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Technological Adoption and its Impact on Employment

In this research paper I will further explore the implications (good and bad) technological advancement and computerization has and has had in our workplaces. Analysis of David Autor's "*Why Are There Still So Many Jobs*?", sparked my interest in this broad conversation. I will use sources cited below to further explore implications associated with this topic and to back my claims. Also, I will get into some more specific analysis within firms and industry, as it provides valuable insights on a microeconomic level, that could correlate too expansion and growth in other workplaces and firms as well. With technological change there is bound to be employment and dis-employment effects that take place, and this paper looks to analyze those attributes. A topic that has come to the forefront of political discussion recently, is growing inequality. Particularly, with regards to the increased returns to higher education, and increased wage differentials between skilled and unskilled workers. We are seeing these differentials widen with time and in this paper, I aim to address concerns that could provide explanation to this. In the past couple decades, there have been dramatic technological advancements and change taking place within our societies, and with that, new and improved technologies have become available to businesses across the spectrum. We know the introduction of new technologies has altered production processes with regards to capital and labor associated in many workplaces. I will begin with analysis of technological change by addressing how it has affected workforce

structure, in hopes to provide an explanation for why there is still so many jobs, and why widening inequality is occurrent in today's society (Doms et al. 253).

To start, I believe it is important to recognize findings from Doms, Dunne and Troske's, "*Workers, Wages, and Technology*". Within their research, they provide cross-sectional data that helps us identify the relationship between workforce, and technological adoption. The cross-sectional data contains details surrounding worker characteristics and plant-level technology use. Their findings suggest a positive correlation between educated workers and technology use for both production and non-production workers. Furthermore, they also find that the fraction of workers employed in fields such as scientific, engineering, managerial and other precision-craft occupations increases with the introduction and use of new technology. Technologically advanced plants employ more high wage production and technical workers. Results from their time-series analysis shows little correlation between changes in workforce characteristics and technological adoption. Graphical evidence provided further proves that plants that adopt a large number of new technologies do not seem to increase their relative share of non-production labor or high wage workers, when compared to plants who adopt a small number of new technologies (Doms et al. 255, 267). The most technologically advanced plants paid their workers more prior to adoption of new technologies. It becomes apparent that plants who adopt many new technologies likely have employed high wage workers with increased technical skills, both prior to and post adoption. Managers foreseeing new technologies being developed could be an explanation for this, as they will adjust their workforce prior to adoption. This study concludes the act of adoption does not necessarily alter wages paid or impact employment structure at the plant level. It is important to recognize the types of technology this study examines. Meaning, these technologies are the ones used directly in the production process of manufactured goods

(CAD-controlled machines, laser technology, LAN technology etc). This study recognizes the difference between these technologies and computing equipment, which is more often a tool used in managerial and clerical positions. Plants who do invest more heavily in computing equipment show larger increases in the share of non-production labor they employ.

Plant-level data shows us that the adoption of new technologies does not seem to influence workforce structure, which could mean that "high-tech" plants may not see middle skill workers as valuable in the first place. Instead, they may see more value in higher skilled technical workers as plants with more technology, may account for future adoption, that would make middle skill workers less productive. As better technologies and more adoption of technology takes place across the spectrum in plants, firms and industry, middle skill workers may be seen as less viable, while those with more education who are higher skill become more valuable. We can now begin to see why widening inequality is taking place while we are simultaneously more technologically advanced than ever before. The data explained above provides us with a foundation of the relationship between workforce structure and technological adoption at the plant level (Doms et al.).

This begs the question, "why are there still so many jobs?". David Autor's research does a fine job providing reasoning to concerns such as how the emergence of new technologies, greatly improved computing power, artificial intelligence and robotics will raise the possibility of replacing labor. Will it be on a scale not previously observed (Autor 4)? Autor's research also addresses concerns about how technological advancement has benefitted us while also providing statistical data that further proves what he calls the phenomenon of widening inequality (wage gains going disproportionately to those at the top and bottom of the income and skill distribution, not to those in the middle). So how does automation and employment interact? Well

an obvious reason is substitution for productivity gains, which often results in short-term unemployment for those being replaced with technology. However, it is hardly mentioned that automation complements labor in many ways while also raising output in ways that lead to higher demand for labor. A historical example is found when looking into the percent of the US workforce employed in agriculture in the 1900s and comparing that to the share of the US workforce employed in agriculture in the 2000s. In 1900, it was 41%, in 2000 that share had fallen to only 2% (Autor 5). The introduction of automated machinery enables many jobs to be fulfilled using less labor, while also meeting satisfactory requirements (productivity gains). I really like the example Autor provides which focuses on the introduction of the ATM machine. This example allows us to get a better understanding of how the introduction of automated machinery can interact with labor positively. During this time (1980-2010), the number of ATM machines in the US economy quadrupled, going from 100,000 machines to 400,000. A look at US bank-teller employment during the same time period shows increases in employment, going from 500,000 to approximately 550,000. So what's going on here? How can substitution of labor due to productivity gains through technological advancement correlate to increased employment? ATMs reduced the cost of operating a bank branch, because less bank-tellers were needed in any particular location, however, the number of urban bank branches rose by more than 40% during this time. The number of tellers in a single location fell by more than a third, however since banks did not need as much labor for routine cash-handling tasks, they were able to allocate more of those employed to fulfill tasks such as "relationship banking". Banks changed the way they viewed their tellers, going from a "check-out clerk" perspective, to viewing them more as salespersons, responsible for forging relationships with customers and introducing them to additional banking services such as credit cards, loans, and investment

products. The newly introduced information technology enabled a broader range of bank personnel to become more involved in relationship banking (Autor 6, 7). Banks were able to expand and grow because the cost of operation in banks fell when ATMs were introduced.

I would like to shift focus to the effects automation has on an individual level. A study by Dodel and Mesch, "*Perceptions about the Impact of Automation in the Workplace*" is unique in that it presents evidence from individuals that perceive negative effects surrounding automation in their workplace, and if these individuals are more likely to report job loss or wage loss. We first need to recognize job polarization, and a big factor that contributes to that is the decline in computing price over the past decades which in turn has resulted in widespread adoption of new technology that substitutes for middle-skill, middle-wage workers (increases in proportion of employment in highly skilled and low-skilled jobs, decreases in proportion of employment in middle-skilled jobs, rising inequality). Jobs that can be performed with a defined set of procedures are relatively easy to automate. Contradictory to that, jobs involving non-routine cognitive and non-routine manual tasks are the jobs that typically fall in the highly skilled category, or the low-skilled category (Dodel and Mesch). So how do perceptions about automation correlate into our workplaces? Findings from Dodel and Mesch indicate only a small percentage (4.6%) of the population reporting they believe to have already suffered from negative effects associated with increased automation. In addition, only 16% of the population also believed that new digital technologies have had a negative effect on their current job. They found that certain socioeconomic groups have tendencies to feel more/less prone to negative effects associated with technology, while some feel more supportive of automation. Occupations with relatively low levels of human capital and the lowest paid, least skilled jobs were the ones found to be the most pessimistic about technological adoption and the impact it may have on

their career. It is also important to recognize the age differential with respect to perceptions about the impact of technology on careers, and concerns surrounding potential job or wage loss. Older groups were found to express more negative, distaste for technology and its role in current jobs. Furthermore, education and income were found to be positively associated with optimistic views about how new digital technology may impact jobs. It was found that jobs involving manual labor or more physical duties were also more likely to express negative attitudes towards technological adoption and innovation. It is important to note that these individuals with negative outlooks on technological adoption who may be employed in manual labor or other physically demanding occupations did not mention nor were more likely to mention actual job loss or reduced incomes, this study analyzes perceptions. Individuals who manage, or engage in data analysis, were more optimistic about impacts surrounding computerization. Frequent internet use was a trait positively associated with optimistic views surrounding impacts technology may have on the future of one's career (Dodel and Mesch).

With the ever-increasing impacts technological innovation and advanced computerization has in our workplaces, it is important for businesses to plan for innovation and coordinate essential training required for employees to maintain skills necessary for the job. A key takeaway from this study is encouraging businesses to address the consequences new technologies may have in their workplace earlier (informing employees that they must partake in newly organized training that enables them the skills they need, informing employees reallocation must be implemented for growth and expansion, etc.), rather than waiting until technological unemployment becomes a major issue. This will ensure support for computerization and help to reduce social tensions that have evolved from it. This study shows

us that new technologies fuel social anxieties and that these anxieties are more pronounced among vulnerable sectors of our economy (Dodel and Mesch).

Daron Acemoglu's "*Why do new technologies complement skills*?", takes a deeper look into the college and skill premium in the late 1900s into the early 2000s. Evidence shows in 1970, college graduates earned roughly 55% more than high school graduates. This number reached 62% by 1995. Daron argues the main cause for the rapid increase in the college premium is skill-biased technological change. According to this viewpoint, new technologies are complementary to skills, and with the introduction of these new technologies, comes emphasis on upgrading the productivity of skilled workers. Resultingly, increases in the supply of skilled workers reduces the skill premium (college premium) in the short-run, while inducing skill-biased technological change and increasing skill premium in the long run, potentially above its initial value. The recent past (1970-1990s) witnessed rapid introduction of new technologies into workplaces. Daron recognizes that when there are more skilled workers, the market for skill-complementary technologies is much larger, which further confirms findings from Doms, Dunne and Troske's research (Acemoglu).

Bresnahan and Brynjolfsson show evidence that skill-biased technological change (Technical progress that increases demand for more highly skilled workers relative to less skilled), is largely responsible for widening inequality at the firm level. They suggest that incorporation of information technology is a large source of increased demand for skilled labor and rising wage differentials. With the introduction of new information technologies within firms, comes skill-biased organizational redesign (substantial changes to a firm's product and labor service mix) that is neccassry for firms to efficiently use their new technology in production while maximizing productivity of labor. This may look like reductions in skill

premium initially, due to skill-biased organizational redesign that might temporarily layoff some skilled workers, however in the long run it results in increases in the skill premium, production and often times exponential expansion and growth within the firm or industry that shows new technologies are complementary to skills. As information technology becomes cheaper and widely accessible to firms, it ultimately induces more complementary investment to skilled labor (Bresnahan and Brynjolfsson).

Contrary to skill biased-technical change being the leading source for widening inequality with regards to income distribution, Kristal and Cohen argue other sources may play equally as large a role. They conclude that the decline and erosion of unions over past decades until recently is a major contributor to inequality growing so much in the US, especially when compared to European countries who have also experience widening wage differentials between skilled and unskilled workers, but not on the scale we have seen in the US. They argue unions served as an important check to the pay of upper management and how they distribute earnings. In post-war years market outcomes were significantly moderated by labor unions which can be described as an industrial system of collective bargaining power which ensures the value of real minimum wage stays high while also encouraging progressive taxes. Furthermore, they recognize the slowdown in growth of college graduates since 2008, which provides further explanation to rising wages of highly educated Americans. Authors conclude that declines in unionization and simultaneously the decline in real minimum wage explains about 50-60% of rising wage inequality in US private industries between 1969-2012, while the spread of computer technology explains roughly 28-29% in the same period. This study finishes by indicating the erosion of pay-setting institutions (unions) has enabled businesses and upper management to

grab a disproportionate share of income, leaving their labor forces far behind (Kristal and Cohen).

Findings from Kristal and Cohen made me realize it is a combination of factors that are to be held accountable for rising wage inequality in the US and even Europe. 1964 – AT&T was the nation's most valuable company, projected to be worth around $267 billion while also employing a whopping 758,611 people. Today's telecommunication conglomerate is Google, which is projected to be worth $370 billion while employing only 55,000 people. With these statistics in mind, we can see that skill-biased technological change and inevitably de-unionization has put us in a place where significantly less labor is required to fulfil even more technically advanced tasks while simultaneously being able to require more preparation for lower starting wages. The rise of computer technology that has been taking place dramatically in workplaces since the 1970s, has led to increased productivity and demand for high-skilled workers that use computers while also raising their wages relative to those who do not use computers. The combination of this and the decline in college graduates since 2008, has raised wages of highly educated Americans even more. De-unionization, especially since the 1990s, has also played a large role in the declining value of the minimum wage, which creates more income inequality between low-skill and high-skill workers. Demonstrations have shown that increased computerization over time reduces the labor's share of income while increasing corporate profits, and indirectly exacerbates union decline. Indirect effects of computerization include the weakening of unions while it enhances the rise of non-standard employment relations (Kristal and Cohen).

I believe I have provided substantial evidence as to why widening inequality is occurrent in today's society, and also the effects technological change has on employment and dis-

employment. Skill-biased technological change, de-unionization, declining value of minimum wage (more preparation, lower starting wages), information technology, organizational redesign and education are all factors that contribute to widening inequality and explain why labor forces in this era are shrinking or smaller than they were in the past. To conclude my paper, I want to share some of my own insights, and how I believe the future may unfold with regards to employment. As we transition from what once was a manually intensive labor force – we can expect to see more part-time employment and less full-time employment. The rise of the internet has allowed vast amounts of people access to cheap artistic tools that have already enabled individuals to produce culture and make a career without specific educational requirements or trainings. (Social media, NFT/digital art, software-design, advertisement, etc.). Recently, we have also seen significant rises in short-term spot employment. Things like Uber, Doordash, Airbnb, Craigslist and eBay allow people to work on their own schedules while also making it easy for individuals to take on small independent projects or tasks. With the increasing difficulty in finding rewarding full-time work and the shrinkage of labor forces and markets, we may see a future that holds more episodic work across a range of different activities. More socialist policies would be set in place as upper management and leaders of big corporations would continue to thrive, things such as universal basic income may be introduced. This would look like increased taxes to those who hold a lot of capital because of the decreasing labor market. Deciding how to reallocate taxed finances from the wealthy would come to the forefront of political discussion. Incentives to cut all worker hours instead of laying off some workers could also be policy we see come into play, in hopes to keep worker attachment to the labor force for those who do work at established firms.

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Revisions

I clarified my underlying theme, which is how technological adoption has effects on employment and dis-employment. I added information from three additional sources that were missing in my rough draft. I also included in text citations, some with page numbers and others without, due to some being articles displayed on a webpage (without page numbers) instead of a PDF. Also many grammatical changes and some rearrangement of paragraphs. Thank you!