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A Historical Comparison, and Speculative Analysis of The Technological Revolution: Winners, Losers, and Technological Capabilities

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Abstract

Technological innovation began long ago, and if we start at its origin, and slowly breakdown its progression to present day, a significant role, and purpose begins to emerge. However, technology is now smarter than ever, and despite being able to refer to the past, there are countless uncertainties regarding the current capabilities, and the predetermined path of automation and computerisation. Moreover, there is much to be discovered surrounding the role of technology within income inequality. How much of the inequality and progression of trends can we attribute to technology? Will technology displace the majority of human labor hours? It is becoming more clear, as new research is completed, that technology has not even begun to run its course, and that human labor is definitely at risk, but to what extent?

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Introduction

Since the Industrial Revolution, technology or machinery has had some sort of relationship with human labor. However, as the centuries have passed, and technology has continued to increase its capabilities, that relationship has changed. Moreover, the impact technology has had on human labor has continued to vary as different time periods, and their respective technology and innovation techniques have transpired. Throughout this paper, the relationship between technology and human capital will be analyzed, displaying its vast difference throughout the 21st century thus far, in comparison to the early 20th century, and prior. Through comparing the Industrial Revolution to the computerisation, and automation revolution, the details will reveal that the purpose of technology has remained the same, however, its capabilities, and therefore residual impact on the economy has increased. Historical analysis as well as the comparison between the bottom 90% income growth and top 10% income growth reveals that technology correlates directly with income inequality and the uneven distribution of wealth that has existed within the American economy for decades. My research provides the explanation as to the depth of this relationship, and its potential path moving forward into further use of advanced technology.

The nature of current technology, and its intelligence in particular, creates a two way road for the future of technology and the labor market in the United States. As told by the experts, the future of technology will take us into either a time of struggle and

recovery, where the displacement of jobs will become a significant issue, or a time of Schumpeterian creative destruction which will involve a full economic recovery, much like the recoveries experienced throughout the Industrial Revolution, or Electrification periods. Many seem to misunderstand the potential for new technologies usage, and its ability to work autonomously in the near future. This detail is significant, as it is the reason for much of technologies potential destruction. The Industrial Revolution was a time period that demanded low skilled workers, due to the nature of the mechanical technology. Humans were the compliment to this wave of technology, as they were needed to operate the technology that displaced the highly skilled craftsmen. However, artificial intelligence, machine learning, and big data have given technology the ability to function on their own, without the need for a human compliment. This wave of technology is different than any that have come before, hence the unpredictability, therefore jobs that have previously been sustainable may be rendered unsecure considering the circumstances. Simply put, the more a job requires interaction, the safer it will remain throughout this period of economic change. In the past, and in the future, the most wealthy people in the country, CEOs, Executives, etc., have/will remain secure as their jobs depend on human interaction and a set of skills that cannot be taught, or learned in a classroom.

Technological innovation has potentially opened the door for an entrepreneurial state in the future, which will cause workers to rely on their own motivation and tenacity

to create a reasonable income for themselves. This is due to technologies ability to potentially displace a large amount of labor. However, this is just one perspective. The schools of thought, or experts that believe technology will wipeout jobs in a large way have placed the future in the hands of the workers themselves, or the government, in the form of an employer of last resort. This post-keynesian solution to high unemployment and significant job loss may prove vital to the success of our economy in the future, as technologies path remains unclear. This would create a situation that would leave many middle class workers to work low skilled jobs for remedial wages as the most wealthy remain atop, and become even further from the bottom 90%, in terms of income. The story of technology's existence in our economy is not a complex one, but rather an unpredictable, and potentially harmful tale. Irregardless, it will become clear who is aided and who is hurt by the presence of technology. Therefore, an understanding of the economic functionality, as well as the history of capital and labor interaction, will prove valuable as the future of technology plays out before our eyes.

Chapter 1
Historical Analysis of Technology: Technologies' progression, and its impact within income inequality, and wealth distribution

The American Industrial Revolution is one of three major revolutions that have happened up to this point in time. Throughout this revolution, the key components regarding innovation were the division of labor, and the creation of mass production. Despite the fact that much of the machinery that was created and relied upon throughout the American Industrial Revolution has been replaced, or improved by now, there is much to be taken away and analyzed in terms of the nature of revolutions in general. With the automation and computerisation revolution developing and progressing as we speak, it is pivotal that everything to be learned is learned, and all aspects of growth, labor, and innovative techniques are broken down from this period of time.

1.1 From Fear to Acceptance

Human error has always played a role within labor, and employment; often times leading to an increase in the use of capital, and a decrease in the use of labor. This idea of creating a relationship between capital and labor is the epitome of the American Industrial Revolution. Throughout this time period, much of the labor force was workers who were completing tedious tasks by hand, which proved unproductive. This is where the development thought process, and demand for machinery came into play. Not only were humans susceptible to error, but they were, in the simplest terms, inefficient. As

stated previously, humans were less efficient than the common machine, and this has continued to be the case for centuries. At the time of the Industrial Revolution, the idea of instituting machinery, or anything that could perform at a higher rate than humans, was not yet widely accepted, dating back to late in the 16th century. Take William Lee, for instance. William Lee created the stocking frame knitting machine in 1589, with the intention of eliminating the need for workers to knit by hand (Frey and Osborne, 2013). However, when he met with Queen Elizabeth 1, he was shut down in huge way. In fact, she refused his patent request, stating: "Thou aimest high, Master Lee. Consider thou what the invention could do to my poor subjects. It would assuredly bring them ruin by depriving them of employment, thus making them beggars" **(**Acemoglu and Robinson, 2012). This claim by Queen Elizabeth alludes to the deep concern, at this point, in making certain types of skill obsolete. This example directly illustrates the concept of creating a balance between labor and capital, and displays that this conversation has existed, and will remain in discussion as long as people desire technological progress.

With that being said, Carl Benedikt Frey and Michael Osborne, who have written a substantial amount on the future of employment and labor, also describe the point in time when the government began to recognize the value of technology. In reference to the British Industrial Revolution, and the riots that transpired following discussion of technology, Frey and Osborne state, "The 'Luddite' riots between 1811 and 1816 were partly a manifestation of the fear of technological change among workers as Parliament

revoked a 1551 law prohibiting the use of gig mills in the wool-finishing trade" (Frey and Osborne, 2013). This excerpt perfectly explains the shift in government intervention from Queen Elizabeth's rejection of technology, to the acceptance of gig mills that would enable the replacement of human labor. This 'change in attitude' came after a simple realization was made that would change the way people thought about technology, and mass production in general. That realization is that, inventors, consumers, and unskilled factory workers, were going to benefit from this alteration in the production process (Frey and Osborne, 2013). The fact of the matter is, human production up to this point was slow, and relied on an 'old-school' craft to create anything that had purpose. This realization opened the door for the Industrial Revolutions in both Britain, and America. In order to create a deeper understanding of this, Frey and Osborne reference Clark's 2008 article which states that, "despite the employment concerns over mechanisation, unskilled workers have been the greatest beneficiaries of the Industrial Revolution" (Clark, 2008). This indicates that although the classic 'artisan' has been considered "skilled" up to this point, he may become obsolete. Moreover, there will be gains from the technological progress, which will have a positive impact on a large portion of the growing labor force as they become the complimentary variable to the simple machines that have entered into factories. (Frey and Osborne, 2013).

1.2 Deskilling

Following the acceptance of technology by workers and the government came the concept of "deskilling" labor (Frey and Osborne, 2013). Through the process of deskilling, mechanisation has ultimately taken a unique craft and turned it into a large amount of simple tasks to be completed by low-skilled workers. This is why the employees become the beneficiaries of mechanisation; as a very skilled workers' artisan shop becomes too inefficient to meet a rising demand, manufacturing warehouses began to appear, which quickly became the workplace of a large number of low-skilled workers.

The perfect case study to analyze, which illustrates the entire process of deskilling, is the change in the creation process of boots and shoes. When discussing the American Industrial Revolution, the common terminology changes just a bit. Where we may have referred to this change in technology as mechanisation, it can now be referred to as capital deepening (Atack, Bateman, Margo, 2005). Throughout the nineteenth century, as the process of manufacturing began, and continued to change, the United States "used increasing amounts of capital per worker" (Atack, Bateman, Margo, 2005). In fact, these economists state that "Capital labor ratios in manufacturing increased by at least 75% between 1850 and 1880" (Atack, Bateman, Margo, 2005). Prior to the shift in the production process, most manufacturing came in stylized artisan shops that were able to fit the owner, and potentially a few workers, who would make goods as they were

ordered (Atack, Bateman, Margo, 2005). At this point, these artisan shops were home to the "skilled workers" who were most likely using common goods and a hand tool or two to create a customized set of boots, for example. However, as the manufacturing sector grew, and demand followed suit, the goal of business owners and manufacturers became maximizing the output per worker. In order to do this, larger manufacturing plants were developed, and filled with machinery, which would immediately increase the amount of output each worker could contribute. For instance, these statistics can indicate an improvement in efficiency within the manufacturing of boots and shoes. The reason we look into this sector is because it experienced capital deepening most rapidly. Atack, Bateman, and Margo refer to the change in production process, explaining it thoroughly, stating:

> Following the primitive shoemaker, who worked on the bench in his own home making shoes to measure...the first change introduced the old-fashioned shoe shops which were large enough to accommodate but 3 or 4 workmen… In time this system gradually gave way to the modern factory system...in which, with the exception of the uppercutting department, machinery has almost entirely displaced hand methods.

This excerpt provides an illustration of the process by which the classic shoemake was replaced, and has remain replaced. The reason for that is because,

> -in the hand production of men's and women's boots and shoes, one or two workers performed between 45 and 83 different operations. While in machine production, boot and shoe manufacturers employed between 98 and 371 workers,

> who performed between 84 and 173 different operations, about half of which were powered or assisted by steam. Depending upon the quality, a pair of handmade boots or shoes took between 2 hours 50 minutes and 22 hours 15 minutes to complete. The same quality boots and shoes produced with the help of machines took between 38 minutes and 2 hours 58 minutes to produce (Atack, Bateman, Margo, 2005).

These economists continue, referring to the process by which men's shirts were made.

> The process engaged 230 workers performing 39 distinct operations using cutting presses, stamping machines, sewing machines, awls and press irons, shears, pleating machines, brushes, knives, and buttonhole cutters as well as needles and thread, whereas in the artisan shop a single worker performed 25 operations, all by hand, with shears, patterns, needle, thimble, and a press iron (Atack, Bateman, Margo, 2005).

These specific examples underline the importance of large quantities of people, and the demand for low-skilled workers at this time. These excerpts set the stage for the role of the complementary variable, low skilled workers. The authors discuss the amount of people it took to run a factory, indicating that there was such a high demand for low skilled human workers. These workers needed no skill or experience of any sort, but simply the ability to pull a lever, cut leather, etc.

1.3 History Repeats Itself

The 19th century was responsible for the existence of mass production, however, as time went on, the premium on skilled workers began to emerge. Economic historians have found no trouble in identifying the lack of continuity between the 19th and 20th centuries, when it comes to the relative demand for skilled-labor (Frey and Osborne, 2013). This concept can be attributed to the change in power source from steam and water, to electricity. When the power source changed from steam and water to electricity, the machinery that was previously run by steam and water had to be replaced by machinery that was run by electricity. In order to further understand this process, Frey and Osborne refer to Goldin and Katz, who state, "In short, while factory assembly lines, with their extreme division of labor, had required vast quantities of human operatives, electrification allowed many stages of the production process to be automated, which in turn increased the demand for relatively skilled blue-collar workers to operate the machinery" (Frey and Osborne, 2013, p.11**)**. This reemergence that appears, when it comes to the premium set on skilled workers, can be attributed to the respective learning curve. In other words, as new technology appears in the form of electricity, the brightest bulbs may grasp the concepts, however, the low-skill workers become worthless, as they did in the age of the artisan shops. At this point in history, the term "skill" is essentially replaced by the term "educated".

When artisan shops were common, and the process of production relied on a small amount of people with skill, the term "skill" referred to the ability of a person to make boots. On the other hand, when electrification was becoming more prominent the term "skill" or "physical capital" becomes irrelevant as almost no one had previous experience, or a background in electricity, obviously. Therefore, the demand for skill within artisan shops shifted to a demand for education within the electrification revolution. The shift from water and steam powered machinery, to automated, electricity run machines was far different in nature than the move from artisan shops to manufacturing plants. This was based on the idea that the complementary variable of the first shift was low-skilled workers, which required minimal understanding, and therefore became easily attainable. However, as electrification emerged, as did the demand for education. Frey and Osborne illustrate this relationship best when they state, "the story of the twentieth century has been the race between education and technology" (Frey and Osborne, 2013, p.12). In order to further explain how this phenomenon emerged, they provide the fact that the high school movement coincided with the first industrial revolution of the office (Frey and Osborne, 2013).

The concept of a learning curve is exemplified perfectly when discussing the creation of the typewriter. "The typewriter was invented in the 1860s, however, was not implemented into offices until the early twentieth century, when it was alongside the wave of mechanisation, with dictaphones, calculators, mimeo machines, address

machines, and the predecessor of the computer -- the key punch" (Frey and Osborne, 2013, p.12). All of these brand new devices are responsible for reducing the cost of information processing tasks, and increasing the demand for the complementary variable; educated office workers (Frey and Osborne, 2013). Because of the high school movement, there was an increased supply of educated office workers, however, this created a significant decline in the wage premium of such clerking occupations relative to production workers (Frey and Osborne, 2013). This was not because of deskilling, but rather, this scenario was created by a large supply of educated workers, and a far lower supply of jobs that required education, therefore, compressing the educational wage differentials (Frey and Osborne, 2013). Electrification was a revolution that merely set the stage for what was to come. As time went on, it was clear that the level of technology would continue to increase, and as expected, so would the premium on education, or the level of skill required to perform tasks in the future. This connection is referred to as capital-skill complementarity, (Frey and Osborne, 2013) and as the use of technology continued to increase, wage gaps, and income inequality began to scale as well, as we will see in discussion of the revolution that follows electrification.

1.4 Historical Takeaways

Within economics, and social studies in general, there is invaluable information that can be derived from history. When discussing the evolution of labor, unemployment,

and an increase in technology, historical evidence provides economists with a means for learning, and understanding. Through the analysis of The British Industrial Revolution, The American Industrial Revolution, and the electrification revolution, it becomes clear that:

(a) There is a significant pattern within the nature of revolutions.

(b) The role of a complementary variable/factor fluctuates based on the learning curve associated with each different revolution.

(c) The nature of the Technological Revolution that is ensuing will be far different from previous revolutions for many reasons.

The pattern that is innate to revolutions stems from the idea that when a new piece of technology is instituted, for instance the addition of water and steam powered machinery, not only is there backlash (as we saw with Queen Elizabeth) but following that, there is an adjustment period. A perfect representation of these two consecutive reactions is the initial attempt by William Lee, followed by a wide acceptance from the British government. Frey and Osborne state:

> "That guilds systematically tried to weaken market forces as aggregators to maintain the technological status quo is persuasively argued by Kellenbenz, stating that 'guilds defended the interests of their members against outsiders, and these included the inventors who, with their new equipment and techniques, threatened to disturb their members' economic status" (Frey and Osborne, 2013, p.7-8).

This quote supports the idea that when a new piece of technology is becoming more popular, and has the potential to threaten the livelihood of a certain group of workers, there is a natural tendency to push back or question the process. Based on the need for the technology, and an understanding that this innovation is best for economic development and growth, it would be without reason that a government would turn down the opportunity to revolutionize and expand an industry. This specific point of realization is illustrated in Frey and Osborne's article; explaining the economic significance that technology has, and the outlets for its usage and potential for growth. Following the riots, which began as a result of new technology, the British government began imposing their will upon anyone who attempted to destroy machinery (Frey and Osborne, 2013) due to its economic value. Finally, a resolution was passed, and the reasoning was that, "The sole cause of great riots was the new machines employed in cotton manufacture; the country not withstanding has greatly benefited from their erection and destroying them in this country would only be the means of transferring them to another...to the detriment of the trade of Britain" (Mantoux, 2006, p. 403**)**. In a world where efficiency and productivity have been a primary concern for centuries, this quote explains why this technology was worth instituting. While workers are at risk, and some may lose their jobs, there is a larger entity at stake, and that is international trade. At this point in history, cotton was a tremendous trade asset, and therefore, Britain could not allow for another country to capture the growth potential that this brand new cotton manufacturing

machine could provide. This machine provided the ability to produce cotton at a far more efficient rate, which would simply increase the margins for international trade.

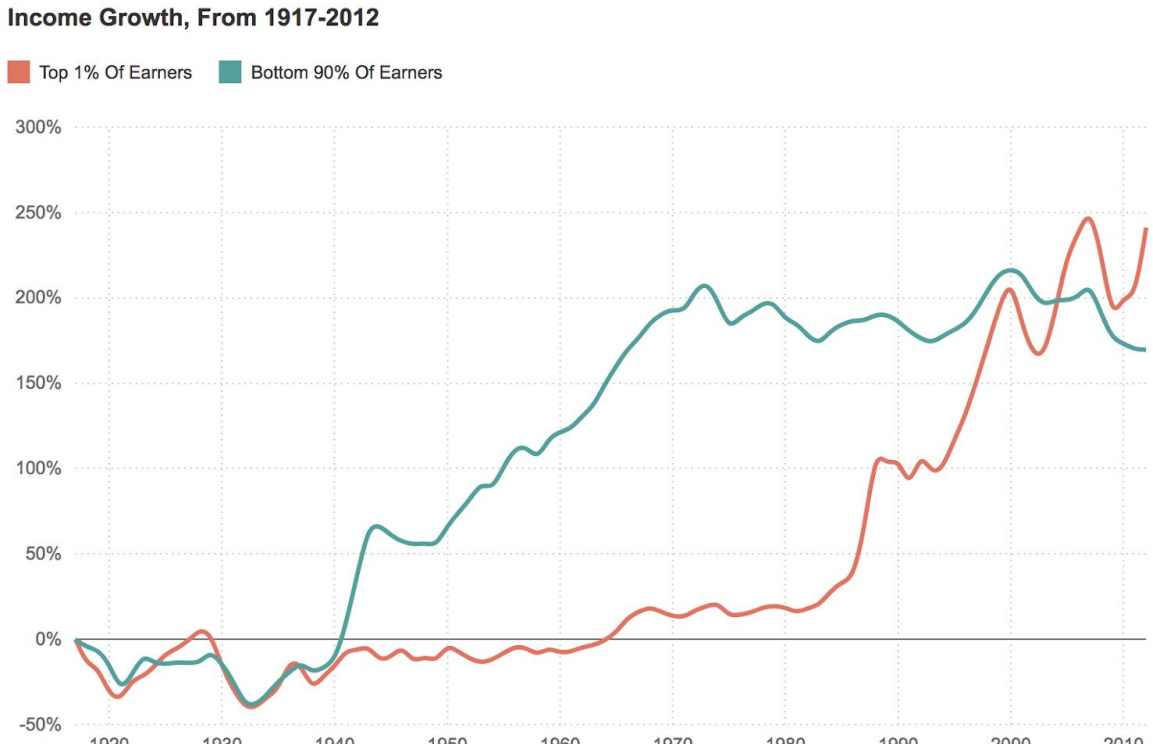
Chapter 1 - Part 2: How has technology impacted income inequality and wealth distribution?

In an attempt to flesh out the importance of the history surrounding technological implementation, we unintentionally uncovered a significant relationship between technological innovation, income inequality, and wealth distribution. As we discussed, the history of technology, and its implementation goes back far enough to recognize the trends previous to electricity. Technology's role within income inequality, at least from a historical standpoint, is simple. Considering technology includes any innovation that simplifies or replaces a human's labor, a human's value is reduced when technology is introduced, due to their now technological companion. Once technology simplifies a worker's job requirements, their value to the business owner, manufacturing operator, or whoever it may be, has decreased. Technology has always been a vehicle for higher labor efficiency, and cutting costs. Therefore, fluctuations within income inequality, and an uneven distribution of wealth in the long-run, are a direct result of a shift in the labor markets, following the start of technological implementation.

Innovation has been around for centuries, ever since someone was able to complete any simple task, the idea of improvement has been a factor as well. Considering the nature of competitive markets, innovation has held value from the start. There is no

competitive market that is content with its efficiency, as most business owners are constantly looking for the most creative enhancement to get a leg up on their competitor, and of course, create a higher margin for profit. Throughout this portion I will, through observation, create a theory behind the impact that technology has upon the adjustment of labor markets, which impacts income inequality, and wealth distribution, dating back to the era of the "rural proletariat". However, before beginning with how income inequality, and an uneven distribution of wealth began, I will discuss the forces, from a more general standpoint, and how they originated. In a TED Talk that aired in 2014, Thomas Piketty discussed income inequality, and the many forces that create it. The two forces that he discusses, which hold substance to my historical, technological based argument, are the race between education and technology, and unequal access to skills within the U.S (Piketty, 2014). The following graph depicts the trends of American income inequality from 1917-2014.

Graph 1



The Fall And Rise Of U.S. Inequality: NPR, 2015

This graph illustrates the trends that income inequality has followed over the course of almost a full century. It is clear that following the 1940s, there is a significant growth period for the "Bottom 90% of Earners" which seems to come to an abrupt halt around 1970. The reason for including this graph so early on in my explanation, is to set the stage, and create a baseline of understanding. That way, as the historical context and development is broken down, arguments surrounding the reasoning for such inequality make more sense considering the reader now is aware of the current and previous state of inequality (which is represented by this graph).

1.2.1 Agriculture Industry Experiences Technological Innovation

Now that there is context surrounding income inequality, it is appropriate to begin explaining the process through which our economy has developed an inclination for fluctuations in income inequality, as well as a long-term uneven distribution of wealth. Beginning with the transformation of the agricultural ladder, it is easiest to establish the role of technology within the simplification of labor, which has forever favored the most wealthy, in the long-run. By simplification of labor, I refer to the process by which a worker's job becomes easier, solely based on a slight (or profound) implementation of technology. The neo-Marxian perspective, although quite radical in nature, provides a lot of context regarding the roots of technology. This becomes obvious, as Roumasset and Smith state, "-history can be usefully interpreted as the history of modes of production"

(Roumasset and Smith, 1981, p.403). This article describes the beginning of induced technological change, and the role that slight technological innovation played in "polarizing society[1]", therefore creating fluctuations within income inequality, and uneven distribution of wealth. Technology was not the only factor in creating a polarized society and uneven wealth distribution, as the Malthusian view, which takes into consideration land scarcity, was also a theoretical factor (Roumasset and Smith, 1981). The author's specifically refer to the role that land scarcity played, parallel to technology, stating, "Not only do producers increase labor intensity by shortening fallow[2] periods and adopting other established methods, but a country's research network may respond to land scarcity by generating new land-saving technology" (Roumasset and Smith, 1981, p.403). In other words, as population rises, land becomes more scarce, and in order to maintain financial stability, landowners are forced to increase production. In order to effectively increase production, without increasing costs too significantly, landowners, as we will see, will somehow incorporate technology. However, at this point in time, technology is incapable of taking over a large role in production, as it is not complex.

[1] Social **polarization** is associated with the segregation within a **society** that may emerge from income inequality, real-estate fluctuations, economic displacements etc. and result in such differentiation that would consist of various social groups, from high-income to low-income.

[2] the term **fallow** refers to land that is plowed and tilled but left unseeded during a growing season

1.2.2 Market Forces, and the Need for Innovation

Based on an understanding of the agricultural demand at this point, it is clear that in order to maximize land usage, the profit seeking landowner will focus on a decreased time of harvest, through a more efficient production process. A simple mechanical device, classified as a land-saving innovation, would eventually create the efficiency that landowners desired. Land preparation was vital to the success of an agricultural business, and by hand, preparation took far too long, which in turn, slowed down the production of crops. In comes the mechanical thresher, and a goal based on efficiency becomes more reasonable. The authors state, "The rapid shift to mechanical threshing, despite a negligible cost advantage, appears to be due to the ability of mechanical threshing to enforce a timely harvest" (Roumasset and Smith, 1981, p.412). Not only did this innovation create optimal harvests, but the authors continue describing the benefits, also mentioning that "Harvest and post-harvest labor declined from 35.8 to 27.8 person-days" (Roumasset and Smith, 1981, p.412). Because there is now an understanding of the positive effects that land-saving technology has on agriculture, it becomes more clear how this technology favors the more wealthy, in the long-run. Due to the fact that efficiency has increased, as well as achieving optimal harvest time, the landowners, and "wealthy operators" receive the most benefit. This piece of technology allows for larger profit margins, and therefore, the capital to scale, and continue to increase production. This is the beginning of income inequality forming within the economy. Although there

is an increased demand for labor, the labor costs are outweighed by the efficiency created by the device, therefore the farm operators continue to generate a more significant of income, while the rural proletariat experience no increase in wage or income. It is clear that based on an increase in population, and therefore increased land scarcity, technology is induced. It is solely based on this fact, that a distinct income inequality arises. There are more gains to be made, by the "wealthy operators" of the farms, while labor costs remain low, based on the low demand for human capital. At this point, the observation of land-saving technology has created a parallel between an increase in technology, and income inequality. This is a correlation that will remain true as technology continues to persist, and develop through the time periods, and revolutions that follow.

1.2.3 Technological Application Within the Industrial Revolution, and its Respective Results

Throughout the Industrial Revolution, many of the same economic factors we discussed from an agricultural standpoint, have retained their importance, in terms of income inequality. Take, for instance, the process of deskilling. Deskilling was a process incorporated by producers, that not only handled increasing demand, but increased profits, and favored those at the top of the food chain within a company, in the long-run. It enabled craft based artisan work, which limited production, to transition into manufacturing plants that were more profitable, and capable of meeting demand. While

the agriculture and farming sector was forced into technology through land scarcity, artisan work turned to technology in order to meet demand, and maximize productivity (the latter showing similarities to agriculture). Before the idea of technology came into the picture, "a pair of handmade boots or shoes took between 2 hours and 50 minutes and 22 hours 15 minutes to complete" (Atack, Bateman, Margo, 2005, p. 589). However, as cutting presses, stamping machines, sewing machines, and other capital intensive production pieces culminated, "the same quality boots and shoes produced with the help of machines took between 38 minutes and 2 hours 58 minutes to produce" (Atack, Bateman, Margo, 2005, p. 589). Technology has once again provided wealthy operators a means for driving down production costs in the long-run, while increasing production and demand for labor in the short-run. The creation of uneven wealth distribution can be pinpointed within this process, due to the complementary variable of low skilled workers, as well as the opportunity to increase firm size, alongside their profits.

Now that the production process has been simplified, business owners can rely solely on the low-skilled labor force, keeping labor costs especially low, considering the corresponding use of technology. At this point in time, there is a significant gap between the upper class and the lower class. Based on the nature of the industry, there is not yet a middle class, because the wealthy owners (upper class) can simply rely on the low wage rates of their employees to carry production. Now, refer back to Graph 1, where we can see an illustration of the income inequality. If you have a look at the earliest dates

included on the graph, it is obvious that the growth in income for both the top 1% and the bottom 90% are the same.

1.2.4 Why the Income Graph Represents a Culmination of Technological Impact

The appearance of the graph may seem to contradict my argument surrounding income inequality, however, at this point in history, there are many economic components to consider. For starters, the labor market, at this point, consists of primarily wealthy operators, and low-skilled workers. However, the continued use of technology will eventually change the labor market, through the creation of a middle class. Before the creation of the middle-class, which I will soon discuss, it is more difficult to pinpoint income inequality. Therefore, it is more effective to consider the long-term effects of technology, and why its role in the production process affected income inequality in the short-run and wealth distribution in the long-run. If we consider the graph, in particular 1940, we see a shift of income inequality, favoring the bottom 90%. However, you must also consider that this is approximately the time period in which the middle class became most prevalent, which, according to the graph, was beneficial in the medium-run, but not in the long-run. This can be explained by the very obvious nature of technology thus far. Technology, as a factor of production, serves to create further efficiency per worker, or in current-day, eliminate human error. The spike within income growth for the bottom 90%,

which we see begin in 1940, comes to an abrupt halt in 1970. This can be attributed to the role that technology played previous to 1940 and the role it assumed following 1970. Prior to 1940, technology's complimentary variable was low-skilled workers, which creates jobs, yet maintains the divide between the upper and lower classes. However, the creation of the middle-class, which was significantly influenced by technology, would initiate these significant fluctuations within income inequality, while simultaneously triggering a future full of uneven wealth distribution.

1.2.5 The Creation and Impact of the Middle Class

Following the second American Industrial Revolution, electricity begins to emerge, which creates a shift in demand from low-skilled workers to skilled workers. Now, in order to receive a job, you had to have some sort of skill set, or further education. Frey and Osborne discuss the effects of this shift, stating, "The US high school movement coincided with the first industrial revolution of the office" (Frey and Osborne, 2013, p.12). This highschool movement, and therefore increased supply of labor, in combination with an increase in demand for skilled-labor, would drive down industry wages, while allowing for vast scaling opportunities (Frey and Osborne, 2013). It is at this point that middle-class jobs such as managerial positions, and clerking positions came into play. As I previously stated, 1940 was a summation of increased technology,

and education, which naturally created the middle class. Graph 1, as previously discussed, illustrates this rise in education and technology, through an increase in the bottom 90%'s income growth. This increase in the growth of income, for the bottom 90%, proves to be temporary, as we see following 1970. This can be partially explained by the fact that technology provided a steady income for a large group of people. However, we cannot forget that the nature of technology, and its capabilities, would not stop there, which became the problem. As technology continued to develop, following the creation of the middle class, the jobs within this class would stagnate, and overtime, lose their value. The middle class worker would retain his/her value, however, as technology became more capable, the value of these workers would slowly decrease. It is based on this idea, that our economy began to experience more significant income inequality, and an inevitable uneven distribution of wealth. In 1940, the labor force would give business owners the capability to scale, however, continued technological improvements would then decrease the value of these same workers. Technology could now provide the same opportunity for growth, however, the benefit for the wealthy became even larger as the long-run played out. It is clear based on the graph, that the top 1% essentially waited out the 30 years that the middle class was rapidly growing, in order to reap the benefits for a far longer period of time. Due to a rapid increase in demand for labor, the wealthy had no choice but to hire workers, which is indicated throughout 1940-70. This would temporarily decrease the satisfaction of business owners, however,

as we can see on the graph, from this point forward, the top 1% experienced consistent growth, with no sign of turning back.

1.2.6 Conclusive Analysis

Through analyzing the trends of income growth in graph 1, as well as breaking down the historical usage and pattern of technology, I am able to establish the role of technology within income inequality, as well as wealth distribution. The graph creates a historical display of a slow, but steady, increase in the use of technology. When technology first became prevalent, it created jobs, and incomes for individuals, which would remain steady for the time being. This is indicated by the graph between 1940 and 1970. This would temporarily decrease income inequality, as it created middle class jobs. However, the long term effects of technologies original installment have reborn significant income inequality, and provided the top 1% with large amounts of wealth. Technology constructed its own path, one that created ebbs and flows within income inequality, and has set our economy up for a, more permanent, uneven distribution of wealth.

Chapter 2
21st Century Technology and its Unpredictability: History, Expectations, and Possibilities

The Industrial Revolution laid the land for how technology would be implemented into factories, and how it could impact labor, and workers, dependent upon the era. Having considered the historical aspect of technology, we have a better understanding as to why it is implemented, and the societal reactions when technology is on the cusp of penetrating a market. However, 21st Century technology differs from previous technology in many ways. I have discussed the role of the complementary variable, and the manner in which low-skilled workers, or educated workers have complemented certain implementation techniques, which vary depending on the revolution, or technology implemented. The key difference between pre-21st century technology, and that of the 21st century, is the potential disappearance of the complementary variable. Due to the nature of technology as we know it, it seems as though much of what is developing, or is developed, is autonomous. This is why the term "unpredictability" comes in to play. The unpredictable nature of this up and coming technology stems from the fact that it is new, and unseen. Therefore, the predictions made by experts are simply educated guesses, acquired by a thorough understanding of previous technology, and the markets that will be impacted.

2.1 The Different Perspectives/Possibilities

Countless experts in the fields of robotics, economics, and AI have made statements as to what will occur, from a technology standpoint, over the course of the next 10-20 years. With that being said, regardless of their field, or their previous research work, it seems nearly impossible for the experts to come to the same conclusion, or make the same predictions as to what the future of technology will do FOR or TO the labor market. In 2014, The Pew Research Center, a nonpartisan fact tank that simply informs the public of developing trends, released an article titled "AI, Robotics, and the Future of Jobs" which is packed full of different thoughts, perspectives, and expectations, all coming from experts around the globe who have taken on this idea of technological implementation. This paper, which was written after conducting a survey amongst experts on this topic, epitomizes the current consensus regarding technology. The current consensus being that nobody is ACTUALLY certain which fields technology will dominate, whose jobs are at risk, or if technology will lead to an entirely new labor market that we are unable to envision at the moment.

The Pew Research Center conducted an "opt in" survey, geared towards experts who were noted as technology builders and analysts. According to the article, 1,896 experts responded to the following question: "The economic impact of robotic advances and AI--Self driving cars intelligent digital agents that can act for you, and robots are advancing rapidly. Will networked, automated, artificial intelligence (AI) applications

and robotic devices have displaced more jobs than they have created by 2025?" (Smith & Anderson, 2014 p. 4-5)

According to their results,

> "Half of these experts (48%) envision a future in which robots and digital agents have displaced significant numbers of both blue and white-collar workers--with many expressing concern that this will lead to vast increases in income inequality, masses of people who are effectively unemployable, and breakdowns in social order" (Smith & Anderson, 2014 p. 5).

This excerpt perfectly describes the group of people who are concerned for the future, based on capabilities within technology. However, who is to say they are correct? The article not only displays the opinions of those who are pessimistic regarding the issue, but also sheds light on those who are optimistic towards a future full of technology. The authors state,

> "The other half of the experts who responded to this survey (52%) expect that technology will not displace more jobs than it creates by 2025. To be sure, this group anticipates that many jobs currently performed by humans will be substantially taken over by robots or digital agents by 2025. But they have faith that human ingenuity will create new jobs, industries, and ways to make a living, just as it has been doing since the dawn of the Industrial Revolution" (Smith & Anderson, 2014, p. 5).

These two sections of the article perfectly illustrate the opposing viewpoints of this argument, and clarify that there is so much uncertainty surrounding this topic. Even the experts within their own field are unable to agree upon what they believe may be in the works. Despite the fact that the uncertainty come off as rather scary, if we refer back to the role of the complimentary variable, much of it makes sense.

Take, for instance, the transition of the classic shoemaker (which we have previously discussed). As the shoemaker was moving from a single workshop, to an industrial site filled with machinery, what was there to be uncertain about? As a worker, you were able to assume the impact of the machinery, and the ensuing demand for low skilled labor, simply by understanding the nature of the shoemaking process. However, fast forward to the 21st century, and technology has got some experts worried, some excited, and others entirely unsure. This is due to the fact that the complementary variable no longer exists. Employers are no longer looking for low skilled employees to work in a factory with their new machinery, and they aren't looking for middle-class employees to manage their new job sites either. Rather, employers are seeking the most impactful piece of technology, ideally one that can function, maneuver, and meet the proper efficiencies on it's own.

2.2 The "Experts"

A majority of the literature included in The Pew Research Center's article is quotes from the experts that explain their thought process regarding whether or not technology will displace more jobs than it creates by 2025. For example, Michael Kende, the economist for a major Internet-oriented nonprofit organization is quoted, stating,

> "In general, every wave of automation and computerization has increased productivity without depressing employment, and there is no reason to think the same will not be true this time. In particular, the new wave is likely to increase our personal or professional productivity (e.g. self driving car) but not necessarily directly displace a job (e.g. chauffeur). While robots may displace some manual jobs, the impact should not be different than previous waves of automation in factories elsewhere. On the other hand, someone will have to code and build the new tools, which will also likely lead to a new wave of innovations and jobs" (Smith & Anderson, 2014, p. 6).

This is just one of the many cited experts that speaks on behalf of technologies capabilities in terms of growth. Kende speaks from a historical standpoint, stating that our economy, and our markets have always seemed to adjust when the industry provides some sort of shock. The question is, have we experienced anything like this? On the contrary, Tom Standage makes a point that is similar to mine, emphasizing that the history of technology is different than what we have coming our way now. Standage, the digital editor for *The Economist* states,

> "Previous technological revolutions happened much more slowly, so people had longer to retrain, and [also] moved people from one kind of unskilled work to another. Robots and AI threaten to make even some kinds of skilled work obsolete (e.g. legal clerks). This will displace people into service roles, and the income gap between skilled workers whose jobs cannot be automated and everyone else will widen. This is a recipe for instability" (Smith & Anderson, 2014, p. 10).

This excerpt, that Standage makes on behalf of the 48% of experts, according to Pew Research Center, perfectly encapsulates the common argument from this perspective. However, the idea of unpredictability, especially considering where we are in history right now, is that there is no certainty to any of the possibilities that are discussed. These are all "experts" in the fields of economics, artificial intelligence, and everything technology, yet they are simply speculating. In order to grasp the basis of each argument, it is worth analyzing the history of automation in the workplace, as well as technological displacement. While considering a historical perspective, it is pivotal to understand a number of concepts in order to remain open minded regarding possibilities:

1. Artificial Intelligence and Machine Learning are far different than any other form of automation in history.
2. What is said regarding history may allude to possibilities, however, none of what is said is for sure...hence the idea of unpredictability.
3. There is no right or wrong, yet. We are approximately 10-15 years from truly determining the "right" and "wrong" theories of today.

2.3 Automation and Market Recovery From a Historical Standpoint

Throughout history, it has become clear that automation, and new technologies are capable of hurting the labor force. In my first chapter, I refer to the Luddite riots, when a large group of workers in the 19th century attempt to destroy the machines that were on the verge of eliminating their jobs in the textile industry. This is simply evidence of such a phenomena previously occurring, and the labor-force reaction to potential job loss. However, I see it as quite impossible for the labor force of today to attempt a similar movement, deciding to go after the robots, or machines that are destructive to their livelihood. The nature of automation and technology is different than it has been, however one thing remains true, "Whether the technology is tractors, assembly lines, or spreadsheets, the first-order goal is to substitute mechanical power for human musculature, machine-consistency for human handiwork, and digital calculation for slow and error-prone 'wetware'" (Autor, 2015, p. 5). Autor speaks to the complexion of automation and technology in general, referring to the demand for more efficient labor, or a labor saving technology. There is no doubt that automation is a substitute for labor, however, it also serves as a compliment to labor, all while attempting to raise output in order to generate a higher demand for labor in general (Autor, 2015).

Considering these characteristics of automation, it would make perfect sense for technological change to have wiped out the majority of workers, right? Well yes, and no.

For starters, automation up to this point has often required human involvement (however we're on the cusp of autonomous technology), so therefore there is definitely technological displacement, but only to a certain point. Technology's purpose, as stated, is to provide employers with a higher level of labor output, and lower costs, therefore providing companies with growth opportunities stemming from higher profits, in the long-run. Since the beginning of automation the desire to maximize output has existed, therefore, since the beginning of automation, there has been creative destruction, specifically of outdated production units. This concept is drawn out by Claudio Michelacci and David Lopez-Salido throughout their article, " Technology Shocks and Job Flows" which concisely describes the process of creative destruction followed by industry expansion. They state,

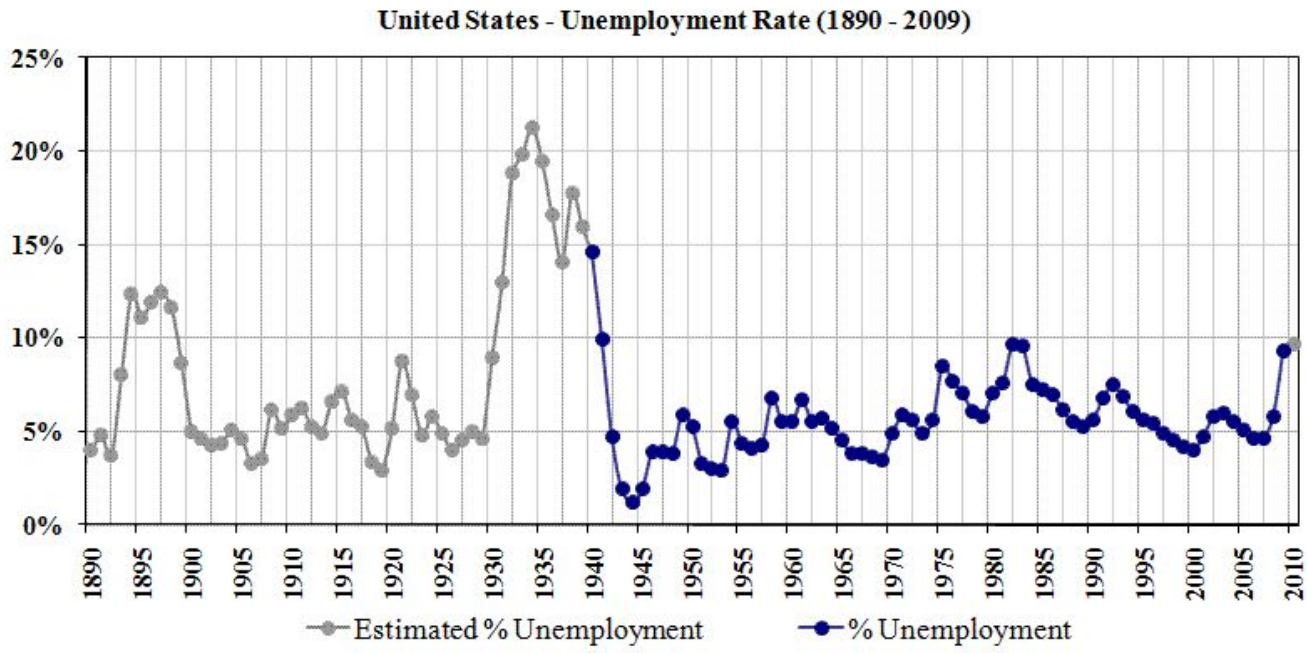
> When old jobs cannot easily upgrade their technology, the first effect dominates and technological progress causes a wave of Schumpeterian creative destruction characterized by simultaneous increase in the destruction of technologically obsolete productive units and in the creation of new technologically advanced ones. But since labour market frictions make reallocation sluggish, employment temporarily falls (Michelacci & Lopez-Salido, 2007, p.1196).

This portion of the article perfectly describes the issue that is ensuing, from a technology standpoint. Here we are in 2018, where technology has become so smart that more often than not, machines are more efficient than human workers. However, Michelacci and

Lopez-Salido reference the process that occurs after technology gains a larger portion of an industries labor responsibility. That is, as technology increases, those that are displaced are forced to find new jobs, and as they said "frictions make reallocation sluggish." This phrase illustrates the workers attempt at finding employment following some sort of technological implementation. These workers, say, blue collar workers, have become comfortable with the skill set they've acquired through their experiences in a factory. Now, a technology is implemented, which requires these workers to either acquire a new skill set through a higher level of education, or hunt for an existing firm that is seeking labor that matches their skills. This describes sluggish reallocation, the process of seeking employment in a market that is very competitive, therefore is not often seeking new workers, but rather, may more often let workers go with technological progressions coming into play.

Now, we are able to compare this idea of sluggish reallocation of employment with the perspective brought about by the Pew Research Center's surveyed experts. Referring back to section 2.2, the optimistic expert is quoted, stating that each and every previous wave of automation has not depressed employment very heavily, and there are always new jobs coming of automation, or technological implementation techniques (Smith & Anderson, 2014, p. 6). In order to thoroughly understand the idea of job creation, despite simultaneous creative destruction, we can look at the unemployment rates of two different time periods.

Graph 2



Source: Economics Help

This graph, which depicts the US unemployment rate from 1890-2009, can be used to indicate the reallocation of employment, that is referred to as sluggish when technology is involved. If we look at 1900 as well as 2000, we can see that the unemployment rates are essentially the same, hovering just beneath 5%. Well, Autor discusses a major shift in the makeup of the US workforce throughout these 100 years. He states, "In 1900, 41 percent of the US workforce was employed in agriculture; by 2000, that share had fallen to 2 percent" (Autor, 2015, p. 5). This quote, in conjunction with Graph 2, alludes to what the optimistic 52% of experts surveyed by the Pew Research Center believe. They believe that human ingenuity will help recover the lost

jobs, and the technology that takes jobs will also create them. Autor bringing forth this fact, strengthens the argument of the 52%, as we can see. In 1900, a large percentage of workers relied upon the agricultural industry. Then, in 2000, only 2% of the workforce relied on that same industry. Now, I understand that 100 years is a long time for human ingenuity to take place, however, it displays the argument brought to the table by optimistic 'experts'.

2.4 The "Endangered" Species

Section 2.3 highlighted the economy's ability to recreate jobs following drastic technological change. However, the purpose of this portion is to not only highlight the economy's ability to adjust, but also highlight the potential for extreme job loss. So, who is at risk? Up to this point, it has become clear that robots and computerisation replace routine tasks at the highest rate, as opposed to non-routine tasks (Frey and Osborne, 2013). A routine task could be a grocery store cashier, who, at most grocery stores, has already become partially replaced by the self-checkout lanes. This, however, is robotics in its simplest form, but as robotics and machine learning become smarter, who becomes the endangered species amongst human laborers? Typically, a human who has "cognitive skill" has been safe from technological displacement. Although, it seems as though big data, and machine learning are combing to find solutions to the most exquisite problems, previously considered impossible for robots to handle.

Frey and Osborne, in their 2013 paper, outline the difficulties within automating certain tasks. For instance, they refer to a specific class of labor as "Perception and Manipulation Tasks" which refers specifically to physical manipulation, in which workers might be required to climb into small spaces, or adjust to an awkward space in a timely manner. In terms of the susceptibility of computerisation, Frey and Osborne state, "tasks that relate to an unstructured work environment can make jobs less susceptible to computerisation" (Frey & Osborne, 2013, p.27). So therefore this is not an "endangered species" of labor? Well, in their 2015 article, just two years later, Frey and Osborne bring into the picture what seems to be an answer to this type of labor. Throughout their 2015 paper, they thoroughly engage in analysis regarding the automation and robotics levels throughout the United States manufacturing industry, in relation to several other countries, and establish that this is a market that has diminished to an extreme (relative to its previous significance within American GDP). Moving on from the manufacturing industry, they bring forth Baxter, a "general-purpose robot". Baxter, which costs approximately $22,000, has the ability to react to a user input. In other words, "Baxter is able to learn new manual tasks by having a human worker guiding its robotic arms through motions that will be reproduced in completing the task" (Frey & Osborne, 2015, p. 52). It seems as though the Baxter robot they have introduced is the answer to the problem they discuss in their previous paper. It is now entirely possible that this labor

market, which requires physical manipulation, and environmental adjustments, may be an endangered species, considering the presence of a robot such as Baxter.

Physical manipulation seems to be in the process of being compromised by technology, and as strange as that may seem, there are technologies that have begun to recreate creativity as well. In other words, there are technologies ensuing that can recreate the images, sculptures, or poetry that humans have come up with using the knowledge and creative instincts stored in their brain (Frey & Osborne, 2013). For instance, Frey and Osborne introduce a piece of technology that uses artificial intelligence to recreate drawings. This technology, referred to as AARON, has the ability to create line-drawings that have been shown in galleries around the world (Frey & Osborne, 2013). Previous to the appearance of such technology, it seemed as though there was a barrier surrounding this type of occupation.

2.5 Safety Where it is Social

Technology is steadily increasing its capabilities, in fact, it seems as though the only real boundary for technology exists amongst jobs involving social interaction. Often labeled “Social Intelligence Tasks” this grouping of professions involves management, leadership, negotiation, and persuasion tasks. The inability of robots and technology to capture this realm of the workforce is captured as Frey and Osborne state, “While algorithms and robots can now reproduce some aspects of human social interaction, the

real-time recognition of natural human emotion remains a challenging problem, and the ability to respond intelligently to such inputs is even more difficult. (Frey & Osborne, 2013, p.29). This makes sense, in my eyes, as the idea of artificial intelligence is that it is ARTIFICIAL. Therefore, the communication abilities of such intelligence would seem entirely engineered, rather than natural. Although, the question is, how much of the labor force falls into this social intelligence category, and is seemingly "safe" from all technology?... for now. The chart below will display different industries, accompanied by the percent of labor that is at risk of automation and computerisation.

Chart 1 (Frey and Osborne, 2015, p. 60)

	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%	12.0%	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%	25.0%	35.6%
Information	51.6%	38.3%	10.1%
Management of Companies & Enterprises	82.8%	6.2%	11.0%
Manufacturing	19.9%	18.4%	61.7%
Mining, Quarrying and Oil & Gas Extraction	7.8%	46.3%	45.9%
Other Services (ex Public Admin)	44.9%	24.7%	30.4%
Professional, Scientific & Technical Services	54.0%	10.9%	35.1%
Real Estate and Rental & Leasing	0.7%	32.0%	67.2%
Retail Trade	14.5%	18.9%	66.6%
Self-Employed	60.4%	8.9%	30.7%
Transportation & Warehousing	5.5%	19.4%	75.0%
Utilities	40.3%	27.8%	31.9%
Wholesale Trade	15.9%	18.4%	65.7%

Source: Oxford Martin School

Chart 1 indicates 21 different industries, and the percent of workers within each that are experiencing low, medium, and high risk of computerisation and automation. In relation to the groupings that I have previously discussed (physical manipulation, creative, and social), you can begin to understand which industry involves each type of labor, and therefore, why it may be at risk. For instance, the top row is "Accommodation & Food Services" which might involve fast food chains, restaurants, cafeteria workers, etc. It has become more and more frequent that you might walk into a restaurant and order on an ipad, or with some type of artificial cashier device, or kiosk. For instance, McDonalds, a high profile fast food chain, as of June, 2017, began implementing self-serve stations within 2,500 stores nationwide (Peterson, 2017). This example displays the reasoning for this industry's 86.7% high risk value. Simply put, this is an industry that does not rely on intelligence, and its workers are therefore easily replaceable. However, if we look at an industry like "Management of Companies and Enterprises" we are dealing with an industry that is more along the lines of social interaction. As I stated, this is the technological industry's most difficult task, replacing human interaction with a device. This is why the high risk value associated with this industry remains at a measly 11%. In essence, this chart can be deciphered by determining the level of social interaction, or human engagement amongst each industry. This rule will hold true in that the industries such as "Retail Trade" which has already

been mostly automated will have a higher value for risk, and an industry like "Educational Services" remains fairly low based on the larger role played by social intelligence (ie. teacher and student).

2.6 Industries in Danger - A Case Study

Having discussed the characteristics that make a job susceptible to technological implementation, I have begun to establish the types of jobs that may be at risk, however, as I have stated, so much remains unpredictable. In the previous section, I referenced the idea of social intelligence, and the fact that technology, thus far, has struggled to capture many human characteristics. With that being said, there are undoubtedly exceptions to this theory, for instance, autonomous robots that are able to minimize human error. While operating a motor vehicle, our mind is required to focus on countless things at once: your passengers, your desired destination, stop lights, pedestrians, etc. Despite this task seeming rather simple, traffic accidents remain amongst the top 10 causes of death, annually, meanwhile human error is responsible for nearly 90% of these accidents (Frey and Osborne, 2015). Not only has there been a distinct push for autonomous vehicles of late, but these robots are capable of minimizing human error. This idea begs the question, is this use of technology being implemented for the greater good, or to take over an industry that happens to deal a lot with the role of human error? In my opinion, the

autonomous automobile does both, however, eliminating human error is simply a benefit of the brilliance that this technology has attained.

Despite the ability of this vehicle to provide a safer means for transportation, the economic repercussions within the transportation industry may provoke significant discussion. Essentially, this vehicle operates based off of sensors that are capable of performing at levels higher than any human. Frey and Osborne describe the capabilities of autonomous vehicles, stating: "These will permit an algorithmic vehicle controller to monitor its environment to a degree that exceeds the capabilities of any human driver: they are not subject to distraction, have the ability to simultaneously look both forwards and backwards, and can natively integrate camera, GPS, and LIDAR data" (Frey & Osborne, 2015, P. 49). So, of course, it is inevitable for this robot to experience implementation simply based on its high level safety features, however, from the perspective of the transportation industry, what type of impact will these vehicles have? Separate from the auto industry, the existence of autonomous cars has the capability to decrease revenues throughout industries of all sorts.

CNBC released an article in May of 2017, which highlights the industries that may potentially feel the effects of autonomous automobiles. However, the author, Joel Barbier does not even mention the primary industries such as trucking, taxi drivers, or those directly linked to driving, but rather, he focuses on industries associated with driving even in the slightest. For instance, one of the examples he uses is law enforcement.

Barbier states that “In 2014, Washington, D.C. issued an average of 773 tickets per day from cameras used to identify speeding cars — adding up to roughly $37.5 million worth of fines, according to the latest figures from AAA Mid-Atlantic” (Barbier, 2017). This quotation highlights the legitimate concern centered around the arrival of autonomous vehicles. Without human error, the reason behind receiving a ticket, police officers or state troopers will lose a significant piece of their revenue. Barbier also mentions in this article the idea of impaired driving at a minimum as well...gone are the days of impaired or reckless driving, which, along with speeding tickets, remain responsible for a large piece of revenue amongst law enforcement agencies. Another industry that Barbier touches on is the insurance industry. Insurance policies are built based on risk, and car insurers are tasked with developing a monthly payment according to the risk associated with your driving record, model of the car, miles on the car, and countless other factors. With human error factored out of driving, the need for insurance will sharply decline. With that being said, it is uncertain as to the implementation rate of these vehicles, therefore, will drivers be on the road amongst these autonomous vehicles? If that is the case, it seems as though crashes will occur, just at a far lower rate, which potentially allows for insurance coverage amongst some drivers.

Another industry that will experience losses associated with a decrease in the amount of automobile accidents is the legal professional industry. Barbier states in regards to this industry: “Vehicle collisions, which accounted for 35 percent of all civil

trials in 2005, will be all but eliminated with automated vehicles. While this may seem like a niche of professionals, around 76,000 attorneys in the U.S. specialize in personal injury and make up approximately 6 percent of the country's population of lawyers" (Barbier, 2017). It is clear that the premier safety capabilities of the autonomous car will hurt many industries in a variety of ways, however, eliminating drivers will create other advantages as well. For starters, the hotel industry, which will often provide long distance drivers and opportunity to sleep, will become obsolete. Without the need to focus on the road, or their surroundings, passengers will be able to sleep throughout the night within their autonomous vehicle. Finally, this article discusses the appearance of this robot impacting package and food delivery on a more profound level. Barbier states that economic gains from this shift in the industry could be as large as $500 billion by the year 2025. Evidently, this economic gain will come from the elimination of wages. With the ability to program a truck for a specific destination, the driver, and therefore his/her wages become unnecessary to the industry as a whole.

The autonomous vehicle epitomizes this technological revolution in many ways. Having described technological implementation from a historical standpoint, it is now clear the nature of the technology that is around the corner. It is not technology that enables humans to maintain a role within the labor force (in this case), which can therefore result in massive job, and revenue losses in certain industries. Again, we can discuss the complementary variable, which was relevant to our historical findings,

however, irrelevant within artificial intelligence and smarter technology. The complementary variable, in previous revolutions, was represented by the need for low skilled workers, or educated workers, dependent upon the era, and technology being implemented. Now that technology is beginning to function on its own through the use of artificial intelligence, big data, and machine learning, the complementary variable is non existent. Instead, these technologies make humans obsolete, and force them out of certain industries.

Chapter 3: The Importance of the Entrepreneur, The Top 10% of Incomes, and Responding to a Potential Large Rise in Unemployment

In my previous chapter, I broke down the opinions of experts, analyzing their words, and opinions as to the future of the labor market, technology considered. It became clear that no matter the field of expertise, or the reputation of the economist, there is no consensus as to the exact direction technology is taking us in. However, despite the uncertainty surrounding the labor market, I am certain that the role of the entrepreneur, and the premium put on entrepreneurial spirit will continue to increase. The experts were torn between the idea of technology recreating the labor market, as it has done in the past, and technology entirely destroying the labor market, forcing people to fend for themselves. When I hear the phrase "fend for themselves" or people being forced to find "self-employment" I immediately think of the characteristics associated with entrepreneurial spirit, and entrepreneurship in general.

In fact, Panglaykim, who discusses the entrepreneur in relation to growth and development opportunities, states that "Personality traits inherent in an entrepreneur include initiative taking, innovation, ego drive, the need to achieve, self-esteem, and an inner desire to accomplish a difficult task well" (Panglaykim, 1979, p.707). This excerpt describes someone who is willing to forgo the hunt for remedial employment, with hopes

of starting something larger than them. The reason these traits, and this style of employment will become more relevant, and more popular is based on the capability of technology to adapt to almost any industry, which puts millions of jobs at risk. However, think of the entrepreneur the same way you would think of a valuable piece of technology. In the age we are in, a valuable piece of technology is one that can cut costs in the long-run, produce at an efficient rate, and eliminate human error. So now consider what makes a good entrepreneur...alike the adaptable traits within a solid piece of technology, this is also what makes a person valuable as an entrepreneur. Just as a piece of technology will be successful due to its adaptability, an entrepreneur will be successful too if it is adaptable as well. Take, for example, the retail industry. The retail industry is being moved online, almost entirely. Therefore, as someone who has years and years of experience within a retail marketplace, I may be out of a job, right? Well, unless I am able to encapsulate the characteristics of an entrepreneur. An entrepreneur is not one to admit defeat, but rather admit uncertainty and strive to learn from there. In 2018, the retailer that has lost his/her job might be inclined to start their own ecommerce store, based on a niche market they picked up on while working within the walls of their last retailer. This is a small example of what the experts I have previously referred to mean when they say, self-employed. Furthermore, self-employment could mean something like affiliate marketing. As marketing becomes easier and easier based on the significance of social media, affiliate marketing has begun to take-off. Hence the creation of

self-employed entrepreneurs that have succeeded solely based off of social media platforms. Despite the nature of this industry, these "instagram famous" people are self employed entrepreneurs. These people simply took advantage of the page they had created, and began to use it to generate an income. Affiliate marketers will market an item on their page in order to generate traffic to that company's page. This has become extremely popular through the years of social media, as there are upwards of hundreds of thousands of affiliate marketers out there. The experts that believe technology will have a large impact on middle-class and low wage employment specifically discuss the ensuing role of the entrepreneur. Tony Siesfeld, the director of the Monitor Institute states, "entrepreneurially minded unemployed and underemployed people are taking advantage of sites like Etsy and TaskRabbit to market quintessentially human skills" (Smith & Anderson, 2014, p. 14). Siesfeld is intentionally recognizing these specific websites, as they have begun to create income for some people who are seeking extra income, or have been laid off and forced to create their own employment.

The fact of the matter is, whether or not there are more jobs created, or destroyed due to technology, entrepreneurship will prove vital. The reason these skills, and outlooks will prove meaningful is because as technology continues to appear, it will take the entrepreneurs to create the powerful companies, and legitimate brands, but also to create the small start ups and self employment opportunities. Moreover, finding a valuable, cost-efficient use for some type of technology will become more and more popular.

Those who are fortunate enough to spot the industry changing algorithms or technologies will be the ones talked about in the future, however, no one will forget the smaller companies whose drive and determination exuded success. There is a clear understanding that entrepreneurial spirit has the potential to drive employment in the future, however, how do we make this shift? Where do we begin? There are millions of high school students around the country, and it is safe to say that not many of them have been taught how to develop these characteristics. It must begin within public education, and continue through college, the same way English, Science, and Foreign Languages are taught. However, Peter Gwynne, the director of Lehigh University's Entrepreneurship Program writes regarding the fact that entrepreneurship is by no means a 21st century phenomenon, but has merely experienced a more rapid installment of these types of courses (Gwynne, 2008). There seems to be more schools offering these programs, and a higher demand for these types of thinkers, when it comes to corporate recruiting. With that being said, the style of learning within public education is in no way preparing children with the skills and capabilities that will become more important.

Despite being unable to determine whether or not the supply of jobs will substantial decrease, the experts that have opposing views can all agree on two things; the meaning of "employment" will change drastically irregardless, and the educational system needs significant adjustments. Howard Rheingold, a "pioneering Internet sociologist and self-employed writer" believes that the current education kids are

receiving are “preparing them for life in a 20th century factory” (Smith & Anderson, 2014, p. 12). He describes the fact that with technology becoming so prevalent, the jobs that will remain for humans will be held by those with the most knowledge. “In other words, only the best-educated humans will compete with machines” (Smith & Anderson, 2014, p. 12). The educational refinement he is alluding to would involve more technologically intensive courses. Following Rheingold's comments, Bryan Alexander, a senior fellow at the National Institute for Technology in Liberal Education, writes, “The education system is not well positioned to transform itself to help shape graduates who can ‘race against the machines’. Not in time, and not at scale. Autodidacts will do well, as they always have done, but the broad masses of people are being prepared for the wrong economy” (Smith & Anderson, 2014, p. 12). These experts are all on the same page when it comes to the education required to prepare our nation for technological developments. There is unpredictable characteristics that surround technology, however, it is obvious that employment and education will change drastically, and there are steps to be taken in order to ease the pain of technological influx.

3.1 Who Has Got the Sustainable Jobs?

In the second part of my opening chapter, I created a significant parallel between technology and income inequality, from primarily a historical perspective. I broke down the relationship between the implementation of technology, the arrival of the middle

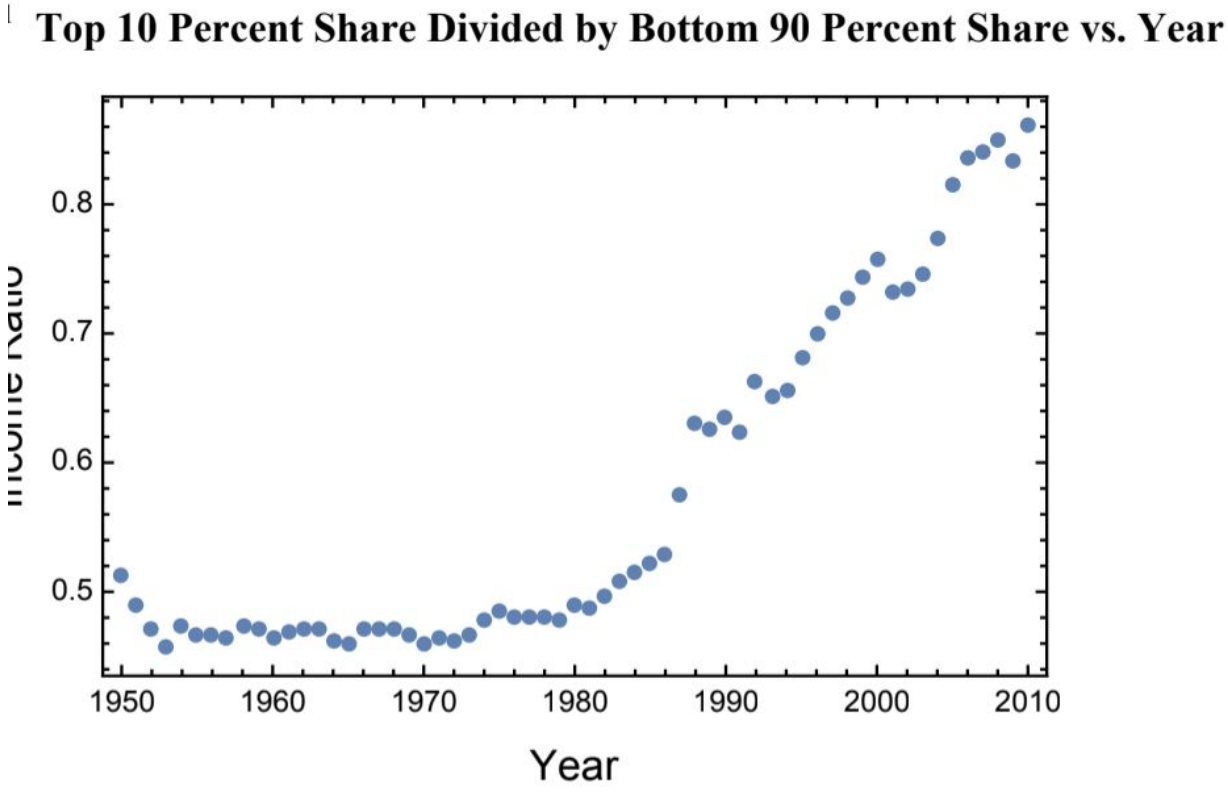
class, and the associated stagnancy experienced by the middle class, while the top 10% of earners continue to experience increases in income and wealth. I described the wealthy owners, and their ability to capitalize on the creation of a new machine or piece of technology. As expected, these same characteristics remain vital to understanding the potential distribution of wealth and income inequality associated with artificial intelligence, machine learning, and big data technologies. Throughout a portion of my last chapter, I broke down multiple job categories, explaining why certain jobs are more likely to be replaced, and why others are more secure. In a nutshell, the primary focus was on the increased intelligence within this technological revolution, and its ability to replace more jobs than previous waves of technological implementation, however, also its inability to recreate human interaction and social skills...yet. The purpose of this portion of my analysis is to create a complete understanding of the parallels between previous waves of technological displacement, and the current AI, and machine learning developments.

Regardless of the chapter, the idea of the "complimentary variable" has continued to arise throughout my analysis. At this point, it is safe to also refer to this complimentary variable as, ultimately, the reason that (more than likely) more jobs will be lost throughout this this technological revolution than in any previous revolutions. It is not the complimentary variable that will *cause* this increase in unemployment, in fact, quite the opposite...it was the existence of a complimentary variable that has previously kept

certain jobs safe, or created an increase in demand for workers. For instance, as mentioned previously, once machinery became a prominent investment within factories, there was a demand for low skilled workers (the complimentary variable) due to the nature of the technology's functionality. In an article that focuses on the income inequality associated with robots, Brito & Curl specifically write about what makes this technology different, and therefore more volatile to workers. They write, "The machine age replaced muscle power with machines. However, until 1980 machines still needed human brains to operate and guide the, and the total number of jobs increased with growing production. *The second machine age is replacing human brains in tasks that can be reduced to an algorithm. It will be difficult to replace the jobs lost to computers"* (Brito & Curl, 2015, pg. 4). This excerpt distinguishes between the technology that compliments a human brain, and the technology that eliminates the human brain. Prior to 1980, as production grew, so did the number of machines, and therefore the number of workers needed. However, now that we have created intelligent softwares, computers, and algorithms, the human brain has lost a significant amount of its value in many industries.

If technology is capable of making some humans obsolete in certain industries (according to Brito and Curl), then in the future, where will you find sustainable jobs, and who are the people that will most commonly attain them? Typically, these jobs belong to people who have "scarce" skills, which the market will always have a demand for (Brito

& Curl, 2015). More specifically, these skills are most commonly found in the highly paid top 10%, who, because of these skills, are unlikely to have to compete with technology (Brito & Curl, 2015). There are details surrounding this situation that shed light on the makeup of these specific people, and why they are safe from technological displacement. For starters, they possess skills that are, simply put, not exceptionally easy to acquire. Brito & Curl actually state that these skills "cannot generally be taught", which would explain why they get paid so much...there is literally no way to reproduce their value. Because of the scarcity associated with these skills, technology will be able to continue to eliminate humans, however, unable to recreate the interaction and business development skills of the top 10%. In other words, as technology continues to get smarter and replace jobs, income inequality will continue its upward trend. This economic phenomena makes sense...essentially, the more jobs that technology eliminates, the larger



the paychecks get for those that attain the "scarce skills" discussed by Brito and Curl. The graph above, which was also presented by Brito and Curl, illustrates this idea quite clearly. As you can see, beginning in 1980 (when machines began working without human brains) the income ratio steadily began to increase...favoring the top 10% of incomes. Simply put, technology favors the most wealthy in every way possible. It puts a premium on their skill set, further separating them from the income classes beneath them. Furthermore, the value of the middle class worker will continue to depreciate, as a result of technologies increased intelligence.

The creation of the middle class created jobs for a large population of American workers, however, the value of the middle class has clearly been presented as short-lived. Middle class workers are, in theory, going to be (at least partially) eliminated by technology, and forced to share opportunities in the labor market with lower income employees. However, I have brought the idea of an entrepreneurial state into the question, which presents possible opportunities for the class of workers that will be faced with job displacement. Entrepreneurship is built around trying to capture a market or niche, nowadays, using some type of innovative technology or software. The workers who are displaced essentially have been faced with few options, considering the destructive nature of ensuing technology. These workers are being forced out of jobs they have become accustomed to, by technology that is capable of eliminating their errors, meanwhile working at a speed humans are incapable of achieving.

3.2 Employer of Last Resort (ELR)

In my second chapter, I broke down the nature of the current technological revolution, and provided insight into the minds of experts regarding the topic. The surveys conducted by Smith & Anderson were entirely focused on the unpredictability of the United States labor force, and economy in general. Two perspectives were defined. On the one hand there are experts that believe the economy will take a hit from the influx of technology, and experience a significant amount of creative destruction. However, these experts are banking on the economy recovery, and rebuilding, the way it has done when faced with technological innovation in the past. On the other hand, some experts believe that the technology we have infiltrating our labor markets right now, is simply too intelligent and corporations around the country will rely heavily upon it. Therefore, employees would be forced out of the labor market, being replaced by technology in a huge way.

The experts that feel there will be minimal recovery, however, do not pose any type of plan that will make up for the lack of employment in a capitalist economy. This, obviously, would prove to be a large problem moving forward. They briefly discuss the idea of an entrepreneurial state, which would mean workers would be forced to fend for themselves, finding income on their own to provide for themselves. However, in the 21st century, I have seen this wave of entrepreneurial spirit, and can attest to the fact that this is not a permanent solution to a potentially significant increase in unemployment. For

starters, this would entirely saturate the current entrepreneurial market, which uses platforms such as instagram, etsy, snapchat, and of course includes smaller businesses that provide a service that is distinct enough to stand out and therefore generate revenue. So, if the pessimistic experts are accurate in forecasting a significant rise in unemployment, what options are left for the workers who are replaced? If the impact of technology is as devastating as these experts think, the United States might consider the use of the employer of last resort. The employer of last resort refers to a stabilization method that would require the government to provide jobs for those that are willing to, or looking for work. This method would, theoretically, provide a means of recovery for the presumably struggling economy. However, will there be enough low-wage jobs to provide for a significant amount of unemployed workers? Moreover, it is difficult to determine how the wage competition would transpire, as a large amount of workers are expected to fit into an already competitive market. Fullwiler describes a large piece of the wage functionality in his article titled, *Macroeconomic Stabilization through an Employer of Last Resort.* He states, "Regarding the wage, traditional government expenditures effectively set a quantity and allow markets to set a price (as in contracting for weapons); in contrast, the ELR program allows markets to set the quantity as the government provides an infinitely elastic demand for labor, while the price (the ELR base wage) is set exogenously and is unaffected by market pressures" (Fullwiler, 2007, Pg.

94). Fullwiler describes the power of the government, outlining the idea that the wages will be “unaffected by market pressures”.

The employer of last resort is a final option, to an economic problem that, in theory, has no other reasonable solution. The need for an employer of last resort in this situation is, obviously, due to the significant influx of technology, however, has much to do with the labor markets inability to compete with technology. In the past, it has been up to the workers within the labor market to compete, on their own, with technology. In other words, as technology has increased at specific points within history, workers have been forced to accept their decreased roll, or fight for higher positions, which may require either more schooling, or training of some type. This concept of competing with technology has long been discovered, however, is just now running out of substance, as technology has seemed to surpass any education that one might acquire. Moreover, technology has created a two way street, to the left there is an entrepreneurial state in the making, which forces people to survive or consider other options on their own. However, to the right, and the last option, is the employer of last resort. This option creates stability within the economy, however, continues to provide growth for the top 10%, essentially eliminating the opportunity for upward mobility, thanks to technology. The ELR takes a difficult situation, and seems to make it slightly less difficult, although without providing much of a solution in the long-run. In the long-run, will the middle class be permanently displaced, or will there be room for growth within the lower skilled labor classes? It

seems as though the ELR simply stops the bleeding, however, does not provide a long term solution to a long term problem.

The use of an ELR is often considered a viable option anytime there is some type of innovation, or "industrial reorganization" occurring within an economy. This is due to the nature of the unemployment, which we refer to as structural unemployment. In the past, this option has been broken down in an attempt to establish whether or not it is suitable for a given situation. For instance, in their article *The applicability of the employer of last resort program to Brazil,* Zoraide Bezerra Gomes and Andre Luis Cabral De Lourenco discuss, on behalf of Minsky and Wray, whether an ELR would be suitable for the Brazilian economy. When discussing the options for employment, from a worker standpoint, they write that the jobs available for these types of workers may be along the lines of infrastructure restoration positions, or helping the disabled. Specifically, they write, "Among other activities, employers could act in the restoration and building of public infrastructure; in the expansion or creation of public services such as recycling and reforestation; as caretakers of ill, elderly, or disabled people; public school class assistants; safety inspectors; cleaning servants; supervisors in restoration works of low-income housing; and so forth" (Gomes and De Lourenco, 2010, Pg. 294). Granted, the Brazilian economy was in a different place, and Brazil as a country is home to a much different economy than the one that will be tested in the United States as technological

implementation picks up. At the same time, the jobs discussed by these authors can't be too far from those that would be attained by the involuntarily unemployed.

Furthermore, Gomes and De Lourenco discuss the details within the Brazilian government, emphasizing that there are other options for these workers. They state that the role of the ELR is to decrease unemployment, however, these workers are free to take other job proposals, which may not be true within the American economy. It seems as though there was more competition related to the Brazilian need for an ELR, as the authors make the point that if the workers within the 'buffer stock' are unsatisfied with working conditions, etc., they may choose to find employment with an entrepreneur who will pay them slightly more than the wage they were previously receiving. This is the reason for my inclusion of this brief example. Where economies like Brazil allow workers in this situation to have that ability, the nature of the technology being implemented in the United States does not allow for the same flexibility. This is simply because any entrepreneur that is creating a new company, because of the technology, will need the most technologically savvy workers on the market. Therefore, there would, theoretically, be a very small amount of wiggle room for American workers...if there were a need for an ELR. This program is a means for stabilization within a struggling economy, and based on the research conducted and input of experts, there is clearly a potential for massive job destruction and a rise in unemployment. Modern day technology is simply too unpredictable to be able to predict what exactly is to come,

however, an explanation and understanding of this program is more than appropriate, and precautionary.

Conclusion

In order to thoroughly understand the future of technology, I have created a comparison between the here and now, and the previous technological revolutions that either created a higher demand for a type of worker, or eliminated jobs based on the needs of the incoming technology. Throughout the Industrial Revolution, it was clear that the ebbs and flows in the labor market were directly related to the use, or lack of usage of technology. Deskilling the craftsmen created a demand for low skilled workers, as their skills were perfectly suited for a factory position. However, as technology's intelligence began to rise, there was a demand for further cognitive skill or a higher amount of human capital. As we begin to approach the 21st century, we see that there is a larger gap in income inequality, as jobs become available for middle class workers, simply because the technology that entered into the economy created a low ceiling for this group of workers. Now, in 2018, technology may cause the middle class to retrain themselves and find new employment in developing industries, or fight for low wage employment with lower skilled workers. However, if this becomes an issue, as the low skilled workers have occupied most of these industries, the government has the ability to mediate this situation, providing jobs to available workers who are seeking employment.

Frey and Osborne, whom I have cited repeatedly throughout my analysis, discuss much of this process, and provide a potential outcome for many industries. Essentially, through their description of different types of labor, they have illustrated the capabilities

of technology, and provided evidence as to why certain job markets are in jeopardy. Through their article, and related research, I have been able to break down, and explore different areas of the labor market, and display their sustainability moving forward, or lack thereof. This wave of technology, and its ensuing autonomous nature, is more advanced than technologies that have come before. This is the reason for a significant amount of the unpredictability surrounding its volatility to human labor. For instance, Frey and Osborne describe that in the past, when one's job was dependent upon physical manipulation, or creativity, they would have remained safe from displacement. However, they also provide evidence that these preexisting notions of job security may not remain true as technology has expanded, and will continue to expand its capabilities.

In the past, technology has played the role of a compliment to human labor, however, it is clear that artificial intelligence, big data, and machine learning have eliminated the human compliment. Technology has the ability to displace human labor permanently, calling for the assistance of the government, but may potentially destroy current industries, only to build new ones and change the nature of human labor. Overall, technology's role within our economy is ever changing, and there is no gauge as to the full potential that it may reach, or the direction it may go. The future of human labor is uncertain as technology's future remains unpredictable, however, one thing is for certain. The top 10% of incomes will continue to experience growth, because this group is

capable of controlling the creation and development of new technologies and industries in the near future.

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