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

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# Abstract

# 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 compared to the level it was it 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. 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 of 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 is 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 the 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 machine 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 included 16-hour work days, low wages, dangerous working conditions with machinery, and a lack of worker rights

### Second Industrial Revolution

* A second industrial revolution occurred around the period of 1870s to the beginning of World War I in 1914
  + Note that the start of the first industrial revolution up until the start of the 20th century saw a dramatic increase in global inequality [2]
* The major technologies in this period were the widespread adoption of electricity and the combustion engine [6]
  + These allowed for mass production in many industries like steel and oil

### Third Industrial Revolution

* The digital revolution
* Similar to others, need to complete later

### The Present: Fourth Industrial Revolution

The leading technology of today lead 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.

# 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 a worker’s average pay adjusted for inflation is about the same as in 1970 [13]. Many factors could contribute to this phenomenon, like overemployment, anti-worker policies, etc. But one is the other unmentioned factor of economic growth, capital.

With the rise of machines which require little to no supervision 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 machine (or 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].

* There are arguments to be made that this does create some jobs as you need engineers or software developers to create this variety of automation
  + Counter arguments can be the inflated cost of education in North America specifically
  + The number of jobs it creates is much less than it replaces
  + Areas with more robot automation have shown more negative effects on employment and wages which do not exist in areas without automation [16]
  + Once created a new automated technology for a certain job can easily replace the entire field with only high deployment costs
  + The benefits of this automation are not given to the workers at all, in fact it may concentrate more wealth into the top firms because of the superstar effect

## The Superstar Effect

One of the greatest benefits of AI automation, and arguably 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].

* Data has shown that as a superstar firm gains market share of an industry, the labor share of the industry falls in response [15]
* Lower skilled workers cannot compete against the productivity that can be produced simply from the huge amount of capital these firms accumulate
* Covid-19 seems to have accelerated the reduction of labor power because of the cost of proximity for many occupations [11]. Simply put, because of the rapid spread and potential damage covid-19 afflict to a local area, this increases the cost to have workers which need to have close proximity to each other
  + This further incentivised the development of digital technologies to automate low skilled work to avoid this new “shadow cost”
* 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

# Algorithms: Using Math to Perpetuate Inequality

Another widespread use of AI is for large data models which can identify patterns in these 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 like 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]. These models have the potential to perpetuate or even exacerbate existing inequality 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 the 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 timed 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 algorithmic overlord’s standards without regard to their physical or mental condition or individual needs.

* Because of same day delivery, employees feel immense pressure to keep working, foregoing any breaks to drink water, use the restroom, or anything else
* This is the nature of algorithm management; people are treated as numbers in a system when in reality the system the model is monitoring is so much more complex and required delicate care to adapt to individuals
* People will try to game the algorithm to get ahead of others
  + 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 everything 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.

* In the United States, tuition costs have skyrocketed at nearly four times the rate of inflation [18]
* The book “Weapons of Math Destruction” describe the self-fulfilling prophecy of using big data models to rank schools (the story of the U.S. News WMD, chapter 3)
  + The tuition rates are a product of this system, because of the mass influence it has on school to optimize their process towards the variables that the model used to train on
* Relating to the Amazon example, algorithms are ruining low-wage workers lives and the barrier to entry to get over to “the other side” has been artificially inflated using these models as well

## The Status Quo

* WMD perpetuate biases in the system which existed in the past since it makes the decision based on past data
* The owners of capital are the ones who can fund the creation of these models and they also choose what output determines success and what inputs to based that decision on

## Big Data Overlords

* Big data models are usually based on user data collected from everyday tasks
* The models can be continuously improved and rack in more profit
  + None of this benefit is seen by the owners of the data (in my opinion if a company collects data and profits from it, they should need to pay their users proportionally)
* Monopolies will naturally arise since the largest companies will have access to more data, thus have the ability to create better models perpetuating the “superstar effect”
  + Even if an independent somehow beats them to the punch, whoever has the most capital can acquire the IP and further increase their dominance in the market

# References

[1] Z. Qureshi, “Technology and the future of growth: Challenges of change,” Brookings, https://www.brookings.edu/articles/technology-and-the-future-of-growth-challenges-of-change/ (accessed Jul. 17, 2023).

[2] Chancel, L., Piketty, T., Saez, E., Zucman, G. et al. World Inequality Report 2022, World Inequality Lab.

[3] M. Davis, “How the Agricultural Revolution Made Us inequal,” Big Think, https://bigthink.com/culture-religion/what-started-poverty/ (accessed Jul. 22, 2023).

[4] D. Charles, “From cattle to capital: How agriculture bred ancient inequality,” NPR, https://www.npr.org/sections/thesalt/2017/11/15/564376795/from-cattle-to-capital-how-agriculture-bred-ancient-inequality (accessed Jul. 22, 2023).

[5] W. RYCKBOSCH, “Economic inequality and growth before the industrial revolution: the case of the Low Countries (fourteenth to nineteenth centuries),” European review of economic history, vol. 20, no. 1, pp. 1–22, 2016, doi: 10.1093/ereh/hev018 (accessed Jul. 22, 2023).

[6] “The stages of Industrial Revolution and its impact on Jobs,” Accountancy SA, https://www.accountancysa.org.za/the-stages-of-industrial-revolution-and-its-impact-on-jobs/ (accessed Jul. 22, 2023).

[7] N. Crafts, “Understanding productivity growth in the industrial revolution,” The Economic history review, vol. 74, no. 2, pp. 309–338, 2021, doi: 10.1111/ehr.13051 (accessed Jul. 22, 2023).

[8] Britannica, The Editors of Encyclopaedia. "Industrial Revolution Timeline". Encyclopedia Britannica, 25 Sep. 2020, https://www.britannica.com/summary/Industrial-Revolution-Timeline (accessed Jul. 22, 2023).

[9] E. Beck, “Working conditions in the Industrial Revolution,” History Crunch, https://www.historycrunch.com/working-conditions-in-the-industrial-revolution.html#/ (accessed Jul. 22, 2023).

[10] M. Y. Vardi, “What the Industrial Revolution really tells us about the future of automation and work,” The Conversation, https://theconversation.com/what-the-industrial-revolution-really-tells-us-about-the-future-of-automation-and-work-82051 (accessed Jul. 22, 2023).

[11] J. Mokyr, C. Vickers, and N. L. Ziebarth, “The History of Technological Anxiety and the Future of Economic Growth: Is This Time Different?,” The Journal of economic perspectives, vol. 29, no. 3, pp. 31–50, 2015, doi: 10.1257/jep.29.3.31.

[12] A. Korinek and J. E. Stiglitz, *“Covid-19 driven advances in automation and artificial intelligence risk exacerbating economic inequality,”* The BMJ, https://www.bmj.com/content/372/bmj.n367.full (accessed Jun. 22, 2023).

[13] “The productivity–pay gap,” Economic Policy Institute, https://www.epi.org/productivity-pay-gap/ (accessed Jul. 23, 2023).

[14] L. Karabarbounis and B. Neiman, The Global Decline of the Labor Share. Cambridge, Mass: National Bureau of Economic Research, 2013.

[15] David Autor and others, “The Fall of the Labor Share and the Rise of Superstar Firms,” The Quarterly Journal of Economics, Volume 135, Issue 2, May 2020, Pages 645–709, doi: 10.1093/qje/qjaa004

[16] D. Acemoglu and P. Restrepo, “Robots and Jobs: Evidence from US Labor Markets”, Cambridge, Mass: National Bureau of Economic Research, 2017.

[17] M. Walsh, “Algorithms are making economic inequality worse,” Harvard Business Review, https://hbr.org/2020/10/algorithms-are-making-economic-inequality-worse (accessed Jun. 22, 2023).

[18] C. O’Neil, Weapons of Math Destruction How Big Data Increases Inequality and Threatens Democracy. London: Penguin Books, 2018.