Automation and Employment

Since the Industrial Revolution, technology has boosted productivity and driven down prices in the United States. Its employment effect were complex. Many skilled laborers lost their jobs and many feared that machines would soon take over. This prediction proved to be false. Technology created many new markets, which meant more jobs. Following the Industrial Revolution, there were more jobs. Though many involved working in miserable conditions, regulations eventually improved them. In the 20th century, automation accelerated, displacing many unskilled workers, but the boost in productivity and drop in prices created even more markets and jobs. Then in 1960, a recession hit. Productivity continued to increase, but fewer jobs were available. This sparked another debate about technological unemployment. The discussion ended as the economy improved and war began.

Today, we face another bout of technological anxiety. Automation technology has continued to accelerate. Is this time any different? Evidence indicates past technology is a poor predictor of present technology. While automation had once overall improved employment, recent developments will eventually lead to mass unemployment. Reasons include artificial intelligence developing human capabilities, decreasing cost of advanced machinery, increasing relative demand for skilled labor, and saturation of total demand. Policy makers must plan to mitigate the consequences. A major limitation of this research include the difficulty of isolating automation's effect from outside factors such as globalization and regulation.

Review of Research

The current consensus is that technology may cause short-term unemployment, but in the long run it improves the employment rate. This optimistic view comes from historical data. Ever since the Industrial Revolution, technology has increased the employment rate through the creation of new markets and increase in demand (Autor, 2015). Even though we cannot predict future markets, it does not mean none will develop. If technology did not create mass unemployment in the past, then who is to say it would displace jobs in the future?

Fear that technological innovation is nothing new, among experts and the general public. Prior to the Industrial Revolution, Queen Elizabeth I rejected William Lee's patent application on the stock frame knitting machine on the grounds that it would eliminate her subject's jobs (Frey & Osborne, 2013). During the Industrial Revolution, Luddites destroyed textile and agricultural machinery to protest the mechanization of their jobs (Mokyr, Vickers, & Ziebarth, 2015). In the 1930's and 60's, periods of stagnation started serious discussions about technology causing long term unemployment. Both times, war prematurely ended the discussions (Woirol, 1996). Anxiety stems from the visibility of the victims. Unemployment is stressful. Less obvious are the benefits of technological change, in terms of productivity and lower prices (Manning, 2004).

New markets displace old ones in a process called creative destruction, which is driven in part by innovation (Schumpter, 1942). Many older firms fail to adapt, while others take advantage of the innovation. More innovation perpetuates the cycle. Empirical evidence suggest that this process large and persistent. Davis, Haltiwanger, and Schuh (1996) found that 10 percent of jobs are displaced every year. Many examples

exist throughout history. Farm machinery reduced the demand for farmers, while increasing the demand for assemblers. The automobile reduced the demand for horse caretakers, while increasing the demand for mechanics. Internet reduced the demand for postal workers, while increasing the demand for programmers.

Recently, more researchers have been taking a pessimistic view of technological unemployment. Some experts question current models of employment. Vivarelli (2014) attacks compensation theory, which holds that job losses will be offset by price reductions, increased investments, wage increases, and creation of new markets. He holds that the theory's assumptions, such as competitiveness of some of the markets, demand constraints, and the time for the labor force to readjust to technological advances, no longer hold. Others add that the labor market is unlike any other market in that people are the allocated resources (Kamedula, et al, 1980). Workers' capabilities vary and the costs of unemployment are human as well as financial. Wolff (2005) shows that short-term unemployment periods are getting longer. Installing new technology requires retraining, which to some workers are better suited than others. Rapid change can cause mass unemployment as jobless people with obsolete skills join the unskilled workforce. Advancement in transportation and communication technology have opened the labor market globally. Lastly, the optimist's argument makes sense only if there is no significant difference between the past and present.

Skill-biased technological change, which benefits high-skilled labor at the cost of low-skilled labor, has grown more common in many developed nations. Since the 1980s, industries requiring high-skilled workers have been growing in size and number, while industries using unskilled laborers have been demanding more skilled laborers (Berman,

Bond, & Machin, 1998). According to Manning (2004), recent technology has an hollowing out effect. Manning has found that demand for low-skilled laborers rose from 1983 to 2003 primarily in the service sector.

Automation vs Past Technology

Recent automation favors highly skilled laborers and therefore contributes more to unemployment. Before the Industrial Revolution, most people worked in farms and artisan shops. With the introduction of the factory system, the labor market shifted towards low-skilled work. Factories were growing in size and efficiency even before mechanization (Sokoloff, 1984). Many skilled artisans were forced out of a job as they could no longer compete with the productivity of factories. The system created a huge demand for factory workers, though some skilled laborers for building and maintaining the machines, were needed too (Goldin & Katz, 1998). The machines needed human operators. This deskilling effect gave the displaced workers alternatives in the growing manufacturing industry sector (Gallman & Weiss, 1969).

But recent development in automation has since disrupted the factory system, diminishing opportunities for low-skilled workers. Automation started to work against workers. Alexandros Vardakostas, co-founder of Momentum Machine, states that his hamburger-making robot "isn't meant to make employees more efficient. It's meant to completely obviate them (Roush, 2012)." Firms must then either have train their current workers or hire new, highly skilled workers. In both cases, the total number of workers in the firm will temporarily decrease (Mokyr, Vickers, & Ziebarth, 2015). According to John Engler, the president of the National Association of Manufacturers, "the lack of

skilled employees is one of the most daunting challenges facing manufacturing. More than 80 percent of NAM members report difficulties in hiring employees with the necessary skills (2015)." Unlike the skilled artisans displaced by the factory system, these unskilled workers may struggle to find new work. Their skills may have become obsolete or poorly suit other work. There has been a decline in the labor participation rate of low-skilled laborers since the 1980's (Juhn & Potter, 2006). Semi-skilled workers struggle too. They must either learn new skills or compete with low-skilled workers for the available jobs. Between 1950 and 1970, manufacturing employment declined relative to service sector employment (Gallman & Weiss, 1969). Since then, automation has displaced service sector employment as well (Stephanou, 1995), for example ATMs and self-checkout. Advances in automation such as self-driving cars and robotic chefs will force many more to look for new work.

Advances in Automation

In both hardware and software, automation is accelerating. The first industrial robot, Unimate, was a just a robotic arm that lifted and stacked hot metal and cost about $25000 (Rosen, 2011). For the same price today, a firm can buy a robot such as Baxter, a multi-purpose robot (Rethink Robotics, 2013). Automated systems are getting faster and cheaper, while human labor is becoming more expensive (Bureau of Economic Analysis, 2016), making automation more cost effective. Education is a major labor cost. The percentage of Americans getting a high school diploma or higher has been increasing (National Center for Education Statistics, 2015). Educated workers expect higher wages. Meanwhile, the cost of robots has fallen (Visser, 2014). Robots demand no wages and

are faster and more accurate. Even Foxconn, one of the largest manufacturing firms in the world, intends to use robots (Kan, 2015) despite the relatively low cost of labor and less regulated market in China.

Unlike hardware, software can be replicated at nearly zero cost. Hardware is expensive and can require time to implement. Software, however, scales easily to the size of the firm, and can be the basis of a superstar enterprise, where few people success, but success is greater (Rosen, 1981). By producing an unlimited supply of a good or service, the winners of a superstar economy can completely eliminate the losers. While Apple and GM are two of the most valued companies in the US, GM employs 5 times as many people as Apple (Fortune 500, 2015). Software could also be transferred easily. This makes firms more mobile, forcing more workers to compete in the global labor market. Many firms have been offshoring work to countries such as India and the Philippines (Blinder, 2013).

Artificial intelligence is introducing a new kind of automation. In the past, horses were used for manual labor and transportation. When automobiles started becoming popular in the mid-1910s, the horse population in the US peaked (Kilby, 2007). Both horses and cars were valued for their power, but horses could not compete. Humans, on the other hand, have the advantage of brains. Past machines, such as cars, needed humans to direct them what to do. Now, automation is developing human-like intelligence. Software can now give medical diagnoses, analyze and write papers, and decipher handwriting (Frey & Osborne 2013). Since humans, unlike horses, drive the economy, displacement can be an issue. A famous exchange between Walter Reuther and Ford motor plant official illustrates the point. "A company official asked Reuther: 'How

are you going to collect union dues from these guys?' Reuther replied: 'How are you going to get them to buy Fords?'(1955)"

Demand

Scarcity of resources constrains demand. Automation has eased this constraint, but eventually we will reach a limit. Even if the supply of goods continue to increase, it does not mean we will continue to demand even more (Skidelsky & Skidelsky, 2012). For example, the labor market may have shifted from agriculture and manufacturing to services, in part due to excess supply of food and product relative to demand. This does not mean the service industry is safe, though. A similar effect applies to the demand for services. The limiting factor in this case is time. There is only so much a person can do in a day, hence demand for services must be finite (Ashta, 2015). If automation satisfies the demand, unemployment follow. Even factoring the exponential growth in population in the past two centuries, the total number of people working in agriculture in the US has peaked in the 1900s and remain relatively constant since the 1970's (Roser, 2016), even while the US exports more food. Jobs opened up in the growing manufacturing and service industries (Gallman & Weiss, 1969).

What if this happens to the service sector? Where will the demand come from if most people don't have jobs? Even if new markets arises from creative destruction, new markets may also be vulnerable to automation. For example, automation have shifted jobs from manufacturing and service sectors to information technology sector, but Google, Amazon, Apple, and Facebook, four of the largest IT corporations, only employ about 150,000 people. This is about the same amount of people that enter the labor force in a

month. Adjusting to new markets takes time as people need to train. Consequent long-term unemployment may become intractable (Nichols, Mitchell, & Lindner, 2013). The labor participation rate has been falling for two decades. (Bureau of Labor Statistics, 2016).

Power Structure

Automation shifts the balance of power in favor of the employer. In the past, many people worked in assembly lines. They worked on one job together. With automation, a single worker is responsible for doing the work of many. It can also introduce different types of work. According to Stern (1963), a sense of unity is lost. Forming a union can be difficult. Union membership have fallen since the 1960's (Bui, 2015). Strikes, in particular, have become less effective. In the late 1900s, oil refinery workers in the US went on strike, but had little effect on the production of oil (Shauk & Olson, 2015). Many refineries have contingency plans using engineers and contract workers to keep the automated system working. In 2015, fast food workers have gone on strike to increase wages. The CEOs have responded with deploying automation. A spokesperson for McDonald states: "with the high demand for a minimum wage of $15/hr and the protests getting worse every day, automation is something we had to implement" (Rubics, 2015). While the technology is getting cheaper, automation is still only cost effective for large industries. The workers can use automation to do their jobs, but it is still the employer's tools. If any issues arise in the workplace, employees have few options. In Obama's state of the union address (2016), he acknowledged the consequences of automation. "Companies in a global economy can locate anywhere, and

face tougher competition. As a result, workers have less leverage for a raise. Companies have less loyalty to their communities."

Potential Solutions

One solution proposed by Neo-Luddites is slowing the deployment of new technology. Neo-Luddites are a diverse group of people ranging from academics to people who have lost their jobs to technology (Banning, 2001). They believe technology worsens social interactions and is exploitable by amoral groups (Glendinning, 1990). Some examples of self-sufficient groups that limit technology are the Amish, Old Order Mennonite, Hutterites. They filter technology by carefully testing its effect on their society. If it violates certain criteria such as separating the community or creating a reliance (Rheingold, 1990). This strategy could not work for two big reasons, developing a suitable criteria that would satisfy the entire country is next to impossible and the huge dependency on technology we have already developed.

Improving training programs is a solution supported by nearly everybody. Demand for skilled labor has been increasing in the past century (Katz & Margo, 2013), but supply was unable to keep up (Engler, 2015). In 2009, President Obama launched the Educate to Innovate initiative to encourage students to go into STEM fields. The program involves hiring more teachers and partnering with industry (Obama, 2013). Obama also launched the America's College Promise to make two years of community college free (Obama, 2013). The only question is whether people are can keep up with advances in automation.

Reducing work hours has been proposed by many economists. Instead of laying off obsolete workers, keep the same amount of workers but have them work for less hours. Countries such as Belgium, the Netherlands and Germany have made the change without any major issues (Coote, Franklin, & Simms, 2010). Workers are also healthier, more productive, and more loyal (Reid, 2015). There are several issues with this solution. One issue is the lower salaries. If wages remain constant, people will end up having to find another job. The cost of living needs to be lowered to accommodate this change, which place the burden on businesses. Another issue is the changing job requirement. Automation have been replacing unskilled work with skilled work. The unskilled work consists of routine tasks (Frey & Osborne, 2013). This means the most, if not all, unskilled workers would have to be fired or retrained. Firms would prefer to retrain a few workers or hire new ones. A third issue is enforcement. In 1938, the US passed the Fair Labor Standards Act which set the standard for the 40 hour work week (Samule, 2000). The fight for the standard was very political. Today, over half of full-time workers work more than 40 hours a week (Saad, 2014). Either firms are fine with paying overtime or they are taking advantage of their employees. There will likely be resistance against reducing work hours.

Another solution is providing a guaranteed minimum income. This idea has been popular with a wide variety of social groups, such as the technological elite, socialists, and libertarians. Left-leaning groups see it as a solution to income inequality. Automation have mostly benefited the owners of the machines, which has worsen income inequality (Hemous & Olsen, 2016). Removing the burden of money will also allow people to work on something more fulfilling work such as art and charity. Many people

today are dissatisfied with their current jobs (Cheng, et al, 2014). Right-leaning groups see it a solution to a bloated bureaucracy. The US waste tens of billions of dollars due fragmented and overlapping, and agency (Government Accountability Office, 2015). It also avoids the welfare trap, since any additional income is a supplement. Arguments against basic income include the cost of implementation and disincentive to work. Assuming the government provides for the 200 million working age Americans (U.S. Census Bureau, 2015) and a $12000 poverty rate (U.S. Department of Health & Human Services, 2015), the cost totals $2.4 trillion. Even if the government provides a fraction, businesses would increase prices in response to the cash flow, which would increase the poverty rate and cost of basic income. People could also end up not working. Many Americans believe that only people who are working or looking for work deserve welfare (Pfeiffer, 2015). There is also the fear that people will use the money to buy drugs and alcohol. Resistance against this proposal will likely be high.

Conclusion

Automation technology entails risks. It can improve standards of living, but only if we manage the risks. Methods may include limiting the deployment of new technology, training programs, and guaranteed basic income. Further research could be done on outside factors affecting automation. This can include analyzing confounding variables such as globalization or the effect of one of the solutions above. Other technology that may have an effect on employment could also be studied.

References

Ashta, A. (2015). Why Does Creative Destruction No Longer Work? Proposing Actions for a Future with Reduced Employment. *Challenge, 58*(5), 428-438.

Autor, D. H. (2015). Why Are There Still So Many Jobs? The History and Future of Workplace Automation. *Journal of Economic Perspectives, 29*(3), 3-30.

Bahrami, B. (2012). Impact of Technological Advance on Income Inequality. *Insights To A Changing World Journal, 2012*(4), 157-170.

Banning, D. (2001). Modern Day Luddites, from http://www.jour.unr.edu/j705/RP.BANNING.LUDDITE.HTML

Blinder, A. (2013). How Many U.S. Jobs Might Be Offshorable?. *Center for Economic Policy Studies*

Bui, Q. (2015). 50 Years of Shrinking Union Membership, In One Map. *NPR*

Bureau of Economic Analysis. (2016). [Personal Income and Its Disposition]. Unpublished raw data.

Bureau of Labor Statistics. (2016). [Labor participation rate from 1995-2015].

Cannady, M, Greenwald, E., & Harris, K. (2013). Problematizing the STEM Pipeline Metaphor: Is the STEM Pipeline Metaphor Serving Our Students and the STEM Workforce? *Science Education, 98*(3), 443-460.

Cheng, B., Kan, M., Gad, L, & Ray, R. (2014). Job Satisfaction: 2014 Edition. *Conference Board*

Coote, A. Franklin, J. & Simms, A. (2010). 21 hours. *New Economics Foundation*

Davis, S., Haltiwanger, J. and Schuh, S. (1996). Job Creation and Destruction. Cambridge, MA: MIT Press.

Engler, J. (2015). Automation lifts the burdens on U.S. manufacturing. *National Association of Manufacturers*

Federal Highway Administration. (1996). [State Motor Vehicle Registration, By Years, 1900 - 1995]. https://www.fhwa.dot.gov/ohim/summary95/mv200.pdf

Fortune 500. (2016). [Top 500 Companies]. Unpublished raw data.

Frey, C. & Osborne, M. (2013). The Future of Employment: How Susceptible Are Jobs to Computerisation? *Oxford Martin School*

Gallman, R. & Weiss, T. (1969). The Service Industries in the Nineteenth Century. *National Bureau of Economic Research*, 287-381.

Glendinning, C. (1990). Notes toward a Neo-Luddite Manifesto. from http://www.jesusradicals.com/wp-content/uploads/luddite-manifesto.pdf

Goldin, C. & Katz, L. F. (1998). The Origins of Technology-Skill Complementarity. *Quarterly Journal of Economics*, *113*(3), 693-732.

Government Accountability Office. (2015). 2015 Annual Report: Additional Opportunities to Reduce Fragmentation, Overlap, and Duplication and Achieve Other Financial Benefits.

Hemous, D. & Olsen M. (2016). The Rise of the Machines: Automation, Horizontal Innovation and Income Inequality.

Juhn, C, & Potter, S. (2006). Changes in Labor Force Participation in the United States, *Journal of Economics Perspectives, 20(*3), 27-46.

Kan, M. (2015). Foxconn expects robots to take over more factory work. from http://www.pcworld.com/article/2890032/foxconn-expects-robots-to-take-over-more-factory-work.html

Katz, L. & Margo, R. (2013). Technical Change and the Relative Demand for Skilled Labor: The United States in Historical Perspective. *National Bureau of Economic Research*

Kilby, E. (2007). The demographics of the U.S. equine population. *Humane Society Press,* 175–205.

Kroft, S. (2013). Are robots hurting job growth?. *60 Minutes*. New York, CBS Broadcasting.

Lee, M. A., & Mather, M. (2008). U.S. labor force trends. *Population Trends: A Publication of the Population Reference Bureau, 63*(2), 1-18.

Manning, A. (2004), We Can Work It Out: The Impact of Technological Change on the Demand for Low-Skill Workers. *Scottish Journal of Political Economy, 51*(5): 581–608.

Mokyr, J., Vickers, C., & Ziebarth, N. L. (2015). The History of Technological Anxiety and the Future of Economic Growth: Is This Time Different?. *Journal Of Economic Perspectives, 29*(3), 31-50.

National Center for Education Statistics. (2015). U.S. Department of Education *The Condition of Education 2015* (NCES 2015–144), Educational Attainment.

Nichols, A., J. Mitchell, and S. Lindner. (2013). *Consequences of long-term unemployment*. Washington, DC: The Urban Institute.

Obama, B. (2013). Educate to Innovate

Obama, B. (2016). [State of the Union Address]. Speech presented to a Joint Session of Congress, House of Representatives, Washington, DC.

Pfeiffer, R. (2015). Welfare Opinion, Public Opinion Polls on Welfare and Poverty. from http://federalsafetynet.com/welfare-opinion.html

Reid, E. (2015). Embracing, Passing, Revealing, and the Ideal Worker Image: How People Navigate Expected and Experienced Professional Identities. *Organization Science*, *26*(4), 997 – 1017

Rethink Robotics. (2013). Rethink Robotics Launches New Generation of Humanoid Robots for Research, Teaching and Custom Application Development [Press release]. Retrieved from http://www.rethinkrobotics.com/news-item/rethink-robotics-launches-new-generation-of-humanoid-robots-for-research-teaching-and-custom-application-development/

Reuther, W. P. (1955). *Automation: A report to the UAW-CIO economic and collective bargaining conference, held in Detroit, Michigan the 12th and 13th of November 1954: With an introduction by W.P. Reuther, a resolution on automation adopted by the 14th constitutional convention of the UAW-CIO, a glossary of terms used in automation.* Detroit, MI: UAW-CIO Education Department.

Rheingold, H. (1999). Look who's talking. *Wired Archive, 1*. Retrieved October 21, 2001, from http://www.wired.com/wired/archive/7.01/amish_pr.html

Rosen, R., (2011). Unimate: The Story of George Devol and the First Robotic Arm. *The Atlantic.*

Rosen, S. (1981). The Economics of Superstars. *The American Economics Review, 71*(5), 845-858

Roser, M. (2016). Agricultural Employment. Retrieved from: http://ourworldindata.org/data/food-agriculture/agricultural-employment/

Roush, W. (2012). Hamburgers, Coffee, Guitars, and Cars: A Report from Lemnos Labs. *Xconomy*

Rubics, Darius. (2015). New McDonald's In Phoenix Run Entirely By Robots. *Newsexamier.*

Saad, L. (2014). The "40-Hour" Workweek Is Actually Longer -- by Seven Hours. *Gallup*

Samuel, H. (2000). Troubled passage: the labor movement and the Fair Labor Standards Act. *Monthly Labor Review*

Schumpter, J. A. (1942). Capitalism, Socialism and Democracy. New York: Harper and Brothers.

Shauk, Z. & Olson, B. (2015). Refineries to Rely on Automation Amid Strike. *Bloomberg*

Stephanou, H (1995), Advanced automation in manufacturing and service industries," *Robotics and Automation*

Skidelsky, R. & Skidelsky, E. (2012). In Praise of Leisure. *The Chronicle of Higher Education*, *58*(39)

U.S. Census Bureau. (2015). Population by Age and Sex.

U.S. Department of Health and Human Services. (2015). U.S. Federal Poverty Guidelines Used to Determine Financial Eligibility for Certain Federal Programs

Visser, A. (2014). Rise of the Industrial Robots on Factory Floors - Connector Supplier. from http://www.connectorsupplier.com/rise-of-the-robots-010714/

Vivarelli, M. (2014). Innovation, employment and skills in advanced and developing countries: a survey of economic literature. *Journal of Economic Issues*, (1), 123.

Woirol, G. R. (1996). *The technological unemployment and structural unemployment debates.* Westport, Conn: Greenwood Press.

Wolff, E. N. (2005). Computerization and Rising Unemployment Duration. *Eastern Economic Journal*, *31*(4), 507-536.

Yongsung, C., & Hong, J. H. (2013). Does Technology Create Jobs?. *SERI Quarterly*, *6*(3), 44-53.