Artificial Intelligence (AI) May Not Solve Japan's labor shortages: an unprecedented automation of knowledge-based jobs

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Abstract

Japan's labor market suffers from labor shortages, especially in manual and physical jobs, a problem that will be exacerbated in the short and medium term by demographic collapse and an aging population. In this context, one possible solution is automation through artificial intelligence (AI) and robotization. However, research on AI and its effects on the U.S. labor market concludes that the jobs with the greatest exposure to this new technology are high-skill jobs and those based in the knowledge economy. If so, the effectiveness of automation in addressing Japan's labor shortages in the most affected sectors will require other strategies.

Introduction

Labor shortage is one of the main obstacles that Japan's economy has been facing over the last several years, and the declining birthrate will aggravate the problem. As the most aging country in the world, Japan's population is expected to decrease to 87 million by 2070 (National Institute of Population and Social Security Research, 2023). It can be anticipated that the demographic collapse will cause a deep economic impact and that the society will be reshaped (Komine, 2014).

In this context, labor shortages will threat the economy and the structure of the welfare state. As a possible solution, it is hoped that technology keeps pushing automation to address the labor shortage. Until now, Japan has proved an enormous capacity to adopt innovation: it is the second country in size of market for industrial robots and the main industrial robot's manufacturer in the world (International Federation of Robotics, 2023). Moreover, the particularities of Japan's economy and labor supply can explain why robot's implementation since 1970 had positive effects in wages and employment (Adachi *et al*, 2020); while in other countries, the impact of industrial robots have shown negative effects in employment and wages (Acemoglu and Restrepo, 2020a).

Nonetheless, automation is not only based on robotics. During the last decade, a combination of heightened computational capacities, vast data collection, and sophisticated algorithm developments had pushed the capabilities of AI to unprecedented results. Thanks to the steadily progress of machine learning techniques, now we can use complex neural networks, a type of deep learning which permits a system to reach accurate conclusions without human intervention. Thus, current AI is particularly good in natural language processing, image, sound and speech recognition, or predictive analytics.

In November 2022, OpenAI released its chatbot ChatGPT, a text-generating AI that uses a Large Language Model (LLM), a deep learning architecture, able to understand natural language and generate content. It became

the fastest-growing consumer application in history and marked a milestone in AI field. Although they are not perfect and commonly create nonsensical or inaccurate outputs (hallucinations), the LLM impressive performance has fueled again the "AI fever", generating high expectations as well as worries.

The rapid advances of AI have significantly shifted the automation landscape, challenging traditional view of how technologies impact labor. Historically, automation first affected manual and repetitive tasks, typically assigned to "blue-collar" workers. Nonetheless, the recent AI's development can automate the tasks of skilled jobs and "white-collar" workers.

Major technological changes can be grouped into the so-called "industrial revolutions". The First Industrial Revolution introduced the machines through the use of steam power; the Second Industrial Revolution brought us the electrification; the Third Industrial Revolution allowed the growth of a new information-based economy, creating high value jobs based on knowledge. Now, in the throes of the Fourth Industrial Revolution, cognitive tasks that were limited to human intelligence are being augmented or automated by AI systems. Thus, it is necessary to reevaluate previous beliefs about automation and develop new frameworks and policies to address the effects of new technology.

To assess the potential impact of AI on existing employment, the literature has increasingly turned to the task-based framework (Acemoglu and Autor, 2010; Acemoglu and Restrepo, 2018). Given the technological landscape, determining whether a job will disappear or remain unchanged is insufficient; AI exhibits high proficiency at certain tasks, but it is unable to cope with others well developed by humans. Recognizing a job as combination of tasks, routine and non-routine, is essential to determine which jobs are more exposed to AI.

In this study, I am going to review the most recent research works about automation and AI effects on the labor market. Even if it is impossible to predict future outcomes of its deployment, recent studies establish insightful models to design labor policies. Japan's demographic declining and labor shortage have pushed expectations on robotics and AI as a solution, but will AI help to diminish those problems in Japan?

Understanding automation: changes in the labor market

Automation refers to the process of implementing new technologies that enable capital to replace human labor (Acemoglu and Restrepo, 2019). Traditionally, automation has been primarily understood as the incorporation of machinery into production processes, which reduces the need for manual labor and consequently lowers costs. Furthermore, the benefits of automation extend to the end consumer, who not only can purchase goods at better prices but also enjoys a wider range of products. The mass production that stemmed from the first two industrial revolutions is a direct result of the automation process.

The technologies that make it possible to automate work are not limited to the industrial level; computerization has progressively transformed our society, and in the process, the structure of labor markets in developed economies has also been altered (Autor, Katz, and Krueger 1998). Thus, innovation was the lever that transformed agrarian economies into industrialized economies, and subsequently led to a preeminent service sector. The emergence of the Internet was the launching pad for Information and Communication Technologies

(ICT), which have been key players in the economy since the end of the 20th century. E-mails, telework, and videoconferencing are now part of the working reality of millions of people.

This study does not aim to detail the development of computer sciences. However, it is necessary to dedicate this section to defining the automation forces of the Fourth Industrial Revolution. Firstly, to properly understand what AI is, one must adequately understand what an algorithm is. According to the Ethical Charter on the use of AI in judicial systems and their environment by the Council of Europe, an algorithm is "a finite sequence of formal rules (logical operations and instructions) making it possible to obtain a result from the initial input of information. This sequence may be part of an automated execution process and draw on models designed through machine learning".

Regarding its definition, and contrary to popular belief, an algorithm is not technology, nor does it refer to software. A cooking recipe, instructions for using a household appliance, or a simple questionnaire for job application can all fall within the definition of an algorithm (Todolí Signes, 2023). Nevertheless, it is more common to associate algorithms with, for example, social networks which are programmed to display content tailored to the user's preferences. Thus, algorithms are all around us and are an integral part of most systems, platforms, applications, and services we use in our daily lives.

Thanks to technological advancement, algorithms are becoming increasingly complex, allowing them to extend their reach into more areas. Among these, the role of predictive algorithms stands out. How is it possible that outcomes can be predicted through a mere sequence of logical steps? The answer lies in data, the oil of the 21st century. In the past, the inability to handle and compute large quantities of information limited us to studying only a small fraction of available data. Now, we have algorithms capable of managing massive amounts of data (commonly called big data) in an automated manner. In the age of digitalization, information about each of us holds economic value for companies, which transact the personal data of users. More data means more information, and thanks to technology, all that information can be properly analyzed and computed through algorithms, a fundamental element of this new economy based on.

Following algorithms, the next force of automation is AI, the latest milestone of the technological revolution that comes with the promise of changing the world as we know it. Despite being a branch of computer science that has progressed continuously since the 1950s, the explosion of Generative AI, a branch of AI dedicated to autonomously generating content, has skyrocketed expectations and uncertainty about the limits of its transformative power.

As with algorithms, AI can be defined in many ways, and there is not a global standardized definition. In Japan, AI had been defined as a "technology for the realization of intelligent functions, such as learning, inference and judgment, by artificial means, and utilization of the relevant functions realized by artificial means." (Article 2 of the Basic Act on the Advancement of Public and Private Sector Data Utilization, Act. No. 103 of December 14, 2016).

In the proposed European AI Regulation, deeply modified as a result of the emergence of Generative AI, AI is defined as a "machine-based system designed to operate with various levels of autonomy and capable of generating, with explicit or implicit objectives, results such as predictions, recommendations, or decisions that impact physical and virtual environments." This is a broad definition, whose ultimate purpose is to ensure that

technological novelties do not render legal regulation obsolete, as happened with the original proposal and its definition of AI, insufficient to incorporate the Large Language Models that have been shaking the world since November 2022.

AI can be classified into two groups, based on its capability. On one hand, there is specific, narrow, or weak AI; on the other hand, there is general AI, also called superintelligence (Bostrom 2014). Specific, narrow, or weak AI is designed to perform certain and limited tasks. Deep Blue is a simple example to understand what specific AI is. Deep Blue was the system developed by IBM that faced chess grandmaster Garry Kasparov in 1996 and 1997. This event perfectly illustrates the scope of specific AI: Deep Blue could beat a human at chess but could not perform other tasks associated with human intelligence. ChatGPT is also a narrow AI, and although its effectiveness in answering questions may make it seem like an "intelligent" system with consciousness, it is simply a language model programmed to identify the most appropriate word patterns.

Then, General AI does not currently exist and is subject to research. It is, therefore, a theoretical concept, by which an AI would be capable of replicating or surpassing human intelligence. Sam Altman, CEO of OpenAI, has stated that his company's mission is to "ensure that General Artificial Intelligence—AI systems that are generally smarter than humans—benefits all of humanity". Thinkers like Nick Bostrom have warned about the risks that such AI could pose, a scenario known as "technological singularity".

For the purposes of this study, AI is a technology with multiple applications in all types of areas. It implements the automation of tasks that until now had to be performed by humans. Due to its rapid progress, it is not possible to make an accurate forecast about what the net result of AI in the job market will be; however, conclusions reached by insightful studies on the matter conclude that this technology, because of its nature, allows a different type of automation than past innovations.

Automation in the labor market: task-based framework and recent research

The variation between living standards is due to productivity (Mankiw, 2018), and technology increases productivity. As Frey summarizes (2019,13), the dominant idea in academia and the most common response to the concerns raised by pernicious effects of automation can be summarized as such: whether technology can destroy some jobs, it will create new and better-paying ones. Furthermore, the productivity gains and cost reduction derived from automation could be enough to improve the net positive outcome by allowing access to products and services at lower costs, improving the common well-being (Hötte, Somers and Theodorakopoulos, 2022).

This framework has been treated as an absolute truth proven through growth data and the improvement of all welfare parameters. However, the results of researchers specializing in the effects of technology and labor are solid enough to change the dominant narrative. The exhaustive historical analysis of technological milestones throughout human history leads to a conclusion: in the long term, the effects of technological innovation are clearly positive; in the short and medium term, automation in the labor market creates winners, but also losers who are thrown into a life of misery and precariousness (Frey 2019). Even though the automation of the Fourth

Industrial Revolution is of a different nature, there is no reason to believe that this time it will be any different. There will be again winners and losers in the short and medium term.

The concept of task is useful to evaluate the effects of automation. In 2003, a study of automation by computer technology concluded that computers substitute workers in routine task and complement workers in the execution of non-routinary tasks (Autor, Levy and Murnane, 2003). Subsequently, professors Daron Acemoglu and Pascual Restrepo have developed a framework for understanding the effects of automation on the labor market: a task-based framework in which tasks carried out by human labor are automated, while other technologies complement the work (Acemoglu and Restrepo 2018). A job, by definition, is a set of tasks, with varying degrees of complexity. By breaking down jobs into a set of tasks, it is easier to determine which tasks are automated and which are newly created, as a result of technological innovation. Moreover, production process assigns tasks either to capital or to labor.

The introduction of a technology such as AI increases the productivity of both capital and labor, compared to productivity before its introduction. However, it also alters the allocation of tasks between capital and labor, allowing the replacement of labor with capital for certain tasks (Acemoglu and Restrepo 2019). This substitution of labor for capital is the "displacement effect" of automation. The ultimate consequence is that the value of labor decreases, while the productivity gained per worker increases. As a counterbalance to the "displacement effect", automation allows for the reassignment of labor to other tasks that are not automatable, which helps to maintain the value of employment while increasing productivity.

Furthermore, the creation of new tasks, which require labor-intensive input, produces the "restoration effect" (Acemoglu and Restrepo 2019). Thanks to the creation of new tasks, successive waves of automation have not destroyed jobs but have allowed for the creation of new ones. Techno-optimists trust that AI will allow for enormous productivity growth. As a result, the economy and society as a whole will be able to benefit from innovation. However, the analysis of labor markets following successive waves of automation shows that the process is not automatic, since the creation of new tasks is necessary to countervail the displacement effect.

We must be prepared for the scenario in which AI merely facilitates automation but without creating new tasks and increasing the demand for labor in the labor market. This is the case of industrial robots in the U.S. labor market: there is evidence that their introduction is associated with lower employment despite having increased productivity (Acemoglu and Restrepo, 2020a).

Moreover, when automation only cause minimal increases in productivity, new jobs will not be created. This scenario, called "so-so automation", explains why, in recent years, technological innovation through algorithms and software has improved capital productivity but has negatively affected working conditions. Professors Acemoglu and Johnson cite self-checkout kiosks in supermarkets as an example of "so-so automation". Through technology, the company can automate the checkout process, reducing labor costs, but the increase in productivity is minimal. No new task is created, and the labor force is transferred to the customer (Acemoglu and Johnson, 2023).

Bearing in mind the abovementioned, the concrete results of AI, regarding productivity increases and new tasks creation, remain unpredictable. However, the astonishing capabilities demonstrated in generating images, texts, voices, etc., should not prevent us from considering intermediate scenarios. Between the utopia wielded

by tech CEOs, based on a wealthy world where AI has solved all our major problems (Clifford, 2018), and the absolute catastrophe due to the disappearance of jobs (Kelly, 2023), it seems appropriate to consider a third way: AI is gradually deployed, automating more and more tasks. In this scenario, the focus should be on identifying the jobs most exposed to such automation.

In 2017, a study concluded that recent advances in algorithms, pattern recognition, and robotics could replace non-routine cognitive tasks. Up to 47% of the jobs analyzed (United States) were classified as high risk of automation in the coming decades (Frey and Osborne 2017). In their model, the authors identified that computerization would polarize the labor market, mainly affecting jobs with lower qualifications and lower wages.

Other authors have contributed to the literature of jobs impact because of technological change, but with a different framework and focusing on the branch of AI that is registering major advances: machine learning. Brynjolfsson, Mitchell, and Rock conclude that machine learning will be different than previous automation technologies; meanwhile previous innovation increased industrial productivity growth and transformed the wage and job market comprehensively, machine learning is a technology that will affect very different parts of the workforce, even though complete automation of jobs is unlikely (Brynjolfsson *et al*, 2018).

Subsequent research concluded through a new methodology that AI will affect high-skill occupations and older workers, in contrast to other previous automation technologies, such as robots, which affect lower-skilled jobs, or software, which affected middle-skill occupations (Webb, 2020). However, Webb remarked that historically, technology adoption requires times and the main impacts on the labor markets may not appear for decades. Moreover, its model determined which tasks can be replaced by AI, but it did not determine which tasks can be complemented by AI, or its indirect impact in product creation and labor supply (i.e., through education).

Similar conclusions were reached in 2021 with a different framework that combined occupations and tasks, introducing an intermediate layer of cognitive abilities (Tolan et al. 2021). The authors found that jobs traditionally "protected" against previous automation waves are exposed to AI, concluding that abilities associated with intellectual capabilities are now subject to automation.

The impact of LLMs on the labor market has also been analyzed. Researchers at OpenAI concluded that approximately 80% of workers in the United States could see 10% of their tasks affected by the introduction of Generative Pre-trained Transformers (GPT), and 19% of workers with up to 50% of the tasks of their job affected (Eloundou *et al,* 2023). In addition, although the impact would occur at all wage levels, the nature of this type of AI would affect more highly qualified and well-paid jobs (Felten *et al,* 2023). While it is true that exposure to AI does not take into account whether a displacement effect or an increase in productivity occurs, the study concludes that the successive advancement of technology poses a challenge to regulators, who will not be able to easily anticipate its effects.

Regarding Generative AI, an analysis of freelance's situation in a large online platform after the release of ChatGPT have found that the freelancers experienced reductions in both employments and earnings (Hui, Reshef and Zhou, 2023). Moreover, it seems that freelancers offering high-quality services were more affected to the AI deployment.

If this is the scenario resulting from the new wave of automation generated by AI, the assumption that higher levels of education and "white-collar Jobs" are less exposed to AI could be inaccurate. Expecting that through AI labor shortages in physical labor can be reduced may be also a wrong assumption. This is an important issue, especially in the case of Japan, whose labor market has been suffering from an intense labor shortage for years. In any case, any forecast of AI effects on the labor market should be taken with caution.

Even if the future outcome of AI remains unpredictable, lawmakers shall be ready to adopt legal measures to protect the most exposed workers. Beyond direct AI regulation, we believe that labor law should provide an adequate framework to mitigate the possible precariousness of working conditions. Since the computerization wave, inequality has been growing, and it is considered that it can be partly explained by insufficient supply of skills (Goldin and Katz, 2008).

AI can force us to rethink our education systems completely. If knowledge-based jobs are highly exposed to AI, it will be essential to provide reskilling schemes to the workforce. If we fail to provide enough opportunities to readapt to this new automated work environment, workers affected will move to lower paying-jobs, damaging the economy in the process.

However, designing training policies is just one of the aspects that we consider urgent. Future research should introduce regulatory proposals in the labor field, in matters that we consider vital for a correct technological transition, such as the revitalization of trade unions and the scope of labor law, going beyond the classic and rigid conception of worker (Todolí Signes, 2021).

AI and Labor shortage in Japan

The policies, reports, and government strategies related to AI in Japan are deeply related with the concept of Society 5.0, introduced by the former Prime Minister Shinzo Abe and the *Keidanren* in the 5th Science and Technology Basic Plan in December 2015. The premise was that there were four societies in the past: Society 1.0, hunting and gathering; Society 2.0, agriculture; Society 3.0, industrial; Society 4.0, information. The Society 5.0 is a human-centered society where the knowledge creation will be made through AI (Rojo Domingo, 2023).

Since then, the idea of using AI as the engine of the society has been recurrent and has been analyzed in the literature (López Aranguren, 2023). Concerning the labor shortages, the Government's *Social Principles of Human-Centric AI*, published in February 2019, considered AI "a key technology to rescue society from these problems" (declining birthrate, aging population, labor shortage, rural depopulation, and increased fiscal spending).

The viewpoint of AI as a solution to labor shortage was also contained in the *Future of Work*: 2035, a report published in 2016 by a panel of Japanese experts. Concretely, the report considers that there will be an AI what can change fields such as agriculture, logistics, construction and everyday chores.

As noted above, the recent studies about AI's impact in the labor market does not fit with this prediction, since the knowledge economy jobs are more exposed to the cutting-edge Generative AI.

In contrast with the optimistic vision about the capabilities of AI to solve labor shortages, the regular analysis of the labor market conducted by the Ministry of Health, Labour and Welfare (MLHW) barely mention AI as a solution of labor shortages. Moreover, they focus on other measures like job market mobility or improvement of working conditions.

Before the outbreak of COVID-19, the MLHW issued the white paper *Analysis of the labour economy 2019. Challenges Faces Japan: Work Styles and Labour Shortages*. The white paper informed that labor shortage was becoming "increasingly serious, especially among small and medium-sized companies". By type of employment and sector, labor shortages of regular employees are bigger in manufacturing and construction; labor shortages of part-time employees affect more at living related services.

According to the companies surveyed, the main difficulty is hiring new workers, mainly because no applications are received. By sector, "Accommodations, eating and drinking services", "Construction", "Medical, health care and welfare" and "Services" are the sector with more than a 60% of the answers pointing out absence of applications in job openings (MHLW, 2019).

In the white paper *Analysis of the Labour Economy 2022. Challenges in Promoting Labour Mobility through Support for Workers' Proactive Career Development*, it is mentioned that despite of increase demand in the sectors of information technology, health care and welfare, there was no significant rise in the number of workers moving to such sectors in recent years (MHLW, 2022a).

However, there are expectations of AI as a solution to labor shortage. The OECD points out that "Japan's working age population is ageing and declining, and so AI technologies can offer opportunities to address labour shortage" (Keese and Araki, 2023). In November 2023, the Ministry of Economy, Trade and Industry (METI) announced a new support program to encourage the introduction of AI and robots in local SMEs as a measure against manpower shortages (NHK, 2023).

The Japan's labor market has particularities. Its low unemployment rate and huge lack of human resources are factor worth mentioning. Above-mentioned introduction of industrial robots impacted differently in U.S. and in Japan. Thus, the characteristics of each country's economy and labor market will be critical (Yoshida and Ince Yenilmez, 2022). According to the AI Capacity Rank published by the Global AI Index (Tortoise Media, 2023), Japan is 12th position, meanwhile U.S. and China are the leaders. The ranking is elaborated measuring the following: talent, infrastructure, operating environment, research, development, government strategy and commercial, which integrates the level of startup activity, investment and business activities based on AI.

Same landscape is contained in the AI Index Report 2023 of Standford University. Private Investment in AI by Geographic Area in 2022 is led by U.S., with $47.36 billion; China reached $13.41 billion; Japan private investment was $0.72 billions. The number of AI companies newly funded was the following: 542 in U.S.; 160 in China; 32 in Japan.

Whose are going to be the most advanced AI systems? Although forecast about this fast-pacing evolving technology is not recommendable, it is possible to anticipate that U.S. and China's companies will be the leaders of the markets, based on its high level of investment in R&D. This means that new advances will be designed mostly paying attention to the needs and goals of those countries. If that is the case, cutting-edge AI main capabilities may be not corresponding to Japan's necessities. The research of AI is not neutral and will depend

strongly on the interests behind it (Acemoglu and Restrepo, 2020).

Japan's labor shortage creates a distinctive context for the adoption of automation by AI, and the results of it can diverge from the trajectory in other countries. The demographic collapse has fostered a perception of AI as an indispensable innovation to face labor shortages, supplementing the workforce and taking over roles that are currently unfilled, rather than displacing employees.

However, this optimistic view shall be reviewed since knowledge-based jobs are the most exposed ones to AI, and there is risk of degradation of work conditions or displacement of skilled labor. To prevent the negative effects of automation, it is imperative for Japan to rethink its labor regulations, focusing on hiring and training practices.

Moreover, developing a robust job mobility scheme is essential in addressing both the labor shortage and the potential side effects of AI-driven automation. By fostering a dynamic job market where individuals can smoothly transit between roles and industries, it will be possible to alleviate labor shortages while helping workers thrive in a new landscape.

Nevertheless, there is a critical precondition to promote labor mobility: the enhancement of working conditions in the sectors in need of additional workforce. In industries like construction and healthcare, where the demand for labor far outpaces the supply, the status of working conditions may act as a deterrent, discouraging potential employees from applying.

Finally, further research about AI effects in Japan's labor market will be necessary to design accurate policies. Future studies should evaluate how AI is being introduced, which sectors are more impacted, and how it is influencing job quality and availability.

Conclusions

This study aims to contribute ideas to the discussion around AI and its impact in the labor market, focusing on the labor shortage problem in Japan. AI has the potential to become a general-purpose technology, such as electricity or the internet. Its recent, fast-pacing advances have brought us remarkable LLM applications able to generate content, images, ideas and sounds that used to be domain human capabilities.

Since the deployment of the Society 5.0, Japan has been oriented towards high levels of automation. The society of the future was designed as human-centered one, but with technology surrounding every corner of it. The good results of automation at the industrial level thanks to the deployment of industrial robots was an example of how good technological automation can be for a society and its economy, particularly when it is affected by labor shortages, a structural issue of the Japanese labor market.

The lack of workforce will become progressively worse, due to the demographic collapse and the aging of the population. In 2040, Japan is expected to face a shortfall around 11 million workers in medical and welfare service (MLHW, 2022). Within the measures, automation through AI is highly considered as a solution. Nonetheless, it is critical to reevaluate the expectations around the role of AI in this issue. The labor shortages are particularly pronounced in sectors that require physical presence, such as healthcare or face-to-face services.

Concretely, the situation in healthcare is particularly worrying, with a projected deficit of 380,000 nursing care workers by 2025 and a need to provide these services since elderly population is increasing.

As several studies from the U.S. labor markets indicate, AI will affect job tasks differently than previous technologies. Its impact is distributed across different job categories, and its potential to displace or augment labor is not evenly dispersed. The big common conclusions that can be extracted from all those studies is that high-skill and knowledge-based jobs, which tasks were once considered secure from automation, are now exposed to automation.

This shift suggests that the strategy to face labor shortage should be changed; focusing on automation through AI may be detrimental to addressing labor shortages in the most pressured sectors. Since Japan is not leading the AI race in any parameter, it is unlikely that short and midterms developments will be designed thinking in Japan's labor market necessities.

Meanwhile one of the most common fears towards the AI automation wave is a massive destruction of jobs, AI automation in Japan may be insufficient to alleviate the labor shortages. Furthermore, following the results of the studies commented, middle class, knowledge workers will do jobs exposed to AI. Policies and regulations will be necessary to direct that exposure to an improvement of productivity, not to a worsening of labor conditions.

Further research will be very useful to analyze more concretely how the AI is being implemented in the Japanese labor market. Also, it is time to redefine training and education policies in labor environments. The combination of labor shortages in unautomated jobs and partial automation of tasks in other jobs will require a regulatory framework able to facilitate employability and retraining of current employees, enhancing labor mobility.

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「人工知能（AI）は日本の労働力不足を解決しないかもしれない：知識ベースの仕事の空前の自動化？」

ブテリエル　オルガンビデス・フアン　カルロス

日本の労働市場は、特に肉体労働における労働力不足に苦しんでいる。この問題は、人口動態の崩壊と高齢化によって短期的にも中期的にも悪化するだろう。このような状況の中で、ひとつの解決策として考えられるのが、AIやロボット化による自動化である。しかし、AIとその米国労働市場への影響に関する研究では、この新しいテクノロジーに最もさらされる仕事は、高スキル職と知識経済に基づく仕事であると結論付けられている。そうであれば、最も影響を受ける部門の労働力不足に対処するための自動化の有効性には、他の戦略が必要となる。