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A Review on the Impact of Robotics and Artificial Intelligence on the Economy of a Nation

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ABSTRACT

Today, the innovations and technological advances are the backbone of developed economies, where technology is used by a vast majority of citizens. Although, digital age together with other sciences like mechatronics, nano technology, genetics, etc., is a step for "Space Economics", some other progresses like robotics and artificial intelligence are going to change business and economics directly or indirectly more than other developments. This paper underscores the impact of Robotics on industries and economy how with the right policy and institutional responses, advanced automation can be compatible with productivity, high levels of employment, and more broadly shared prosperity.At this juncture of automation boom, what is required is harnessing the positive and mitigating the negative effects of automation across economies and societies.

KEYWORDS: Robotics, Artificial intelligence, Labour demand, Productivity, Automation

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INTRODUCTION

The world is changing fast and the advent of technological advances has made it easier to build products, produce more food for a growing population, and connect people across the globe. Apart from "Space Economics", some other progresses are going to change business and economics directly or indirectly more than other developments. These progresses are named Robotics and Artificial Intelligence.Thus, apart from other technological advances, automation technology has also significantly improved in recent years, with faster, smaller, and more affordable machines. More and more companies are using advanced machinery in their warehouses and factories to increase their competitiveness and reduce their production costs. Robots and other forms of automation which was more predominantly seen in automotive industry has spread its wings today in other spheres also like the health care industry, military and public safety industry, manufacturing industry, mining industry, distribution centres, pharmaceutical packaging, etc. The assistance ability that robots can bring to humans in performing various tasks and the incredible dexterity they exhibit in recognising objects, absorbing data and responding to information in their environment with greater precision, time is not far away when these machines will perform nearly half of the work done by humans, and that too more cheaply.

Future progress is expected to be even more amazing and these transforming technologies will create a virtuous cycle by fuelling progress, enhance productivity, lower labour costs, ensure a positive restructure of the labour force, allow new jobs to emerge, increase living standards and encourage healthy competition among nations. Undoubtedly, Robotics and Artificial Intelligence will continue to connect the world and drive virtually all aspects of a competitive global economy. However, automation and improved technology does have severe repercussions on business and workforce impacting performance, mass production, jobless ratio, strategic planning, sales, customer relationship management, Philips curve, banking system, taxes, accounting, inflation, Purchasing Power Parity, GDP, etc. This paper aims to address and discuss the impact of automation and robotics on the economy of a nation in different perspectives.

LITERATURE REVIEW

Studies on automation and artificial intelligence have garnered writer's imaginations and interests for almost a century. There is considerable contribution of literature from classical economists who had embarked upon the issue of the relationship between innovation and employment in their discussions and studies. Adam Smith[1] who is considered to be the father of economics pointed out how machines could help favor the division of labour and underscore the labour-saving effects. James Stuart[2] addressed the problem of unemployment caused by

mechanization. David Ricardo[3] addressing the loss of jobs brought about by industrial revolution in England at the beginning of the nineteenth century affirmed that mechanization brings about unemployment and prove to be detrimental to the society. Karl Marx[4] was highly critical towards mechanization and highlighted that deskilling of processes and mechanization can never be in favor of workforce. According to Schumpeter[5], innovation is the major source of disequilibrium in the economic system. He emphasized on this fact by stating that innovations do not occur harmoniously across the economy but instead they tend to concentrate in key sectors, leading to structural adjustments between sectors. He also stated that the introduction and exploitation of innovations brings shocks to business cycles, with long periods of growth followed by decline.

There has been a considerable surge of interests in robotics and AI with the passage of time and post-2007 data reflect that the number of robots has continued to swell, and the set of tasks they can perform has also expanded. Though most of the studies indicate that robots will continue to play an important role in improving productivity, however, there are some notable exceptional studies by Frey and Osborne[6], the Organization for Economic Co-operation and Development (OECD), Mann and Puttman[7], and the McKinsey Global Institute (MGI).

Acemoglu and Autor's [8]study highlighted that the process of automating the production process changes the composition of the workforce. They assert that introduction of capital intensive techniques do not bring about displacement of labour. Instead he believes that technology is assumed to complement highly skilled workers and provide them with better employment opportunities, as well as a skill premium on their earnings compared to those of low-skilled workers.

Even though most of the researchers have led to labour displacement, Acemoglu and Autor's[8] in their study developed a task-based approach which hypothesizes that a job is composed of different tasks and that new technology does not always favor better-skilled workers but often complements workers in certain tasks of their job, while substituting for them in others. This approach distinguishes between manual, routine and abstract tasks. While many occupations involve a combination of tasks and different manual and routine tasks have been mechanized for centuries, the suggestion is that new technologies, including robots, predominantly substitute labour in *routine* tasks, which are those that can be clearly defined and follow pre-specified patterns, so that they can be coded and translated into the software. The study also highlighted that from a technical point of view – workers doing routine tasks are most at risk of robot-based automation. It also means that the current wave of automation has increased displacement risks because it is characterized by machines that are technically capable of performing an increasingly wider range of such tasks.

Frey and Osborne[6]attempt to study the Impact of automation could have on the US labor force. They stress on the fact that how automation can make jobs susceptible. Their study proposes a model to predict the impact of computerization on non-routine tasks by focusing particularly on machine learning and its application to mobile robotics on and propose a model to predict the extent of computerization's impact on non-routine tasks. They note potential engineering bottlenecks at tasks involving high levels of perception or manipulation, creative intelligence, and social intelligence. After categorizing tasks by their susceptibility to automation, Frey and Osborne map these tasks to the O*NET job survey which provides open-ended descriptions of skills and responsibilities involved in an occupation over time. Integrating this dataset with employment and wage data from the Bureau of Labor Statistics (BLS) allows the authors to propose certain subsets of the labor market that may be at high, medium, or low risk of automation. The study finds that 47% of US employment is at high risk to computerization. It should be noted that this study is at an aggregate level and does not examine how firms may react, any labor saving innovations that could arise, or potential productivity or economic growth.

Bowles[9]applied the same methodology for studies in Europe finding that the share of workers that may be displaced by technological change ranges between 40% and 60%. According to this study, the countries that will be affected most will be Romania, Portugal, Bulgaria and Greece.

According to the study conducted by Rifkin[10], Rochet[11] and Volle[12],digitalized goods and services are both intangible and non-rival and have zero or quasi zero marginal costs for reproduction.

Valenduc and Vendramin[13]have mentioned that "One of the implications of the principle of growing returns is that the costs of production and distribution bear little or no relation to the volumes produced, but must be paid when the initial investment is made. The marginal cost of production is accordingly close to zero, and so although the digital economy is highly capital intensive, digital goods can be reproduced in vast quantities at zero or quasi-zero unit cost. Digital economy experts believe that markets for digitized goods and services follow a model of monopolistic or oligopolistic competition, hegemonies as they are by a few large companies which are frequently born of mergers and acquisitions and whose strategies boil down to locking in customers and keeping competitors at arm's length."

A study on artificial intelligence was also produced by the World Economic Forum[14].In order to conduct their study, the forum conducted a survey of 370 companies around the world. The pool of respondents comprised the 100 largest global employers in each of the targeted industry sectors. The companies interviewed overall accounted for about 13.5 million employees. As stated in the

report, "respondents seem to take a negative view regarding the upcoming employment impact of artificial intelligence, although not on a scale that would lead to widespread societal upheaval—at least up until the year 2020." In terms of quantitative employment growth, "respondents expect strong employment growth across the Architecture and Engineering and Computer and Mathematical job families, a moderate decline in Manufacturing and Production roles and a significant decline in Office and Administrative roles. Other sizeable job families, such as Business and Financial Operations, Sales and Related and Construction and Extraction have a largely flat global employment outlook over the 2015–2020 period."

Graetz and Michaels[15]in their study entitled "Robots at work?" used industry-level panel data between 1993 and 2007 from EU KLEMS and the International Federation of Robotics, to investigate the impact of the use of industrial robots on economic outcomes. The study finds an increase in robot density of 150 percent over the time span considered. Countries particularly affected included Germany, Denmark and Italy, whereas at the industry level increased robot density is recorded for transport equipment, chemicals and metal industries. The findings of the study suggests that they have a substantial effect on economic growth, accounting for 0.37 percentage, which is about one tenth of aggregate growth after considering possible confounding factors. Whilst aggregate employment appears to be unaffected by the increased use of robots, the study finds evidence for labour-saving outcomes for the low-skilled, and to a lesser extent the middle-skilled. The results of the empirical investigation also confirm previous findings of skill-based technological change. Further important outcomes of robotization include a positive and significant relationship with total factor productivity as well as average wages.

Florian[16] studied the effect of automation on the human behavior. This paper focuses on some important aspects regarding the interaction between human workforce and fully automated production lines and examines the effects produced by introduction of robots in factories all over the world. This study has made the effects of automation on the human behavior considerably transparent and visible. This study has come out with both positive and negative facts about automation have shown promising results for improving the upcoming technologies.

Marikina Masayuki[17]conducted a survey from October to December 2015 to a variety of public and private Japanese firms operating in both manufacturing and service industries. The study presents new evidence on firms' attitudes toward artificial intelligence (AI) and robotics, as well as their attitude toward the impacts of these new technologies on future business and employment prospects. The data used in this paper are the results of the original survey of more than 3,000 Japanese firms. The study concluded with three major findings.

First, firms operating in the service industry have a positive attitude on the effects of AI-related technologies, suggesting the importance of paying attention to "AI-using industries."Second, it was observed that there exist complementarily between AI-related technologies and the skill level of employees. This finding suggests that in order to accelerate the development and diffusion of AI and to maintain employment opportunities, it will be necessary to upgrade human capital. Third, firms that engage in global markets tend to have a positive attitude toward the impacts of AI-related technologies, indicating that globalization of economic activities will facilitate the development and diffusion of these new technologies.

Graetz and Michaels[18] established whether the picture of "jobless recoveries" due to technological change observed in the US is replicated in other countries of the developed world. In the US workers holding middle- skill jobs involving routine-tasks are likely to be subject to displacement and subsequent transitioning into other industries and occupations. By making use of data on recoveries after 71 recessions in 28 industries and 17 countries within the time period from 1970 until 2011, the authors do not find empirical evidence for slower employment growth during recoveries since the late 1980s. In fact GDP recovered more slowly, the pattern of recovery does not deviate in routine-intensive industries. Hence, the findings of this study do not support the hypothesis of jobless recoveries caused by technological change.

Felten et al.,[19] their study provides a method that can help researchers and policy makers to understand the link between AI and labor. Their study developed a methodology that could be applied in a couple of specific cases, including a correlation between advances in AI to actual changes to occupational descriptions, and a prediction about which occupations and industries will be most affected by further advances in AI. They also conducted an analysis to identify whether there was any statistically significant correlation between the occupation-level impact score and whether an occupation was scheduled to receive a definition change. Their study found a statistically significant correlation coefficient of 0.0735 ($p=0.0412$) between the impact score and a scheduled definition change. They also conducted an analysis to investigate whether there was any correlation between the occupation impact scores and changes in employment or wages from 2010 to 2016. While there was no significant correlation between effect scores and employment, there was a statistically significant correlation coefficient of -0.1682 ($p=0.000$) between impact scores and annual wages. Their study further suggested that while AI does not have a large directional impact on employment figures, it may depress wages in affected occupations. The transportation industry and occupations associated with transportation industries will be among the most affected by advancement in AI technology. Aside from that commonality, we see that the most impacted

occupations and industries change quite dramatically depending on which AI category we manipulate. The least affected occupations and industries appear to be those associated with service industries. We see that across manipulations, restaurant services and food services-related industries and occupations appear to be among the least impacted regardless of which AI category is manipulated. Other service industry occupations also appear frequently on the lists of least impacted occupations, including housekeeping and hospitality-related occupations.

Calvino and Virgillito[20]in their study **"**The Innovation-Employment Nexus: A Critical Survey of Theory and Empirics**"** reviews the most recent literature on the link between innovation and employment. Their study critically underlined that theoretically, innovation may affect job creation via different mechanisms. On the one hand, technological progress leads to displacement of workers and, as long as innovation is labour saving and capital and employment are substitutes, the lower labour demand will be. On the other hand, increases in productivity can reduce prices, leading to higher demand and eventually higher labour demand. Empirically, several stylized facts emerge from the empirical study. At the firm level, a general positive effect of innovation on employment is found, in particular for high-growth and high-knowledge intensive companies. Product innovation is also confirmed to be positively related to employment suggesting that the net effect on job creation is positive.

Mann and Puttman[7] in their study, they have provided a new measure of automation based on patent texts and study its impact on employment. They resort to a different approach to analyze the effects of automation on employment. In their study, the authors rely on information provided from granted patents. They apply a machine learning algorithm to all US patents granted from 1976 to 2014 to identify patents related to automation (an automation patent is defined as a "device that operates independently from human intervention and fulfils a task with reasonable completion"). They then link the automation patents to the industries they are likely to be used in, and identify which areas in the US that these industries are related in. By examining economic indicators in comparison to the density of automation patents used in an area, Mann and Puttman find that though automation causes manufacturing employment to fall, it increases employment in the service sector, and overall has a positive impact on employment.

McKinsey Global Institute[21]in their executive summary highlights 2017 that the economics of automation are convincing. They estimate that automation could raise productivity growth globally by 0.8 to 1.4percent annually as improvements in robotic technologies allow robots to match or even outperform their human counterparts in certain tasks. MGI further perceives that about half of all the activities people are employed to do worldwide could potentially be automated, at least in part, by

adapting currently to demonstrated technologies, amounting to almost $15trillion in wages. In many areas like insurance, healthcare, financial services and business process outsourcing, etc. competitive pressures have made automation a necessity rather than a nice-to-have.[21]

Ramaswamy[22]made and presented a selective survey of recent papers in the area of technological change, automation and employment. The objective of this study is to put across the analytical ideas and the empirical evidence of the studies in this area and contemporary policy relevance. Based on the review of available studies and empirical evidence, his study came out with the following statements. (1) Increasing automation and robots adoptions do not seem to cause loss of employment in (2) Low skilled workers in routine jobs are more likely to suffer job losses (3) There will be demand for new types of skilled workers or new specialization within occupations. Thus, he concluded his survey by highlighting that the new developments on technologies (or the lack of understanding of their impacts) greatly add to the uncertainty of labour market outcomes in terms of employment and wages in different countries.

IMPACT OF ROBOTICS AND AI ON INDUSTRIES AND ECONOMY

Whether we are already living in the "Automation Economy" along with the pros and cons of automation on the economy of a nation is a matter of debate, but it won't be for much longer. The current wave of artificial intelligence (AI), robotics and revolutionizing technologies is transforming the business landscape, with machine learning, natural language processing, robotic process automation (RPA) and other advancements allowing companies to automate an increasing number of routine tasks once performed by humans. As they do, they are causing what observers describe as seismic shifts in the world economy.

Automation of industries comes with various benefits and drawbacks. It seems to offer us thrilling prospects, risks and difficult choices almost in all spheres. Let us discuss a few of them.

POSITIVE IMPACT OF ROBOTICS ON INDUSTRIES AND ECONOMY

Emergence of robotics and artificial intelligence has not only mitigated the effects of labour shortages but has also outperformed human performance in a wide range of activities. Industrial robots or so called programmable manipulators can be regarded as replacements for workers. Industries today are in favor of installing robots in industries primarily to save money, if the cost of a robot over its lifetime is less than the cost of employing a person or persons if it replaces more than one. By incorporating automated machines to an operation, less employees are required to get the work done. It also indicates less safety issues, which leads to financial savings of the employer in terms of payroll, benefits like health care, compensations, sick days, etc.

- It is also perceived that robotics and automation will increase production, improve product quality through improved consistency, handle loads too heavy for a person, handle dangerous loads (radioactive, explosive, toxic),etc.Introducing automated machines means transferring workforce from active hands on positions to supervisory roles thus deviating employees from performing tasks that can be dangerous and prone to injury. By reducing the number of workers in a firm, the power of trade unions resorting to potentially disruptive strikes also reduces. Further, automated equipment is capable of producing much larger production volumes than a largely human workforce thus reducing direct and indirect labour costs.
- With more production, automation also leads to more profit and higher wages. This may lead to increased investment and consumption which further lead to more production and employment. Amazon is a leading example for this observable fact. The online company has over the last few years increased the number of robots in their warehouses from 1,400 to 45,000. However, the rate at which it hires workers hasn't changed.
- Automation of activities can enable improved product quality, speed, accuracy, check repeatability and reduce human errors. A machine that is programmed to perform repeated tasks is less likely to make mistakes than an employee. Automation also contributes to productivity, as it has done historically. At a time of lacklustre productivity growth, this would give a needed boost to economic growth and prosperity and help offset the impact of a declining share of the working-age population in many countries.
- Human and technology collaboration can reap substantial benefits for humans. In the near future, the entire human workforce could gain confidence through using of robots and automation, could find answers to questions and solutions to problems. A machine has no ability to asset situations and cannot look at a set of transactions and provide an overall picture of what they could mean. The human-robot interaction should produce positive effects, taking into consideration their practical cooperation. For example, humans are not able to search for something in a wide amount of data, but they use algorithms and machineries to help them do this job. It's less time-consuming are very efficient. The machine finds patterns and indicates different activities and situations. Humans do usually the best thing that can be done: analyze the situations, think at a probable solution and then respond to it in an appropriate way. The new technologies provide humans access to intelligent systems that ultimately allows them the freedom to become smarter in how they work.

- Industrialization and technological progress enables output to increase faster than labour and capital. This in turn becomes the main driver of growth of GDP per capita. Smart manufacturing practices will not only increase productivity, it will lead to new opportunities slated to be more skill intensive and facilitate industries to remain globally competitive.
- Apart from the benefits accruing to firms, automation can have various benefits for wider society and empower citizens through customer care. Automation and globalization have made consumers accessible to a wide array of goods and services. For instance, a very simple example of automation can be cited of ATM cash machines which enable people to avail cash when banks remain closed. Further, when routine processes are automated, customer service agents can focus their full attention on solving problems for their customers, rather than on filling in forms. This leads to a more natural interaction and improved customer satisfaction.
- Automation reduces the cost of production which in turn leads to reduction of prices. Reduced prices leave more disposable income in the hands of the consumers thus enhancing the purchasing power of the people of the country. Further, lower prices makes products more appealing and creates an increased demand that lead to the need for more workers thereby generating employment avenues.

Firms profiteering from automation can contribute more to the government kitty in form of taxes. This enables governments to receive more tax revenue to spend on public goods.

PROBLEMS OF AUTOMATION FOR THE ECONOMY

Machine automation is undoubtedly a hot topic of debate for advocates who have been fervently putting forth their views for and against automated machines, robotics and AI. Although these technologies have fascinating prospects of future developments which brings with them progress, productivity improvements, increased efficiencies, safety, and convenience, but they also raise some serious policy issues that cannot be ignored.

- Automation raises the possibility of unemployment by affecting the competence of less progressive firms which may be undersold by their more progressive rivals. Here, too, everything depends on the economic climate in which automation is applied. During a period of bad trade the progressive firms pass on to the consumer the full benefit of their cuts in costs. They lower their prices. This is necessary in order to maintain and to increase their share in the inadequate and contracting market. As a result, the less progressive firms are forced out of business. However, during a period of expanding economy and rising prices there is much less inducement for the progressive firms to pass on to the consumer the benefit of automation. They are able to sell their increased output at prevailing prices, and for this

reason they are tempted to employ the benefit of lower costs for increasing their profit margins or they are inclined to take the line of least resistance in face of wage demands, and seek to attract and retain their employees by providing them with costly amenities. Since progressive firms do not cut their prices, even the less progressive firms are in a position to sell their goods. The difference between automated and non-automated firms is that the latter have to be content with a narrower margin of profit and cannot afford to pay higher wages or spend money on additional amenities for their employees. They may thereby lose part of their staff as many of their employees will be tempted to join automated firms for the sake of higher wages and additional benefits.

- Automation is affected by business cycles and is prone to produce a 'delayed-action' effect if the period of boom in which it is adopted gives way to a business recession. Industrial firms, having hoarded their employees who had become redundant as a result of automation, may then be forced to dismiss them. Thus, automation many give rise to unemployment when it progresses in a contracting economy, and also if, having progressed in an expanding economy, the trend becomes reversed.
- Increasing customer satisfaction is another limitation of automation. In developing countries, all firms might not be automated. With increasing automation, as customers become used to increasingly seamless automation, their expectations of businesses will continue to grow regardless of whether those industries have embraced automation. They will expect faster response times, more sophisticated self-service options and to be able to avoid repeating information multiple times during a single phone call. If they don't attain the speedy service, they might get annoyed.
- Automation also affects business costs. These technological advances don't come for free. With technological transformations costs are coming down and companies compete on the supply side to deliver better value, quality, speed and prices. To make the most of robotic process automation, companies need to invest in more modern, more powerful hardware plans for it. These additional costs will be offset by the ability of robotic automation to improve productivity and free up money currently spent on payroll. Other financial benefits will come in the form of increased customer satisfaction and an organization's ability to scale up or down when demand does, without needing to add or reduce staff.
- Governments also cannot do away with the drawbacks of automation. It is known that unemployment increase with technological advancement and propagation. Unemployment affects the demand and purchasing power of people. Since the government generates most of

its revenue through both direct and indirect taxes, it could witness a fall in its base as fewer people are employed. Governments would be in a situation where their expenditure far exceeds their revenue.

From the above drawbacks, it is perceptible that globalization and automation are about to usher in a new era of unemployment, poverty and inequality on a global scale. Many economists argue that automation bears much more blame than globalization for the decline of jobs in the manufacturing sector and the gutting of its middle class. However, one cannot deny the fact that automation is essential to remain internationally competitive. If one country doesn't automate, production will shift to those countries who do, and then gain comparative advantage. At this juncture of automation boom, what is required is harnessing the positive and mitigating the negative effects of automation across economies and societies.

POLICY RESPONSES

At this stage of technology evolution, people will need to continue working alongside machines to produce the growth in per capita GDP to which countries around the world aspire. Automation, atomic energy and other technological developments respect no national frontiers. They move from one country and area to another with the unexpected logic and strength of material forces. And their migration raises international as well as national problems. Given appropriate attention and the right policy and institutional responses, advanced automation can be compatible with productivity, high levels of employment, and more broadly shared prosperity. The government can resort to the following strategies to overcome the gaps created by automation.

- The government has to take utmost care while investing in automation and developing AI so that their drawback doesn't outweigh its many benefits. If care is taken to responsibly maximize its development, AI will make important, positive contributions to aggregate productivity and growth. Government has an important role to play in advancing the AI field by investing in research and development. Education curricula must be reoriented to STEM (science, technology, engineering and mathematics) skills along with human skills like creativity, empathy, systems thinking etc. that robots can never replace.Framing sound pro-competition policies in order to combat competition from new and existing firms will progressively play an important role in the creation and adoption of new technologies and innovations related to AI.
- As AI changes the nature of work and the skills demanded by the labour market frequently, workers will need to be prepared with the education and training that can help them continue to succeed and successfully navigate job transitions. Delivering this education and training

will require significant investments. First and foremost, the government should start with providing all children with access to high-quality early education so that all families can prepare their wards for continued education. This will groom them for further higher education and make them career ready.

- Thirdly, policymakers should ensure that workers and job seekers are both able to pursue the job opportunities for which they are best qualified and best positioned to ensure they receive an appropriate return for their work in the form of rising wages. This includes steps to modernize the social safety net, including exploring strengthening critical supports such as unemployment, insurance, medical aid, etc. New programmes can be introduced such as wage insurance and emergency aid for families in crisis.
- Further in order to overcome the displacement of jobs and gap created by automation, government should strengthen the unemployment insurance system and opt for countervailing job creation strategies to smoothen the transition.

CONCLUSION

Rapid advances in technology through automation and AI are a major influence on the global economy and will continue for more years to come. Automation can lead to significant benefits for the whole economy through greater GDP, higher productivity and increased customisation of the consumer experience. However, there are justifiable concerns about how these gains will be evenly distributed. Mounting public interests in robotics and automation is a fascination in one side with the potential of these technologies to transform our lives and fear of losing jobs on the other side. Further there is hardly any assurance that displaced workers will be effortlessly integrated into a very different labour market.

In this fast changing world, however it would be a mistake to hold such pessimistic views. One cannot deny the fact that automation will lead to new opportunities, enhance productivity, revitalize cottage industries, improve quality, increased national competitiveness and increasingly shape the way we work in the future. For business, the performance benefits of automation are relatively clear, but the issues are more complicated for policy-makers.

In order to strike a balance between the benefits and drawbacks of automation, Governments and firms must work to create an environment that will enable workers, companies and nations to reap the rewards of these improvements. They must evolve and innovate policies that help workers and institutions adapt to the impact on employment. This will likely include rethinking education and training, income support and safety nets, as well as transition support for those displaced. This means supporting investments in research and development in robotics and, most importantly, providing

education and skills re-training for existing and future workers. Education curricula must focus on improving basic STEM (science, technology, engineering and mathematics) skills but also promote the human skills that robots will not replace creativity, empathy, systems thinking etc.At the same time, individuals in the workplace need to keep themselves updated to face the challenges of changing world. They will also require engaging themselves more comprehensively with machines as part of their everyday activities and acquiring new skills that will be in demand in the new automation age.

Debates on the pros and cons of AI might go on for some more years to come. And this raises many new policy questions, which should be continued topics for discussion and consideration by future administrations, stakeholders and people from all walks of life belonging to the private sector, academia, policy experts, industries, and the public. This would definitely play a tremendous role in moving nation toward policies that create broadly shared prosperity.

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