

Automation, the Thief of Labor

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Abstract—Given advances in artificial intelligence and robotics research over the past decade, the prospect of widespread technological unemployment lingers on the horizon of the near future. We briefly examine the state of the art in robotics research today and consider a projection for the scale of technological unemployment in the future. We follow this with a discussion of the impact of widespread technological unemployment by robots on the human race, assuming no external intervention. We conclude with a review of potential policies we might enforce to alleviate such an impact.

Index Terms—automation, jobs, robots, technological unemployment.

I. INTRODUCTION

IN 1930, economist John Maynard Keynes pondered the future of work. In his essay, “Economic Possibilities for our Grandchildren,” he imagined a path of prosperity that would leave future generations much richer than the Silent Generation. While his essay was optimistic overall, one of his fears was a “new disease”: “Technological unemployment...due to our discovery of means of economising the use of labor outrunning the pace at which we can find new uses for labor”[3]. Keynes was referring to a phenomenon to which history has been a witness over and over again, ranging from the advances in the iron and textile industries brought on by the first Industrial Revolution in the early 19th century to the rise of the language of 0’s and 1’s during the Information Age in the late 20th century. Technological unemployment is much more than the loss of labor from humans to technology. Technological unemployment refers to the loss of labor to a technology at a rate far greater than the rate at which new labor can be found. It is more than just employing individuals to fix the new machines that replaced their work. Technological unemployment speaks of a phenomenon where the laborers lose their work to the machines, and there is not enough work to go around to substitute what was lost.

Responses to technological unemployment have varied over time over different cultures. In his book, *Will Robots Take Your Job?: A Plea for Consensus*, Nigel Cameron cites a famous example of resistance to technological unemployment: Queen Elizabeth I’s refusal of a patent that she considered would impoverish her subjects by taking their jobs. “It would assuredly bring to them ruin by depriving them of employment, thus making them beggars” [2] [pp. 17]. On the other hand, American Robber Barons of the late 1800s, such as Andrew Carnegie and John Rockefeller, generally favored a social Darwinistic approach: the absence of external higher order intervention

during unstable employment periods...the survival of the fittest [5]. In other words, if technological unemployment does occur, may good fortune fall upon those whose labor cannot be replaced by the new machines. Everyone else? Tough luck. That is their problem.

The prospect of widespread technological unemployment is particularly fascinating today as we examine technological growth over the past few decades. We have already seen the replacement of human labor in the context of new software performing functions that were once solely performed by humans. For example, tax software, such as TurboTax, has already substituted for much of the work of tax professionals [7]. An untraditional example is that of massive open online courses, or MOOCs, which some expect to cause many teachers and university professors to become obsolete within the next 15 years. Software automates various tasks, generally having no additional marginal cost for servicing one more user as opposed to one thousand more users [2] [pp. 22-38].

Given recent advances in artificial intelligence, many individuals have begun considering the scope of jobs that may be automated within the near future by physical robots—as opposed to software. Some are even considering the societal-wide impact of massive technological unemployment by these robots, which some expect to replace the livelihoods of various individuals, such as lawyers, bankers, and, surprisingly, even software engineers.

Naturally, a discussion of the impact of technological unemployment by robots must begin with an examination of the present, followed by an expectation of the future. What is the state of the art today in robotics? What might we expect to happen tomorrow? From there we can ask, “If the robots do take our jobs, what should we do about it? Why should we do something at all and not stand on the sidelines if structural unemployment were to take its course?”

II. WHERE ARE WE NOW? PREDICTIONS?

One at a time, we are either transforming functions that humans used to perform into functions for machines OR our world’s inquisitive academics and engineers are in the process of thinking about how to expedite existing human tasks with technology. The concept of the autonomous vehicle drives on the realm of possibility, threatening the livelihood of truckers and cabbies. In the care of the elderly, robotic companions threaten the livelihood of caretakers. Paro, the mechanical seal that responds to petting and will cry if dropped or ignored,

actively engages with the elderly, while the Palro humanoid robot can, “play games and dance with the elderly, keeping their minds active with trivia.” The Roomba robot vacuum cleaner, and the general robots being developed to wash dishes and deal with laundry, threaten the livelihood of housecleaning services [2] [pp. 22-38]. For the industrial world, the cost of owning and operating a robotic spot welder has tumbled from \$182,000 in 2005 to \$133,000 in 2014 and then is projected to drop to \$103,000 by 2025, according to the Boston Consulting Group [8].

While robotics and artificial intelligence research is still very much in its infancy—especially for the examples mentioned previously—many scholars have begun to consider how research may progress in a way that produces artificial agents capable of replacing a majority of the work performed by humans. One of the most famous studies is that of Oxford economists Carl Frey and Michael Osborne. In 2013, Frey and Osborne assigned numerical values to each of 903 occupations on the U.S. Department of Labor division of the current labor force, the values measuring each occupation’s susceptibility to machine takeover. They concluded that about 47 percent of total U.S. employment lies in the “high-risk” category: “jobs we expect could be automated relatively soon, perhaps over the next decade or two.” Frey and Osborne’s model predicts that, “most workers in transportation and logistics occupations, together with the bulk of office and administrative support workers, and labour in production companies, are at risk” [2] [pp. 15-16].

Considering the Frey-Osborne study and the prior examples demonstrating the state of the art in robotics today, it is evident that the possibility of robots replacing much of the work done by human beings is looming closer on the horizon. This possibility has become especially more evident over the last decade.

As technical robotics research continues, we must prepare ourselves as a society for the possibility of a new phase of structural unemployment comparable to that which was brought on by the first Industrial Revolution. This possibility requires us to think about what could happen as a result of the onset of the job-stealing robots. What would happen if we permitted structural unemployment to run its course? What if we allowed the job-stealing robots to function without any form of external intervention?

III. THE FUTURE STORY

Among the ramifications of a future dominated by robot labor, we must address two key questions:

- 1) What is the fate of an economy where consumers do not have the income to purchase the goods and services provided by robots?
- 2) What will people do with their time when technological unemployment becomes rampant?

We briefly consider these two questions.

A. The Economy

In his book, *Rise of the Robots: Technology and the Threat of a Jobless Future*, author Martin Ford compares

job-stealing robots to a strange alien species that has come to our planet—not to conquer us, or to extract our resources, or even to meet our leader...but rather to work.

[The species] is highly intelligent and capable of learning language, solving problems, and even exhibiting creativity... [They] have no interest in leisure, entertainment, or general intellectual pursuits...[They] are driven to work...They are eager to work, and they demand no wages... Even those business owners who initially resist replacing people with [the] aliens eventually have little choice but to make the transition once their competitors do so...The aliens, of course, buy nothing. Human consumers increasingly turn away from any purchase that is not absolutely essential...As more people are unemployed, or become fearful that they will soon lose their jobs, frugality becomes tantamount to survival [4].

Ford’s anecdote primarily highlights a future with an economy in ruin. Our assumption is that labor serves as the primary mechanism for earning purchasing power. Given the loss of labor by technological unemployment, we would expect a subsequent loss overall in purchasing power. Every product and service produced by the economy ultimately gets consumed by someone. Businesses may purchase inputs that are used to produce something else, and a business may sell to another business. However, “down the line, that chain has to end at a person (or a government) buying something just because they want it or need it” [4]. Ford predicts that while the top 5 percent of US households in terms of income may survive technological unemployment pretty well, the remaining 95 percent are expected to suffer.

Many blame the financial crisis of the late 2000’s to an increase in consumer debt among the lower 95 percent. Using that event as a precedent, it may be possible that the loss of work and purchasing power among the individuals in the lower 95 percent of household incomes could lead to a similar recession where consumers continue to take on more debt than they can handle. This phenomenon would lead to severe income inequality among the different social classes. In an April 2011 report, economists Andrew Berg and Jonathon Ostry of the International Monetary Fund came to the conclusion that higher inequality was strongly correlated with shorter periods of economic growth. The reason? Ultimately, the top 5 percent of households, which may survive technological unemployment, do not consume enough goods and services to fuel our mass-market economy[4].

Another feature of technological unemployment to consider is its impact on government, primarily through the loss of tax revenue. The U.S. government relies on the taxable income of its citizens to provide public goods and services, such as transportation infrastructure, mail delivery, and—of course—unemployment benefits. When much of the population encounters unemployment, we may expect losses in revenue from income taxes, which may be then followed by losses in revenue from sales taxes due to lack of spending. The government, being expected to provide support to the unemployed, may end up in a perpetual cycle of not having enough resources

to support those who have been a victim of technological unemployment [7].

It is evident that widespread technological unemployment by robotic labor yields the possibility of dire negative impact on the economy. What of the people who experience it?

B. The People

For a future plagued by technological unemployment, we must consider: what happens to the people who no longer have a means to make a living?

1) *Unemployment and Crime*: It has been seen in the past that increasing unemployment is strongly correlated with a rise in crime and random violence. Economists Mary Merva and Richard Fowles of the University of Utah found that in the United States, a one percent rise in unemployment results in a 6.7 percent increase in homicides, a 3.4 percent increase in violent crimes, and a 2.4 percent increase in property crime [6] [pp. 208].

Throughout history we have seen how unemployment in general leads to more frequent cases of violence. The L.A. riots in the 1970's are especially attributed to, "increasing unemployment, poverty, and hopelessness that ignited the collective fury of inner-city residents" [6] [pp. 211]. Furthermore, a riot in October 1990 in Vaux-en-Velin, France was believed to have been spurred by increasing unemployment and poverty, ultimately causing \$120 million in damages [6] [pp. 213]. French sociologist Loic Wacquant asserts that almost all riots in first-world cities share a common theme: such cities were, "formerly working class communities that have been caught up in and left behind by the transition from a manufacturing to an information-based society" [6] [pp. 214]. In other words, history has witnessed an interplay between unemployment, poverty, and crime and violence—even in the context of different geographic locations and situations.

In his book, *The End of Work: The Decline of the Global Labor Force and the Dawn of the Post-Market Era*, Jeremy Rifkin asserts that, "Reduced wages, steadily rising unemployment, and the increasing polarization of rich and poor is turning parts of America into an outlaw culture....Trapped in a down-ward spiral...a growing number of unemployed and unemployable Americans will of necessity turn to crime to survive" [6] [pp. 212]. Rifkin predicts that the shift to crime and violence among those displaced by technological unemployment is inevitable.

2) *Unemployment and Self-Worth*: Another factor to consider is the psychological impact of technological unemployment on people. In the United States, "The notion of being a 'productive' citizen is so imprinted on the nation's character that when one is suddenly denied access to a job, his or her self-esteem is likely to plummet" [6] [pp. 195]. For many people, being unemployed is associated with a feeling of worthlessness, as they see their self-worth and personal fulfillment in their contributions to society. Dr. Thomas Cottle, a clinical psychologist and sociologist, often observes a psychological death in much of the unemployed, "an overwhelming sense of shame and worthlessness, punctuated by a loss of vitality" [6] [pp. 196]. The psychological death caused by unemployment sometimes leads to suicide.

It is evident that technological unemployment is not just the problem of those who are directly impacted by it. As a society, it our responsibility to consider the psychological impact of a life without work and the loss of purchasing power among those who are affected by it.

IV. GETTING PREPARED

The prospect of technological unemployment raises a myriad of questions. In this paper, we will attempt to address the following three:

- 1) How should we educate our youth for the future with skills that may not be substituted for by robots?
- 2) How can we support those displaced by technological unemployment with the ability to live comfortable lives?
- 3) What are policy approaches that we may enact to protect existing jobs from technological unemployment?

A. The Future of Education

As technological unemployment becomes a possibility, we must consider how we can modify the curriculum in schools to prepare students for a changing workforce. Nigel Cameron provides his outlook:

In fact, looking ahead, our children will need to be almost infinitely adaptable to manage lives that will likely be increasingly long and may include variants on full-time and part-time "work," both employed and self-employed, voluntary work, periods of leisure time, and more. What will prepare them well? Plainly such skills as a capacity for self-invention and re-invention, the ability to fill their time fruitfully on their own and without either supervision or the pressure of economic need, a life of the mind, a capacity for relationships of many kinds, perhaps above all a capacity to manage, cope with, even enjoy change [2] [pp. 102-103].

Such an outlook is far from the general STEM prescription that is being encouraged today. Cameron and many others believe that creativity, intuition, and emotional intelligence, which are relatively difficult to replicate with robots, will be central to careers of the future. Perhaps an educational system focused on a healthy combination of the liberal arts and STEM will be the solution. STEM skills are essential for those who wish to work on the machines. Liberal arts skills would be essential for those who wish to work on the machine-human interface.

B. Supporting the Unemployed

Among the most popular means of supporting the unemployed is the concept of Universal Basic Income, or UBI. As rising unemployment leads to pressure on the economy due to the loss of purchasing power among consumers, UBI could provide a means for individuals to regain their purchasing power. However, the question of "Who would pay for UBI?" is a dilemma in itself, which requires further thought [2] [pp. 99-100].

Others believe that we can solve both the problems of lost purchasing power and the idleness among individuals by

having our government incentivize individuals to work in the voluntary sector. The government may encourage volunteer work by providing tax deductions for those who serve certain nonprofit domains, such as education and housing projects for the poor.

Many individuals support the replacement of the current welfare system in favor of a “social wage” for volunteer work, claiming that it would provide purchasing power to those laborers who become displaced by technology. Furthermore, an increase in volunteer work simultaneously benefits those who are served. This could help the government reduce spending on welfare and public services, since volunteers would be caring for the work that the government had previously performed [6] [pp. 250-267].

Perhaps a combination of UBI and “social wage” policies are a viable solution to potential mass unemployment and the loss of purchasing power among consumers.

C. Policy Defenses

Another view encourages the initiation of policies to deter technological unemployment. One potential policy approach is the concept of a “robot tax,” to allow the government to tax companies who have replaced human labor with robot labor. Some purport that a robot tax could help offset the loss of revenue associated with the income for actual human employees and also help encourage businesses to preserve human labor. This approach is controversial, with many citing a fear of the United States losing its competitive edge if it deters robotic labor when other countries, such as China, utilize it.

Insitution of a robot tax also incites the question of, “what kind of automation should be taxable?” Should the mail delivery robots of the future be taxed for taking the jobs of postal delivery service workers? Should companies who use TurboTax, instead of hiring tax professionals, be taxed for using this software [7]?

The concept of a robot tax, alongside other regulations to either deter robotic labor or to obtain additional income from it, must be considered carefully.

V. CONCLUSION

In this paper, we have addressed the possibility of technological unemployment by robots—given the current state of the art in robotics research. We have considered the economic and psychological impact of technological unemployment on our society. Finally, we attempted to answer various questions in regards to getting prepared for technological unemployment if it were to occur.

It is possible that our concern is ill-founded. Perhaps robots will never take over all of the vulnerable 47 percent of occupations predicted in the Frey-Osborne study cited early. Perhaps legal concerns and a resistance to the new robots will mitigate attempts to replace human labor. Nevertheless, as a society, we must consider the worst case and be ready to support those who find themselves replaced by robots in the workplace. Furthermore, we must be ready to prepare our youth for jobs of the future, which may not be susceptible to robotic automation.

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REFERENCES

- [1] T. Black. “Cheap Robots Are Helping Small Businesses Survive.” Internet: www.bloomberg.com/news/articles/2017-05-10/armed-with-don-t-hurt-humans-sensors-robots-hit-small-factories, May 10, 2017 [Mar. 5, 2018].
- [2] N. Cameron. *Will Robots Take Your Job?: A Plea for Consensus*. Malden, MA: Polity Press, 2017.
- [3] The Economist, “The Future of Jobs: The Onrushing Wave.” Internet: www.economist.com/news/briefing/21594264-previous-technological-innovation-has-always-delivered-more-long-run-employment-not-less, Jan. 18, 2014 [Mar. 8, 2018].
- [4] M. Ford. *Rise of the Robots: Technology and the Threat of a Jobless Future*. [On-line]. New York, NY: Basic Books, 2015, pp. 139-60. Available: www.ebookcentral.proquest.com [Mar. 4, 2018].
- [5] P. Hall. “Social Darwinism and the Poor.” Internet: socialwelfare.library.vcu.edu/issues/social-darwinism-poor/, [Mar. 8, 2018].
- [6] J. Rifkin. *The End of Work: The Decline of the Global Labor Force and the Dawn of the Post-Market Era*. New York, NY: Penguin Group, 2004.
- [7] M. Simon. “Who will Pay for the Future if not the Robots?” Internet: www.wired.com/2017/05/will-pay-future-not-robots/, May 30, 2017 [Mar. 5, 2018].
- [8] P. Wiseman. “Robots Are Replacing Us Faster Than We Expected.” Internet: www.inc.com/associated-press/robots-are-replacing-human-factory-workers-at-fast-pace.html, Feb. 10, 2015 [Mar. 5, 2018].

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