. SWOT Analysis of the Fourth Industrial Revolution

Strengths	Opportunities
1. Connected world, open systems, knowledge economy.	1. New jobs (computer engineers and scientists, network experts, etc).
2. Networks, exchange, sharing and collaboration, with access based on functionality rather than ownership.	2. More "agile" work organisation; new forms of more flexible and more autonomous work.
3. Integration of industries and services: intelligent factories, energy systems, mobility, transport and cities and "optimised" governance.	3. Abolition or repetitive and routine tasks.
4. Automation, robotisation, learning machines.	4. Better ergonomics, help in performance of heavy or complex tasks.
5. Productivity, efficiency and profitability gains.	5. New forms of collaboration and cooperation among workers.
6. Zero marginal cost economy.	6. Reshoring or onshoring (return of industries and new "smart" factories and jobs to their country of origin).
7. Innovative products and services, proliferation of mobile apps to "make life easier".	7. Possibility of new ways of distributing productivity gains (working time reduction).
8. New autoproduction capacities, micro factories.	8. Possibilities of social emancipation, change of economic model geared to peer-to-peer and common goods ("post-capitalist" society).
Weaknesses	**Threats**
1. Jobless growth, jobless future.	1. Massive destruction of medium-skilled jobs (computerisation).
2. Emergence of super powerful oligopolies, new world data masters.	2. Intensification of "anytime, anywhere" work; blurring of the boundary between private life and working life leading to stress and burnout.
3. Concentration of power and wealth in value chains (equivalent losses for other companies, sectors and countries).	3. Loss of control by workers of their own expertise and know-how and free will (becoming the tool of a machine).
4. Frequent problems of (non)-compliance with regulatory, administrative, labour and taxation standards.	4. Digital management, policing of workers, risk of mutual loss of trust between employees and management.
5. Protection of personal data exposed to intrinsic risks.	5. Precarisation of jobs and statuses, total dependence on "data masters"; "servification".
6. "Algorithmisation" of individual behavior, work and consumer habits, social and cultural preferences; normalisation and standardisation of the individual.	6. Weakening of collective action and industrial relations.
7. Hollowing out of the middle classes and polarisation of society between a reduced number of "top-of-the-scale" workers and a mass of "bottom-of-the-scale" workers.	7. Skills and training/labour demand mismatch.
8. Under-investment and under-utilisation of digital tools for the social emancipation of low-income sections of society.	8. Exacerbation of inequality, wage stagnation.
	9. "Digital Taylorism" and emergence of a class of digital gallery workers (crowd sourcing); world competition among workers for all jobs not requiring face-to-face contact.
	10. Erosion of tax base and social insurance financing.

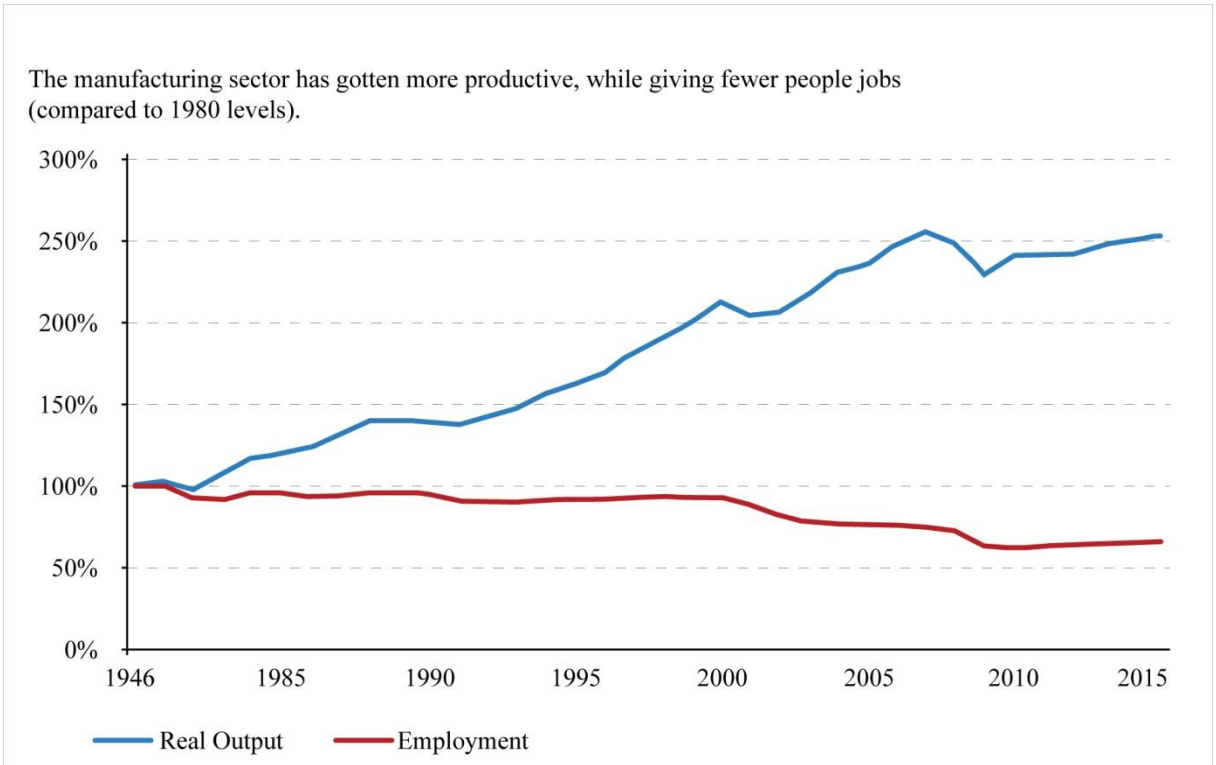
Source: Christophe Degryse. *Here Are The New Social Risks Of The Fourth Industrial Revolution.* 2016. Page 1.

The new technologies being currently developed in the fourth industrial revolution allow for greater labor reduction then the industrial revolutions of the past. Many economic and social impacts will create many new opportunities and threats that will be present new challenges for individuals, companies and governments.

2 THE IMPACTS OF THE FOURTH INDUSTRIAL REVOLUTION ON THE LABOR MARKET

Economic Possibilities for our Grandchildren" by John Maynard Keynes popularized the phrase "technological unemployment" in the 1930s a term Keynes defined as "unemployment due to our discovery of means of economizing the use of labor outrunning the pace at which we can find new uses for labor" (Miller & Atkinson, 2013). The process of automation in the workforce is not a new phenomenon, nor has the previous occurrence of automation been of much concern to economists either. Constant new advancements in technology and the resulting changes in society have always been met with some form of skepticism. Plato 3,000 years ago, quoted the Egyptian king Thamus as "complaining that those who practice writing will stop exercising their memory and become forgetful: they might start believing that wisdom dwells in writings … when it resides in the mind" (Miller & Atkinson, 2013). Figure 5 demonstrates how employment levels are currently less than 1980s levels (based on an index level with the base year of 1980), while real output has increased by levels of 250 percent.

Figure 5. Manufacturing Output is Being Achieved with Fewer Workers



Source: Mark Muro. *Manufacturing Jobs Aren't Coming Back.* 2016. Page 4.

Acemoglu (2016) has stated that huge transformative changes in the labor markets of US and other advanced economies are occurring related to the wave of new disruptive technologies based recently on AI and robots. Currently the largest factors that are impacting the economy and simultaneously transforming the world the labor force are also the biggest influencers of growth and productivity, however these forces in the form of digital technologies are neither

fully understood nor appreciated (Brynjolfsson & McAfee, 2011). Technologies are advancing at an unprecedented level with organizations and individual skill-sets falling behind unable to grapple with what is becoming known as a "Great Restructuring" (Brynjolfsson & McAfee, 2011). Researchers estimate that the scale of threatened jobs over the next couple of decades has a range of 9 to 47% (Executive Office of the President, 2016). Every 3 months 6% of the jobs in the economy are removed (either by closing or a reduction of business, or even the outright destruction of businesses) while only a slightly larger percentage of jobs are created (Executive Office of the President, 2016).

A key tenant over the course of history is that the technological advancements allowed machines to perform tasks at an economical advantage compared to humans allowing the enactment of new technology increased productivity therefore creating jobs, raised earnings and expanded the desperate need for skilled labor (Nath, 2017). This new era of automation and artificial intelligence has invoked fear in society in which computers replace both blue collar and white collar jobs (Nath, 2017). This trend departs from the tradition were only unskilled manual labor was affected by the advancement of technology.

Computers are replacing tasks and with skill-biased technological change occurring allowing additional possibilities for automation to occur in the labor market (Acemoglu, 2016). There are two potential and very different labor market implications:

1. Enabling: the technology that is being created complements and increases the productivity of certain types of skills (Acemoglu, 2016).
2. Replacing: the technology is taking over tasks previously performed by labor (Acemoglu, 2016).

Besides these direct impacts of industrial revolution, technology will impact the labor market also through the following two effects:

1. Task effect: tasks are being automated that the requirement for human labor is being reduced and jobs are being consolidated reducing the aggregate demand for human labor.
2. Income effect: the gains from automation will not be distributed evenly with incomes and other monetary benefits at risk for the majority.

In continuing, these impacts are discussed in detail.

2.1 Enabling Impact

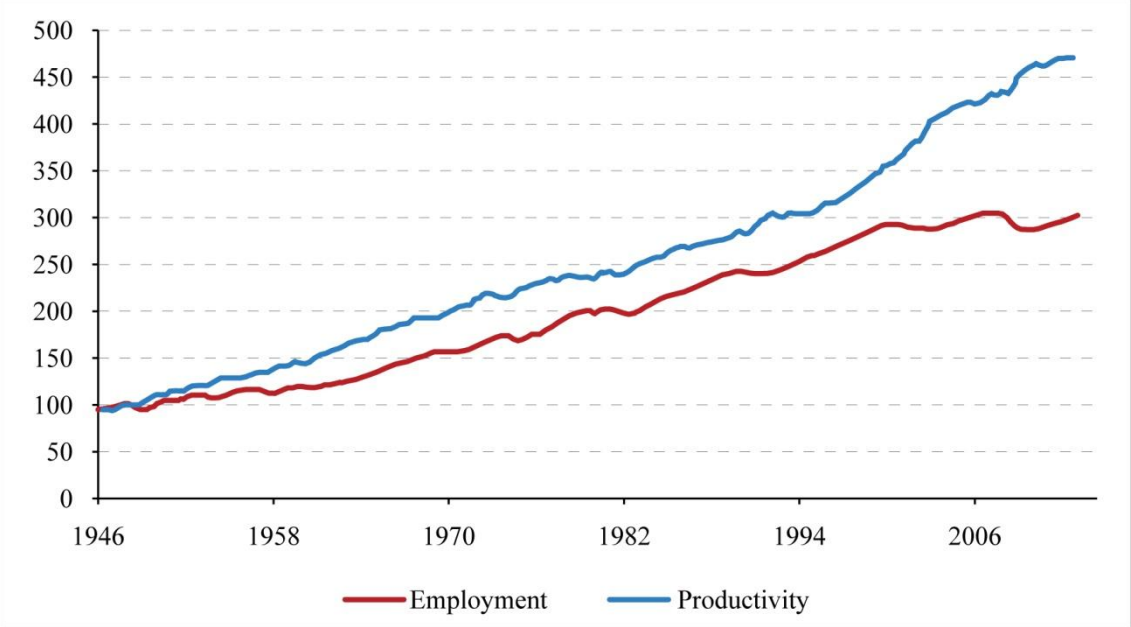
Accelerating AI capabilities will enable automation of some tasks that have long required human labor (Lee, 2016). New opportunities will be created for individuals, the economy, and the society from this new technological metamorphosis, but they will also disrupt the employment of millions of Americans (Lee, 2016). On some reports an estimated half of all occupations in the US and other advanced economies are at risk to be substituted by some form of automation within 10 to 20 years (OECD, 2016). Critics claim that whole occupations are unlikely to be automated and it is much more likely that tasks will be automated away instead of whole occupations (OECD, 2016). As a result an improved way to understand the number of jobs that are at risk of automation is to analyze each task that is likely to be automated in each occupation (OECD, 2016). In he US labor market based on 2,000 individual work activities that 18 different capabilities could potentially be automated (Chui, Manyika & Miremadi, 2015). These transformations can be either positive or negative and people have already been affected by them. As well as impacting the economy the threat from AI will be how the government can respond to these threats and to modernize, enhance, and alter administration to respond (Lee, 2016). Therein lies the key principle, it's how the technology will be used, not what is created.

The results from new technological productions must revert back to the economy in either: lower prices, higher wages for the fewer remaining employers, or higher profits (Miller & Atkinson, 2013). The result is a benefit to an individual that currently possess a job. This in turn leads to raising the productivity of one industry, increases demand either in that industry or in all the other industries in aggregate (Miller & Atkinson, 2013). These then become direct and indirect ("second order") effects (Miller & Atkinson, 2013). Direct effects are when a corporation or industry adjusts the employment and therefore impacts their employment the difference in production has an impact in the demand for workers. Indirect effects are the increase in demand coupled with a reduction in prices granting greater purchasing ability and creating growth in other sectors creating an economic expansion. The savings from these two effects can be felt in two ways. Labor may receive a proportion of the savings and receive higher wages and will spend their wages increasing demand leading to greater employment (Miller & Atkinson, 2013). Another method is that the increased savings could be distributed to shareholders and generate additional wealth (Miller & Atkinson, 2013). Higher profits need not be spent to create jobs as automation industry itself can also produce some new jobs in the companies that sell labor-saving technology and in general there should be an overall change in the economy to higher-skill and higher-wage jobs (Miller & Atkinson, 2013). Some go as even so far to state that all employment problems will be fixed by creating employment that develops the machines that remove the old jobs (Miller & Atkinson, 2013). This scenario is unlikely as firms adopt technology to save money and not to move workers from simply one industry to another because otherwise than productivity would have stayed the same with no gains towards the economy.

Figure 6 illustrates the decoupling of employment and productivity starting at an index level of 100 at the base year of 1946 then starting in the mid 1990s employment and productivity

are no longer advancing in tandem and this divergence has been persistent for over 10 years, then the lines cease to move in tandem with productivity climbing and employment shrinking. The neo-Luddites make two related claims: that increasing productivity limits total employment growth, and that it causes unemployment (Miller & Atkinson, 2013). The first claim explained by Brynjolfsson and McAfee is: "The pattern is clear: as businesses generated more value from their workers, the country as a whole became richer, which fuelled more economic activity and created even more jobs. By 2011, a significant gap appears between the two lines, showing economic growth with no parallel increase in job creation." (Miller & Atkinson, 2013). Brynjolfsson and McAfee refer to this as the "great decoupling," associating the absence of employment growth to poor demand of labor and alleging that it creates unemployment (Miller & Atkinson, 2013). This claim in itself creates a problem. No relationship between productivity and total employment growth has been established nor proven and the extent of a country's workforce displays no connection to productivity (Miller & Atkinson, 2013). This also contradicts with the fact that growth in productivity reduced in 1970s and early 1980s, however despite this the US witnessed high job growth (Miller & Atkinson, 2013). A major explanation as to why growth in occupations decreased in the US in the 2000s was due in part to the amount of women entering into the labor market for the last 30 years had finally reached its height (Miller & Atkinson, 2013). Individual occupations and sectors the nature of jobs varies enormously, and the effects of technology will not impact all sectors and occupations evenly and there is a probability that an immediate shift will arrive over night (Miller & Atkinson, 2013). "Baumol's Cost Disease" can assist in explaining why many sectors in the service industry display reduced gains in productivity and why manufacturing experienced the largest amount of gains (Miller & Atkinson, 2013). In regions of the economy that did not increase their production yield they were forced to increase wages in order to contend with workers from other regions of the economy (Miller & Atkinson, 2013). This results in the fact that many employees received wage increases, but companies were not able to improve their production yield and therefore saw a reduction in their profits and become unable to compete in the global arena. This has impacted many important facets of our society where wages have increased (albeit only marginally) while productivity has been little to none, the most notable examples being police and fire, construction, nursing homes and janitorial services, and it is ambiguous how technology rectify the situation (Miller & Atkinson, 2013).

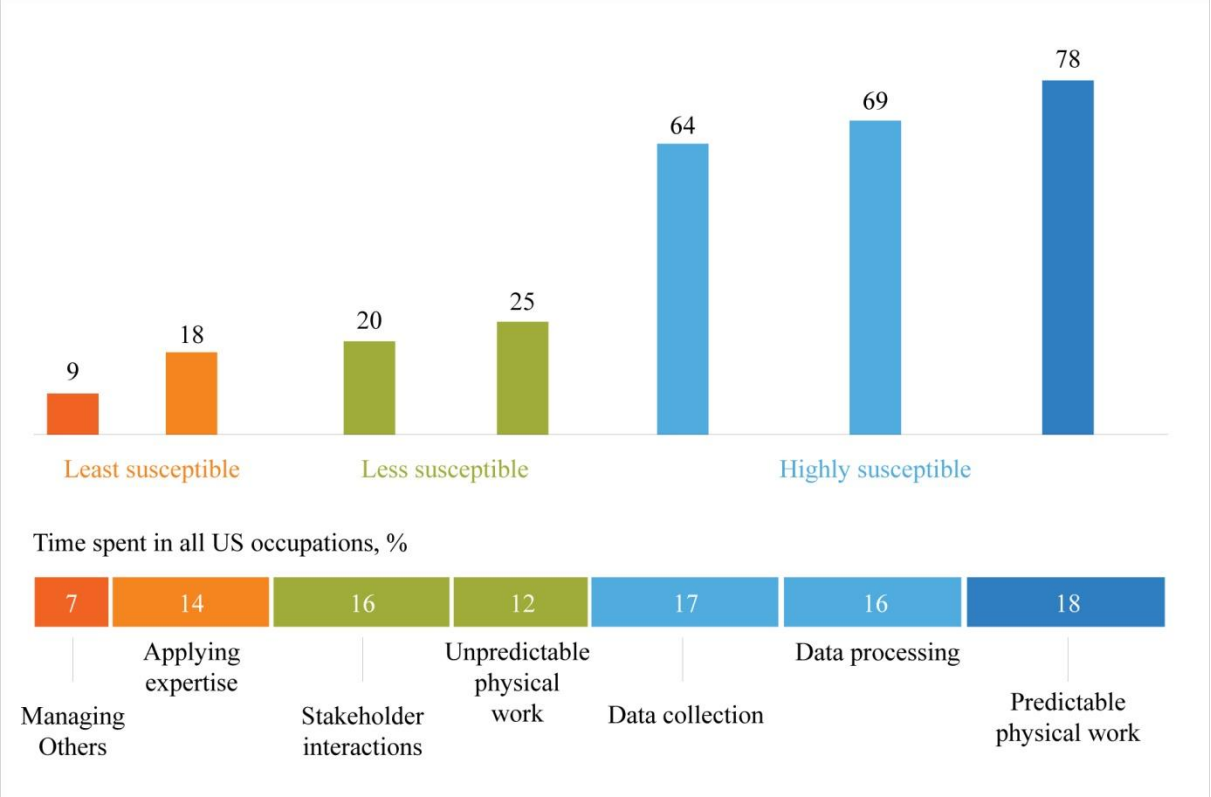
Figure 6. Employment and Productivity are not Directly Related



Source: Ben Miller & Robert D. Atkinson. *Are Robots Taking Our Jobs, Or Making Them?* 2013. Page 12.

Technology if utilized correctly can bring benefits to individuals and increase employment. Digitalization combined with modern methods organization, the "platform economy" can create efficiency in coordinating workers to jobs and tasks (OECD, 2016). These platforms allow people from any location and better matching of supply and demand. This contract type work then creates further pressure about wages, labor rights and contact to other forms of social protection (OECD, 2016). This will create new opportunities for many skilled workers in non-routine tasks, but it could and will pose challenges for others with growing inequity in the ability to under privileged individuals to gain access to jobs that have quality and career potential (OECD, 2016). New policies will have to be invented to enable workers to obtain opportunities and counter to the threats that automation will bring to the larger economic environment (OECD, 2016). In figure 7 the technical feasibility for different type of skills and the likelihood of being automated.

Figure 7. The Technical Feasibility of Automating and the Time Spent on Tasks



Source: Michael Chui, James Manyika, & Mehdi Miremadi. *Where Machines Could Replace Humans – and Where They Can't (yet).* 2016. Page 5.

Five factors are involved: technical feasibility, costs to automate; the relative scarcity, skills, and cost of workers who might otherwise do the activity; benefits of automation beyond labor-cost substitution; and regulatory and social-acceptance considerations (Chui et al., 2016). AI is allowing the opportunity for a plethora of tasks to become the domain of machines than once previously imagined (OECD, 2016). The categories are working with new information, interpersonal skills, and solving unstructured problems (OECD, 2016). Low skilled jobs that have seen an increase are mostly in caring type professional services that are difficult for machines to perform (OECD, 2016).

AI and its technologies will not arrive overnight. Just because the technology is changing it does not mean that this is the destiny. "Given appropriate attention and the right policy and institutional responses, advanced automation can be compatible with productivity, high levels of employment, and more broadly shared prosperity" (Wladawsky-Berger, 2017). There will be time to prepare and decide when and how they best can be used. The best ways to prepare for AI era is the following:

1. "First, and probably the most important step, is to comprehend the potential of AI" (Petropoulos, 2017).
2. "The next step is to establish a framework of the operational procedures for machines and AI automated systems" (Petropoulos, 2017). This framework must ensure that that the safety, security, and privacy are all ensured and therefore by building on trust the

transition from the current era to an AI era would be accomplished easier and avail anxiety of the general populace (Petropoulos, 2017).

3. "Finally the need to arrange and establish procedures that will allow new possibilities of technology" (Petropoulos, 2017). Education and training programs will need to be redesigned to ensure they provide the qualifications to enable individuals to interact and work efficiently in competition with machines (Petropoulos, 2017). Initiatives such as these and ones similar to it will require adjacent interaction by governments and institutions combined with major technological firms that contain the ability and knowledge to devote to the education of workers (Petropoulos, 2017). Finally when workers acquire their new skills they will require assistance in job searches and job reallocation to mitigate concerns that workers may have when they are displaced from their jobs (Petropoulos, 2017).

2.2 Replacing Impact

Digitalization is decreasing the need for mundane tasks while shifting demand for lower and higher skilled occupations and interpersonal skills (OECD, 2016). The growth prospects of AI have the potential to grow at exponential rates because of the cloud computing to support it, low computing and storage costs, advanced algorithms and the increasing availability of AI-based talent (UBS, 2017). This type of technology allows individuals to be more productive than before and should be welcomed as it allows the performance tasks of difficult tasks and tasks to be performed faster or a combination of both. The "aggregate production function" captures this idea with two types of skills Low (A_L) and high (A_H) in the function F(A_L L, A_H H) were A_L and A_H play the role of "boosting" the amount of labor supply of different types of workers (Acemoglu, 2016). This approach describe how economics in the past explained skill-biased technological change and the reason that economists were and still to lesser extent excited about new and improved technology (Acemoglu, 2016).

Routine tasks will clearly be automated away, but cognitive tasks, once considered only the domain of humans, can be also automated away (OECD, 2016). Humans do have abilities such as emotional and creative intelligent that are a challenge to automate, however the duration of time that most individuals allocate on these actions requiring these abilities is low, at around 4% of tasks across the US economy require a modest level of creativity (Chui et al., 2015). Perceiving human emotion is also low with only 29% of tasks requiring a modest level of creativity median human level of performance in sensing emotion (Chui et al., 2015). While AI supplants routine tasks, it enables individuals concentrate on an individual's creativity and emotion (Chui et al., 2015). Workers could spend less time on data analysis and number crunching and more time ensuring that their clients' needs are meet. Industries such as creative design, workers can focus less time on technical tasks and more time in innovation (Chui et al., 2015). If workers lack a creative ability they could become completely out of work because other jobs have been automated away by AI.

AI based automation does shift demand away from labor, but AI based automation also displaces labor and increases production to a position that creates an increased need for labor

and adjustments (Autor, 2015). Digitalization creates an inquiry on technology's ability to substitute work based on the Survey of Adult Skills (herein referred to as PIAAC) estimate that 9% of jobs are at a great risk of being automated, 25% of jobs and 50% of tasks will change significantly as a result of automation (OECD, 2016). Across the developed world where wages are high, automation is being chosen as the method to increase productivity and gain competitive advantages. The changes that are brought due to technology alter the type of jobs available and lately a polarization of labor market is becoming apparent as increases in salary occurred at an irregular rate with a larger percentage occurring to the higher and lower distributions, with the middle distributions having their wages reduced (Autor, 2015). Table 3 breaks down the ability of computerisation of various tasks.

Table 3. O*NET Variables that Serve as Indicators of Bottlenecks to Computerization

Computerisation Bottleneck	O*Net Variable	O*NET Description
Perception and Manipulation	Finger Dexterity	The ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.
	Manual Dexterity	The ability to quickly move your hand, your hand together with your arm, or two hands to grasp, manipulate, or assemble objects.
	Cramped Work Space, Awkward Positions	How often does this job require working in cramped work spaces that requires getting into awkward positions?
Creative Intelligence	Originality	The ability to come up with unusual or clever ideas about a given topic or situation, or to developed creative ways to solve a problem.
	Fine Arts	Knowledge of theory and techniques required to compose, produce, and perform works of music, dance, visual arts, drama, and sculpture.
Social Intelligence	Social Perceptiveness	Being aware of others' reactions and understanding why they react as they do.
	Negotiation	Brining others together and trying to reconcile differences.
	Persuasion	Persuading others to change their minds or behavior.
	Assisting and Caring for Others	Providing personal assistance, medical attention, emotional support, or other personal care to others such as coworkers, customers, or patients.

Source: Carl Benedikt Frey & Michael A. Osborne. *The Future of Employment: How Susceptible Are Jobs To Computerisation?* 2013. Page 31.

An inflection point emerges what is technologically feasible in the future decades and the ability the of machines will be in supplanting human labor (Petropoulos, 2017). Based on a study by Manyika et al in 2017 estimates that only a fraction of less than 5% of tasks consist of activities that are 100% automatable, suggesting that a task based approach can better capture the impact of automation (Petropoulos, 2017). Based on the same study, 60% of occupations have at least 30% of their activities that are automatable (Petropoulos, 2017). While the displacement effect of automation is difficult enough, it becomes more difficult to determine the productivity effect of automation (Petropoulos, 2017). It is extremely difficult to predict impending developments in the market due to the constraints such as which jobs, sectors and tasks will be created by new technologies that have not yet been created (Petropoulos, 2017). Smith and Anderson in 2014 asked 1900 experts in the field about the

impact of AI on employment by the year 2025 (Petropoulos, 2017). Of the experts interviewed 48% imagine a prospective world where robots and digital agents have replaced a substantial amount of both blue-collar and white-collar workers resulting in grand gain in income inequality and mass unemployment because individuals effectively become unemployable, not because of their lack of skills, but because they are unable to compete with automation in their current forms (Petropoulos, 2017). Bob Gordon thinks that the explanation of weak US productivity expansion implies that the gains of the digital revolution ended by 2005 and in the future AI will have only a small impact (Petropoulos, 2017).

The current form of automation is taking on a new and different dimension from the past. In the past, technologies removed the demand for human muscle and actually expanded the need for individual effort and therefore economic progress (Davidow & Malone, 2014). These new machines could in aggregate perform more physical work than any human being could ever possibly achieve. This adaptation of technology and automation did not completely reduce the need for physical labor, but it did reduce physical labor enough that many people moved into service oriented jobs. The economy grew at a steady pace and was able to provide a solid middle class life to millions of people who were willing to work. As the standard of living improved steadily for people, US workers were eventually deemed too expensive and jobs were outsourced to countries with cheaper labor, new automation technologies were utilized or a combination of both factors. The next step in automation could be an even greater replacement in substituting for man's senses and brain (Davidow & Malone, 2014). This will only serve to accelerate the process of putting millions of individuals who will be sidelined and therefore unable to work to devote their abilities (albeit limited ones) to the economy (Davidow & Malone, 2014).

John Maynard Keynes **"technological unemployment"** theory holds two opposing views of the impact of automation on the labor force (Petropoulos, 2017):

1. Negatively by the displacement effect: automation will directly displace workers from tasks they were previously performing (Petropoulos, 2017).
2. Positively by the productivity effect: increasing demand for labor in other industries of jobs that arise due to automation (Petropoulos, 2017).
3. Both effects will of course have an effect on the economy, but the question becomes which effect will take precedence. To best answer that we can take a look at two technological instances in history that addresses this question (Petropoulos, 2017).

The **displacement effect of automation** on the labor market is demonstrated in the 19th century when the extent of cloth that a lone weaver could generate expanded by about 50 times, while the input of labor required to generate a yard of cloth decreased by 98% (Petropoulos, 2017). As a result the price of cloth became cheaper, the demand for cloth expanded and thusly four times as many jobs were generated (Petropoulos, 2017). The introduction of automobiles illustrates the productivity effect of automation on the labor market. When the automobile was introduced into the mainstream public the number of horse related jobs decreased to the point of almost entirely disappearing (Petropoulos, 2017).

Despite this decline in the horse related industry the overall number of jobs increased with new industries emerging to serve the needs of motorists (Petropoulos, 2017). As a result both the automobile and other industries grew as a result, creating more employment opportunities for individuals (Petropoulos, 2017). Estimates of job creation by high-tech industries for every job generated in the high-tech industry an estimate of about five additional complementary positions are generated (OECD, 2016). The problem then becomes that the deployment of new technologies is a lagging process due to economic, legal and social obstacle and as a result technological replacement does not occur as quickly as to be expected (OECD, 2016). Both these past scenarios demonstrate that the displacement effect may dominate in the short run, technological change brought may in fact remove more people from the employment pool than it will initially create, causing a overall decline in the number of employment opportunities (Petropoulos, 2017). In the long run this can reverse as people, companies and society whole have time to absorb the changes and cater to the new demands of the new growth industries and eventually being to create new jobs (Petropoulos, 2017).

The first factor and probably the less significant factor (but received far more attention in both the media and in the public) was the offshoring of jobs to countries were cheaper labor was available (Arnade, 2016). For example in China the company Foxconn, the world's largest contract manufacturer, in 2011 installed 10,000 robots (called Foxbots) and in 2014 is installing them at the rate of 30,000 per year (Davidow & Malone, 2014). The Chief Executive Officer (herein referred to as CEO) of Foxconn (Terry Gou) stated that "In the future we will add one million robotic workers" (Davidow & Malone, 2014). There is a potential to displace 1 million workers from their jobs in a relatively short time frame. The wage for each worker is lower than the US and workers are stilling getting displaced. Baxter a $22,000 robot is being produced in quantities of 500 per year (Davidow & Malone, 2014). This robot may be expensive, but $22,000 is a fixed cost, not a yearly salary; suddenly Baxter isn't just cheaper in the US and other developed economies, but soon all over the world. Based on the assumptions of Moore's Law performance gains of 40% per year will continue in the foreseeable, then a more intelligent Baxter could be produced in amount of 10,000 per year at less than $5,000 (Davidow & Malone, 2014). At this charge it becomes almost impossible for any human to compete with this robot, wherever they reside in the world. While Baxter is a robot that will displace manual workers from their jobs, intelligence work is also not safe from the threat of automation. Already the vanguards of 115 point Intelligence Quotient (herein referred to as IQ) machines are already here (Davidow & Malone, 2014). Highly educated doctors are no longer needed and in 2013 the Food and Drug Administration (herein referred to as FDA) approved Johnson's & Johnson's Sedasys machine, which delivers propofol to sedate patients without the need for an anesthesiologist (Davidow & Malone, 2014). Another example occurs in the emerging computer-aided diagnosis (herein referred to as CADx) in radiology. Studies have shown that computational machines perform with more accuracy in analyzing radiolucency (the appearance of dark images) as compared to radiologists of approximately by a factor of ten (Davidow & Malone, 2014). The last two professions are populated by extremely educated professionals that have spent many years to become important pillars in their profession and provide an important service in their

industry. The machines that are being built to replace them are not only cheaper, but more effective at solving the problem.

The second factor and by far the more important of the two factors (and receives less attention in the media) is the **restless pace of automation**. Many economists contend that automation carries much more reasonability than globalization for the reduction of jobs in the US manufacturing sector and the destruction of its middle class (Rotman, 2017). President Obama even went on to warn in his farewell speech, "The next wave of economic dislocations won't come from overseas. It will come from the relentless pace of automation that makes a lot of good middle-class jobs obsolete" (Rotman, 2017). The quote illustrates the magnitude and the concern that is starting to happen in the US economy and is reaching the upper echelon of the government. History dictates that new technologies have increased overall employment opportunities, but there is no notable economic rule that determines this to be a rule (Rotman, 2017). This is exactly the great fear from automation. There is no law or even rule in economic theory that dictates that automation should create jobs.

The consequences of the fourth industrial are wide and varied with both positives and negatives to look forward to. Positive benefits include: connecting billions of people to digital networks, improve the efficiency of organizations, and assist to regenerate the environment (Schwab, 2016). Negative benefits include: management might be ill-prepared to adapt, and therefore required government policies are needed (for example to administer new technologies to reap the benefits, potential security concerns due to interconnectivity, growing inequality and societies fragmenting) (Schwab, 2016). The biggest challenge facing the free market will be to examine how to negotiate the impacts of this development of millions of people being unable to provide any economic benefit to society (Davidow & Malone, 2014).

AI is also causing trends to break and is radically evolving from the past, causes us great fear (Dobbs et al., 2015). A departure from that could lead to a better world or a worse world; it is the unknown that causes us great fear. The decisions and actions that are now taken not only influence our local communities, but also people in other countries. With globalization our world is now much more interconnected with trade and movements of capital, people and information (Dobbs et al., 2015). Globalization now impacts everyone and decisions cannot be made in a vacuum. From this we need to realize that our decisions and actions can have a larger impact than in the past ensure that there is some sort of plan or framework for the future.

The economic impacts of AI-driven automation may be tough to isolate from the other impacts present in our society such as technological change, globalization, reduction in market competition and worker bargaining power, and the effects of past public policy choices policy responses must be targeted to the whole economy (Lee, 2016). It is important to ensure that everyone benefits from any changes. Persisted engagement between the government, various sectors, governmental experts, and the overall public should play a pivotal role in moving the world toward policies that create broadly shared prosperity (Lee, 2016).

In an article in The Atlantic entitled "The End of Labor: How to Protect Workers From the Rise of Robots," blogger Noah Smith puts it more bluntly: "Once human cognition is replaced, what else have we got?" (Miller & Atkinson, 2013). Median US incomes could increase at quadruple amount to an estimate of $200,000 a year a families would still find items to consume and incomes could even expand 20 times to $1 million per year without decreasing consumption and creating jobs (Miller & Atkinson, 2013). Despite this fact neo-luddites however contend that an increase of even this magnitude would not be adequate as computers and other machines are surpassing human abilities because machines now contain the capacity to perform both routine manual or cognitive tasks and now even complex actions (such as decision-making) (Miller & Atkinson, 2013). For there to be demand for human labor, humans must be able to perform tasks at a cheaper rate than machines, however machines are not only becoming better at performing tasks, but machines are also able to compete these tasks cheaper than humans ever could hope for (Miller & Atkinson, 2013). In his book, *The Singularity Is Near* futurist Ray Kurzweil contends that because of Moore's law, Information Technology (herein referred to as IT) will continue on a course of declining prices and increasing processing power, cumulating in advances that society that result in gains in productivity that is approaching the steeper part of the exponential curve (Miller & Atkinson, 2013). Stuart Elliott, in a paper for the National Research Council, extrapolates Moore's law and argues that in a short 23 years computers are likely to displace 60% of all jobs (Miller & Atkinson, 2013).

Kurzweil, Elliott, and other techno-utopians make two key faults because they exaggerate the potential of computers to replace individuals, because both men assume that current trends will persist or even accelerate due to the fact that growth of innovation is not exponential, has never been exponential and never will be exponential (Miller & Atkinson, 2013). Singularity University co-founder Peter Diamandis debates that we are undergoing an era that the speed of innovation is growing at an exponential rate (Miller & Atkinson, 2013) The world could soon experience a world where the majority of the globe is able to will enjoy living standards in comparison to the US within a generation, however for this to occur, the current rate global productivity growth would require to increase at a rate estimated 20% per year, approximately six times quicker than the current rate of growth during the past two decades (Miller & Atkinson, 2013). Former US Treasury Secretary Lawrence Summers is pessimistic about the employment impact and argues that "if current trends continue, it could well be that a generation from now a quarter of middle-aged men will be out of work at any given moment" (West, 2015). From his standpoint, "providing enough work" will be the major economic challenge facing the world not even accounting for various nonmonetary benefits (West, 2015). Economist Robert Gordon from Northwestern takes an extremely firm view and makes the statement that "recent progress in computing and automation is less transformative than electrification, cars, and wireless communication, and perhaps even indoor plumbing" (West, 2015). Advances in the past allowed individuals to connect and move great lengths may result in a greater significance in society than any technology in the 21st century (West, 2015).

The basic principle of automation is to relieve humans of heavy, repetitive and dangerous work and achieve performance gains that otherwise would not be possible with human muscle

alone (Černetič, Strmčnik & Brandt, 2002). A problem however begins to develop because of the conflicting goals of automation were management aims to better utilize resources and workers desire easier, safer jobs and improved satisfaction of their personal and social needs (Černetič et al., 2002). Automation's potential can bring about both positive and negative changes. Positive changes include improving productivity and efficiently and the reduction of waste. Negative changes include exploitation of employees, increased competition between man and machines creating increased tensions.

More recent examples of **labor saving inventions also demonstrate potential future benefits of the impact of technologies**. For example the introduction of new legal software to analyze documents has created a gain in the amount of legal clerks (although a relatively small amount of a 1.1% increase) instead of a decrease as would be explained by the displacement effect (Petropoulos, 2017). Automated Teller Machines (herein referred to as ATMs) are also further evidence of the displacement effect. While ATMs did decrease the number of bank tellers from 20 per branch in 1988 to 13 per branch in 2004 (Petropoulos, 2017). However the expenditure of managing a bank branch decreased, banks in fact opened more branches, 43% more bank branches and as a result the total number of employees increased (Petropoulos, 2017). Based on past studies of societies experiencing changes brought upon them by technology, this period in history is different because of the disruptions of technology within the economy are occurring at an unprecedented rate (Florida, 2017). Even if AI does create jobs and opportunities the other possibility, technological stagnation is a more adverse concern (Florida, 2017). This does not solve the crisis of workers being left behind; when in our capitalist society your occupation is your identity (Florida, 2017). The problem in the US is that in the past there are few programs that are available to help people who have lost their jobs during periods of technological change (Florida, 2017). The US spends only about 0.1% of its Gross Domestic Product (herein referred to as GDP) on programs to assist individuals with adjustments in the labor demand, and much less than developed countries, additionally this funding is also decreasing over the previous 30 years (Florida, 2017).

2.3 Task Effects

AI-based jobs will fall into four main categories: Engagement, Development, Supervision and Response to Paradigm Shifts (Wladawsky-Berger, 2017).

1. Engagement: tasks that cannot be substituted by automation and are generally complemented by technology entering into this occupation, which results in higher demand for workers (Wladawsky-Berger, 2017). This could lead to what experts attribute to a large range of AI technologies such as Augmented Intelligence, emphasizing the part that technology performs in helping and bolstering the productivity of people instead of substituting for human work (Wladawsky-Berger, 2017). This is where Augmented Intelligence pays a pivotal role as technology's main goal here is assistive, not disruptive and will lead to higher productivity among workers (Wladawsky-Berger, 2017).

2. Development: AI for now must still be created and developed by programmers and developers (Wladawsky-Berger, 2017). It is excepted that the required for skilled software developers and engineers to make AI applications a reality across a wide range of industries (Wladawsky-Berger, 2017). As AI increases its presence in our lives, there will be a need for highly-skilled software developers and engineers to not only program, but put AI to good use (Wladawsky-Berger, 2017). As a result jobs that require the analyzing of data will be highly sought after to deal with are the data that is not being generated from IoT (Wladawsky-Berger, 2017). These jobs will most likely become the highest paid and most sought after jobs in a world dominated by AI. These are creators of the ultimate machines.

3. Supervision: there will also be a growing number of jobs to monitor, license, maintain and repair AI systems and applications (Wladawsky-Berger, 2017). Jobs that involve monitoring, license and maintenance and repair of AI system will also increase (Wladawsky-Berger, 2017). AI will require supervision to ensure that it doesn't deviate too far from its intended design and application (Wladawsky-Berger, 2017). If AI based technology can really learn on its own then they needs to be some supervision to ensure the technology doesn't use its power for malice. Similar to companies in their current form many programmers first start out programming and with time and experience become managers. In the future, much like today, the people who work directly with AI will start out in development and as they gain a deeper knowledge and understanding of AI they will ensure that AI is used correctly and will begin to groom a new generation of developers and future supervision of AI.

Response to paradigm shifts, AI innovations will likely require major changes in the surrounding environment (Wladawsky-Berger, 2017). AI will cause a major disruption of skills in the economy and this must be with other factors to ensure that the economy can still function and provide for people (Wladawsky-Berger, 2017). While AI will complement current jobs, it will require people to develop and supervise jobs, new jobs will be needed to fill the void. If our current consumption based economy is to survive and continue, we cannot simply have only engagement, development and supervision type of jobs. This is where the

response to paradigm shifts becomes very important to meet demand. Historically whenever a ground breaking technology is invented new industries emerge to take advantage of this new technology and leave an impact on society.

The trends in employment service jobs, identified by the US Census Bureau as occupations that include helping, caring for, or assisting others, then by middle-skill jobs, comprising sales; office and administrative support; production, craft and repair; and operator, fabricator, and laborer all could experience related from automation (Autor, 2015). From a subset of ten occupations they can further subdivided into three groups: managerial, professional, and technical occupations, which are highly educated and highly paid (Autor, 2015). The bulk of employees in service jobs have little to no post-secondary education, and the regular hourly wages in service jobs are usually less than the other occupational categories (Autor, 2015). Quick employment growth in high-education and low-education occupations has decreased the percentage of employment that encompass for by "middle-skill" jobs (Autor, 2015). In 1979, the four middle-skill occupations (sales; office and administrative workers; production workers; and operatives) regarded for 60% of employment (Autor, 2015). In 2007, this number was 49%, and in 2012, it was 46% (Autor, 2015). The employment amount of service jobs has remained the stable during 1959 and 1979 period and therefore the increase in growth since 1980 represents an important reversal in this trend, where middle-skilled workers were displaced from their routine tasks (Autor, 2015). Throughout the 2000s the growth of wages was poor and even before the Great Recession and the period of 1999 and 2007, real wage changes were negative below approximately the 15^{th} percentile, and were below 5 percentage points (Autor, 2015). Growth in wages was faster at all percentiles during the 1980s and 1990s than in the pre-recession 2000s, with growth in wages near zero at all percentiles during the 2007 to 2012 period (Autor, 2015).

Based on a report published in February 2016 by Citibank completed by Carl Benedikt Frey and Michael Osborne in partnership with the University of Oxford estimated that 47% of US jobs are at risk of automation, in the UK 35% are at risk and in China 77% are at risk compared to the Organisation for Economic Co-operation and Development (herein referred to as OECD) average of 57% (World Economic Forum, 2016). These numbers are fairly high and could affect large segments of the population made superfluous through advances in automation. Most of the research is based on the US and the long term damage that will befall the US economy, the US is towards the lower spectrum because while the percentage in the US is high, other countries are at a greater risk.

Other studies such as Chui, Manyika and Miremadi study in 2015 estimate that 45% of labor activities have the potential to be automated using currently available technology (Petropoulos, 2017). These studies suggest that nearly 50% of the current workforce is at risk of displacement to automation. Arntz, Gregory and Zierahn study in 2016 predicts that across 21 OECD countries only 9% of jobs on average are able to automated (Petropoulos, 2017). So what causes this difference between the two studies? Frey and Osborne put their efforts on entire occupations instead of single occupation-tasks, known as the occupation based approach (Petropoulos, 2017). Some jobs are known as high-risk jobs, the job itself can

contain numerous tasks that are unable to be automated and thus are relatively safe, so a large percentage of the job is automatable, while the entirely of the job is not and as a result dramatically reduces the estimated impact of automation (Petropoulos, 2017).

The effects of workers who could potentially lose their jobs are of great importance to judge how the economy will adapt in the future. Costs of worker dislocation in experienced workers incur substantial earning losses immediately after they separate from their firms as a result from the initial loss of increased unemployment (Jacobson, LaLonde & Sullivan, 1993). These losses are present in all demographic groups and most sectors and persist for several years after displacement (Jacobson et al., 1993). The estimated losses of earnings can take years to catch up to as workers can experience a $6,500 or 25% of their salary lost (Jacobson et al., 1993). This is made worse further by earnings beginning to diverge two to three years before workers have even left their firms in the form of reduced hours, cuts in real wages and increased temporary layoffs (Jacobson et al., 1993). Employees are both hurt when they lose their jobs and even before they lose their jobs in the form of decreased pay. Government programs also fall short of providing compensation for employees who have lost their jobs (Jacobson et al., 1993). One reason is that most of the losses accumulate after an employee is reemployed, in the form of lower pay because they joined a new company, which unemployment benefits do not cover (Jacobson et al., 1993). Government programs fail to meet the gap when employees face a loss of their jobs and therefore other programs such as an income or earnings subsidy must be created and developed (Jacobson et al., 1993).

Automation will reduce only a very few occupations in there entirely in the coming decades, but it's much more likely to impact occupations to some level and the deciding factor will be to the degree on whether or not a task is routine or non routine in nature (Chui, Manyika & Miremadi, 2016). Automation has long surpassed simple ordinary manufacturing processes and has the ability, (from at least a technical feasibility), to change industries such as healthcare and finance (Chui et al., 2016). This demonstrates that jobs that are under threat are no longer ones were simple mechanics and movement are required and therefore thinking and knowledge type of jobs are able to be under great distress as well.

2.4 Income Impact

The past decade has shown that working-age household's real median income has actually fallen from $60,746 to $55,821 (Brynjolfsson & McAfee, 2011). Median net worth also declined in this past decade when adjusted for inflation (Brynjolfsson & McAfee, 2011). Both these numbers declined for the first time in this decade possibly the beginning of a worrisome trend (Brynjolfsson & McAfee, 2011). However on the reverse side the GDP per person has continued to grow fairly steadily in stark contrast to median income shrinking (Brynjolfsson & McAfee, 2011). This observation has lead many experts to believe that the main benefits of automation are received by the owners of capital instead contributing to an increase in salaries despite a large increase in productivity.

It is not just the salaries and hourly wages we must take into account if jobs are lost but also the benefits workers receive from their labor. The effects of workers who could potentially lose their jobs are of great importance to judge how the economy will adapt in the future. Costs of worker dislocation in experienced workers incur substantial earning losses immediately after they separate from their firms as a result from the initial loss of increased unemployment (Jacobson et al., 1993). These losses are present in all demographic groups and most sectors and persist for several years after displacement (Jacobson et al., 1993). The estimated losses of earnings can take years to catch up to as workers can experience a $6,500 or 25% of their salary lost (Jacobson et al., 1993). This is made worse further by earnings beginning to diverge two to three years before workers have even left their firms in the form of reduced hours, cuts in real wages and increased temporary layoffs (Jacobson et al., 1993). Employees are both hurt when they lose their jobs and even before they lose their jobs in the form of decreased pay. Government programs also fall short of providing compensation for employees who have lost their jobs (Jacobson et al., 1993). One reason is that most of the losses accumulate after an employee is reemployed, in the form of lower pay because they joined a new company, which unemployment benefits do not cover (Jacobson et al., 1993). Government programs fail to meet the gap when employees face a loss of their jobs and therefore other programs such as an income or earnings subsidy must be created and developed (Jacobson et al., 1993). At the present individuals must toll 60% of their time (around 24 hours a week) in order to entitle them for nonmonetary benefits (West, 2015). Under full employment employees become eligible for company-sponsored health care plans and pensions (West, 2015). Following the World War II period, employment has been the primary distribution method for nonmonetary benefits, not including the poor and elderly, the primarily method to obtain benefits outside of the public sector and places the burden of providing benefits to employees on the private sector (West, 2015). The post World War II method was satisfactory in an period when the majority of individuals who desired jobs were capable to obtain a job and individuals with limited skills were still capable to obtain good paying jobs with benefits in the manufacturing sector, educate their offspring, and achieve a reasonable standard of living (West, 2015). All these factors changed when the occupations in economy changed, wages stagnated, and new technology allowed companies to utilize less workers (West, 2015). Robotics, machine learning, artificial intelligence, and machine-to-

machine communications reduced a large amount of occupations and removed a large amount of individuals from labor force of the past (West, 2015).

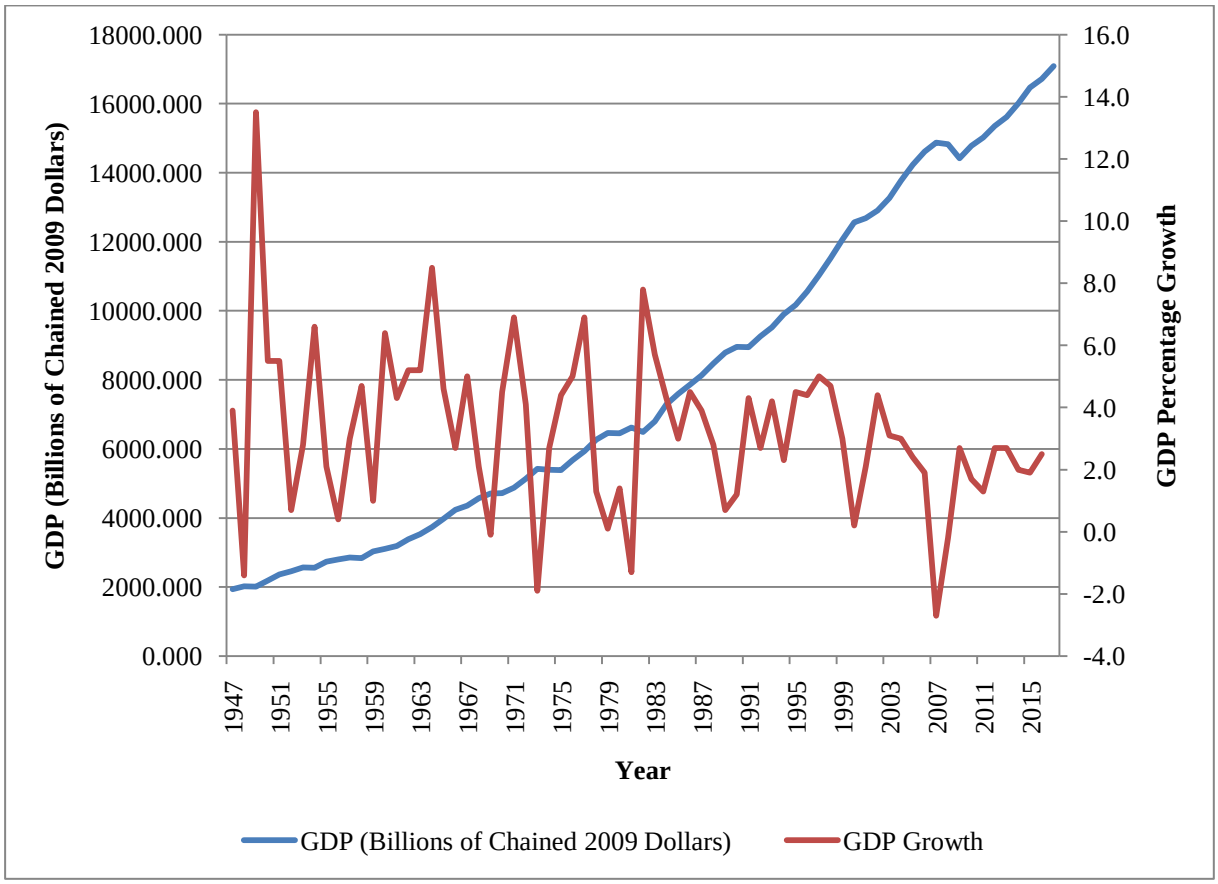
The first impact of computerization on compensation (jobs such as managerial, professional, and technical occupations) these jobs call upon large amounts of regularly evolving expertise (for example medical knowledge, legal precedents, sales data, financial analysis, programming languages, and economic statistics) (Autor, 2015). Information technology and computerization could greatly complement employees performing task-intensive occupations by greatly reducing the expenses and expanding the capacity of knowledge and analysis, digitalization allows employees operating in abstract tasks to add special abilities in their area of comparative advantage, with less time being used on gathering and analyzing data, and additional time spent on interpreting and applying it (Autor, 2015).

3 RECENT DEVELOPMENTS IN THE US LABOR MARKET

3.1 General Trends In The Labor Market

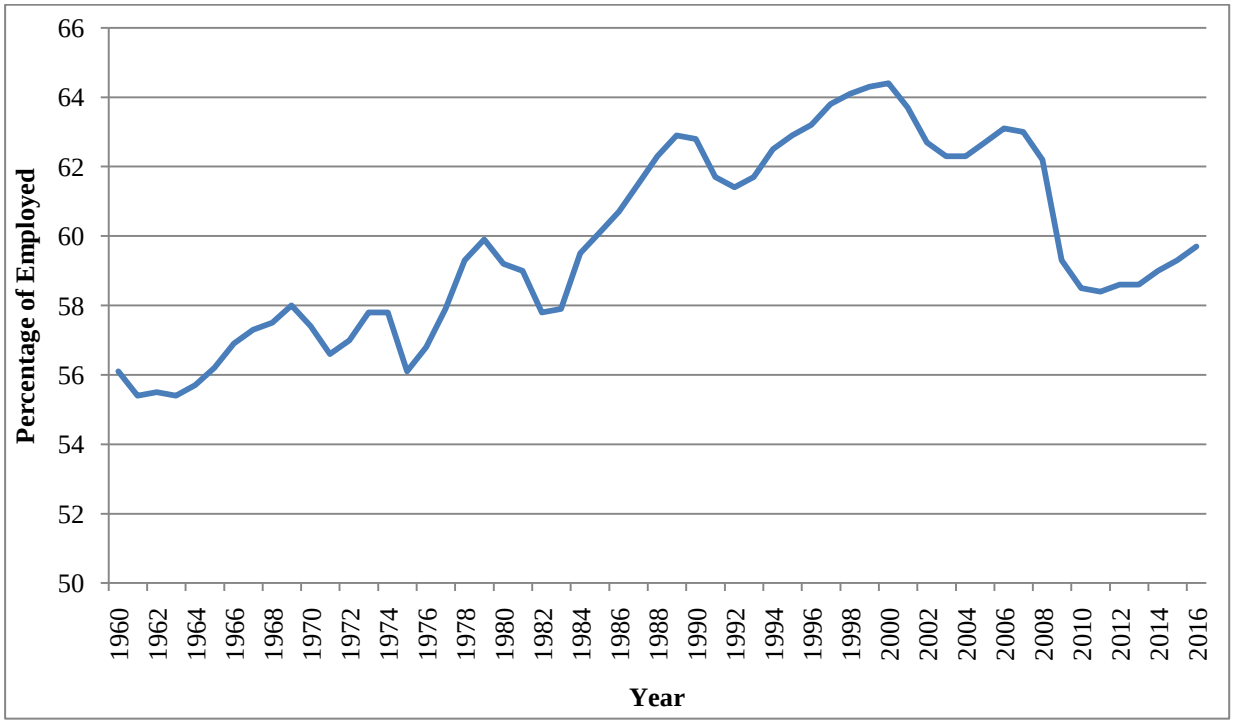
The US economy has increased steadily during the post war period despite growth slowly down starting in the 1980s. This growth has translated into over 50% employment during the post war period, with increases in the 1970s and 1980s as woman earned the workforce on mass. Despite the growth in GDP well in the 2000s, employment as a percentage of population peaks around 2000 (FRED, 2018). This clearly illustrates the decoupling of the employment precisely around the time that automation in the form of advanced computers become available (FRED, 2018). Employment decreased at a drastic rate during The 2008 Great Recession and as of 2017 still has not recovered from pre 2008 levels. Education attainment has also increased steadily in the US during the post war period (FRED, 2018). Currently nearly 90% of Americans possess a high school diploma and 33% of Americans have at least four years of college or more (FRED, 2018). Figures 8, 9 and 10 show a rather paradoxical US economy with a growing economy, increasing post secondary education attainment, but employment at significantly lower rates than in the past, before the widespread use of automation resulting in a divergence of labor productivity, private employment, median household income and real GDP as illustrated in figure 8. Figure 9 shows the percentage of people employed in the US labor market from 1960 – 2016. Figure 10 illustrates the percentage of the US labor market that has a high school education and/or 4 years of college from 1940 – 2015.

Figure 8. US GDP and US GDP Growth



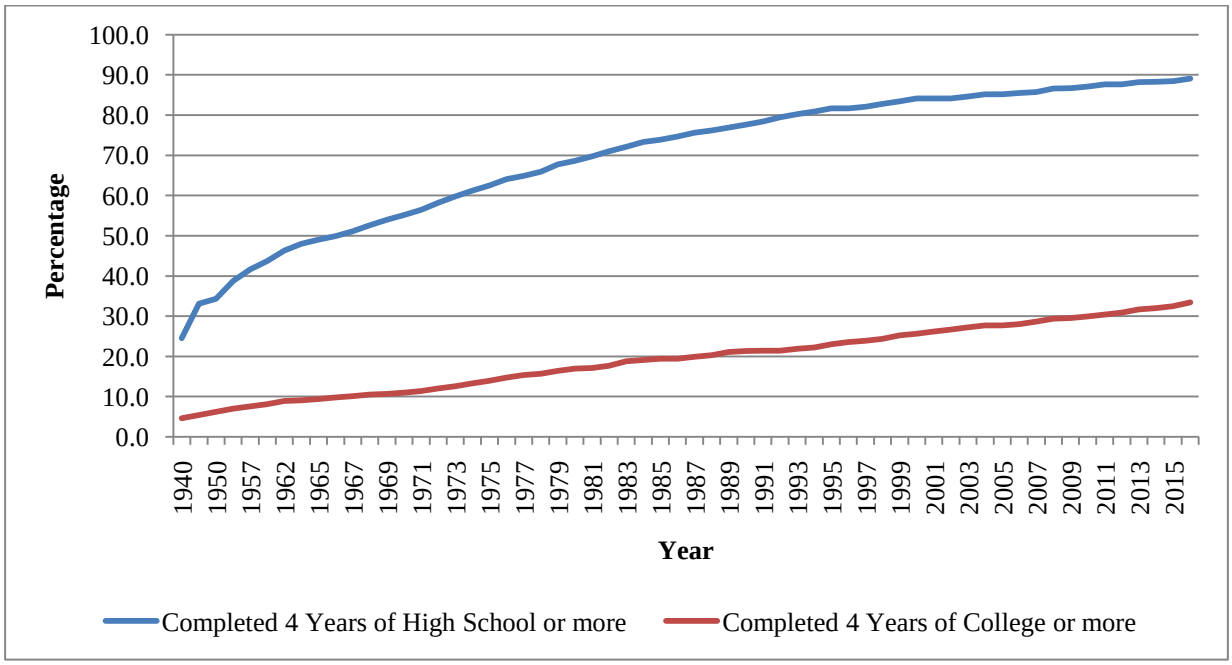
Source: FRED (a), FRED (b). Real Gross Domestic Product. 2018. Page 1.

Figure 9. Percentage of US Population Employed



Source: FRED (c). Civilian Unemployment Rate. 2018. Page 1.

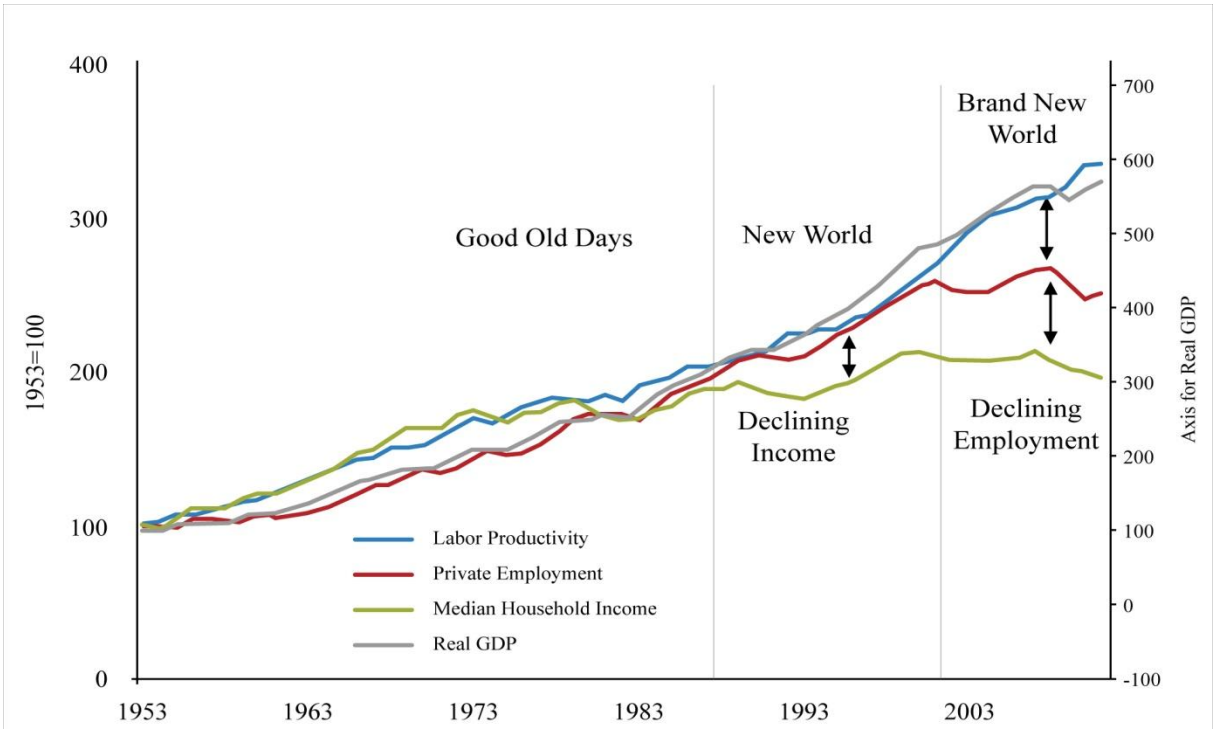
Figure 10. Percentage of US Population with High School and/or 4 Years of College



Source: US Census Bureau. *Educational Attainment in the United States: 2016.* 2018. Page 1.

Figure 11 shows how labor productivity, private employment, median household income and real GDP have changed during 1953-2011 (based on an index measurement with the base year of 1953).

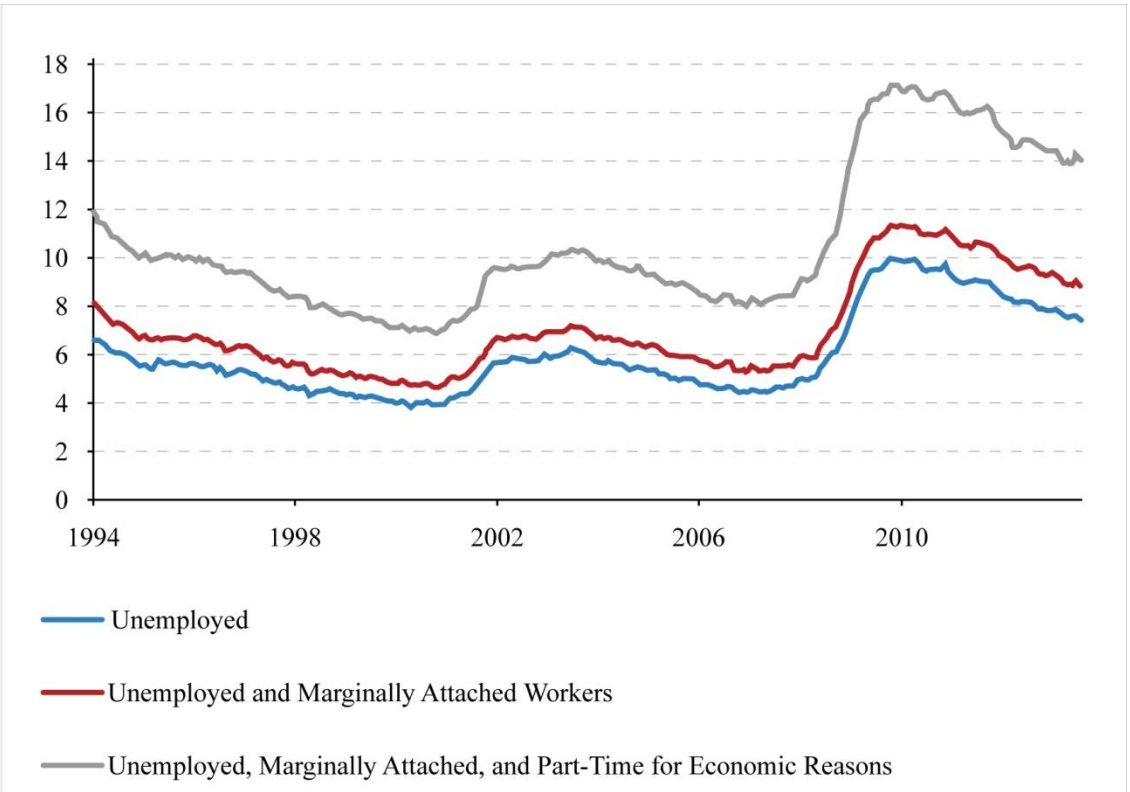
Figure 11. The Effect of Productivity on the Labor Market and Employment



Source: Danny Leipziger & Victoria Dodev. *Disruptive Technologies and their Implications for Economic: Some Preliminary Observations.* 2016. Page 15.

The Lump of Labor fallacy shows how this inaccurate understanding of the technological adjustment because it doesn't consist of critical second order effects such as the savings from gains in production are converted back into the economy that induces demand (Miller & Atkinson, 2013). It's notable how extensive the neo-Luddite perspective has become and how well-accepted it is in Western society (Miller & Atkinson, 2013). In the past neo-Luddite viewpoint was temporary appearing only when a lack of jobs increased, but this viewpoint would decrease as the number of jobs increased (Miller & Atkinson, 2013). The real threat of neo-Ludditism is that if the perspective of machines are the cause of the problems, not a solution, removes the required backing for innovation and progress (Miller & Atkinson, 2013). Figure 12 illustrates the percentage of unemployed workers in the US labor force.

Figure 12. Percent of Unemployed Workers in the US Labor Force



Source: Ben Miller & Robert D. Atkinson. *Are Robots Taking Our Jobs, Or Making Them?* 2013. Page 7.

Despite periodic concerns about technology reducing jobs, in the past the number of jobs always recovered from their lows and continued to increase and when they the fear from machines decreased and support for machines recovered (Miller & Atkinson, 2013). Once again as we continue through the Great Recession the confidence in innovation is beginning to fade exactly when it is needed the most and understanding productivity is of the upmost importance (Miller & Atkinson, 2013). By the late summer of 2011 a report based on the US economy stated that 117,000 jobs had been created in July (Brynjolfsson & McAfee, 2011). This was treated as good news because the previous months of May and Jun a fewer than 100,000 total jobs had been created (Brynjolfsson & McAfee, 2011). Even if job growth doubled to an amount of 208,000 new jobs added every month it would take until 2023 until

the gap that was opened by the recession had been closed (Brynjolfsson & McAfee, 2011). The bigger problem was the fact that the unemployed couldn't find work even after economic growth had resumed and as of July 2011, 25 months after the Great Recession was officially over unemployment remained at 9.1% (Brynjolfsson & McAfee, 2011). The average time of unemployment had increased to 39.9 weeks, a length of time twice as long as during the postwar recovery, workforce participation rate fell below 64% a level not seen since 1983 when women had not yet entered the labor force in large numbers (Brynjolfsson & McAfee, 2011). This was of further concern because other statistics of the economy also looked healthy with GDP growth was at 2.6%; US corporate profits were at all time records and contributions in hardware and software returned to 95% of its historical peak (Brynjolfsson & McAfee, 2011). The history of economics states that industries grow, reap profits they purchase hardware and employ people (Brynjolfsson & McAfee, 2011).

3.2 The Impact Of Technological Change On The Labor Market In The US

The viewpoint that technology is destroying more jobs than it creates is being echoed by Erik Brynjolfsoon and his collaborator and coauthor Andrew McAfee (both of MIT Sloan School of Management) believe that the monumental improvements in computer technology are lagging the sluggish employment growth of the last decade (Roosevelt Institute for the Open Society Foundations, 2015). The duo state that the poor performance also extends not just to the traditional jobs that were at risk for automation such as manufacturing, clerical and retail work, but higher skilled professions such as law, financial services, education and medicine (Roosevelt Institute for the Open Society Foundations, 2015). These factors, they believe, are adding to the stagnation of median incomes and the increase of inequality in the US and believe that this is also occurring in other advanced economies around the globe (Roosevelt Institute for the Open Society Foundations, 2015).

Brynjolfsoon and McAfee believe that technology is progressing at such an increased rate that it is eradicating the requirement for numerous groups of occupations and abandoning most individuals worse off than in the past (Roosevelt Institute for the Open Society Foundations, 2015). Brynjolfsson believes that this is the great paradox of our age, with productivity at record highs, high amounts of innovation, but accompanied with falling median wages and fewer jobs and thusly people are decreasing because technology is accelerating at such a pact that knowledge and organizations are unable to keep pace with the changes that are occurring (Roosevelt Institute for the Open Society Foundations, 2015).

In continuing, I focus on two major aspects of the impact of technology on labor market, which are related to the enabling and replacing effect. These are:

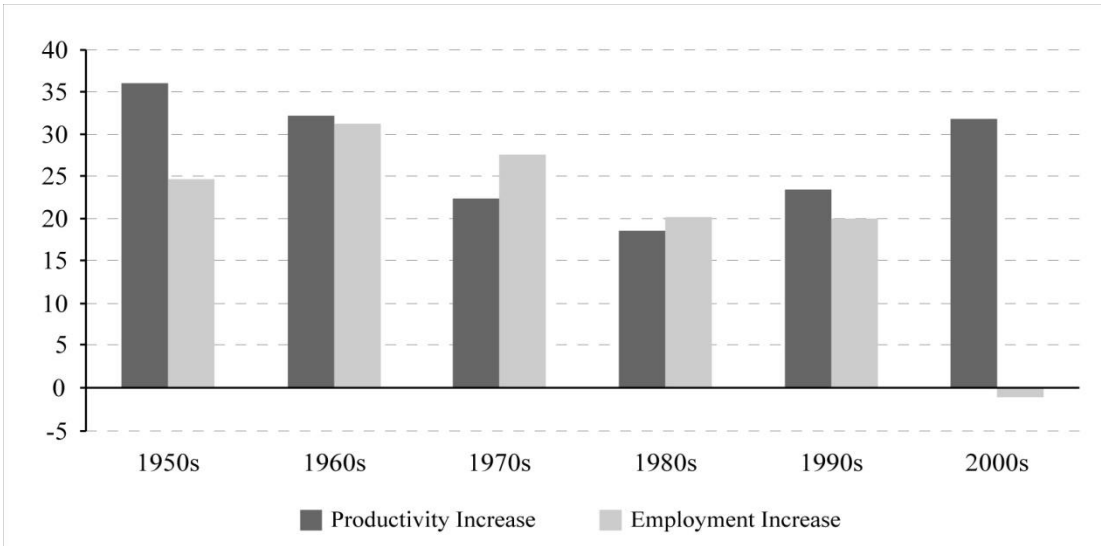
1. Jobs and occupational effect
2. Income effect

I will first provide an overview of the overall impact at the US level, including the sector and occupational impact. Following this general presentation, I will present in more details also the causes of these trends by focusing on automation potential.

3.2.1 Overall impact

The "Second Economy" is a term first coined by economist Brain Arthur describing the percentage of the economy where computers solely transact business among themselves without human involvement (Davidow & Malone, 2014). This "Second Economy" is expected to grow to the size of the "first economy" (the economy that includes humans) was in 1995, about $7.5 trillion by as quickly as 2025 (Davidow & Malone, 2014). If the growth rate is maintained than it could replace an estimate of 100 million workers (Davidow & Malone, 2014). Currently the civilian labor force encompasses an estimate of is 146 million people (Davidow & Malone, 2014). That number may seem alarming, but not all 100 million will be displaced, some portion will be replaced by jobs that will be created by in the "Second Economy", but there is no guarantee that all those jobs will be brought back (Davidow & Malone, 2014). Estimates of as many as 40 million could be displaced in the US alone by automation due to the fact they have no economic value, not taking into consideration into other countries (Davidow & Malone, 2014). This scenario of robots doing human work is not as farfetched as people believe. If a robot that was capable of the IQ of the average human, an IQ of 100, but if technology improves at a rate close to Moore's Law than that translates to a gain of 1.5 IQ points per year so by the year 2025 machines will have an IQ greater than 90% of the US population (Davidow & Malone, 2014). The 15 point IQ gain within 10 years would be able to allow an additional 50 million jobs within the range of these new smart machines (Davidow & Malone, 2014). Figure 13 shows the employment and productivity increase per decade with a notable exception during the 2000s.

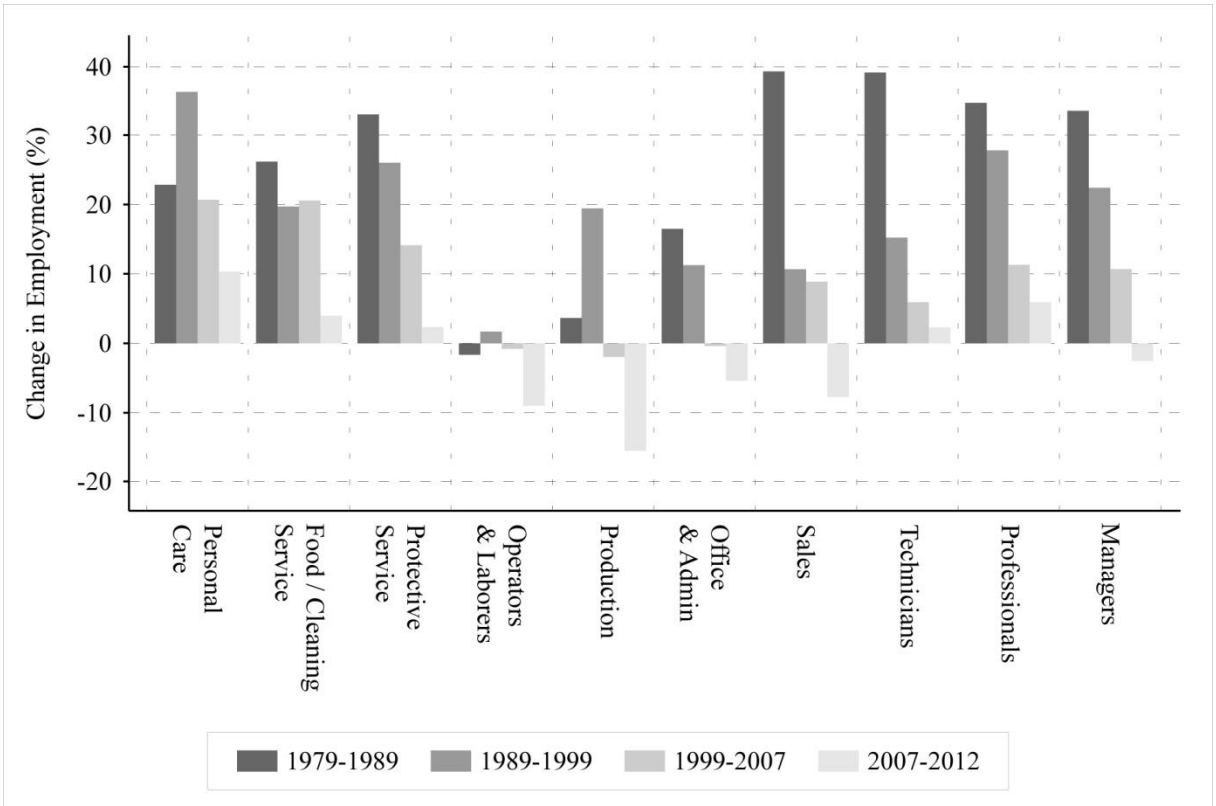
Figure 13. US Employment and Productivity Change by Decade (in Percentage)



Source: Ben Miller & Robert D. Atkinson. *Are Robots Taking Our Jobs, Or Making Them?* 2013. Page 15.

Figure 14 illustrates the log level of employment per major occupational category per each decade; notice the reduction of jobs susceptible to automation especially during the 2007 – 2012 time frame.

Figure 14. Change in Employment by Occupational Category, 1979 - 2012



Source: David H. Autor. *Why Are There Still So Many Jobs? The History and Future of Workplace Automation.* 2015. Page 13.

Table 4 shows the level at risk by each industry in the US labor market.

Table 4. Employment Share at Risk by Industry in the US

Industry	Low Risk (%)	Med. Risk (%)	High Risk (%)
Accommodation & Food Services	2.8	10.5	86.7
Administrative & Support Services	1.6	36.2	62.2
Construction	21.6	19.8	58.6
Manufacturing	19.9	18.4	61.7
Mining, Quarrying, Oil & Gas Extraction	7.8	46.3	45.9
Real Estate and Rental & Leasing	0.7	32	67.2
Retail Trade	14.5	18.9	66.6
Transportation & Warehousing	5.5	19.4	75
Wholesale Trade	15.9	18.4	65.7

Source: Business Leadership for an Inclusive Economy. *Good Jobs in the Age of Automation.* 2015. Page 13.

Analyzing entire occupations however can be misleading and create the impression that more people are at risk than they actually are. It is better to look at the tasks that will likely be automated away instead of complete jobs that can be automated (Chui et al., 2015). Researchers, Carl Benedikt Frey and Michael Osborne suggested a new way of judging how vulnerable numerous jobs are to forthcoming technological progress, they concentrated on the extent to which jobs involve three types of tasks: perception and manipulation, creative intelligence and social intelligence that, they state, are the least likely to be fully and successfully automated within the next few decades (Bright & Company, 2014). The more a job involves these tasks, the less affected it is to computerization (Bright & Company, 2014). Osborne and Frey divide sectors by the exposure that individual could be automated (Atkinson, 2016). Osborne and Frey discover that, in accommodation and food services, "as many as 87% of workers are at risk of automation, while only 10% of workers in information are at risk" (Atkinson, 2016). Table 5 further breaks down the risk of employment in each industry in the US labor market.

Table 5. Employment Percentage at Risk by Industry in the US

Job Category	Low Risk (%)	Medium Risk (%)	High Risk (%)
Accommodation & Food Services	2.8	10.5	86.7
Administrative & Support Services	1.6	36.2	62.2
Agriculture, Forestry, Fishing & Hunting	75.6	12	12.3
Arts, Entertainment & Recreation	47.9	12.5	39.6
Construction	21.6	19.8	58.6
Educational Services	63.1	19.7	17.2
Finance & Insurance	28.9	17.3	53.7
Government	46.2	30.6	23.2
Health Care & Social Assistance	39.4	25	35.6
Information	51.6	38.3	10.1
Management of Companies & Enterprises	82.8	6.2	11
Manufacturing	19.9	18.4	61.7
Mining, Quarrying, Oil & Gas Extraction	7.8	46.3	45.9
Other Services (ex Public Admin)	44.9	24.7	30.4
Professional, Scientific & Technical Services	54	10.9	35.1
Real Estate and Rental & Leasing	0.7	32	67.2
Retail Trade	14.5	18.9	66.6
Self-Employed	60.4	8.9	30.7
Transportation & Warehousing	5.5	19.4	75
Utilities	40.3	27.8	31.9
Wholesale Trade	15.9	18.4	65.7

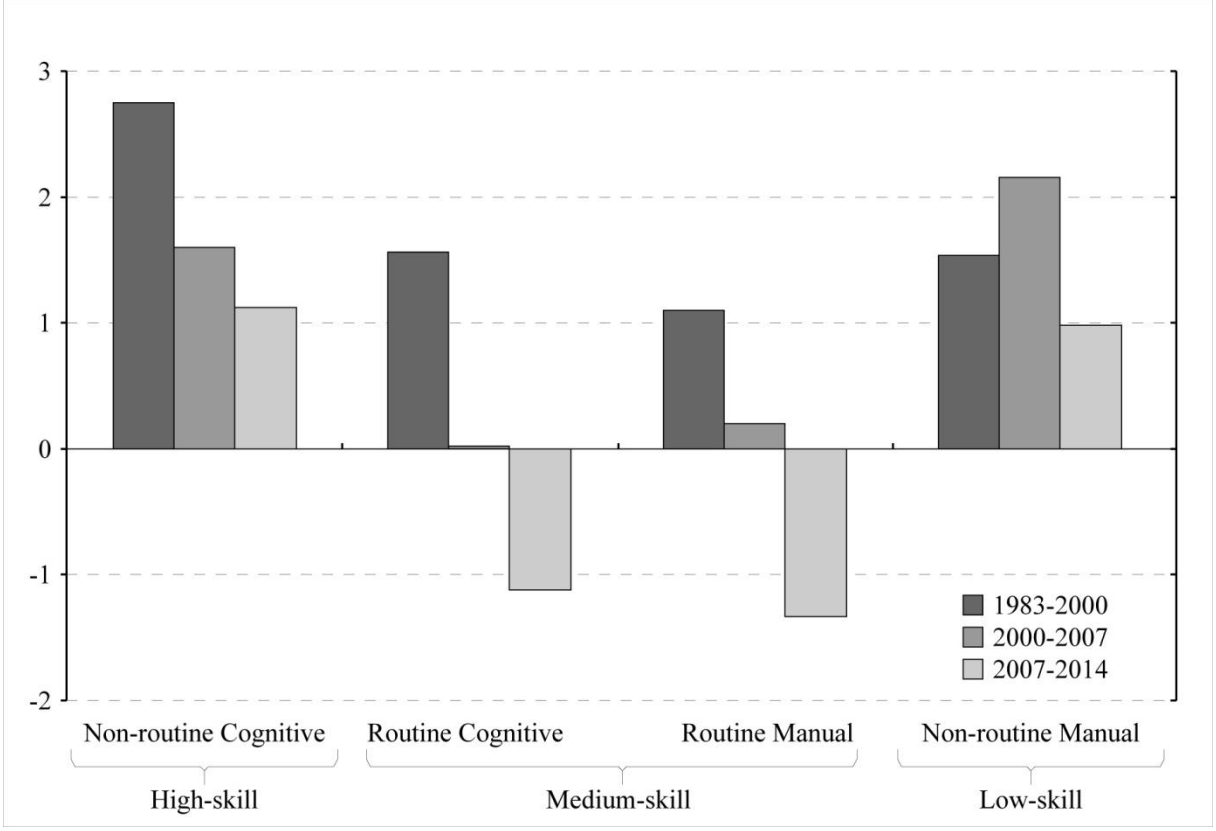
Source: Carl Benedikt Frey & Michael A. Osborne. *Technology At Work The Future of Innovation and Employment. 2015.* Page 60.

The mean level across the 21 OECD countries is that 9 percent of occupations are able to be automated and therefore the risk of technology at an occupation-based approach is lower (Arntz, Gregory & Zierahn, 2016). In many advanced countries the Information and Communications Technology (herein referred to as ICT) sector is a key driver of economic growth accounting for between 15% and 52% of all investments in OECD countries between 2008 and 2013 (Arntz et al., 2016). The amount of jobs generated by ICT sector in OECD countries amounts for 22% of the labor force in 2013 (Arntz et al., 2016).

Technology increased at such a rate partly due to Moore's Law and although it has continued, (currently at a slower rate than the previous decade) as numerous experts think that Moore's Law will increase continually allow Artificial General Intelligence (AGI) a real possibility and merely just a manner of time (Miller & Atkinson, 2013). Technology is increasing at an exponential rate whereas humans are not able to because evolution is a much slower process than engineering. To fully understand how much technology has changed, people need to realize that the smartphone they now have in their pocket is more powerful than all the computing power that The National Aeronautics and Space Administration (herein referred to as NASA) had in 1969 when they put a man on the moon (Khoso & Khan, 2016). Robots are becoming so good at being people that it is beginning to become difficult to determine what makes us human. Sophisticated virtual learning techniques, machines are now able to

complete a large amount of physical and cognitive tasks (Petropoulos, 2017). Machines are beginning to be able to perform work that was once considered only the domain of humans. While these technologies are already advanced, their ability will continue to grow and improve. Productivity and precision of individuals work is thought to grow as AI processes progress through machine learning, big data and increased computational power (Petropoulos, 2017). Figure 15 shows the annual percentage of employment in the US labor market. Notice how routine middle-skilled jobs have been the only ones decreased with a minimum of 1 percent during the 2007 – 2014 period.

Figure 15. Annual Percentage Change of Employment in the US



Source: Carl Benedikt Frey & Michael A. Osborne. *Technology At Work The Future of Innovation and Employment.* 2015. Page 20.

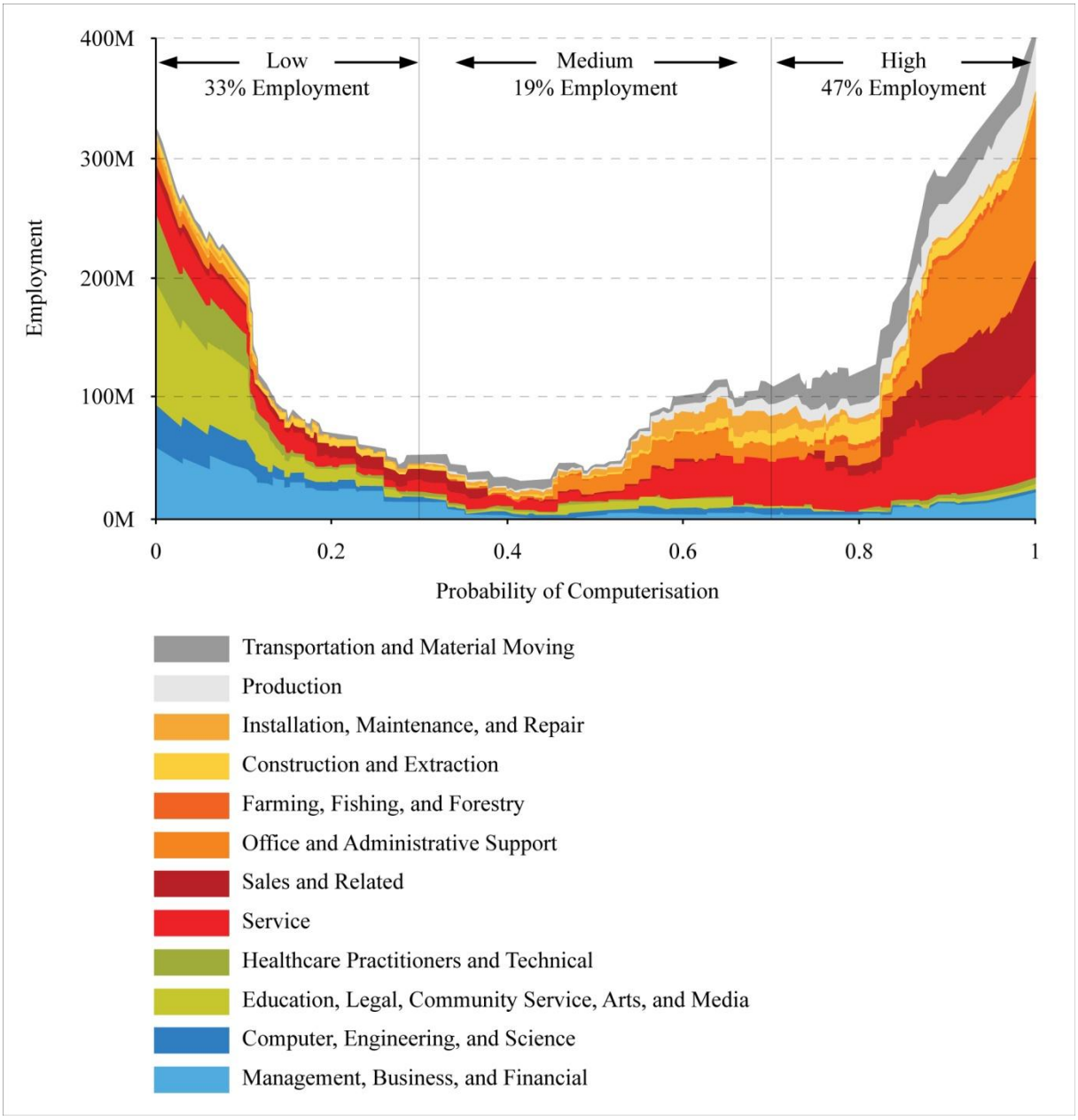
3.2.2 The potential and impact on occupations impact and automation potential

A job is susceptible to threats from automation if the technical feasibly exists to automate the tasks that constitute the job. Full occupations are comprised of numerous groups of tasks, each with varying levels of technical feasibility (Chui et al., 2015). These outcomes base themselves on an depth understanding of 2,000-plus work activities for more than 800 occupations (Chui et al., 2015). Using data from the US Bureau of Labor Statistics (herein referred to as BLS) and O*Net, the study identified both the extent of time used on these endeavors in the US economy and the technical feasibility of automating these tasks (Chui et al., 2015). Currently available technology has the potential to automate 45% of the activities people are paid to perform and that about 60% of all occupations could see 30% or more of their individual tasks being automated (Chui et al., 2015). From this three categories emerge: those that are highly susceptible, less susceptible, and least susceptible to automation (Chui et al., 2015). Occupations in retailing, for example, involve activities such as collecting or processing data, interacting with customers, and setting up merchandise displays, which are classified as physical movement in a predictable environment (Chui et al., 2015). Due to the fact that these encompassing actions have a different automation possibilities, an comprehensive assessment for each sector by examining the amount of time employees spend on them during their working week (Chui et al., 2015). With a task based approach we can better understand which particular tasks are the most likely to be at risk from automation technologies. From this it can be determined which jobs are at greater risk to automation by analyzing the percentage of time that these jobs spend on tasks that have the potential to be removed through automation technologies. This creates a better understanding to determine not only what jobs are at risk, but how much of the time spent on the current job is at risk. This helps to serve both managers and policymakers. Managers can benefit from this by understanding the extra time they now have. Employees can now utilize their extra time by performing tasks that are not affected by automation, allowing for a maximum productivity gain by utilizing the hybrid abilities of man and machine. Policy makers can use this information to provide better training and education programs that facilitate people to learn skills that are least likely to be automated, giving people a potential competitive advantage over machines. Figure 20 breaks down employment into low, middle and high employment and industry to determine the probability of computerization.

To quantify this, the researchers developed an index of “routine task intensity,” (herein referred to as RTI) (Bright & Company, 2014). The greater a job’s RTI, the more it is defined by unremarkable tasks with comparatively little manual labor or abstract reasoning included (Bright & Company, 2014). RTI can “be interpreted as an occupation’s potential susceptibility to displacement by automation” (Bright & Company, 2014). Of the 15 occupations with the highest RTI scores, only one (cashiers) accounted for a higher share of US employment in 2005 than it did in 1980, while 10 of the 15 lowest-RTI occupations grew as a share of total employment over that time span (Bright & Company, 2014). As computers have increased in power and reduced in cost computer have become more fundamental part of our lives and becoming involved in occupations that only a few years ago would have been

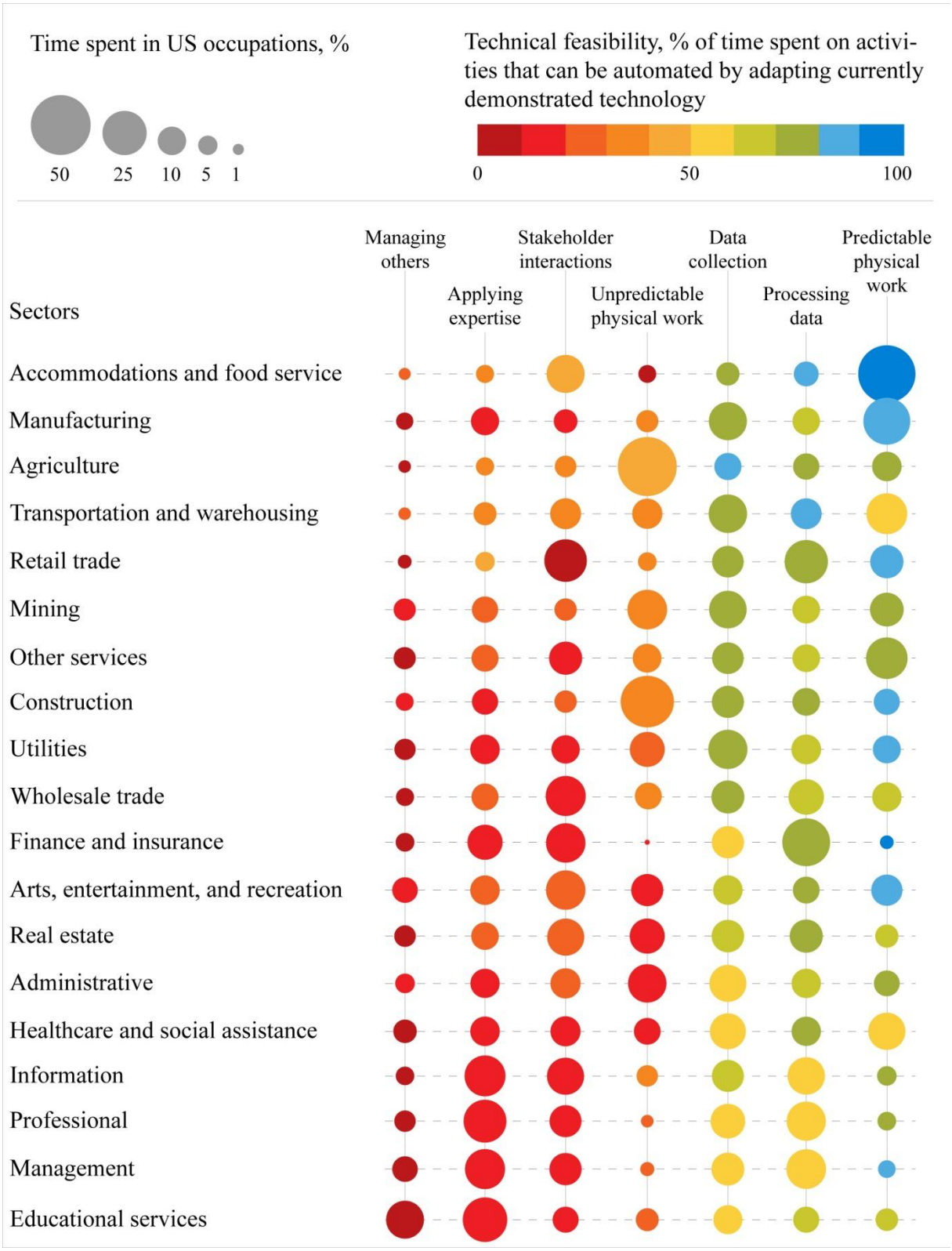
thought safely in the “humans only” zone (Bright & Company, 2014). For instance in 2004, Frank Levy and Richard Murnane wrote that “executing a left turn across oncoming traffic involves so many factors that it is hard to imagine discovering the set of rules that can replicate [a] driver’s behavior.” today, Google is rapidly making self-driving cars a reality (Bright & Company, 2014). This also demonstrates that predicting the future from a technology standpoint is a difficult challenge and that experts routinely get it wrong and underestimate the speed at which technology is invented and developed. Figure 16 shows the time spent on each task and the technical feasibility to be automated. Figure 17 displays time spent in US occupations and their technical feasibility to be automated.

Figure 16. Occupational Employment Over the Probability of Computerisation



Source: Carl Benedikt Frey & Michael A. Osborne. *The Future of Employment: How Susceptible Are Jobs To Computerisation?* 2013. Page 37.

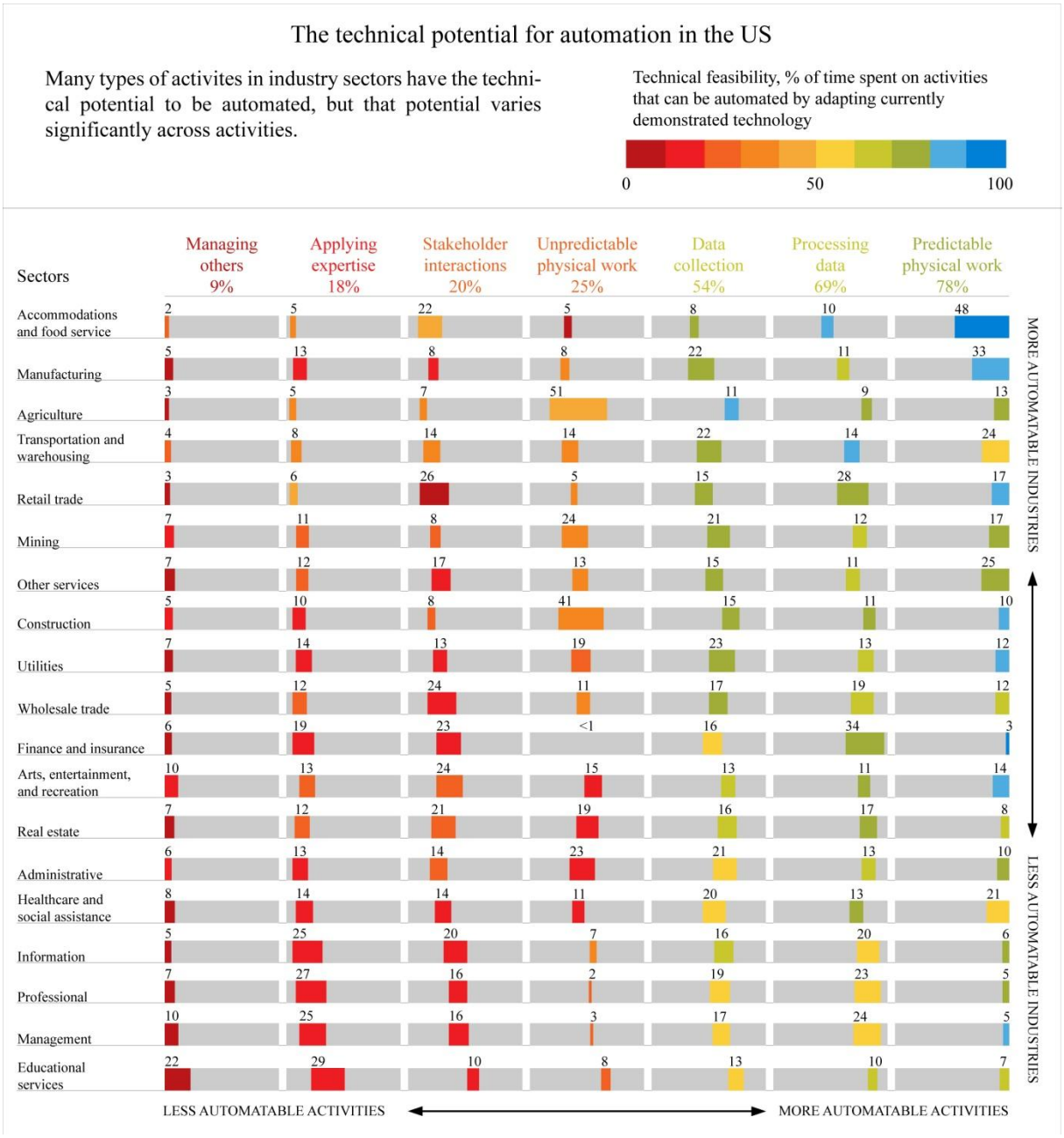
Figure 17. Time Spent in US Occupations and Their Technical Feasibility



Source: Michael Chui, James Manyika, & Mehdi Miremadi. *Where Machines Could Replace Humans – and Where They Can't (yet).* 2016. Page 10.

Figure 18 shows the type of task and the percentage of time each task is devoted to in each sector and the probability of automation of those tasks.

Figure 18. The Technical Potential for Automation in the US



Source: Michael Chui, James Manyika, & Mehdi Miremadi. *Where Machines Could Replace Humans – and Where They Can't (yet).* 2016. Page 3.

Table 6 illustrates the susceptibility of occupations to automation first in 1980, then in 2005, [occupations with the highest RTI scores].

Table 6. Jobs Most and Least Susceptible to Automation, Highest RTI Scores.

Jobs Most and Least Susceptible to Automation

Occupations ranked by routine-task intensity (RTI), a measure of its potential susceptibility to automation

Occupations with highest RTI scores	Share of total U.S. employment in:	
	1980	2005
Proofreaders	0.02%	0.01%
Motion picture projectionists	0.01	0.01
Meter readers	0.04	0.03
Butchers and meat cutters	0.31	0.17
Secretaries and stenographers	3.82	2.53
Payroll and timekeeping clerks	0.17	0.12
Bank tellers	0.47	0.27
Barbers	0.10	0.06
File clerks	0.23	0.22
Boilermakers	0.04	0.01
Announcers	0.04	0.03
Cashiers	1.31	1.49
Typists	0.61	0.23
Pharmacists	0.16	0.16
Bookkeepers and accounting and auditing clerks	1.70	0.98

Source: Bright & Company. *Impact of Technology on the Future of Work.* 2014. Page 40.

Table 7 illustrates the susceptibility of occupations to automation first in 1980, then in 2005, [occupations with the lowest RTI scores].

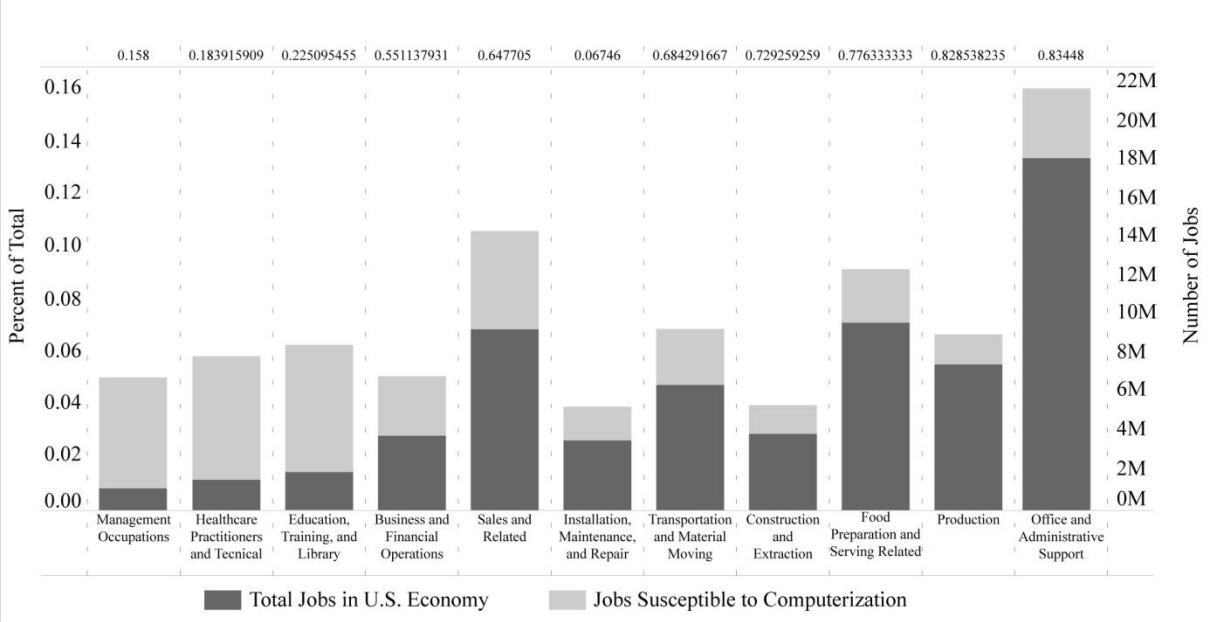
Table 7. Jobs Most and Least Susceptible to Automation, Lowest RTI Scores

Occupations with lowest RTI scores			
Athletes, sports instructors, and officials	0.05%	0.13%	▲
Fire fighting, fire prevention, and fire ispection occupatons	0.34	0.33	▼
Railroad conductors and yardmasters	0.06	0.05	▼
Recreation and fitness workers	0.03	0.17	▲
Foresters and conservation scientists	0.04	0.02	▼
Public transportation attendants and inspectors	0.06	0.11	▲
Locomotive operators: engineers and firemen	0.10	0.06	▼
Kindergarten and earlier school teachers	0.12	0.32	▲
Archivists and curators	0.01	0.03	▲
Police and detective, public service	0.59	0.75	▲
Primary school teachers	1.96	2.20	▲
Airplane pilots and navigators	0.08	0.13	▲
Surveyors, cartographers, mapping scientists/ technicians	0.11	0.10	▼
Actors, directors and producers	0.06	0.13	▲
Bus drivers	0.30	0.33	▲

Source: Bright & Company. *Impact of Technology on the Future of Work.* 2014. Page 40.

Figure 19, shows the industry's most at threat by automation in the US.

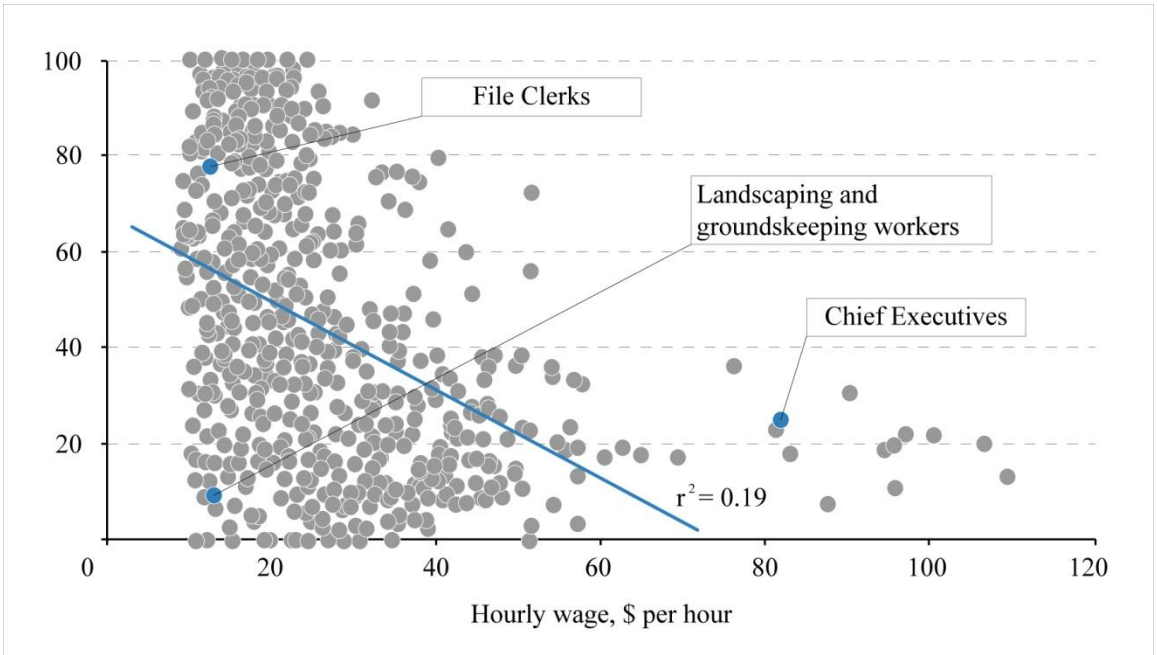
Figure 19. Probability of Computerization and Number of Jobs Susceptible



Source: Danny Leipziger & Victoria Dodev. *Disruptive Technologies and their Implications for Economic: Some Preliminary Observations.* 2016. Page 17.

Many people thank that automation has been the primary factor in decrease of US manufacturing workforce, but many Chinese workers would disagree with this statement as they have experienced factory closures that can now produce a greater amount of goods with a fewer amount of workers (Greenfield, 2011). In the US and China, the world's manufacturing powerhouses, less people are employed in manufacturing currently than in 1997 (Bright & Company, 2014). This draws an interesting comparison, two large countries and economies that both account for much of the production of the world are being both experiencing similar affects, negative ones from technology. Automation is not just occurring in the US, but part of a much larger global trend. The US and China are two countries with a lot of differences (such as structure of employment, form of government) yet they are both struggling to find new ways to adapt to the world that is constantly changing due to technological advancements. Similarly the European Union (herein referred to as EU) also has potential for change (again sadly as in the case of China and the US a negative one). Based on a European application of Frey and Osborne 2013 data, the coming decades the proportion of the EU workforce to be impacted significantly by technological advancements ranges from the mid 40% to well over 60% (similar to the US) and averaging 54% across the EU-28 (Bowles, 2014). The EU and the US share a lot more similarities to each other than the US and China share and therefore explains why the EU and US numbers are more similar, but it just continues to prove that this global problem and not isolated to just the US and as technology advances and has the ability to impact people on a global scale not just a local one. Figure 20 shows the correlation of hourly wage and the ability to automate. This correlation shows the comparison of wages and automation for US jobs and determines the ability to automate by the percentage of time spent on activities that can be automated by adapting currently available technology (Chui et al., 2015).

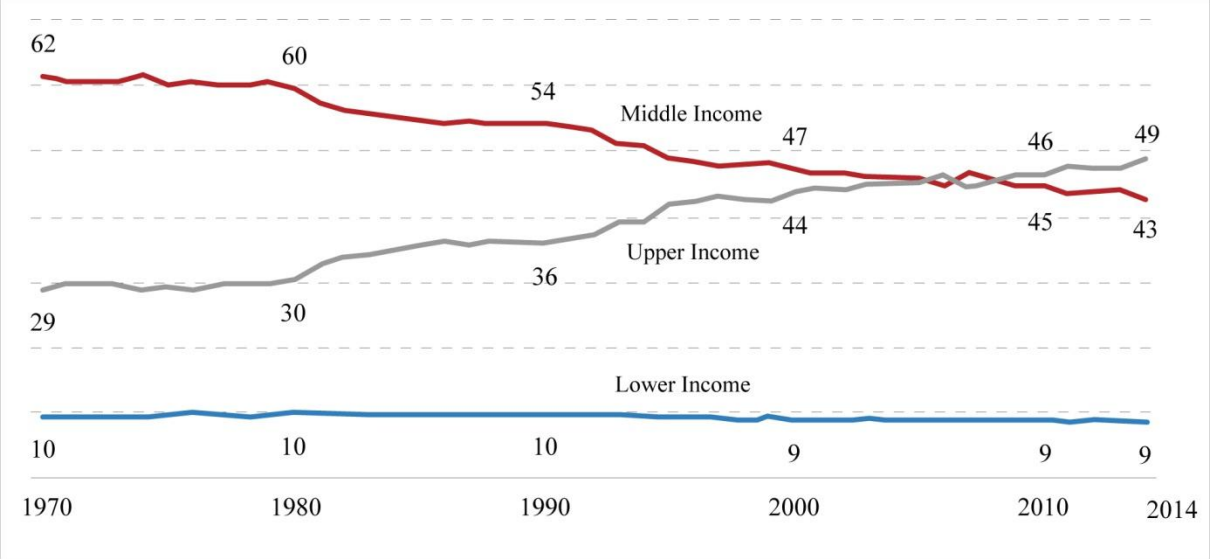
Figure 20. Hourly Wages is Not a Strong Predictor of Automation



Source: Michael Chui, James Manyika, & Mehdi Miremadi. *Four Fundamentals of Workplace Automation.* 2015. Page 7.

The rapid pace of adoption of AI is reaching a point were well articulated strategies are needed by business and governments to ensure a stable growing economy. Other factors that must be taken into consideration is that the majority of benefits that people receive (healthcare, retirement) are tied to employment, and as jobs disappear not only are individuals at risk of losing their jobs and livelihood, but also they could lose their benefits. The present methods to gain benefits are currently insufficient unless trending employment patterns reverse (West, 2015). Figure 21 shows the percentage of aggregate income during 1970 to 2014 held by lower, middle and upper income households.

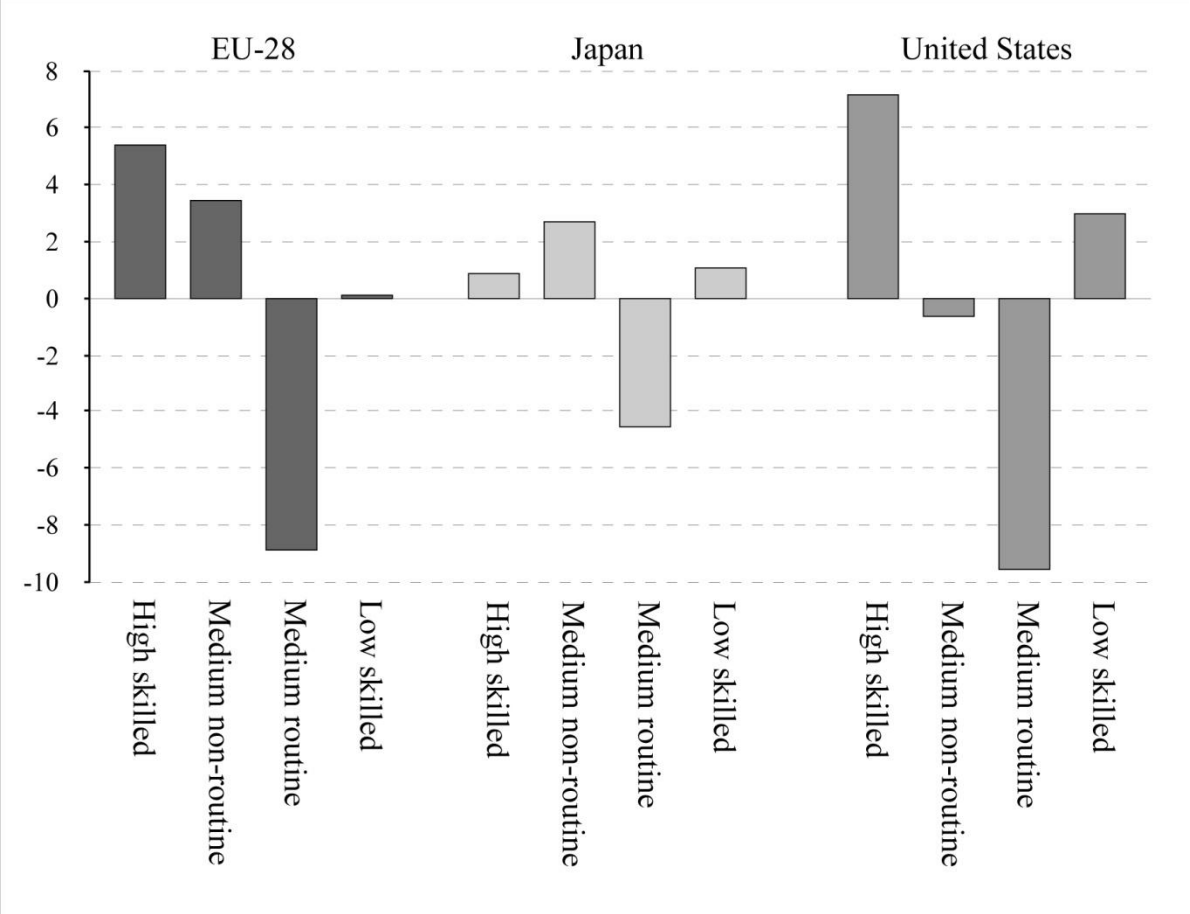
Figure 21. Percentage of Aggregate Income Held by Households: 1970 to 2014



Source: Danny Leipziger & Victoria Dodev. *Disruptive Technologies and their Implications for Economic: Some Preliminary Observations.* 2016. Page 23.

The benefits of technology have not been widely shared (Benedikt Frey & Osborne, 2015). Real **median wages** have stagnated in about half of all OECD countries since 2000 have fallen even further behind growth in productivity (Benedikt Frey & Osborne, 2015). This has resulted in declines in labor's share of GDP both in advanced and developing economies (Benedikt Frey & Osborne, 2015). Approximately 50% can determined by the reduction in the relative cost of investment goods, which in turn is increased by progress in computer-driven technologies allow companies to replace labor for capital in production (Benedikt Frey & Osborne, 2015). In the US, when small groups of highly skilled workers are excluded, the decline in labor is even more substantial (Benedikt Frey & Osborne, 2015). The biggest recipients of this new digital age have been shareholders of these companies (Benedikt Frey & Osborne, 2015). This is clearly demonstrated in the three leading companies of Silicon Valley were they employ around 137,000 workers in 2014 with a combined market capitalization of $1.09 trillion as compared to 1990 the three largest companies in Detroit had a market capitalization of $36 billion employing 1.2 million workers (Benedikt Frey & Osborne, 2015). This difference demonstrates that more wealth (203% more wealth) can be generated with fewer workers (89% less workers). These facts have not gone unnoticed by the public. Fewer than 20% of American workers now conclude that the generation currently entering the workforce will have improved lives than themselves (Benedikt Frey & Osborne, 2015). Many people are feeling worse about the future. This is partly due to the fact the wealth is being generated with a smaller number workers and for the majority wages may not rise over their lifetime (Benedikt Frey & Osborne, 2015). Figure 22 shows polarisation of employment in different regions of the globe based on different skills levels.

Figure 22. Job Polarisation in the European Union, Japan and the United States



Source: OECD. Automation and Independent Work in a Digital Economy. 2016. Page 1.

Analyzing the US economy a clear understanding of which sectors, industries and tasks are at the most at risk of automation begins to formulate. Comparing the feasibility among different skill levels allows the detailed analysis of the probability that a task could be automated. From this forecast, a better understanding of which tasks and occupations face the greatest threat factor from automation.

4 FUTURE CHALLENGES FOR THE US ECONOMY

4.1 Potential Future Trends Currently Emerging

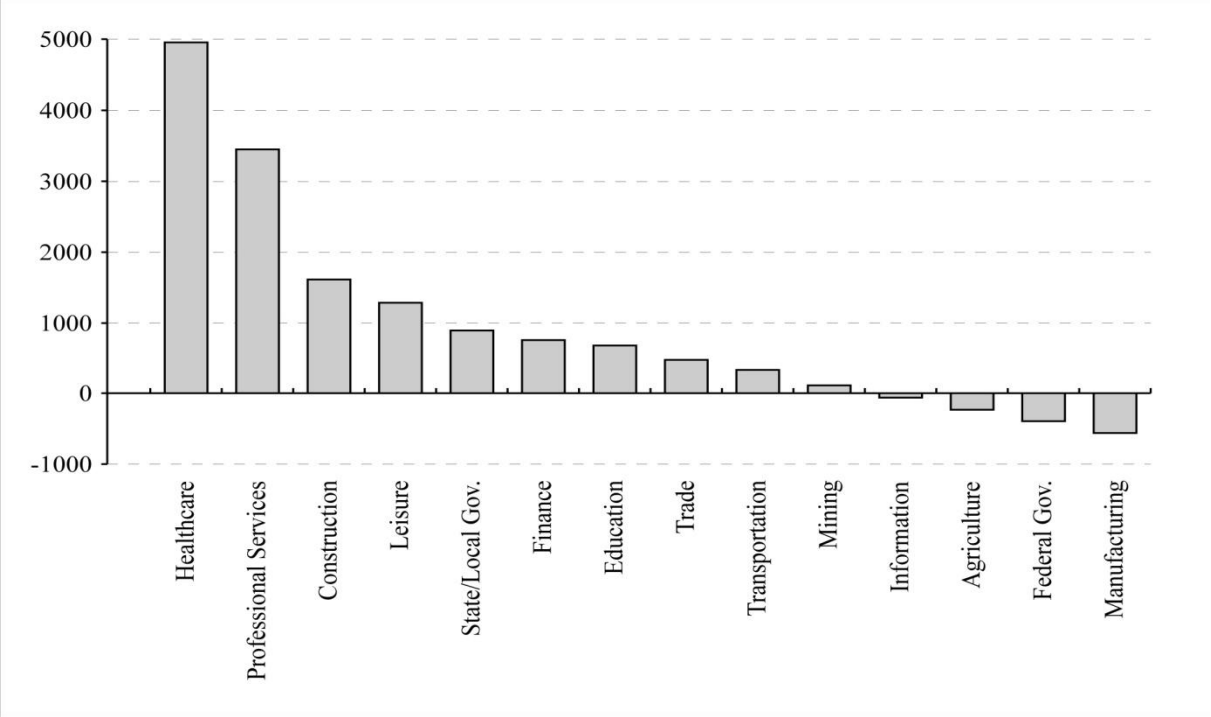
Based on the 2016 Whitehouse report titled "Artificial Intelligence, Automation, and the Economy" from the Obama administration there are three broad strategies for focusing on the effects of AI-driven automation along the US economy:

1. "Invest In and Develop AI for its Many Benefits": Advancements in AI can deliver important contributions to both the productivity growth and innovation rate in the US (Wladawsky-Berger, 2017).
2. "Educate and train Americans for jobs of the future": AI will change the nature of work and the skills required (Wladawsky-Berger, 2017). As a requirement for the jobs of the future will change the education in preparation for those jobs change must also change. AI will change the job market and begin to create new skills. Assist US workers in maneuvering occupational changes will become increasingly critical and opportunities for lifelong learning must be improved and appropriately funded to assure that US workers receive skills, training, and the assistance needed to navigate a changing economic landscape (Wladawsky-Berger, 2017).
3. "Aid workers in the transition and empower workers to ensure broadly shared growth" (Wladawsky-Berger, 2017). The fast increase and change of pace of technology the old adage of going to school and then working and gaining experience and performing the task is no longer a valid model. The skills needed in one's jobs can change so much and so quickly that there must be constant retraining and good policy must be ready to be able to meet those requirements (Wladawsky-Berger, 2017). The social safety net should be increased and improved to ensure that workers who will most likely lose their jobs from AI will be able to make ends meet, retrain their skills and find a new job, and then transition into their new careers (Wladawsky-Berger, 2017).

4.2 Expectations For The Future

The US BLS compiles future employment estimates and in its most current analysis, the agency predicts that 15.6 million new positions will be created between 2012 and 2022; this amounts to growth of about 0.5% per year in the labor force (West, 2015). The health care and social assistance sector is expected to grow the most with an annual rate of 2.6%, this will add around 5 million new jobs over that decade (West, 2015). That is about one-third of all the new jobs expected to be created (West, 2015). Other areas that are likely to experience growth include professional services (3.5 million), construction (1.6 million), leisure and hospitality (1.3 million), state and local government (929,000), finance (751,000), and education (675,000). The information sector is one of the areas expected to shrink in jobs the BLS projections anticipate that about 65,000 jobs will be lost there over the coming decade (West, 2015). Figure 23 shows future employment broken down by sector.

Figure 23. Future Employment Projections by Sector, 2012 – 2022 (in millions)



Source: Darrell M. West. *What happens if robots take the jobs? The impact of emerging technologies on employment and public policy?* 2015. Page 7.

Figure 24 shows employment by the net number of employment impact by job family.

Figure 24. Net Employment Outlook by Job Family, 2015 – 2020

Source: Danny Leipziger & Victoria Dodev. *Disruptive Technologies and their Implications for Economic: Some Preliminary Observations.* 2016. Page 18.

Manufacturing is additional field thought to displace jobs and the BLS expects the US to lose 550,000 jobs, while the federal government will reduce an additional 407,000 positions, and agriculture, forestry, fishing, and hunting will lose 223,000 jobs (West, 2015). Since BLS projections make few assumptions about emerging technologies, it is likely that these figures underestimate the destructive impact of these technological (West, 2015). Based on this research, telemarketers, title examiners, hand sewers, mathematical technicians, insurance underwriters, watch repairers, cargo agents, tax preparers, photographic process workers, new accounts clerks, library technicians, and data-entry specialists have a 99% of having their jobs computerized (West, 2015). On the opposite occupational coin, recreational therapists, mechanic supervisors, emergency management directors, mental health social workers, audiologists, occupational therapists, health care social workers, oral surgeons, supervisors of fire fighters, and dieticians have less than a 1% chance of having their tasks computerized (West, 2015). This research is based on bettering levels of computerization, wage levels, and education required in different fields (West, 2015). Other sectors such as health care and education have been gradual to adopt the technology improvements, but are slowly accepting new models (West, 2015). Innovations in personalized learning system and mobile health demonstrate that numerous schools and hospitals are shifting from traditional to computerized service delivery (West, 2015). Educators are utilizing Massive Open Online Courses (herein referred to as MOOCs) and other technological based lessons, while health care professional are depending on medical sensors, electronic medical records, and machine learning to better diagnose and determine health treatments (West, 2015).

Public policy will demand to be limber enough to assist in preparing for and managing labor dislocations (Benedikt Frey & Osborne, 2013). The majority of countries, be they developed or emerging, fiscal expenditures are mainly secured by current programs and predominant political concerns (Benedikt Frey & Osborne, 2013). This creates insufficient place for responsible expenditures and governments seem uniquely nonchalant and unaware for the effect of considerable technological changes that may very well cause seismic compensation adjustments (Benedikt Frey & Osborne, 2013). Debate of this new industrial age are overshadowed by digitalization, robotics, and AI are often removed from considerations about education and skills (Benedikt Frey & Osborne, 2013). Brynolfsson and McAfee debate that the average worker will have to establish the expertise that creates a comparative advantage over computers, including idea creation and creativity, great amount of pattern recognition, and complex forms of communication (Benedikt Frey & Osborne, 2013). Bettering schooling can improve economic action by increasing the amount of equivalent knowledge of the economy requires the support new technologies (Benedikt Frey & Osborne, 2013).

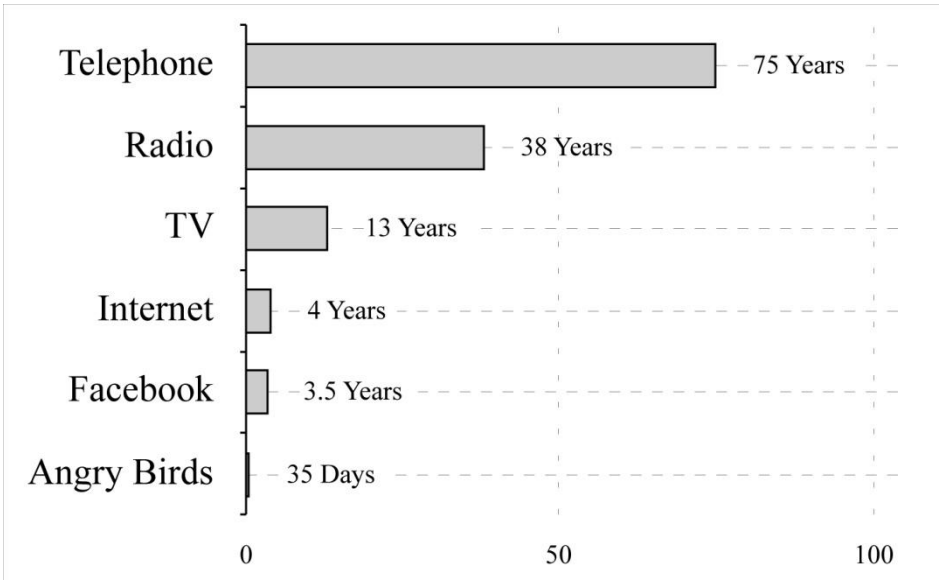
Tyler Cowen, an economist at George Mason University and a much-read blogger, writes in his most recent book, “Average is Over”, that richer nations economies appear to be dividing into smaller subsets of individuals with skills highly complementary with machine intelligence, for these people Cowen believes they will benefit greatly from machine intelligence while the rest with greatly suffer from this technology (Bright & Company, 2014). These factors are all contributing to the growing inequality in many western countries. Brynjolfsson and McAfee establish that creating the corporate culture which best utilize

contemporary technologies impact trial and error and human flexibility, it is also the scenario that this industrial age will allow this trial and error more accessible to commence a startup, bring a new merchandise to market (Bright & Company, 2014).

Thomas Piketty, an economist at the Paris School of Economics, debates that America may be creating an incredible unequal economic model where the top 1% of capital-owners and "supermanagers" own an increasing amount of national income and horde an increasing concentration of national wealth (Bright & Company, 2014). The rise of the middle class, a 20th-century innovation, was a largely meaningful political and social development across the world, the decimation of the middle class could result in a more antagonistic, unstable and potentially dangerous geopolitics (Bright & Company, 2014).

The World Economic Forum (herein referred to as WEF), also puts forth an argument that recreating the corporate Human Resources (herein referred to as HR) function will benefit both individuals and the corporate world greatly (World Economic Forum, 2016). In its 2016 report "The Future of Jobs" they dispute that recreating education organization, incentivizing life-long learning, and reinforcing collusion between the public and private organizations and placing public institutions to the front of policy solutions (World Economic Forum, 2016). Unfortunately it is becoming apparent that many governments around the globe are extremely ill-equipped for this task (Benedikt Frey & Osborne, 2013). Figure 26 shows how new technology is able to reach 50 million users in exponentially less time than in the past.

Figure 25. The Time to Reach 50 Million Users



Source: Carl Benedikt Frey & Michael A. Osborne. *Technology At Work The Future of Innovation and Employment.* 2015. Page 13.

Part of this growth is that the world's population has been steadily increasing since World War Two. Another reason is that some countries are larger than others and within a nation many legal and political barriers are removed as compared to growing to overseas markets. For example WeChat has 300 million users, more than the entire adult population of the US,

but China also has more people than the US, so while this number is still impressive, it just needs to be put into perspective (Dobbs et al., 2015). Twenty years ago less than 3% of the globe's population owned a mobile phone, now two-thirds of the world's population posses a phone and one-third of all humans are able to communicate on the internet (Dobbs et al., 2015). This allows businesses to benefit from the additional amount of customers with great pace while using little investment and therefore the result is that entrepreneurs and their newly launched start-ups now regularly relish a position over larger, more traditional businesses (Dobbs et al., 2015).

4.3 Possible Scenarios

With a large amount of research on the potential of AI and other forms of automation and its impacts on the US economy and labor market, the best way to understand and forecast the future is by analyzing possible future scenarios. In order to best understand the impact of AI and other forms of automation on the labor market we analyze both negative scenarios and positive scenarios based on present data to gain a better understanding of where it might lead us in the future.

4.3.1 Negative scenarios

The majority of jobs have a small amount of exposure of exhaustive automation, but among 50% and 70% of these tasks are automatable (OECD, 2016). The jobs themselves will not be completely automated and therefore not substituted entirely, but because of the large amount of tasks being automated the nature of the jobs themselves will change drastically (OECD, 2016). Workers with the least amount of education face the greatest amount of risk of displacement, with 40% of workers with a lower secondary degree occupy occupations with a greater risk of job automation and less than 5% of workers with a tertiary degree are at risk (OECD, 2016). Education can help cushion some of the impact of automation, but not provide a definite future nor a social safety net for people. New York Times columnist David Brooks has advised that the government should be advancing to build infrastructure and "reduce generosity to people who are not working but increase its support for people who are", shift to a more progressive consumption tax, more human capital in the form of early education to community colleges and beyond (Davidow & Malone, 2014). These ideas may never be achieved because of lack of political will and public support, but also and most importantly, that all these measures may still not be enough to keep up with a 40% rate of progress for only a short time.

Other ideas and solutions must be created to solve the future potential problems that may develop from automation in the workforce. Brynjolfsson and Mitchell are calling for "the creation of an integrated information strategy to combine public and privately held data" (Wladawsky-Berger, 2017). This allows policymakers and the public with methods to negotiate the improving and uncertain effects of technology upon the labor force and developing on additional appeal for policymakers to accept an evidence-based approach, as

pioneered by the private sector (Wladawsky-Berger, 2017). In order for the government to best prepare for the future it must gather data and develop a plan to best prepare for the future, which can be difficult as government usually gains its power through elections were people vote based more on ideology than on data and analysis.

Autonomous vehicles are one area were AI technologically can make a large and visible impact on the economy. It is difficult to estimate the amount of time it will capture the impacts of driverless trucks and cars; the potential loss of millions of jobs is still possible (Rotman, 2017). By current estimates self-driving automobiles could threaten 2.2 to 3.1 million existing US driving jobs (Rotman, 2017). The majority of individuals believe that self-driving cars will impact consumer vehicles the most; however the greatest and earliest gains could come to the biggest vehicles (Stewart, 2017). Large trucks could put an additional 1.7 million jobs at risk (Rotman, 2017). The OECD believes that approximately 9% of US jobs are at great risk (Rotman, 2017). Despite all the excitement of AI in driverless cars they face many limitations. Self-driving automobiles work fairly well on clear sunny days, but appear to underperform in inclement weather such as fog or the snow and cannot be trusted in emergency situations (Rotman, 2017). Further AI can indentify complicated arrangements in massive data sets, but lacks the common sense of a small child and possesses the innate language skills of a two-year-old (Rotman, 2017).

Numerous companies are busy attempting to create 18-wheelers that will reduce the requirement for humans operating the vehicle, vastly reducing their employees, or relocate them to a driving simulator in a cubicle (Stewart, 2017). The benefits are clear. It's wonderful for trucking companies that want to reduce their expenses and improve the safety: as crashes involving trucks kill about 4,000 people on US roads every year (Stewart, 2017). While it has been argued that driving was one of the tasks that were least likely to be automated, AI systems excel at the kind of tedious concentration where humans so often fail (Stewart, 2017). It now seems at this point that it is only a matter of time before the technology hits the road, the question becomes how this will affect the individuals that work one of the most commonplace jobs in the country, a job that provides a solid and steady middle class income for 2.8 million truck drivers (Stewart, 2017). While truck driving may not be an interesting job, it is a very well paying one especially considering the level of education required.

The surprise result of the 2016 US Presidential Election of Donald Trump and the result of Brexit begin to illustrate the profound effects that changing economics can have at the ballot box. The average voter may be unaware of the macro economic impacts of the fourth industrial revolution, but they are aware of what is occurring in their own lives. For many their motivations overwhelmingly "started with economics and ended with economics" and their anger was pointed at previous politicians that forgot them when global trade deals were negotiated (Smarsh, 2016). Many of these trade deals were negotiated and signed in the 1990s and at that time hailed as the benefits of globalization. Fast forward about two decades later and the people that have been negatively affected by trade deals have voted out any politicians who were involved with this old establishment. A world could develop where a society and a economy have the technology and the knowledge to create machines capable of replacing

human labor, but the general populace is angry and afraid of what impact this technology would have on their lives and could create a political movement to remove technology from the workplace, something akin to the Luddites in 18th century Britain. This problem is made worse by the media about trying to put a stereotype of Trump and Brexit supporters and using the term "populism" in a negative light. That the term "populism" has morphed into a sort of insult among prominent liberal commentators should give us great pause (Smarsh, 2016). This illustrates the current emotions regarding AI. Many media organizations and experts take dismissive views on people who fear AI and the impacts on the economy. Similar experts brushed off concerns of the danger of US manufacturing and then were totally surprised and unprepared for the results. Even now media outlets still do not see automation as having played any part in the US 2016 election. This lack of insight and awareness does not bode well for future events, if experts cannot see some of the factors from the past affecting the present, they definitely cannot have the slightest understanding of the future, yet they still make predictions regarding the future.

The internet allows for efficient matching between supply and demand of many resources, such as labor, products and tasks (OECD, 2016). With this greater opportunities are created for workers to enjoy the flexibility that comes from working for one's self (OECD, 2016). Service providers can now split these complicated tasks into low cost number of routine mini-tasks allocated to workers around the world (OECD, 2016). This system is leading to what is known as the "gig" economy (OECD, 2016). While this creates greater opportunities for employees it does come at a cost with employees not having full time employment. A lack of full time employment leads to two major problems. First workers cannot ensure a steady income and as a possible result they are likely to spend less causing growth problems for the economy. Second most of the benefits that workers receive are connected with full time employment (usually paid partly by the company and partly by the government). With the lack of full time employment workers are less likely to get benefits and therefore the total amount of their wages will decrease.

4.3.2 Positive scenarios

While positions and methods get reinvented; the economic gains of automation will broaden far beyond just simply savings in labor (Chui et al., 2015). In the best paid jobs, machines can complement human capabilities to a large amount and thus free the time and expertise of the employee to focus on other work that is considered to be of higher value (Chui et al., 2015). For example lawyers can utilize text mining software for reading thousands of documents and then classify the most applicable cases for further analysis by legal stuff (Chui et al., 2015). By some calculations about of 20% of CEO's their time (tasks including analyzing reports and data, preparing staff assignments and reviewing status reports) can be automated by utilizing current technologies (Chui et al., 2015). In the future we will see more reports that will be prepared by some form of AI being released to the public. A central theme here is that analyzing, reviewing and preparing can now be done by AI technology that allows the human worker time to do something better, tasks a machine is unable to perform.

Part of helping the American manufacturing worker displaced will be to strengthen the ineffectual Trade-Adjustment Assistance (herein referred to as TAA) program to provide more financial and transitional support to affected workers (Muro, 2016). The TAA program will need to be expanded and reach beyond trade adjustment to other factors that are putting a strain on the American worker, such as the "gig" economy that doesn't provide full time employment or benefits (Muro, 2016). Part of the proposed plan should be that displaced workers receive $10,000 a year during a multiyear transformation period to substitute an allocation of displaced wages while the worker trains and searches for a career (Muro, 2016). Another plan to ensure that maybe AI doesn't get too out of hand has been developed by entrepreneur Elon Musk in empowering as many people as possible to have access to AI to act as a deterrence policy against AI domination (Domonoske, 2017). This idea is that everyone understands AI and therefore AI is unlikely to take us completely by surprise and we should be better prepared for its impacts on our lives both personal and professional.

The BLS in the past provided some good guidance on how computers could alienate the negative advantage that automation upon the workforce. They could be summed up in the following three ways:

1. Provide advance notice to workers affected by the new technology (Mark, 1987). This would provide ample time for the changeover to newer methods to develop plans and adopt the correct approach for the future of both the company and employees. Many firms went further to announce to employees that were impact by workers will allow them to have a job, however not necessarily the same job that the employee held before the new technology was introduced (Mark, 1987). This is extremely beneficial as it builds loyalty and trust between the employee and the firm and it reduces fear and apprehension of new technology and progress.
2. Coordinate labor adjustment with technical planning (Mark, 1987). Telephone companies would project their labor requirements one to two years in advance and minimize displacement of employees by utilizing temporary employees, overtime and other human resources methods (Mark, 1987). Other companies would go even further by timing the introduction to new technology by implementing it during a time period of firm expansion (Mark, 1987). All methods ensure the company is still growing through utilizing more efficient methods, while at the same time ensuring that employees who are affected are kept to the minimum through careful planning.
3. Provide employees with new knowledge associated with newer technology and retrain those displaced from their work (Mark, 1987). Employees are kept and again this builds trust and loyalty throughout the firm and employees see that the action management takes is that they really care about them. This also ensures an up-to-date workforce and provides the required training that is needed with the adoption of technology (Mark, 1987).

To best prepare the younger generation for the future it is imperative that schools don't equip students for occupations that won't continue to be present in the future because they may not be still viable when students join the labor market (West, 2015). The current education structure must be reexamined if it is to meet the objectives of the future where the jobs of

tomorrow will be vastly different from the jobs of today (West, 2015). Eventually polices will need to be created that account for when automation is near 100% and robots and machines are able to do nearly all jobs better than us humans. The term "end of work" may develop a new type of economy. Based on the analysis of Harvard economist Lawrence Katz, "it's possible that information technology and robots [will] eliminate traditional jobs and make possible a new artisanal economy … an economy geared around self-expression, where people would do artistic things with their time" (West, 2015). From his point of view, the transformation could change the economies of the world from one of consumption to creativity and with individuals spending their leisure time to seek interests in other endeavors such as the arts and culture, or other special areas of interest that they enjoy (West, 2015).

One of the proposed solutions to the potential impacts of AI on employment is the establishment for a universal basic income as a method to assist individuals not capable to find employment (Florida, 2017). Another take on this popular scenario is a "universal basic adjustment benefit" (Florida, 2017). This plan consists of aiming to assist the individuals in finding new job opportunities and enable further assistance such as insurance of wages, career counseling, subsidies for relocation, other financial and career assistance (Florida, 2017). This plan would target individuals that are most impacted negatively by automation. This plan helps people with benefits and advice for them to navigating through the changes that are occurring in the economy. Writer Ben Schiller puts forth the argument that "a universal basic income is the bipartisan solution to poverty we've been waiting for" (West, 2015). Schiller goes on to claim that with occupations disappearing to various machines and with employee wages not increasing, governments should administer "a single payment that would give someone the chance to live reasonably" (West, 2015).

As previously mentioned by David Brooks, a universal basic income must ensure that it goes to the right people, not people who simply lack the ambition to work. Universal basic income is not without its critics for two main reasons. The first reason being that the value of work itself adds to human worth (West, 2015). Many people define a significant part of their self-esteem through their employment, even though a large number report they are unhappy in their current position, jobs are vital to many people (West, 2015). The second reason being, individuals are concerned an absence of employment motivations in an income guarantee, that it must be structure in such a manner that balances payments with work encouragement, otherwise individuals may simply stop working and do little to contribute to community goals (West, 2015). Evidence proofs that bestowing individuals with basic income does not generate a dependency according to Charles Kenny of the Center for Global Development, supplying a social safety net "may help lift people up and out of poverty (West, 2015). "Give poor people cash without conditions attached, and it turns out they use it to buy goods and services that improve their lives and increase their future earnings potential" (West, 2015).

To best handle with dependency questions, the basic income could and should be pegged to volunteer activities or work requirements (West, 2015). Derek Thompson uses a citation from the Works Progress Administration example from the 1930s of having "the government to pay people to do something, rather than nothing." and suggests the development of a "national

online marketplace of work" in which individuals are able to be involved in projects that could best assist in the community (West, 2015). These tasks could include personal services that humans excel at compared to machines such as, but not limited to tutoring, eldercare, childcare, disaster response, or arts and culture work and many more of course (West, 2015). That would people to devote their time, effort and energy to their communities in an extremely positive manner while at the same time earning a modest income from the government and still maintaining a sense of fulfillment, dignity and self worth (West, 2015).

The idea of fully autonomous robots could create a world where there is of little need for individual workers and the end-of-work scenario becomes achievable resulting in a transition in the economy that is already occuring and the types of occupations are qucikly changing (Florida, 2017). Experts such as Acemoglu believe that political leaders are "totally unprepared" on how to best correct the problems being brought about by automation and changing employment (Florida, 2017). In order to be best prepared for AI the government shouldn't stop it, but policymakers must be prepared to deal with the impacts that AI will most likely bring, and best minimize the possible disruptions of AI that might impact the livelihoods of millions (Wladawsky-Berger, 2017).

This is not a destiny and the institutions and the policies that come from them are vital to shaping the direction and the effects of the change that AI related technologies will bring to the economy (Wladawsky-Berger, 2017). Regarding AI, policymakers should commit on the innovation principle, not the precautionary principle (Miller & Atkinson, 2013). Stated otherwise, society must continue on the assumption that AI will be fundamentally good, and while it will pose a few risks, as with every technology, the focus should be on addressing these risks, not slowing or stopping the technology (Miller & Atkinson, 2013). In order for AI to achieve its maximum benefits we must always try and ensure that it is developed for good intentions. With this behind the development of AI people will begin to feel that the development of AI will be for their benefit as well and the owners of the technology and there will be less aversion to it. Finally, policymakers must do more to support research on AI technologies, including on making AI safer, more secure, and more transparent (Miller & Atkinson, 2013). By being transparent with the public researches and policymakers can demonstrate what they are trying to develop and why we should embrace the future of this technology. Government should boost spending for AI research because this funding will impact the role in fostering the next generation of scientists and engineers with the skills needed to advance AI (Miller & Atkinson, 2013). There should also be additional support for companies and government institutions in utilizing AI to off improved achievements (Miller & Atkinson, 2013). In order to fully improve our lives AI will have to take a larger role in it. By fostering its growth AI can help improve the economy and assist researchers in non-AI fields increase the rate of their discoveries.

5 POLICY RECOMMENDATIONS

The election of Donald Trump may have been a shock to many experts, but it comes as no surprise to many who understand his voters, blue collar workers who work in manufacturing. Trump's promises of bringing manufacturing jobs back to the US sounds wonderful to many, but are simply not possible. The US election in 2016 has arguably been decided by a small number of Midwest states in what long has been known as the "Rust Belt" (Muro, 2016). An important point for numerous voters was the failure of adequately well-paying jobs and the narrative of the presidential campaign was that the exodus of jobs was only due to globalization and the outsourcing of jobs to other countries and nothing was stated about automation (Muro, 2016).

Table 8. The Problems And My Proposed Solutions

Problem	Proposed Solution
Readjustment period of labour changes	Constant redevelopment and iteration
Skills/education mismatch related issues	New methods to obtain new skills
Job displacement in labour intense industries	Changing the hiring market

Source: Author's Own.

The best case scenario is that this is simply a temporary period of readjustment. Even if this best case scenario is to be believed, for many this temporary period could be the remainder of their lives. For some, those lucky few, they will be rich beyond their wildest dreams, controlling an extremely unequal share of the benefits. Unless something drastically changes the large majority will live more akin to people in the Medieval Ages, then their grandparents of the 20th century. Government is notorious for moving slowly, technology is known for moving extremely quickly. Now, more than ever, the policies that are made today will matter. The world is changing we cannot use the same old tools from the past for this new world. It is one thing to diagnose, another entirely to cure. Here a lesson can be learned from technology itself. We must develop something new, and constantly improve on our achievements starting with education.

In the majority of the world the view is you receive an education, sometimes a post secondary education in the form of University and start your career in your mid 20s working for 40 some years and then retiring. This idea to in itself is depressing. The average American will finish University at around age 22, I know I was one. The average age in Europe is around 26, 4 years behind their American colleagues (Little & Tang, 2008). Either of those ages is too soon to stop learning. The old education system of learning while young and stopping in adulthood

is absurd. Things change, the world changes. One could even make the argument that this is in fact democracies greatest threat, surviving in a world where the voters who make the decisions are basing it off old outdated knowledge from when they were educated, a bygone era. Many have advocated that education be free to ensure that all have access to it. This I also believe is not an answer. We all do not have the same abilities, or passion and creating free education does not bridge the gap caused by aptitude. Even if university is free, it is only free in currency not opportunity cost and not free in the greatest resource of all; time. The education system in Europe will not be able to keep pace with the changing technological landscape as compared to the American education system. In the regards of time and speed the American system wins. However the high financial commitment required from the American education system may be too big of a hurdle for many to climb and leave many unable to retrain and be productive members of society. In the regards to cost and availability the European system wins. A good mix of the two would be ideal, but even then neither of these systems takes into a lifelong learning process. Companies, governments and universities must partner together to ensure that individuals have the ability to learn new skills. Companies would be able to invest in their employers gaining a competitive advantage with a form of continuous education. Governments could create welfare programs that help people gain the skills they need for long term employment therefore reducing the burden of the state. Education itself must be overhauled too. New advancements in learning should not only be designed for the robots, but given to teachers to help students learn more, quicker and gain a deeper understanding. Education should no longer be constrained by geographic location. We possess the technology to watch sporting events as a global collective, yet to learn a class such as “Economics” must physically be present. The gains are only going to a few because the knowledge is held only be a few. By having more skilled workers companies are able to higher better skilled workers.

This leads next step in the retraining process, the hiring of employees. Companies and universities still select based not always on merit, but on other dubious factors. The most common advice given to jobseekers is to network. It’s not what you know, it’s who you know. This does not bode well for a flexible future, were people could be able to change careers. This is also suboptimal for the companies because they’re not gaining knowledgeable and useful employees, but instead employees who are friends of the hiring managers. An inept employee can gain a position of power; hire all their friends resulting in a terrible corporate culture driving all the good employees to the competition. Compounding this is hiring based on “Identity Politics” the hiring based of false diversity of race and gender, instead of real diversity of life experiences and education. In order for an economy and free markets to grow and change, employees need to be hired on merit. The next generation of antibiotics will not be developed by networking, but hiring the scientists with the correct skills, education and mindset. If companies continue their poor hiring policy employees will not seek retraining opportunities because individuals realize their skill set will be overlooked because education does not factor into being hired. Even if education is improved it does little good if the benefits are not realized.

While the experts argue about the effects of AI on the economy the people have already made their opinion and rendered their verdict of what they feel is the problem and the solution to their problem. Hawking argues that automation may expedite the ever expanding economic inequality currently occurring around the globe, the internet and other media allows a very small group of individuals to generate large profits while employing a very small amount of individuals, this is inevitable, it is progress, but it is also socially destructive (Price, 2016). The continued creation of AI could see the end of us humans as a species, because humans are limited by the slow process known as evolution aren't able to compete, and would be superseded by machines (Price, 2016). Increasing the mental capability of human beings could only increase by small gains, conversely machines are doubling thanks to the affect of Moore's Law. The very nature of many technologies is to reduce the work for people. Hawking frames the anxiety over the economy as a cause for the increase in the right-wing, populist politics in the West (Price, 2016). Hawking continues to say that currently the world is experiencing a widening financial inequality where many individuals are experiencing their standard of living and means to earn a living is vastly disappearing, it comes as no surprise that millions of individuals are seeking new answers to their problems (Price, 2016).

In the early 1900s large investments in secondary education assisted the US in making the change from an agriculture-based economy to a manufacturing based economy (Rotman, 2017). While parts of the US have created training programs at educational institutions to local business and their requirements, the federal government have been a very small active role in this regard (Muro, 2016). Income inequality increased divisions between the different areas in the US in which individuals benefit and which individuals don't benefit and the impact of automation in the Midwest is very unlike from the impacts in Silicon Valley (Muro, 2016). One of the best predictions of voting was not a county's unemployment rate, but the percentage of jobs that are "routine" (Muro, 2016). A county with a large percentage of routine jobs overwhelmingly went for Trump (Muro, 2016). Jobs that were easily automated decided a pivotal outcome in the election. Not all manufacturing jobs in the US suddenly disappeared and went overseas, but many have become highly automated resulting in a continued decline of employment in manufacturing in the US (Muro, 2016). Feelings that people have about this are clear from the viewing of an electoral map of the Rust Belt (Muro, 2016). However the reduction of labor-intensive manufacturing in commodities in the past decades and the increase of hyper-productive advanced manufacturing has created millions of working-class individuals feel abandoned, irrelevant, and angry (Muro, 2016).

The trend begin in 1980 with the removal of more than one third of US manufacturing positions, decreasing from 18.9 million jobs to 12.2 million (Muro, 2016). The majority this was in the Midwest, where many towns were left devastated by the loss of production work, jobs that would pay $25 per hour ($52,000 annually) plus health and retirement benefits (Muro, 2016). Once those jobs were gone service-sector occupations started to appear as alternatives without benefits paying $12 dollars an hour ($24,960 annually a reduction of 52% not including benefits) (Muro, 2016). Autor believes that this has resulted in staggering boost in political polarization and eventually the election of Trump, despite the feelings of many people manufacturing employment has increased since 2010, partly from the post-crisis auto

boom, the advanced manufacturing industries (Muro, 2016). This has done little to the angry voters who feel that this is too little too late despite that US manufacturing sector has been succeeding in the past years (Muro, 2016). “The number one thing we did wrong was not present a strong, bold economic agenda” Democratic Senate leader Chuck Schumer has said following the defeat of Hilary Clinton to Donald Trump (BBC News, 2017). In many ways the election of Donald Trump was a referendum on current economic situation in the US and to a greater extent the West.

The changes above may not solve the entire problem, they are at the very least, a realization that large fundamental changes are required in order for society and capitalism to function and survive. While large structural changes are needed they are not impossible. Humans have achieved much greater feats in the past and we can again. What is required is a will to constantly improve and to make improvements that benefit all, not just the few. Policymakers must realize that the world is not broken yet, it just needs some adjustments before the problem becomes unfixable and we all suffer a great deal more.

CONCLUSION

Just as a new social compact was forged in the 1930s, 40s, and 50s that saw manufacturing workers as a source of productivity improvements and raised their wages to create a broad middle class to power growth, a new social compact, a Creative Compact, that extends the advantages of our emergent knowledge and creative economy to a much broader range of workers (Bright & Company, 2014). Every job must be "creatified"; we must harness the creativity of every single human being (Bright & Company, 2014). In order to ensure that we have a viable future, we need to take lessons from the past and ensure a new social contract that enables all people to participate in the future. As people’s quality of life may lag behind, they begin to feel frustrated and lash out and grasp at the ability to “turn the clock back”. The idea that robots could make employment itself optional may sound fantastic, No more work!, but the end result could be more, not less angst (Bright & Company, 2014). We’d still have to find our place among the robots, except this time without work as a guidepost for defining a sense of purpose (Bright & Company, 2014). By eliminating the need for people to work, robots would free us up to focus on what really makes us human, the scariest possibility of all is that only then do we figure out what really makes us human is work (Bright & Company, 2014). Many people get a sense of pride from their work besides the enjoyment of simply getting paid. What happens if and when robots are able to do everything better than us and leave us with near zero occupations left. Studies have shown that the most effective mix of cash subsidies, retraining opportunities and job search assistance depends critically on such factors as the relative importance of unemployment in determining displace workers losses and whether the displaced are likely to find similar work to their former jobs (Jacobson et al., 1993).

As digital technologies make markets and businesses more efficient, they benefit all of us as consumers (Brynjolfsson & McAfee, 2011). As they increase government transparency and accountability and give us new ways to assemble and make our voices heard, they benefit us

as citizens and as they put us in touch with ideas, knowledge, friends, and loved ones, they benefit us as human beings (Brynjolfsson & McAfee, 2011). The twists and disruptions will not always be easy to navigate but we are confident that most of these changes will be beneficial ones, and that we and our world will prosper on the digital frontier (Brynjolfsson & McAfee, 2011). Roger Schank writes, “Everyone should stop worrying and start rooting for some nice AI stuff we can all enjoy” (Miller & Atkinson, 2013).

AI is providing us a powerful tool to reshape our destiny and eventually to a larger extent our own species. But what do we do with this new found power? Once again Stephen Hawking may provide us with the answer. Hawking suggests that in order for humanity to survive we need to leave earth (Ghosh, 2017). If humanity is to continue for another million years, our future lies in boldly going where no one else has gone before (Ghosh, 2017). Robots may in fact take our jobs and redefine what it means to be human, but with that change gives us the chance to do exactly what evolution created us to do, survive and spread our species throughout the cosmos. Before a golden age of AI occurs, society could face a lot of tough choices.

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