Review

AI & Economy

On the Impact of Artificial Intelligence on Economy

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Rapid advancements in artificial intelligence (AI) will have a dramatic impact on the global economy. This paper provides a systematic review of the economic impact of AI, focusing on the promotion of AI on productivity and economic growth; the impact of AI on labor employment; and the question of whether AI will increase income inequality. On this basis, a summary of how to implement public policies to reduce the potential negative impacts of AI on the employment structure and income inequality is provided. Finally, a summary and prospective research directions are provided.

Keywords: Artificial Intelligence; Economic Growth; Employment; Inequality of Income

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Introduction

THE influence of technical advancement on the economy has long been one of economists' primary concerns. Every major technology advancement throughout history has been accompanied by a tremendous rise in productivity. Recently, with the advancement of artificial intelligence (AI), the academic community has taken a renewed interest in the influence of AI on the economy. Since the 1940s and 1950s, AI research has increased, and the 1956 Dartmouth Conference, hosted by Dr. John McCarthy and others, is regarded as the beginning of the area of AI. The term "AI" was explicitly introduced for the first time during the meeting. Dr. McCarthy defined AI as "the science and engineering of making intelligent machines" in 1955. Recent advancements in big data, technology, and algorithms have ushered in a new apex of development for AI. AI is expected to develop faster in the future, which will lead to big scientific and technological breakthroughs and have a bigger and deeper effect on the economy and human society (1).

Studies on AI's implications for the economy, income inequality, employment, and other themes continue to grow as AI continues to affect every aspect of the present and future economies and societies. In addition, the effect of AI or deep learning technology development on the spread of economic ideas and other essential themes was examined. Studying how AI affects the economy can help us understand the pros and cons of its growth. This will let us make good public policies to deal with any possible threats.

The Impact of AI on Productivity and Economic Growth

AI is a significant advance in science and technology, and it is widely believed that AI will boost productivity and economic growth. Brynjolfsson and McAfee predicted that the second machine revolution based on AI and the digital revolution, which will achieve extraordinary technical advancement (2). A 2016 report by Accenture consulting firm viewed AI as a new factor of production, noting that AI will promote economic growth in at least three ways: first, AI can automate complex physical tasks, a phenomenon known as "intelligent automation; second, AI can supplement existing labor and assets, enhancing

worker capabilities and capital efficiency; and third, AI can promote innovation and spread across industries (3). In recent years, much theoretical and empirical research has focused on the role of AI in fostering economic expansion. Under the assumption that inputs of production elements such as capital and labor stay fixed, productivity affects the pace of economic growth. In the literature, it is a measure of both technical advancement and economic efficiency. Typical indicators

Theoretical Research

Using economic growth models, some studies attempted to explain, on a theoretical level, how AI influences economic growth. In this context, Hanson attempted to evaluate the economic impact of AI using neoclassical models of economic development (4). The paradigm posits that technology may complement or replace human work, with varying possibilities for complementing or replacing human labor depending on the task. The model also assumes that computer technology advances faster than general technology and that labor input for machine intelligence may develop as quickly as required, hence improving the economic growth rate by at least an order of magnitude with the usage of machine intelligence in batches. The authors also say that their method may underestimate the economic effects of AI because it doesn't take into account the possibility of new types of jobs being created.

The work by Acemoglu and Restrepo compensated for the above deficiencies. They present automation technologies based on the task-based model and assume that the number of tasks is endogenous (5). The uniqueness of the concept is that it presents a unified framework in which formerly labor-intensive jobs may be automated while new labor-intensive ones can be established. According to the study, automation has both a substitution effect and a productivity effect. The substitution impact decreases labor demand, but the productivity effect boosts productivity by substituting labor with less expensive capital and raising labor demand for non-automated work. Acemoglu & Restrepo also stated that the variables that may impede the increase in labor productivity include the mismatch between the skills required by new technologies and the skills of the labor force, as well as the rapid adoption of automation (6). If the education system does not deliver these capabilities in a timely manner, economic change will be hindered by the need for new talents. Also, because the current tax system tends to subsidize capital rather than labor and the labor market is not perfect, the equilibrium wage will be higher than the social opportunity cost of labor. This means that automation technology will be used too much, capital and labor will be used in the wrong places, and labor productivity will be slowed down.

Empirical Research

With the steady development of several theoretical models and the availability of data, empirical research examining the influence of AI or automation on productivity has increasingly increased. The majority of available empirical research investigates a specific sector of AI, such as the effect of computer capital or industrial robots on productivity, and uses multi-component productivity, total factor productivity, or labor productivity as metrics of productivity. Almost all of these works support the productivity-enhancing effects of AI.

Brynjolfsson and Hitt performed an eight-year analysis utilizing stock data from 527 US businesses and discovered that computerization has a favorable short-term impact on productivity and that its long-term contribution to productivity may be bigger (7). And they analyzed survey data from 179 big-listed firms to examine the influence of the adoption of data and business analysis on corporate productivity, and discovered that the average productivity of businesses that make choices based on data and business analysis is greater (8). Kromann et al. applied cross-country and cross-industry data to conduct an empirical study using the use of industrial robots as a measure of automation and discovered that automation has a significant positive impact on productivity over the short and long term if a country increases the degree of automation to a certain level (9). Graetz and Michaels performed a study utilizing industry panel data from seventeen nations between 1993 and 2007 and discovered that industrial robots increased worker productivity and created value (10). The automation of industrial robots boosted economic growth by 0.37%, and total factor productivity increased as well. The study also found that there is a "crowding effect" when robots are used. This means that the marginal effect of adding more machines quickly goes down.

It is clear that the extant empirical studies focused on the influence of AI on economic development and productivity in industrialized countries. Evidence on the influence of AI on economic growth in underdeveloped nations is still limited due to a lack of data. Currently, the usage of AI is progressively rising in developing nations, and future studies will require more empirical evidence from developing countries or from additional businesses.

Is AI on Its Way to the Singularity?

AI may be distinct from other technical developments in economic history. Deep learning has brought about a fundamental shift in computing since the first technological revolution. In the past, computer programs recorded human knowledge sequentially, changing input into output based on human assumptions. Using massive datasets, however, deep learning can comprehend this mapping process on its own. This technology has enabled robots to make enormous strides in perception and cognition, both of which are required for the majority of human occupations. Given the fast growth of AI, some academics have begun to question whether the singularity will occur. In the 1960s, Good developed the singularity theory, which states that self-improving AI might soon transcend human cognition, resulting in an explosion of intellect that brings limitless knowledge in a finite amount of time. According to Kurzweil, the technological singularity may occur around 2045, if progress continues at the current rate (11). Economists, on the other hand, are concerned about the occurrence of the economic singularity – that is, the crossing of a threshold by the rapid development of AI, after which economic growth would increase at an unprecedented rate.

Different academics have divergent opinions on whether and when the singularity will occur. According to conventional knowledge, exponential expansion is unsustainable since it demands finite resources. However, if the expansion is primarily

represented in the realms of knowledge, culture, or pure value, economic growth does not necessarily have a ceiling. Consequently, some fear that the evolution of AI may approach a singularity in the future. Aghion et al. considered how the development of AI could drive the growth explosion and pointed out the path of rapid growth or singularity that the automation brought by AI could bring, but also proposed some bottlenecks that would limit the emergence of singularity, such as limitations on the level of automation, and limitations on finding new ideas (12). Nordhaus incorporated the singularity theory into the economic development model, concentrating on important input factors such as salaries, productivity growth, pricing, intellectual property goods, and R & D, among others, and offered seven tests to determine if we are now in a singularity (13). Considering the singularity, such as the increase in the share of intellectual property goods in the capital stock, these tests eventually indicate that the singularity is still a long way off. Upchurch and Moore feel it is still uncertain if the singularity will occur, and they identify other criteria that restrict the singularity's occurrence (14). First, from a technological standpoint, it is extremely difficult to construct sentient, human-like robots. Second, the societal fear of unemployment may impede wider acceptance of technology. In addition, manufacturing in the real economy is the required gear and software are not infinitely available, and there will be limitations on scientific advancement at a certain time. The preceding research examined whether AI would progress towards singularity, but no consensus has been reached. Exploring the prospect of the singularity remains a future research direction.

The Impact of AI on Workforce Employment

The growth of AI will lead to a progressive decrease in the price of automation, resulting in the replacement of human labor with machines. In reality, technical improvements leading to the replacement of human labor by robots are not a new issue. Since the onset of industrialization in the late 18th century, numerous economists have conducted constant and in-depth studies on this topic, examining whether technological advancement promotes or diminishes employment. According to available research, technological advancement may have both a negative inhibiting effect and a positive creating effect on employment. On the one hand, technological advancement enhances labor productivity and substitutes a portion of labor, consequently diminishing job chances. For example, Schumpeter proposed that while technological innovation and productivity improvements will cause a temporary increase in demand for the main factors used to produce new products, the saving effect of process innovation will result in a decline in labor demand and an increase in unemployment (15). In contrast, technical growth also generates employment opportunities through capitalization effects. Accordingly, the cost of employment prospects brought about by capitalization has already been incurred, and the faster technical advancement, the lower the effective discount rate of future earnings and the greater the present value of profits. In order to maximize earnings, businesses will extend their manufacturing scale and provide additional employment opportunities. The scholarly community cannot agree on which of the two aforementioned consequences is more significant. Automation and technological advancement have not displaced more workers over the past two centuries, and while unemployment has changed cyclically, there is little evidence to suggest a long-term increase in unemployment due to technological advancement.

AI is comparable to earlier technology revolutions in that it liberates human labor and considerably increases productivity. In addition, AI has several new functions. The primary distinction between AI and earlier technology revolutions is its pace, scope, and depth. The advancement of machine learning has made it possible to computerize manufacturing processes by transforming previously non-routine tasks into routine ones. Brains are beginning to be replaced by machines. It is not simply a machine that augments human capabilities, and not just complements human labor but also has the potential to replace human labor in an entirely new way, which will impact numerous vocations that have not been impacted by technology previously. The development of AI has permitted the replacement of labor at an unprecedented rate and scale. Current research on the influence of AI on the labor market focuses mostly on three aspects: the risk of job automation; the impact of AI on employment as a whole; and the impact of AI on the employment structure.

The Risk of Job Automation

As the price of computers continues to decline, computers continue to replace ordinary activities, and a growing number of jobs are automated. Currently, AI development is advancing, and automated occupations are no longer restricted to regular activities; more jobs may be automated. Numerous researchers have examined the dangers of job automation in various nations and industries.

Frey and Osborne estimated for the first time, using the O-NET database and a probabilistic classification algorithm, the possibility that 702 jobs in the United States would be replaced by computers in the future (16). The O-NET database provides descriptions of the fundamental qualities of each role, from which researchers determined nine skill attributes that cannot be readily automated: assisting and caring for others; persuasion; negotiation; social insight; creative ability; creativity; and craftsmanship. By measuring the risk of the job being automated, assess the degree to which target occupations are affected by computerization along these nine typical variables independently for each occupational description. Based on the size classifications of high, medium, and low, 47% of US employment is at risk of being highly automated.

Arntz et al. noted that the study by Frey and Osborne (16) has a number of methodological flaws, with the amount of automation being assessed in terms of jobs rather than labor activities being one of the most significant drawbacks. This may result in an overestimation of the number of jobs that will be automated in the future, given that high-risk occupations frequently involve a high proportion of difficult-to-automate tasks. Therefore, Arntz and coworkers utilized a task-based methodology, taking into account task variability across worker positions, to estimate the proportion of job automation in 21 OECD nations using real job task data from the PIACC database (17). They discovered that assessing the likelihood of becoming automated by work task was far lower than in the majority of

job-based research, at only 9%.The report also talks about how automation of work is different in different OECD countries. For example, 6% of jobs in South Korea are automated, while 12% of jobs in Austria are automated.

Notably, the aforementioned studies only addressed the substitution effect of automation on occupations or activities, and the danger of employment being automated does not indicate actual job losses. According to Arntz et al. (17), there are three primary causes behind this: (i) technological adoption is a slow process, and technology substitution may not occur as anticipated due to economic, legal, and social obstacles; (ii) even if new technologies are introduced, workers can change their technological endowments by changing their tasks; (iii) technological changes create new job opportunities due to the increased demand for new technologies. According to estimates by the International Federation of Robotics (IFR), the robotics sector alone produces 170,000 to 190,000 jobs globally. Acemoglu and Restrepo noted that the influence of new technologies on the labor force is not just reliant on the role they play but is also intimately tied to the adjustment of other economic sectors (18). So, it's important to look at how AI affects jobs from different points of view.

AI and Work-Life Balance

Most available theoretical models predict that computers or automation will primarily influence the job market via two channels: Computers may augment human labor and increase the efficiency of some types of work performed by the workforce. In addition to this assumption, using task-based models, they found that automation will reduce the number of jobs in traditional jobs, but the creation of new jobs will lead to more jobs (19).

The aforementioned theoretical literature on the influence of AI on employment uses economic models to qualitatively explain the mechanism and effect of AI on labor employment, whereas empirical research quantitatively analyzes the effect of AI on labor employment using historical data. Existing empirical research on how AI affects jobs mostly looks at how AI affects certain fields, like industrial robotics or computing capital.

IFR data is utilized in the majority of research from the standpoint of industrial robots. The IFR offers information on the usage of industrial robots in 50 countries from 1993 to 2014, representing about 90% of the market for industrial robots. Using IFR panel data from 17 countries between 1993 and 2007, Graetz found no significant influence of industrial robots on overall employment (20). Using the IFR and EU KLEMS (European Union Capital, Labor, Energy, Materials, and Services) datasets, Acemoglu & Restrepo analyzed the impact of increased robot use on the local U.S. labor market between 1990 and 2007 and found that the use of robots will indeed reduce employment, and adding one robot per thousand people will reduce the employment-population ratio by about 0.18% to 0.34% (18). However, Dauth et al. conducted a study using IFR data in Germany from 1994 to 2014 and discovered that the use of robots did not result in overall job losses but rather altered the composition of German employment, i.e., while robot use decreased manufacturing employment, it increased employment in the service sector (21).

Various empirical studies based on other data sources, such as ICT investment or the number of robotics patents, have reached different conclusions. Using EU KLEMS data, Thomas concluded that ICT investment would increase employment (22). Hoedemaker utilized a 15-year dynamic panel patent dataset in 15 countries and 8 industries in the OECD using the GMM approach to analyze the impact of robotics innovations on the labor market (23). They concluded that robotics innovations had a somewhat favorable influence on employment.

Comparing the aforementioned texts reveals that the influence of AI on labor employment varies between locations and data sets. Possible causes for the aforementioned good and negative impacts include: (i) Automation's impact on the labor marketing is really complex. The development level and status of AI in various nations or areas are not coordinated, and the labor market itself is marked by substantial disparities. The production elasticity and labor supply elasticity are not identical, resulting in distinct employment consequences. (ii) The many expressions of AI include industrial robotics and digitalization. There is a chance that the effects of different technical situations on labor employment are not always the same.

The Impact of AI on the Employment Structure of the Workforce

Although the influence of AI on employment as a whole is unknown, it is undeniable that the impact of AI on employees in various industries or with different abilities varies. Numerous academics have stressed the necessity for vigilance over the job polarization caused by AI and automation. Employment polarization, the displacement of intermediate-skilled employees by AI or computerization, is the most severe problem, although employment has expanded in both high-skilled industries and low-skilled service industries. There is substantial evidence that employment polarization has formed in the labor markets of several nations. Autor et al. performed study and provided explanations for the causes of employment polarization (24). They identify two main groups of tasks that are challenging to automate. One is abstract work, typically in professional, technical, or administrative roles, requiring problem-solving, intuition, creativity, and persuasion. The other is manual labor, which often requires environmental adaptation, visual or verbal awareness, and interpersonal skills. Polarization of employment happens because these two sorts of professions are often dispersed at different extremes of the skill spectrum.

Feng and Graetz theorized how the historical and contemporary growth of labor-substituting technologies (such as computers, electric motors, and steam engines) has led to job polarization and provided a model that can differentiate work complexity and training demands (25). When the cost of automation decreases for two jobs of equal complexity, the labor required for the activity requiring more training is proportionally more expensive, so businesses will automate this portion of the work. Moreover, it is difficult to automate labor that is very sophisticated and training-intensive. This explains the phenomenon of job polarization, in which labor is redirected towards occupations that are extremely complicated or natural and need minimal training.

The Impact of AI on Income Inequality

In addition to encouraging economic development and generating greater wealth, a significant number of economists have raised the alarm about the potential increase in income inequality brought about by AI and automation. For instance, Autor noted that if technology renders a segment of the labor force superfluous, then distribution, rather than scarcity, would be our primary economic challenge (24). There are several ways in which AI influences economic inequality. Berg and colleagues found that the current growth in inequality is mostly due to two factors: as robotics become less expensive, production per person will increase, and as a result, the capital share of total income will rise (25). Moreover, productivity Wages for skilled work and skilled labor will progressively increase, while wages for low-skilled labor will decline and the pay disparity will deepen. Multiple factors, including the degree of complementarity between skilled individuals and robots, will determine the magnitude of inequality. Numerous studies examine the process and effect of AI or automation on income inequality from two perspectives: the reduction of the labor income share, the increase in the capital income share, and the expansion of labor pay disparity.

The Impact of AI on Capital and Labor Income Shares

In reality, the capital distribution is more unequal than the labor distribution. The majority of capital is frequently held by a small number of individuals. The growth of AI and automation will raise the proportion of capital components in the production process and capital returns, leading to an increase in income inequality.

Hansen discovered, using the neoclassical economic development model, that wage growth is contingent on whether the capital owner compensates labor for its value (27). Wages will rise with economic development if workers receive a fair share of labor compensation; if capitalists receive a larger share of labor compensation, wages will fall faster than computer prices, and income inequality will worsen. DeCanio utilized a Houthakker model that incorporates labor, machines, and conventional capital to examine the effect of broad AI deployment on wages (28). According to the results of the study, its effect depends on the aggregate production relations and the replacement connection between human and machine labor. Future advances in AI may cut wages and therefore exacerbate inequality, unless the returns to robotic capital are widely dispersed across the population. However, it is uncertain how this distribution will occur. Benzell et al. utilized a two-stage overlapping generation model (OLG) that included high-skilled and low-skilled individuals and hypothesized that high-skilled people had comparative advantages in analytical activities while low-skilled workers had comparative advantages in interpersonal tasks (29). According to study, advances in robot productivity benefit the capital-owning generation, the proportion of intangibles in national income rises over time, and the proportion of labor finally drops with a wage decline, impoverishing future generations. Brynjolfsson and coworkers (2014) further clarified that the imbalance of higher returns to capital is a potential driver of AI-induced income inequality (30). The study discovered that more sorts of labor were being replaced by robots, which, since they could duplicate themselves, could generate more capital. This implies that neither low-cost labor nor regular capital will have an edge, but will instead be steadily squeezed by automation. Those with the capacity to innovate and produce new goods, services, and business models will prosper. The way this creative group's income is shared out follows a power law, with a small number of winners getting prizes and a large number of members getting small incentives along the long tail of the distribution.

The Impact of AI on Income Inequality across Labor Markets

While AI has an influence on the employment of low-and medium-skilled workers, it will also have a detrimental impact on their relative pay share. Lankisch et al. incorporated automation capital as a factor of production into the endogenous economic growth model, assumed that low-skilled workers are more likely to be automated than high-skilled workers, and analyzed the impact of automation on the wages of low-skilled and high-skilled workers (31). Automation decreases the actual earnings of low-skilled laborers, thus raising the skill premium and income inequality. Acemoglu and Autor discovered that the positions and earnings of the middle class are steadily declining, and that pay polarization is followed by job polarization (32). Dauth et al. suggested that as the usage of industrial robots increases, intermediate-skilled workers will experience significant income losses (33). Nevertheless, these losses will not result from job loss or replacement, but rather from a fall in existing employment earnings.

Acemoglu and Restrepo elaborated on earlier study findings. Contrary to popular belief, it is unlikely that highly skilled professionals will be replaced by machines since they frequently require soft skills such as judgment, analysis, and problem-solving (34). With the growth of AI, however, intelligent machines can increasingly replace highly qualified employees. Therefore, they incorporated low-skilled and high-skilled automation into the model. The former refers to occupations that can be performed by machines instead of unskilled laborers. Unlike earlier studies, this model considers that high-skilled employment may potentially be displaced by AI. The concept posits that the final product is comprised of consecutive jobs, each of which may be performed by machines or laborers with varying degrees of competence. The study examines how automation affects the price of labor and the price of capital using a task-based model and concludes that, while the aggregate effect of automation on wages is unclear, low-skilled automation always increases wage inequality, whereas high-skilled automation reduces wage inequality. Pay disparity.

The Heterogeneous Impact of AI on Income Inequality

Income Inequality in Stages

Since AI grows at varying rates at various stages and the economy evolves gradually, the influence of AI on income inequality may vary throughout periods of economic growth. By including automation into the horizontal innovation growth model, Hémous and Olsen demonstrated that economic development

occurs in three stages: in the first stage, low-skilled wages and automation are lower, while income inequality and labor share are essentially steady (35). In the second phase, the degree of automation and the talent premium will both grow proportionally. In the third stage, the percentage of automated goods begins to stabilize, and low-skilled labor salaries are expanding at a slower rate than high-skilled labor wages. Using task-based models, Acemoglu and Restrepo demonstrated that automation and the concurrent development of new activities have distinct consequences for inequality (6). Automation raises inequality in the short and medium term, and the introduction of new tasks increases disparity in the short term. But in the long run, as activities become more standardized, low-skilled work will become more productive, which will limit the gains in inequality.

Income Inequality between Regions

Berger and Frey discovered that the increase in income inequality among different strata of the population will also lead to an increase in inequality between regions as well as the accumulation of high-skilled workers in cities that create new jobs, despite the fact that these cities frequently experience job losses or replacements (36). Because cities are not uniform, the economic disparity across them will steadily grow. Alonso and colleagues contended that the substitution of unskilled labor in emerging nations by robots would cut relative wages in these nations, consequently changing the worldwide distribution of production (37). Industrial automation will make labor replacement less expensive, and low-wage countries will gradually lose their cost advantage. Hence, wealthier nations may relocate output to automated plants in close proximity to their domestic markets. In addition, technological advancement implies that industrialization will provide fewer manufacturing jobs in the future, and low-income nations will no longer follow the path of fast growth that relied on labor migration from agricultural to high-paying urban factory work (38).

Relevant Suggestions for Public Policy to Lessen the Impact of AI on the Job Market

AI will increase both productivity and economic growth. However, some academics are concerned that AI may cause unemployment among low-and middle-skilled employees and raise economic inequality. For political considerations, the adoption and development of AI technology may be hindered or even prevented if a means of creating shared wealth cannot be identified. Therefore, the role of public policy in mitigating the potential negative effects of AI on the job market and preserving the general social welfare has been a topic of debate among several academics. In the past, the changes brought about by the technological revolution allowed humans sufficient time to adapt and achieve a balance between labor supply and demand. However, the changes brought about by AI are significantly more rapid and extensive than those brought about by the technological revolution. Because of this, it is even more important for the government to come up with the right policies to deal with the effects of AI on the job market.

The Importance of Public Policy

In the course of human history, any major technical advancement will eventually result in profound changes to the structure of human society as well as the administrative system. The economy undergoes structural changes as a result of profound developments. A market-driven change may not be possible since individuals must shift expenses from one industry to another or from one location to another. Technological change can result in a decrease in well-being in the context of fluid friction and stiffness. Rapid developments in U.S. agriculture in the 19th and early 20th centuries, for instance, led to a fall in labor demand, a steep decline in farm earnings, and a decline in demand for urban products, all of which contributed to the Great Depression of the U.S. economy. Government action played a good influence during this period. The government contributed to the achievement of this structural change by embracing Keynesian expansionary economic policies and facilitating the movement of workers from rural to urban and agricultural to industrial settings. The government's design of acceptable and successful public policies was crucial in reducing income disparity following the British Industrial Revolution (39). According to their analysis of 19th century Britain, in the process of lowering wealth disparity following the first industrial revolution, Britain offered free public education, enhanced the legal standing of labor unions, and assisted the elderly, the sick, the unemployed, and the unemployed, according to their analysis of 19th-century Britain. Income inequality has been cut down a lot by changes to the law, such as changes to personnel and the switch from indirect taxes to progressive taxes.

As the pace of AI development quickens, it is especially important for the government to formulate reasonable and optimized public policies in order to enable people to face the problems of total employment and structural changes that may be brought about by the major technological change in AI, as well as unfair income distribution. Berg contended that the growth in inequality is mostly due to the unequal distribution of income (26). Since total output is rising, if appropriate public policies are enacted to ensure the equitable distribution of capital income, everyone will be better off. By theoretical models, Korinek and Stiglitz explored the influence of AI on wellbeing (40). The study found that market imperfections may cause a drop in welfare during the transition period. However, if there are reasonable policy tools (like taxes and transfer payments), innovations in science and technology will lead to a more fair distribution of income and resources, which is called Pareto Improvement.

Public Policy Advice

Faced with the potential negative consequences of AI, the literature addresses the benefits and drawbacks of a variety of policy instruments, the most prevalent of which are: enhancing worker education and training; instituting a universal basic income policy; and taxing robots.

Strengthen Education and Training for Workers

The growth of AI might result in the unemployment of middle-and low-skilled individuals, but enhancing the training and preparedness of disadvantaged workers could assist them in regaining employment, thereby reversing or reducing this trend. As a result, there will be a greater demand for vocational re-

training and proactive, adaptable personnel. Governments must play an active role in educating new skills, retraining employees to utilize AI more effectively at work, and facilitating smoother job transfers as technology evolves.

Numerous studies have emphasized the need for enhancing education and workforce training and offered specific solutions. Glaeser et al., for example, believed that improving education levels is critical and that the United States should make targeted investments in education and workforce training that would benefit employees, particularly low- and middle-skilled workers (41). Thierer et al. noted that job-oriented training and preparation must be valued by society in order to make jobs more difficult to automate (42). How to build the specialized technical abilities are desperately required in the era of globalization (43). Primary and secondary education must emphasize the development of skills such as mathematics, science, and communication; higher education must benefit more students, including economically disadvantaged groups; classroom instruction cannot be divorced from labor market demands; and higher education mechanisms must train people with specialized skills while cultivating more managers, professionals, and entrepreneurs.

It should also be noted that low- and medium-skilled employees face considerable obstacles to re-entering the employment market through training. Arntz and coworkers noted that it is more difficult for low-educated employees to restore comparative advantage through training, particularly since the rate of technological change is faster than at any time in the past (44). Bessen also noted that it is slow and hard for a lot of regular employees to learn new skills and knowledge, and that institutional and cultural support are important for social change (45).

Implement a Universal Basic Income Policy

Implementing a "Universal Basic Income" (UBI) policy is an effective response to the surge of automation induced by AI and robotics. The concept of a universal basic income, in which all citizens receive regular, unconditional payments from the government, is not novel. Friedman introduced the concept of "negative income tax" in his 1962 book, "Capitalism and Freedom" (46), which proposes that the government replace the present welfare system with a negative income tax and punish households with incomes beyond a specific threshold. Since then, this plan has evolved into a policy for a universal basic income. A key advantage of the universal basic income policy compared to other welfare systems is that it provides all citizens with a fixed amount of unconditional transfer payments, which may be used for any purpose. Automation will provide immense wealth and value for society as a whole, but a universal basic income policy can ensure that everyone achieves a suitable quality of life, even if they are not employed. The amount of UBI is usually set in a moderate way, and it could be set at or below the poverty level.

There is still much dispute about the UBI policy. Proponents of this strategy said that it may be adopted to maintain high levels of consumption, reduce unemployment, ameliorate extreme poverty and inequality, and stimulate corporate activity. In addition to reducing unemployment caused by automation, UBI policies may also advance gender equality, promote work-life balance, enhance job quality, and better equip individuals, particularly young people, to meet the more severe instability factor. Furthermore, the UBI program will also benefit users' physical and mental health (47). In addition, the universal basic income policy will pose a number of challenges, such as how the government will be able to fund such a large amount of annual expenditure, whether this policy can meet the fundamental needs of residents, and how to coordinate this policy with the existing welfare policy.

However, the universal basic income policy is difficult to execute in its entirety due to its high cost and the large number of jobless individuals. Therefore, careful consideration must be given to its implementation. A key downside of a UBI policy is that it would encourage claimants to abandon the job market or remain jobless, thereby reducing taxable income and resulting in a loss of revenue for UBI programs. Therefore, there is currently no national policy implementing a universal basic income.

Tax on Robots

Massive investments are required to improve low- and middle-skilled workforce training as well as to establish a universal basic income program. Since the majority of the U.S. government's revenue comes from employees under the existing tax system, the growth of automation technologies would drastically cut tax revenue, making it harder to achieve the above two policies. As a result, Abbott and Bogenschneider developed a strategy for taxing robots as a result (48). They claim that there should be "neutrality" between the taxes of robots and human labor, that automation should be taxed similarly to human labor, and that there should be no automation deductions. The falling cost of machine capital allows machine capital to increasingly replace labor in manufacturing, which is the primary route via which automation or AI influences employment and earnings. By charging robots, the introduction of automation will be slowed, allowing employees time to shift to alternative vocations. This part of the income can also be used to help employees and raise money for a universal basic income.

A substantial amount of theoretical research has backed the robot-taxing strategy. Through theoretical model research, Guerreiro et al. determined that the drop in automation costs under the current tax structure in the United States will result in a large increase in income disparity (49). Automation-caused income disparity can be mitigated by taxing robots and offering a one-time tax refund to ensure that employees earn the minimum wage. However, robot taxation is only effective if automation is inadequate. Gasteiger and Prettner studied the impact of taxing robots using the OLG model, and their findings support the taxing robots viewpoint (50). The model suggests that taxing the revenue created by robots and allocating it to employees who do not own the assets might raise capital per capita and production per capita at a steady state, according to the research. Further, the analysis revealed that taxing robots is only possible if adopted simultaneously in many nations; otherwise, robot capital will be shifted to countries that do not tax robots. It should be noted that taxing robots is not always the best course of action. Atkinson argued that taxing robots may harm societal wellbeing (51). The taxation of robots might impede technical growth in the field of robotics. The loss of production caused by imposing a high tax on robots may exceed the amount of tax

collected. Guerreiro et al. also noted that taxing robots when the economy is entirely automated is inappropriate (49). Because when the economy is fully automated, employees will no longer be required to work. Taxing robots will influence production decisions without lowering income disparity.

Conclusions

First, the studies addresses the influence route of AI on economic development by the use of neoclassical growth models or task-based models, or through empirical study to verify the effect of AI on economic growth, although it remains uncertain whether AI will go toward singularity. Scholars have pointed out that AI will produce some new jobs while causing labor substitution, but they have not reached an agreement as to whether the impact is dominant; it may depend on market conditions. In addition, the majority of the available literature asserts that the decrease in automation costs would raise short-term income inequality, mostly through the two channels of a drop in the labor income share and a rise in the wage gap between various labor groups. On this premise, various sources argue that it is crucial to establish appropriate public policies to handle the possibility of AI-caused job loss. Experts have suggested policies like improving the education and training of the work force, putting in place a universal basic income policy, and taxing robots as a way to deal with the possible bad effects of AI on unemployment and economic inequality.

The economic effect of AI is an essential subject. We must recognize that AI technology is still in its early stages of development and spread, and that there is a significant deal of uncertainty regarding its influence on future economic growth, employment scale and structure, and income inequality. It is anticipated that in the future, more scholars will strengthen research on the impact of AI on the economy, discuss how to formulate optimal policies to mitigate the enormous impact caused by technological changes, and ensure that society as a whole enjoys the benefits brought by AI, so as to assist individuals in effectively coping with the impact of AI.■

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