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The Impact of Historical and Ongoing Technological Advances on Economic Inequality

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Abstract
This research paper delves into the complex interplay between technological advancements and economic inequality. Tracing the evolution of the digital economy, the study highlights how emerging technologies like automation and artificial intelligence have reshaped and are still reshaping labour markets and exacerbating existing disparities. While acknowledging the efficiency gains that such technologies can bring, the paper explores how these benefits are not uniformly distributed across different strata of society, contributing to widening inequality both within countries and internationally. The paper serves as an exploratory look into how technological change impacts economic structures, inviting further discussion and research into this pressing issue.

Keywords: Economic Inequality, Technological Advancements, Digital Economy, Labor Markets, Disparities

I. Introduction

The 21st century has ushered in a period of rapid technological advancement, transforming the ways in which we understand and interact with the world around us. Devices like smartphones are no longer luxury items but everyday necessities, and artificial intelligence is not an abstract concept but an increasingly integral part of various industries and businesses. These advancements, while propelling unprecedented growth, innovation, and productivity also bring to the forefront complex challenges related to economic disparity. The rise of automation, and more recently, AI, in numerous sectors throughout history has introduced notable changes in employment patterns and distributional effects in the labour market.

Alan Turing's famous test in 1950 proposed a seemingly simple question whether a machine is intelligent: can it imitate a person so well that you can't tell it is one? Ever since, many researchers have been chasing this goal. In recent times, AI researchers and businesses especially have begun focusing on building machines to replicate human intelligence. However, while doing so, this obsession with mimicking human intelligence has led to AI and automation that often

simply replace workers, rather than extending human capabilities and allowing people to do new tasks.[1] If such an approach is true, could this potentially pave a pathway to further economic inequalities?

As we tread deeper into the 21st century, it becomes increasingly clear that technological change is an evolving continuum rooted in history. Rewind to the advent of the first industrial revolution, where the introduction of machinery began a shift in production methods and labour. Moving into the 20th century, the advent of the computer age simplified tasks that once seemed insurmountable or time-consuming. This trajectory of innovation has only accelerated. Fast forward a few decades, and now artificial intelligence is not only streamlining processes but also predicting, learning, and, in many ways, thinking.

However, as with all transformative shifts, there's a deeper narrative beneath the surface. Industries, once robust and teeming with workers, are able to automate processes, potentially leading to major shifts in labour demand. For example, e-commerce platforms powered by AI-driven recommendations have severely impacted employment. In an extreme case, Suumit Shah, founder of e-commerce platform Dukaan laid off 90% of its support staff due to chatbots, claiming it was in fact, 'necessary.'[2] Such shifts aren't just restructuring businesses but are possibly reshaping socio-economic constructs.

This research will assert that technological advancement is key to our evolving economy. It is a critical element influencing substantial changes, both positive and challenging. It introduces efficiencies, innovations, and novel opportunities but potentially exacerbate vulnerabilities as well, particularly for economies not prepared for rapid technological uptake or individuals with diverse skillsets and backgrounds. By delving deep into these dynamics, this thesis aims to explore the central question: "How have historical and ongoing advancements in technology, including artificial intelligence and automation, impacted economic inequality?"

II. Methodology

This research paper adopts a multi-method approach to explore the complex relationship between technological advancements and economic inequality. The methodology employed combines literature review, historical analysis, data analysis, and comparative analysis to provide a comprehensive understanding of how technology influences economic disparities.

Study Design

The paper follows a descriptive and analytical design that serves two main purposes: first, to document the historical relationship between technological advancements and economic inequality, and second, to analyze the impact of these advancements on various segments of society. The choice of this design was influenced by the need to not only present factual information but also to offer an interpretation that allows for a nuanced understanding of the complexities involved. Tracing the evolution of the digital economy from the First Industrial Revolution through the 20th century allows for a longitudinal perspective, facilitating a more complete understanding of the mechanisms driving economic inequality in the face of technological change.

[1] Rotman, David. 2022. "How to Solve AI's Inequality Problem." *MIT Technology Review.* April 19, 2022. https://www.technologyreview.com/2022/04/19/1049378/ai-inequality-problem/.

[2] Elimian, Godfrey. 2023. "As ECommerce CEO Replaces 90% of Staff with Bots, Are Fears of AI Taking over Jobs Coming True?" *Technext.* July 12, 2023. https://technext24.com/2023/07/12/ceo-cuts-90-staff-replace-with-ai-bots/

Data Collection

The primary method for data collection is an extensive literature review. This paper references a variety of sources, including academic articles, news pieces, historical records, existing debates, and external research papers. These diverse sources offer both qualitative insights and quantitative data. Additionally, specific statistical figures from reputable databases and reports have been incorporated to lend empirical weight to the arguments presented.

Data Analysis

Historical Analysis: A meticulous review of historical events and trends helps in understanding how technological advancements have shaped labour markets and contributed to economic inequality over various time periods.

Quantitative Data Analysis

The paper uses specific data points such as "Efficiency Levels in England (1700–1880)" and "Output per Worker and Real Wage in Britain" to analyze the impact of technology on economic outcomes. This adds an empirical layer to the research, complementing the qualitative analyses to offer a balanced presentation of research.

Comparative Analysis

The study compares different time periods and corresponding technological changes to understand their evolving impacts on labour markets and broader economic structures.

By synergizing these various methods of analysis, the research offers a multi-faceted view of the impact of technological advancements on economic inequality. This methodology aims to provide a balanced and comprehensive analysis, making the paper a substantive contribution to the existing body of knowledge on this topic.

III. Literature Review and Discussion

Historical Context and Background

A. The First Industrial Revolution: A New Mechanised Labour Force

Background

The evolution of labour markets has always been intricately tied to technological disruptions. Throughout history, the introduction of new technologies and methods has consistently reshaped how work is done, leading to both the obsolescence of certain jobs and the creation of new ones. The First Industrial Revolution was a significant turning point in this regard, spanning from approximately 1750 to 1830. Originating in England before spreading to continental Europe and America, this transformative era saw a decisive move away from the predominant Agricultural Revolutions which involved mainly handcraft.[3] Instead, the world began gravitating towards more efficient and stable manufacturing processes, from traditional manual production methods to the introduction and widespread adoption of machinery, bringing forward a new age of mechanised industry and change in skills.

The onset of the 19th century introduced significant advancements in the realm of mechanisation, with water and steam emerging as major sources of power. Central to this era, particularly in Britain, was the textile industry, which experienced a series of revolutionary changes. John Kay's invention of the flying shuttle in 1733, the spinning jenny in 1764 and the

[3] Academic Accelerator. n.d. "Industrial Revolution Encyclopedia, Science News & Research Reviews." https://academic-accelerator.com/encyclopedia/industrial-revolution.

water frame in 1769 just to name a few. Further, Thomas Newcomen's design, seen in the coal mines of regions like Lancashire and Yorkshire, was integral in extracting water from mines. This increased coal yield, which in turn fuelled more steam engines, epitomised the synergistic relationship between technological advancements and industrial productivity and expansion.[4]

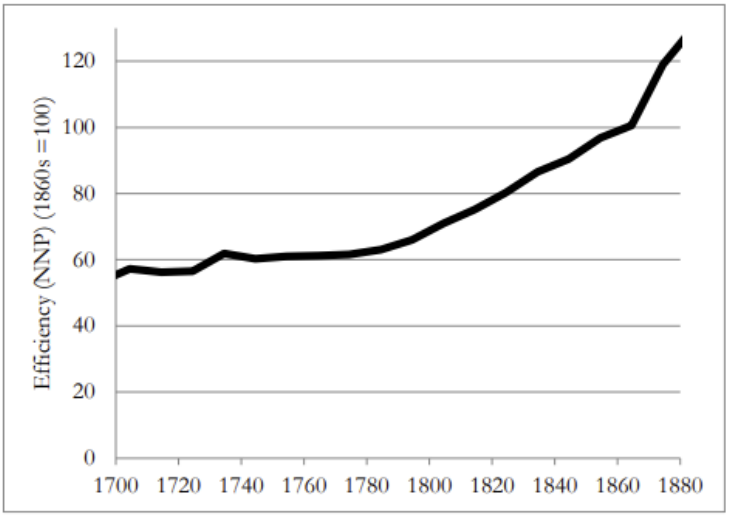

Figure 1: *Efficiency Levels in England (1700 – 1880)*[5]

Efficiency Gains through Mechanisation

While such innovations in machinery transformed industrial processes, substantial efficiency gains emerged. Specifically, during the period from 1780 to 1869, the textile sector emerged as the most prominent beneficiary, contributing a staggering 43% to the overall productivity growth. Meanwhile, the introduction of railways propelled the transport sector to account for 20% of the efficiency gains. Surprisingly, agriculture mirrored these advancements, also claiming nearly 20% of the productivity rise.[5]

So, while mechanisation enhanced efficiency, what did it mean for labour markets, wages, workers, and jobs?

[4] Engineering, Society for Industrial Management and. 2021. "Industrial Revolution 1.0 — Era of Mechanization." *Medium.* September 29, 2021. https://medium.com/spark-by-sime/industrial-revolution-1-0-9e6dc9c62c8c.

[5] Clark, Gregory. n.d. "The Industrial Revolution." *University of California, Davis.* https://faculty.econ.ucdavis.edu/faculty/gclark/papers/HEG%20-%20final%20draft.pdf.

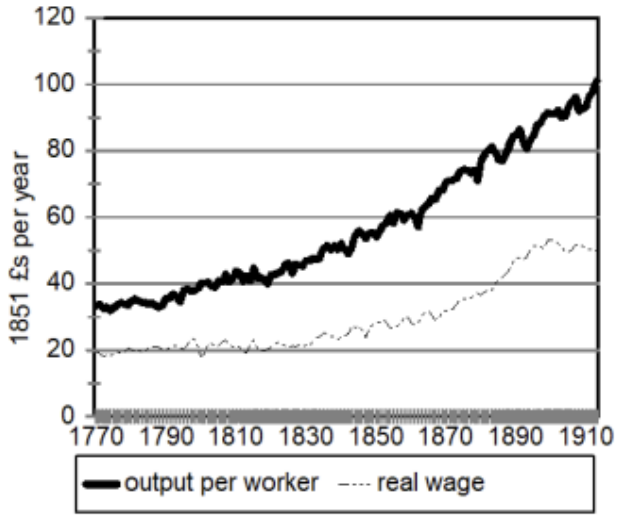

Figure 2. *Output per Worker and Real Wage in Britain*[6]

Productivity vs Wages Growth

The average worker, now equipped with the latest innovations (at the time), could produce a significantly higher amount of goods in a given timeframe. Consequently, the marked surge in "output per worker," reflects the newfound efficiencies brought about by mechanisation. Yet, as the productivity curve rose, the trajectory of real wages did not mirror this ascend between 1770 and 1830. Average real wages, in fact, remained relatively stagnant for a significant period.

Distributional Effects in the Labour Market

The rapid urbanisation that marked the era ensured a plentiful supply of workers. As towns grew into bustling cities, they attracted a vast number of individuals looking for work in new factories. Employers, bolstered by this abundance of willing labour, were able to keep wages relatively low. Factories became increasingly specialised and new roles emerged that demanded a specialised set of skills. Those with the capability to adapt, such as engineers and mechanics, found their wages and job prospects significantly improved.[7]

But what of those less adaptable? The plight of the handloom weavers serves as a cautionary tale. Once regarded as skilled artisans, they found their skills losing market value in the face of industrial-scale looms and spinning machines.[6] This nuanced shift in the job market was not without its critics. The Luddites, a group of textile artisans in the United Kingdom, embodied this resistance starting protests in around 1811. Workers sent threatening letters to employers and broke into factories to destroy the new machines, such as the new wide weaving frames. They also attacked employers, magistrates, and food merchants and fights often occurred between them and government soldiers.[8] For the Luddites, these new machines weren't just disruptive; they were seen as a direct assault on their way of life.

[6] Allen, Bob. n.d. "The Interplay among Wages, Technology and Globalisation: The Labour Market and Inequality, 1620–2020." *British Library.* Accessed June 23, 2023. https://www.bl.uk/britishlibrary/~/media/bl/global/social-welfare/pdfs/non-secure/i/f/s/ifs-the%20interplay-among-wages-technology-and-globalisation-21.pdf.

[7] Rafferty, John. 2019. "The Rise of the Machines: Pros and Cons of the Industrial Revolution." *In Encyclopedia Britannica.* https://www.britannica.com/story/the-rise-of-the-machines-pros-and-cons-of-the-industrial-revolution.

[8] Archives, The National. n.d. "The National Archives - Homepage." *The National Archives.* https://www.nationalarchives.gov.uk/education/resources/why-did-the-luddites-protest/.

Concluding Remarks

The First Industrial Revolution serves as an early example of how technological advancements can impact economic inequality: while overall productivity and economic growth may soar with technological advancements, the benefits are not evenly distributed. Some workers, particularly those with adaptable or specialised skills, may find new opportunities and higher wages. Others, however, may find themselves marginalised, their skills devalued, and their economic prospects dimmed. Further, the disconnect between rising output per worker and stagnant real wages serves as a significant indicator of how the benefits of increased productivity were distributed as well. While factories and owners saw enormous gains, the average worker did not proportionally benefit. As we consider the role of technological advancements in contemporary labour markets, we should remember that increased efficiency and output do not always automatically translate to improved benefits for all stakeholders.

B. 20th Century Tech Advancements

Background

Fast-forward to the 20th century, advancements in materials and technologies marked a departure from the First Industrial Revolution to the new "Technological Revolution." Steel supplanted iron, becoming the go-to material for infrastructure, enabling the railroad network to expand to 254,000 miles by 1916. Electricity replaced steam and waterpower, opening doors to a host of new inventions from household appliances to industrial machinery. The internal combustion engine, invented during this period, changed the face of transportation, paving the way for automobiles and airplanes. Further, Henry Ford's assembly line, introduced around 1913, transformed manufacturing, scaling up production and reducing costs. These technological shifts both evolved the labour market and changed the way society operated, setting the stage for further examination into the impact of technology on labour.[9]

Advancements in technology accelerated dramatically as the 20th century progressed, giving way to the "Digital Revolution". The transistor, introduced in 1947, was a pivotal invention that laid the foundation for advanced digital computers. By the 1980s, computers had moved from being specialised tools for government and industry to becoming a household staple. Around the same time, the first cell phones were introduced, signalling a shift in personal communication. By the 1990s, the World Wide Web had arrived, becoming an integral part of business operations by 1996. The decade saw a convergence between websites and mobile technologies. changing how we consume media and use business applications.[10]

Globalisation and Interconnectivity

The technologies that emerged during the Technological Revolution were intricately linked, creating a network of interconnected systems that transformed society. The expansion of railroads both moved people and goods and facilitated the rapid deployment of telegraph lines. Television also transitioned from analogue to digital signals. In the 2010s, the internet was accessible to over 25% of the global population, and almost 70% owned a mobile phone. Cultural historian Stephen Kern described this transformative period as the "annihilation of distance," as these innovations extended the scope of human interaction from local to national and even international scales.[9] The result was a new tempo of life and work, as well as a sense of global interconnectedness. These systems allowed for a new dynamic in labour and capital allocation across regions, affecting economies in different ways.

[9] Engineering, Society for Industrial Management and. 2021. "Industrial Revolution 2.0 — Era of Mass Production." *Medium.* July 16, 2021. https://medium.com/spark-by-sime/industrial-revolution-2-0-era-of-mass-production-594acfa228c6.

[10] Techopedia. 2019. "What Is the Digital Revolution? - Definition from Techopedia." *Techopedia.* 2019. https://www.techopedia.com/definition/23371/digital-revolution.

Social and Economic Impacts

After discussing the technological milestones and their effects on the world, the socio-economic impacts of these advancements must be considered as well. Specifically, this section will focus on how technology influences economic inequality and employment in the 20th century.

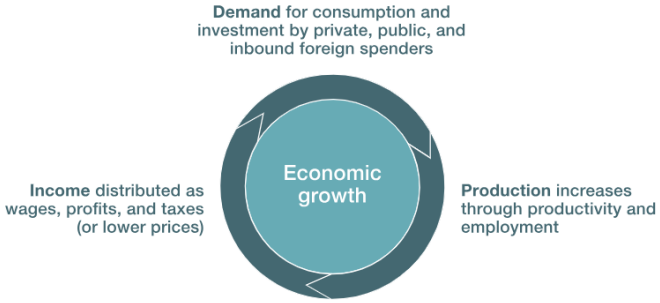

Figure 3: *Virtuous cycle of increases in demand, production, and income*[11]

Productivity and employment

Building on the productivity patterns established during the first industrial revolution, recent technological advancements have had varying but significant effects on job displacement. A virtuous cycle unfolds: technological innovations boost productivity, which lowers the cost of goods, which in turn, increases demand, ramping up production and eventually creating more jobs. According to data since 1960, in the United States, productivity and employment have grown in tandem 79% of the time within individual years. On a longer time frame, such as over five or ten years, there are virtually no instances where productivity increases while employment falls. Importantly, due to globalisation this correlation between productivity and employment growth was observed not just in the United States but also in countries like China, Germany, and Sweden.[11]

Skilled vs Unskilled Workers Debate

As was evident during the initial industrial revolution, heightened productivity did not necessarily result in equitable gains for everyone. Likewise, skill level remained a critical determinant in shaping workers' earnings and career prospects throughout the 20th century.

[11] "What Can History Teach Us about Technology and Jobs?" 2018. *McKinsey & Company.* 2018. https://www.mckinsey.com/featured-insights/future-of-work/what-can-history-teach-us-about-technology-and-jobs.

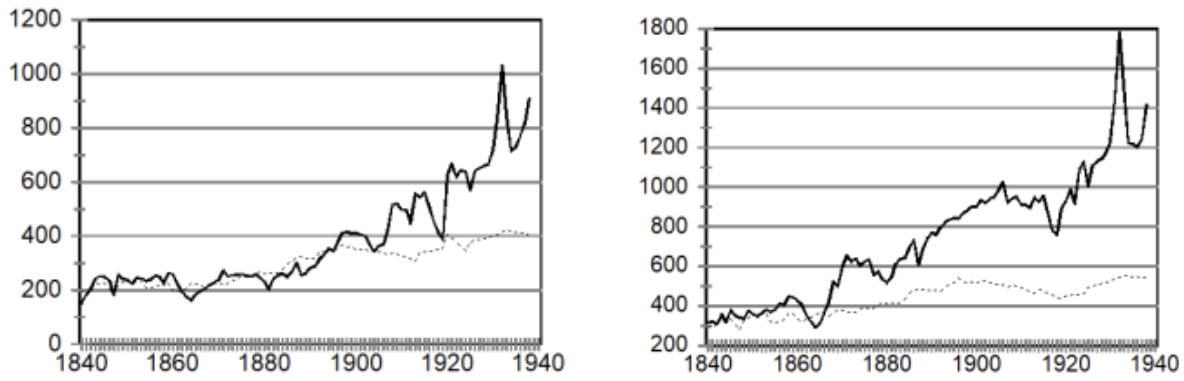

Figure 4: *Unskilled Real Wages (Left) vs Skilled Real wages (Right) in 1905 British Pence*[6]

While it may seem that the shift from skilled to semi-skilled jobs would suppress wage growth, the booming expansion of the manufacturing sector more than compensated by driving up the demand for skilled labour. Concurrently, mechanisation of material transport led to the elimination of low-skill labouring jobs, elevating the average skill level across the board. This mechanisation and the resultant rise in labour productivity intensified competition among firms for workers, which translated into an increase in real wages. Furthermore, up until World War I, unskilled wages were strikingly similar between the UK and the US.[6] However, the period following the Civil War and especially after World War I saw wages in the U.S. pull dramatically ahead, establishing a considerable gap by the end of the nineteenth century. By 1940, U.S. factory workers and unskilled labourers were earning 25-50% more than their skilled counterparts in Britain.[6] This disparity can be attributed, in part, to the U.S.'s quicker adoption of technological innovations and mass production techniques, which gave American firms a competitive edge in labour productivity and consequently wage levels. Yet, the early U.S. economy was not uniformly advantageous for all workers; unskilled labourers often earned just half of what skilled craftsmen and mechanics made, with nearly 40 percent of urban workers comprising low-wage labourers and seamstresses who lived in less-than-ideal conditions.[12]

Skilled vs Unskilled Workers Debate: Role of Technology

Henry Ford's perspective on technology's influence on labour serves as a meaningful counterpoint to popular discourse. The general concern is that technology would devalue or make obsolete unskilled labour; however, Ford argued that it's not about elimination but transformation. Technology doesn't devalue skill; it redistributes it, especially toward management and planning roles. In essence, as technology advances, the skill sets required for labour shift. While certain manual jobs may diminish or be altered by automation, new types of skilled roles emerge, even in the early 20th century. For instance, there's a growing need for personnel who can manage complex systems, understand data analytics, and implement strategic planning. These roles may not require the same skills as traditional factory work, but they are skills, nonetheless. This shift has complex implications for both skilled and unskilled labour markets. On one hand, unskilled labourers may find fewer job opportunities in traditional sectors, requiring them to acquire new skill sets for employment. On the other hand, those with skills in management, planning, and data analysis may find more lucrative opportunities, potentially exacerbating income inequality.

[12] U.S. Department of State. 2019. "Outline of the U.S. Economy." Usembassy.de. 2019. https://usa.usembassy.de/etexts/oecon/chap9.htm.

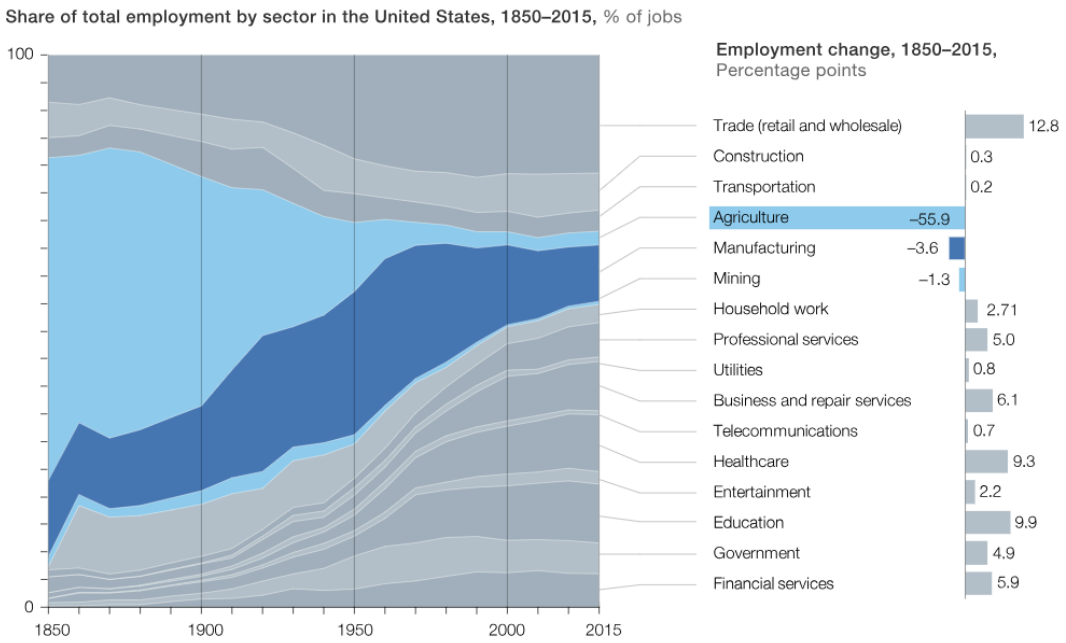

Figure 5: *Historical Employment and Sector Shifts*[11]

In examining the historical shifts in labour sectors from 1850 to 2015, a clear transition from agrarian to service-oriented economies is evident. This transformation is reminiscent of earlier industrialisation periods, where new forms of labour-saving technologies led to a decline in traditional roles but also gave birth to entirely new sectors. The decline of 55.9% in agriculture and 3.6% in manufacturing highlight the adaptability of labour markets and the potential for skill shifts over time. Interestingly, the data reveals growth in trade, healthcare, and financial services, indicating that as some sectors decline, others rise to fill the void.

This echoes earlier observations about how technological advancements not only displace existing jobs but also create new types of employment, often requiring different skill sets. Yet, the speed and equity of these transitions is under debate. While some argue that the rate of change is consistent with historical patterns, this assertion is laden with uncertainty.

C. Comparative Analysis of the Revolutions

The different historic revolutions significantly shaped labour markets, exhibiting recurring patterns in productivity, wages, skill shifts, and employment opportunities that offer insights for understanding future technological impacts on work and inequality.

Firstly, both revolutions led to significant increases in productivity. The First Industrial Revolution was focused more narrowly on the textile industry and mechanisation, revolutionising the way goods were produced. However, the gains in productivity didn't correspond with a significant rise in real wages for the average worker. During the Second Industrial Revolution, the improvements in manufacturing and transportation resulted in a much broader and quicker economic expansion. Unlike its predecessor, this period saw productivity and average wages grow more or less in tandem, particularly in industrialised nations.

Secondly, the skill sets required for work underwent transformational shifts during both eras. The First Industrial Revolution necessitated basic literacy and numeracy, as workers had to read and follow basic machine operations. On the

other hand, the Second Industrial Revolution called for specialized skill. This trend indicates a progressive increase in the complexity of skills demanded by labour markets.

Thirdly, both industrial revolutions shared the paradoxical role of being both a disruptor and a creator in the labour market. The First Industrial Revolution led to job losses in artisanal and agricultural sectors but created new roles in factories. The Second had similar disruptive effects, particularly in manual and low-skilled jobs, but it also introduced new sectors and roles that had not existed before.

Overall, while the First and Second Industrial Revolutions differed in many aspects, their impacts on labour markets reveal recurring themes: increases in productivity, evolving skill requirements, sectoral shifts in employment, and the dual role of technology. These recurring patterns provide a nuanced framework for evaluating how current technological advancements, such as AI and automation, may shape the future of labour.

IV. The Modern Age: A Focus on AI, Algorithms, and Automation

A. The AI Revolution

Modern Advancements

Artificial Intelligence (AI), a concept initially inspired by Alan Turing and formally conceptualised in the late 1950s, had the goal of mimicking human-level intelligence, commonly referred to as "human-imitative AI."[13] Initially, the focus was on higher-level cognitive capabilities like reasoning and thought, distinct from other fields like operations research and control theory that were inspired by animal behaviour or low-level signals. Despite the initial focus, AI evolved to specialise more in low-level pattern recognition and movement control, disciplines closely tied to fields like statistics and engineering.[13]

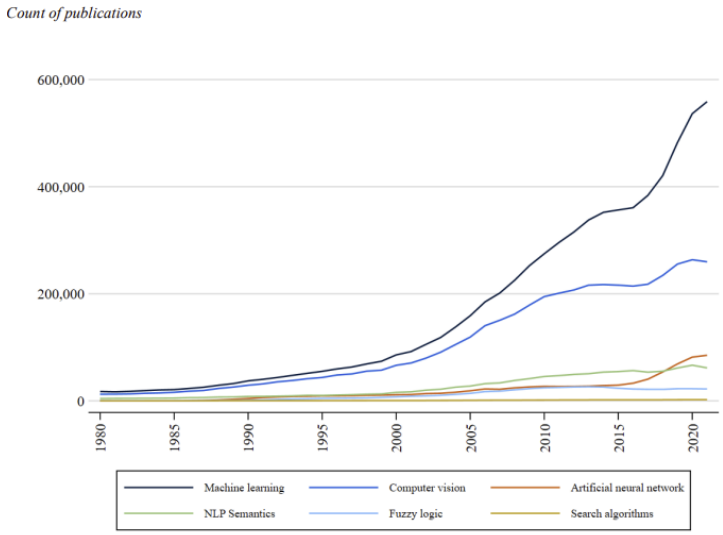

Figure 6: *AI research publications by topic, 1980-2021*[14]

AI's strength primarily lies in machine learning, a subset focusing on designing algorithms that iteratively build analytical models from new data and making predictive analyses. Machine learning has been the leading area of AI research since

[13] Jordan, Michael I. 2019. "Artificial Intelligence—the Revolution Hasn't Happened Yet." Issue 1 1 (June). https://doi.org/10.1162/99608f92.f06c6e61.

[14] The White House. 2022. "THE IMPACT of ARTIFICIAL INTELLIGENCE on the FUTURE of WORKFORCES in the EUROPEAN UNION and the UNITED STATES of AMERICA." https://www.whitehouse.gov/wp-content/uploads/2022/12/TTC-EC-CEA-AI-Report-12052022-1.pdf.

the 1980s and its applications have substantially grown over the last decade. Technologies ranging from music recommendation systems to automated language translation and targeted advertising rely on machine learning algorithms for their functionality. These developments have been critical in the success of major tech companies like Google, Netflix, and Amazon, and their applications extend to areas such as document retrieval, text classification, and social network analysis.[13]

B. Existing Debates, Arguments, and Insights

The Case for Technological Unemployment

Technology has been historically known to put workers' jobs in fear, and in the case of AI and automation, it could be even scarier. Goldman Sachs' research suggests that two-thirds of American occupations are exposed to some level of automation, with a potential impact on 300 million jobs globally.[15] A Challenger job report revealed that as recently as May 2023, 3,900 jobs were eliminated due to AI. Similarly, companies like IBM and British Telecom have announced significant job cuts attributable to automation, with the latter planning to replace more than 10% of its workforce with AI by 2030.[16] However, the work of Acemoglu and Restrepo adds nuance to these alarming figures. According to their research, introducing one additional robot per 1,000 workers might decrease the U.S. employment-to-population ratio by just 0.37% and lower wages by a range of 0.25% to 0.5%.[16] This suggests that while automation does pose some risks to employment and wages, the impact may be more complex and less catastrophic than initially thought.

Despite the concerning headlines, other analyses argue that the fears may be overblown. The World Economic Forum predicts that AI could actually result in a net increase in jobs by 2025.[17] Lawrence and Arntz support this more optimistic view, emphasising AI's potential for "creative destruction" in the labour market.[17] They argue that automation is likely to transform rather than eliminate jobs. Arntz for example, estimates that only 9% of jobs in the UK are highly susceptible to automation in the next decade, proposing that job transformation rather than job elimination is the more probable scenario.[17] Moreover, OECD findings suggest that the "AI revolution" has yet to make a significant dent in overall employment. Despite identifying that 27% of jobs could be at high risk of automation, the OECD notes that there's little current evidence of AI substantially impacting jobs.[18] Additionally, a survey from the same organisation found that among workers already using AI, two-thirds reported that automation made their jobs less dangerous or tedious.[18]

This growing body of research highlights the complexity of AI's impact on employment. While there is a possibility towards automation replacing certain types of jobs, the overall impact is far from settled. The real challenge is to understand how AI and automation affect wages and productivity, and how these changes intersect with existing disparities in skill demand and educational levels to influence economic inequality.

Income Inequality: The Disconnect Between Wages and Tech Productivity

In recent years, the relationship between productivity and wages has garnered significant attention, especially in the context of technological advancements and automation. Historically, increased productivity was synonymous with rising wages. However, this correlation has weakened considerably in the past few decades, and the implications are profound

[15] Gow, Glenn. 2023. "ChatGPT and Generative AI: What to Do with All the Productivity?" *Forbes.* July 2, 2023. https://www.forbes.com/sites/glenngow/2023/07/02/chatgpt-and-generative-ai-what-to-do-with-all-the-productivity/?sh=38b735913edc.

[16] Gries, Thomas, and Wim Naudé. 2018. "Artificial Intelligence, Jobs, Inequality and Productivity: Does Aggregate Demand Matter?" *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3301777.

[17] Ilzetzki, Ethan, and Suryaansh Jain. 2023. "The Impact of Artificial Intelligence on Growth and Employment." *CEPR.* June 20, 2023. https://cepr.org/voxeu/columns/impact-artificial-intelligence-growth-and-employment#:~:text=The%20World%20Economic%20Forum%20concluded.

[18] Reuters. 2023. "27% of Jobs at High Risk from AI Revolution, Says OECD." *Reuters,* July 11, 2023, sec. Technology. https://www.reuters.com/technology/27-jobs-high-risk-ai-revolution-says-oecd-2023-07-11/.

for income distribution and economic equality. Since the 1970s, a chasm has grown between productivity and wages, culminating in what economists call the "decoupling" phenomenon (this refers to the gap between productivity growth and wage growth for the typical worker, not the average wage, which could include high earners and skew the results). Between 1973 and 2011, worker productivity grew by an astounding 80%, yet median hourly compensation after adjusting for inflation only grew by a tenth of that amount.[19] A study from the Economic Policy Institute reports that from 2000 to 2011, while the American economy expanded by over 18%, the median income for working-age households declined by 12.4%.[19]

Technology plays a dual role in this trend once again. While it contributes significantly to productivity, it also allows companies to cut labour costs, contributing to income inequality. A study co-authored by MIT economist Daron Acemoglu estimates that technological replacement of workers "explains 50 to 70%" of the rise in inequality from 1980 to 2016. Self-checkout machines in retail settings are a prime example.[20] They may not bag groceries more effectively than human clerks, but they do allow companies to spend less on labour.[20]

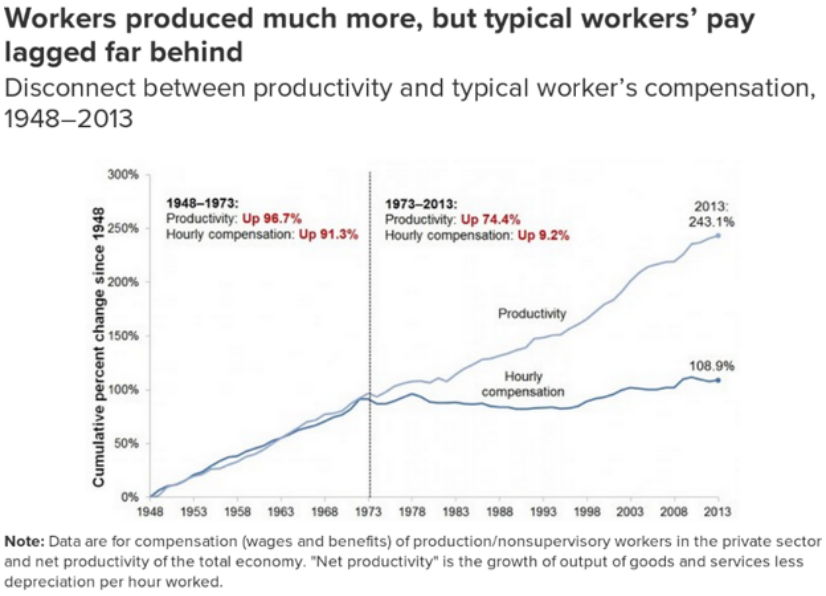

Figure 7: *Disconnect between Typical Worker's Compensation, 1948 - 2013*[21]

Wage stagnation is another concern. Corporations like Caterpillar, once icons of American industry, have reported record profits but insist on wage freezes for blue-collar workers.[21] Part of this trend can be attributed to outsourcing, where jobs are shifted overseas to cut costs, benefiting corporate bottom lines at the expense of domestic wages.[21] Not everyone has been equally affected by these changes. Data indicates that the share of wages going to the top 1% increased to 12.9% in 2010, up from 7.3% in 1979.[19] Overall, during the period 1979–2013 the top 1% of the population enjoyed a wage growth of 138%, while the bottom 90% of people only experienced a wage growth of 15% which should have grown 32% if wages grew evenly across all circles. Erik Brynjolfsson, an economics professor at MIT, notes, "There is no economic law

[19] Greenhouse, Steven. 2013. "Our Economic Pickle." The New York Times, January 12, 2013, sec. *Sunday Review.* https://www.nytimes.com/2013/01/13/sunday-review/americas-productivity-climbs-but-wages-stagnate.html.
[20] "Automation Drives Income Inequality." 2023. MIT Technology Review. February 21, 2023. https://www.technologyreview.com/2023/02/21/1067563/automation-drives-income-inequality/.
[21] Progresa. 2020. "Technology Won't Help Labourers: The Real Cause behind Wage Stagnation." Medium. November 22, 2020. https://progresaid.medium.com/technology-wont-help-labourers-the-real-cause-behind-wage-stagnation-f6811f9be89d.

that says technological progress has to benefit everybody or even most people."[21] This unequal distribution is problematic because it undermines the assumed societal contract where productivity gains lead to widespread economic improvement.

Skill and Educational Disparities

The labour market's increasing polarisation into low-skilled and high-skilled jobs has been a subject of much concern, particularly as middle-skilled roles continue to decline. This polarisation has been significantly influenced by technological advancements, especially computing and AI.[17] Autor's findings suggest a nuanced picture where not all low-and-medium-skilled jobs are at risk. For example, roles in healthcare and human services that require emotional intelligence and nuanced decision-making are less susceptible to automation. On the bright side, certain high-skilled but routine tasks, like data analysis, might easily be automated, adding another layer of complexity to the job market.[17]

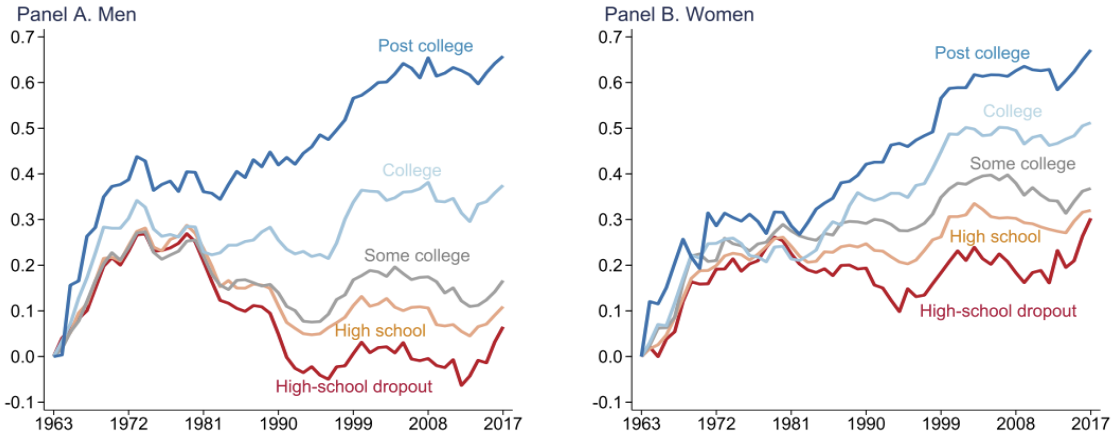

Figure 8: *Cumulative growth of real hourly wages by gender and education*[22]

The impact of automation is particularly striking when examining real wages in relation to educational attainment. In the United States, men without a high-school degree have experienced a significant decline in real wages, which are now 15% lower than they were in 1980. This trend contrasts with the wage gains seen among individuals with post-graduate degrees.[22] In this scenario, educational attainment serves not just as a marker of skill but as a predictor of financial stability and, more broadly, economic inequality.

Skillset Demands in a Changing Labour Market

Technological advancements have not only led to job displacement but also changed the types of skills that are in demand. The falling costs of carrying out routine tasks with computers have created an increasing demand for more abstract and creative services. This shift is observable in multiple sectors, from law to business management.[23] For example, the advent of text and data mining technologies has revolutionised legal research, significantly boosting the productivity and consequently the wages of legal professionals. Similarly, real-time market information has made managerial decision-making more efficient.[23]

[22] Acemoglu, Daron, and Jonas Loebbing. 2022. "Automation and Polarization." SSRN Electronic Journal. https://doi.org/10.2139/ssrn.4238255.
[23] Benedikt, Carl, and Michael Osborne. 2013. "The Future of Employment Published by the Oxford Martin Programme on Technology and Employment." https://www.oxfordmartin.ox.ac.uk/downloads/academic/future-of-employment.pdf.

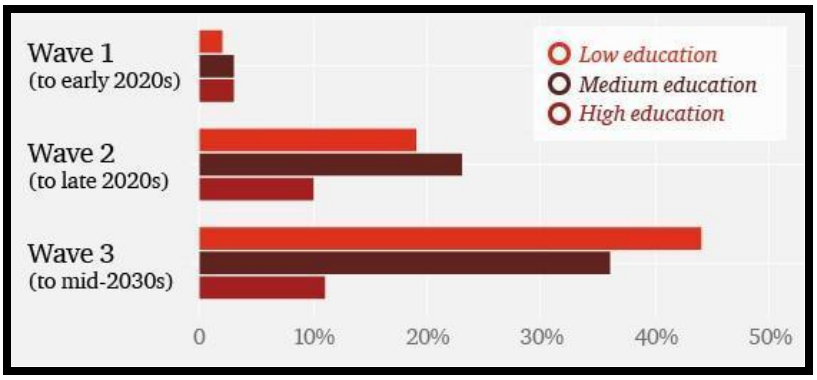

Figure 9: *Job Automation Risk Based on Education Level*[24]

The Role of Education and Retraining Programs

To navigate these complex shifts in labour market demands, retraining and educational programs will be vital. Current evidence suggests that while the short-term impact of automation is relatively low across all education levels, the long-term picture is much more concerning for those with lower educational backgrounds.[24] This makes a strong case for proactive collaboration between governments and businesses to create retraining programs. A culture of adaptability and lifelong learning, emphasising both STEM and soft skills, will be critical in preparing the workforce for the volatile demands of a technologically driven economy.[24]

Overall, the evolving landscape of automation and technology is reshaping labour market dynamics, placing a premium on high-skilled labour while marginalising low-skilled roles. This transformation emphasises the link between educational attainment and economic stability, making it imperative to address skill-set demands through targeted retraining and educational programs. These programs will need to foster both specialised skills and adaptability to prepare the workforce for a future defined by technological fluidity.

Potential Efficiency and Economic Gains

Despite fears over job displacement, sluggish growth and socio-economic disparities, the potential for AI is promising in terms of efficiency and economic growth. Generative AI technologies in particular such as ChatGPT, have shown remarkable potential in this way. A study by the National Bureau of Economic Research reveals that the introduction of generative AI can lift workforce productivity by an average of 14%, with some companies even reporting spikes of up to 400%.[15] In the customer care sector, McKinsey estimates that the application of generative AI could elevate productivity rates by as much as 45%. This dramatic improvement is largely attributed to AI's capacity to grasp customer intent and sentiment, streamlining problem-solving processes for customer service personnel.[15] In the software development sector, 88% of software coders experienced an uptick in productivity when utilising generative AI tools.[15] These systems are adept at automating mundane tasks such as inserting boilerplate code snippets and scrutinising human-generated code for bugs or security vulnerabilities. The technology also takes over the time-consuming task of software documentation, which allows human coders to focus on more high-level, creative aspects of programming. Further with its ability to process and analyse enormous volumes of data, it has the potential to boost the efficiency of business operations too. The McKinsey Global Institute predicts that around 70% of companies will adopt at least one type of AI technology by 2030, and less than half of large companies may use the full range of AI technologies. Price Waterhouse Coopers predicts that AI could increase global GDP by 14% in 2030.[17]

[24] PwC. 2018. "How Will Automation Impact Jobs?" PwC. 2018. https://www.pwc.co.uk/services/economics/insights/the-impact-of-automation-on-jobs.html.

AI and Geopolitical Inequality

However, another glaring divide lies in the existing technological capabilities and the capacity for future investment. For instance, the United Kingdom's planned $130 million investment in AI chips is not just a national endeavour but a strategic move to secure the country's position in the global tech hierarchy.[25] Contrast this with Germany, which is allocating nearly a billion euros over the next two years to catch up with AI leaders like China and the United States.[26] These investments are made in the context of already mature tech ecosystems, with firms and educational institutions that can rapidly adapt to and integrate new technologies. On the other side of the spectrum, developing countries face a daunting reality. In fact, only 0.4% of total employment in low-income countries is at risk of automation, compared to 5.5% in high-income countries.[27] This may seem like a saving grace for developing nations, but it could be seen as an indicator of how far behind they are in technological adoption. The opportunities for growth and development through technology that were available to the United States and China in their formative years are not the same for countries like Cambodia and Tanzania today.[28]

Moreover, the dynamics of global capital investment are also shifting due to AI. High-income countries, which are already using AI more intensively due to their higher labour costs, are likely to see a surge in investment aimed at further automation and AI integration.[28] This draws capital away from developing nations, where it might otherwise have been invested in labour-intensive industries. Over time, this divergence in investment exacerbates existing inequalities, as the rich countries get richer, and the poor one's struggle to even maintain their economic position. Furthermore, in developed countries, where there's a higher percentage of skilled labour, AI acts as a tool that augments human capabilities. It makes jobs more efficient without necessarily eliminating them. On the other hand, in developing nations, AI threatens to replace unskilled labour, overturning one of the few competitive advantages these economies have.[27]

AI has the potential to exacerbate existing inequalities between nations. The differing capacities for AI investment, the divergence in technological adoption, and shifts in investment and production have created an environment where advanced economies are likely to benefit more than developing ones. The onus is on policymakers globally to ensure that the technology serves as an equaliser rather than a divider.[27]

C. Future Concerns: Can Economic Inequality Be Mitigated in a Technological Age?

The question of economic inequality in the technological age is a pressing issue that defies simplistic solutions. The gap between the rich and poor is widening, and there is an increasingly urgent need to examine the role that technology plays in this divide. Specifically, how can we ensure that the benefits of technological advancements, often enjoyed by a privileged few, can be more evenly distributed? This is not just a policy question but also a moral and ethical dilemma that intersects with society.

[25] COGHLAN, JESSE. 2023. "UK to Spend $130M on AI Chips amid Scramble to Buy up Computing Power." Cointelegraph. August 21, 2023. https://cointelegraph.com/news/rishi-sunak-buy-ai-chips-in-race-for-computing-power.

[26] Escritt, Thomas. 2023. "Germany Plans to Double AI Funding in Race with China, U.S." Reuters, August 23, 2023, sec. Technology. https://www.reuters.com/technology/germany-plans-double-ai-funding-race-with-china-us-2023-08-23/?utm_source=www.neatprompts.com&utm_medium=referral&utm_campaign=germany-invests-1b.

[27] "Generative AI Likely to Augment rather than Destroy Jobs." 2023. ILO. August 21, 2023. https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_890740/lang--en/index.htm.

[28] Alonso, Cristian, Siddharth Kothari, and Sidra Rehman. 2020. "How Artificial Intelligence Could Widen the Gap between Rich and Poor Nations." IMF. December 2, 2020. https://www.imf.org/en/Blogs/Articles/2020/12/02/blog-how-artificial-intelligence-could-widen-the-gap-between-rich-and-poor-nations.

Addressing economic inequality in the age of technology requires a multi-pronged approach that involves governments, businesses, educational institutions, and society at large. Governmental solutions like progressive taxation and universal basic income may help redistribute wealth but raise questions about their impact on work ethic and innovation. Businesses, especially in tech, hold significant wealth and could collaborate with governments on retraining programs, but the effectiveness and fairness of such partnerships remain contentious. Education can adapt to future skill demands, but the slow pace of curriculum reform and the uncertainty of future needs present challenges. Finally, societal values must evolve to emphasise collective well-being over individual success, a change that would require deep cultural shifts. Each of these elements presents its own sets of opportunities and challenges, making the issue complex and ongoing.

V. Conclusion

The exploration conducted in this research reveals a complex landscape where technology acts as both an enabler and a divider. On one hand, it holds the potential to revolutionise productivity and economic prospects. On the other, it stands to widen the chasms of inequality, be it in terms of skill, education, or geographic location. The key takeaway is that while technology serves as a catalyst for economic activity, it does not inherently assure equitable distribution of its benefits but certainly has the potential to do both with appropriate use and management.

As we contemplate the evolving role of technology in shaping economic inequality, it’s crucial to consider the factors that could steer this trajectory toward more equitable outcomes. While technology's promise for economic expansion is undeniable, as demonstrated by potential leaps in workforce productivity and global GDP, it also reveals an urgent need for adaptive public policy that is both global and granular in its approach. Retraining programs and educational reforms are essential but perhaps insufficient; they must be thoughtfully paired with policies that address wage stagnation and wealth concentration. Geopolitically, the disparate impacts of AI investment and adoption raise questions of equitable technological diffusion, requiring international collaboration to prevent the widening of global economic divides. The topic of economic inequality in the technological age is nuanced and multi-faceted. Nonetheless, the debate needs to be ongoing and adaptive, given the relentless pace of technological change.

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References

Academic Accelerator. "Industrial Revolution Encyclopedia, Science News & Research Reviews," n.d. https://academic-accelerator.com/encyclopedia/industrial-revolution.

Acemoglu, Daron, and Jonas Loebbing. "Automation and Polarization." SSRN Electronic Journal, 2022. https://doi.org/10.2139/ssrn.4238255.

Allen, Bob. "The Interplay among Wages, Technology and Globalisation: The Labour Market and Inequality, 1620–2020." Accessed June 23, 2023. https://www.bl.uk/britishlibrary/~/media/bl/global/social-welfare/pdfs/non-secure/i/f/s/ifs-the%20interplay-among-wages-technology-and-globalisation-21.pdf.

Alonso, Cristian, Siddharth Kothari, and Sidra Rehman. "How Artificial Intelligence Could Widen the Gap between Rich and Poor Nations." IMF, December 2, 2020. https://www.imf.org/en/Blogs/Articles/2020/12/02/blog-how-artificial-intelligence-could-widen-the-gap-between-rich-and-poor-nations.

Archives, The National. "The National Archives - Homepage." The National Archives, n.d. https://www.nationalarchives.gov.uk/education/resources/why-did-the-luddites-protest/.

Benedikt, Carl, and Michael Osborne. "The Future of Employment Published by the Oxford Martin Programme on Technology and Employment," 2013. https://www.oxfordmartin.ox.ac.uk/downloads/academic/future-of-employment.pdf.

Clark, Gregory. "The Industrial Revolution." University of California, Davis, n.d. https://faculty.econ.ucdavis.edu/faculty/gclark/papers/HEG%20-%20final%20draft.pdf.

COGHLAN, JESSE. "UK to Spend $130M on AI Chips amid Scramble to Buy up Computing Power." Cointelegraph, August 21, 2023. https://cointelegraph.com/news/rishi-sunak-buy-ai-chips-in-race-for-computing-power.

Elimian, Godfrey. "As ECommerce CEO Replaces 90% of Staff with Bots, Are Fears of AI Taking over Jobs Coming True?" https://technext24.com/2023/07/12/ceo-cuts-90-staff-replace-with-ai-bots/, July 12, 2023. https://technext24.com/2023/07/12/ceo-cuts-90-staff-replace-with-ai-bots/.

Engineering, Society for Industrial Management and. "Industrial Revolution 1.0 — Era of Mechanization." Medium, September 29, 2021. https://medium.com/spark-by-sime/industrial-revolution-1-0-9e6dc9c62c8c.

———. "Industrial Revolution 2.0 — Era of Mass Production." Medium, July 16, 2021. https://medium.com/spark-by-sime/industrial-revolution-2-0-era-of-mass-production-594acfa228c6.

Escritt, Thomas. "Germany Plans to Double AI Funding in Race with China, U.S." Reuters, August 23, 2023, sec. Technology. https://www.reuters.com/technology/germany-plans-double-ai-funding-race-with-china-us-2023-08-23/?utm_source=www.neatprompts.com&utm_medium=referral&utm_campaign=germany-invests-1b.

Gow, Glenn. "ChatGPT and Generative AI: What to Do with All the Productivity?" Forbes, July 2, 2023. https://www.forbes.com/sites/glenngow/2023/07/02/chatgpt-and-generative-ai-what-to-do-with-all-the-productivity/?sh=38b735913edc.

Greenhouse, Steven. "Our Economic Pickle." The New York Times, January 12, 2013, sec. Sunday Review. https://www.nytimes.com/2013/01/13/sunday-review/americas-productivity-climbs-but-wages-stagnate.html.

Gries, Thomas, and Wim Naudé. "Artificial Intelligence, Jobs, Inequality and Productivity: Does Aggregate Demand Matter?" SSRN Electronic Journal, 2018. https://doi.org/10.2139/ssrn.3301777.

ILO. "Generative AI Likely to Augment rather than Destroy Jobs," August 21, 2023. https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_890740/lang--en/index.htm.

Ilzetzki, Ethan, and Suryaansh Jain. "The Impact of Artificial Intelligence on Growth and Employment." CEPR, June 20, 2023. https://cepr.org/voxeu/columns/impact-artificial-intelligence-growth-and-employment#:~:text=The%20World%20Economic%20Forum%20concluded.

Jordan, Michael I. "Artificial Intelligence—the Revolution Hasn't Happened Yet." Issue 1 1 (June 23, 2019). https://doi.org/10.1162/99608f92.f06c6e61.

Kothari, Jash. "Artificial Intelligence: Cause of Unemployment." GeeksforGeeks, August 16, 2019. https://www.geeksforgeeks.org/artificial-intelligence-cause-of-unemployment/.

McKinsey & Company. "What Can History Teach Us about Technology and Jobs?," 2018. https://www.mckinsey.com/featured-insights/future-of-work/what-can-history-teach-us-about-technology-and-jobs.

MIT Technology Review. "Automation Drives Income Inequality," February 21, 2023. https://www.technologyreview.com/2023/02/21/1067563/automation-drives-income-inequality/.

Progresa. "Technology Won't Help Labourers: The Real Cause behind Wage Stagnation." Medium, November 22, 2020. https://progresaid.medium.com/technology-wont-help-labourers-the-real-cause-behind-wage-stagnation-f6811f9be89d.

PwC. "How Will Automation Impact Jobs?" PwC, 2018. https://www.pwc.co.uk/services/economics/insights/the-impact-of-automation-on-jobs.html.

Rafferty, John. "The Rise of the Machines: Pros and Cons of the Industrial Revolution." In Encyclopedia Britannica, 2019. https://www.britannica.com/story/the-rise-of-the-machines-pros-and-cons-of-the-industrial-revolution.

Reuters. "27% of Jobs at High Risk from AI Revolution, Says OECD." Reuters, July 11, 2023, sec. Technology. https://www.reuters.com/technology/27-jobs-high-risk-ai-revolution-says-oecd-2023-07-11/.

Rotman, David. “How to Solve AI’s Inequality Problem.” MIT Technology Review, April 19, 2022. https://www.technologyreview.com/2022/04/19/1049378/ai-inequality-problem/.

Stanford, Steven C. “Henry Ford - an Impact Felt.” Henry Ford Heritage Association, n.d. https://hfha.org/the-ford-story/henry-ford-an-impact-felt/.

Techopedia. “What Is the Digital Revolution? - Definition from Techopedia.” Techopedia, 2019. https://www.techopedia.com/definition/23371/digital-revolution.

The White House. “THE IMPACT of ARTIFICIAL INTELLIGENCE on the FUTURE of WORKFORCES in the EUROPEAN UNION and the UNITED STATES of AMERICA,” December 5, 2022. https://www.whitehouse.gov/wp-content/uploads/2022/12/TTC-EC-CEA-AI-Report-12052022-1.pdf.

U.S. Department of State. “Outline of the U.S. Economy.” Usembassy.de, 2019. https://usa.usembassy.de/etexts/oecon/chap9.htm.