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Automation and How it has Affected Employment in Walmart



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Chapter One

Introduction

The automation of tasks that have previously been done by humans is a phenomenon that has occurred recently in almost every industry. Automation is constantly improving and progressing. Automation in the retail industry has been no exception to this. We have seen an increase in the amount of automation that has been integrated into retail stores. Wal-Mart, one of the biggest retail stores in the world, has seen many different types of automation implemented. The effect these different forms of automation has had on employment has been dramatic. In this paper, I will examine how different forms of automation that have been integrated into Wal-Mart have affected employment. This is important because automation is a steady and progressive technology, and therefore we must adapt and learn the effects it has on employment so that we can integrate changes before negative consequences occur. Without proper preparation and the ability to adapt quickly, automation could result in anything from decreased wages to increased unemployment.

Take farming as an example. Automation has long been known to displace workers in the farming industry. Examining the US, in 1900, 38% of the labor force were farmers. By the early 2000's, only 2.6% of the population were farmers, yet the population had grown by over 300% (Mitsuoka, 2019). The above statistics come from studies on integration of partial automation. Is it possible that complete automation could take these jobs? China is testing this theory out. Currently, there are 250 million farmers living in China. The government is attempting to replace these farmers with complete automation. They are trying a "seven-year pilot, which is running in Jiangsu Province, featuring unmanned tractors, pesticide applicators, and rice transplanters" (Kotecki, 2018). The automation could determine where and how much of the

pesticides/fertilizer are necessary to save time and resources. Along with saving time and resources, full automation will likely also displace many of the laborers working in China's 250 million farms (Kotecki, 2018). This technology will not completely do away with farming jobs, but it will change the type of labor performed by the farmer. Farmers will no longer be working in the fields, they will be behind computers and machines, coding and maintaining the automation process. There will be a massive shift in skills throughout the farming industry that will require farmers to be extremely adaptable if they wish to thrive (Kotecki, 2018).

This case is relevant because we have witnessed automation change labor in many industries. Farming is one industry that has lost employment due to automation. Retail jobs, on the other hand, have only been around since approximately 1900. The increase in productivity of farms alongside urbanization led to a need for an increase in sales jobs. This, in turn, led to the retail industry that has continually evolved into what we all know today (Americans, 2019). Since the very early 1900's we have seen a massive explosion in the amount of employment in the retail industry. In 2016 there were just short of five million people working in the retail industry. The notable thing about retail employment is that the job outlook between 2016-2026 is 2% lower than the national average, which means that the average industry has a 2% higher growth rate than in the retail industry. With a growth rate 2% lower than the national average there is an estimated growth of only 92,400 jobs by 2026 (Bureau, 2018). Will we see the same loss in retail industries as we have seen in the farming industry? Will automation integration within Wal-Mart stores lead to major shifts in the skills of employees, unemployment or growth?

Throughout this paper I investigate these questions. I start by reviewing different economists' opinions on automation and what they believe to be its effects on employment. Next, I move into the history of automation. I give some examples of automation throughout

history and move into automation in the retail industry. I give past examples, current examples, and even future examples of automation throughout Wal-Mart. After this, I try and tease out the effect each one of the integrations of automation has on employment at Wal-Mart. Finally, I sum up my results in order to give a clear, concise conclusion on what effect automation has had on Wal-Mart's employment, give policy implications, and pose a question for further research.

Chapter Two

Literature Review/Theory

Automation is defined as "the technique of making an apparatus, a process, or a system operate automatically" (ISA). Acemoglu, a highly renowned MIT economist who has done a lot of work on automation, believes that AI, or artificial intelligence, is anything that replaces human labor in its assigned task (Acemoglu & Restrepo, 2018). The question that I want to delve into is why automation is becoming more prevalent in retail stores and how it is affecting employment. In order to answer this question, I investigate different relevant theories of economists who have examined this issue in different markets and see how I can apply these theories to the retail market. In this chapter, I will not be diving into the retail market because before I investigate a specific market, I believe I must evaluate the theories in general in order to apply them to the retail market as a whole.

It is very difficult to create a measure for the actual amount of automation in any given industry. Each economist measures automation differently, so further discussion is theory-based on a case by case basis. Each economic theory I will be examining is based on a different market or automation as a whole. I believe in examining these different theories I will be able to apply them to later chapters, and in turn create a conclusion on the effect automation has on the retail market.

I.

Before I evaluate theories on automation, it is important to make some major distinctions. Firstly, there are two types of automation, partial and complete automation. Bessen (2016) makes a distinction between the two. He states that "Complete automation implies a net loss of jobs; partial automation does not" (Bessen, 2016, p.5). Partial automation would be something that

makes a job easier, such as the scanner that a cashier uses to scan an item instead of enter everything manually. Complete automation would be if a store were to add tags to everything so that someone could leave a store with whatever they selected and have a machine scan all of their groceries without the use of a human labor. This differentiation is important because he believes that jobs are rarely ever completely automated. He only reviews partial automation because he does not believe complete automation has been achieved and does not see it progressing to that level for many occupations any time soon. Bessen believes that automation is an augmentation to human labor and therefore partial automation leads to decreasing prices. With a decrease in price and an increase in net productivity, the outcome is an increase in the quantity demanded that can only be filled by a mix of higher human employment that is augmented by the partial automation.

Second, along with the differentiation that Bessen makes between partial and complete automation, he makes an important distinction between automation and other technological changes. Technology is what Bessen believes eliminates jobs and changes how industries run. "Technology can make industries and products obsolete, eliminating industry-specific occupations" (Bessen, 2016, p.7). An example of the difference between technology and automation is how the technology of computers has put typewriter companies basically out of business, while the automation of mathematical processes on computers has augmented the amount of labor one can do with the technology. Technology has created a loss of one market while automation has augmented the amount of labor people can do with that technology. Another example of the difference between technology and automation is the difference between a computer, the technology, and the automated programs that complete higher level tasks, such as a tax program. Bessen does, however, point out that automation need not lead to job loss, but

it can lead to occupational shifts because automation has been known to remove low-wage occupations and increase high-wage occupations. Bessen sees US markets as being flexible, therefore automation has not been observed taking US jobs, but it has been observed increasing the income gap between the rich and the poor. This happens because high paying jobs usually have automation as a complement to their labor while medium wage jobs have automation as a substitute to theirs (Bessen, 2016). Complements are things that go together, a good example of a complement would be vehicles and gasoline. When one is used it is likely that the other one will be used as well. Substitutes are things that can be substituted for one another, a good example of a substitute would be Coke and Pepsi. When one is used it is unlikely that the other will be used as well (Econogist, 2019).

Jeffrey Sachs and Laurence Kotlikoff are economists that review the issue of automation overall. They have a similar definition as Bessen of what they believe automation to be. The way that they developed their theories was by taking a model that looks at inputs such as machines, unskilled labor and skilled labor, and evaluating the effect on gross output. (Sachs & Kotlikoff, 2012, p.9)

They believe that a major problem that occurs because of automation is that it widens the income gap. The income gap that is present between high skilled and low skilled workers will always be there and there is no changing that in our economic system. This isn't a terrible thing because it encourages innovation and hard work by forcing people to form creative solutions to problems that may have never been fixed if the gap were never to exist. Although the gap can be a positive thing in some circumstances, Sachs and Kotlikoff worry because automation widens this income gap by reducing "the marginal productivity of low-skilled workers while raising the marginal productivity of high-skilled workers" (Sachs & Kotlikoff, 2012, p.17). They worry that

this gap will grow to the point where the middle class ceases to exist. On top of this, they see that machine productivity leads to a decrease in the wage of unskilled workers, which furthers the income gap. If people are unable to make a livable wage - or an amount that sustains their basic needs, the wage gap becomes a bad thing. As for the skilled laborers, they usually see benefits from increases in machine productivity. This is not to say that skilled laborers cannot see job loss or decreases in wages due to automation, skilled laborers are just the ones that tend to benefit in most situations where automation has implemented.

In addition to the income gap, Sachs and Kotlikoff argue that automation causes a generational effect since the older generation is benefiting from automation as a complement while the younger generation may be forced into unskilled labor if automation starts to become a substitute for higher skilled jobs. They point out how income will rise for those who have already stopped saving and fall for those who need to save more. This decreased saving rate will further decrease wages which will, in turn, increase the wage gap even further (Sachs & Kotlikoff, 2013). Sachs and Kotlikoff suggest that the way to avoid all of this is not to destroy automation or stop its progression but to develop "tax-and-transfer" policies (Sachs & Kotlikoff, 2012, p.17). They argue that without these policies automation will leave one generation better off and the others worse off, but with the correct policy put in place it will lead to the betterment of every generation. This is because increases in machine productivity will lead to greater outputs, so distributed in the right ways, Sachs and Kotlikoff believe that it will be better for everyone. These policies will allow technological advancement as well as ensure the income gap does not increase to a point that is unsatisfactory (Sachs & Kotlikoff, 2012).

II.

Autor (2015) has a different argument than Sachs and Kotlikoff. Autor believed that the polarization of the job market would not continue forever. He believes that middle class jobs will always require a broad set of skills and that some of those skills will not be automated anytime soon, if ever. Autor sees automation as an extension of human labor that augments it by taking away easily automated, repetitive tasks. He discusses machine learning, which is how difficult automated programs are created. Instead of hard coding every little task, programmers can write rules for a program that teaches itself the code. Autor explains how programmers wrote rules for a program that could learn how to visually identify chairs. Programmers do this by writing rules that define a chair and letting the program identify pictures of chairs. With these programs, there are inherent problems. What defines a chair also defines many other things. What if this program were to include the fact that some chairs don't have backs? The program may then start to identify tables as chairs, yet any person could easily identify the difference between the two. This is the main reason that Autor believes automation will not become a substitute for human labor. Even a simple task such as identifying a chair becomes very difficult when we try and automate it. He ends this example by quoting Carl Sagan's, "If you wish to make an apple pie from scratch, you must first invent the universe" (Autor, 2015, p.26). He believes that if we can adapt to the changing needs of our economic markets, we will not have an issue of job loss due to automation. Autor puts the pressure on the education systems to teach the upcoming generations the skills that will be necessary and not the skills that are able to be easily automated (Autor, 2015).

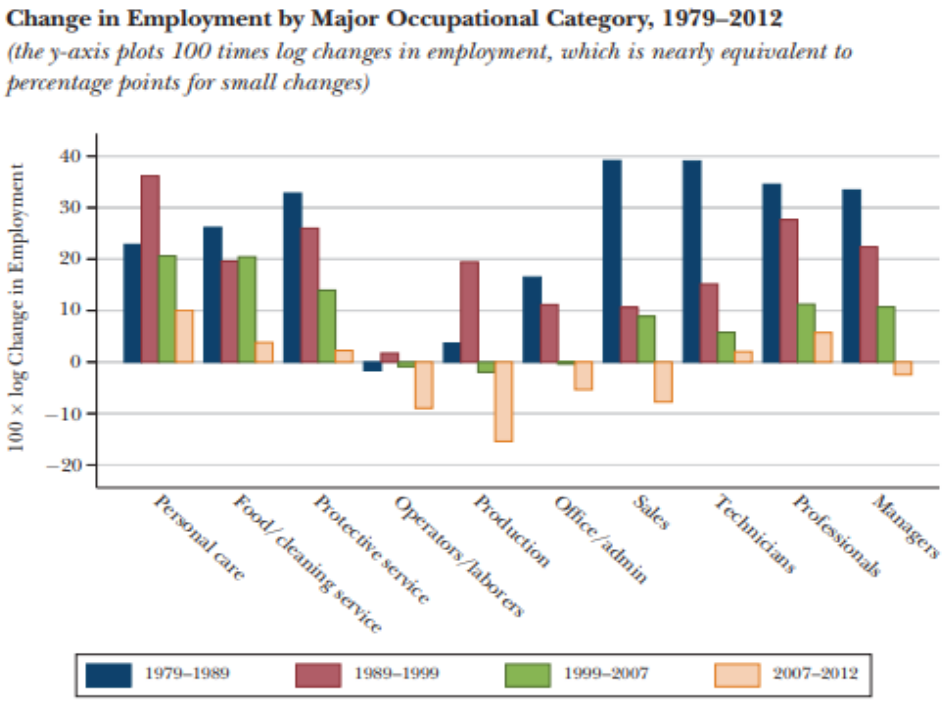
> In this and other ways, the issue is not that middle-class workers are doomed by automation and technology, but instead that human capital investment must be at the heart of any long-term strategy for producing skills that are complemented

> by rather than substituted for by technological change (Autor, 2015, p.25)

Autor comes to this conclusion in a very different way than Sachs and Kotlikoff. Where Sachs and Kotlikoff approach this issue by using a series of equations, Autor uses graphical models to visually represent data and compare changes over time as can be seen below.

Graph 1.1

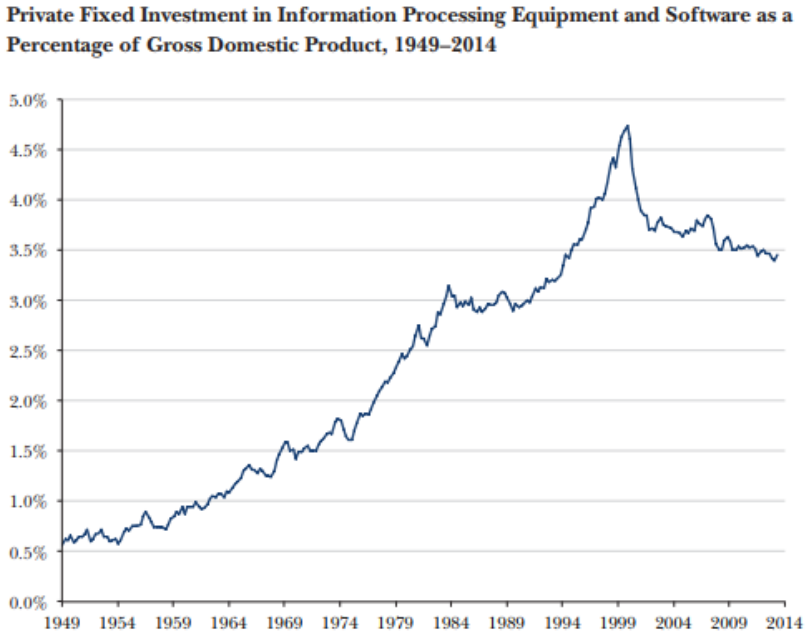
Occupational Category Employment Changes (1979-2012)



(Autor, 2015, P.13) Graph showing change in occupational categories from 1979-2012 organized by time frame and job type. The occupations are organized in ascending order of skill needed starting at personal care on the left and going to the highest skilled work at managers on the right.

Graph 1.2

Investment in IPE and Software as a Percentage of GDP (1949-2014)



(Autor, 2015, p.21) Graph showing investment in technology and software as a percentage of GDP. This graph peaks around 1999 which is when spending on technology and software as a percentage of GDP started decreasing until 2014 when it began to level out. This is because technology, although still increasing in use, is decreasing in price. There seems to be a leveling out because technology use is increasing, and price is decreasing at similar rates since early 2000.

Two of the graphs that he examines; Graph 1.1 - occupational category employment changes, and Graph 1.2 - investment in technology and software as a percentage of GDP, back up his claim that polarization of the job market will not continue. On the first graph, one can see how there is a higher rate in the growth of lower skilled jobs that seems to almost simultaneously mirror the decrease in growth of higher skilled jobs in the later years. Consistently lower skilled jobs are requiring more laborers while middle skilled jobs need less and less laborers. The highest skilled jobs, managers,

need fewer as of 2007. This is because automation is hollowing out the middle class and concentrating labor in the lower and higher classes. On the second graph it is shown that around 1999 investment in technology and software as a percentage of GDP was at an all-time high yet changes in the occupational categories were not at an all-time high. From 1979-2012 we see a periodical decrease in the change of percentage in high and low skilled professions while middle class jobs have started to see a much greater decrease from 2007-2012. Autor believes that if automation was the cause of this polarization, we would have seen an increase in spending on technology and automation as a percentage of GDP in the later years, yet we have spent less since 1999, and cannot conclude that there is one "single factor or common cause" (Autor, 2015, p. 14) to occupational category changes. Autor is saying that since investment in automation fell after 1999, automation cannot be the only cause of the occupational category changes.

Autor makes it a point to describe how even if automation is to take over, which he sees as unlikely, and human labor is no longer valued, we will still not run into a problem of scarcity of wealth caused by automation, but the issue we will run into is that of distribution. This is where Autor, Sachs and Kotlikoff's theories intersect. Both agree that IF automation is to become a substitute for human labor then there will be a necessity for policy on distribution of wealth. The difference is Sachs and Kotlikoff discuss tax-transfer-policy while Autor doesn't see the future of automation being a substitute for labor as plausible, so he does not discuss the changes that would be necessary in the face of this future (Autor, 2015).

III.

The last economists that I reviewed are Erik Brynjolfsson and Andrew McAfee. Brynjolfsson and McAfee's theories were like Sach's and Kotlikoff's in that they believed automation had a polarization effect on the economy. Many economists' conclusions and theories show how there is a "hollowing out" (Rotman, 2013, p.3) effect of automation. Brynjolfsson and McAfee like to point out that "even as overall wealth increases, there can be, and usually will be, winners and losers" (Brynjolfsson & McAfee, 2012, p.37). They define three types of winners and losers. One of these is high vs. low skilled workers. This dynamic is created because a lot of high skilled jobs involve higher level thought that is not able to be automated yet. Low skilled physical labor jobs are easily automated, which widens the gap between the winners (high-skilled workers), and losers (low-skilled workers). The second set of winners and losers are superstars vs. everyone else. The superstars are those who create the automation while the losers are everyone else who loses their job because of the automation created by these superstars. Lastly, the third set of winners and losers are capital vs. labor. Capital is the winner because as jobs get automated, companies tend to switch from labor to capital because the opportunity cost is drastically reduced by automation. (Brynjolfsson & McAfee, 2012, p. 39).

Brynjolfsson and McAfee state that new automated technologies are "encroaching into areas that used to be the domain of people only, like complex communication and advanced pattern recognition. And we've shown how this encroachment can cause companies to use more computers and fewer people in a growing set of tasks" (Brynjolfsson & McAfee, 2012, p.71). They believe that automation is growing exponentially and do not really see an end to its growth, pointing out fields that one

would not expect to be automated, even at this point in time. Cognitive computing, or extremely smart computers, are already being integrated into high-skilled fields such as medicine (Rotman, 2013).

IBM created a system called Watson which is basically a super computer that learns massive amounts of data and then evaluates situations it is given against the data that it has learned, providing answers to complex questions that would previously only be able to be answered by complex thought. Watson's debut win on Jeopardy was its original crowning achievement in 2011. Now, new versions of Watson are working on complex problems in the medical field. It takes information from many medical sources such as "medical journals, textbooks, and information collected from the physicians or hospitals using the system" (Rotman, 2013, p.5) and helps doctors diagnose difficult conditions as well as develop treatment plans for patients. They are integrating Watson into call centers and it is taking jobs from customer service personnel while providing support to doctors. I bring this section into account because it shows Brynjolfsson and McAfee believe the income gap is arising between the technological superstars and the digital losers. High-paid workers are receiving automated complements to their labor, middle class jobs are being substituted, and low-paying jobs are growing due to this polarization. Autor referred to this polarization as the ""hollowing out" of the middle class" (Rotman, 2013, p.6), and Brynjolfsson and McAfee agree (Brynjolfsson & McAfee, 2012, p. 51).

IV.

Overall, many economists disagree on whether automation is a complement or substitute to labor. Most economists agree on the fact that if automation becomes more of

a substitute for human labor than a complement, it will likely require major policy reforms since we will not suffer an issue of scarcity but the issue of distribution.

Specifically, automation has been seen throughout retail markets in recent years. In later chapters I will be looking at what forms of automation have been integrated into the retail setting and how it has affected employment. How has it affected the skill sets of the employees? Have we seen job loss, or an augmentation of labor due to this automation?

Chapter Three

History/story

Automation has been seen for many years and is rapidly advancing. Automation is defined as “the technique of making an apparatus, a process, or a system operate automatically” (ISA). Edward Chikuni prefers to define automation as “the application of machines to tasks once performed by human beings, or increasingly, to tasks that would otherwise be impossible” (Chikuni, 2012). This definition is better that that in the last chapter in my opinion because it includes the fact that without automation, the task being performed may be impossible without automation. A good example of this would be data-mining, which is the process of evaluating many data points and making sense of all of it, which would be impossible at large scales without automation. For something to be automated in today’s age it must meet some basic criteria. A good starting point for this criterion is to look at what Chikuni has laid out. The criterion includes that which; “relieves humans from monotony and drudgery”, “relieves humans from arduous and dangerous tasks”, “increases productivity and speeds up work rates”, “improves product quality”, “reduces costs and prices”, “increases energy and material savings, improves safety”, and “provides better data capture and product tracking” (Chikuni, 2012). Something does not need to meet this criterion in order to be considered automated, although without most of these criteria being met it is unlikely that a process will become automated.

(1.1) $$P(L, K) = bL^{\alpha}K^{\beta}$$

This Cobb-Douglas production function shows mathematically why a company would choose to automate something. An increase in technology, represented by an increase in β in the Cobb-Douglas production function above, will lead to greater marginal product of labor. This means that each extra input of labor (L) and capital (K) will lead to greater returns to scale after the

technological advancement. If $\alpha + \beta > 1$, then "returns to scale are increasing" (Bao, 2008) which means that each input into L or K will lead to greater outputs of total production (P) (Bao, 2008).

I.

The earliest forms of automation are described by Chikuni as "mechanisation" (Chikuni, 2012). which has a similar definition as automation but is used more often to describe earlier, more rudimentary forms of automation. One of the oldest and most influential forms of automation came out in 1913 as the assembly line. An assembly line makes it simple to automate a process because the assembly line breaks something down into simple steps, making automation easier. The first major assembly line was seen in the production of vehicles in Henry Ford's factory. After Henry Ford brought automation to his factories it became essential to success in the industry and was soon adopted by many other vehicle producers.

Another early form of automation came in a different form than the assembly line. This other, early automation came as the power system for railroads. This was different because it cannot be seen as simply as seeing the automation in an assembly line. These power systems were automated by power being generated and sent to be used by the railroads, once the power got to the railroads the automation would start. Something called a synoptic panel would automatically determine when and where to distribute that power so that the railroads could be functional with limited human interactions with the system. The problem with these earlier systems were that they were very expensive and required a lot of maintenance (Chikuni, 2012).

II.

Over this last century, we as a country have seen a shift in what we specialize in. The US, traditionally being a country that specializes in agriculture as well as manufacturing, has seen a shift and has started to specialize in the service industry. We have moved away from small

industry and started to make big retailers an integral part of our economy. In today's age, we can go to one store and get any agricultural good and a near endless supply of produce and meat. This is, in part, due to automation. Our farms are becoming increasingly automated, our distribution centers have increased automation, and over recent years, our retail stores have tried to capitalize on this surge of automation. We are automating tasks that were once thought to be impossible. In this section I will give a brief overview of how automation has made such a quick rise in investment, why it has allowed large companies to flourish, and why this leads to even more automation (Carden, 2012).

Diminishing Marginal returns, or DMR, states that "at a certain point, employing an additional factor of production causes a relatively smaller increase in output" (EconomicsHelp, 2019). This, according to neo-classical economists, is supposed to hold up. DMR is supposed to limit the amount a firm can grow through decreasing returns. Firms are only supposed to grow so much before they hit a point where any increase in growth will start to bring in negative returns on investment. This has not seemed to hold up in the real world with retail markets which is rather troublesome. Instead of the rapid growth causing decreased returns, we tend to see growth lead to increased returns, seemingly endlessly. In order to make the production function work economists will manipulate the production function so that it still functions in the real world.

> First, the new theories recognize that knowledge (e.g. about how to make things) can raise the return on investment. Second, whereas in the neo-classical theory technological progress just happens, in the new theories knowledge is a factor of production which, like capital, has to be paid for by forgoing current consumption. … Third, since past investment in capital may make it more profitable to accumulate knowledge, the new theories admit the possibility of a virtuous circle in which investment spurs knowledge and knowledge spurs investment (Keri, 1998, p.167)

Neo-classical economists will endogenize variables into the production function to show that DMR still holds up, although this leads to a snowball effect. If a company gets an initial advantage and then is able to progress quicker, instead of DMR coming into play, they are able to invest in things, such as knowledge, that give them increasing returns to scale, so they are able to grow past the original point where DMR would say growth would lead to negative returns. This is capable because investing in things like automation and information, allows for increasing returns to scale which offsets DMR because you are not holding all the variables constant (Keri, 1998).

We can see this happening around the US. Massive corporations such as Wal-Mart have taken over large portions of the US. By 2005 nearly 88% of Americans lived less than 15 miles away from a Wal-Mart and "67 percent of all retail stores in the United States are located within five miles of a Wal-Mart" (Carden, 2011, p.6). When stores are this size it allows them to invest in knowledge, technology, and automation. All these things give increasing returns which allows them to grow exponentially and greatly diminish the effects of DMR.

With the increasing returns seen with investment in knowledge, large corporations such as Walmart can benefit from the virtuous circle where "investment spurs knowledge and knowledge spurs investment" (Keri, 1998, p.167) therefore allowing them to continually grow if they keep up with investment in knowledge. Knowledge can envelop many different things, but I am going to be focusing on how automation, something enveloped in knowledge, is helping stores grow and I will attempt to determine the effect it has on employment within those corporations.

III.

Although automation has been seen throughout the world more and more in recent years, looking at the retail industry is when automation gets extremely interesting. When we look at the retail industry, there has been so much automation integrated it is astounding. The most astounding thing about it is the speed at which autonomation has occurred. Since the late 1980's retailers have made massive gains in the amount of automation (Fiorito, 2010). In this section I would like to review just the surface of some of those technologies.

As for the retail industry, there have been many changes in automation use over recent years. The kinds of automations range from something that automatically creates a total for someone when they go to check out to tracking customers' buying patterns to determine how to advertise. I will be reviewing several pivotal integrations of automation in the retail industry, but the amount of automations that have been implemented in the retail industry are much greater than what I will be reviewing because of the pure scale of automation that has been created for retail stores.

One of the earliest forms of automation that was adopted by Walmart, as well as the majority of stores, was the barcode scanner. This is a simple form of automation that made it possible to scan the barcodes we see on almost every item in stores. The implementation of this automation did away with the need for cashiers to type in items manually. Barcodes were developed in the 1950's and soon became an industry standard. By 1973 "Ad Hoc committee composed of grocery industry executives chose the 11-digit, linear bar code that is now commonly referred to as UPC" (Sharma, 2013, p.2) or the Universal Product Code. This method of scanning is considered automation, not technology, because it replaces the human labor of entering the product into the system. Some may mistake this for technology because human labor

is still required to actually scan the barcode, but it is automation because it replaces the job of physically entering the information into the system.

One of the largest forms of automation in retail that has been implemented is the automation of data mining. Data mining is "computerized technology used to find relationships and interesting patterns hidden in database in order to assist the buyer in making informed decisions" (Fiorito, 2010, p.884). The process of receiving this data is technology. Data mining is considered automation because it doesn't just receive the data, it finds patterns in the data that originally required large amounts of human labor. Data mining reviews massive amounts of data, not just from one store, but from many stores. Data mining determines what customers want and need and will give the retail stores this information in order to allow the stores to make better decisions and foster better relationships with their customers (Fiorito, 2010).

EDI, or electronic data interchange, is another automated system that has been integrated in retail stores. EDI is relatively new, only being implemented in the last 20 years, and is "defined as the transport of standardized electronic documents and controlled data between and within computer systems in businesses and organizations without human involvement" (Fiorito, 2010, p.886). EDI connects all aspects of the retail market within each company. It can unite "Corporate offices, stores, manufacturers and distribution centers" (Fiorito, 2010, p.886) all with the same data with no human interaction. EDI makes sure that each employee that needs the data in each department can get the data. If someone in the corporate office is trying to find out how many of X good or Y good were sold over the past three months in order to determine which one to push more, they are able to do that because of the automation provided through EDI (Fiorito, 2010).

RFID tags, although seemingly just a tag that prevents people from stealing, are a simple form of automation that has a greater purpose than just preventing stealing. RFID tags, or better known as radio-frequency identification, has been used for many years, but has just recently been adopted by retailers. Retailers use these tags for many things, but mainly for different aspects of tracking "such as payment method, date of manufacture, transit time, and distribution center location can be transmitted through RFID technology" (Fiorito, 2010, p.887). It takes out the monotony of counting how much of each product is received or still on the shelves at each store. RFID tags will track products every step of the way and do it all automatically thanks to automation. This automation goes as far as actually reordering products that register as being in low quantity in an individual store (Fiorito, 2010).

As for the future of automation in retail, we can look at one process that may be pivotal in Wal-Mart's near future, machine learning. "Machine learning is the science of getting computers to act without being explicitly programmed" (Coursera, 2019). The way these programs work is they learn by taking human inputs then extrapolate that to many decisions in the real world. Wal-Mart has over 5000 categories of items and millions of different items that must be sorted into these categories in order to keep everything organized. Wal-Mart created a machine learning program that is used to classify what something is and what category it falls under. They use machine learning along with hand-written rules to classify items, then use crowdsourcing as a method of verifying the categorization that machine learning assigns each item. Without machine learning, it would be near impossible to categorize every product that Wal-Mart sells, and this technology only gets better with time. When mistakes are made machine learning programs learn from them, and the programs are much less likely to repeat the same

mistakes again. Machine learning is one of the most powerful tools automation has to offer and all the possibilities it has are still unknown (Sun, 2014).

IV.

In this chapter I have shown why automation is so important to be successful in the retail industry and have given examples of processes that have become automated. In most any field we have seen automation integrated in some way or another. What we see is automation either being a substitute for human labor or a complement to human labor. Throughout chapter four I will be evaluating different forms of automation within the retail industry and what effect each kind of automation has on the employment.

Chapter Four

Wal-Mart and Automation

Automation can be a complement to human labor or can be a complete substitute to human labor. What I will be doing in this chapter is looking at different automated technologies that have been, or currently are, integrated into the Walmart corporation. I will evaluate what these technologies are doing to employment in the corporation and answering what effect we should see with the implementation of each technology.

I.

Barcodes have made it easier for Wal-Mart cashiers to perform their jobs. Before barcodes, employees would have to manually enter the prices to everything. In today's day and age, this process is basically a necessity because manually entering prices would require many more workers and would take much longer for customers. Bar codes, like many other forms of automation that I am reviewing, are labor augmenting. They allow the common cashier to do the same job they were already doing, but at a much faster pace. By doing this, bar codes are a way of receiving increasing returns to scale, allowing for growth. They are very labor-enhancing, allowing the individual cashiers to perform more transactions in shorter amounts of time. Along with being labor-enhancing, barcodes are also inequality narrowing because they are a complement to human labor and do not take jobs. It allows low skilled workers to perform the job they already have, but at a more efficient pace. This should lead to increased wages because of the increased profits due to fewer workers being necessary to serve the same number of customers. With this, Wal-Mart is able to grow and employ more people in more stores to serve more people. Even though it may allow for fewer employees to take care of the customers, it allows growth which will lead to higher employment at a higher wage.

II.

Data mining is one thing that has been crucial in Wal-Mart's continued success. It is a program that allows Wal-Mart to make more informed decisions on what the customers are going to buy. Data mining, although seemingly completely automatic, is not. It requires human input on what patterns to look for as well as human input to determine what patterns are meaningful. Without data mining, the huge amount of data stored by Wal-Mart would just be that, huge amounts of data. No human would be expected to possess the capability of sifting through that amount of data. With data mining, professionals can see patterns that we wouldn't even think to look for. There are several reasons that make data mining so valuable, its uses include; "market segmentation", "customer churn", "fraud detection", "direct marketing", "interactive marketing", "market basket analysis", and "trend analysis" (Alexander, 2019).

Market segmentation is the ability to find characteristics of people who would buy the same product. This is helpful because it allows the marketing team to find out which demographics are buying what, and in what markets. Data mining then allows marketing to cater to those customers. Customer churn is the turnover rate of customers, or how likely they are to terminate their business with a company. Fraud detection helps the company determine which sales are more likely to be fraudulent. Direct marketing helps decide whom to focus marketing campaigns on so that money is not wasted on marketing if it will not bring in a sale. Interactive marketing is what online websites use to determine what to advertise to you while you are on their site and is useful because if everyone got the same advertisements the likelihood of them buying something from an advertisement would be greatly diminished. Market basket analysis is looking at what items are purchased together. This is useful because if someone is going to buy something that complements something else, such as peanut butter and jelly, it would be more

beneficial to keep those together so that you may get more sales on both. Trend analysis is when data mining tries to reveal differences over time and possibly try to predict what the next trend may be (Alexander, 2019). These technologies can be helpful, but the commonality between them is that none of these would be any help if humans were not involved in the process. What would trend analysis be if nothing were done with the discovered trends? What would fraud detection be if Wal-Mart did nothing to fix the issue? All of these things are complements to human labor, not substitutes. Data mining is inherently labor-enhancing because without it, the job could not be done properly by any human at the scale data mining is capable of. It gives professionals in each field the use of data mining as a tool on their toolbelt. It is inequality narrowing because it creates high skilled jobs that were not available beforehand and does not remove jobs in other classes. The people who select which products go where will still have a job even when data mining is telling them the things that are most important to put up front, they just do it better. The people who go after fraudulent activities will still have a job even when data mining is telling them the transactions that are more likely to be fraudulent. Data mining is a tool. Without human labor, data mining would be just values on a screen. It will help raise the wages of workers within Wal-Mart, because it is a complement to human labor, allowing employees to do the same job better. Without a hammer a carpenter would struggle to do a good job but without the carpenter the hammer would be useless.

III.

EDI is another form of automation that has been integrated by Wal-Mart. Electronic data interchange (EDI) is a form of automation that unites data throughout Wal-Mart's systems without human interaction. This seems like it must be a substitute for human labor because it automatically orders things for Wal-Mart. There is no human interaction. When a store registers

that it is low on a product it will generate an order. When the system finds that a certain product that usually sells well isn't selling as much, it can automatically decrease the order. These are jobs that used to be done by employees; counting things, taking inventory, re-ordering items…etc. So, has Wal-Mart seen a drop in employment due to EDI (Maltz, 1997)?

My argument is that Wal-Mart may not need employees to do this menial job anymore, but EDI works as an augmentation to labor. It is labor-enhancing, allowing people to do the job they were already doing, only better. I discussed in the previous chapter how stores are investing in things that bring increasing returns to scale. EDI is one thing that corporations are investing in that brings increasing returns. Wal-Mart could never manage to make the stores look as nice as they are, have great customer service, keep everything clean 24/7…etc. if their employees were having to place orders directly to the distributors. EDI takes over these important yet menial tasks and allows workers to focus on other things. It augments the amount of labor everyone is doing, allowing the store to grow and prevent DMR from bringing negative returns. Not only does it have the effect of increased returns through labor augmentation, it has also drastically decreased the risk that Wal-Mart must take on when ordering. EDI can order weekly or bi-weekly and can adjust for changes in buyer preference immediately. Wal-Mart no longer must worry about buying too much of something and it never selling, nor buying too little of something and missing out on sales because of lack of inventory. Through the implementation of EDI, Wal-Mart can keep a reasonable stock of every item selling in the stores. It must be inequality narrowing because it raises the skill level of all employees. It allows low level employees to do a better job and provide a better experience for the customers. This should lead to increased wages because of the increased profits due to more customer needs/wants being catered to. Because of these things, I would say that EDI may be a substitute for human labor,

but it has an augmentation effect because it allows companies to employ more people doing different jobs (Maltz, 1997).

IV.

While EDI is the actual physical information being transferred between Wal-Mart stores, warehouses, distributors…etc. the information that must be transferred needs other technology to gather that information. Another huge form of automation that is being used by Wal-Mart is RFID, or radio frequency identification technology. RFID tags give the retailer the ability to track the amount of product that sits in the warehouses and distribution centers as well as the inventory that is in the stores. RFID technology does away with the transaction times of information as well as the extra work that comes along with counting inventory. It instantaneously transfers the information about packages received and sent to anyone that needs it (Delen, 2007). RFID differs from EDI because it is the way the information is automatically gathered while EDI is the automation of the transfer of information. RFID technology is similar to EDI in the fact that they are both not only substitutes to human labor but also augment labor and provide increasing returns, offsetting DMR. For similar reasons they both are labor-enhancing, inequality narrowing and increase wages.

In 2003 Wal-Mart made it mandatory for its top 100 suppliers to use RFID tags on all large shipments of goods by 2006. This meant that for Wal-Mart, it would drastically cut down the amount of human labor required in order to keep track of this inventory. There was a major worry though. The RFID technology was untested in the retail industry. The technology had been around for a long time but implementing it into the real-world situation of tracking packages scared a lot of suppliers. Suppliers did not know that it was going to work and “it's one thing, however, for a company to spend its own money on an unproven technology with an unproven

return on investment. It's quite another to force other companies to do so, even when the company doing the pushing is as big and powerful as Wal-Mart" (Malone, 2012). Pushing these technologies onto suppliers was scary to the suppliers because some products being shipped to Wal-Mart already had small margins and including the price of a RFID chip on every pallet could mean that the company may no longer be able to profit on each product. Along with this, the suppliers were now forced to manage two different forms of tracking shipments. They had to deal with Wal-Mart's new mandatory system as well as the system they had for every other supplier.

> Several in the industry likened RFID to technology like fax machines: it only becomes financially viable once everyone uses it. But the so-called network effect never materialized. "[Wal-Mart] thought, 'If we do this, other retailers will follow on and that will create a critical mass, so all the suppliers will be forced to do it," Roberti said. "The biggest issue is that the industry didn't go along (Malone, 2012).

The issue came up that a lot of other companies were not adopting this technology alongside Wal-Mart. Wal-Mart seems to have been pushing technology that was not being implemented correctly. They received some major push-back by suppliers, and for good reason. The suppliers were struggling to implement this technology while maintaining good profits on some products. Along with this, Wal-Mart was having its own problems with this technology because they lacked the databases that would support such a large change in data format so quickly. There were many unforeseen issues and it was extremely difficult to integrate this technology in the way Wal-Mart wanted at the time they wanted. It is still possible to see this technology used in Wal-Mart stores, but it has not seen the dramatic use that Wal-Mart expected (Malone, 2012). RFID technologies are a great example of how automation can fail. It can be a

great technology on paper, but if not implemented correctly, we can see a huge investment not lead to a large positive change in efficiency.

V.

Machine Learning is possibly the most powerful form of automation that any retailer will see. It can be applied to near any kind of automation and once these programs are developed, they basically write themselves. The program that I will be reviewing is Chimera, the program used by WalmartLabs. This is the program that categorizes information in the Wal-Mart systems. Chimera does away with the extremely monotonous task of categorizing all the products received by Wal-Mart. Without Chimera, an analyst is only capable of categorizing approximately "100 items per day" (Sun, 2014, p.1531). It would be nearly impossible to categorize all the already existing products as well as all the incoming products that come in every day. Doing it internally would require too many employees to make it a viable option and outsourcing this process would not be cost effective. It is predicted to cost approximately $770,000 to categorize one million items by outsourcing, which is not a reasonable cost for the company to incur for such a task.

The solution to this problem is the implementation of the program Chimera, which uses machine learning alongside crowdsourced and handwritten rules to solve the issue. So, the question is, what effect does Chimera have on employment? Chimera is a substitute for human labor. It replaces the human labor that was necessary to categorize items sold at Wal-Mart. Even though it is a substitute for human labor, the fact is that it also, like many substitutes for human labor, creates a need for new jobs. Since it is improbable to just have machine learning without written rules, there is a need for employment in writing these codes. Instead of the unskilled labor of labeling each item individually, there is now a need for skilled coders that can write

rules that dictate how Chimera functions. Along with the skilled jobs Chimera produces, it also produces the unskilled jobs of the people who are being used to crowdsource. If Wal-Mart wants to ensure that its technology is functioning properly, they need people who are still going to do some individual item categorization to verify that Chimera is getting the correct answer. On top of the people that are being crowdsourced, there need to be analysts and developers that can make sense of the information provided by crowdsourcing. The analysts will make sense of the data being submitted and report to the developers if there are any issues with the program that need to be addressed (Sun, 2014). Overall, the system of using Chimera seems to be create jobs rather than costing them, even though it is a substitute for human labor. Chimera is labor-replacing, although, it creates jobs for high-skilled workers as well as for low-skilled workers which not only is inequality narrowing, it also increases the overall wages.

Chapter Five

Conclusion

I have looked at the effects automation has on employment at Wal-Mart. Surprisingly, it has not seemed to take jobs, but rather increase the amount of employment within Wal-Mart. The effects of automation seem to offset the effects of diminishing marginal returns and instead of job loss, automation leads to growth within a company allowing for more jobs. Because of such growth being possible, the firm can add more of the same jobs that automation has made easier by increasing the number of stores, as well as adding jobs that are required to create, upkeep and use the automation.

I.

We don't see the same effect on farming that automation has had on the retail industry. Farmers are hardworking and the jobs required can vary, but the main work of a farmer is rather specialized. Labor is not very mobile on a farm. Once a hands-on job is automated, it takes that job away. On dairy farms, the main job is feeding and milking the cows. Automation has taken the job of milking cows and technology has increased the amount of work one farmer can do. On corn farms, the main job is planting, tending, and harvesting corn. Automated machines that pick the corn, remove the stalk, and transport the cleaned corn to holding bins have all made it possible for one farmer to do the job of many. Jobs in the retail industry vary much more and labor is much more mobile because not all jobs in retail are laborious. There are so many variables in the retail industry that when one task is automated it doesn't just take away that job, it creates the need for different skill sets. When data-mining came along, determining trends was still a job, it was just improved and the scale at which it was done increased. When barcodes and scanners came along there was still a need for cashiers, but fewer of them. When fewer people

were needed to do these jobs, profits rose and DMR was offset. This led to growth which created a net increase in cashier jobs, along with others.

Another reason that farms have seen a dramatic decrease in employment due to automation is because there is a limiting factor in production, land. Farms can only exist on land capable of sustaining farm life. This means that farms must be as productive as possible in order to maximize profits. Automation has made profits possible through increased yields with decreased employment. In the retail industry the factors of production are much broader. There are many more inputs required to run a store than there are to run a farm and most of them are not in short supply. This means when jobs are automated and profits increase, they can add more stores. Farms can sometimes buy more land, but because the automation on farms is labor-replacing, increasing factors of production didn't mean adding more labor, it just meant adding more profits. The bigger farms got, the more automation replaced labor. The more Wal-Mart stores there are, the more employees are needed to do the jobs that automation has simplified.

II.

Throughout my research I have found out that my previous assumptions on automation were very off base. Before my research my assumption was since automation does a job, it must lead to decreased employment. I couldn't have been more wrong. Most forms of automation in the retail industry I actually found to be labor-enhancing. They allowed people to do jobs quicker and more efficiently. This efficiency leads to growth, which creates jobs. When DMR is offset and a company can grow larger and larger, it doesn't matter that automation is taking jobs because automation is a double-edged sword. It can take a job but in the same swipe it will create the need for more labor. It creates more jobs in different fields, and because a lot of forms of automation are labor enhancing, not labor replacing, when automation inevitably leads to

increasing returns on investment, the amount of people needed to do the job still increases because of the increase in the number of stores. This is important because we need to look at the effects that automation has on an industry.

III.

Currently, there is not a real need for policy dictating automation. Automation offsets DMR and allows for growth and job creation. The worry that arises is that, if instead of being labor creating, what would happen if, like farming, automation became labor replacing? Complete automation of retail stores is not in our near future, but we need to plan for when/if it occurs. Automation, like previously stated, is constantly advancing. We are doing more things through automation than ever thought possible. What will be required when the possibility of all jobs becoming automation becomes a reality? Will stores become completely automated and the only jobs left be those that maintain automation? Will we have to write policy about the amount of automation stores are permitted to integrate or will complete automation become widespread through many industries requiring a complete overhaul of our economic systems? What would we do if complete automation became the norm and human labor became near worthless?

IV.

The future of automation taking over human labor has been prophesied many times in the past. It is a sad truth that "wide-scale automation would create a new form of inequality between those who design and control the technologies of automation and those who do not" (Van, 2018). The point where automation overtakes human labor is referred to as the tipping point. When people are no longer valued because automation becomes so widespread it will require policy reform, and many people believe this policy reform will come in the form of UBI, or universal basic income. UBI is regular cash payments to all individuals within our society that are

obligation free and equal between everyone. This would be possible because if the point is reached where automation takes over, we will have an overabundance of goods. The reason UBI would be considered is because the overabundance of goods would be unequally distributed to those who control the automation while the common laborer would not be able to find work not capable of being done for less by a machine. Our current economic system functions by paying people for the work they do. If massive unemployment occurs due to automation, many people will not be able to find work at all. One way to replace the "primary source of income is for the government to provide its citizens with a Universal Basic Income (UBI). Just as income generated through labor, UBI would be obtained on a regular basis. The major difference being that the recipient would not have to work in order to receive it, he would just get it: free money" (Van, 2018). This is only viable if the amount received through UBI is enough to sustain a reasonable living standard. If people are to lose their jobs due to automation, they may become a drain on our economic system. With UBI, it does not allow this to happen because with or without employment, each person is able to sustain themselves through the payments received with UBI. This is beneficial because without UBI, massive job loss will lead to more and more people seeking benefits while fewer and fewer people would be paying income tax, further straining the system. UBI could only be viable through increased corporate tax rates, but with the increased profit margins corporations would receive due to automation, the increased tax rate could mimic the wages the companies are no longer paying their employees (Van, 2018).

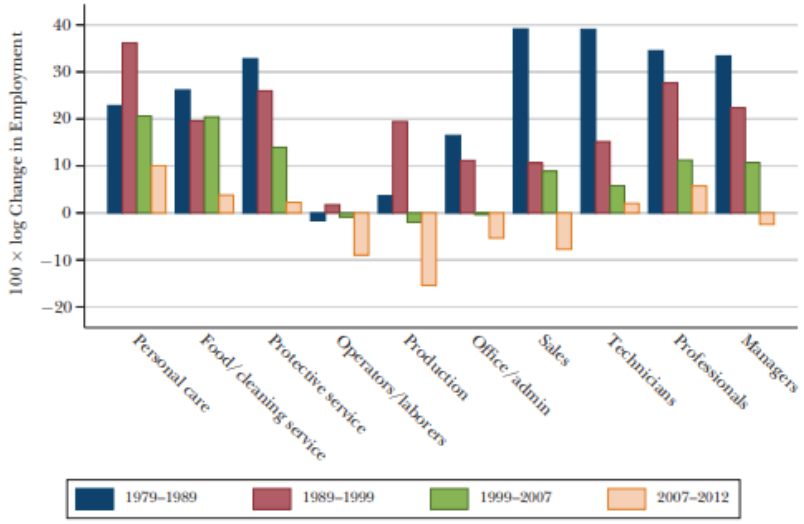
I am, by no means, suggesting immediate implementation of UBI, especially at a level that would more than sustain life. I am only providing an example of policy reform that would be needed if the future of automation overtaking human labor comes to fruition. Massive levels of

permanent unemployment would be catastrophic for our society. Without proper planning and preparation, some believe that this future is all too real.

Appendix

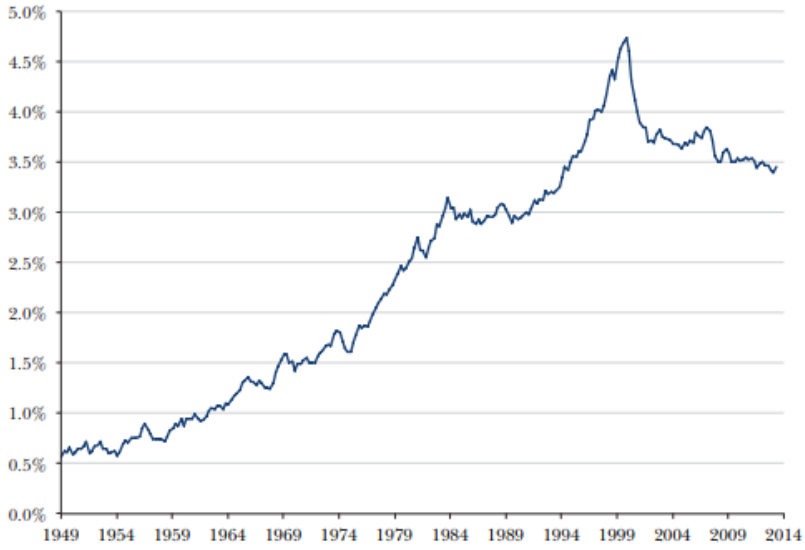
Graph 1.1

Change in Employment by Major Occupational Category, 1979–2012
(the y-axis plots 100 times log changes in employment, which is nearly equivalent to percentage points for small changes)



Graph 1.2

Private Fixed Investment in Information Processing Equipment and Software as a Percentage of Gross Domestic Product, 1949–2014



Equation 1.1

$$P(L, K) = bL^{\alpha}K^{\beta}$$

Citation

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