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Revisiting Interconnection Between Technological Evolution and The Dynamics of Employment and Income Distribution

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Abstract
Technological development has been a continuous process. In fact, this signifies the strength of the process of development. There has been quantitative as well as qualitative changes in the way the human being produces its means of production as well as the means of livelihood. One must say that the development in the means of production (the machines and tools) determines the availability of quality and quantity of means of livelihood. Hence, it may be assumed that the availability of means of livelihood to the common masses should be a direct function of the evolution of the technology of production. But, the benefits of the development of technology spreads among the stakeholders in varying proportions. Distribution of means of livelihood, (income and output) depends on the distribution of ownership of the means of production as well as the number of people and the labor hours utilized in the production process. Distribution of means of production and income and output is a socio-political process. With the advent of the Industrial Revolution, the world faced changing socio-political structure through constitutional and democratic movements. At various milestones of technological evolution, various provisions determining the quality of life of the workforce like the number of working days and working hours and the disbursement of the reward for production kept changing. Different parts of the world experienced a reduction in the number of working hours and days at various stages under pressure of democratic movements. In light of this, the paper attempts to revisit the impact of the technological evolution, particularly, information technology and artificial intelligence, on the distribution of income and wealth and, also its connection with the growth of employment (or, unemployment). For this it takes a journey through the history since the Industrial Revolution in general and the post-liberalization era (since 1990s) in particular, in view of the qualitative changes in the production process owing to the emergence computer and information technology, robotics and artificial intelligence. The paper finds that there has been a mismatch between the rate of growth of production and the allocation of the output among the stakeholder, particularly the workforce. This has resulted into widening inequality of income along with high rate of unemployment.
Keywords: *Technological evolution, Industrial Revolution, democratic movements, workforce, income and wealth inequality, constitutional development, economic reforms, liberalisation, neoliberalism, artificial intelligence, etc.*

1. Introduction
Human history has been the story of its journey through the evolution of technology along with the tremendous growth in quantity and quality of means of livelihood required for sustenance of its race. Beginning with the separation of thumbs enabling it to hold the tools of production may be in the form of a stone or a stick to pluck fruits and hunt animals to begin with, the invention of fire, wheels, discovery of metals, art of agriculture, and so on, the journey never stopped, rather it kept gaining momentum. The quantity and quality of production kept growing by lips and bounds. [1] Through this journey, the human

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civilization passed through various milestones of its progress, marked by changes in the modes of production and that in the systems of control of the means of production, and as a result, control over the producers of the means of production and the means of livelihood. Passing through the savage to slavery, feudalism, commercial capitalism to modern capitalism, there have been profound changes in the production relations and the strength of productive forces. Britanica puts forth the phases of Industrial Revolution in the following way. The technological progress in production since the Industrial Revolution marks a profound transformation in how humans manufacture goods, affecting economies, societies, and the global environment. This progress can be divided into several key phases, each characterized by groundbreaking innovations and the introduction of new production methods and technologies. Here is an overview:

1.1. First Industrial Revolution (Late 18th To Early 19th Century)

Introduction of Mechanical Production: Powered by water and steam, this era saw the shift from manual production methods to mechanical. [2] The textile industry was among the first to undergo this transformation.

Innovations: The spinning jenny, the water frame, and the steam engine revolutionized production methods, leading to the creation of factories and a significant increase in output.

1.2. Second Industrial Revolution (Late 19th To Early 20th Century)

Advent of Mass Production: Fuelled by electricity, this period witnessed the development of mass production techniques. The introduction of the assembly line, notably by Henry Ford in the automobile industry, significantly reduced production times and costs [3].

Technological Advancements: The widespread use of electric power, development of chemical processes, and the introduction of the internal combustion engine.

1.3. Third Industrial Revolution (Late 20th Century)

Digital Revolution: The advent of computers and information technology marked the beginning of the digital revolution, automating production processes **further. Key Technologies:** Robotics, computer-aided design (CAD), and computer-aided manufacturing (CAM) led to more flexible and efficient production methods. [4] This era also saw the beginning of the Internet, radically transforming business operations and global supply chains.

1.4. Fourth Industrial Revolution (21st Century - Ongoing)

Smart Manufacturing: Characterized by the fusion of technologies that blur the lines between the physical, digital, and biological spheres. The Internet of Things (IoT), artificial intelligence (AI), and big data analytics play crucial roles in this phase.

Innovations: Additive manufacturing (3D printing), advanced robotics, and augmented reality (AR) are among the technologies driving unprecedented efficiencies, customization, and flexibility in production.

1.5. Key Characteristics of Technological Progress in Production

Ashwani Sharma and Vikramjeet Singh, in the article titled Evolution of Industrial Revolution: A Review, in International Journal of Innovative Technology and Exploring Engineering (IJITEE) speaks about the characteristics of technological transformation through Industrial Revolutions. He lays down the following points:

Efficiency and Productivity: Each phase significantly increased production efficiency and output, reducing costs and making goods more accessible.

Labour and Skills: The role of labour transformed with each revolution, with a shift towards more skilled work, especially in the digital era.

Environmental Impact: While technological advancements have often led to increased resource use and environmental degradation, there is a growing focus on sustainable production methods and technologies.

2. Future Trends

Talking about the future trends of technological progress in industrial production Ashwani Sharma and Vikramjeet Singh say that the evolution would

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sustain with certain changes in the economic structure of the society. [5] They point out the following changes in future.

Sustainability and Circular Economy: Technologies focusing on renewable energy, recycling, and waste reduction are becoming increasingly important.

Customization and Personalization: Advances in AI and manufacturing technologies are making it easier and more cost-effective to produce customized products.

Integration of Services and Manufacturing: The boundaries between products and services are blurring, with companies increasingly offering both as integrated solutions. The trajectory of technological progress in production is a testament to human ingenuity and its capacity to transform the material conditions of life. As we move forward, the challenge will be to harness these technologies in ways that promote not just efficiency and growth, but also sustainability, equity, and well-being.

3. Impact of Technological Progress on Income and Wealth Distribution

Technological progress profoundly impacts income and wealth distribution, influencing economies and societies in multiple, often complex, ways. While it has the potential to generate growth, improve productivity, and create new opportunities, its effects on distribution can be uneven, leading to disparities in income and wealth. Here's an overview of the key dynamics at play: there are contrasting points of views about how does technological evolution impact income and wealth distribution. The positive view claims that wealth and income distribution changes positively and tends to become more even with passes of time. In a research paper in the Journal of International Studies titled The Impact of Technological Progress on Income Inequality: the EU States Case Study, the authors claim that the technological progress led to the creation of millions of new jobs, helped improve labor productivity, and thus contributed to rapid increase in income and wealth. [6] The authors further claim that income distribution is not a direct function of technological progress. Rather, the countries of Scandinavia with greater income redistribution system achieved more equity in the income distribution while the other parts of Europe where there was less state intervention in controlling inequality, the disparity increase more sharply.

3.1. Positive Impacts on Income and Wealth Distribution

Creation of New Industries and Jobs: Technological advances can lead to the emergence of new industries, fostering economic growth and creating new employment opportunities. For instance, the tech industry has produced a significant number of high-paying jobs.

Increased Productivity: Innovations can increase productivity, leading to higher wages and living standards for workers. For example, automation and digital tools can enhance the efficiency of work, potentially leading to wage growth in sectors where workers can leverage these tools effectively.

Lower Costs and Prices: Technological progress can reduce the cost of production, leading to lower prices for consumers. This price effect can increase real income, particularly benefiting lower-income households by making goods and services more accessible.

3.2. Negative Impacts of Technological Intensity on Employment and Income Distribution

Technological intensity, characterized by rapid advancements and the widespread implementation of new technologies across various sectors, can have profound effects on employment. [7] While technological progress can drive economic growth and create new job opportunities, it also poses significant challenges. The negative impacts on employment primarily revolve around job displacement, skills mismatch, income inequality, and changes in job quality. Here's an exploration of these issues:

4. Job Displacement

Automation and Robotics: One of the most direct impacts of technological intensity is the automation of tasks previously performed by humans. In manufacturing, for instance, robots and automated systems can perform tasks more efficiently and at a

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lower cost than human laborers, leading to the displacement of workers in those roles.

Digitalization and AI: Similarly, the rise of artificial intelligence (AI) and digitalization affects service and knowledge-based jobs. Roles in data entry, customer service, and even some aspects of legal and financial services can be automated, reducing the demand for human employees in these areas.

4.1. Skills Mismatch and Job Polarization

Skills Obsolescence: Rapid technological changes can render existing skills obsolete faster than workers can acquire new ones. This skills mismatch can lead to higher rates of unemployment or underemployment among workers whose skills are no longer in demand.

Job Polarization: Technological intensity often leads to job polarization, where there is growth in high-skill, high-wage jobs and low-skill, low-wage jobs, but a decline in middle-skill, middle-wage jobs. This polarization can exacerbate social and economic inequalities, as the middle class shrinks and the gap between high and low earners widens.

5. Income Inequality

Explaining the income inequality with technological progress the IMF Working Paper titled "Rising Income Inequality: Technology, or Trade and Financial Globalization?" the authors say "We examine the relationship between trade and financial globalization and the rise in inequality in most countries in recent decades. [8] We find technological progress as having a greater impact than globalization on inequality. The limited overall impact of globalization reflects two offsetting tendencies: whereas trade globalization is associated with a reduction in inequality, financial globalization—and foreign direct investment in particular—is associated with an increase. A key finding is that both globalization and technological changes increase the returns on human capital, underscoring the importance of education and training in both developed and developing countries in addressing rising inequality." The paper further says "In addition, while inequality has risen in developing Asia, emerging Europe, Latin America, the Newly Industrialized Economics, and the advanced economies over the past two decades, it has declined in some sub-Sahara African countries". The authors in the above paper say that income inequality increased more rapidly in developing countries and newly industrialized and emerging economies. They find the following causes responsible for the increased inequality:

Wage Disparities: The benefits of technological advancements tend to disproportionately favour those with the skills to leverage new technologies, often leading to significant wage disparities. High-skilled workers in tech-driven industries can command high salaries, while workers displaced by technology may have to settle for lower-paying jobs, if they can find employment at all.

Concentration of Wealth: Technological intensity can also lead to a concentration of wealth among those who own or invest in tech companies and innovations. As a small number of individuals and companies gain a larger share of the economic pie, income inequality can increase.

Precarious Employment: The gig economy, fuelled by digital platforms, often offers flexibility but can also result in precarious employment conditions. Gig workers may face uncertain income, lack of job security, and absence of benefits such as health insurance and retirement plans.

Increased Work Intensity: For those employed, technological intensity can lead to increased work intensity and pressure. The blurring of work-life boundaries, especially with remote work and digital communication tools, can lead to longer working hours and stress.

6. Mitigating Negative Impacts

Addressing the negative impacts of technological intensity on employment requires concerted efforts from governments, businesses, and educational institutions. Policies and strategies that can mitigate these effects include:

Education and Reskilling: Investing in education and lifelong learning to equip workers with the skills needed in a technologically advanced economy.

Social Safety Nets: Strengthening social safety nets to support displaced workers and those in precarious employment.

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Inclusive Growth Policies: Promoting inclusive growth that ensures the benefits of technological advancements are broadly shared, including through progressive taxation and investments in public services.

Labor Rights in the Gig Economy: Implementing labor protections for gig economy workers to ensure fair wages, job security, and access to benefits.

Education and Skill Development: Investing in education and continuous skill development can help workers adapt to new technologies and secure high-paying jobs.

Social Safety Nets: Expanding social safety nets, including unemployment benefits and retraining programs, can support those displaced by technological changes.

Progressive Taxation: Implementing progressive tax policies can help redistribute wealth and fund public services and infrastructure that benefit the broader population.

Encouraging Innovation and Competition: Policies that encourage innovation and competition can prevent the concentration of market power and ensure that the benefits of technological progress are more widely shared. Technological progress can be a double-edged sword regarding income and wealth distribution. While it has the potential to drive economic growth and improve living standards, it also poses challenges that need to be addressed through thoughtful policy and societal response to ensure that its benefits are broadly shared.

6.1. Impact of Technological Progress on Employment

After the first Industrial Revolution in the late 18th century with a sudden intensity of use of machines and unregulated economic system, there appeared serious economic crisis and unemployment started growing to an alarming level. [9] Because the machines were used for the first time with such an intensity, workers feared that the machines were taking away the jobs. The agitating workers initially started breaking the machines treating the machines as the culprits of unemployment. The agitation created a lot of damages before the workers could realize that the problem was not in machines.

According to a report by the World Economic Forum, Table 1 and Figure 1. here are the estimated sector-wise job losses in India due to Artificial Intelligence (AI) by 2022:

- **Manufacturing:** Approximately 1.8 million jobs lost.
- **Retail:** Approximately 1.6 million jobs lost.
- Automotive and transportation: Approximately 1.6 million jobs lost.
- **Energy and utilities:** Approximately 600,000 jobs lost.
- **Financial services:** Approximately 400,000 jobs lost.
- **Healthcare:** Approximately 270,000 jobs lost.
- Construction and mining: Approximately 180,000 jobs lost.
- **Information and communication technology:** Approximately 160,000 jobs lost.

Table 1 World Economic Forum

Sector	Loss of Job (Lacs Approx.)
Manufacturing	18
Retail	16
Automotive and transportation	16
Energy and utilities	6
Financial services	4
Healthcare	2.7
Construction and mining	1.8
Information and communication technology	1.6

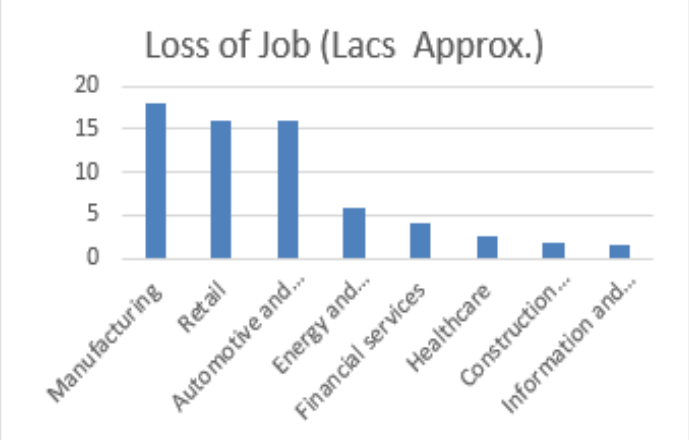

Figure 1 World Economic Forum

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These estimates are based on a number of factors, including the level of automation expected in each sector and the potential impact of AI on various job roles within those sectors. [10] It's important to note that while some jobs may be lost, new opportunities are also expected to be created in industries related to AI and other emerging technologies. Technological progress affects employment in several profound ways, influencing the nature, quality, and quantity of jobs available in an economy. The 20th century, a period of rapid technological advancement, offers clear examples of these dynamics, highlighting both the opportunities and challenges posed by new technologies. Here are some key trends and impacts:

7. Creation and Destruction of Jobs

Job Creation: Technological advancements often lead to the creation of new jobs and industries. For example, in software development, IT support, and digital content creation, employment in medical research, biotechnology, and other health services. At the same time, technology can render certain jobs obsolete. The automation of manufacturing processes and the introduction of robots in the automotive industry, significantly reduced the need for manual laborers, digital technologies have decreased demand for jobs in some traditional sectors, like print media and postal services.

7.1. Shift in Skills Demand

Higher Demand for Skilled Workers: There has been a consistent trend towards a higher demand for skilled workers due to technological progress. Jobs requiring complex problem-solving, creativity, and interpersonal skills have become more prevalent, reflecting the shift towards a knowledge-based economy.

Reduction in Routine Jobs: Conversely, technology has tended to reduce the number of routine and repetitive jobs. Automation and computerization have particularly affected clerical and production roles, leading to a decline in these types of employment opportunities.

7.2. Changing Nature of Work

Increased Flexibility: Technological advancements have made work more flexible in terms of hours and location. The rise of the internet and mobile communications enabled remote work, freelancing, and gig economy jobs, trends that became particularly notable at the turn of the 21st century.

Precarious Employment: While technology has created new job opportunities, it has also been associated with more precarious forms of employment. Gig economy jobs, for example, often offer limited job security and fewer benefits compared to traditional employment.

7.3. Globalization of Labour

Offshoring and Outsourcing: Technological improvements in transportation and communication have facilitated the offshoring and outsourcing of jobs to countries with lower labour costs. This has had a dual effect, reducing employment in some sectors in developed countries while creating jobs in developing countries.

7.4. Impact By Sector

Manufacturing: The 20th century saw significant technological advancements in manufacturing, leading to increased automation and productivity but also to a reduction in the number of manufacturing jobs, especially in more developed economies.

Services: The service sector expanded rapidly, driven by technological progress in areas like finance, healthcare, and information technology. This shift contributed to a growing demand for professional and technical workers.

7.5. Policy Responses

Education and Training: To mitigate the negative impacts of technological change on employment, there has been an emphasis on education and training programs to help workers adapt to new job requirements.

Social Protection: Enhancements in social protection measures, including unemployment insurance and social security, have been implemented to support those affected by job displacement.

Technological progress in the 20th century profoundly reshaped the employment landscape, demonstrating both the transformative potential of innovation and the need for adaptive measures to address its challenges. As technology continues to evolve, these dynamics underscore the importance of flexible, forward-looking policies to harness the

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benefits of technological progress while mitigating its disruptive effects on the labour market.

8. Discussion

Democratic and constitutional movements vis-a-vis technological progress and their effect on the employment and income distribution Democratic and constitutional movements have historically sought to expand political participation, protect individual rights, and establish legal frameworks that govern the exercise of power. These movements often intersect with periods of significant technological progress, influencing and being influenced by shifts in the economy, employment, and income distribution. Here's an exploration of how these dynamics have played out, particularly in the context of the Industrial Revolution and the digital age.

9. Democratic And Constitutional Movements in The Industrial Age

Paul Nemitz in his paper Constitutional Democracy in the Age of Artificial Intelligence gives a vivid picture of the importance of constitutional movements along with the increasing size of the economy under the impacts of technological progress. There appear various institutional changes and economic reforms in favor of the masses causing their economic and social empowerment. Therefore, in the countries where such movements are stronger and more effective, the equity in income and wealth distribution is maintained, while in absence of weaker democratic and constitutional movements, the inequality tends to rise. The author put forth the characteristics of constitutional democracy which can be explained as follows:

Expansion of the Franchise: The First and Second Industrial Revolutions were periods of significant technological and economic change that fuelled the growth of the middle class and the working class. As these social groups grew in size and economic importance, there was increased pressure to expand political participation. Movements for democratic reform, such as the push for universal suffrage, were influenced by these economic changes. In turn, the expansion of the franchise allowed for the enactment of policies that aimed to address the needs and interests of a broader segment of the population.

Labor Rights and Protections: The technological advancements of the Industrial Revolution led to the rise of factory work, which was often characterized by long hours, low wages, and unsafe conditions. This prompted the formation of labour unions and the labor rights movement, which fought for better working conditions, higher wages, and the right to collective bargaining. These movements contributed to the establishment of labour laws and protections that helped distribute the benefits of technological progress more equitably.

Social Welfare Policies: The economic disparities exacerbated by the Industrial Revolutions also spurred movements for social welfare policies. Democratic reforms enabled the working and middle classes to have greater political influence, leading to the adoption of policies such as unemployment insurance, health care, and public education. These policies aimed to mitigate the negative impacts of technological progress on vulnerable populations and promote a more equitable distribution of income. It can be observed that the social and political movements create a pressure group to mitigate the negative impacts of economic concentration in the form of growing inequality of income and wealth.

10. Impact on Employment and Income Distribution

The intersection of democratic and constitutional movements with technological progress has had significant implications for employment and income distribution:

Employment: These movements have historically fought for policies that protect workers from the negative impacts of technological change, such as job displacement and the erosion of labour rights. They have also advocated for education and training programs to help workers adapt to new technological realities.

Income Distribution: By pushing for labour rights, social welfare policies, and fair economic practices, democratic and constitutional movements have worked to ensure that the wealth generated by technological progress is more equitably distributed. This includes efforts to address income inequality through progressive taxation, social security, and

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public services. Overall, democratic and constitutional movements play a critical role in shaping how societies navigate the challenges and opportunities presented by technological progress. Their influence can help ensure that the benefits of innovation contribute to the broader public good, promoting more inclusive and equitable economic outcomes.

Conclusion

The entire discussion relates technology to various phenomena like its relation with employment, income and wealth distribution, social and economic inequality etc. It is a fact that the changes in technology is an unending process and along with that the socio-economic impacts with be continuously associated. The job of the technology is to create income and wealth and the means of livelihood. It is the responsibility the social and political organizations to take care of who gets what out of the production process. When the economic power is concentrated in fewer hands, the benefits will also remain confined among few people and the unemployment and inequality will remain serious problems. This is obvious from the comparison between the countries with more social and political system of greater welfare in the Scandinavian region and the other parts with weaker participation of the stakeholders in the system. The fear of machines could be overcome only by bringing in economic reforms like Eight Hour Law, control of monopolies, more welfare and social security to the workforce. Likewise, post Great Depression the Deal adopted in the USA gave bigger boost to the economy applying Keynesian economics based on demand side economics. The fact is, to sustain economic development aggregate demand must be adequate to absorb huge increase in output driven by rapid technological progress.

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