

The Effect of Emerging Technology on Economic Inequality: The Role of Automation, Algorithms, and Beyond

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Abstract

Discussion of technologies bringing harm to employment has existed for centuries, but this paper wishes to investigate what the data has to say about advancing technology and its effects on economic inequality as a whole. Numerous patterns of inequality since the first industrial revolution line up with historical events like the industrial revolution and the start of the digital age. The first industrial revolution brings around rapid development allowing the colonization of the poor, in turn raising the inequality between countries. The digital age brought a global medium which can scale oppression and exploitation on a previously unthinkable scale, bringing back early 20th century level within country inequality. New technology like automation have shown to actively harm the livelihoods of the working class, and machine learning algorithms have countless examples of hiding oppression under the veil of mathematical objectivity. The Covid-19 pandemic has accelerated the progression of many digital technologies, and has fully unleashed the truth that all working class individuals, skilled or not, are affected by emerging technology.

Introduction

Innovative technology has always been a driving factor in economic development because technological advances allow for productivity to increase beyond its previous limits [1]. This was true for the steam engines in the first industrial revolution and remains true for emerging technologies such as automation and big data machine learning algorithms. However, this growth is not equally received by all; in fact, global wealth inequality by 2020 is comparable to the level it was in the early 20th century, at the height of Western imperialism [2]. Some interesting patterns have been discovered with the addition of powerful technologies like robot automation and some associate the rise in unemployment with these technologies in part. Many complex factors can contribute to our rising economic inequality, and understanding the history of advancing technology on the socioeconomic status of society is perhaps a key to understanding and preventing further inequality. The current paper focuses on two major players in the tech field; automation and machine learning algorithms. Furthermore, it is equally important to explore how these technologies compare to society changing innovations of the past like the steam engine or the domestication of horses.

We have famously known that correlation does not equal causation, and this is a careful area of consideration when comparing the advancement of technology verses inequality. While numerous periods of time have both rapidly advancing technology and inequality, it is not sufficient to say there is a causation

between the two. Before considering the nature of some emerging technologies themselves we will analyze how technology has affected inequality in the past, inspecting patterns in periods of major technological growth and periods of stagnation.

Historical Prevalence of Economic Inequality

It is important to preface this analysis of economic inequality with the fact that global inequality has always been a prevalent issue as far back as the 19th century. The global top 10% of the population consistently received over half of the world's income for centuries. Meanwhile the bottom 50% has only peaked at 14% of the world's income and has only reduced since 1820 to 7% in 2020, about the same as it was in 1910 during the aforementioned peak of Western Imperialism [2]. Most people viewing this data objectively could infer that modern globalization, technological development, or any other major factor has not closed the overall wealth gap by very significant levels. Most of this data is concerned with the past few centuries of development, but can consider root causes stemming from some of the earliest human societies in history.

Back to the Beginning: The Agricultural Revolution

While it is undeniable that much of society today is possible because of the agricultural revolution, we also need to consider the implications of this early technology on human society at the time. The societies of hunter-gatherers in the pre-agricultural era displayed religious following of egalitarianism, the doctrine which states all people should have equal rights and opportunities. This equality is what modern society has tried to obtain with no end in sight for centuries. Concrete evidence like skeletons displayed characteristics of strict equality of splitting up roles like hunting, gathering, and raising children [3]. These characteristics were not present in post-agricultural societies. In fact, the health of post-agriculture humans seemed much worse than the hunter-gatherer era equivalents.

Because of the random nature in agriculture, there was reasonable incentive to store and control the excess production. This abundance of food was the first instance of "capital," an accumulation of wealth [4]. The process of agriculture was heavily institutionalized and research shows that societies in this era who had more food surpluses tend to have higher levels of inequality [3]. It is no surprise that those in the higher tiers of the hierarchy who controlled the means the produce this early capital were the ones who benefitted the most from it. An example of this is that many skeletons of those at the top of the societal pyramid did not display the deterioration of health which their subjects did. Even in the earliest versions

of our society those who had the ability to use the technological innovation the most, like owning horses to plow the land or having slaves to work the farmland had a disproportionate share of the benefits.

Pre-Industrial Era

Recent discussion on inequality since the 2008 recession theorizes that economic growth itself as a factor in the increase of inequality. Data prior to the economy boom of the industrial revolution suggests otherwise however. Economic growth generally has three basic building blocks; productivity, capital, and labor [1]. Prior to technology that allowed workers to improve their productivity, labor and productivity were directly correlated with population growth and thus grew relatively slowly.

A study conducted from data of the Low Countries from the fourteenth to nineteenth centuries visualized data of economic growth and inequality in this time period. During this time, the technology of the world was relatively unchanging. Because of the lack of development, the nature of the economy in the pre-industrial era closely represented a zero-sum game. This means the number of resources in the world was constant, and one party gaining a part of the resource pie means another party is losing that piece. The aggregate data clearly displayed increasing inequality, especially in the two centuries prior to the industrial revolution [5]. The redistribution of wealth followed the classical hypothesis of wealth favouring capital over labor. The only events that seemed to signal decreasing inequality are large scale disasters like the Black Death. Laborers had much more value because of the Black Death removing a significant population of the workforce, but this value diminished over time until the industrial period. This piece of history is key to understanding technology can only be a part of growing inequality, as despite the lack of groundbreaking innovations in this era, economic inequality was still on the rise.

The Industrial Revolutions

The context in the industrial revolutions can have more significant insight as to how new expansive technologies affect economic inequality because of its recency and how it has shaped the modern era. Many ideas like neoliberalism and capitalism were solidified in numerous Western states in this period of time.

First Industrial Revolution

Stepping from the mostly agricultural societies, the first industrial revolution in the 18th to 19th centuries came with industry defining technologies like the steam engine and waterwheel. This marks the start of rapid industrialization around the globe [6]. This technology enabled productivity unlike anything seen before, allowing workers to exponentially increase their output per hour [7]. This also marked the

beginning of job replacement via automation with James Watt's steam engine. In 1764, Watt refined the steam engine to a point where it was able to power machinery consistently, and by 1770 it was being used to spin yarn on an industrial scale [8].

From this point onwards, an enormous variety of uses were found for these powerful new technologies and had an astounding effect on the agricultural industry especially. Naturally, many workers in industries that were being taken over by this technology like textile and yarn artisans protested against this industrialization, as it would essentially render their career obsolete. Though some jobs would be lost, the demand for mechanics to maintain the new machines increased, satisfying the theory that as technology replaces old jobs, it will create new and hopefully better jobs. This is the theory many economists would like to believe, but in reality, the factory working conditions were often extremely poor due to the dramatic increase of farmers migrating to factory jobs [9]. This induced supply of workers to satisfy the new demand came with 16-hour work days, low wages, dangerous working conditions with machinery, and a lack of worker rights. Note that this time period of around 1820 marks the clear rise of economic inequality as reported in the World Inequality Report [2], a lot of which is contributed to the colonialist nature of the empires back then.

Second Industrial Revolution

A second industrial revolution occurred around the period of 1870s to the beginning of World War I in 1914. The major technologies in this period were the widespread adoption of electricity and the combustion engine [6]. The key developments were mostly the expansion and development of existing industry using mass production and also the transition from steam to combustion power. The story here mimics the first industrial revolution with the steam mechanics transforming into electricians. The pattern of increasing economic inequality continued throughout this time period from the first industrial revolution until the start of the 20th century [2]. The end of this revolution is also known as the peak of Western imperialism where many powerful countries in Europe were rapidly increasing their influence over the periphery, especially in Africa. The dominance of the Western core over the periphery was halted because of World War I, which explains the change in global inequality starting from around 1920 [2].

From World War I until the next industrial revolution there would be an exceptional level of economic growth in the global North, while the global South was still dealing with the fallout of the two World Wars and numerous proxy wars. The wars gave incentive to innovate quickly to get ahead of the other side, and many technologies initially designed for warfare could be repurposed for civilian use. While global

inequality seems to slightly diminish, the inequality between countries was extremely apparent with the ratio of average income of the top 10% of countries to the bottom 50% nearly quadrupling [2].

Third Industrial Revolution

The 1980s marks the beginning of the digital revolution. The computer, the internet, many technologies part of our everyday lives began here. This time also marked the historic end of the Cold War, with the iron curtain collapsing throughout Europe by the end of the decade. With sophisticated computer programs, a much larger variety of jobs could be automated. And the mass production of more and more refined products was possible too. Again, while jobs may be rendered obsolete, it would create notable new ones like software engineers. Around 1980 also saw the trend of between country inequality decreasing as rapidly as it grew [2], likely because of international tensions easing up because of the end of the Cold War. Though the gap between the rich and poor countries was tightening, within country inequality which had almost halved since 1900 started to sharply rise once more, plateauing slightly nearing the present at late 19th century levels [2].

The Present: Fourth Industrial Revolution

The leading technology of today have led some to believe we are on the cusp of a fourth industrial revolution. The human ability to learn and have sentient thoughts is the last field that many experts believe could be automated by machines. Evidence for this may be breakthroughs in machine learning artificial intelligence, automation, and any other modern field of technology. Using the past as a prediction for the future we can imagine a future with many common jobs being replaced by technology, though some think that this time will be different than before.

Automation: The End of Labor Power?

Economists generally used say that as technology renders some jobs obsolete, it will create new and better jobs for the future [11]. History has fairly consistently shown this to be true. The invention of the steam engine came with the career of a mechanic, the widespread use of electricity brought the role of the electrician, and the popularity of the computer solidified the demand for computer scientists. The recent scare of AI automation replacing jobs reflects the mentality of workers in the previous industrial revolutions. Each time that technology has leaped in performance it allowed workers to increase their production with the same amount of labor, two of the main keys to economic growth. This effect has been especially pronounced from the start of the first industrial revolution until stagnating at about 1970. Clearly as technology improved drastically, the demand for labour also increased, thus increasing the

average income labourers earn. From income data we see this as the share of income going to middle-class workers increasing from 1920 to 1970 [2]. So now lies the question of what happened the 1970s that caused the stagnation of this pattern. Productivity has continued to grow consistently since then, but worker wages remained the same, even decreasing for a period of time, and today an average worker's pay, adjusted for inflation, is about the same as in 1970 [18]. Many factors could contribute to this phenomenon like overemployment, anti-worker policies, etc. But one is the other unmentioned core contributor of economic growth, capital.

With the rise of machines which require little to no supervision or maintenance to perform work, it creates a direct conversion from capital into productivity. You can imagine a job that used to require numerous factory workers to maintain a supply line for say, car parts, but then you design a set of machines to perform the same duty with only a large upfront cost and minimal maintenance cost. Compare this to workers which have a consistently growing maintenance cost and it is not hard to imagine why capital owners choose to install the former option. The data supports this theory as well, with a larger chunk of economic output going to the owners of capital during this period [12]. While the displacement of workers in the past was "acceptable" because of the labour-using nature of new technologies, this type of automation is really more labour-replacing than using. Studies have shown a real qualitative difference between AI automation and previous technologies which simply augmented the productivity of workers to increase their production output per labour hour [14]. The data shows that areas with robot automation exhibits negative effects on employment and wages which did not exist prior and areas without automation do not exhibit these traits [16].

Proponents for innovation and economic growth argue that the current landscape promotes skilled work like engineers or software developers to be able to create this variety of automation. While this may be true, the time and cost for workers to adapt to new technology has to come into consideration here. The cost of a post-secondary education has severely outpaced inflation, costing nearly five-times the amount it did in 1980 for private institutions. In fact, a key point left out of the historic discussion of job replacement is how difficult the adoption period is. The period of adjustment to new technologies after the industrial revolution is studied to be so long that most of the affected people would be long dead before they get to see the benefits [7]. A hypothesis could be that the benefits of this automation are not given to the workers at all, and in fact it may concentrate more wealth into the top firms because of what is called the superstar effect.

The Superstar Effect

One of the greatest benefits of AI automation, and possibly the most dangerous to economic equality is the superstar effect. Because of the ease of deployment of a digital technology once it has been developed, a few top performers may dominate their respective fields with no room for competition [11]. The labor share of a market is important because it represents the power which the workers have in a capitalist economic system. If the labor share is significant, the laborers' demands are more likely to be heard for issues like work safety, wages, and workers rights. Data has shown that as a superstar firm gains market share of an industry, the labor share of the industry falls in response [15]. It is not difficult to imagine that once a set of machines can do the job of an industry of lower skilled workers, it becomes next to impossible for these workers to compete against the productivity that can be acquired simply from the enormous amount of capital these firms accumulate.

The Covid-19 pandemic seems to have accelerated the reduction of labor power because of the shadow cost of proximity for many occupations [11]. Simply put, because of the rapid spread and potential damage Covid-19 has on a local area, the cost to have workers which need close proximity to each other is vastly increased (think max occupancy mandates, healthcare equipment, etc.). This only further incentivised the development of digital technologies to automate low skilled work to avoid this new "shadow cost." Though one might think that a global disaster that affects a large number of workers should provide incentive to increase protection of workers similar to times like the Black Death and the World Wars. In reality, the overall productivity ultimately did not drop significantly because of the virus [13], perhaps because of the slightly less malicious nature of Covid-19, the ability for some careers to work remotely, or the fact that many companies allow workers to keep working regardless of the pandemic. In any case, even skilled fields like the medical industry are not safe from automation superstars and while these innovations are no doubt an advancement of the industry, it is important to make sure the workers do not suffer because of them. More superstars will give more and more power to capital owners rather than labourers, which in turn shifts the focus to maximizing the effect on the market rather than focusing on the well being individuals. A strategy to make sure our work does not become outdated is to actively reskill ourselves through educational programs, alas this field has also been fraught with technological limiters.

Algorithms: Using Math to Perpetuate Inequality

Another widespread use of AI is for large data models which can identify patterns in vast datasets. These models can then be optimized towards a certain result to be able to predict the result of new data fed as

parameters. Models relevant to the magnitude of predicting the result of a basketball match given the team line ups and player history are fairly harmless, but as described in O’Neil’s book “Weapons of Math Destruction,” these models can be weaponized to bring suffering and oppression on an unprecedented scale. These such models are thus dubbed “Weapons of Math Destruction” or WMDs for short [18], and have the potential to perpetuate or even exacerbate existing inequalities in almost any industry.

Automation may cause inequality for those who lose their jobs from it, but what about those who do not? Many of today’s lower-skilled workers will typically be managed by AI algorithms rather than a human manager. A high-profile example would be Amazon workers. Employee surveillance is widespread in Amazon warehouses. Under the veil of “customer obsession” and “working hard,” warehouse employees are constantly monitored for performance, and this causes immense distress and anxiety [17]. Their work is simple to put into data, “how fast can you store and pack your assigned items?” With a simple statistic like items per hour, employees are forcibly made to work purely to meet the algorithms standard without regard to their physical condition, mental condition, or individual needs. Some deem this necessary to keep up with Amazon’s same day delivery promise which elevated their service to what it is today, but the cost is one of the highest employee turnover rates of any company [17]. The employees often feel immense pressure to keep working, foregoing any breaks to drink water, use the washroom, or anything else. This lesson is repeated constantly in O’Neil’s book. The nature of algorithmic management of treating people as numbers in a system, when in reality the system the model represents is so much more complex and requires delicate care to adapt to individuals, not just something you can accurately manage using proxy data. This sort of management also unnecessarily fosters animosity between coworkers to outperform each other in order to be chosen by the algorithm to receive more shifts or benefits. This results in more of a game to figure out the variables to game the algorithm to get ahead of others. Going back to the Amazon example again: Amazon delivery drivers have reportedly been hanging their devices on trees to increase their delivery speed, if only marginally, to gain any advantage against their own coworkers [17].

The world of machine learning models is vastly different based on your background. Those who have access to higher-level education reap the rewards that these algorithms bring in, but these rewards come at the cost of everyone who was not lucky enough and ended up on the other side.

The Algorithmic Digital Divide

While a higher-level education would bring the necessary skills to adapt to the supposed fourth industrial revolution, inequality has long plagued this system to favour the wealthy. Mentioned back in the

automation section of the current paper, tuition costs have skyrocketed at nearly four times the rate of inflation [18]. Not only that, the book “Weapons of Math Destruction” describes the self-fulfilling prophecy of the U.S. News using a model to rank schools (Chapter 3). The aforementioned insane tuition increases recently are a product of this system, because of the mass influence it has on schools to optimize their process towards the variables that the model is used to train on, the book mentions that because the already existing top schools can be very selective with candidates and charge large amounts of tuition, other schools will follow suit in an attempt to raise their rankings. This effect could be counter-acted if a government body helped support workers get a higher-level education in order to reskill the workforce, and to an extent, this is what loans are meant for.

Because of the absurd prices of post-secondary education, most of the population will have to rely on government loans, and the schools knew this. The student loan market was ginormous, and they needed funding from somewhere to be able to purchase all the fancy features the top schools had to be able to raise their ranking. This is one of many pernicious feedback loops caused by algorithms which affects the ability for less privileged individuals to climb the ladder. Not only are they ruining low-wage worker job environments, they have also been artificially increasing the barrier to entry to get over to “the other side.”

Maintaining the Status Quo

Another persistent theme in O’Neil’s book is the lack of readjustment causing WMDs. It is not hard to see that many important decisions have been plagued by human bias in the past. Neo-slavery was still ongoing for many decades after the Civil War and slavery was supposedly abolished. Since the data we feed into the model will be biased in some way, it should seem necessary to adjust the weights and variables when exceptions inevitably occur or the nature of the system has changed. This seldomly happens for systems managing large numbers though, as an example from the book points out: “The company may be satisfied with the status quo, but the victims of its automatic systems suffer [18].” While ignoring the outliers maximizes profit flow, the outliers in question are real people who may not even have an idea as to why a decision was made against them to get a job, receive a loan, or get a good insurance rate. The nature of the decisions made by these algorithms may even be illegal in some cases like the Kronos personality test [18], and are exceedingly difficult to judge because of the illusion of an objective decision based on computer calculations.

Big Data Overlords

It is no secret that large tech companies harvest an immense amount of data from its users, but it can be easy to underestimate the level of control this gives over the users of their platform. All the feeds we see on social media like Instagram and Facebook and all the advertisements places on our search engines are carefully constructed and optimized using the user's data. A ton of research in psychology and social science goes into see "what happens if we show this type of info to this type of user," and the kind of experiment can be conducted on a national or even global scale now. The only limitation being government regulation, which can also be affected using this type of targeted user content. The Cambridge Analytica scandal had potentially devastating effects on the 2016 United States election, yet the regulation today is still fairly loose when it comes to political targeting [18]. The data can be used to determine the user's political alignment, and they believe, and what it might take to change their behaviour, then using this data simply target similar users with ads, recommending media which might bring their opinion over the fence, and in the end can potentially swing elections. Research estimated a Facebook campaign increased voter turnout by an estimated 340 000 people [18]. While increasing voter turnout is innocent enough, the potential for another Cambridge Analytica remains entirely possible today.

Because of the massive amount of data these companies continuously harvest, the models can be continuously improved and rack in more profit over time. None of this benefit is seen by the owners of the data. With this kind of technology monopolies will naturally arise since the largest companies will have access to the most data, thus having the ability to create better models (relating back to the "superstar effect"). Even if an independent party gains some traction, they will typically be bought up because of the pure amount of capital the top players own; then acquiring the IP can further increase their dominance in the market.

Conclusion

History has consistently displayed the classic tale of the rich get richer, this time through technology. In all eras of technological development, from the agricultural revolution to machine learning AI, innovation has potential to be, or has been actively exploited by those in power. The recent rapid development of technology starting from the industrial revolution in 1820 improved living standards greatly, but left many workers stranded for large chunks of their life with little chance to catch up. Historical data of income from the World Inequality Report consistently had patterns which at least align with the development of technology. 1820 saw the start of increasing global inequality, especially between countries. Key factors of

this area are the Western colonization of Africa, mass production of many resources, and the rapid industrialization in the imperial core.

Newer technologies have brought new behaviours to the forefront recently. An unprecedented amount of data, programs that can perform intelligent tasks better than any human, and the dominance of the United States all affect the global inequality statistics. The story of companies disregarding their users, employees, and even the general public for profit is not a new concept, but the scale of which this is possible is absurd because of globalization. Automation is not just a performance enhancing tool for workers, but an active replacement of their work. Combine this with WMDs actively hindering the working class to reskill themselves with education, we can start to imagine how new technologies can be exploited by the ruling class. A handful of companies own data on billions of people around the globe, and none of them are being compensated for it. Some systemic issues will exist mostly independent of technological influence, but as our digital world being more and more sophisticated, we should proceed cautiously with what and how these should be regulated to preserve democracy.

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