CORE PROGRAM REPORT

Adaptation to the Fourth Industrial Revolution

－ Reorganization of the Socioeconomic System －

International Institute for Advanced Studies

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- Reorganization of the Socioeconomic System -

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The Fourth Industrial Revolution is pressing for fundamental changes in the economic society. Unmanned factories, substitution of office work by artificial intelligence (AI), and substitution of functions of professionals such as doctors and lawyers by AI will progress without limit. As a result, the following structural changes of the economic society are expected.

First, at least 10 to 20 percent of jobs will be lost. Second, along with the development of the Internet of Things (IoT), the marginal cost (the cost of supplying another unit of goods and services) of many goods and services will be almost 0, as exemplified by information acquisition using search engines, sending and receiving of e-mail, and renewable energy. GAFA (Google, Apple, Facebook, and Amazon) and Microsoft are among the world's top 5 companies in terms of market capitalization as of the end of May 2019, leaving manufacturing and financial companies behind. It is because in terms of labor productivity and capital productivity, IT companies dominate the manufacturing and finance industries. Third, in a mature market economy society, consumers begin to value "use" rather than "ownership." In anticipation of that trend, Uber Technology, the company operating a ride-hailing app, was founded in March 2009, and it quickly became a global service. In addition, the platform business via the Internet has swept the world. The IT industry or platformers have become the center of the economy, beating out the manufacturing and finance industries.

In response to these changes in the economic society, a paradigm shift in existing economics, which is premised on an industrialized society, is required. We look at the direction of economic paradigm shifts and suggest optimal adaptation measures. (Takamitsu SAWA)

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CHAPTER 1

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It has become an era in which it is easier for individuals to post their own videos on shared sites. A huge number of videos are uploaded by individuals in search of revenue from the ads attached to the videos and the satisfaction of the posts per se and viewed around the world every day. What are the roles of TV stations in this era? In this chapter, we consider the case of Japan, in which television stations are affiliated, and conclude that television stations are expected to search, select, and edit videos provided by individuals on behalf of viewers, to accurately and quickly convey important information to local residents, to sort out the images owned by each TV station, and to produce large-scale programs that cannot be produced without large capital and information networks. (Ken-Ichi SHIMOMURA)

CHAPTER 2

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This article introduces basic concepts such as "copyrighted works" and "authors" under the current Copyright Law, introduces what discussions have been made on legislation for works in which the use of computers is involved in the creation process, and adds some considerations.

Computer creations (AI products) without human creative involvement are not protected under the current Japanese copyright law. There has been debate about whether future legal changes should be made to protect AI products, but protecting AI products is considered not to be consistent with the idea behind the current copyright law. It would be sufficient to take minimal action against the act of claiming that an AI product is a work of one's own. (Masaharu MIYAWAKI)

CHAPTER 3

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In the 4th Industrial Revolution, the importance of R&D investment in the ICT field has been augmenting. However, in the area, the relationship between patent rights among companies is becoming complicated. Besides, in recent years, a large number of players with different interests have entered the market, and the so-called entangled patents problem is becoming severe. To solve this problem, fair, reasonable, and non-discriminatory licensing are required, but such contracts may reduce the profit from R&D. In other words, the patent system that increases the appropriation of earnings from inventions does not function well in the ICT field, and as a result, the appropriate incentive for R&D is impaired, and R&D investment may decrease in the future. (Koichiro ONISHI)

CHAPTER 4

Causal and Heterogeneous Economics and Machine Learning (from page 69)

Recently, "causal machine learning" which is a fusion of machine learning and econometrics is rapidly advancing. In my lab, Causal Forest is used multilaterally to examine the strengths and weaknesses of causal machine learning. While maximizing the explanatory power, it can be used in various ways and has a wide range of application as it can be used not only for causality but also for heterogeneity. Its strength stems from the assumption of conditional independence of the data called "Unconfoundedness" and requires controlling the data. Also, the difficulty in deriving the marginal effect (partial differential coefficient) is a weakness, making it difficult to carry out the social welfare analysis required for economics. This chapter discusses marginal intervention effects, the economics of causality and heterogeneity. It also discusses Causal Forest, a machine learning of causality and heterogeneity. (Takanori IDA and others)

CHAPTER 5

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This paper describes the process of automation by artificial intelligence, and shows that it is important that the relationship between tasks that have been automated and tasks that have not been automated is complementary or alternative. When automation is completely advanced, economic growth is sustained, but when automation is incomplete, sustained economic growth stops, and in the worst case, the economy shrinks. The labor share does not continue to rise when automation is not fully completed, but when automation is completely advanced and labor is no longer needed, the labor share comes to 1 if the relationship between tasks is complementary. The reason that there are few tasks that use labor but the share is 100% is because the labor input to non-automated tasks is essential to automated machine tasks. (Koichi FUTAGAMI)

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The Fourth Industrial Revolution has created platform companies. Platform companies mediate a huge number of transactions on a daily basis. In recent years, the attribution of personal data collected by the platform companies and the abuse of a dominant position to their business partners have been a problem. If such platform companies merge with each other, would that lead to socially desirable consequences? What would be the policy concerns in that case? This paper also discusses how the researchers (both theoretical and empirical industrial organization economists) who play the role of conducting economic analysis, in-house economists, and policy makers should adapt to the 4th Industrial Revolution in the environment where platform companies have emerged. (Naoki WAKAMORI)

CHAPTER 7

How Platforms, the Sharing Economy, and P2P Trading Change the Market Economy? (from page 97)

This article outlines the changes in the Japanese economy and society from the period of Japan's high economic growth in the middle of Showa and the period of product differentiation and increase in variety to the period of economic globalization after the collapse of the bubble economy in the early Heisei period and more than 20 years of stagnation of the Japanese economy, and from the late Heisei period to the period of Reiwa in which the trade by the platform sharing economy develops. In addition, this paper outlines the changes brought by these changes, which have taken place in the Japanese economy and society, in the distribution structure and market transactions from the production of goods and services to the delivery to consumers. Then, the effects of the transition of information transmission methods from producers of goods and services to consumers through advertisement and the change in the composition of marginal costs on the distribution structure of market transaction value, which is obtained by enterprises, consumers, etc. at each stage, to each trading participant were explained intuitively by plotting. (Tetsuya SHINKAI)

Part 1: What Is the Fourth Industrial Revolution?

Takamitsu SAWA [i]

The Fourth Industrial Revolution is pressing for fundamental changes in the economic society. Unmanned factories, substitution of office work by artificial intelligence (AI), and substitution of functions of professionals such as doctors and lawyers by AI will progress without limit. As a result, the following structural changes of the economic society are expected.

First, at least 10 to 20 percent of jobs will be lost. Second, along with the development of the Internet of Things (IoT), the marginal cost (the cost of supplying another unit of goods and services) of many goods and services will be almost 0, as exemplified by information acquisition using search engines, sending and receiving of e-mail, and renewable energy. GAFA (Google, Apple, Facebook, and Amazon) and Microsoft are among the world's top 5 companies in terms of market capitalization as of the end of May 2019, leaving manufacturing and financial companies behind. It is because in terms of labor productivity and capital productivity, IT companies dominate the manufacturing and finance industries. Third, in a mature market economy society, consumers begin to value "use" rather than "ownership." In anticipation of that trend, Uber Technology, the company operating a ride-hailing app, was founded in March 2009, and it quickly became a global service. In addition, the platform business via the Internet has swept the world. The IT industry or platformers have become the center of the economy, beating out the manufacturing and finance industries.

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[Part 1] Chapter 1: The Light and Shadow of the Past Industrial Revolutions

1. The First Industrial Revolution led by steam engine

Originally, the Industrial Revolution was a proper noun used to describe a series of technological innovation-driven industrial changes that took place in and around the United Kingdom from the middle of the eighteenth century to the nineteenth century, and the accompanying changes in social structure. Recently, however, the original Industrial Revolution has been called the First Industrial Revolution, and after 2 industrial revolutions, the perception of the times that we are in the middle of the Fourth Industrial Revolution has been shared. Thus, the word Industrial Revolution changed from a proper noun to a common noun. It means “innovation-driven industrial changes and changes in social structure". The following is a summary of the 4 industrial revolutions focusing on industrial changes from the 3 aspects of communication, energy, and transportation.

The invention (by James Watt, 1769) of a coal-fired steam engine (a device that converts heat energy into piston kinetic energy) marked the start of the First Industrial Revolution. Manual printing machines were replaced by steam printing machines, and the wide and quick propagation of character information became possible. At that time, coal, which is a solid fossil fuel, was being used as an energy source to replace firewood and charcoal. Coal was used as a fuel for heating. The coal-fired steam engine was first put to practical use in the drainage of underground water in coal mines. Steam engine drainage extended the life of coal mines and enabled mass production of coal.

The iron-making industry, which used charcoal as a fuel, was suffering from the supply constraints of charcoal, but the supply of cheap coal in large quantities made it possible to mass-produce iron and steel, the most versatile metallic materials. To promote infrastructure development and industrialization, a large supply of cheap iron and steel is indispensable. As the sayings “Iron is the nation" and “Iron is the rice of industry" suggest, a "common sense" that the production volume of iron and steel is the source of national power has come to the fore for a long time.

After World War II, on a little different note, Prof. Hiromi Arisawa of the University of Tokyo (at that time) proposed a priority production system, which “inclines” resource allocation priority to increasing the production of fundamental materials for post-war reconstruction, coal and iron, by concentrating limited resources on the recovery of the coal industry and then of the iron and steel industry, as an efficient resource allocation method for post-war reconstruction. The proposal was put into practice under Shigeru Yoshida's administration. Precisely in line with the First Industrial Revolution, economic policies for post-war reconstruction were drawn up.

Let's go back to the story. The mechanization of transportation, such as steam locomotives and steamships, dramatically increased the speed of transportation of people and goods, enabling long-distance and mass transportation. Traditional express messengers and horse carriages were replaced by trains, and sailing ships were replaced by steamboats (originally, hybrid ships with steam engines on sailing ships). To say the least, it was truly revolutionary that humans and horses as power sources were replaced by steam engines. At the same time, it should be noted that the Luddite Movement, a movement to destroy machines by handicraftsmen who were afraid of losing their jobs, took place in the middle and northern textile industrial zone of the United Kingdom.

2. The Second Industrial Revolution driven by electricity and oil

The Second Industrial Revolution, which occurred from the late nineteenth century to the early twentieth century, was driven by new sources of energy: electricity and oil. Typical examples of communication revolution are telephone and radio. The advent of phones, which enable remote talking (Alexander Graham Bell acquired U.S. patent for the first time in 1876), must have been more shocking than the modern Internet. A sender's phone converts audio into electrical signals, which are sent over the wire to a receiver's phone, where they are converted back to audio. It was in the early twentieth century that the development of the radio, which transmits and receives voice by radio communication, began. The first commercial radio station, KDKA (a subsidiary of Westinghouse Broadcasting, a major electronics manufacturer), began broadcasting in Pittsburgh, Pennsylvania, on November 2, 1920. On the first day of the opening of the station, it reported the results of a presidential election in real time and this incredible

rendition worked excellently well.

The fact that we have the energy source of electricity has brought about the communication revolution of telephone and radio. Electric power was also the origin of the mass transit system, trains. In addition, various electric appliances were created, and convenience and amenity of life were dramatically improved. In the early twentieth century, hydropower and coal-fired power were the only sources of electricity. The electricity generated by turning a turbine with the steam generated by heating water with the power of falling water or coal-fired power became possible to be freely transported through the power transmission and distribution network. Gasoline, light diesel oil, and heavy oil, which are derived from the refining of petroleum, another energy source, were used as fuel for transportation means such as vehicles, propeller planes, and ships.

It is appropriate to say that the twentieth century is the “century of electricity and oil.” It is ironic that the third session of the Conference of the Parties to the United Nations Framework Convention on Climate Change was held in Kyoto in December 1997, when the twentieth century was about to end. The Kyoto Protocol was adopted, under which 41 developed countries were required to reduce their emissions of CO2 (to be precise, greenhouse effect gas including also methane, N2O, 2 alternative CFCs, and sulfur hexafluoride, but CO2 is the major component) by at least 5% from the 1990 level over a period of 5 years from 2008 to 2012. Climate change was discussed for the first time in international politics at the Group of 7 summit in Toronto in June 1988. "Global climate change" was included for the first time in the “Economic Declaration” of the Toronto Summit. At the Paris Arche Summit next year, 1989, global environmental issues accounted for one third of the Economic Declaration. The United Nations Conference on Environment and Development was held in Rio de Janeiro in June 1992, and the United Nations Framework Convention on Climate Change was adopted. I said earlier that the twentieth century was the "century of electricity and oil," but to put it another way, the twentieth century was nothing less than the "century of carbon dioxide emissions."

3. New industrial revolution brought by digitalization

It was computers that drove the Third Industrial Revolution that began in the 1960s. From large mainframe computers (from the 60s to the 70s) to desktop computers (in the 80s) and notebook computers (in the 90s), the price of computers was lowered by pursuing downsizing while keeping performance and speed, and the diffusion rate of computers rapidly increased. At the same time, there is fierce international competition for the speed and performance of supercomputers, large-scale and high-speed computers for scientific and technological computing. In the late 90s, Internet search engines such as Yahoo and Google became available in Japan, and e-mail and mobile phones also spread rapidly, creating a big revolution in communication.

From the 70s to the 90s, the rush to build new nuclear power plants continued. The surge in crude oil prices caused by the 2 oil shocks in 1973 and 1979, and the obligation in the Kyoto Protocol to reduce CO2 emissions, have steered the Japanese government's energy policy toward positioning nuclear power as a key energy source. In terms of transportation, internal combustion engines have become more energy-efficient, and trains have become faster.

The Fourth Industrial Revolution, which began around 2005 and is now underway, is driven by Artificial Intelligence (AI) with deep learning, IoT (which means that everything is connected through the Internet), and smartphones. From PCs to tablets, and to smartphones. Since smartphones are always carried with ourselves, the Internet has become more mobile, which means that communication between individuals has become more dense and regular. Smartphones are essential to receiving benefits from car-hailing services such as Uber and DiDi Chuxing, as well as other sharing economy services.

Since the accident at the Fukushima Daiichi Nuclear Power Plant in March 2011, any developed country has actually been promoting to abandon nuclear power generation. With the entry into force of the Paris Agreement (November 2016), in addition, decarbonization of power sources became an essential issue. With these 2 factors combined, the global trend is to position renewable energy as the main power source. The ongoing shift of renewable energy from a supporting role to a leading role is not unrelated to the series of technological innovations that drive the Fourth Industrial Revolution.

A revolution in transportation is also under way. The United Kingdom and France, China, and Norway are reportedly considering banning the sale of engine-powered vehicles after 40, 30 and, 25 years, respectively. Level 5 fully self-driving cars are likely to be ready in the

not so distant future.

Each of the past 3 industrial revolutions has contributed to the rapid growth and development of the economy and has significantly had a positive effect of improving substantially the convenience and comfort of our lives. An industrial revolution literally brings about drastic changes in the industrial structure. As a result, the industry is divided into winner and loser industries. Individuals are also divided into winners who benefit from the revolution and losers who suffer the consequences of the revolution. The negative effects of the industrial revolutions, such as frictional bankruptcies, unemployment, and widening economic disparities resulting from the changes, require the government, corporations, and individuals to pay the corresponding adjustment costs in return for the benefit of macro-economic growth and development. As far as at least the past 3 industrial revolutions are concerned, we did obtain more than enough benefits to cover the adjustment costs.

However, as far as the Fourth Industrial Revolution is concerned, few people talk about a bright future. As is often quoted, a joint study by Nomura Research Institute and Oxford University, in which AI and robots are expected to replace labor, with 49 percent of Japan's workforce expected to lose their jobs around 2030, has caused anxiety to everyone. Factories become unmanned and most of the clerical work is replaced by AI. More than half of the professional tasks, such as diagnosis and prescription by doctors and the creation of debating scenarios by lawyers, might also be handed over to AI.

In the past 3 industrial revolutions, the pace of expansion and deepening of technological innovation was moderate, making it generally easier to "adapt" to change. However, as far as the Fourth Industrial Revolution is concerned, the speed of technological innovation is unusually fast, which is different from the past 3 industrial revolutions. The iPhone, for example, was launched in 2007, but now there are nearly 3,000,000,000 smartphones around the world. Google unveiled its first fully self-driving car in 2010, but its popularization is near at hand. The faster the technological innovation, the higher the adjustment costs. In other words, corporate bankruptcies, unemployment, and widening economic gaps will be surging at a tremendous scale and speed. Be prepared, and you will have no regrets. From the next chapter, I will explain how to wisely “adapt” to various changes to be brought by the Fourth Industrial Revolution.

[Part 1] Chapter 2: How Much Human Work Does AI Steal?

1. Do 1 out of 2 people lose their jobs because of artificial intelligence?

On December 2, 2015, Nomura Research Institute (NRI) released a news release titled "In several decades, 49% of Japan's working population will be able to be replaced by artificial intelligence, robots, etc. - For each of 601 occupations, the substitution probability by computer technologies is calculated." It is a result of a joint study by Associate Professor Michael A Osborn and Dr. Carl Benedikt Frey at Oxford University. Osborn, an associate professor who specializes in machine learning, and Dr. Frey, an economist, published similar results in 2013 for the United States and in 2014 for the United Kingdom. For comparison, they say that 47% of workforce is replaceable in the United States and 35% in the United Kingdom. In short, the probability that each job will be replaced by AI and robots (the level of possibility is expressed as a number from 0 to 1) is calculated, and jobs with a value of 0.66 or more are evaluated as having a high possibility of extinction. It means that the total number of workers engaged in occupations whose probability of extinction exceeds0.66 accounts for 49% of the total number of workers in 601 industries.

The conclusion that "1 out of 2 people will lose their jobs because of artificial intelligence" was rather sensational. However, I don't think it was always appropriate to use the source of the data used in this calculation, “Study on Job Structure II - Analysis of Data about Current State, Change, Ability, and Life from a Web Survey of 50000 Workers’ Job Trends” by the Japan Institute for Labour Policy and Training (an incorporated administrative agency). The above survey report based on the Internet survey was analyzed by repeatedly extracting a random sample of 24,000 people who are engaged in 200 jobs selected in advance for 2 years, and conducting questionnaire surveys concerning one of the attributes, "occupation" (self-report). Nomura Research Institute used that data, but some questions remain.

First, the Ministry of Health, Labor and Welfare (MHLW) revised the Occupational Classification Table in 2012, which is organized into the major, intermediate, minor, and sub-classifications, and the number of occupations in the sub-classification is 892. And now, a joint study by NRI and Oxford University estimates the probabilities of extinction for each of the 601 occupations in the above report. For example, the sub-classification of researchers in the Ministry of Health, Labor and Welfare's occupational classification remains at a level corresponding to faculties of universities, and it is not further subdivided. However, the sub-sub-classification categories such as anthropologists, psychologists, sociologists, physicists, mathematicians, etc. appear. Even though doctors are regarded as a category of the sub-classification, physicians, surgeons, obstetricians and gynecologists, pediatricians, psychiatrists, etc. appear. In addition, there are many occupations that do not appear in the sub-classification of the occupation classification. In other words, the jobs covered by the NRI/Oxford University joint study, i.e., 601 occupations subject to the examination of the possibility of extinction, are a mixture of those that match the 892 categories in the sub-classification of the occupational classification and those that should be described as sub-sub-classification categories. Therefore, it is rather unreasonable to conclude that 49% of all Japanese workers will lose their jobs only based on the results calculated.

A sophisticated technique called supervised machine learning is used to calculate the probability of extinction of an occupation. As with economic analysis, increasing the mathematical sophistication of the method to be used never means that the credibility of the results increases. In fact, why do the probabilities of physicists and mathematicians overwhelmingly outnumber those of anthropologists and psychologists in the list of the probabilities of extinction for each occupation? My own interpretation is as follows. While mathematicians and physicists use logical thinking power and mathematics freely, that might be because a considerable extent of logical thinking power and mathematical operations fall within the scope of AI. That said, no one would agree with the observation that mathematicians and physicists are relatively more likely to be replaced by AI than anthropologists and psychologists.

As these examples show, when there are limitations to the available data, the conclusions that are drawn are often not convincing, no matter how sophisticated mathematical methods are employed. Apart from that, what kind of jobs cannot be replaced by AI or robots? I will list the following four.

The first is the professions of hospitality. In hotels, restaurants, and shops, AI-equipped robots can serve

customers well. For hotel receptionists, concierges, restaurant waiters, and sellers, replacing humans with robots can save money. In a somewhat long term, it would be a good idea to replace people with robots, since they don't need the same training as new graduates, salary and benefits, holidays, breaks, overtime, and tailoring and washing of their uniforms. However, from the customer's point of view, it is necessary to accept the disadvantage of having boring dialogue with robots in exchange for the merit of being cheap. Therefore, even if it is expensive, guests with abundant money must prefer hotels and restaurants that offer hospitality.

The second is the jobs that require non-routine communication. They include teachers of elementary, junior high, and high schools, doctors, nurses, lawyers, salespeople, and caregivers.

The third is the jobs that require creativity. They include artists, writers, researchers, editors, reporters, and entrepreneurs.

The fourth is the professions of management. From the owners of large companies to the owners of small restaurants, there are too many management jobs to count.

The fifth is the jobs in which not only explicit knowledge but also tacit knowledge is indispensable. Most professional occupations fall under this category. The skills of so-called “artisans" of traditional crafts and cooking are supported by tacit knowledge cultivated through experience.

In order to deepen our understanding of what tacit knowledge is, I will detail below the immortality of professional physicians who are said to be exposed to the fury of AI.

2. What are occupations that cannot be replaced by AI or robots?

Physicians interview patients and, based on blood tests, MRI and CT imaging data, and genetic information, offer diagnosis and prescription in light of his/her medical knowledge and experience. Even a very good doctor can have a chance of misdiagnosis. As part of the AI boom in recent years, the opinion that AI may surpass the ability of doctors to diagnose and prescribe medicine has been argued plausibly. Few years ago, in August 2016, the Institute of Medical Science, Tokyo University, announced the following cases that demonstrated the power of AI.

After entering test data on a leukemia patient and genetic information on cancer cells into IBM's AI Watson, which has learned nearly 20,000,000 medical articles on cancer research and more than 17,000,000 drug-related information, it gave a diagnosis of a special type of leukemia that the doctor had never thought of, and even prescribed an appropriate combination of anticancer drugs. It reportedly took only 10 minutes. Shortly after switching to chemotherapy as prescribed by Watson, the patient recovered, was discharged from the hospital, and was able to return to society.

Reading and storing nearly 20,000,000 cancer research papers and more than 17,000,000 drug-related information is easy for AI, but it's impossible for humans. It would take nearly 5,500 years even at the rate of 10 papers per day. Moreover, it is impossible for a human physician to accurately memorize the numerical values and the like described in papers one by one, and it is inevitable that the memory will be lost as time passes.

As this case shows, if doctors fall behind AI in diagnosis and prescription, their jobs are only to interview patients, inform patients of the diagnosis as told by AI, and offer prescriptions drugs. The only thing doctors can do to demonstrate their talent is to be skilled in interviews. Will the term “good doctor" become a relic of the past? Let's show that this is never the case.

In 20,000,000 cancer research papers, there is a mixture of meaningful and meaningless things in cancer treatment. A doctor’s ability depends on whether he/she has an ability to judge the meaningfulness or meaninglessness of a paper, just only by skimming it through. Needless to say, reading meaningless papers is nothing but a waste of time.

In the field of medicine and life science in particular, moreover, there are reportedly many dishonest papers such as fabrication and falsification of images and data. The ability to see through fabrication and falsification at a glance is the intuition that doctors as professionals have in particular and AI cannot imitate. In addition, having the ability to read and memorize all of the articles and information published in professional journals does not necessarily mean to exceed the ability of doctors in diagnosis and prescription. This is because AI does not have the knowledge based on the experience accumulated through the diagnosis of many patients as clinicians. However, as far as the image analysis of MRI and CT, which is actually used to diagnose cancer, is concerned, it is safe to conclude that AI is superior to radiology doctors and technicians. It is certain that AI, which is tireless, free from evil thoughts, and devoted to analysis, will offer accurate image analysis, in the face of long working hours.

The knowledge that doctors acquire through the decoding of technical books and papers is called explicit knowledge. Tacit knowledge refers to knowledge gained through the interview and treatment of a large number of patients and acquired as intuition and sensation. Physicians make the diagnosis by combining these 2 pieces of knowledge. The doctors who are called excellent doctors have enormous tacit knowledge accumulated through extensive clinical experience, let alone explicit knowledge. Tacit knowledge cannot be expressed and transmitted in writing, diagrams, numbers, or mathematical formulas, or be written in a paper. What AI learns from papers and information is limited to explicit knowledge expressed in sentences and numbers. In other words, the opportunity to gain clinical experience (acquire tacit knowledge) is closed to AI.

I, as an amateur, cannot imagine how much doctors' tacit knowledge, cultivated through clinical experience, plays an important role in the diagnosis and prescription of patients, but the following is certain. In the first place, AI doesn't have any tacit knowledge. That is, the diagnosis and prescription of AI depend only on the enormous amount of explicit knowledge and logical thinking.

AlphaGo, developed by Google Deepmind, is a fruit of the deep learning of Go achieved by playing not only matches with human Go players but also tens of millions of self-matches after learning tens of thousands of game records in the past in addition to set sequences. In May 2017, AlphaGo played against Korea's most powerful Go player and won a landslide victory with 4 wins and 1 loss. The difference between Watson and AlphaGo lies in the fact that the latter has performed the deep learning on the refined tacit knowledge based on the enormous number of matches (several million times as many as those of human players).

At least in the world of Go, it could be said that there is no Go player who can beat AI. But in the diagnosis and treatment of cancer, I am convinced that there should be many better doctors than Watson, which lacks tacit knowledge.

[Part 1] Chapter 3: The Actual Situation of Employment Decline Brought About by the Third Industrial Revolution

1. Optimal allocation of scarce resources

As I mentioned in the previous chapter, the joint research project between Nomura Research Institute and Oxford University, in which 1 in 2 people will lose their jobs due to artificial intelligence and robots, was taken up largely by the mass media. I would like to re-examine the meaning and significance of working and propose a desirable reform of labor market that would make “people happy” for workers who are threatened by the conclusions based on unsubstantiated numerical calculations claiming as if the Fourth Industrial Revolution were to make people unhappy, and for middle and high school students who are anxious about their future after graduation, in the run-up to 2030, when artificial intelligence and robots will rush into workplace in droves.

Before I get into the point, I want you to be patient with the explanation of the fundamentals of labor economics at the risk of boring you.

The model answer to the question, "What is economics?" is "the study of the allocation of scarce resources.” As for scarce resources, fossil fuels such as petroleum and mineral (metal) resources such as iron ore will come to your mind first. However, when economists refer to scarce resources, they refer to 3 "productive factors”: land, capital, and labor. When asked what evidence of "scarcity" is, the answer is “it is because all of them are valuable (not free)." Diamonds are extremely expensive because they are rare. Drinking water is valuable because it is rare, while river and lake water is free because it is not rare.

Capital is the sum, in terms of money, of 3 types of capital: fixed capital such as factories and machines, liquid capital such as raw materials, work in process, and inventory, and financial capital such as cash, stocks, and bonds. Financial capital includes the following. Stocks and bonds issued by a company are loans from shareholders (direct finance), and are negative assets (liabilities) like loans from banks (indirect finance). Retained earnings (own funds), that is, deposits, other companies' stocks and bonds, and government bonds, both domestic and foreign, are positive assets.

2. Declining labor force

The other resource (production factor) is labor. Let's review the basis of labor statistics just in case. The labor force population is defined as the population aged 15 or older minus the population who has no motivation or capacity to work because of reasons such as school attendance, housework, and old age. Since the Labor Force Survey is published every month, the number of workers, or people who worked (including part-timers and those who were absent from work) in the last week of the previous month, plus the number of unemployed people is published as the labor force population of the previous month. The unemployed refers to those who have not been able to work even though they have looked for work during the survey period. In other words, the labor force is the total number of people aged 15 or older who are willing to work regardless of whether they have a job or not. The ratio of the unemployed to the labor force is called the unemployment rate.

In the case of Japan, due to the low birthrate and aging population, not only is the labor force population itself declining, but the aging of the labor force population is also remarkable. The percentage of those aged 25 or younger in the labor force fell from 23.5% in fiscal 2000 to 17.7% in fiscal 2017. On the other hand, the percentage of those aged 60 or older rose from 13.6% in fiscal 2000 to 17.9% in fiscal 2017. During this period, the ratio of non-regular employees to non-agricultural, forestry, and fishery employees also increased from 25.8% in fiscal 2000 to 38.1% in fiscal 2018, in addition to the increase in women's labor force participation rate.

The term "regular employment" refers to "employment with a contract to work until the retirement age without specifying the period”. Non-regular employment refers to employment that is not regular, especially employment with a limited duration. Lifetime employment, one of Japanese style employment practices, was praised as a sign of the strength of Japan's manufacturing industry from the 80s to the mid-90s, because it "nurtures the loyalty of employees to their organization." However, since the Third Industrial Revolution, lifetime employment has been an obstacle to flexible corporate management, and many companies have become more dependent on non-regular employment.

And now, the decline in the labor force is a major factor in slowing the potential rate of economic growth. The government is taking the following measures to make up for the decline in the labor force. They include extension

of retirement age, improvement of employment environment through work style reform, deregulation of employment of foreign workers, etc. In other words, they are trying to promote the employment of the elderly and women's participation in the labor force, and to make up for the shortage with foreign workers. Instead of struggling to prevent the decline of the labor force, the most effective way is to improve labor productivity (the value added per worker). The key to dramatically boosting labor productivity is none other than innovation.

Each of the past 3 industrial revolutions has brought about a quantum leap in labor productivity, drastically changing production and life. As we have seen, steam engines introduced by the First Industrial Revolution, energy sources of electricity and petroleum by the Second Industrial Revolution, and computers by the Third Industrial Revolution improved productivity significantly, transforming people's lifestyles by introducing new products that enhance convenience and comfort of life.

3. "Increased work" and "Decreased work"

As shown by Japan's postwar trajectory, the Second Industrial Revolution prompted a massive shift of labor from agriculture, forestry, and fisheries to manufacturing. After the mid 1950s, boys and girls, except for the eldest sons and heirs of farmers, were rocked by mass employment trains and sought jobs at factories and shops in the 3 major cities after graduating from middle school. Since the end of the war, Japan has pushed ahead with the Second Industrial Revolution at a dash with the motto of "catching up and overtaking" the advanced nations of the United States and Europe. Large companies recruited college graduates or high school graduates, while small and medium-sized businesses competed to recruit young middle school graduates from rural areas.

The ratio of workers in the secondary industries (manufacturing, construction, and mining) increased gradually from 2.3% in fiscal 1955. It reached a peak of 36.6% in fiscal 1973 when the oil crisis hit the country. After being flat for a while, the ratio started to decrease in fiscal 1995 and declined to 23.9% in fiscal 2015. The ratio of workers in the primary industries (agriculture, forestry and, fisheries) dropped sharply from 39.8 percent in fiscal 1955 to 3.4 percent in fiscal 2015. Meanwhile, the ratio of employed people doubled from 35.8% in fiscal 1955 to 70.0% in fiscal 2015 in the tertiary industries (also referred to as the industries other than the primary and secondary industries or the service sector).

According to "What are the 'jobs that have increased' and 'jobs that have decreased' in the past 15 years?" by Kenta Konomi ("Toyo Keizai Online", September 8, 2015), from 1995 to 2010, care staff was ranked first in the list of "jobs that have increased" (increased by 1,250,000), with sales staff in the second place (510,000) and nursing staff in the third (410,000), followed by cleaning workers (250,000), childcare workers (160,000), and cooks (120,000). Most of the jobs that have increased over the past 15 years, during which computerization has been developed, are due to the aging of society, the increase in the number of double-income households, and unfavorable employment.

Agricultural workers (down by 1,260,000) were ranked first in the list of "jobs that have decreased," civil engineering and construction workers (1,230,000) were ranked second, and accounting workers (1,130,000) were ranked third. Corporate and organization managers (620,000), retail store owners and store managers (590,000), company executives (560,000), real estate and insurance brokers (700,000), car drivers (470,000), and printing and bookbinding workers (160,000) follow. The decrease in the number of farmers is an extension of the past trend. The decrease in the number of civil engineering and construction workers is due to the prefabrication of houses and the reduction of public investment. The decline in the number of managers of stores, organizations, and companies, and car drivers is probably due to the recession. The influence of the Third Industrial Revolution (digitalization and computerization) is only seen among accountants, insurance and real estate brokers, and printing and bookbinding workers. These "facts" suggest the following hypotheses.

Hypothesis 1: There are certainly "works that are reduced (replaced by machines)" due to technological innovation. There is almost no place for technological innovation to contribute to an increase in the number of jobs to create enough employment opportunities to compensate.

Hypothesis 2: The job losses due to the Third Industrial Revolution were offset by increases in employment due to changes in the social and economic environment that were not related to technological innovation.

In fact, with aging of the population, the number of workers in essential jobs (caregiving, nursing, etc.) increased rapidly. Along with the increase in the number of working couples, the number of employees in essential jobs (nursery teachers and cooks) increased. The number of nursing care workers, convenience store and supermarket clerks, cleaning workers, and others who

were forced to be engaged in undesired jobs increased. It is a real fact that many of the people who have been deprived of their jobs by computers can find only undesired and low-wage jobs at Hello Work. Fortunately, the Third Industrial Revolution was able to avoid the disaster of a drastic increase in the unemployment rate, as it progressed in parallel with the aging of society.

If “1 out of 2 people will be unemployed” in 2030 due to the Fourth Industrial Revolution as predicted, it is unlikely that new posts to accommodate the 33,000,000 people who will lose their jobs will be created. Most of the unemployed will be forced to be engaged in low-wage work that does not require special skills, or “hard,” “dirty,” and “dangerous” work that many avoid. If we don't do anything, AI and robots will certainly bring us to the depths of misfortune.

This time, I focused on explaining the fundamentals of labor economics. It is impossible that the extreme scenario that “1 out of 2 people are unemployed” will come true. Innovation and diffusion of AI will contribute to improving the efficiency of most jobs. Nevertheless, it is inevitable that a considerable number of existing occupations will disappear. From the next chapter, we will refer to the classics of Thomas More and John Maynard Keynes to understand the meaning and significance of “working” for human, and explore ways to make people happy by having AI and robots do at least part of or half of human labor.

[Part 1] Chapter 4: Creating a "Prosperous Society” by Learning from Thomas More and Keynes

1. Utopia of Thomas More

As described in Chapter 2, according to the joint study by Nomura Research Institute and Oxford University, the time when 49 percent of the employed will lose their jobs will come in 10 years or so from now. Whether the figure of 49% is true or false, it’s clear that artificial intelligence or robots will replace at least a portion of routine skilled labor and office work, and that more or less some percent of workers will lose their jobs. The government must take some measures.

I think if the purpose of the measures is to support the lives of the unemployed or to stimulate domestic demand, it is undeniable that they seem to be temporal and ad hoc. And not only that, it makes no sense that technological innovation contributes to dissatisfaction, anxiety, and misfortune of the society. Let us consider what measures the government must take and how our values must be reformed in order to make the Fourth Industrial Revolution, just like the past 3 industrial revolutions, a catalyst for the creation of a better-off society, in which everyone can experience an increase in their happiness. To find a clue, let's read the writings of Thomas More and John Maynard Keynes.

In 1516, shortly after the Sengoku period began following the Onin War here in Japan, an English lawyer, Thomas More (1478-1535), published his classic masterpiece “Utopia.” Utopia is translated into Japanese as "an ideal world," but More's Utopia is a mock managerialist state reminiscent of communism. At the same time, fair and transparent decentralization, which is more than epoch-making in the historical context of the early sixteenth century, is implemented. There are 54 cities (or provincial capitals) in Utopia, and once a year 3 "elders with excellent knowledge and experience" from each city gather in the capital to discuss common national issues.

The Utopian people’s main occupation is agriculture, and there are farmhouses with all kinds of agricultural equipment in the countryside (the suburbs of the provincial capitals). In addition to 2 slaves, a total of 40 men and women live together in a farm household. There is a leader called family head who manage 30 farm households. Of those who have stayed in rural areas for 2 years, an average of 20 (about half) people per household moved to urban areas, and in turn, the same number moved from the provincial capitals to rural areas. It is like a conscription system, but it is a wisdom to have as many people as possible learn farming techniques in preparation for the crisis of food shortage. The work of farmers is not limited to cultivation of fields, raising of livestock, and felling of forests, but also includes the production of breads and fruit liquors, such as wine, and lumbering. This means that it got ahead of what is now called the fifth industrialization of agriculture.

In addition to agricultural skills, all Utopian men and women must acquire some non-agricultural skills. For example, they include wool looming, flax spinning, masonry, smithery, carpentry, and so on. It was unusual that all women worked in Europe in the early sixteenth century. The almost only task of family heads is, in modern parlance, labor management. Family heads direct and supervise each person so that they concentrate on their work and avoid long working hours. The working hours per day are 6 hours in total, 3 hours in the morning and 3 hours after 3 hours for lunch and rest. 40 family members have dinner together. 1 hour after dinner is a time for family to communicate. They play music and have lively talks about noble and healthy topics there.

Lectures are given early in the morning every day. They were originally lectures aimed at educating young elites selected as future intellectuals, but many men and women in general attend it eagerly. The Utopian people are obliged to devote all their leisure time, if any, to the free exercise of their mind and the cultivation of their education. They believe with confidence that happiness in life is in this very point. Therefore, the level of education of the Utopian people is considerable.

Partly because of their deep education, the Utopian people despise mammonism and extravagant and dissolute lifestyle. Dogs' collars and toilets are made of gold and silver earned through exports. This is a mechanism to enable a quick recovery of gold and silver needed for settlement in the event of an import surplus in the future. Intellectuals are exempt from physical labor, but if they fail to improve themselves, they will be deprived of their privileges and will be turned back to craftsmen. On the other hand, if craftsmen give every spare moment to learning, they will be freed from manual labor and can be promoted to intellectuals. Among the

intellectuals, diplomatic missions, priests, tribe heads, and mayors are chosen.

Hearing that only 6 hours per day are spent to work, many readers will think that the supply of goods necessary for life is insufficient. But in Utopia, 6 hours of work is enough because everyone, except for a handful of intellectuals, work and they have simple life, keeping a dress in a good condition for a long time and wanting no other luxuries. What is important is that most men and women devote their leisure time to intellectual production activities. Thomas More regards the maximization of leisure time and the intellectual activities of the Utopian people as the culmination of “happiness” in life.

At the beginning of the sixteenth century, when the concept of technological innovation (or innovation) did not exist, it was possible to dramatically reduce the number of working hours (improve labor productivity) required for the production of necessary goods and services by changing people's consciousness (avoiding luxury) instead of innovation. Thomas More says that people are made “happy” by dedicating their leisure time earned by reducing their working hours to intellectual production.

Thomas More’s “Utopia” provides valuable tips for people who lose their jobs due to artificial intelligence (AI) and robots to live happily.

2. Keynes’s “Essays in Persuasion”

In 1931, John Maynard Keynes predicted the possibility of technical unemployment that would occur because "the speed of finding ways to reduce the use of the labor outweighs the speed of finding new uses for the labor" (“Essays in Persuasion,” the following is the summary with my personal views). In other words, technological innovation rapidly drives labor efficiency (replacement by machines), and as a result, more people lose their jobs. On the other hand, the rate of unemployment rises, at least temporarily, because the pace of finding new uses for the workforce (creating new jobs) tends to lag.

Unemployment resulting from technological innovation is a great long-term benefit, as it means that “people solve their own economic problems," although in the short term it will hurt people. When economic needs are met, people seek to devote their time and energy to non-economic purposes. Machines boost labor productivity and free us from labor and hardship. Machines push down the marginal cost of production, providing cheap goods and services, and dramatically increasing the convenience and comfort of people's lives.

The meaning of Keynes's phrase "solving economic problems" can be deduced from the following anecdote.

For those who work hard for their daily food, leisure time is a cherished pleasure. However, the interest in the broader economy (income, assets, ownership, production, technology) begins to fade proportionally. Many people will pay a great deal of attention to ethical questions such as "how humans should live" and ecological issues such as "how to prevent the destruction of the natural environment" and "how to maintain biodiversity." The government will have no choice but to respond to people's requests and promote academic research and enlightenment activities, such as literature, art, history, philosophy, etc., which have been neglected or treated coldly because they have nothing to do with the economy. Only when technological innovation solves economic problems, the time will come for humanities, literature, and art, which are useless to the economy, to revive. This will be just until they get that leisure time.

An old odd-job woman wrote a fateful epitaph for herself like the following. "Don't grieve for me, my friend, don't weep for me, because I don't have to work forever from now on." This was her paradise. Like other people looking forward to their leisure time, she imagined how wonderful it would be to spend her time listening to the radio. "Hymns and delightful music will be in heaven. But I have nothing to do with singing."

3. Loss of possessiveness

In the United States, Europe, and China, the sharing economy is now taking advantage, providing services that allow us to “use” goods when we need them, without time and effort, rather than to “own” them. Taking automobile as an example, in developed countries, the household penetration rate of passenger cars is around 90%. The costs associated with “ownership,” such as ownership tax, insurance premiums, parking fees, gas bills, and time costs due to road congestion, are considerable. Uber Technologies, a ride-hailing service company founded in 2009, has taken this opportunity. Uber offers the following services. You travel by train to the nearest station of a business destination. A taxi, a private passenger car (equivalent to an unlicensed taxi, which is legally prohibited in Japan), or a short-time rental car, which has been reserved in advance by a smartphone, is waiting in front of the station and takes you to the business destination in a short time. In the case of a rental car, you can leave it in the parking lot of the

nearest station on your way back. The smartphone will take care of everything from the payment of the fee to the locking and unlocking of the car. What brought about the sharing economy is none other than the explosive prevalence of smartphones.

The year-to-year cumulative cost of using a ride-hailing service should be much lower than the annual cost of owning a private car (including the depreciation of the purchase cost). In the case of a major auto power like the United States, Uber was able to develop a large market because the "utility" of owning a private car is almost nonexistent. On the other hand, in Japan, the "show off" effect of owning high-end passenger cars is still large, and the scale of the ride-hailing service market is limited due to the regulation on unlicensed taxis. In the future, the sharing economy is expected to expand further, not only in passenger car, but also in clothing, bicycle, guesthouse, and other markets.

The impact of losing the desire to own on the real economy is immense. You do not own things and use them as needed. Market expansion of the sharing economy will certainly depress economic growth, but it is also certain that it will improve the convenience of life. No one would have expected smartphone penetration to pave the way for the sharing economy.

[Part 1] Chapter 5: Can Basic Income Bring About a Utopia?

1. 3 points of contention over basic income

As we have repeatedly stated, it is likely that a considerable number of workers will lose their jobs as a result of the Fourth Industrial Revolution. At least in Japan, a proposal to introduce the basic income made by Tomohiro Inoue in “The Future of Artificial Intelligence and the Economy: The Great Collapse of Employment in 2030” (Bunshun Shinsho, 2016) is widely supported.

Basic income (BI) is translated as "basic income security" or "minimum living standard security" in Japanese. The system provides the same amount of income to all citizens (including children) without exception. This system is characterized by providing benefits to each individual citizen rather than to each household. In exchange for the introduction of the BI system, existing social security systems such as basic pension, livelihood protection, and minimum wages will be abolished or reduced in whole or in part.

Originally conceived as a measure against poverty, it has been recommended since the 1980s by neo-classical economists aiming for a "small government" as a means of simplifying the social security systems. This is in the hope of reducing administrative costs by unifying the social security systems based on individual measures. The aim of the BI system is to correct the negative effects of various social security systems, which require time and effort for qualification, resulting not only in incurring wasteful expenses such as labor costs, but also in discouraging low-income people from working, while at the same time, leaving the working poor behind.

On the other hand, about half of liberal economists and political parties support the introduction of the BI system itself, or a modified version, in the sense that it guarantees a minimum standard of living for the people. This is also true of socialist parties. In Japan, the Liberal Party is so enthusiastic about introducing the BI system as stated in its election pledge, but the Liberal Democratic Party is clearly opposed to it. Neither other ruling nor opposition parties have come up with a clear revised version, although they have expressed more or less approval.

In June 2016, a referendum was held in Switzerland on the introduction of the BI system (providing 280,000 yen for adults and 70,000 yen for minors), which was rejected by the majority of the people. However, a social experiment on the introduction of the BI system in specific regions is currently being conducted. Besides that, in the Netherlands, Finland, and Canada, community-based social experiments are under way. The following are 3 points of contention about for and against the BI system.

The first is a discussion about the pros and cons of providing the same amount of BI to both the poor and the rich. Liberals and social democrats argue that an income ceiling should be set. Conservatives, who thoroughly insist on simplifying the social welfare system, oppose setting an income ceiling. There are both arguments for and against whether to differentiate payments to adults and minors.

Second, if a BI of 50,000 yen is provided per month, the total amount to be paid to the 125,000,000 population is 62,500,000,000,000 yen. A BI of 200,000 yen that a family of 4 receives in a month can be regarded as enough money to live a minimum standard of living. The question is how to secure financial resources to cover the enormous government expenditure of 62,500,000,000,000 yen. If the social security systems (excluding medical care) are abolished in exchange for the introduction of the BI system, the account will balance. In fiscal 2016, the amount of social security benefits is 118,300,000,000,000 yen. If medical expenses of 37,900,000,000,000 yen are subtracted, it is 80,400,000,000,000 yen, which is more than the expenditure for BI. Therefore, the introduction of the BI system will reduce social security expenses. In addition, the fact that it is no longer necessary to pay social insurance premiums other than those for medical care will lead to the reduction in households' non-tax burden. The abolition of the long-term care insurance system threatens the lives of elderly people, even if it is unavoidable to abolish the state's share of pensions and public assistance.

If the social security systems remain unchanged and the consumption tax is used as a revenue source, the consumption tax rate should be raised by 21 percent. The consumption tax rate of 29 percent is a high level, which is unprecedented in Europe and actually unacceptable. Therefore, it must be said that it is impossible to realize a BI system that guarantees a minimum standard of living to all citizens while maintaining social security as it is. Then, revised proposals are proposed, such as setting an upper income limit, creating a gap between adults and minors, and increasing tax revenues by increasing the

progressive rates on taxable income.

The third question is whether the introduction of the BI system will increase or decrease the motivation to work. On the one hand, there are people who don't want to work (who like laziness, or want to devote time to volunteer work or hobbies) if a minimum standard of living is guaranteed. On the other hand, there are people who choose to get jobs they like and work actively regardless of the amount of salary because they feel secure that a minimum income is guaranteed.

2. Pure mechanized economy and basic income

“In a pure mechanized economy, the ‘basic income’ is the most appropriate system to guarantee the income of workers (who have lost their jobs),” said Tomohiro Inoue. “It is desirable to set a BI payment of about 70,000 yen per person per month, in the sense that extreme inflation can be avoided,” he added (some parts of the quotations are summarized in author’s own way, and the same hereinafter). The total amount of annual payment will be 100,000,000,000,000 yen, but referring to "Basic Income" (Chuko Shinsho, 2015) by Yutaka Harada, “a total of 36,000,000,000,000 yen will be transferred to financial resources for BI through the abolition of the government's contribution to pension, child allowance, and livelihood protection, and through the partial reduction of expenses for the measures for small and medium-sized enterprises, public works expenses, and expenses for agriculture, forestry, and fisheries business (all of them intend to secure income as one of the purposes).” He also proposed “a 25 percent income tax increase to raise a remainder of 64,000,000,000,000 yen, calculated by deducting 36,000,000,000,000 yen from 100,000,000,000,000 yen.” “If a person with an annual income of 4,000,000 yen lives alone, the net burden is only 160,000 yen, the remainder calculated by deducting an annual benefit of 840,000 yen (70,000 yen x 12) from a tax increase of 1,000,000 yen...and a BI benefit for a family of 3 people is 840,000 yen x 3 = 2,520,000 yen. Since the tax increase amount is 1,000,000 yen, a net benefit of 1,520,000 yen will be generated to this household (omitted). As for the income of an elderly people living alone who used to live only on the basic pension, a basic pension of about 960,000 yen (80,000 yen × 12) per year will be reduced by half to 480,000 yen due to the abolition of the government’s share of the pension costs, but it will be increase to 132 (48 + 84) 0000 yen with BI added,” the estimates say.

The above estimates have nothing to do with the pure mechanization of the economy. That's because Inoue is intending to use the personal income tax increase as a source of revenue for BI. Since the majority of personal income comes from compensation of employees, it is hard to accept the proposal as a solution to the "bleak future" in which "the development of AI will deprive more people of their jobs and cut off their income sources," leading to a sharp decline in compensation of employees. It is like the saying, “Counting chickens before they are hatched."

3. Dystopia that reduces opportunities for participation

In addition, Inoue said as follows. “The pure mechanized economy makes BI much easier to implement. At that point, the economy sees explosive growth, with growth rate increasing year by year, and the tax income also increases explosively. The government will get enough taxes to make it ridiculous to worry about the funding source for BI." “It can also increase benefits in proportion as the tax increases. If we adopt a rule where a certain percentage of income, say 25 percent, is allocated to BI, the amount of BI will increase at a rate similar to the economic growth rate."

Why is the "explosive economic growth" possible? Why will personal income tax revenues increase at the same rate as economic growth in the AI society too? Inoue does not explain the reason at all. Basis of the argument that IB is preferable to public assistance based on household units is also hard to accept, given that about 50% of household heads lose their jobs and their income is 0. The monthly income of a 2-member household with an income of 0 is 140,000 yen, and the monthly income of a 5-member household with 3 children is 350,000 yen. The monthly income of the latter is sufficient for a modest life, but it should be said that the monthly income of the former is insufficient to live a minimum standard of living. Although a significant effect can be expected as a measure to cope with the declining birthrate, the basis for Inoue's judgment that the BI system, in which the amount of benefits differs significantly depending on the number of family members, is more desirable than public assistance is unknown.

Inoue said, "AI without BI brings dystopia. But AI with BI brings utopia." In the previous chapter, Thomas More's "Utopia" was introduced, but in More's Utopia, people work 6 hours a day and devote a lot of leisure time to intellectual activities. On the other hand, in Inoue’s Utopia, 1 in 2 of the labor force live like “Every day is Sunday."

I'm sure they have too much leisure. It is hard to believe that such a society is sustainable.

One of the necessary conditions for people to feel happy is the feeling of "participation" in some sense. In Inoue's Utopia, 1 out of 2 people have too much time on their hands while living a modest life with BI because they are deprived of opportunities to participate such as work, human interactions, and social contributions. To me, this is just dystopia.

As of February 2017, the percentage of households receiving public assistance in all households is 1.6% (1,640,000 households). The majority of them are elderly households. However, in a utopia of "AI with BI" which Inoue proposes, 49% of households (as far as we can trust the figures from the joint research between Nomura Research Institute and Oxford University) are actually welfare recipients. Both old and young people are given less opportunity of "participation," and live an idle life. This is truly a dystopia. Everyone wants to be included in the society through work, and long-term exclusion from workplace must be painful and difficult to endure. Anyone who lives in a society, where 1 in 2 people are excluded from their workplace whether they like it or not, will feel anxious and helpless.

We will see later what means are available to give reasons for living and feeling of participation to people who have been excluded from the so-called productive labor, or in other words, to create a Utopia brought by AI.

[Part 1] Chapter 6: Can AI End Industrial Civilization of the Twentieth Century?

1. Who are “teachers" of machine learning?

Let us begin our discussion by showing that the results of the joint research between Nomura Research Institute and Oxford University, which we have covered a number of times, or in other words, the conclusion that “along with the development of the Fourth Industrial Revolution, many occupations will disappear and 49 percent of the labor force will lose their jobs,” is nothing but a product of “arbitrariness” and hard to trust.

A technique called "supervised machine learning" is used to derive this formidable number. It means that the characteristics of each occupation represented by numerical data or binary data (Clause 2) are applied to a given (defined in advance by teachers) mathematical formula and each “extinction probability” is calculated. Who in the world are the machine learning teachers who give mathematical expressions? The “teachers” of machine learning are none other than these 2 people, Michael A. Osborn, an associate professor at Oxford University, and Carl Benedikt Frey, a fellow at Oxford University, who made a name for themselves by publishing a paper titled "The Future of Employment" in September 2014 and showing the shocking results that "47 percent of the U.S. labor force will lose their jobs because they will be deprived of their jobs by artificial intelligence and robots." Associate Professor Osborn is an expert in machine learning, and the fellow Frey is an economist.

Of course, given that the characteristics of each occupation to be used (or to be profiled) and specifications for the formulation of the mathematical formula to calculate the extinction probabilities are given by the “teachers” without clarifying the basis, it is inevitable that the results themselves are criticized as a product of arbitrariness by the non-divine teachers (the above 2 researchers). In the case of Japan, 601 occupations were subjected to the evaluation of whether or not they would disappear. An occupation whose probability of extinction is calculated to be 60% or more is judged to be "extinct" (completely replaced by computers). The joint study concluded that the total number of workers in jobs that will disappear accounts for 49 percent of the labor force.

2. 10 to 20 percent of the labor force lose their jobs

I consider the impact of the Fourth Industrial Revolution on employment as follows. Artificial intelligence (AI) certainly helps make most jobs more efficient, but few jobs will disappear completely. This is because there are almost no professions requiring only routine work, which AI is good at. In other words, there are actually very few professions that require only explicit knowledge (knowledge that can be expressed in words or mathematical expressions) that AI can acquire very easily.

There used to be a profession of telephone operator. Pick up a handset on the left side of a wooden box phone, and turn a handle on the right side to connect the phone to an operator. The operator says hello. You give him or her by voice the phone number of someone who you want to talk to. The operator connects the phone and then you can begin a conversation. Until the connection was automated, telephone operator was one of women's desired professions. But with the automation of the telephone connection, the profession of telephone operator has almost disappeared. However, when you call the main number of a large corporation, government office, or university, you can still find an operator who allocates your call to the extension line. However, the number of operators is small compared to those that Nippon Telegraph and Telephone Public Corporation (now NTT) employed in the past.

With the progress of the Fourth Industrial Revolution, there can be few jobs that will disappear completely, but it is certain that the efficiency and speed of operations will increase. Certified public accountants and certified public tax accountants are judged to be occupations that disappear with a probability of around 90%. Therefore, it is concluded that both occupations will disappear completely. However, I believe that this is not possible. In addition to explicit knowledge, conducting financial and tax audits requires tacit knowledge (knowledge that cannot be expressed in words or formulas, and therefore cannot be acquired by AI) based on a wealth of experience. However, it is expected that the number of accountants employed by auditing firms will be reduced by half due to the improved efficiency of operations.

The same is true of law firms. Most of the work of paralegals who assist attorneys by carrying out routine and limited legal work under the supervision of attorneys will be entrusted to AI, which remembers all the judicial precedents and has memorized the compendium of the Six Laws. Therefore, it is very likely that the profession of

paralegal will disappear. However, it is impossible that the profession of attorney will disappear. That's because AI doesn't have a role to play in interviews with clients and fierce bargaining in courtrooms. However, it is undeniable that the number of lawyers required will decrease because the time required for routine legal work can be greatly reduced and the number of lawsuits that a lawyer can handle will increase.

As described above, although there are few jobs that will disappear as a result of the Fourth Industrial Revolution, the number of workers in most jobs will more or less decrease because each job is made more efficient by AI or robots. Therefore, even if 49 percent is excessive, it is highly likely that 10 to 20 percent of the labor force will lose their jobs.

On the other hand, the Fourth Industrial Revolution is unlikely to create new jobs. Most of the unemployed have to look for jobs at Hello Work. Unless they make up their minds and receive any kind of vocational training, they will have no choice but to get "tough," "dirty," and “dangerous" jobs which were often avoided during the economic boom. The revised Immigration Control Law, which was passed and enacted by the House of Councilors in December 2018, legalized the acceptance of foreign workers in 14 industries, including construction, dining-out, nursing care, agriculture, and accommodation. Depending on the level of proficiency in the skills, workers are divided into those who can stay for up to 5 years (but cannot renew the period and accompany their family members) and those who can stay for 1 to 3 years (and can renew the period as many times as they want and accompany their family members). Those who are particularly skilled are classified as the latter. At present, the above 14 industries are suffering from a serious labor shortage, but the situation will change drastically in 10 years, and fierce competition is expected between foreign residents and unemployed Japanese for jobs in the above 14 industries.

3. AI should be used to realize a utopia

Although the introduction has been long, in the previouschapter, I refuted Tomohiro Inoue’s opinion that "the minimum standard of living for the unemployed should be guaranteed by introducing the basic income." Now, I will present my opinion on what alternatives are possible.

The national income is the sum of the added value earned by individuals living in Japan and corporations with headquarters in Japan from both inside and outside Japan in a year, and is almost equal to the gross national product. National income (at factor cost) is distributed to capital and labor that contributed to production. Income distributed to labor is compensation of employees, and income distributed to capital is redistributed to corporate income, interest income, dividend income, and directors' bonuses. The labor share (compensation of employees divided by national income) in fiscal 2016 was 62.2 percent. After all, just under 60,000,000 people (about half of the population) are employed and contribute to production, so many readers are convinced that it is reasonable for the workers to be given a little more than 60 percent of the value added that is produced in a year.

As mentioned earlier, however, 10 to 20 percent of the 67,200,000 people in the labor force will lose their jobs if many factories become unmanned (robots replace workers), the majority of clerical work are entrusted to AI, the number of professionals required decreases, and professional assistants are no longer be needed. Half of them have to seek jobs in sectors such as nursing care, construction, retail, and cleaning, where labor shortages are chronic and at the same time, replacement by AI and robots is difficult or it is cheaper to hire humans.

And now, income generated in the country is taxed. There are national taxes and local taxes (in order to make the story easier to understand, we focus only on national taxes). Graduated taxation is applied to taxable income after various deductions from income. Under the current tax system, the national tax rate imposed on high-income earners is close to 45 percent of taxable income. As for the tax rate imposed on low-income earners, on the other hand, taxable income is smaller and the ratio of income tax to pre-tax income is extremely lower because the deduction rate is relatively higher. The ratio of total income tax revenue to total compensation of employees is around 5 percent. On the other hand, the tax rate for interest and dividend income is uniformly 20%. The corporate income tax rate is around 23% (in the case of corporate tax, the fact that there is a reduction for small and medium enterprises, and in addition, local tax are omitted).

According to the Nomura-Oxford joint study, the rate of distribution to workers, i.e. the share of the compensation of employees in the national income, will be almost halved from 62 percent. It means that the distribution rate to labor and capital changes from about 6:4 to 3:7. If the average tax rate on the income allocated to capital is 22 percent, the national income tax revenue will increase by about 43 percent. On the assumption of the tax revenue

in fiscal 2017 (31,300,000,000,000 yen, which is the total of personal income tax revenue and corporate tax revenue), total tax revenue from personal income tax and corporate tax will increase by about 15,000,000,000,000 yen. It is the best way to increase employment in public service sectors such as research, art, education, medical care, nursing care, and environment by utilizing the increased tax revenue. If the average cost of employment is 4,000,000 yen per person, about 3,750,000 people can be employed at 13,300,000,000,000 yen. In other words, about 10% of the unemployed can be engaged in public services. As of January 1, 2018, the number of national public employees is 580,000 and the number of local public employees is 2,740,000.

Whether it is the utopia of Thomas More or the future society that Keynes predicted, in which many people will lose their jobs due to technological innovation, it is a step towards a utopia in the sense that people will be freed from the drudgery and burden of labor and become more interested in intellectual activities. By increasing the number of staff involved in caregiving, geriatric nursing, and primary and secondary education, the elderly, the sick, and children will benefit greatly. The intellectual utopias of Thomas More and Keynes can be approached by promoting academic research and enlightenment activities such as literature, art, history, and philosophies, which have been neglected or treated coldly because they have nothing to do with the economy. Only when technological innovation solves economic problems will humanities and art regain their rights. AI will put an end to the industrial civilization of the twentieth century, which prioritizes the contribution to economic growth. Isn't that great?

[Part 1] Chapter 7: The Power Hungry AI

1. Electricity charges account for more than half of the AI development cost of 400,000,000,000 yen

As the advance of the Fourth Industrial Revolution advances, factories will become unmanned and simple clerical tasks will be replaced by artificial intelligence (AI). This is just a "forecast," and we must say that at present, it is uncertain whether it will be realized or not.

Technical availability doesn't immediately drive people and businesses to put them to practical use. Even if it is technically possible to replace human labor with computers, rational companies and governments will continue to employ cheaper workers if massive initial investment or routine operating costs (equivalent to compensation for AI or robots) are required for replacing human labor with AI or robots. Because of cloud computing, you don't have to install a large computer at the initial investment stage. One PC is enough. However, the right to access to cloud computing services is expensive.

The reason why it is so expensive is that AI has to "learn" a huge amount of knowledge through the so-called machine learning to gain far more intelligence than humans have. This requires several or tens of high-speed computers to run for a long time. For example, Watson by IBM, which is touted for its outstanding ability in cancer diagnosis and anticancer drug prescriptions, has learned about 20,000,000 cancer-related clinical papers and about 17,000,000 drug-related materials. It is no surprise that Watson, which has so much knowledge and abilities to search information and recognize image rapidly and accurately, demonstrates superhuman diagnostic and prescription capabilities in cancer genomic medicine.

However, it is said that (a tuition fee of) about 400,000,000,000 yen was spent to have Watson learn a huge number of articles related to cancer medicine. Probably, it can be said that electricity charges account for the majority. As well as the power consumption required to operate a high-speed computer, the power consumption required to cool the heat generated by the computer is considerable. With a variable fee, which is determined in proportion to the number of diagnoses and prescriptions, added to the basic fee for obtaining access to Watson, it will cost 100 to 300 million yen per year.

2. Virtual currency mining site built in a village that thrived on gold

Located near the Italian border of Switzerland, the village of Gondo once prospered from gold mining. After the closure of the gold mine in 1891, the population gradually declined, and now it has become a poor village with a population of 40. In early 2017, a venture company called Alpine Mining offered to “build a blockchain mining site" in this forlorn and poor village. Of course, the village mayor had no idea what the company was going to mine.

According to information of the Internet, a blockchain (distributed ledger) is an "encrypted digital system (ledger) for storing and trading virtual currencies." Virtual currency is "a kind of digital currency that can be used in exchange for goods and services among many unspecified people and companies through the Internet, and can also be exchanged for legal currencies such as yen, dollar, euro, and won through specialized exchanges." So what can be mined in this kind of mining? Mining is said to mean “the calculation to check a blockchain and see if there is any illegal remittance and falsification by decoding encryption because transactions of cryptocurrencies are encrypted.”

A company to mine blockchains of cryptocurrencies will be established in Gondo Village, which once prospered in gold mining. The village mayor welcomed it, saying, “It is just what I wished for.” The mine began operations in November of the same year, but only 6 workers moved in. The cryptocurrency mining site is a small room with computer servers flashing lights and giving a low growl, covered with tangled cables and pipes. If you solve a complex mathematical problem and mine a blockchain successfully, the reward is paid in cryptocurrency. A number of mining companies are competing for high rewards. Because a variety of cryptocurrencies are traded around the world, computers have to run 24 hours at full capacity.

Why did Alpine Mining build the new mine in Gondo Village? There is a high-output hydraulic power plant in Gondo Village. Of course, it was an electric power company that built the power plant. In compensation for the construction of the power plant, the price of electricity in Gondo Village has been reduced to one-third of the official price. In addition, the high altitude and cold climate of Gondo Village contribute to saving power for cooling computers. As a power-intensive company, it was a really rational choice for Mining to focus on cheap electricity

rates and cold climate in Gondo. At any rate, Gondo Village's electricity consumption grew by 50 percent at the same time as mining began. When discussing the pros and cons of virtual currencies, wasteful use of electricity has sometimes been pointed out.

3. Using 12,000 times more power than humans

The following news from Google surprised people in August 2012. They had an artificial intelligence (1,000 high-speed computers) with a multi-layer neural network read 10,000,000 still images randomly taken from YouTube over a period of 3 days. As a result, the AI acquired an ability to recognize cats (neurons responding to cats). This is considered the beginning of deep learning. The AI was able to recognize cats (or sort out images in which cats appear) without asking for any human instruction. It is the so-called "unsupervised learning." Watson has learned a huge number of articles related to cancer medicine under the direction of “teachers.” In this sense, Watson is the gift of “supervised learning.” Even a 3-year-old child naturally acquires the ability to recognize cats. To embed the ability to recognize cats, which is common for humans, we have to keep 1,000 computers running for 3 days. That consumes a lot of power.

In March 2016, Google DeepMind’s Go software with a multi-layer neural network, AlphaGo, played 5 games against a world-class Korean player, winning a landslide victory with 4 wins and 1 loss. It also defeated a Chinese master with 3 wins and 0 losses. AlphaGo is an excellent product that was developed by deep learning based on “unsupervised learning,” which means to repeat self-playing games tens of millions of times, in addition to “supervised learning” of the rules, set sequences, and an enormous number of past game records of Go. The development cost was 1,000,000,000,000 yen. Probably the majority of this is electricity cost.

Progress in machine learning is rapid. In an academic paper published on “Nature” on October 19, 2017, DeepMind revealed AlphaGo 0, the ultimate gift of deep learning. What “teachers” taught to this latest version of AlphaGo was only the rules of Go. By repeating 4,900,000 self-playing games (unsupervised learning) in just 3 days, AlphaGo 0 has acquired an excellent ability to beat the old version of AlphaGo, which won a landslide victory over the Korean Player, with 100 wins and 0 losses. The “fact” that it is harmful and useless to learn set sequences and records of games between professional Go players suggests the following.

Set sequences are a kind of convention for professional and amateur Go players, and it is not always the best way to play games following them. The reason why all the top-class professional Go players bowed down to AlphaGo is that even professional Go players would find it difficult to find the right move within the allotted time in the face of moves by AlphaGo, which seem to be chimerical under the paradigm (framework) of set sequences and have been acquired through “unsupervised learning” by repeating self-playing games tens of millions of times.

Of course, there is no way that a human Go player will be able to compete with AlphaGo 0, which has developed a new paradigm (set sequence) through 4,900,000 self-matches. 4,900,000 games can be played in about 45 years, assuming that 200 Go players play 3 games each day. AlphaGo 0 achieved to play this number of games in just 3 days and created a new paradigm through deep learning. Even a professional Go player cannot immediately understand the meaning of a move that he or she has never seen, and in the end, would lose by a wide margin due partly to the limited allotted time.

So how much electric power is needed for the deep learning for AlphaGo and one match? When one thinks intensively, he or she consumes 21 watts of energy in terms of electricity. The source of energy is, of course, food. AlphaGo, on the other hand, consumes 25,000 watts of electricity (equal to the amount consumed by 12,000 people). The energy efficiency of the human brain is surprising.

4. Electricity rates are a decisive factor for the introduction of AI

The cost of AI depends entirely on power consumption required for deep learning and routine operations. So the key to decide whether humans should be replaced by AI and robots in factories and offices is electricity charges.

Aluminum consumes so much electricity during the refining process that it is called a “can of electricity." After the oil shock, Japan's aluminum smelting industry, which had been the second largest producer in the Western world following the United States, had to disappear due to the rise in electricity rates. Later, Canada and Iceland, whose main energy sources are hydroelectric and geothermal power, became major aluminum producers.

Just as the blockchain mining plant was built in Gondo Village, Switzerland, where electricity rates are low, providers of cloud computing services will have to be located in Scandinavian countries, Switzerland, and Canada, where electricity charges are low. At the end of

the twentieth century, manufacturers in developed countries moved their production bases to East Asian countries in search of cheap labor. Similarly, as competition among cloud providers intensifies, they seek to locate their bases looking for low electricity rates. As a result, the introduction of AI and robots will be accelerated.

However, if a cloud provider has a foreign origin, a large portion of its domestic value-added, which is distributed to capital, flows abroad (it is included in imports in the national accounts). In other words, instead of transferring the full amount of the reduction in compensation of employees to domestic capital, the corresponding amount is transferred to foreign cloud providers via domestic capital.

[Part 1] Chapter 8: Changes in Consumer Behavior Force Major Changes to the Automobile Industry

1. Toyota's entry into the subscription market

In the morning edition of the Nihon Keizai Shimbun issued on February 6,2019, there was an interesting article entitled "Toyota to Enter the Flat-Rate Service Market with Lexus." Here is the highlight of the article.

On the fifth day of the month, Toyota Motor Corp. announced the outline of a fixed price service for its luxury car “Lexus." The service starts in Tokyo on the sixth day of the month, and will be expanded nationwide from this summer onwards. With a monthly fee of 194,400 yen (including tax), customers can select a different car to ride from 6 models, including a new sport utility vehicle, every 6 months for 3 years. The move is aimed at consumers who want to use cars at a low cost, including tax and insurance fees. Fixed price services are widely used for music and video, but it will be a touchstone if it becomes common in the car industry.

Toyota has finally embarked on the car subscription business as an adaptation to the growing trend of young people turning away from driving, changes in consumer behavior that emphasizes "use" rather than "ownership," and the shrinking domestic new car market. The following message from the president is included in Toyota's “Corporate Information.” "I decided to change the business model of Toyota from a ‘car manufacturing company’ to a ‘mobility company.’ In other words, it will be a company that provides all the services related to the ‘mobility’ of people around the world.”

Prior to the Fourth Industrial Revolution, the automobile industry, which has been described as more than a symbol of the twentieth century, is being forced to undergo “a once-in-a-century major change" in terms of both supply and demand. It is certain that such changes will be accelerated at once as the Fourth Industrial Revolution progresses. The signals can be found in the launch of Toyota's subscription business and the president's message.

2. The automobile industry has been the driving force of economic growth

From the end of the nineteenth century to the beginning of the twentieth century, the Second Industrial Revolution completely changed the way people lived in Western developed countries. The second industrial revolution in history was driven by 2 energy sources: electricity and oil. Electric power not only nurtured the electric equipment industry but also paved the way for mass production by promoting the automation of production processes. Oil nurtured the transportation equipment and petrochemical industries, and led the economies of the developed countries to the so-called heavy and chemical industrialization. Among the many new products created by the Second Industrial Revolution, 2 kinds of products, home appliances and passenger cars, stand out in terms of the fact that they drastically changed our daily life. Indeed, the exports of these 2 products had played a role in driving Japan's economic growth since the late 1970s.

Information and communications technology (ICT), which promoted the Third Industrial Revolution, improved the convenience and comfort of electric appliances and automobiles dramatically. Almost all of the manual, hydraulic, and belt-type mechanical parts of automobiles were replaced by electronics technology. Airbags and car navigation systems, which are heavily used by all people, are none other than the outcomes of electronics technology. At the end of 1997, when the Kyoto Conference where the Kyoto Protocol was adopted to oblige the advanced countries to reduce CO2 emissions came to an end, Toyota Launched the Prius hybrid vehicle. The hybrid vehicle, which uses both an engine and a motor to run, doubled its fuel efficiency, which means a significant reduction in carbon dioxide emissions. Smartphones came to play an essential role in everyday life as super-miniature Internet devices. Electronic component manufacturers became one of the cornerstones of the Japanese economy by supplying smartphones and auto parts throughout the world.

There is a phrase called “industrial civilization of the twentieth century.” It means a civilization that has been under criticism since the rise of global environmental problems at the end of the twentieth century, with the aim of mass production, mass consumption, and mass disposal of industrial products. The model for mass production was the passenger car production system that began with the Model T Ford, which was launched in 1908. Every family had a passenger car, not to mention household appliances. Once they start to spread, the demonstration effect will work, putting them on track to mass production immediately. When mass production of industrial products becomes commonplace, large

numbers of jobs are created. Increased employment and higher wages stimulate demand for a variety of goods and services, resulting in smooth economic growth. This creates a “virtuous cycle.” This is the process of economic growth and development that Western developed countries, Japan, South Korea, and China followed mainly through industrialization.

The ratio of the number of automobile-related workers to the total number of workers in Japan is 8.3%, and the actual number is 5,390,000 (the 18-year average). One engine automobile is made by assembling about 30,000 component parts. Steel, various nonferrous metals, petrochemicals, textiles, and electronic components and devices are used as raw materials for parts production. As a result, industrial ripple effects of automobiles are enormous. During the last quarter of the twentieth century, two of the most fundamental drivers of Japan's economic growth were the electronic and automobile industries. However, the trade surplus in the electronic industry peaked at just under 10,000,000,000,000 yen in 1992 and then started to decline. In 2013, the trade deficit started finally (the deficit in products exceeded the surplus in electronic components). Since then, Japan's economic growth has run into an unstable unicycle structure based solely on automobiles.

3. "5 factors" for young people turning away from driving

As I mentioned at the beginning, the automobile industry is undergoing a wave of major changes. Signs of changes are seen in both supply and demand. Now let's focus only on demand-side changes.

Soon after the beginning of the twenty-first century, a trend of “young people turning away from driving” became the talk of the country. This is not a phenomenon peculiar to Japan, but a phenomenon that is more or less common among developed countries. According to various statistical surveys, young people (in their 20s) are far less interested in cars than before, and young people who purchase a car with a large loan of 2 to 3 million yen are now becoming a minority. During the last quarter of the twentieth century, cars were undoubtedly a "symbol of affluence," and owning a high-end private car at a young age was an epitome of what Thorstein Veblen described as “conspicuous consumption.” In fact, automobile sales volume has been on a gradual downward trend since peaking in 1990. Here are some of the reasons why young people are turning away from driving.

First, in Japan, the cost of owning a car is much higher than that in Western developed countries. First, the acquisition tax is imposed when one purchases a car. In addition, the annual fixed expenses including loan repayment, holding tax, insurance premium, and cost of garage are not small. Other than those costs, car inspection fee should be paid every 2 years, and parking fee and repair costs as necessary. Except for the case where a private car is used for commuting, the utilization rate of cars is less than 10 percent in metropolitan areas. On the other hand, in provincial cities, where the population density is low, private cars are indispensable for daily commuting and shopping because there is almost no public transportation. The ratio of light cars to private cars as daily necessities is overwhelmingly high. Migration of young people to metropolitan areas reduces their ownership rate of cars.

Second, obtaining a driver's license takes a long time and costs a lot in Japan. As a result of this and due to the declining birthrate, the number of people in their 20s with driver's licenses is decreasing.

Third, due to the spread of the Internet, young people are looking at the screen of their smartphones anytime, anywhere. Young people have come to avoid cars, which need to be driven, and prefer public transportation (trains and buses), which allow them to stay on their smartphones, when they go somewhere. In addition, one of the reasons people are turning away from driving is that they don't have to go shopping because now they can buy most things online.

Fourth, as young people have become more aware of global environmental conservation, they refrain from using CO2-emitting private vehicles and prioritize the use of public transportation.

Fifth, many young people pursue a "cool" lifestyle. The number of young people who feel that driving a luxury car is "cool" has decreased significantly compared to the past. Such a shift in the values of young people also cannot be overlooked as one of the reasons for the trend of turning away from driving.

4. Consumers value "use" more than "ownership"

The change of the consumer behavior, which emphasizes "use" rather than "ownership" of things including not only automobile but also clothes, is progressing at present. Until about 1970, for example, everyone believed that a watch was a “life-long thing," which means they can use it for a lifetime. In fact, at that time, a spring watch was very expensive. At that time, no

one expected that high-precision quartz watches, which lose or gain only 15 to 30 seconds a month, and atomic watches with perfect accuracy would be released at a low price. There might no longer be durable consumer goods that can be described as “life-long things" in both name and reality. Technological progress, shortening cycle of the fashion, and lower prices have undermined the durability of consumers' durables.

As already mentioned, the cost of owning a car is about 400,000 yen per year (in the case of a typical car). Now in metropolitan areas, very few workers commute by their own cars because it is difficult to arrive at their office in time due to traffic jams. The motive for owning a car is reduced accordingly. As the number of double-income households has increased, the need to own a private car is virtually eliminated because they use online shopping to purchase voluminous goods and buy daily food on the way home from work. A comparison of the number of vehicles per household by prefecture shows that Fukui Prefecture came in first at 1.75, followed by Toyama Prefecture, Yamagata Prefecture, Gunma Prefecture, and Tochigi Prefecture. On the other hand, Tokyo ranked at the bottom at 0.46, followed by Osaka Prefecture, Kanagawa Prefecture, and Kyoto Prefecture. In the end, residents of provincial cities with poor public transportation have no choice but to own cars whether they like it or not. In addition, 2 cars are necessary, one for a husband to commute and one for a wife to go shopping.

The household penetration rate of automobiles (for households with 2 or more members) peaked at 87% at the end of 2003. Since then, it gradually decreased and dropped to less than 80% at the end of 2018. The penetration rate for single-person households is well below 50 percent. The contraction of the domestic automobile market, which has become clear since 1990, is forcing all auto manufacturers to change their business conditions. In his message, Toyota’s president described it clearly as the “model change from a car manufacturing company to a mobility company.” It is none other than the changes in consumer behavior that makes the model change to a mobility company inevitable. Consumers play the main role in the major transformation of the automobile industry.

[Part 1] Chapter 9: The Real Meaning of Intense Competition for Development of Self-Driving Cars

1. History of the movement of people and things

As I mentioned in the previous chapter, the automobile industry is now facing a “period of once-in-a-century major change” or the first major change in its history.

In ancient times, consumers held sovereignty in the market economy. Consumers “pick up" goods and services that manufacturers create and distributors sell, and manufacturers and distributors cannot survive without knowing how to "adapt" to consumer preferences. Manufacturers and service providers, who have a keen sense of what kind of goods and services consumers want, have an advantage in market competition. Under the consumer sovereignty, a company's technological innovation is demand-pull. In other words, a company can achieve the improvement of a product or the development of a new product by responding to implicit demands of consumers.

Let's look back at the history of the movement of people and things. As people begin to live in groups, they need to move and transport goods. Walking and running are the most primitive means of movement and transportation. In any age, everyone has shared the desire to move and transport as fast as possible. In Japan until the Edo period, the legs of people and horses were the only means of movement and transportation, and it is said that traditional express messengers carried documents between Edo and Kyoto in about 70 hours. It was an amazing service to deliver a document or letter from Edo to Kyoto in just 3 days. The fee for the express messenger service must have been very high. People had to rely on horses to transport goods too heavy to be carried by humans. Horses were also used for movement of humans. A palanquin carried by 2 palanquin carriers played the role of what is now called an official vehicle for samurai and court nobles, and a taxi for common people.

Shortly after entering the Meiji period, chair-palanquins appeared for foreigners, but later they were replaced by jinrikisha. It was not until the Edo period that carts began to be used to transport goods. Transportation by cart, such as large hand‐drawn cart, depended on human labor. In the Meiji period, carts were also replaced by bicycle trailers. Needless to say, bicycle trailers driven by tires are superior to large hand‐drawn carts driven by wooden wheels.

It was in January 1898 when cars imported from France ran for the first time on the streets of Japan. Although the number of imported cars from Ford and GM in the United States gradually increased, only a few very wealthy people owned their private cars. Only government officials were allowed to use official cars and only corporate executives to travel by company cars. It was in 1936 when Japan started domestic production of cars. It was just a year before the outbreak of the Sino-Japanese War and military truck was the main production. The cost of passenger car production was so high that, judging from the income level at that time, mass production effect was hardly expected and it was not profitable. The popularization of passenger cars began more than 10 years later, when the high economic growth period arrived after World War Two.

2. Evolution of internal combustion engines and energy conservation

The axises of "progress" in the transport of people and goods were very specific, such as "faster," "more comfortable," "more convenient," and "larger in volume," and the path of progress was obvious to all. In the First Industrial Revolution, steam locomotives, steamships, and others brought about epoch-making advances in transportation. During the Second Industrial Revolution, automobiles and airplanes powered by internal combustion engines fueled by gasoline, light diesel oil, and jet fuel brought about revolutionary advances in transportation. During the Third Industrial Revolution, transportation equipment became a mass of electronics, and progress was made in saving energy for internal combustion engines innovatively and improving the speed of trains. The energy conservation of internal combustion engines was a result of the surge in crude oil prices due to the oil shock in 1973 and the adaptation to the United Nations Framework Convention on Climate Change, which was adopted at the United Nations Conference on Environment and Development held in Rio de Janeiro in June 1992 and entered into force in March 1994. As represented by Toyota's hybrid cars, Japanese automobile manufacturers have been generally recognized as one of the world's top runners in technological innovation for energy conservation.

3. From a car manufacturer to a mobility company

As described in the previous chapter, young people’s

trend of turning away from driving and the shift in consumers' preferences from car ownership (private use) to car use (enjoyment of services) as a means of mobility are underway in many developed countries. One of the measures to adapt to such environmental changes is the change in business conditions from a car manufacturer to a mobility company. As I quoted the remarks of the president of Toyota in the previous chapter, similar messages were delivered by the heads of world's major automakers. A term describing such circumstances, MaaS (Mobility as a Service), seems to have been generally recognized to some extent.

Car manufacturers are not companies that assemble and sell goods, or automobiles, but are companies that provide mobility services. In other words, buying a car is not about owning it, but about enjoying mobility services "anytime, anywhere, and as much as you want" at your own expenses. Even in the case of household appliances, you own them in order to enjoy the services provided by the products. Owning them itself is not your purpose. When the Japanese economy was in a period of rapid growth and automobiles became popular, there were two purposes for owning an automobile. One, of course, is the enjoyment of mobility services. The other is to own a luxury car and show off one's wealth to others. During the bubble economy in the late 1980s, luxury foreign cars such as Mercedes-Benz, BMW, and Jaguar demonstrated the showing-off effect, which was worth paying a lot of money for, to the fullest extent. Luxury cars are more or less superior in terms of "use" because they offer more safety, taking advantage of their comfortable ride and high accelerating power. But those who buy a car with poor fuel efficiency expect it to demonstrate the showing-off effect to display their wealth.

4. Technology-push innovation

In June 2016, Daimler's CEO Dieter Zetsche demonstrated the company's CASE strategy at Paris Salon, one of the world's 4 major motor shows. CASE, a coined word by Daimler, is an acronym for the following 4 words: (1) Connected (access to information network services by connecting to the cloud), (2) Autonomous (automated driving), (3) Shared & Service (sharing and services), and (4) Electric (electrification).

Certainly, these 4 points beautifully summarize the implications of the major changes in the auto industry from the viewpoint of the supply side. As for (1), being connected is essential to achieving automated driving and providing car sharing services, in addition to the advantages such as improved safety, comfortable driving, driving management, and advanced car navigation systems. As I have repeatedly stated, (3) is nothing but the adaptation of car manufacturers to changes in consumer preferences that emphasize usage rather than ownership. (4) not only contributes to the reduction of CO2 emissions and economic cost associated with driving, but also leads directly to the simplification of automated driving.

(2), the centerpiece of the major changes, has not been achieved at least at this point. The US National Highway Safety Administration defines the level of automated driving as follows: Level 0: Driver always performs all operations. Level 1 (Driving Assistance): The system supports any one of acceleration, steering, or braking. Level 2 (Partially Automated Driving): Sensors, radars, and cameras observe the driving environment, and the system performs at the same time two or more of the operations: acceleration, steering, and braking. Level 3 (Conditional Automated Driving): The system performs all of acceleration, steering, and braking, i.e., automated driving, only in certain circumstances or traffic conditions, and asks the driver to drive in other situations. Level 4 (Advanced Automated Driving): The system performs fully automated driving (the driver doesn't have to do anything) only on expressways (or when the weather is normal), for example. But it asks the driver to drive when the car runs on public roads (or when the weather changes). Level 5 (Fully-Automated Driving): The driver doesn't have to be on board and the car is automatically driven.

At this point, all automakers are selling cars of up to level 2, but it is more appropriate to describe them as cars with driving assistance systems rather than self-driving cars because the driver cannot let go of the steering wheel and must always be prepared to step on the brake and the accelerator. Japan's Road Traffic Law allows vehicles of up to level 2 to run on public roads. At present, however, the Road Traffic Law bans self-driving cars of level 3 or higher from running on public roads. It is understandable that cars of up to level 2 are within the scope of the existing Road Traffic Law, as humans are in charge of driving. When it comes to those of level 3 or higher, revision of the Road Traffic Law and fundamental reform of automobile insurance are required to prepare for the practical application because the initiative of driving shifts to the system.

I mentioned earlier that most innovation is demand-pull, but I can't help thinking that self-driving cars are

technology push. The only people who want to privately own a self-driving car are the elderly and the disabled, who are at high risk of driving. Most healthy people must prefer to drive holding the handle and stepping on the acceleration and brake freely. The initial catalyst came in the twenty-first century when the artificial intelligence boom began, and Google and other IT companies embarked on developing software for automated driving as one of the applications. Just as Microsoft's Windows and Google's Android have strong control over basic software for PCs and for smartphones respectively, Google and other companies seem to aim to dominate basic software for self-driving cars.

In the past few years, automakers have been investing in the development of self-driving cars and working with other businesses in the same industry and IT companies to prevent the move. In that sense, the development of self-driving cars is not a demand-pull model, but a classic example of technology-push innovation. At the same time, there must be a fierce war of aggression between different industries, in which IT companies are trying to exercise control over the automobile industry.

[Part 1] Chapter 10: Zero Marginal Cost Society Brought by the Rise of the Internet

1. The emergence of hybrid subscription services

“Diamond Weekly” issued on February 2, 2019, featured an interesting topic entitled “Subscription Revolution.” Let's use 2 examples from this special article to see what the Zero Marginal Cost Society (which is explained later) really is.

"Sony expects to achieve a consolidated operating profit of 870,000,000,000 yen in fiscal 2018, the highest level since its establishment. The key to the success was "hybrid subscription" services, which continue to grow rapidly in the game market." It says that a subsidiary engaged in gaming business, which seems to be far from the mainstream of the electronic manufacturer Sony Corp., raked in an operating profit of 310,000,000,000 yen. The Sony subsidiary launched the PlayStation console in 1994. Since then, it has updated the model several times. In 2010, it began offering a flat-rate all-you-can-play service “PS Plus” for the latest PS4. If you pay 476 yen (excluding tax) per month, you can enjoy online multiplayer game with other users via the Internet. You can also play about 10 new game titles distributed every month, anytime, anywhere, and as much as you want. It now has about 35,000,000 members worldwide. As the number of members increases, regular and continuous revenue from membership fees increases proportionally. The cost of developing a new game title is fixed and independent of the number of members. Since game titles are distributed on the Internet, there is no communication cost. This is the important point.

Panasonic launched a subscription business for consumer electronics in February 2018, but it says that the results are not always good. For example, a TV subscription (which means a flat-rate service for newspaper or magazine in English) is as follows: If you pay 7,500 yen a month, your TV will be replaced with the latest model every 3 or 5 years. This type of subscription business has the following drawbacks: In effect, it is similar to installment payments, forcing customers to buy new products of only Panasonic every 3 or 5 years. Since the performance of a TV cannot deteriorate in 3 years, it is almost needless to replace a TV every 3 years. In addition, is there any expectation that Panasonic can wipe out a large amount of stock of used TV, which it will have to hold?

The success of Sony’s PS Plus is due to its ingenious use of the advantage brought by the Internet, zero marginal cost of communications. Not only in the case of Panasonic, but also in other cases, it is very doubtful whether subscription businesses for things can be a sustainable business model or not.

2. Internet brought a zero marginal cost

Goods and services traded in the market are priced. Positive prices motivate manufacturers to produce goods, making service-selling businesses profitable. An introductory text of microeconomics says as follows: Making goods requires costs. Under the assumption of perfect competition, there are innumerable companies that produce the same thing, and for each company, the price of a product is nothing less than a figure defined by the “god” named the market without clarifying the basis.

A producer who sells goods in a perfectly competitive market is not a price maker, but a price taker, and increases production until the marginal cost (the cost of producing one more unit of a product) equals a given price. In general, the marginal cost is assumed to increase gradually. If the marginal cost is less than the price, the difference is an additional profit of a unit of the product. Therefore, it gives an incentive to rational companies aiming to maximize profits to increase production. In contrast, if the marginal cost exceeds the price, the difference is an additional loss. Therefore, rational companies stop production when the marginal cost equals the price.

American critic of civilization Jeremy Rifkin's "The Zero Marginal Cost Society” (originally published in 2014 and translated version in Japanese by Yasushi Shibata was published in 2015 by NHK Publishing) pointed out that the Internet of Things (IoT) minimizes marginal costs and undermines the adjustability of the market mechanism (to fluctuate prices to balance supply and demand). For example, when sending and receiving e-mail messages, there is no cost other than a very small electricity charge. The cost, or marginal cost, of sending a single e-mail is almost 0. The marginal cost of sending a standard snail mail (letter) weighing 25 grams or less to Japan by express is 262 yen. Because the cost of sending an e-mail message is almost 0 and it can be sent to every corner of the globe in real time, it is unlikely that snail mail (letter) service will win. However, I have to notice that a

document requiring a signature and seal can be sent only in the form of snail mail and it is more desirable that letters of thanks are written in one's own hand with an ink brush or a brush pen.

In fact, the number of postal items such as letters and postcards dropped sharply from 26,200,000,000 in fiscal 2001 to 17,200,000,000 in fiscal 2017. It is said that the main reasons for this are the webification of various bills, the reduction of communication and promotion costs in companies, and the decrease in communication between individuals through letters (including New Year's cards). With the advent of the communication method, e-mail, there is almost no need to spend time, energy, and money sending paper letters. In the future, the postal industry will have to shift its focus from snail mail service (letters) to distribution (transportation of goods).

3. Rise of online shopping

According to “Market Research on Electronic Commerce” (Commerce and Information Research Bureau of the Ministry of Economy, Trade and Industry, April 2018), the market size of mail order sales via the Internet is steadily expanding at an annual rate of just less than 10 percent. The size of the online shopping market reached 16,504,500,000,000 yen in fiscal 2017, accounting for 5.79 percent of household consumption expenditures. In the United Kingdom, China, and the United States, online shopping accounts for more than 10% of consumer spending, while in Japan it remains relatively low. For consumers, attractive points of online shopping are that it is relatively cheap, that goods can be delivered to a specified address in a short time, that the cost of payment (by credit card) is 0, and that menus of goods are well arranged with informative customer reviews. For sellers, it is convenient because they do not need to have a store and can save a lot of rent and labor costs. In addition, they can solicit orders for hot-selling products based on the purchase history of their customers. In the case of a business model like Rakuten Shopping Mall, where millions of retailers have opened their virtual stores, they do not need to keep stock at all.

We cannot deny that the market size of the online shopping for products other than perishable foods will more and more increase in the future. After the Large-Scale Retail Stores Control Law was abolished in 1998, most of the urban shopping avenues became deserted, and the retail market rapidly changed, with supermarkets for daily necessities, mass retailers for electric appliances, and convenience stores for small shopping. But things are changing now. Mass merchandisers, which were believed to be “the strong” that wiped out “the weak,” shopping avenues, are the prey of online shopping businesses. To describe in an extreme manner, they are at the risk of ending up as exhibition halls rather than sales floors. In short, it can be said that online shopping is the leader of the third “distribution revolution” that benefits both sellers and buyers. Since fiscal 2013, the number of Internet users has leveled off at around 83% of the population. Now, more than half of online shoppers use smartphones instead of PCs as their devices. The implementation of cashless systems, which the government is aggressively promoting, will further increase the dependence on online shopping.

4. Distribution revolution in software

When it comes to software for e-books, game titles, music, and video, the distribution revolution is even more serious. For example, once a book is digitized, the marginal cost of selling one e-book is 0. In August 2016, Amazon launched an all-you-can-read subscription service, Kindle Unlimited, which costs 980 yen (including tax) per month. You can read all you want from a selection of more than 120,000 Japanese books and more than 1,200,000 foreign books. Of course, as the number of members increases, regular income increases. However, incremental cost per additional membership is 0. What’s more, the key is that it imposes a limit of 10 downloads per month. It is because books that are interesting to read and likely to be useful are almost certainly going to be downloaded for a fee, or paper-based versions are likely to be purchased. In other words, launching an all-you-can-read subscription service is likely to lead to increases in the number of paid downloads of e-books and the number of sales of paper-based books.

There is also a wide range of services (more than 10 companies) that allow you to read more than 200 magazines (most of them are weekly magazines) for as little as 500 yen per month. As of the end of fiscal 2016, d-Magazine, the largest service in the industry, had 3,250,000 members (e-Book Business Survey 2016). Assuming a membership fee of 400 yen per month, annual sales amount to 15,600,000,000 yen. The total sales of more than 10 companies providing all-you-can-read subscription services is expected to exceed 40,000,000,000 yen in fiscal 2018 (the same as above). In order to motivate the offering of all-you-can-read magazine subscription services, some measures might have been taken such as adjusting the amount of money

allocated to magazine publishers in proportional to the number of views. However, the total amount of money distributed to publishers will only around 10 percent of the revenue from d-Magazine. The cost of digitizing 200 magazines is not so expensive, and the marginal cost of access by members to magazines is 0. Therefore, d-Magazine can secure stable profits as long as the number of members does not decrease.

While it is well known that sales of publications are generally declining, the decline in magazine sales is particularly pronounced. Sales fell from 869,400,000,000 yen in 2007 to 499,700,000,000 yen in 2017. There is no way to estimate the impact of all-you-can-read subscription services on the decrease in the number of copies based on statistics, but considering that the decline has been more severe in magazines than other publications since 2010, it can be said that the impact of all-you-can-read subscription services on the decrease in the number of copies is not negligible. But in the near future, I think it's very likely that the amount of money distributed by companies providing all-you-can-read services will well make up for the decline in sales of paper-based magazines. Magazine publishers specialize in content creation, and readers enjoy the contents through all-you-can-read subscription services. I hope that in the Zero Marginal Cost Society, magazines will leave the world of paper and bloom in the world of the Internet.

[Part 1] Chapter 11: Strategic Cuts in Electricity Rates Determine Japan's Fate

1. The Fourth Industrial Revolution consumes a lot of electricity

The central player of the Fourth Industrial Revolution is AI with deep learning capabilities, but in fact, AI itself is located at a data center far from the field. In other words, it is at a facility dedicated to accommodating and operating tens or thousands of computers, servers, and large numbers of communication lines. In the field, what is needed is only a device to communicate with servers at the data center.

Of course, a huge supercomputer is not brought into the field when AlphaGo plays against a human player. There is only one personal computer as a device near the board. AlphaGo's server, which stands ready at the data center, finds the next move. Necessary information is exchanged instantaneously through the Internet. It is the so-called cloud computing.

Regardless of whether it is a self-driving car or Watson for cancer diagnosis and treatment, a supercomputer isn't needed on-site, and necessary data is sent and received through the device, PC, connected to a data center server via the Internet. In the case of a full self-driving car, the data collected by the sensors, radars and cameras installed in the car is sent in real time to a server in a data center, where the server plays the role of a professional-level driver, such as braking or changing lanes.

Driving a full self-driving car for a month consumes almost the same amount of electricity as a typical household uses per month. The electric power is consumed at the data center. One of the selling points of 5G high-speed mobile communication is the low latency. If a camera in the car detects a person crossing in front of the car, the information is transmitted to the server in real time, and the brakes are applied immediately. The time lag is about 1 millisecond.

When you drive a full self-driving car for an hour, the server must receive the information that the car sends and issue appropriate instructions to prevent accidents and delays without cessation. It's no surprise that it consumes a lot of electric power. Another selling point of 5G is multiple simultaneous connections. It can connect to 1,000,000 devices simultaneously per square kilometer. It seems that there is no need to worry about the congestion in the servers dedicated to automated driving. It is certain that the Fourth Industrial Revolution will dramatically increase electricity consumption.

One of the conditions of location of the data center is low electricity rates. An international comparison (by DECC, 2017) of electricity rates (industrial without tax) in 27 developed countries shows that Japan is the highest at $15.19 per 100 kWh and Norway is the lowest at $3.64 per 100 kWh. Norway is rich in hydropower resources, and 95% of its electricity is generated by hydropower and 4% by wind power. Norway is a major renewable energy power. AI data centers will be concentrated in Northwest European countries and North America, where electricity rates are low, due to the development of communication at higher speed with lower latency and multiple simultaneous connections.

One of the reasons for the high electricity rates in Japan is that thermal and nuclear power accounts for 85% of the generated electricity. In other words, the ratio of renewable energy is low. Until around 1955, it had been said that hydroelectric power was primary and thermal power was secondary and in fact, hydroelectric power accounted for 90% of the generated electricity. However, with the spread of household electric appliances and the progress of industrialization, the demand for electricity increased gradually at an annual rate of around 5%, and coal-fired and oil-fired thermal power plants were constructed one after another, which led to a sudden shift to a situation where thermal power was primary and hydroelectric power was secondary. After the oil crisis in 1973, nuclear power was regarded as the core electricity source, which would play the main role in electricity supply, and there was a continuous rush of construction of new nuclear power plants. In the year before the accident at the Fukushima Daiichi Nuclear Power Plant, the share of nuclear power was close to 30%.

2. New basic energy plan

The "Fifth Basic Energy Plan" adopted by the Cabinet on July 3, 2018, contains the following description. "We will lay the groundwork to make renewable energy the main power source, aiming to achieve the energy mix for 2030 (set by the fourth basic plan)." It is not clear what the phrase "make it the main power source" means, but the numerical target was reconfirmed and it was clarified that "renewable energy would account for 22 to 24% of the generated electricity."

The renewable energy ratio in 2018 was 17.4% (source: an estimation by ISEP based on electricity survey statistics, etc.), and it indicates that the

achievement of the above target is within the range of possibility. However, it is important to note that large-scale hydropower accounts for nearly half, or 7.8%, of the total. When it comes to only new energies, those with the highest percentages are solar power at 6.5%, biomass at 2.2%, wind power at 0.7%, and geothermal power 0.2%.

The basic plan begins with a statement as follows. "There are things to consider whenever planning energy choices. First, we should make efforts, taking the experiences, reflections, and lessons of the Fukushima Daiichi Nuclear Power Plant accident into consideration. Second, the principle of our energy choices has been the energy independence consistently since the end of the war. Third, we should follow the global trend toward decarbonization following the entry into force of the Paris Agreement." Nevertheless, the basic plan does not deviate from the established policy, which places nuclear power as an "important baseload power source," saying that nuclear power accounts for 20 to 22% of the amount of electricity generated."

The Third Basic Energy Plan, which was announced in the year before the accident at the Fukushima Nuclear Power Plant (2010), set a target that nuclear power, which is semi-domestic energy, would account for 53% of the total electricity generated in fiscal 2030 as a trump card for stable power supply and decarbonization. To that extent, Japan's energy policy has been promoted on the premise that "nuclear power could overwhelm other power sources in the light of its low per unit electricity cost and stable supply."

In the basic plan, the only positive reason for placing renewable energy as the main power source is that "we should follow the global trend toward decarbonization." The basic plan points out the difficulties of introducing a large quantity of renewable energy, saying that since the output is unstable depending on the weather, support by auxiliary power sources such as thermal power and water pumping is indispensable and complete decarbonization cannot be expected, and adding that the additional cost for load adjustment cannot be ignored.

Assuming a large-scale and centralized energy transmission and distribution system, it is true that if the share of renewable energy exceeds 20%, it will take time and effort to adjust the load. Let us estimate the cost of adjusting the load based on the changes in electricity rates in Germany, an advanced country in terms of renewable energy.

Germany, which aims to increase the share of renewable energy to 80% in 2050, achieved a 37% share in 2018 (including 2.6% for hydropower). The difference between the fixed price and the electricity rates, as a result of the introduction of the feed-in-tariff system, is mainly added to the household electricity charges, instead of being borne by electric power companies or the government. The surcharge accounts for 23% of household electricity charges (2018). Household electricity charges, including value-added taxes and environmental taxes, have been around 29 Euro cents since 2013, while raw household electricity charges (costs of generating, transmitting, distributing, and selling electricity), excluding taxes and surcharges, have been around 13.5 Euro cents. At least, as far as Germany's experience suggests, it is unlikely that the cost necessary to adjust the load associated with the introduction of a large quantity of renewable energy, which lacks supply stability, will significantly lead to an increase in electricity rates, even if the renewable energy mix will be increased to nearly 40%.

3. Importance of using renewable energy as the main power source

Let's go ahead with the story. All energy sources including thermal, nuclear, and renewable energy power require a large amount of construction cost as initial investment. By comparison among power sources, the marginal cost, which means the cost of generating 1 kWh of additional electricity, is the highest for thermal power, which burns fossil fuels (coal, natural gas, and oil). In the case of nuclear power using enriched uranium as a heat source, the marginal cost is 1 to 2 yen (most of which is nuclear fuel cycle costs). In the case of renewable energy, the marginal cost is 0. Once solar panels or windmills are installed, the free natural energy, such as solar and wind power, can be converted into electricity without human intervention.

As far as the construction cost is concerned, thermal power plants are relatively inexpensive. Before the accident at the Fukushima Dai-ichi nuclear power plant on March 11, 2011, the construction cost of a nuclear power plant with an output of 1,200,000 kW was estimated at about 500,000,000,000 yen. However, as the Nuclear Regulation Authority was newly established and safety standards were strengthened after the accident, the above construction cost soared to more than 1,500,000,000,000 yen. Even in developed countries, which strengthened their safety standards following Japan, the estimated cost of constructing a nuclear power plant was doubled or tripled. All planned

exports of Japan’s nuclear power plants to the United Kingdom and Turkey have remained frozen.

The reason why the resumption of the existing nuclear power plants is attractive to electric power companies is that they can generate a large amount of electricity at a marginal cost of just more than 1 yen per kWh and sell it at an average of just more than 20 yen. After all, because construction costs are sunk costs, or costs that have already been spent and can't be recovered in any event, willingly suspending the operation of nuclear power plants is an unthinkable choice for electricity companies. In the case of coal-fired power generation, whose per unit electricity cost is the lowest as compared to other forms of thermal power, the marginal cost of power generation is almost equal to the cost of coal required for generating 1 kWh of electricity, 5.5 yen. Certainly, as long as we ignore the sunk cost, the marginal cost of nuclear power generation is especially cheap.

European countries other than Norway and Iceland, which are blessed with abundant hydropower resources, were originally highly dependent on thermal and nuclear power, but are now gradually increasing the ratio of renewable energy, mainly solar and wind power, in the energy mix. This is not necessarily only due to the move to abandon nuclear power and promote lower carbon emissions, but also due to the fact that the marginal cost of renewable energy is 0. In addition, it is also because its growth will lead to a gradual decrease in the initial investment cost, and per unit electricity cost of renewable energy, including depreciation costs of equipment, will fall below that of thermal and nuclear power.

Considering the decline in electricity demand due to the decline in the population, the steep rise in the cost of constructing nuclear power plants, the fact that Japan is an importer of fossil fuels, and the need for lower carbon power, it is inevitable that Japan will have to make serious efforts to use renewable energy as its main power source in order to achieve lower electricity rates, which are a necessary condition for locating data centers in the country. If most of the AI data centers are located overseas, Japan will be a massive importer of computer services, and the Fourth Industrial Revolution will certainly bring about a further decline in the Japanese economy.

I'll repeat that. While the Fourth Industrial Revolution will undoubtedly improve productivity, it makes no sense that more than half of the added value will go to overseas data centers. Under the Fourth Industrial Revolution, what determines whether Japan will be a winner or not must be a strategic reduction in electricity rates.

[Part 1] Chapter 12: What Is the MOOC that Revolutionize College Education?

1. Merits and demerits of PowerPoint in college education

The Fourth Industrial Revolution is expected to have a serious impact on the state of college education. Before going to the main topic, let's begin with the Third Industrial Revolution, which changed the landscape of college classes. Instead of blackboards, white screens to display PowerPoint (PPT) slides have started to be installed on walls behind teachers.

PPT, a presentation software for Microsoft's Windows 3.0, was installed on laptops in 1990. Since then, PPT has become an essential software for lectures and presentations at academic conferences, and has often been used in college classes. PPT is a very useful tool for showing pictures, videos, graphs, and diagrams to audience or students. However, when it comes to using it in college classes, the following difficulties cannot be overlooked.

From the Meiji era to the end of the twentieth century, it was common for students to add what a teacher have written or drawn with chalk on a blackboard to their notebooks, such as the main points of the lecture, technical terms, mathematical proofs, and diagrams, and write down summary of the lecture in their notebooks during a college class.

Most graduate students in the United States serve as teaching assistants while they are in school. This is not just to make up for the cost of living, but also to receive training on how to give lessons in front of students as a professional teacher. The ability to teach exciting lessons that are easy to understand and do not make students bored is a prerequisite for becoming a full-fledged college teacher after obtaining a doctorate. One of the decisive factors is the technique of writing on a blackboard. As far as I have experienced, you should divide a wide blackboard into 3 equal parts with chalk to write things excellently from the audience's left to right. In classes where expansion of formulas is featured frequently, the speed at which a teacher writes things on a blackboard and students add them to their notebooks is almost equal to the speed at which students with standard academic skills understand these things. Students who attend an hour or an hour and half of class can understand the contents of the lecture almost completely. They can visit the teacher's laboratory at office hours to ask about points that they could not understand.

Generally speaking, few Japanese college teachers deserve to be called "masters of class." One of the reasons is that there is no system like teaching assistants and almost no opportunity to learn teaching techniques in graduate schools. In addition, many students are reluctant to speak in classes, making it difficult to establish an interactive class like Harvard University Professor Sandel's political philosophy lectures. Bored students are dozing off, chatting with friends next to them, and fiddling with their smartphones. Regardless of whether it is because teachers are not good at teaching or because students are not willing to study, in general, classes at Japanese colleges are far from exciting.

In the late 1990s, PPT became popular in college classes. The whole contents of a lesson are covered in 20 to 30 slides, and their copies are distributed to students in the classroom. PPT class has the following drawbacks (or advantages?): First, it prevents teachers' lack of ability to express things in words (especially when Japanese teachers teach in English) from interfering with students' understanding. Second, students don't have to take notes. Third, students spend more than half of their time in class reading copies of slides rather than listening to teachers, which certainly reduces students' concentration. Fourth, in PTT slides, the summary of a lecture is often written in a bullet list in addition to charts. However, it is difficult to understand the logical context just by reading a copy of PTT slides. In addition, since there is no need to take notes, the contents of a class are hard to remember. Fifth, what stands out is the level of teachers' techniques to create PPT slides, instead of the original excellence of contents and techniques for classes.

As listed above, PPT has both merits and demerits. There is a psychological theory that "listening" while "seeing," in other words, using ears and eyes simultaneously, could be an obstacle to understanding. Apple's Steve Jobs banned the use of PPT in internal meetings and conferences, and Amazon founder Jeff Bezos also prohibited presenters from using PPT and ordered employees to prepare summaries written in sentences in 1 or 6 A4 size papers. It is not only because it cannot deepen on-site discussions, but also because you cannot get the point when you read a copy of slides again later (Masayuki Sato "Amazon's Greatest Rules" 2018, Takarajima).

There is nothing more comfortable for teachers than finishing a college class by only reading PPT slides. It must be the essence of the "master of class" to make students understand only by writing things on a board and giving lectures (oral explanation). On the other hand, students don't have to concentrate on listening to lectures because they no longer need to take notes. Therefore, they focus on (?) reading copies of PPT slides while absently shrugging off what teachers say. That is why the Third Industrial Revolution provided the revolutionary "sacred treasure," making it easier for both teachers and students to give and receive classes without using their brains, or hands to write things on a blackboard and to add them to a notebook.

While PPT certainly eased the works of teachers and students, it required them to pay an enormous cost. First, students lack an understanding of the contents of lectures and it becomes more difficult to remember them. Second, classes using PPT prevent students from honing what the MEXT calls "true academic abilities," those to think, judge, and express. Third, teachers tend to focus only on making their PPT slides look better, putting off creating original and ingenious contents for their lectures. Fourth, students lost the training opportunity to take notes while listening to what teachers say during lectures. When they work in a company or government agency as an office worker after graduating from college, one of the most important skills required is the ability to add the main points of a discussion or meeting to their notebook or memo pad.

In short, the sacred treasure brought by the Third Industrial Revolution, PPT, caused a deterioration in the ability of college teachers to give lectures and the ability of students to listen to lectures, resulting in a significant deterioration in the quality of college education. Because everyone wants to choose an easier way, college classes are now full of PPT slides.

2. Possibility of an online college education, MOOC

The MOOC (Massive Open Online Course) is a good example of the college education revolution brought about by the Fourth Industrial Revolution. Google Vice President Sebastian Thrun, who leads the research and development of self-driving cars, offered "free" online lectures on artificial intelligence in 2011, when he was also a professor at Stanford University. It served as an opportunity for MOOC to put its enormous power on the world map. As soon as the lectures started, 160,000 students registered. They are required to take short tests after every lecture and complete midterm and final exams. Nearly 15% of the 160,000 participants, or 23,000 people, completed the course. The lectures can be offered for free because the marginal cost of attending online classes is 0. Surprised by the figure of 160,000 people, Thrun founded Udacity, an online college specializing in computer science and related fields. The aim of Udacity was to provide free education of the highest standards to the poor living in developing countries far from advanced science. Following Udacity, a series of online colleges have opened. No credits can be earned, but those who complete the course can receive a diploma (Jeremy Rifkin "The Zero Marginal Cost Society").

One of the attractions of online colleges is that you can watch lectures on your laptop whenever and wherever you want, according to your convenience. If you find it difficult to understand or listen, you can stop it at that point and listen again. Textbooks and handouts can be distributed and downloaded online. There is also a discussion forum where you can ask teachers questions and communicate with other students.

The most well-known online college of the lot is edX, which Massachusetts Institute of Technology (MIT) and Harvard University worked together to establish in 2012. The number of registered students in the first year was 155,000. Since then, more than 30 prestigious colleges around the world have taken part in edX, and leading teachers of each school have been in charge of the lectures. Kyoto University, Tokyo University, and Osaka University are also participating from Japan.

Of course, English is the only language used in the online colleges. Therefore, the number of registered Japanese students is still small. In the fall semester of 2012, a 15-year-old boy living in Ulaanbaatar, Mongolia, attended "Electronic Circuits," a course given by MIT for second graders at edX. He became one of the 340 out of 150,000 students who received full marks in short tests and midterm and final exams. The boy entered MIT in September 2013 on favorable terms, including tuition exemption and scholarships, and his future is promising.

At first, it was said that the establishment of online colleges would threaten the existence of existing colleges. But even in the United States, the country of freedom, there seems to be a lot of difficulties for online colleges in giving credits to their students and allowing those who have earned enough credits to graduate. For now, the only thing they can do is issue diplomats of each subject.

3. Introduction of MOOCs into liberal arts education

Finally, I would like to propose a way to utilize MOOCs to reform Japanese college education. First, several colleges form online education consortia. Lectures on the so-called liberal arts subjects, philosophy, psychology, economics, politics, and international relations can be found in the syllabus of any college. Many colleges leave most of their liberal arts classes to part-time teachers even though it has been claimed that liberal arts education is needed. Then I would like to propose the following measures.

Let us suppose that 10 colleges form a consortium. Taking philosophy as an example, philosophy teachers of the 10 colleges hold a number of meetings in advance to discuss the contents of classes, textbooks, and supplementary books. A “master of class" is carefully selected from among the 10 teachers, and students of the 9 colleges attend an hour of MOOC class given by him or her. Teachers of each college supplement the class and answer questions from students in the remaining 30 minutes. If there are 2 generally recognized “masters," they should be in charge of the MOOC every other year. Computer science and data science are also subjects suitable for MOOCs. The creation of the online education consortium gives all students in the participating colleges the opportunity to take as high as possible level of prestigious courses for liberal arts subjects.

[Part 1] Chapter 13: Japanese Institutions and Practices Hinder the Path to the Fourth Industrial Revolution

1. Job cuts at mega-banks

What is often talked about these days is that the 3 mega-banks have embarked on drastic cuts in jobs and their domestic branches. By the end of fiscal 2023, MUFG Bank will reduce its workforce by about 6,000 and its stores by 180. By the end of fiscal 2019, Sumitomo Mitsui Banking Corp. will cut its workforce by nearly 4,000 and shift 430 branches to the next-generation ones that will be improved in efficiency by digital technologies. Mizuho Bank will cut 19,000 jobs in the whole group by fiscal 2026 and consolidate 130 branches by fiscal 2024. According to the morning edition of Tokyo Shimbun issued on May 22, 2019, the bank will go ahead with the job cuts by reducing the number of new graduates to recruit, in addition to natural reduction due to retirement and temporary transfer of employees.

Indeed, many tasks of bank employees are routine work that is easily replaced by computers. As a result, the banking industry is blessed with "opportunities" to produce a high effect (reduction of labor costs) with relatively low IT investment. However, the improvement of the efficiency of banking operations remains within the framework of the Third Industrial Revolution, which is led by computers. This does not mean that an innovation incorporating artificial intelligence (AI), which is breakthrough enough to lead the 3 mega-banks to simultaneously rush to reduce the number of employees and consolidate their branches, has happened.

In the case of most financial institutions, customers can use ATMs at convenience stores to deposit and withdraw money in their accounts, and those installed at the entrance of banks managing their accounts to transfer money or update their account books. Ordinary people are required to go to a bank and receive a face-to-face service at the counter only when they withdraw or transfer a large sum of money exceeding 500,000 yen. As you can see, most banking operations have already been replaced by computers ages ago. The 3 mega-banks have all been forced to cut the number of employees and branches (or shift to the next-generation model) because the ultra-low interest rate policy has been continuing, keeping them from earning profit from interest payments as brokers, and squeezing their profits.

2. "Labor glut" is looming around the corner

On the other hand, non-manufacturing companies other than banks and manufacturing companies have hired more new graduates since 2015. Although companies looking for personnel are aware of securing IT human resources, they have not taken into consideration the fact that they will see an excess of employment sooner or later as the Fourth Industrial Revolution, in which AI with deep learning capabilities will replace many routine tasks, will promote the rapid development of unmanned factories and mechanization of office work in the coming 10 years.

The government has also decided to accept foreign laborers, citing a "serious labor shortage." The government also has no concern that a "serious labor glut" will hit the country around 2030. As of April 1, 2019, foreign unskilled workers were allowed to settle in Japan only in 14 industries, including construction, agriculture, nursing care, lodging, restaurants, and building cleaning. Many foreigners have already entered Japan with visas to study at Japanese language schools and are working at construction sites or convenience stores without studying at all. Japanese language schools do not expel foreign students who do not come to school in order to secure tuition income. The main purpose of the majority of foreign students is not to learn Japanese but to make money in Japan.

The 14 industries in which the restriction has been lifted are facing a serious labor shortage because Japanese job seekers have better job opportunities. Regardless of whether it's because of AI or not, if employment opportunities are going to be significantly reduced in the industries in which Japanese people want to get jobs, they will have to find jobs in the 14 industries where they do not want to work, whether they like it or not. By about 2030, a significant number of factory workers and office workers will be forced to change jobs because factories will be unmanned and many clerical tasks are replaced by AI. According to a joint study by Oxford University and Nomura Research Institute, 49% of employed people will lose their jobs because of AI. However, since the job cuts due to the full-scale introduction of AI are expected to begin first in large enterprises, the most desirable place to find jobs would be SMEs, where AI or robots have not yet been introduced, and they will get the same jobs as

before (such as finance and general affairs). However, many of those who lose their jobs will be forced to find other jobs in one of the 14 industries. If that happens, there will be a fierce job-hunting competition between foreign workers and Japanese unemployed. If this happens, it is highly likely that a right-wing anti-immigration populist party will emerge, as in Western developed countries.

3. Lack of sense of crisis caused by Japanese-style institutions and practices

According to a survey commissioned by the Ministry of Health, Labor and Welfare, "Report by the Study Group on the Effects of IoT, Big Data, AI, etc. on Employment and Labor" (March 2017), when it asked “What percentage of white-collar workers in their mid-50s who graduated college will have their jobs entirely replaced by AI or IoT (and therefore, will no longer needed in their companies)?” 48.2% of companies answered that 0 to less than 10% will, while 27.2% answered that 10 to less than 20%, and 16.3% said 20 to less than 30%. Only 2.8% of the companies said more than 50% will.

Though it is uncertain whether the lifetime employment system is a blessing or a curse, it seems that Japanese companies estimate AI and other factors have comparatively low impact on employment. According to Japanese employment practices cultivated over many years, it is an employer’s duty and an employee’s right to continue to take care of an employee, who is no longer needed, until he or she retires at the age of 65 by transferring the employee to a different position within the company or to a subsidiary, instead of firing him or her. Not only companies but also government offices and colleges are consistently maintaining the practice of lifetime employment.

Therefore, the warning that “49% of the labor force will lose their jobs,” which a joint study by Oxford University and Nomura Research Institute made, is a far-fetched idea for both Japanese companies and their employees. Under normal circumstances, the personnel department in charge of new graduate recruitment should take some measures looking ahead 10 years from now. However, looking at the recruitment situation in fiscal 2019, major companies other than the 3 mega-banks tend to rather hire more new graduates compared to the previous year.

In Japan, where the lifetime employment system is considered a matter of course, employees whose jobs are being replaced by AI or IoT could be no longer needed but will never be dismissed. Many of the companies that responded to the survey commissioned by the Health, Labor and Welfare Ministry must take it for granted that Japanese-style employment practices will continue to be observed. Employees who rely on the safety net of the Japanese-style management, in which companies transfer them into other positions to take care of them until their retirement, do not rush to buy introductory books on IT and data science just because they hear that computers will take over 49% of their jobs.

4. Fundamental review of Japanese-style institutions and practices is required

Even if it is possible that AI and robots will replace the labor, it is another question whether it is valuable in terms of cost-effectiveness. A variety of AI systems with deep learning capabilities are stored at data centers in countries far away, where electricity rates are low. Through the so-called cloud, you can send your company’s financial data from your PC to a data center, leaving the data processing to AI at the data center. For example, if you enter necessary and sufficient data into a PC in the financial department of the company, a data center’s AI system dedicated to finance receive the data via the cloud and immediately send the results of requested data processing back to the PC in the financial department of the company.

The decision to adopt AI will depend on whether the reduction of personnel costs (effect) by cutting workers of the financial department will be higher than the price (cost) of computer services. At first, perhaps, the price of computer services is so high that the costs outweigh the benefits in most companies, and adoption is discouraged. Only large companies that can derive a lot of benefits from reducing labor costs will embark on introducing them. However, if two, three, and more computer service companies begin offering financial AI services, the price of the services will definitely fall as a result of competition. As the price falls, demand increases and the number of companies introducing financial AI services will increase. However, if the lifetime employment system is firmly maintained, the above discussion will have to be suspended. Even if the personnel costs of the finance department are reduced, the cost of securing employment of the department’s staff members until their retirement will increase, and the “effect” may be insignificant.

In the electric and automobile industries, which were at their height under the Second Industrial Revolution, Japanese companies were able to dominate the world

largely because of the Japanese-style employment practices and the affiliated relationship between products and parts manufacturers. Japanese companies and colleges were not able to be the vanguards of technological innovation during the take-off period of the Fourth Industrial Revolution because Japanese-style management, as typified by the Japanese-style employment practices, resulted in harmful effects. In addition, there remains a concern that the Japanese-style institutions and practices could hinder the Fourth Industrial Revolution from making a smooth start. As already mentioned, it is because the effects of introducing AI systems into companies (mainly the reduction of personnel costs) are discounted by the Japanese-style employment practices.

In order to revive the Japanese economy under the Fourth Industrial Revolution, a fundamental review of the Japanese-style institutions and practices must be given the top priority. In order to reorganize national colleges, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) planned to privatize them and incorporate market principles into their operations in fiscal 2004. However, the reality was that "even if the institutions changed, the practices did not change." Perhaps the same is true of corporate management.

The speed of the changes under the Fourth Industrial Revolution is remarkably fast. While smartphones have become popular rapidly (the first iPhone was launched in 2007), China has adapted to the speed and already achieved putting in place cashless services, ride-hailing services, unmanned convenience stores, and unmanned hotels. Unmanned home delivery vehicles and self-driving buses are just around the corner to become commonplace (Nikkei electronic edition published on July 16, 2019). Smartphones are essential to use these unmanned services. It must be said that the Japanese-style institutions and practices that are not compatible with the Fourth Industrial Revolution are the main cause of the widening AI gap between Japan and China.

[Part 1] Chapter 14 "A New Renaissance" to be Realized by the Evolution of AI

1. Is the coming society a utopia or dystopia?

All of the first, second, and third industrial revolutions fostered new industries, developed a variety of new products, and greatly increased economic growth, labor productivity, and convenience and comfort of life. Of course, friction was inevitable at the beginning of the transition, but the welfare of the society as a whole has been significantly improved after living through the period of transition.

However, opinion is divided on how the Fourth Industrial Revolution will change the society, the economy, and our life and whether the coming society will be a utopia or a dystopia. Artificial intelligence (AI) with deep learning capabilities will replace most human labor. Human labor was replaced by machines in the past 3 industrial revolutions as well. However, new industries were created one after another, employment opportunities were expanded, and we were able to avoid a situation where a great number of people became unemployed.

A far-fetched prospect that AI will automate factories, replace most of the clerical works, and cause “nearly 50% of the labor force to lose their jobs” is widely accepted. Some argue that actual public assistance should be available to help those who lose their jobs. If the far-fetched prospect is right and the government provides the livelihood of jobless people unconditionally, 1 out of 2 people in the labor force have to live an idle life. Without a sense of participation in society, all human beings will lose their reason for living. The most basic social participation is labor. About half of the population who have been excluded from the labor force live a life of boredom isolated from society, using the benefits provided by the government as their livelihood. Under these circumstances, the Fourth Industrial Revolution will result in a dystopia, rather than a utopia.

There are certainly jobs that will disappear as a result of the Fourth Industrial Revolution. The joint study by Oxford University and Nomura Research Institute estimates that 63 out of 601 jobs have a more than 98 percent probability of extinction (or will almost certainly disappear). General clerks, medical clerks, receptionists, school clerks, dormitory and condominium administrators, catering chefs, bank clerks, cleaning staff, construction workers, convenience store and supermarket workers, home delivery workers, hotel room staff, train cleaners, and route bus drivers are familiar occupations that the joint research predicts will "almost certainly disappear."

It is certain that the jobs listed on the right are all likely to be replaced by AI or robots. Still, courier service is currently one of the most understaffed jobs, and the number of deliveries will continue to grow indefinitely. It will take several more decades before robots deliver packages by self-driving vehicle. Therefore, the number of delivery workers will never decrease, only increase for the time being. Before route bus drivers are no longer needed, we have to wait until fully self-driving cars are put to practical use.

A considerable amount of deep learning is needed in order to have robots perform superhuman work on behalf of train cleaners, who can clean up cars of a Tokaido Shinkansen train shuttling back and forth from Tokyo Station in 12 minutes (and those of Tohoku and Niigata Shinkansen trains in 7 minutes). It is a hospitality, “Omotenashi” that is unique to human in which passengers receive when they get off the Shinkansen, and the janitors bow at the exit. The cleaning robot's bow is just funny, and the passengers don't feel any appreciation.

After 5 years, 10 years, 20 years, and beyond, the timing of vanishing jobs that the Oxford-Nomura joint research predicts vary. In addition, the disappearance of each job gradually progresses, and it goes without saying that not all employees are dismissed all at once. Therefore, the conclusion of the joint research, "49 percent of the labor force will lose their jobs," must wait until 2050 at earliest.

2. AI and hospitality

As we discussed in the previous chapter, the 3 megabanks have to cut the number of new graduates they hire, aiming to decrease the number of employees in earnest. The banking industry has a plenty of room for reducing the number of people, as most of the work of bank clerks, including the teller, is routine and can be replaced with very basic AI. The ongoing reduction in the number of people at the banks is only a sign that banks, which are suffering from prolonged low interest rates, have made efforts to cut costs and increase efficiency at the expense of hospitality for customers.

If trade friction between the United States and China escalates in the near future, a simultaneous global recession will occur, the global economy will contract, and all industries will have to entrust routine work to

computers as much as possible and proceed for the reduction of the number of new graduates they hire. The following points should be emphasized. The substitution of computers for routine tasks, which is aimed at improving management efficiency, should be positioned within the framework of the 3rd Industrial Revolution (in which computers play a leading role) that began in the late 1960s. A classic example of the reduction of people brought by the 4th Industrial Revolution is the substitution of professional assistants (e.g., a paralegal as an assistant to a lawyer) by an AI that has learned the expertise.

The choice between computers and humans depends on corporate decision making. At least I think it would be better to have a job that involves serving customers, such as a receptionist for visitors. It is too boring for a visitor to tap the keyboard to enter its name and destination and pass through the gate. It's possible to replace human visitors with computers right now, but most businesses rely on humans to accept visitors. This is because that they believe that the value of the hospitality possessed by their receptionist who receives the customer is worth more than the salary that they pay the receptionist. In short, the reason that businesses daringly use people to do what computers can do is to give weight to hospitality toward customers.

3. Increased tax revenue from AI

As mentioned earlier, gross domestic product (gross domestic income) is divided between capital and labor. Currently, the labor share is around 60 percent. However, if the factory becomes unmanned and AI replaces most of the regular routine office work, the labor share will fall to around 20 percent. While the effective tax rate on compensation of employment is about 5 percent, the tax rate on income distributed to capital, such as corporate income, interest dividend income and executive compensation, exceeds 20 percent. Thus, a significant reduction in the labor share would significantly increase government tax revenues. More than 20 percent of the income earned by AI and robots, the core of capital, will be transferred to governments, taxation powers. This means that labor productivity gains from AI, IoT, and big data will double the value added that is distributed to capital, and more than 20 percent of it will be transferred to the government as taxes.

How should the government spend the increased tax revenue? My answer is: Increased tax revenues should be spent to enhance public services, promote useless academic research and education (which are considered worthless under a market economy), and support the development of artists, etc. Specific examples of the enhancement of public services should include free medical and educational expenses, free nursing care, conservation of the natural environment, and the reduction of greenhouse gases, etc. A scholarship system should be established to support young researchers in such useless fields as philosophy, history, archaeology, aesthetics, literature, and pure mathematics, and a government-sponsored research institute should be established to open the door wider for their employment. We offer similar support to young people who aspire to be artists.

Is it not the arrival of the ultimate utopia that mankind should aim for, that people are freed from the "labor" of producing goods and services that can be priced and therefore useful, and that they are given the opportunity to devote themselves to intellectual pursuits that have been regarded as useless or wasteful in the market economy, while living humbly?

4. Renaissance again

The interests of those who have been freed from the economic yoke such as poverty, labor, unemployment, and production, etc. bound to leave the economy and go to philosophy, literature, art and natural science. Ancient Greece threw up philosophers such as Socrates, Plato and Aristotle, and mathematicians such as Euclid and Archimedes. The reason why many wise persons were able to indulge in useless learning was that largely due to the work of slaves (who are said to have made up of one-third of the citizens) working in the poleis (city state). It was the existence of slavery that enabled the people in Utopia by Thomas More to work 6 hours a day, and to spare enough time for intellectual activities.

Until production became mechanized, the so-called 'higher idlers' were supported only by slavery (in Japan, the tenancy system). The teachers of "Kokoro" (The Heart) and many of the high idlers who repeatedly appear in Soseki NATSUME's works are privileged classes who collect rent from tenant farmers, have parasitic landlords as their parents who lead a peaceful life, have no need or desire to work on their own, and can spend their days reading books and thinking without any inconvenience.

The 4th Industrial Revolution will make AI replace stereotyped human labor. As a result, the government should spend a lot of money on human resources development, such as scholars and artists, as one of the

ways to spend the increasing tax revenues. Thankfully, AI plays the role of ancient Greek slaves.

From the 20th century to the 21st century, universities recognized the cultivation of useful human resources (contributing to economic growth) as their main raison d'etre. Private companies employ people and pay them salary if they can contribute to production. Since the middle of the 1950s, Japan has focused on the growth of gross domestic product, and the development and expansion of science or engineering faculties to foster the leaders of technological innovation, which is the driving force of economic growth, has been a top priority in the education policy.

AI, which is said to be the "last technological innovation of mankind," may make the labor involved in production unnecessary. The government, which collects part of the added value (income) generated by AI, should spend much of the increase in tax revenue to promote science (humanities, basic science) and art (including traditional crafts), which are considered useless from the economic (industrial) point of view. That's why.. Renaissance again To be sure, I must say the following: Make needless academic researchers an option for young people. The elites chosen from him or her will be given the privilege of reading, thinking, and debating in laboratories in which the state provides operating expense grants. Paving the way for new renaissance is the reality of the social change brought about by AI.

Part 2: Social Changes Associated with the 4th Industrial Revolution

How will the 4th Industrial Revolution change the society and what are the challenges? Changes in Media (Chapter 1), Law (Chapter 2), Innovation (Chapter 3), Economics (Chapter 4), Labor (Chapter 5), Competition Policy (Chapter 6), and Industrial Structure (Chapter 7) are discussed from the perspective of economics and law.

[Part 2] Chapter 1: The Role of Japanese TV Stations in the 4th Industrial Revolution

Ken-Ichi SHIMOMURA [ii]

[Summary]

It has become an era in which it is easier for individuals to post their own videos on shared sites. A huge number of videos are uploaded by individuals in search of revenue from the ads attached to the videos and the satisfaction of the posts per se and viewed around the world every day. What are the roles of TV stations in this era? In this chapter, we consider the case of Japan, in which television stations are affiliated, and conclude that television stations are expected to search, select, and edit videos provided by individuals on behalf of viewers, to accurately and quickly convey important information to local residents, to sort out the images owned by each TV station, and to produce large-scale programs that cannot be produced without large capital and information networks.

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1. Uploading on video sharing websites as provisions of public goods by individuals

Since Nippon Television (NTV) began broadcasting on August 28th, 1953, it has been the privilege of commercial TV stations that have been licensed by the government for almost half a century to earn advertising revenue through the distribution of videos in Japan. The emergence of online video platforms such as YouTube, which was established in the United States on February 14th, 2005, has made it possible for the individual level in Japan as well. Shared site videos, according to the economic classification, are public goods with non-competitiveness and non-exclusivity. Once someone has consumed an ordinary good (private good), no one else can consume it. However, videos on non-competitive shared sites have inexhaustible consumption opportunities for everyone (except during periods of exceptional congestion). In addition, non-exclusive sharing sites like YouTube, which are not subscription-based, cannot block specific individuals from consumption opportunities. As with commercial TV stations, these shared sites can be operated free of charge simply because of advertising revenues.

Advertising revenue is also a big incentive for individuals who upload videos. A YouTube uploader whose primary purpose is to earn this advertising revenue is called a YouTuber, and is not solely motivated by his or her satisfaction or contribution to his or her organization. Regarding this advertising revenue, according to the "Top-Grossing You Tubers in the World" ranking, a boy born in 2011 in the US made $ 22 Million and $ 26 Million respectively in 2018 and 2019, and ranked first in the world for 2 consecutive years. 1) The reason for this high income is that video is a public good, especially an international one. It has been a long time since the "globalization of the economy" was mentioned, but it is a remarkable example of unexpected phenomena created by "economic globalization" that video clips are so highly valued even though they do not need either real transactions or as much production cost as movies.

Needless to say, video distribution is not just for revenue. Many distributors are interested in the number of views of their videos, in themselves, or in sharing the information of an organization to which they belong. In other words, it can be said that a mutually beneficial relationship has been established in which the shared sites are likened to "landowners" and the uploaders to "farmers." In this case, a video posted by a common person to a public sharing site may be used by a TV station, and it is particularly useful for a news video. These correspond to "voluntary contributions of public goods" in the classical economics.

There are two conditions for an economic model to represent voluntary contributions by individuals of a public good. The first condition is that each individual has "free access to the production technology" for the public good, and the second condition is that each individual receives "direct benefits of his /her own consumption" from the public good. Typical examples are security, disaster prevention, and public health. Conventional TV broadcasting, in terms of public goods production, has been excluded from the analysis of voluntary contribution because the first condition was not satisfied. In video sharing websites, the condition is met. While the second condition is clearly met, it seems important that some video sharing websites should meet a third condition that is not found in traditional models. It means that each individual is an agent who receives "indirect benefits of the consumption by others" from the public goods. In other words, each individual is an economic person who has "altruism," in which he/she feels happy when others are happy. A typical example is those who are committed to charity and volunteerism: In principle, they do not consume at all the public services that are the final outputs even though they contribute by donations and labor. In keeping with the structure of the model, a fully altruistic individual is a person who does not consume public goods but consumes "the satisfaction of others who consume public goods." In the classical economic model, an individual who does not satisfy this third condition is regarded as the basis of an economic person. The main purpose for this is to emphasize that, even in the absence of altruism, each individual has an incentive for voluntary contributions of public goods. However, in the real world, there are many cases in which altruism is the incentive for voluntary contributions of public goods.

In light of the above, the motivation for video uploading by individuals who do not focus primarily on advertising revenue can be divided into those that focus on "direct benefits of their own consumption" and those that focus on "indirect benefits of consumption by others."

The "direct benefits of self-consumption" of public goods are, to be precise, to produce and consume by itself public goods that enhance its own satisfaction by using production technology with strong externalities, and it is an incidental event that the same service is supplied to others due to the nature of public goods. Security, disaster prevention, and public health, as exemplified above, and installing fire-prevention devices and security cameras, and removing wasps' nests from houses, and regularly disposing of garbage to prevent a house from becoming a hoarding house, are the actions taken to directly raise one's standard of living, while considering others in the vicinity. Even in the case of video uploading, the purpose of posting a video containing the uploader's own words (general persons, politicians,

businesspersons, musicians, entertainers, persons of culture, etc.), traveling, eating, drinking, singing, performing, dancing, etc., are not in many cases to enhance the satisfaction of the viewers of the shared site and to enjoy "indirect benefits of consumption by others." The purpose is to "share" the same video which is created in body with many and unspecified people instead of viewing it on your own personal computer as a private property by uploading it to a sharing site and transforming it into public goods. In other words, the motive for transforming one's own video from private goods to public goods without the purpose of advertising revenue is a desire to be known to others and is the sole purpose regardless of the interests and disadvantages of others. Thus, it is decisively different from the direct benefits of one's own consumption of private goods and that of public goods.

In contrast, the emphasis on "indirect benefits of consumption by others" is based on one's desire to simply "inform others" regardless of one's own interests or disadvantages. A clear difference from the "direct benefits of self-consumption" is the existence of the "anonymity" of the contributor, which is expressed in "want to let others know" and "want to be known to others." Videos uploaded to shared sites are easier to keep anonymous than videos broadcast on television. There are some bad points in this regard, but a post by someone who has a pure motivation to "let others know" is a voluntary supply of public goods that is extremely socially beneficial.

Regarding the Kobe Earthquake, which occurred at 5:46 on January 17th in 1995, the existing video records (at least those accessible to the general public) are relatively limited. There are two types of video that can be quoted as the video taken immediately after the occurrence: The video in the station which was automatically recorded when the skip-back recorder of NHK (Japan's public broadcaster) Kobe Broadcasting Station detected the shake, and the video of "Ohayo Tenki desu (Good morning weather)" of Asahi Broadcasting Corporation (ABC, Osaka), which was the only TV station in the Kansai region to broadcast live. Considering the fact that the earthquake occurred early in the morning and that most of the video recordings of ordinary citizens at that time were made on home video, thus, these two videos are extremely valuable. In fact, it was after 8 o'clock when then vision was broadcast live, and it was taken from the sky by a helicopter. On the other hand, the Tohoku Earthquake and Tsunami, which occurred at 14:46 on March 11th in 2011, has many images. There are many stored images that show the situation in which, from the moment of its occurrence, the damages became enormous hour to hour and the buildings were being destroyed, together with the expressions of the people who confronted the scenes. In particular, national TV stations continue to send real-time images of tsunamis seen from helicopters in the sky, local TV stations continue to relay images of coastal areas and urban areas, and in addition, ordinary citizens continue to post images of residential areas and homes one after another on sharing websites. These 3 types of information transmission records can still be confirmed on YouTube. As a historical record, it can be said that the value as a video archive is very high from the necessity of considering disaster prevention from various fields in the future.

In addition, there are intensively used videos taken by ordinary citizens as a news video: They are video clips of the sinkhole near JR Hakata Station on November 8th, 2016. This accident occurred during the tunnel extensionwork of the Nanakuma Line of Fukuoka City Subway. As the time of occurrence was before 5 o'clock in the early morning and abnormal water discharge was confirmed in the pit, the surrounding roads were immediately closed and the closure was completed at 5:10. After that, the road was continuously caved in, resulting in a huge hole about of 30 meters in length and breadth and 15 meters deep. It was only a short time in the early morning that the shooting seemed to be relatively easy. Thus, the TV station did not broadcast live the scene immediately after the accident, and the subsequent scene was broadcast from the sky by a helicopter of a TV station nationwide, but it was after a huge hole had already been made. In short, up to this point, it is similar to the Kobe Earthquake of 1995. However, in the evening news broadcast nationwide, the scene taken from the ground in which two holes on both sides of the road near the sidewalk were gradually enlarged was broadcast first. Then, the broadcast video was what had been taken from a window of a nearby high-rise building, looking down on the ground: The scene was that two holes were connected by an underground cavity made by subway construction, and the road resembling a bridge that was barely built on the holes collapsed. The video camera operators were all ordinary citizens.

As described above, the video sharing websites have been continuously responding to the inexhaustible demand of the general public to supply voluntarily variety and large quantity of videos as public goods owing to the scale of the public nature and the payments of advertisement fees by the sponsors. The "landowner" equivalent for the video sharing service, the "farmer" equivalent for the uploaders, and the "consumer" equivalent for the viewers all became rich. These are undoubtedly the fruits of the 4th Industrial Revolution. But

institutional design naturally lags behind technological and market evolution. The rise of video sharing websites has begun to create problems.

2. The essential difference between video sharing websites and TV

The advent of video sharing websites has also created phenomena not necessarily desirable for the digital society, and eventually for the general public. Some uploaders earn money by illegally copied videos broadcast by TV stations or those produced by other uploaders as a secondary use, and others earn advertising revenue by posting fake news. On YouTube, too, a large number of identical videos can be found using the same search terms, confirming the existence of videos broadcast by TV stations and videos produced by other contributors (especially the former). In the case of YouTube, a video broadcast by a TV station is supposed to be deleted if the copyright manager of the TV program reports an illegal posting to YouTube. However, the same video may be posted a few days later. There are also a number of low-quality videos with text on the photo but the thumbnails look like normal videos, so it's easy to guess that they were uploaded only for advertising revenue. In 1957, the late Soichi Oya, a journalist, said, "It is fair to say that ‘the Transformation of a 100 Million People into Idiots' was being carried out by TV” in Japan. 2) However, the low-quality videos on YouTube have little meaning, and the number of such videos is enormous. Therefore, the impact on the current cultural environment, both in terms of quality and quantity, is incomparably greater than the TV programs criticized by Oya in 1957.

The reason for this problem is that the video sharing website is a place for "voluntary contribution of public goods" and that the "anonymity" of contributors to viewers is guaranteed. In other words, the main factor of the success of video sharing services as a business and as a means of improving the quality of life has become “two-edged blade." In fact, in the context of the production and consumption of public goods in traditional economics, various phenomena that prevent the achievement of Pareto optimality have been pointed out as examples of "market failure" and "prisoner's dilemma," and the disorder caused by this uploader for the purpose of advertising revenue is a situation in which "Gresham's law" can be applied to "the tragedy of the commons," a special case of "prisoner's dilemma." In other words, if you use a video sharing website where all of your contributors post bad videos, no one wants to see the videos on that site, and there should be no ads for the videos. So if you post low-quality videos that are created at no cost to a site that is reputed to have a lot of high-quality videos, you can at least benefit yourself if you post low-quality videos with good thumbnails as if they were of good quality at first glance. However, the quality of the entire videos will be degraded if other people make such intended posts and the number of bad posts increases. This phenomenon can be described as a "tragedy of the commons" in which quality declines rather than quantity. If things become more and more like this, contributors who have valuable videos or are serious about creating new ones will change their sites to other video sharing websites even if they are to pay higher registration fees. In other words, Gresham's law, "Bad money drives out good," is to be established.

Considering the current situation, YouTube, which started its business in 2005, did not think of designing a system that not only focused on the light of its prosperity but also focused on the shadow of its prosperity. Rather, it did not have the time to think about designing a system because of its rapid growth that exceeded expectations. Even though when poor quality videos are posted, good quality videos are voluntarily posted from all over the world at any time, so YouTube runs 24 hours a day and distributes videos of both good and bad quality all over the world.

Then, the role of the television comes into question. The TV stations have been given the initiative in providing information and entertainment from the film companies and have been keeping this initiative for more than 50 years after broadcasting commemorative programs such as "the International Professional Wrestling Match: Rikidozan and Masahiko Kimura vs. the Sharp Brothers " in 1954, the "Wedding of Crown Prince Akihito to Michiko Shoda" in 1959, and "Tokyo Olympic Games" in 1964, but now their position has been threatened by the video sharing service companies. Today's TV stations are at the stage of identifying the problems that movie studios faced half a century ago: "What can only TV do?"; developing a thorough product differentiation strategy against video sharing services; protecting what needs to be protected; and exploring new things through repeated trials and revisions.

3. What only TV can do

Now let's consider the assets that Japanese TV stations should protect and the issues that they should explore newly when they think through the product differentiation. First of all, since anyone can be a contributor to video sharing services, most of them are ordinary citizens who are not trained in video production, and it is expected that the number of people who are professionals in video production and have experience of producing and publicly releasing videos for a relatively long time (30 minutes or more) to the public is limited. On the other hand, it is difficult to enter TV stations located

both in the big cities and in the local cities, and only those who are judged to be the right person are allowed to participate in the production of a program. Although TV stations are subject to various restrictions, including legal regulations, technology, expression, ethics, budget, and consideration for sponsors and other broadcasting stations, TV stations broadcast enough programs to fill the TV schedule for almost 24 hours 365 days a year. What are the competencies of TV producers to support this?

In the first place, there are regulations on entries for television broadcasting. In order to open a broadcasting station and start broadcasting, the station must pass a strict examination and be granted a license from the Minister of Internal Affairs and Communications. In the production of a program, a producer usually supervises the planning, personnel and budget, and the division of labor among a director, AD (assistant director) and many other staff is indispensable. Scripts exist for ordinary programs and are written by professional writers. Whether it is live or recorded, the quality of the program depends on photographers and the voice technology by sound technicians. The accuracy of the information and the appropriateness of the expression are always required, and any broadcast that goes against them should be corrected and apologized immediately. In addition, the program will be discontinued if the above failure is substantial, if there is a failure to achieve a certain rating even with no significant mistakes, or if the program is no longer sponsored. If it is terminated, all the staff will lose their jobs. Producers therefore have a strong incentive to produce the programs that society demands.

In light of the above, the competencies of TV producers, including the organizational skills of the groups they supervise, must be so comprehensive and detailed that they cannot be compared with those of contributors to general video sharing websites. As for long-running shows, the outstanding ability of successive producers can be surmised. The know-how to find and train TV producers is a tradition that Japanese TV stations should keep up.

However, Japan's advertising expenditures by companies through TV peaked in 2016 and began to decline. As a result, according to "Advertising Expenditures in Japan in 2019" announced by Dentsu on March 11th, Internet advertising expenditures were 2,104,800 Million yen (up 19.7% from the previous year), which is the first time that Internet advertising expenditures surpassed television advertising expenditures of 1,861,200 Million yen (down 2.7% from the previous year). 3) This phenomenon is reminiscent of the rapid increase in the number of specialty stores in shopping malls amid a series of department stores closures in recent years. In other words, a large organization with a long history, a distinguished track record and a high profile is threatened by the emergence of a large number of individuals who do not have these strengths. If TV stations recruit talented people but they do not have the opportunity to produce TV programs, they may end up losing their talented people to other companies or to different jobs. TV stations need a strong mission to retain these people.

In light of this situation, TV stations are expected to play the following four roles when individuals can send videos online now and the future.

1. To search, select and edit videos provided by outside agencies on behalf of viewers
2. To convey important information accurately and promptly to the region
3. To classify and organize images owned by the company
4. To produce programs that cannot be produced without large capital and information networks

The first role, "to search, sort, and edit videos provided by outside agencies on behalf of viewers," is, in short, "TV stations should be a good judge." On the video sharing websites, a huge number of videos are uploaded without being censored or classified in principle, and viewers choose videos based only on search terms and thumbnails. The judgement of good or bad depends only on the "evaluation button" and comments of ordinary viewers. It is also possible to consolidate the videos in which politicians talk about with glowing comments and praise from supporters alone. The possible way of sorting out videos on shared sites is aggregation of public ratings, which can be good or bad. The reason for the recognition of Japanese manga as high quality by global standards is because the manga was serialized in weekly or monthly magazines endorsed by the editors with strict "discerning." In addition, the world is full of videos taken by amateurs and professionals, including sharing websites, and there are various types of videos that are neither informative nor commercially valuable. TV stations are expected not only to produce their own programs, but also to play the role of "discerning editors" who select what to broadcast from these videos. That is, in physical sales, it is not the producer but the "intermediary" or "retail" who buys good quality products for sale to consumers. This job cannot be done by amateurs without professional knowledge.

The second role, "To convey important information accurately and promptly to the region," means, in a nutshell, "TV stations should function as an alarm annunciator." Since 1995, the year of the Kobe

Earthquake, natural disasters such as earthquakes, torrential rains, typhoons, infectious diseases have occurred almost every year somewhere in Japan. For the general public, the most important information about these disasters is the degree to which their danger is imminent, and this is nothing but information of the region in which they live. It is not unusual for an announcer of a local TV station to report the latest situation of heavy rain and strong wind. How many citizens survived the 2011 Tohoku Earthquake, after seeing a video of Tsunami by helicopters from the sky on TV and took shelter? Typhoons have been hitting Japan almost every year, and a large number of people across the country probably stopped going out after hearing an announcer say, "Don't go near the sea, the river, or the irrigation channel." At home, however, we can see the images of the raging sea and the swollen river taken by TV stations. This is because television professionals can shoot images as close as possible to with sophisticated equipment and excellent techniques based on their own knowledge and experience although it would be too dangerous for amateurs to do so.

The third one, "To classify and organize images owned by the company," is, in a word, "TV stations should become databases." TV stations have an overwhelming advantage over video sharing services, which began in the 21st century, as they have a long history of broadcasting archives. In recent years, it is conspicuous that NHK and commercial TV stations have cooperated in producing programs on a certain theme, and many programs have been produced by sharing old images. In particular, the deaths of celebrities who played an active role in the Showa era have been frequently reported in recent years, and such a cooperative system is indispensable for programs that look back on the footprints of such celebrities. It is also said that programs that feature popular songs of the past based on a single theme are the "steel-plate TV show," meaning that they can get a high rating without fail. In recent years, TV stations' advertising revenues have been declining, so it is inevitable to reduce production costs. Among them, archive is a precious resource that enables the production of programs by editing existing images, and the high viewing rate of programs by editing increases advertisement revenue, and also promotes the production of programs by new shooting. Such programming is nearly impossible at the personal level, unless a huge number of videos have been collected.

In recent years, NHK regularly broadcasts programs that use old images, delivers them on the Internet, and offers free access to some old programs at NHK stations around the country. These tasks can only be done by broadcasters with more than half a century of history and track record. Since NHK began to systematically keep the master tapes in 1981, it has however been calling on the private sector to provide video records before that. 4) This is because it has become clear that the private sector has tapes that TV stations do not have as master tapes: The private sector has a large number of difficult-to-find items such as tapes recorded by individuals who owned the video and films recorded on TV screens with 8 mm cameras. It is not hard to imagine that the discovery was triggered by the emergence of video sharing services. This is a good example of how a company's entry into the market has provided new opportunities not only for consumers but also for competitors.

The fourth one, "To produce programs that cannot be produced without large capital and information networks," is, in a nutshell, "TV stations should leave behind quality images that will become archives of the future." Except for the latest news programs, the daily news programs in recent years are based on the images that “catch audiences’ interest” such as on-the-spot interviews and live broadcasts. After watching them, the TV presenter often called MC (Master of Ceremonies) communicates with a few of commentators about the news topics in order as planned. The costs of the interview and the relay will be reduced, but if you make even one mistake in the process, meaning that the MC and the commentators will have too much subjective view, then the program will become different from the original purpose. Rather, the style of "special program", which focuses on on-site interviews and video editing by giving it time in any way, is more suitable for archiving.

You can also see what the archive should look like on sports shows: The seventh game of the 1979 Japan Series on November 4th, which matched Hiroshima Carp against Kintetsu Buffaloes (produced by NHK and called ‘Enatsu's 21 Pitches’), and the doubleheader between Lotte vs. Kintetsu on October 19th, 1988 (produced by ABC and called “10.19”) are regarded as a monumental games of Nippon Professional Baseball. These games have been taken up many times by both NHK and private broadcasting. What is included is actual scene and explanation by the announcer on the day and the guest, and the interviews on site to the players and people involved made at a later date including the narration. This is enough for archiving. Some news reports start suddenly without notice, and people are glued to the television. This is true with breaking news on disasters as well. Other than that, the Mishima Yukio Incident (1970), the Asama-Sanso Incident (1972), and the sporting gun kidnapping at the Kitabatake branch of Mitsubishi Bank (1979) were broadcast nationwide instead of the originally scheduled programs of the day. TV programs that reflect on the turbulent times of Showa often use the

images of those times. In fact, the Lotte Orions vs. the Kintetsu Buffaloes, the doubleheader game of Nippon Professional Baseball called "10.19" in 1988, was not shown on the program list of the day except for ABC (Osaka), Higashi Nippon Broadcasting (Miyagi) and Kyushu Asahi Broadcasting (Fukuoka). However, it was suddenly broadcast nationwide by the decision of the upper management of TV Asahi (Tokyo), and not only scheduled programs but also commercials were omitted 5). (Even on the last day of the Asama Sanso Incident on February 28th, 1972, TBS and Fuji TV omitted all the commercials. 6))

It is a unique Japanese TV network that has made it possible to broadcast these nationwide suddenly. In Japan, there are five major private broadcasters with key stations in Tokyo and Osaka: TV Asahi with ABC, TBS with Mainichi Broadcasting, NTV with Yomiuri Television, Fuji TV with Kansai TV, and TV Tokyo with TV Osaka. These are news networks centered around the national newspapers: Asahi, Mainichi, Yomiuri, Sankei, and Nikkei. These affiliates share not only news, but also a considerable number of programs produced by the key stations in Tokyo on a daily basis, so in Japan there are essentially five nationwide TV stations. In the case of "10.19," TV stations affiliated with TV Asahi and ABC nationwide simultaneously broadcasted the game. All of these affiliates have enormous capital and information networks backed by newspaper companies, and are powerful business alliances extending from Hokkaido in the north to Kyushu and Okinawa in the south. There is no organization other than NHK and these five major TV stations that has the power to create a video archive that is a valuable cultural product in terms of Japan's politics, economy and society.

The mission of these organizations is to ensure that this unwavering position and role is maintained, and not giving it to the fast-growing video sharing services. For this reason, TV stations cooperate with each other in the same network to produce programs that are universally evaluated as good quality, and the number of viewers will surely increase if better quality programs are produced through competition among TV stations. Japanese viewers have an experienced eye. It may sound optimistic that advertising budgets will come back to television from the Internet as more viewers turn to TV. The feasibility is however high enough. This is because becoming a sponsor of a popular national TV program will improve the corporate impression of society. In fact, as soon as Toshiba had withdrawn itself as a sponsor from the popular animated TV show "Sazae-san" at the end of March 2018, nearly 10 companies offered sponsorship. Then, Amazon Japan (Internet shopping), Nishimatsuya Chain (baby products), and Daiwa House (home builders), all of which are prominent big companies, were selected.

4. Concluding Remark

The five major TV station networks in Japan, which are centered around main newspaper companies, were designed based on the concept of the late Kakuei Tanaka (Prime Minister of Japan from 1972 to 1974) when he was the Minister of Posts and Telecommunications from July 1957 to June 1958. This project was completed on April 1st,1975, after his resignation as Prime Minister 7). This article concludes by saying that the influence of Kakuei Tanaka on TV stations will continue until the Reiwa era in competing with video sharing service companies as long as the cooperation of TV station networks becomes inevitable for themselves.

[Note]

1) Natalie Robehmed and Madeline Berg (2018) "Highest-Paid YouTube Stars 2018: Markiplier, Jake Paul, PewDiePie and More," *Forbes*, Daily Cover, December 3, 2018; Madeline Berg (2019) "Highest-Paid YouTube Stars 2019: The Kids are Killing it," *Forbes*, Daily Cover, December 18, 2019.
2) Soichi Oya (1957) 'Whatever one wants to say (Iitai Hodai)' *Weekly Tokyo* (*Shukan Tokyo*), February 2nd,1957. Later, the word "*so* = all" came to be attached, and the trendy word "All-100 Million-Will-Become-Idiot-Transformation" were coined.
3) DENTSU INC. "Japanese Advertising Expenditures 2019" News Release March 11th, 2020. https://www.dentsu.co.jp/news/release/2020/0311-010027.html
4) NHKArchives https://www.nhk.or.jp/archives/ NHKTV program Hakkutsu Project Correspondence https://www.nhk.or.jp/archives/hakkutsu/
5) From the explanation of Hiroshi Kume (MC) in the broadcasting "News Station" on December 30th,1988.
6) "Asama Sanso Incident" Wikipedia
7) Masayasu Hosaka (2010) *Tanaka Kakuei no Showa*, Asahi Shimbun Publications.

[Part 2] Chapter 2: Copyright Law's Treatment of Computer Creations

Masaharu MIYAWAKI [iii]

[Summary]

This article introduces basic concepts such as "works" and "authors" under the current Copyright Law, and introduces what discussions have been made on legislation for works in which the use of computers is involved in the creation process, and adds some consideration.

Computer creations (AI products) without human creative involvement are not protected under the current Japanese copyright law. There has been debate about whether future legal changes should be made to protect AI products, but protecting AI products is not consistent with the idea behind the current copyright law. It would be sufficient to take minimal action against the act of claiming that the AI product is a work of its own.

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1. Introduction

Today, the news that artificial intelligence (AI) has created novels, paintings, and other works is becoming more common, and in the future, AI-created works may become pervasive in society. If AI produces art pieces, such as paintings, music, and poetry, whose output is not predictable to the developer, will they be protected by copyright? If not, should they be protected in the future?

This issue has been discussed since the 70s, as described in more detail below, but has not been concluded yet. In the following sections, we introduce basic concepts such as "works" and "authors" under the current Copyright Law, and then introduce some discussions on the legislation of works in which the use of computers is involved in the creation process (hereinafter referred to as "computer creations", and among them, works produced by AI, which is a particular problem today, are referred to as "AI products").

2. Copyright and Authorship Basics

2-1 Copyrightability

To be regarded as copyrighted material, it must be a work to be copyrightable. A work under the Copyright Act is "a creative expression of thought or emotion that falls within the scope of literature, science, art or music" (Article 2, paragraph 1, item 1 of the Copyright Act). The term "thought or emotion" as used herein does not have to be academically or artistically superior, but can be any thought or emotion. If such a thing is expressed in a state that can be sensed objectively by human's five senses, it can be called "expression." With regard to the requirement of "belonging to the scope of literature, science, art or music," it is not usually necessary to consider each of these categories, such as "literature" and "art," and in short, this requirement is satisfied if the expression belongs to the domain of culture. Then, what remains is the requirement to be "creative." In many cases, whether or not a work is a copyrighted work depends on whether the work satisfies this requirement (the requirement of creativity).

In order to satisfy the requirement of creativity, it is not necessary to have a high level of originality or artistic quality. Creativity is traditionally understood to be the manifestation of some individuality. And creativity is denied if expressions will be the same if done by anyone based upon the identical idea, or if they are ordinary expressions. Conversely, creativity is affirmed if the expressions do not apply to these. In recent years, the position of understanding that the 'room for choice' of expression sufficiently remains (the theory of choice) in creativity has become dominant, but since the concrete criterion is the same as the traditional understanding, it can be said that there is no difference in the conclusion between the traditional understanding and the recent dominant theory (theory of choice).

In this way, the hurdle for recognizing copyrightability is not high in general, and even pictures drawn by kindergarteners are copyrightable. However, this is only the case when a real person created it. The above "thought or emotion" is considered to be "thought or emotion" of a real person. Therefore, if a real person is not involved in the process of creating a specific expression, it cannot be said that the "thought or emotion" of a human being is expressed, and the work is not a copyrighted material.

2-2 Author and Creator

The author has a copyright (copyright property right) and moral rights of an author (Article 17 of the Copyright Law). Of these, copyright is transferable (Article 61 (1)), and it is possible that copyright belongs to someone other than the author, but when the work is created (Article 51 (1)), in principle, it is the author who first acquires the copyright, and this is called "creator-on-principle." I would like to explain the concept of this "author" just in case.

The Copyright Law defines "author" as "a person who creates a work" (Item 2, Paragraph 1, Article 2). As mentioned above, in order to be a work, it must be a creative expression (Item 1, Paragraph 1, Article 2). Copyright is the right to the work, and the effect of copyright does not extend to the part that is not a creative expression. That is, even if there is a part in common with an existing work that is created on the basis of an existing work, if that part is not a creative expression but merely a fact or an idea, it is not a copyright infringement. On the contrary, if the essential part of the creative expression is maintained, even if there is a difference from the existing work, the copyright is infringed (if the creative expression which is not in the original is added, it can be regarded as the creation of the adaptation, but this does not exempt the copyright infringement). Considering that creativity is an important concept that determines the scope of

copyrightability and copyright, it is most natural to understand that "a person who creates a work" means a person who makes a creative expression of the work.

Even if it is an act that contributes to the completion of a work, such an act cannot be regarded as a creative act if such a contribution is not directly related to the creative expression of the work. Specifically, the provision of equipment, funds, and opportunities for creation, or the mere provision of ideas, is not a creative act in itself.

The only exception in which a person who has not made a creative act becomes the author is in the following case of a work for hire.

2-3 Work for hire

As already mentioned, the author under the Copyright Act is a person who has made a creative expression. Although a creative act is a factual act that can only be performed by a physical person, the Copyright Act allows an organization such as a corporation to become an author if certain requirements are met (Article 15). There are various theories about the Copyright Act, which defines authors as "persons who create works," but on the other hand, recognizes that corporations which are not allowed to create works can be authors. Here, we explain that the Copyright Act is based on the principle that physical persons who create works are authors, but in certain cases the corporations are assumed to be authors and they are the authors from legal perspective.

In the case of basic requisite for a work for hire, other than a program,

(i) ON THE INITIATIVE OF A COMPANY OR OTHER EMPLOYER ("COMPANY, ETC."):

(ii) A WORK PRODUCED BY A PERSON ENGAGED IN THE BUSINESS OF THE CORPORATION, ETC. IN THE COURSE OF HIS DUTIES

(iii) THE CORPORATION, ETC. PUBLISHES UNDER THE NAME OF ITS OWN WORK

(iv) THE CONTRACT, THE RULES OF SERVICE, TIME OF ITS PREPARATION DO NOT PROVIDE OTHERWISE;

ARE REQUIRED (para. 1, Article 15). In the case of a work of program, the requirement for the title of publication in (iii) above is not necessary (paragraph 2).

2-4 Current Institutional Treatment of Computer Creations

As described above, there are many computer creations that can be said to be creative expressions (if they were created by humans) today, but if there is no human creative involvement, it cannot be said that human "thoughts or emotions" are expressed, and therefore they are not considered to be works. The only exception in the current system in which a person who does not act creatively becomes the author is the work for hire system, and there is no assumption that a machine acts creatively on behalf of a human being.

3. Debate over legislation to protect computer creations

As described above, under the current Copyright Act in Japan, AI products in which humans are not involved creatively are not protected under the Copyright Act. Then, should such works be protected in the future? Discussions on computer creations have been held in various countries, including Japan, since the70s, and are briefly introduced below.

3-1 United States

The debate over the protection of computer creations under copyright law has a long history. For example, in the United States, the National Commission on New Technological Uses of Copyrighted Works was established in 1975. CONTU) also discussed the treatment of computer-generated works.

In the CONTU report, published in 1978, the following were examined as examples of computer creations at that time: assistance in drawing anime, computer composition, and simulation of instrument tones. The report concluded that computers are just like cameras and typewriters, and typewriters; they cannot be authors in their own right. Given the technology of the time, it is only natural. To date, the United States has not provided copyright law with computer creations.

3-2 United Kingdom

The United Kingdom created provisions for computer-generated works through a 1988 amendment to the Copyright Law, which allows computer products without human authors to be protected for 50 years after their creation. That is, Article 178 of the United Kingdom Copyright Act provides that "computer production" means that a work is produced by a computer in the absence of

a human author of the work ", and Article 9 (3) of the United Kingdom Copyright Act provides that" the author of a work produced by a computer is deemed to be the person by who the arrangements necessary for the creation of the work are undertaken. "(The Irish Copyright Act, the New Zealand Copyright Act, etc. have similar provisions.)

An English case in which the application of this provision became a problem is Nova Productions Ltd. v. Mazooma Games Ltd. 1). In this case, the similarity of video games based on billiards was challenged, and the question arose as to who was the author of the screen display (shown below) that was generated in response to user operations. The judgment shall be that the screen representation is the work of the programmer or a computer work. (as referred to Article 9 (3) of the United Kingdom Copyright Act) However, in this case, it is only agreed that the same expression must be used if a similar game is to be created, and the parts that should be protected under the Copyright Act (the creative part) were not similar, so the infringement of copyright is denied.

In other words, this case is a case in which copyright infringement is denied regardless of the author, and whether it is a computer product or not does not influence the conclusion, so the value of this case as a court precedent is low. Also, because the work in question is different from the work created by AI, as was the case with the 4th Industrial Revolution (it is hard to believe that the law of 1988 assumed such a work in the first place), it is not very useful in this respect. There seems to be no court precedent yet in which the authorship of AI-produced works is being contested.

3-3 Japan

In Japan, the protection of computer creations under the Copyright Act has been under consideration since the 70s. In other words, this issue was discussed in the second Committee of the Copyright Council (Computer Relations) established in 1972, and the report 2) was published in 1973. As in the United States, computers of this age are no more than mere "tools," and it is concluded that "the author of a computer creation embodies his feelings of thought as a unique expression in the computer creation."

In the 80s, the ninth Sub-Committee of the Copyright Council (Computer Creations Subcommittee) was established, and studies on computer creations have been conducted. However, computers of this age have not yet come out of the realm of tools, so it is not assumed that computers express themselves creatively. In the Report 3 published in 1993, it is concluded that "if a computer creation is copyrightable, the author is considered to have contributed creatively to the creation of the concrete result, but in normal cases, it is considered to be the user of the computer system." The report says, "At least at this point in time, most computer creations used in various fields can be regarded as human contributions, and internationally, only the United Kingdom has established provisions for computer creations that do not have human authors. It is therefore appropriate to conduct a careful examination while observing international and domestic trends in technology and legislation in the future."

In 2015, when it was predicted that AI would create creations equivalent or superior to human beings (without human involvement in creation), the Cabinet Office, the Intellectual Property Strategy Headquarters, and the Next Generation Intellectual Property System Review Committee discussed "Creations Created by Artificial Intelligence and the Intellectual Property System." The Report 4), which was published in 2016, states that the "future direction" is to "examine in detail how intellectual property protection should be, from the perspective of investment protection and promotion for those involved in certain" high-value "AI creations, focusing on, for

example, the value created by their provision to the market."

In the following year, the Cabinet Office, the Intellectual Property Strategy Headquarters, and the new Information Property Review Committee discussed the copyrightability and authorship of "AI products." However, in the Report 5), it is recognized that "it is difficult at this point to determine a specific direction for the extent of involvement as a creative contribution in a situation where changes in AI technology are very severe and there are not many specific examples." As a future direction, the Report states that "the ongoing understanding of specific examples of AI products" and "the relationship between the copyrightability of AI products and creative contribution……., we will continue to examine the matter in line with specific cases while paying attention to the situation." This direction was also indicated in the “Intellectual Property Promotion Plan 2017,” and was described as a continuing issue from the previous year in the “Intellectual Property Promotion Plan 2018” of the following year, but it is no longer described in the “Intellectual Property Promotion Plan 2019” and the latest “Intellectual Property Promotion Plan 2020.” 6)

4. Examination on the necessity of revising the Act

There is a debate on the need to revise the Copyright Act to protect computer creations (AI products) that do not involve human creativity. The reasons why AI products should be protected under the Copyright Act include (1) the unfairness of not receiving any legal protection from expressions that would be a work if created by a human being, and (2) the issue of content that is self-claimed.

The problem of (1) is that AI products without human creative involvement are not protected by the law, so that such products can be used freely. Indeed, it is intuitive that this is a problem, but it is unclear why it should be protected under the Copyright Act. According to the Copyright Act, copyright is granted to a work in order to provide an incentive for creation. However, AI does not need such an incentive.

What is likely to be a problem is the incentive for the development of AI to create a creative product. However, such an incentive is different from the incentive for creation in the first place, and it is not clear whether the free use of the product itself will reduce AI development. Research and development of human equivalent creations is an attractive research theme in itself, and there seems to be sufficient development incentives for research institutions such as universities, regardless of the legal protection of their deliverables. For commercial AI development, the commercial value of creative AI seems to be high, so there is a possibility that the invested capital can be recovered by selling AI (machines for creation that installed AI), which is a direct product.

Rather, the problem is that, by allowing free use, AI products (without human involvement) can be used much cheaper than content created by humans. In other words, if the AI is able to create a creation equal to or better than a human being, there is a for professional creators to lose their job. But that doesn't mean that the copyright of AI products should be allowed in order to protect professional creators and raise the price of the use of AI products. The cheap availability of good content is welcome in itself, and the possibility of "AI steals jobs" is happening in all professions, and it seems hard to find any reason why professional creators should be treated exceptionally.

The self-claimed content issue of (2) is that there may be a person who claims that a creation created by AI is his or her own creation (in order to receive copyright protection). However, allowing copyright protection for AI products in order to eliminate such a disguised self-claimed incentive seems inadequate as a means. As mentioned above, the free use of excellent content has its own social merit and should not be reduced. It seems that the problem of self-claimed content can be dealt with simply by strictly requiring proof of authorship and by strengthening penalties for self-claimed content. In other words, it will suffice to say that regarding the expression creatable by AI, so long as detailed creation process is not proved, authorship shall not be recognized at the court. At least for the time being, such a revision of the law would be sufficient.

[Note]
1) Nova Productions Ltd. v. Mazooma Games Ltd., [2006] EWHC 24 (Ch).
2) http://www.cric.or.jp/db/report/s48_6/s48_6_main.html

3) https://www.cric.or.jp/db/report/h5_11_2/h5_11_2_main.html#1_2
4) https://www.kantei.go.jp/jp/singi/titeki2/tyousakai/kensho_hyoka_kikaku/2016/jisedai_tizai/hokokusho.pdf
5) https://www.kantei.go.jp/jp/singi/titeki2/tyousakai/kensho_hyoka_kikaku/2017/johozai/houkokusho.pdf
6) For each year's "Intellectual Property Promotion Plan," visit the Intellectual Property Strategy Headquarters website. See https://www.kantei.go.jp/jp/singi/titeki2/.

[Part 2] Chapter 3: The 4th Industrial Revolution and Innovation in the ICT Field and Intellectual Property Rights

Koichiro ONISHI [iv]

[Summary]

In the 4th Industrial Revolution, the importance of R&D investment in the ICT field has been augmenting. However, in the area, the relationship between patent rights among companies is becoming complicated. Besides, in recent years, a large number of players with different interests have entered the market, and the so-called entangled patents problem is becoming severe. To solve this problem, fair, reasonable, and non-discriminatory licensing are required, but such contracts may reduce the profit from R&D. In other words, the patent system that increases the appropriation of earnings from inventions does not function well in the ICT field, and as a result, the appropriate incentive for R&D is impaired, and R&D investment may decrease in the future.

Notice: *The English in this report was machine translated from the original Japanese before undergoing post-editing by human translators. In the event of any discrepancies between this translated document and the Japanese original, the Japanese original shall prevail.*

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1. Introduction

In the 4th Industrial Revolution, progress in software technology, such as AI, and data accumulation, is an increasingly important issue. However, innovations in hardware equipment, such as the minute refinement and miniaturization of semiconductors that support such technology, the speedup and capacity enhancement of communication technology, and the refinement and miniaturization of sensor technology, are also essential. However, the ICT field, including the hardware devices described above, faces various intellectual property rights problems. Originally, there are many patents related to products that count from several hundreds to several thousands in this field, and efforts to adjust patent holders' interests have been carried out mainly by major electronics manufacturers. However, in recent years, while the number of players with different interests has been increasing, there has been a situation in which it is not possible to appropriately coordinate among companies.

As for innovation activities, there is so-called "market failure" in which R&D investment is not made to a socially desirable level due to the fact that investors cannot fully appropriate the profits from R&D investment due to knowledge spillovers. One of the means to solve the problem is the patent system. This is a system for invigorating innovation by granting companies, etc. for their invention the right to use an invention exclusively for a certain period of time, thereby providing an opportunity to secure benefits from the invention. However, while the importance of R&D investment in the ICT field has increased under the 4th Industrial Revolution, the patent system in the ICT field does not function well in this original sense, and as a result, there is a possibility that appropriate R&D incentives may not be provided. This article outlines research and development and patent rights in the ICT field, which plays a central role in the 4th Industrial Revolution.

2. Current status of patents in the ICT field

The patent right is originally a system to exclusively grant the right to use an invention for a certain period in order to promote the invention to the inventor. However, the extent to which a patent allows a company to monopolize the profit from an invention varies greatly depending on the technical field (Cohen et al. 2000). In the chemical and pharmaceutical industries, it is possible to patent chemical agents. Since it is difficult for other companies to imitate it, we can say that the radical patent system functions effectively.

One of the characteristics of the ICT field is that it is impossible for a particular company to monopolize the market by exercising its patent rights. This is because various technologies are used in a product in this field, such as semiconductors, liquid crystal displays, and smartphones, and a large number of technologies are patented in the product. Under the situation, too many patents are related to the product, creating a situation in which it is not known in advance whether or not there is an infringement. And there is always a risk in which companies that manufacture products are infringing other companies' rights. This state is called "Patent thickets" (Shapiro 2001) 1). Again, in areas where patent thickets are occurring, patents don't work in the original meaning that each company makes money from a market monopoly. Patent thickets suggest that companies are always likely to infringe on the rights of others, and that if they manufacture a product under such circumstances, they may be suddenly charged with massive damages for the infringement.

To alleviate this situation, large companies that market their products make a large number of patents that other companies are likely to infringe, so that they can counter-claim infringement if they are sued for infringement. This practice of patenting in which each company tries to acquire rights in patents that are likely to be infringed by other companies is called patent portfolio competition. There is an aspect that such an act further aggravates the patent thickets 2).

With the exception of patent infringement lawsuits between Apple and Samsung, in many cases, companies avoid the lawsuits by negotiating licenses between the parties. 3) However, the issue here is the issue of transaction costs for licensing negotiations and the issue of royalty stacking, which means that it increases manufacturing costs due to the accumulation of license royalties. The both companies will have to agree on the financial value of patents when negotiating a license, but it will take a lot of time and money for them evaluate an enormous number of patents one by one. Such transaction costs can interfere with a firm's production activities. Also, even if an agreement is reached on a low license royalty for an individual patent, the accumulation of the license royalty will result in an increase in the company's manufacturing costs, which makes it impossible for the company to make sufficient profits. And, in the worst case, it may prevent the company from engaging in production activities.

For this reason, large manufacturers in the ICT field have been trying to solve problems using cross-licensing and patent pooling. A cross-license is a licensing agreement between the two companies under which each company can, in principle, freely use the patents necessary for product commercialization free of charge. Cross-licensing avoids paying license royalties for individual patents, thus avoiding the so-called "double marginalization" that arise when licensing each other at monopoly prices (Shapiro 2001).

Another solution is a patent pool, in which multiple companies bring their licenses linked to the products with each other, and have them licensed all at once. However, as discussed in the next section, patent pools can be used as a means of substantially restricting competition. Therefore, under Anti-Monopoly Act, only the essential patents for the manufacture of products are permitted, and licenses are granted to companies that do not participate in the pool at low prices. The impact of such patent pools on firms' innovation activities is discussed in the next section.

Another problem with patent thickets is that patent holders who are not willing to use their patents (Non-Practicing Entities: NPEs) exist. These include not only companies that do research and development by themselves, but also companies that purchase patents from other companies to exercise their rights. Among those companies, what will become particularly problematic is the one in which they use their own patents and warn manufacturers implying injunction or a lawsuit as injuria and they receive settlement money as license royalty as the main source of profit, called the PAE (Patent Assertion Entities: PAEs). They used to be called patent troll. There is a lot of room for these companies to work in the patent tickets, as they are likely to infringe other companies' patents potentially. On the other hand, there is no risk of infringement of other companies' patent rights, and since license royalty itself is the main source of profit, the interests with manufacturers are different, so participation in the patent pool for cross licensing and low-cost license royalty as mentioned above cannot be expected. Therefore, the possibility of litigation by PAE will reduce the profitability of traditional large manufacturers and hinders their commercialization of products. Therefore, in the United States, voices have been raised to restrict the exercise of patent rights centered around large-scale manufacturers. Since the amount of compensation for patent infringement has been large, and such PAE activities have been active, there has been a tendency for policy guidance to weaken the effect of patent rights, such as raising the bar for the suspension of patent rights by PAE, etc., since the middle of the 2000 s. 4)

3. Patent Pools and the Anti-Monopoly Act

Because patents are a recognized system for monopolizing the market, it is not a problem for a company to exercise market control by patents alone. However, it can be a problem under the Antimonopoly Act that multiple companies, such as patent pools, consolidate patents and jointly exercise market power. As an aspect of competitive restriction of a patent pool is there is a possibility that it can be used as a means of conspiracy, such as a price agreement or allocation of production, as several competing firms in the same market come together to negotiate. In fact, in the case of the Pachinko Machine Patent Pool in 1996, cartel activities using the patent pool were recognized. Even if cartel activities are not carried out, it is still possible to use them as a means similar to a cartel by increasing the license royalty of pooled patents so that they can be sold only at a practically monopoly price. Furthermore, it is possible to ease market competition by imposing various conditions on licenses such as market segmentation, restriction of product prices, and entry restrictions. In fact, according to an analysis by Lampe and Moser (2015), which focused on patent pools conducted before World War II, and in which the Anti-Monopoly Act did not apply, the number of patent rights and patent citations in the industry in which patent pools were conducted significantly decreased, and competition in R&D among companies declined.

Due to the above issues, in the United States, the FTC (Federal Trade Commission: Before the Federal Trade Commission (FTC) and the Department of Justice (DOJ) jointly issued guidelines for patent pooling in 1995, the patent pool was almost never allowed. However, it has come to be recognized as a means of eliminating patent thickets in the ICT field, and the competition authorities have come to allow patent pools within a range that does not constitute a restriction of competition by providing such guidelines.

Then, what is a patent pool that is not regarded as restriction of competition? The Japan-U.S. Guidelines provide the following requirements: (1) a patent pool consisted only of essential patents for products in the relevant market; (2) patents in a complementary relationship; (3) agreement concerning FRAND

conditions (fair, reasonable and non-discriminatory) under which licenses are licensed fairly and indiscriminately with appropriate license royalties; and (4) realization of receiving a license of the pooled patents individually. The idea behind these requirements is to prevent the possibility that allowing to pool patents other than essential patents or technologies in alternative relationships may increase the patent pool's market power.

The degree to which such patent pools affect corporate R&D incentives is controversial. According to Joshi and Nerkar (2011), the creation of an Mpeg2 patent pool for an optical disc resulted in fewer patents for both licensors and licensees than non-participating companies. However, Shinbo, Nagaoka and Tsukada (2015) analyzed the impact of the establishment of a patent pool on patent acquisition and R&D investment by companies, the analysis of which includes the generations of standardization of optical discs such as DVDs and Blu-ray discs: They found that both licensers and licensees of the patent pool actively invested in R&D even after the establishment of the pool, and found a tendency to acquire patents not only for technologies related to the patent pool but also for technologies related to next-generation standards.

An important problem associated with patent pools is the existence of outsiders. For vertically integrated companies that do both R&D and product manufacturing, there are benefits to forming and participating in a pool of patents based on reasonable licensing royalties under FRAND conditions as long as they can make money in the product market. However, the benefits of participating in the patent pool are small because the NPE is not profitable when the license royalty is low. Rather, it is possible to increase profits by acting outside the patent pool as a so-called outsider with essential patents for manufacturing. In particular, after a company licensed from a patent pool has invested in production equipment, it is possible to drive the company into holdup by using the injunction of production as a threat for patent infringement.

Competition authorities have accused outsiders of being anti-competitive, as this problem undermines the efficiency of patent pools. As with the PAE, policy tends to weaken the exercise of patents through the issues of outsiders.

4. Standardization and patent

In the ICT field, as seen in communication standards such as 5G, it is possible to enhance convenience for users by making companies' products compatible. In the 4th Industrial Revolution in particular, it is assumed that all things will be connected to the Internet, and the merits of standardizing interfaces for individual devices and software are considerable.

In the ICT field, standardization in which a plurality of enterprises decides a standard in advance has been frequently carried out since 90s. As for standardization, in addition to the case in which the standardization is carried out mainly by the organizations with strong public character such as International Telecommunication Union (ITU), International Organization for Standardization (ISO), and European Telecommunications Standards Institute (ETSI), the formation of a forum in which companies voluntarily gather to decide their own standards is observed. It can be said that the latter is an attempt to gain the benefits of network externality and at the same time to increase market power through cooperation among multiple companies.

It is debatable to what extent the government and other public institutions should intervene in the standardization process, or whether they should be left to the discretion of companies. In general, it is desirable to establish a single standard under the leadership of a public organization, because there is a risk of a proliferation of standards if it is left to the independent efforts of the enterprises. However, Cabal and Salant (2014), for example, pointed out that it may be socially desirable to have multiple standards as a necessary evil, since a single standard by a public body may reduce corporate R&D incentives due to lack of competition, which in turn may reduce social welfare.

Because many ICT-related technologies are often patented, in deciding the technologies set in standardization, companies that have Standard Essential Patents (Standard Essential Patents:SEP) are required to commit to the FRAND condition called the FRAND Declaration in advance in many cases. This is because without the FRAND Declaration, companies that produce compliant products could be forced into holdups by imposing high licensing royalties after incorporating the technology into standard in the standardization negotiations. In order to avoid such risks, essential patents not being declared as FRAND in the standardization negotiation is not basically adopted, as a policy. In the case of standardization, there are cases in which the companies that hold essential patents form a

patent pool and license the patents collectively, and there are cases in which each company negotiates a license. Therefore, standardization is not equal to a patent pool.

Although the FRAND Declaration is indispensable for the smooth development of standardization, there are many thorny problems that enterprises with essential patents may have. In general, essential patents indispensable to products are basic patents, and the value of the invention, as a whole, is high. However, the FRAND Declaration requires reasonable licensing royalties, which makes it difficult to generate sufficient returns from R&D investments. In addition, because FRAND technology can be used by anyone who pays a license royalty, competition in the market will become intense and the product itself can become a commodity. Both the low royalty rates and the intensification of the product market may hurt R&D profitability.

Another recent concern is "holdout" or "reverse holdup" (Nagaoka 2019). This means that any company that has made the FRAND Declaration will have to license indiscriminately; the licensees take advantage of the fact that any of the licensees cannot be excluded. They will not accept the license royalty negotiation in the first place, or they attempt to delay the negotiation, thereby they avoid the payment of license royalties or force them into low-cost license royalty contracts. The actions taken by licensees have also been influenced by the strengthening of a series of restrictions on the rights of patent holders, such as making it more difficult for patent holders to request an injunction by patents in order to prevent PAE and outsiders. From this perspective also, in reality, for R&D companies, the market is becoming very difficult to make profits in proportion to their R&D activities.

5. Open Source Software (OSS)

In order to avoid the risk of patent infringement and the problem of loyalty stacking, globally famous known IT companies centered around Google and Apple, etc.have started to go ahead with Open Source Software (OSS). Open Source Software allows companies to use their patents free of charge if they agree, while participating companies are required to provide their patents free of charge. The provision of these mutually free rights is expected to facilitate entry into the product area by large enterprises and small- and medium-sized enterprises that do not have sufficient patent portfolios (Ceccagnoli and Gorman 2017). However, the free use of patent rights is to restrict the original function of the patent, and, in the first place, it may hold back companies' R&D investment in this field. It is also possible that some companies do not necessarily offer significant patents for such Open Source Software (Hall and Helmers 2013).

6. Conclusion

The intellectual property system is a system to give incentives for innovation activities by giving exclusive rights to enterprises that have made inventions. However, as far as the present situation is concerned, it cannot be said that such functions are functioning properly in the ICT field. Originally, due to the concerns about adverse effects on the product market caused by patent thickets and PAE activities, centrally, large corporations have been working to weaken patent rights since the 2000s, and this has been carried out as a policy. While these moves solve the problem of high license royalties and hold-up issues in the product market, they also force patent-holding companies to license theirs at low prices, which may make it difficult for them to earn enough license income for their R&D investments. According to the OECD report, R&D investment by large enterprises in the ICT hardware industry (Computer & Electronics, Electronic equipment, Telecommunications) is on the decline, globally. 5) Similarly, according to Nagaoka (2019), it has been confirmed that R&D investment in ICT by Japanese companies is on a declining trend. It is not certain whether such tendency is caused by the above factors. However, despite the increasing importance of innovation in the ICT field in the 4th Industrial Revolution, there is a kind of paradoxical situation in which R&D investment is declining in the ICT field. 6)

It cannot be denied that patent pooling, standardization and the accompanying FRAND Declaration are indispensable tools for eliminating patent thickets in the ICT field and avoiding problems of PAE and outsiders. What kind of situation is socially desirable is a subject of analysis for the future, and under such circumstances, it is necessary to discuss further what kind of innovation policy and intervention by competition authorities are desirable.

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[Note]

1) This situation is also called "the Tragedy of the Anti-Commons" (Heller and Eisenberg 1996) The Tragedy of the Commons is a problem caused by excessive consumption of shared resources. But the Tragedy of the Anti-Commons refers to a situation in which resources are not used due to excessive claims of private rights.
2) This situation may hinder the entry of SMEs and start-ups that do not have a sufficient patent portfolio. In fact, in the software field, some studies have shown that the technology sector with more patent rights has fewer new entrants (e.g., Cockburn and MacGarvie 2011).
3) For example, in 2011, when Apple sued Samsung for infringement of smartphone patents, a series of counterclaims were filed by Samsung for patent infringement against Apple, and lawsuits were filed in 10 countries, including Japan. A settlement was finally reached in 2018.
4) However, in the sense of utilizing patents that have not been used by SMEs and large enterprises, the lawsuits have contributed to the development of the licensing market. It is also pointed out that for SMEs with not enough complementary manufacturing assets, it has a side for promoting innovation in terms of monetizing the results of R&D. (Haber and Werfel 2016).
5) Dernis et al. (2019), a report of OECD, analyzed the R&D investment amount of the top 2500 companies investing in R&D in the world. According to the report, if we compare the R&D investment amount in 2012 and with that in 2016 by industries, we will come

to understand that R&D investment in computer & electronics that are ICT-related is on the decline, although the amount is large. The R&D investment amount is also declining in electronic equipment and telecommunications. Like this, that in the ICT-related field, R&D investment by top companies is on the decline is the reality. On the other hand, we understand that R&D investment in IT service, Purchasing, and Broadcasting is increasing. This shows that while hardware-related investment is declining in the ICT-related sector, investment in software-related services using IT is increasing as a global trend.

6) The R&D investment is on the rise in the industries that are expected to advance the use of ICT field in the future, such as IT services, automobiles, finance, and retail (including Amazon) that are leading open source software, and this trend can be seen as a sign that the leaders of innovation are changing. In these industries, ICT technology itself does not depend on profits. Therefore, there is a possibility that they will become innovation driver by acquiring large companies in the ICT industry

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[Part 2] Chapter 4: Economics of Causality and Heterogeneity and Machine Learning

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[Summary]

Recently, "causal machine learning," which is a fusion of machine learning and econometrics, is rapidly advancing. In my lab, Causal Forest is used multilaterally to examine the strengths and weaknesses of causal machine learning. While maximizing the explanatory power, it can be used for a wide range of applications as it can be used not only for causality but also for heterogeneity. Its strength stems from the assumption of conditional independence of the data, which requires “Unconfoundedness.” Also, the difficulty in deriving the marginal effect (deviation coefficient) makes it difficult to carry out the social welfare analysis required for economics, and this is the weakness. This chapter discusses marginal intervention effects, the economics of causality and heterogeneity. Also discussing is Causal Forest, a machine learning of causality and heterogeneity.

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1. Introduction

Artificial intelligence has “weak artificial intelligence” and “strong artificial intelligence.” We can say that the current artificial intelligence is generally weak. Concrete examples of weak artificial intelligence include tools that complement humans, such as automatic driving and Alpha Go. On the other hand, the development of strong artificial intelligence has yet to be seen. Robots like Astro Boy and Doraemon are concrete examples of strong artificial intelligence, but they are still in science fiction.

Weak artificial intelligence and "machine learning" can be considered almost synonymous. It can be said that the "Singularity" in which the artificial intelligence of machines exceeds the natural intelligence of humans is not on this line. There are many kinds of machine learning. Examples include "supervised learning" and "unsupervised learning." What is useful in society now is supervised learning. In supervised learning, it is necessary for humans to prepare correct answers. There is also a way to discern "classical machine learning" from "deep learning." Deep learning has brought about innovation in image recognition and speech processing, while classical machine learning is more effective in economic data.

Next, let's compare machine learning with econometrics. Both are applied statistics, but the difference is that machine learning emphasizes nonparametric estimation and econometrics emphasizes parametric estimation. Machine learning minimizes prediction errors and is excellent in explanatory power, and econometrics (causal inference) is excellent in causal inference. There are differences between machine learning, in which training data and test data are used separately to suppress overlearning, and econometrics, in which hypotheses are tested on the basis of asymptotic nature.

However, the fusion of machine learning and econometrics has been progressing rapidly in recent years. The advent of "Causal machine learning." There is a flow from "Random Forest" to "Causal Forest" discussed in Section 2. It is expected that the Nobel Prize in economics will be awarded soon. In my lab, Causal Forest is used multilaterally to examine the strengths and weaknesses of causal machine learning. While maximizing the explanatory power, it can be used for a wide range of applications as it can be used not only for causality but also for heterogeneity. Its strength stems from the assumption of conditional independence of the data, which requires “Unconfoundedness.” Also, the difficulty in deriving the marginal effect (deviation coefficient) makes it difficult to carry out the social welfare analysis required for economics, and this is the weakness. Econometric methods that exploit causality and heterogeneity have also emerged (called "Marginal Intervention Effects") and are excellent for social welfare analysis with value judgments.

Section 2 discusses marginal intervention effects, the economics of causality and heterogeneity. In Section 3, we discuss Causal Forest, a machine learning of causality and heterogeneity.

2. Economics of Causality and Heterogeneity - Marginal Intervention Effects -

2-1 Introduction

One of the main roles of economics is the evaluation of policies and the prediction of their effects (Heckman and Vytlacil, 2005; Heckman, 2010). To this end, economics has traditionally taken a structural estimation approach using models built from economic theory, but this approach has been criticized for the strength of assumptions and the complexity of estimation methods. On the other hand, the program evaluation approach using experiments and quasi-experiments is widely used as a policy evaluation method because it can identify the effects of treatments while ensuring the transparency of the method. However, there is criticism that the program evaluation approach is not effective in predicting policy effects. A way to compensate for both of these shortcomings is to use the marginal treatment effect (MTE: Marginal Treatment Effects). MTE is interpreted as "the effect of treatment by people who are indiscriminate between receiving and not receiving intervention." MTE can be used to identify the impact of policy changes on the outcomes of interest. This effect is called the effects of policy-related treatments (PRTE: It is called "Policy Relevant Treatment Effects," and it enables prediction of policy effects.

Another advantage of estimating MTE is that heterogeneity of effects can be verified. Heterogeneity in this context means that the effect is different for each individual or group. The heterogeneity of treatment effects provides important implications for policy evaluation. For example, the Average Treatment Effect (ATE: Even if there is no treatment effect when assessed by Average Treatment Effects, the influence of "effective" and "ineffective" may only be annihilated each other. At this time, it cannot be said that policy intervention is ineffective. It is also possible that to realize the targeting

of policy interventions based on observable attributes of effects can be explained. On the other hand, heterogeneity of intervention effects is not always explained by observable attributes alone. For example, the impact of an intervention may vary depending on the preference for the intervention and the cost of receiving the intervention. However, these attributes are often not observable. It is MTE that makes it possible to verify the heterogeneity of intervention effect by such unobservable factor. In other words, MTE can also be interpreted as "a treatment effect conditioned by observable and unobservable factors."

2-2 What is MTE?

The observed outcome Y is expressed as D with or without of a policy intervention. However, to receive intervention is $D = 1$ and not to receive intervention is $D = 0$. The observed outcomes are:

$$Y = DY_1 + (1 - D)Y_0$$

Like these. (Y_0, Y_1) are the potential outcomes and are determined as follows:

$$Y_j = \mu_j(X, U_j), j \in \{0, 1\}$$

Where μ_j is an arbitrary function, X is an observable variable, and U_j is an unobservable variable.

The MTE's analytical framework determines whether an individual will receive intervention. This choice is determined as follows:

$$D = 1[D^* \geq 0], D^* = \mu_D(Z) - U_D \qquad (1)$$

In equation $1[\cdot](1)$ is an indicator function and μ_D is an arbitrary function. Z is an observable variable and contains X. However, among Z, it is assumed that there is an exclusion variable not included in X. U_D are an unobservable continuous variable and (U_1, U_D) and (U_0, U_D) are assumed to be independent of Z when conditioned by X. In here, the propensity score U_D is expressed as $[0, 1]$ if $P(Z)$ is normalized as $P(Z) \equiv \Pr(D = 1 \mid Z) = \mu_D(Z)$ so that it is uniformly distributed in.

Under the above setup, the MTE is defined as follows.

$$\text{MTE}(x, u_D) \equiv E(Y_1 - Y_0 \mid X = x, U_D = u_D)$$

Thus, the MTE represents an intervention effect conditioned by observable X and unobservable variables U_D. Since $U_D \sim \text{Unif}[0, 1]$, individuals whose u_D is close to 0, for example, are more likely to receive intervention with respect to unobservable variables. Like this, the MTE enables the inference of the effect of an intervention according to the "acceptability of the intervention." In addition, MTE refers to individuals who are $\mu_D(z) = u_D$. In short, it is "indiscriminate between receiving and not receiving intervention." It can also be interpreted as the effect of individual intervention.

Then, how can we guess MTE? In Heckman and Vytlacil (1999, 2005), the local manipulated variable method (LIV: Local Instrumental Variables) is proposed. LIV is defined as the outcome of derivative conditioned $P(Z) = p$ and has been shown to be:

$$\frac{\partial E(Y \mid P(Z) = p, X = x)}{\partial p} = \text{MTE}(x,)$$

In other words, the MTE can be determined nonparametrically by differentiating $E(Y \mid P(Z) = p, X = x)$ by the tendency score. Figure 2-4-1 below shows an example of estimated MTE. In this example, the MTE is on the decline with respect to U_D. That is, individuals who are more susceptible (u_D is closer to zero) to an intervention of an unobservable variable are more likely to benefit from the intervention. On the other hand, individuals who have bigger u_D and less susceptive to the intervention have smaller effect of the intervention. In particular, the sign of the intervention effect has changed from positive to negative at around $U_D = 0.8$. Thus, estimating MTE allows for discussion of the heterogeneity of intervention effects.

2-3 The Application of MTE

Carneiro, Heckman, and Vytlacil (2010, 2011) examined the effects of college entrance on wages by estimating parametric or semi-parametric MTE. As a result, we perceived declining MTE. Thus, individuals with fewer obstacles for college entrance tend to show higher effect on wages with respect to unobservable variables. In addition, the marginal policy-related treatment effects that can detect marginal effects of policy changes under the weak support condition (MPRTE: "Marginal Policy Relevant Treatment Effects" is defined to measure the marginal effects of policies that promote advancement to university.

In an earlier study, Cornelissen et al. (2018), under the

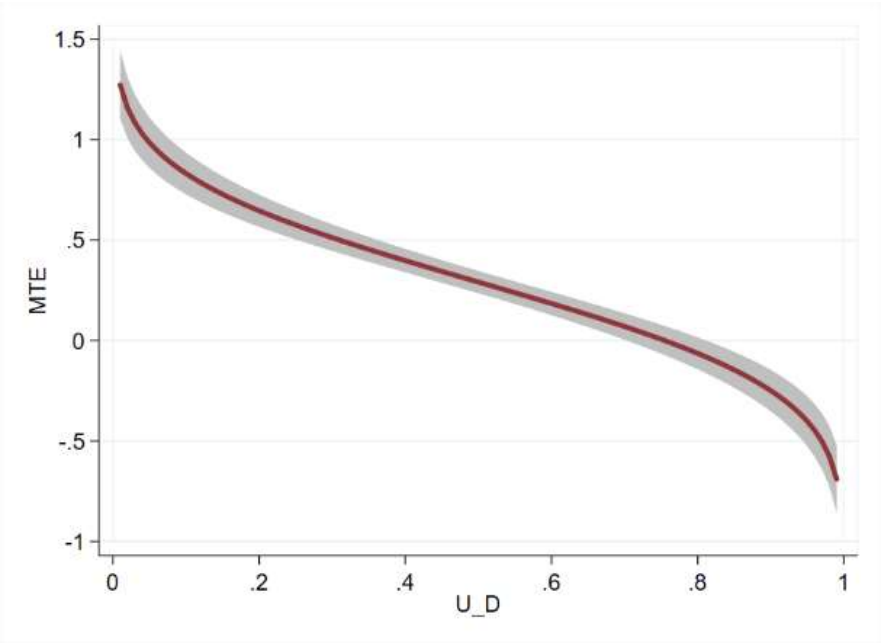

Figure 2-4-1 Sample Estimation of MTE

problem consciousness in which there is no consensus on the impact of a child care program on child outcomes, estimated MTE and pointed out that heterogeneity of effects due to observable and unobservable variables is the factor. In particular, the MTE function shows that the more difficult an individual is to receive a child care program with respect to unobservable variables, the more effective the child care program is. In addition, PRTE is derived from the estimated MTE to simulate the effects of implementing policies to increase the participation rate in child care programs.

In addition to the benefits of policy intervention, the costs of intervention are also important for policy. Eisenhauer et al. (2015) proposed a method for identifying and estimating costs by applying the MTE framework, even when there is no direct information on costs. Recall that MTE can be interpreted as an individual intervention effect in which it is "indiscriminate between receiving and not receiving intervention." In short, for such individuals, the benefits of the intervention are equal to the costs of receiving the intervention. Using this property, Eisenhauer et al. (2015) proposed a method of identifying the costs of intervention, and estimated the effects of college education on wages, having the costs of college education, and the total surplus.

As one of the studies that used MTE for the predicting policy effects, we have Kline and Walters (2016). The study examined the effectiveness of a U.S. government-sponsored Head Start preschool education program for low-income and other circumstantially disadvantaged groups. The authors use a randomized-controlled trial called the Head Start Impact Study to examine the effect of the program on test scores. Then, the authors consider the cost-benefit analysis of marginal policy changes. A difficulty with this calculation is that many of the infants assigned to the intervention group and were not able to receive the program, had received different preschool education. Taking this into account, the authors showed that marginal fiscal spending depends on MTE.

Finally, we introduce Kowalski (2018) who examines the heterogeneity of intervention effects using economic experimental data. This author used an experiment conducted in the 1980s to examine the negative aspects (overdiagnosis) of mammography on health. In the same experiment, women assigned to the intervention group were given the opportunity to take x-rays. However, women in the intervention group do not have to have x-rays, and women in the control group can have x-rays, so the experimental design is bilateral disapproval. In such experimental designs, individuals are classified into three types. First, individuals assigned to either group, and are always involved (x-rays): They are called always takers. The next type of person is called a Never Taker: He/she will, in any assignment, never take an intervention. Finally, there are compliers who receive intervention when assigned to the intervention group and do not receive it

when assigned to the control group. Kowalski (2018), under the MTE framework, assumes a monotonicity about U_D for the expected value of potential outcome, conditioned U_D. In doing so, he proposes a method of determining the bounce of intervention effects, and testing for the existence of heterogeneity in intervention effects among these types. The results showed that Always Taker had at least 3.5 times more overdiagnosis than Complier.

3. Causal and Heterogeneous by Machine Learning - Causal Forest -

3)-1 Introduction

In recent years, several economic studies have used machine learning techniques to predict intervention effects conditioned by multiple attribute and environmental information, and to analyze the predicted intervention effects. Machine learning techniques were originally used to predict x results using multiple attribute information y. However, in recent years, there has been a great deal of research not only on predicting results, but also on using machine learning for causal reasoning (Imai and Ratkovic, 2013, etc.). Among them, there are remarkable developments in tree-based methods such as CART and Random Forest. Athey and Imbens (2016) introduced a tree-based approach for causal reasoning, and Wager and Athey (2018) developed the approach as a causal forest, revealing that the conditional effects predicted by the approach have agreement and asymptotic normality under some conditions.

Economic studies in various areas, such as energy conservation studies, poverty and labor studies, development studies, and tax studies, use Causal Forest to predict conditional mean intervention effects and to verify the characteristics of their distribution and what covariates explain their heterogeneity (Carter, Tjernström, and Toledo, 2019; De Neve et al., 2019; Farbmacher, Kögel and Spindler, 2019; Hoffman and Mast, 2019; O'Neill and Weeks, 2018). In addition, energy-saving studies and poverty and labor studies evaluating single intervention effects have demonstrated the utility of targeting in terms of who should be intervened in through illustrations using conditional average intervention effects (Bertrand et al., 2017; Davis and Heller, 2017; Knittel and Stoller, 2019).

3)-2 What is Causal Forest?

Wager and Athey (2018)'s Causal Forest (hereinafter referred to as CF) is a non-parametric estimation method that brings Random Forest, one of the machine-learning methods, into the context of causal reasoning. Therefore, when introducing CF, it is necessary to supplement Random Forest and decision trees. Here, the decision tree and Random Forest will be introduced as a supplement.

Random Forest is an ensemble method applied to decision trees. In the decision tree, a classification tree is used for the purpose of classification, and a regression tree is used for the purpose of regression such as prediction of numerical values. The algorithm for creating these decision trees is CART (Classification and Regression Tree: Breiman et al. 1984) is often used. In the decision tree, a prediction model is constructed by dividing the data into two parts a plurality of times starting from the vertex of the tree. In the following, the term decision tree refers to a regression tree based on the CART algorithm.

Given the current set of training data $i = 1, \dots, N$, under the condition of $\{Y_i, X_i\} \in \mathcal{R} \times \{0,1\}^p$, consider a case in which decision tree is constructed. Here, Y_i is the response (or the result variable) X_i, and is assumed to represent a characteristic quantity (or a covariate). The goal of the decision tree is to construct a model that predicts the conditional expectation of the response $X_i = x$ conditioned by Y_i. The conditional expectation value Y_i of the response $\mu(x)$ to be predicted is expressed as follows.

$$\mu(x; \Pi) = \mathbb{E}[Y_i | X_i = x; \Pi]$$

In order to construct a model for predicting the above $\mu(x)$, in the decision tree, dividing data is necessary to construct a model. A vertex that has not yet been split is called a parent node, and the lowest node R_1 or R_2, R_3 is called a leaf or final node. A point c_1, c_2 is determined as shown in Figure 2-4-2, and the data is divided according to the point. When the number of data in the leaf is fewer than a certain number, the division is stopped. Finally, for the predicted value $\hat{\mu}_j$ in each segmented area, a mean squared error (MSE) is often used as a criterion for a division point described as。 c_1, c_2 as an average of responses data in the area. MSE is defined as below:

$$MSE = \frac{1}{N} \sum_{j=1}^{J} \sum_{i \in R_j} \left(Y_i - \hat{\mu}_j\right)^2$$

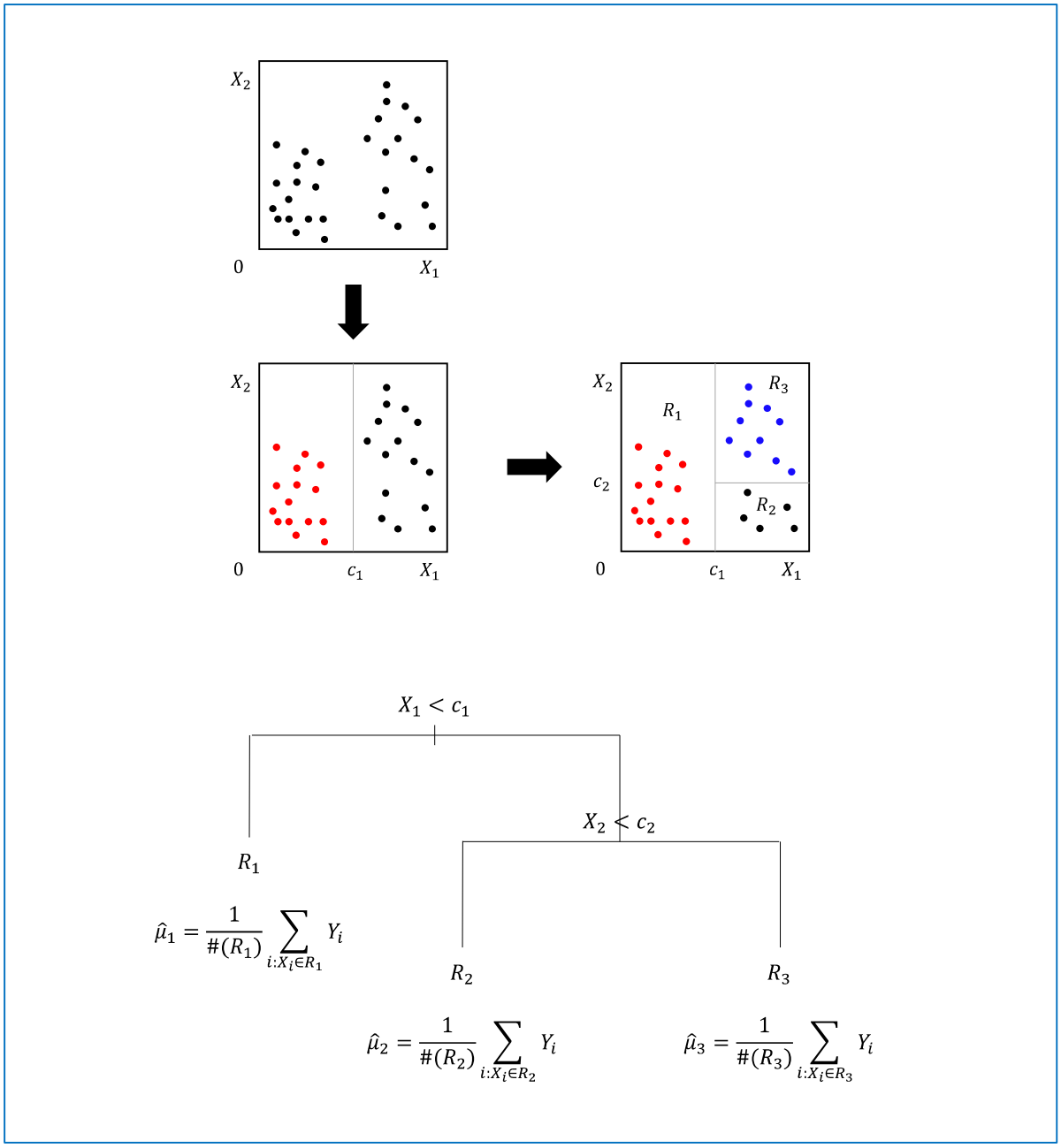

Figure 2-4-2 Example Decision Tree

Here,$j \in \{1,\ldots,J\}$shows the number of divided areas is shown, and indicates the number of data $\#(\cdot)$. In addition,$\hat{\mu}_j$shows an average of responses in a divided area$j$.

Like, in the decision tree, the division point is determined by selecting the one with the smallest MSE as the threshold value. In practice, regarding all theR_j, the MSE calculation is performed by the recursive two division method, because the calculation volume of the above MSE to consider requires an enormous number of calculations. This method does not focus on all the divisions as described above, but do so only on a specific division point to perform optimum division. More specifically, it is performed by considering the values of all the feature amounts written as$X_1, \ldots, X_p$and all the division points$c$with respect to the feature amounts, and selecting the feature amount and the division point for creating a tree having the minimum MSE.

Decision trees can cope with complex structures in the data by deepening the tree. However, it is also known that the prediction results of regression and classification by decision trees vary widely. Therefore, the idea of reducing the variance by averaging a plurality of decision trees is Random Forest, for the purpose of driving down the

dispersion of prediction of this decision tree.

The Random Forest algorithm takes samples B of N trees from the training data of each size of Z^*, using a bootstrap method. With respect to the extracted sample Z^*, p pieces of characteristic quantities are randomly extracted from the characteristic quantities of m pieces. Then, from the m pieces of variables having the highest correlation with the response Y_i is extracted from the characteristic quantities. Then, the sample Z^* is divided into two on the basis of a certain threshold value so as to reduce the least squares errors. This division is repeated until the minimum node size of n_{min} is reached. The final prediction is made by integrating the prediction results of the final B pieces of decision tree. In the case of regression, this integration is done by taking the average of each decision tree. Random Forest also has an indicator called Variable Importance that reports the importance of the variables used to grow the forest. This indicator shows how much the division by the feature quantity contributes to the regression to the response.

Causal Forest introduced the idea of the Random Forest algorithm to causal inference. The Causal Forest, like the Random Forest, generates multiple causal trees and combines the results to produce a predicted conditional intervention effect. In Causal Forest (hereinafter referred to as CF), a model is constructed from a plurality of trees in the same manner as in ordinary Random Forest (hereinafter referred to as RF). The goal of RF is to predict using response Y_i and feature quantity X_i. On the other hand, the purpose of CF is to perform causal inference using, the allocation variables Y_i of intervention in addition to the response X_i and the feature quantity W_i.

In general, the following conditional independent assumption (Unconfoundedness) of potential consequences is required for causal inference using observational data.

$$\left\{Y_i^{(0)}, Y_i^{(1)}\right\} \perp\!\!\!\perp W_i \mid X_i$$

In addition, the following overlapping assumption (Overlap) is used, because both the person assigned to the intervention group $X_i = x$ and the person assigned to the control group $W_i = 1$ must be included regarding the specific feature quantity $W_i = 0$.

$$0 < Pr(W_i = 1 | X_i = x) < 1$$

Under these assumptions, the following conditional average treatment effect (CATE) is estimated.

$$\tau(x) = \mathbb{E}\left[Y_i^{(1)} - Y_i^{(0)} \mid X_i = x\right]$$

In CF, as in the case of usual causal inference, the purpose is to extrapolate $\tau(x)$ under the above 2 assumptions. The basic algorithm is like the CART decision tree and RF, but it needs to be modified because the goal is to get an estimated $\hat{\mu}(x)$ of the CATE rather than an estimated $\hat{\tau}(x)$ of the response.

Also, in a normal decision tree or RF, a sample on hand is divided into training data for constructing a model and test data for evaluating the model. On the other hand, one of the features of the causal tree of Athey and Imbens (2016) and the CF of Wager and Athey (2018) is that the training data is further divided into 2 parts by the method named Honesty. It is known that by carrying out this Honesty, the predicted $\hat{\mu}(x)$ or $\hat{\tau}(x)$ satisfies properties such as coincidence and asymptotic normality. In Honesty, one data is used to select the split points of the model and the other data is used to estimate the predicted values.

The tree which constitutes CF is called Causal Tree. Now, consider estimating Causal Trees for a sample $\mathcal{S}$. Here, $\mathcal{S}^{te}, \mathcal{S}^{tr}$ represent the test data and the training data respectively, and $\mathcal{S}^{est}$ represents the data used for estimating the effect of the intervention. The CATE on a leaf, Π, of Causal Tree, $\ell(x;\Pi)$, is expressed as follows:

$$\tau(x;\Pi) \equiv \mathbb{E}[Y_i(1) - Y_i(0) | X_i \in \ell(x;\Pi)] = \mu(1,x;\Pi) - \mu(0,x;\Pi)$$

Here, $\mu(w,x;\Pi)$ is arbitrary about $w \in 0,1$ for any $\mu(w,x;\Pi) \equiv \mathbb{E}[Y_i(w) | X_i \in \ell(x;\Pi)]$. This estimated quantity is expressed as follows.

$$\hat{\tau}(x;\Pi) = \frac{1}{|\{i: W_i = 1, X_i \in \ell(x;\Pi)\}|} \sum_{\{i:\, W_i=1, X_i \in \ell(x;\Pi)\}} \mathrm{Y_i} - \frac{1}{|\{i: W_i = 0, X_i \in \ell(x;\Pi)\}|} \sum_{\{i:\, W_i=0, X_i \in \ell(x;\Pi)\}} \mathrm{Y_i}$$

That is, the CATE in a leaf of$\Pi$of Causal Tree,$\ell(x;\Pi)$, is determined as the difference between the mean of the intervention group's response in the leaf and the mean of the control group. In estimating the CATE in these leaves, it is necessary, of course, to grow Causal Trees.

As in the case of the CART decision tree, it is necessary to consider searching for the division point where the MSE of the Causal Tree is the smallest and performing the division. Here, the MSE for intervention effects is expressed as:

$$MSE_\tau(\mathcal{S}^{te}, \mathcal{S}^{est}, \Pi) \equiv \frac{1}{\#(\mathcal{S}^{te})} \sum_{i \in \mathcal{S}^{te}} \left(\tau_i - \hat{\tau}(X_i; \mathcal{S}^{est}, \Pi)\right)^2$$

In addition, unlike the usual CART, it is not possible to actually observe each subject ofτ_i. Therefore, the above MSE cannot be used as it is. Therefore, it is necessary to estimate the MSE. The estimates of the intervention effects of MSE are as follows (see Athey and Imbens (2016) for a detailed discussion of this part).

$$MSE_\tau(\mathcal{S}^{te}, \mathcal{S}^{est}, \Pi) \equiv \frac{1}{\#(\mathcal{S}^{te})} \sum_{i \in \mathcal{S}^{te}} \left(\tau_i - \hat{\tau}(X_i; \mathcal{S}^{est}, \Pi)\right)^2$$

Therefore, to develop Causal Tree, division is made at the division point where the dispersion of CATE in the training data is maximized.

The CF is a result of creating a plurality of Causal Trees and integrating the results. In this explanation, the CATE determined by the CF is explained as the difference between the responses of the intervention group and the control group in the same leaf. However, in the actual CF algorithm, it is also possible to estimate the effect of the intervention using the predicted propensity score (Propensity Tree). In Athey, Tibshirani and Wager (2019), Random Forest is generalized as (generalized) Random Forest, using the generalized moment method. An estimation package for this approach has also been published as the grf package of R (Tibshirani et al. 2020).

3-3. The Application of Causal Forest

We will introduce demonstration research using this CF algorithm. The authors believe that use of CFs in empirical studies to be broadly divided into (1) studies used to estimate conditional mean intervention effects and to verify the characteristics and heterogeneity of the distribution of intervention effects, and (2) studies used to estimate conditional mean intervention effects and to target them from the perspective of "who should be intervened?"

The former type of empirical studies include Carter, Tjernström, and Toledo (2019), De Neve et al. (2019), Farbmacher, Kögel and Spindler (2019), Hoffman and Mast (2019), and O'Neill and Weeks (2018), which estimate the heterogeneity of intervention effects in the context of labor policy and tax behavior. The latter empirical studies include Bertrand et al. (2017), Davis and Heller (2017),and Knittel and Stolper (2019), which seek for heterogeneity in the effects of interventions in the context of labor policy and electricity-saving behavior and then target who should be involved.

In particular, Knittel and Stolper (2019) examined the heterogeneity and targeting of intervention effects in a multi-faceted manner using a wealth of information, and the author believes that CFs are useful for future empirical research. For this reason, Knittel and Stolper (2019) will be introduced as a study example of the applications of CF being used as demonstration research.

Knittel and Stolper (2019) verified the effects of Home Energy Report (HER) on electricity-saving behavior of more than 900,000 households in their Home Energy Report. This HER provides information on how much consumers consume electricity and how their neighbors consume it, as well as how to conserve energy.

They first calculate the average intervention effect of HER per month. According to the calculation, the intervention effect by HER was - 0.085 kWh (- 1%). Subsequently, in order to examine the heterogeneity of

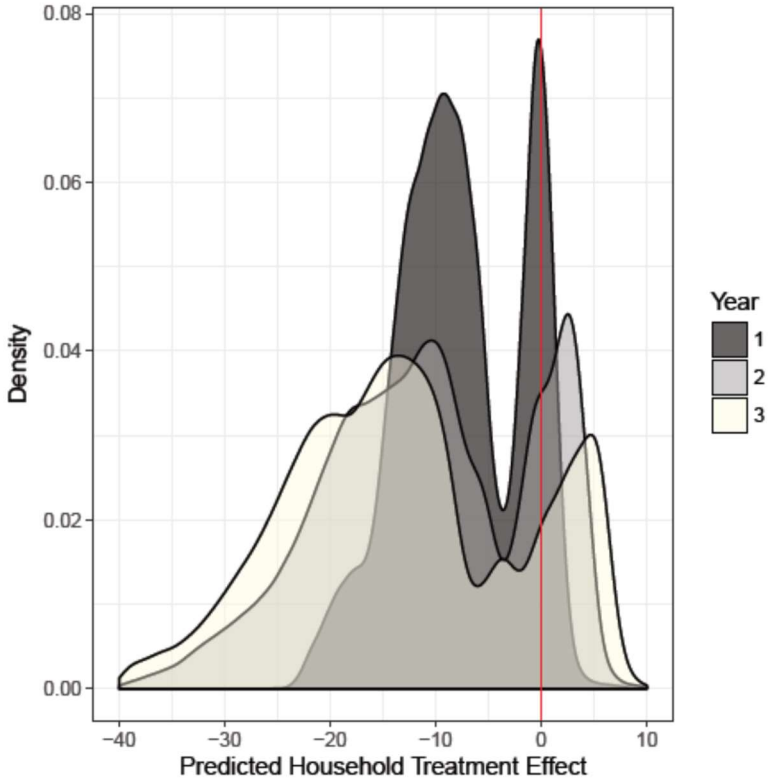

Figure 2-4-3 The distribution of predicted intervention effects

Figure 7, Knittel & Stolper. (2019)

intervention effects, the effect of heterogeneous intervention is estimated by CF using 13 characteristic quantities such as electricity consumption, home asset value, site area, and income. The estimation results are shown in Figure 2-4-3.

Figure 2-4-3 shows the distribution of heterogeneous intervention effects from year 1 to year 3. From this, it can be seen that 1) the heterogeneity of the intervention effect can be observed even within the same fiscal year, and 2) this heterogeneity can also be observed after the second year and the degree of dispersion of the effect is expanding. Specifically, as a result of the intervention in the first year, there is a large peak around the intervention effect - 10 kWh, and there is also a peak around the effect 0. In the second and third years, the peak observed in the first year gradually expanded outward. From this, it can be seen that households that were affected by the intervention learned about power saving over time and started to take more power-saving actions, but about 18% of households that were not affected by the intervention did not start to save power, but rather increased their power consumption.

Next, in their analysis, the group was divided into groups: one with a power-saving effect (Reducers) and the other without a power-saving effect (Increasers). Then, the difference in the attributes of these groups was examined (Figure 2-4-4).

From Figure 2-4-4, it can be seen that there are differences in many attributes between households that averagely take power-saving actions and households that do not. In particular, there is a marked difference regarding the past Baseline Usage. This indicates that the past Baseline Usage of the households that take power-saving actions, on average, is considerably higher than that of households that do not do it.

Thus, after mentioning the heterogeneity of intervention effects, they focus their analysis on targeting. By targeting, they aim to increase the effectiveness of their interventions by limiting people to those who are more power-saving by HER. Specifically, considering the cost of HER, they consider the case of maximizing the power-saving effect. They also perform simulations, assuming that a marginal cost of electricity generation is $ 7. The distribution of net HER benefits for each year is shown in Figure 2-4-5.

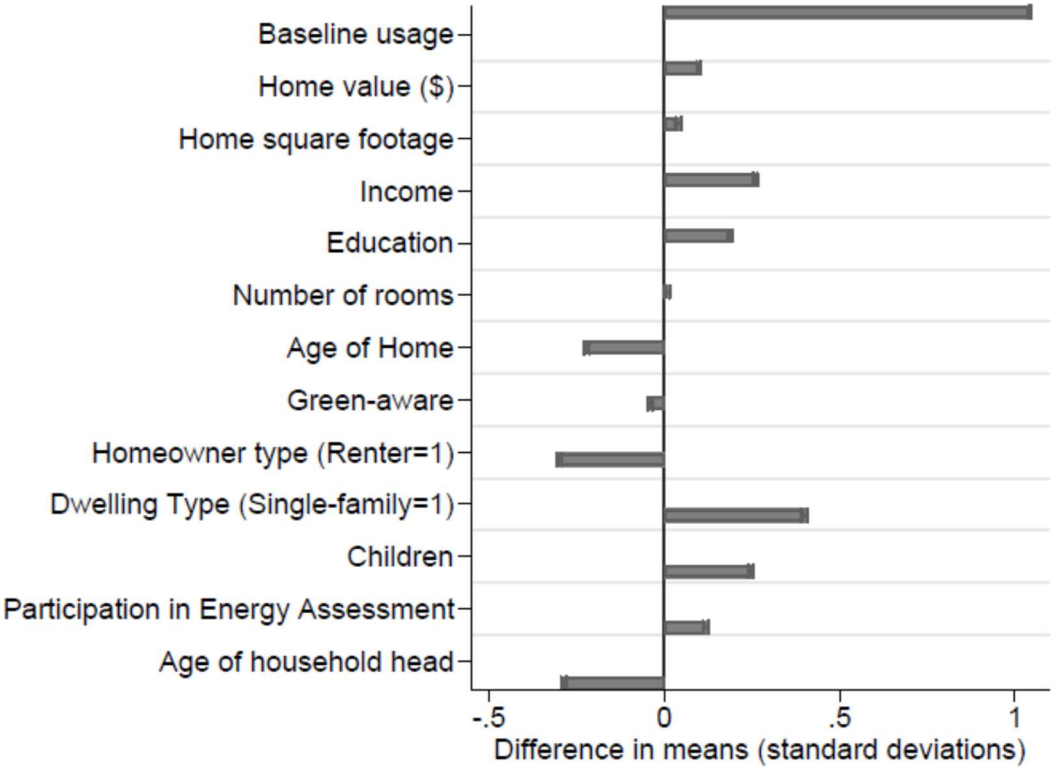

Figure 2-4-4 Attributes Comparison of "Reducers" and "Increasers"

Figure 8, Knittel & Stolper. (2019)

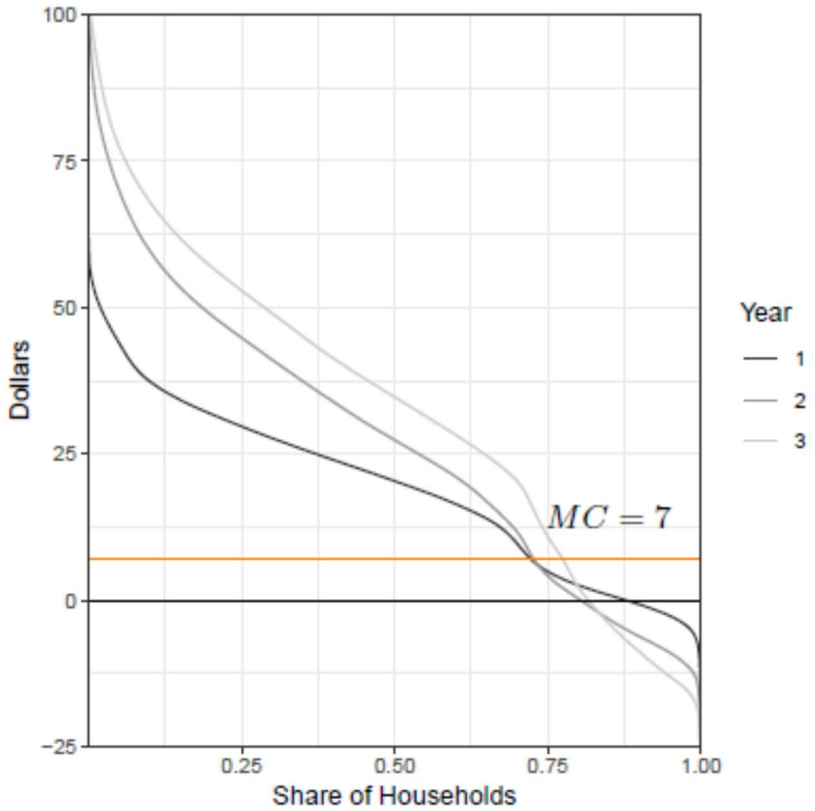

Figure 2-4-5 The distribution of Net HER Benefits

From Panel A in Figure 10, Knittel & Stolper. (2019)

Figure 2-4-5 shows that if you send an HER to everyone, the total surplus from HER is $ 5.5M in year 1, $ 9.1M in year 2, and $ 11.5M in year 3: You will see that as time goes by the total surplus will increase. This corresponds to the increasing heterogeneity of intervention effects over time. Next, we consider the case of targeting. Considering that interventions are targeted only to households that exceed marginal costs, approximately 72% of households receive HER at year 1. At this time, the total surplus is $ 6.4M, which is 14% more than the total surplus of the intervention when comparing to the case of holistic intervention. In the second year, about 73 percent of households will be allocated interventions, with a total surplus of $ 10.4M, which is expected to increase by 14 percent. Finally, for the third year, with similar targeting, the total surplus will be $ 13.0M, up 12 percent. If the effect of the intervention can be predicted in advance, it can be seen that the total surplus can be improved by targeting.

Like this, Knittel and Stolper (2019) demonstrated the utility of targeting after considering heterogeneity, using the CF approach to examine the heterogeneity of intervention effects based on data from actual social experiments.

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[Part 2] Chapter 5: Artificial Intelligence and Economic Growth

Koichi FUTAGAMI [viii]

[Summary]

This paper describes the process of automation by artificial intelligence, and shows the importance of whether the relationship between tasks that have been automated and tasks that have not been automated is complementary or alternative. When automation advances completely, economic growth is sustained, but when automation is incomplete, sustained economic growth stops, and in the worst case, the economy shrinks. The labor share does not continue to rise when automation is incomplete, but when automation is complete and labor is no longer needed, if the relationship between tasks is complementary, the labor share tasks will become 1 in the end. The reason that even though there are few tasks that use labor and that the share is 100% is because the labor input to non-automated tasks is essential to automated machine tasks.

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1. Introduction

Since the Industrial Revolution, which began in the eighteenth century, the process by which machines replace human labor has been going on in waves. The process of replacing labor with machines has advanced through the first Industrial Revolution based on Watt's steam engine, the second Industrial Revolution in the early twentieth century based on mass production using electricity, and the third Industrial Revolution based on electronics, which began in the 1970s. Ricard, an eighteenth-century classical economist, wrote in his book “On the Principles of Political Economy, and Taxation” as follows:

"The opinion of the working class that the use of machinery is often detrimental to their interests is not based on prejudice or error, but on the right principles of economics."

It is predicted that wages will decline and the labor share will decline as labor becomes unnecessary as the replacement of human labor with machines advances. Many workers may also lose their jobs.

However, the replacement of human labor with machines did not completely eliminate human labor. Acemogul and Restrepo explain this as follows 1). Old types of tasks are replaced and superseded by machines, and in the process new tasks are created that have a competitive advantage over labor. It is true that horses will lose their positions when carriage is replaced with rail. But unlike horses, humans will be able to take on the new task as operators. Also, when a machine is introduced, a machine operator, who performs tasks complementary to the machine, is required. Even in the third Industrial Revolution, the introduction of industrial robots and computers requires programmers and digital workers to perform complementary tasks. That is to say, it is expected to be very important whether the work done by humans against machines, or what they call tasks, is in an alternative or complementary relationship.

Economic growth theory has carried out economic analyses considering such alternative processes. Economic growth theory has emphasized the accumulation of capital, the increase of the working population, and the advance of technology as three factors to promote economic growth. In particular, technological progress has been the most important factor in economic growth theory as a factor that increases per capita production and consumption. So how has the theory of economic growth dealt with technological progress? The view that economic growth holds for technological progress is that it increases labor productivity. In other words, as technology advances, more output is obtained from the same labor input, which is called labor-augmenting technical progress. This view is the same as the endogenous growth model of Paul Romer, who won the 2018 Nobel Prize in Economics. However, as can be seen from a little consideration, there should be a view that even if capital investment is the same, more output will be obtained as technology advances (capital-increasing technological progress), but the reason for not doing so is the fact that a balanced growth path exists only in the case of labor-augmenting technological progress 2). As its name suggests, balanced growth is a path through which all economic variables increase at the same growth rate. Economic growth theory has focused on labor-augmenting technological progress, because the capitalist economy has experienced sustained growth for more than two centuries, and the mathematical model of economic growth theory has provided a clean solution. It has also supported the view of labor-augmenting technological progress that it was consistent with the stylized facts about economic growth pointed out by Kaldor. Among the stylized facts, the distribution relation is particularly important in relation to the following discussion. Under labor-augmenting technological progress, the capital share and the labor share will remain constant at the steady state of the economy. This is consistent with the stylized facts.

Then, can the fourth Industrial Revolution, which is based on artificial intelligence, be viewed as labor-augmenting technological progress? Big Data-based artificial intelligence can make a lot of work unnecessary. Customer service at business hotels is a typical example. Automated driving could also replace truck drivers and taxi drivers. Perhaps a task based on a routine will be replaced by artificial intelligence, but some tasks are not based on a routine and therefore cannot be easily replaced by artificial intelligence. AI can replace routine accounting and tax administration tasks, but it cannot replace tasks such as finding new accounting manipulation. Even if AI replaces routine educational activities, AI does not seem to be able to replace the various incidents and events that suddenly occur in the classroom. These require work that is different from routine work and may become more important as artificial intelligence becomes more widespread. These tasks that are difficult to replace by artificial intelligence are rather complementary tasks.

If work and tasks by artificial intelligence should not be viewed as labor-augmenting technological progress, various conclusions in economic growth theory will be affected. In particular, it is expected that distributional relations, which have been constant under labor augmenting technical progress, will be greatly affected. It is very important to clarify this point.

In this article, in the next Section 2, we describe how artificial intelligence models the technological progress that replaces labor. A simple economic growth model is used in Section 3 to illustrate the growth process under the approach described in Section 2. Section 4 describes the temporal development of the partition relation in the growth process. In Section 5, we summarize and discuss future issues.

2. Machinery and labor

In the economic growth theory, what expresses the production technology is a method that uses production function. The production function expresses the technical relationship between the two production factors which produce output, capital and labor. In general, it is expressed as$F(K,L)$. K represents capital input and L represents labor input. The labor-augmenting technical progress described in the previous section is expressed as follows.

$$F\ (K, A\ \cdot\ L)$$

The variable A multiplied by labor input represents technological progress, and an increase in A plays the same role as an increase in labor input without an increase in labor input L. However, it seems that machines are not modeling the process of labor substitution, intuitively.

It was Zeira who created a model, a model of which describes that machines replace labor, and its modeling is as in the following. 3) Output is performed by n kinds of work and tasksx_i $(\mathrm{I}\ =\ 1,2,\cdots,\mathrm{n})$, and when each task is performed by labor, it is called non-automation, and when each task is performed by machine (capital), it is called automation. The formulation uses the Cobb-Douglas production function as follows.

$$Y = Ax_1^{\alpha_1}x_2^{\alpha_2}\cdots x_n^{\alpha_n}, 1, \ldots, n$$

$$x_i = \begin{cases} L_i, \ \mathrm{Non-automated\ tasks} \\ K_i, \ \mathrm{Automated\ task} \end{cases}$$

Thus, the increase in the number of automated tasks has made it possible to represent automation and mechanization processes.

However, since the Zeira model is based on the Cobb-Douglas type of production function, the analysis is limited to cases where the relationships between input elements are alternative. Therefore, Aghion et al. performed an analysis based on the CES production function, in which the elasticity of substitution is constant (4). As a result, it became possible to analyze the case where the relation between input elements is complementary. The function has a complicated form, and is as in the following:

$$Y_t = A\left(\int_0^1 x_{it}^{\rho}di\right)^{\frac{1}{\rho}}, \rho\ <1$$

Where the integration range [0, 1] represents the type of task 5). The parameter ρ means the elasticity of substitution between input elements. When 0≤ρ <1, the relationship between tasks is alternative, and when ρ <0, the relationship between tasks is complementary. Because the economic growth model in the next section examines the change in each variable with time, each variable is given a subscript t, which represents time. Automation uses the same concept as Zeira. The automated range is [0, Bt] and the non-automated range is (Bt, 1). Assuming that the total capital of the economy is Kt and the total labor is Lt, the capital and labor divided into tasks are as follows. For simplicity, we assume a symmetrical equilibrium.

$$x_{it} = \frac{K_t}{B_t}, I\ \in [0, B),$$

$$x_{it} = \frac{L_t}{1-B_t}, I\ \in\ [B, 1]$$

At this time, the production function is rewritten as follows.

$$Y_t = A\left(B_t\left[\frac{K_t}{B_t}\right]^{\rho} + (1-B_t)\left[\frac{L_t}{1-B_t}\right]^{\rho}\right)^{\frac{1}{\rho}}$$

$$= A\left(\left[B_t^{\frac{1-\rho}{\rho}}K_t\right]^{\rho} + \left[(1-B_t)^{\frac{1-\rho}{\rho}}L_t\right]^{\rho}\right)^{\frac{1}{\rho}}, \rho\ <1$$

Since the progress of automation is the extension of the range automated by machines, it can be said that the increase of B is the progress of automation and mechanization. So, when ρ <0 (complementary between elements), albeit paradoxical, automation (artificial intelligence adoption) is a rise in Bt, it will be a function of capital-reducing technical progress and labor-augmenting technical progress. On the other hand, when 0≤ρ<1 (elements are alternative), automation (adoption of AI) is a function of capital-increasing technological progress and labor-reducing technical progress. And when looking at this aggregated production function, it

can be said that automated tasks and non-automated tasks are alternative when 0≤ρ <1. On the other hand, when ρ <0, the automated task and the non-automated task are complementary.

The next section describes the process of economic growth based on the production function presented in this section.

3. Economic growth model

In this article, we will incorporate the automation mechanisms described in the previous section into the Solow model, which is a of economic growth model. Let's begin by outlining the Solow model. For the sake of simplicity, transactions between the government and foreign countries are disregarded.

The output Yt produced in the economy is distributed to households accounts as income. Households accounts allocate income to consumption and savings at a fixed rate. Regard s (<1) as the savings rate. Household savings are used for corporate capital investment through financial markets. The capital investment of the enterprise increases the physical capital of the economy and increases the output of the economy in the next period and becomes a source of the economic growth. On the other hand, when the working population increases, It may contribute to an increase in total output, but it may reduce output and consumption per worker. It is the basic equation of the next economic growth theory to analyze the balance of the magnitude relation.

$$\Delta k_t = sy_t - nk_t$$

Where the lower case letters y and k represent per-capita output Y/L and per-capita capital K/L. AlsoΔk_trefers to the change in capital per person per hour. The first term on the right represents per-capita savings, which increases per-capita capital. On the other hand, the section 2 term represents the following facts. As the working population in the denominator of the per-capita capital K/L increases, the per-capita capital will decrease accordingly. The magnitude of the first and second terms means that the capital per capita will increase or decrease. The following equation is obtained by dividing both sides by the capital per person and changing the production function of the previous section into the dynamic equation.

$$\frac{\Delta k_t}{k_t} = \frac{sy_t}{k_t} - n = sA\frac{\left(B_t^{1-\rho}k_t{}^{\rho} + (1-B_t)^{1-\rho}\right)^{\frac{1}{\rho}}}{k_t} - n$$

SinceΔk_trepresents the change in capital per capita, the left side represents the growth rate of capital per capita. If the first term exceeds (falls below) the growth rate of the working population, the growth rate of the capital per capita is positive (negative).

How will progress be determined? It is important to analyze the behavior of R & D workers and engineers involved in the practical application of automation that decide how to develop and use artificial intelligence. However, in this paper, for simplicity, we assume that the progress of automation (increase of Bt) is exogenous. However, the upper limit of the range of automation is Bt = 1. In the first analysis, automation is assumed to proceed exogenously to that limit. In the end, therefore, there is little need for human labor (full automation). Next, we analyze where the progress stops before the upper limit (incomplete automation). It is also assumed that economic productivity A is sufficiently high and sA> n is satisfied.

Then, we look at the dynamics of the economy over time. What is useful for studying this dynamic is called phase diagram. The vertical axis represents the capital per-person, k, and the plane of coordinates in which the horizontal axis represents the level of automation, B, is a phase diagram. The phase diagram shows the movement of these variables over time using red arrows (see Appendix 1 for details).

First, when the relationship between elements is complementary ($\rho < 0$), the economic fluctuation can be expressed in the following phase diagram. Here, the curve on the upward of$\Delta k_t = 0$indicates the position where the movement of kt stops. In the region above this curve, kt decreases (downward red arrow) and in the region below this curve, kt increases (upward red arrow). Because automation is always exogenous, Bt is constantly increasing (red arrow to the right). In summary, the economy follows the U-shaped curve depicted in Figure 2-5-1. That is, if the combination of per capita capital and automation is represented by the H point at the beginning of the economy, the economy will have a decline in per capita capital at the beginning. However, after Point D, per-capita capital begins to increase, and the growth continues forever.

It can be seen that when the relation of between elements is alternative the economic fluctuations in ($0 < \rho < 1$) are similar to those in Figure 2-5-1, although there are some differences between them. Thus, when automation proceeds to an upper limit of 1, the economy

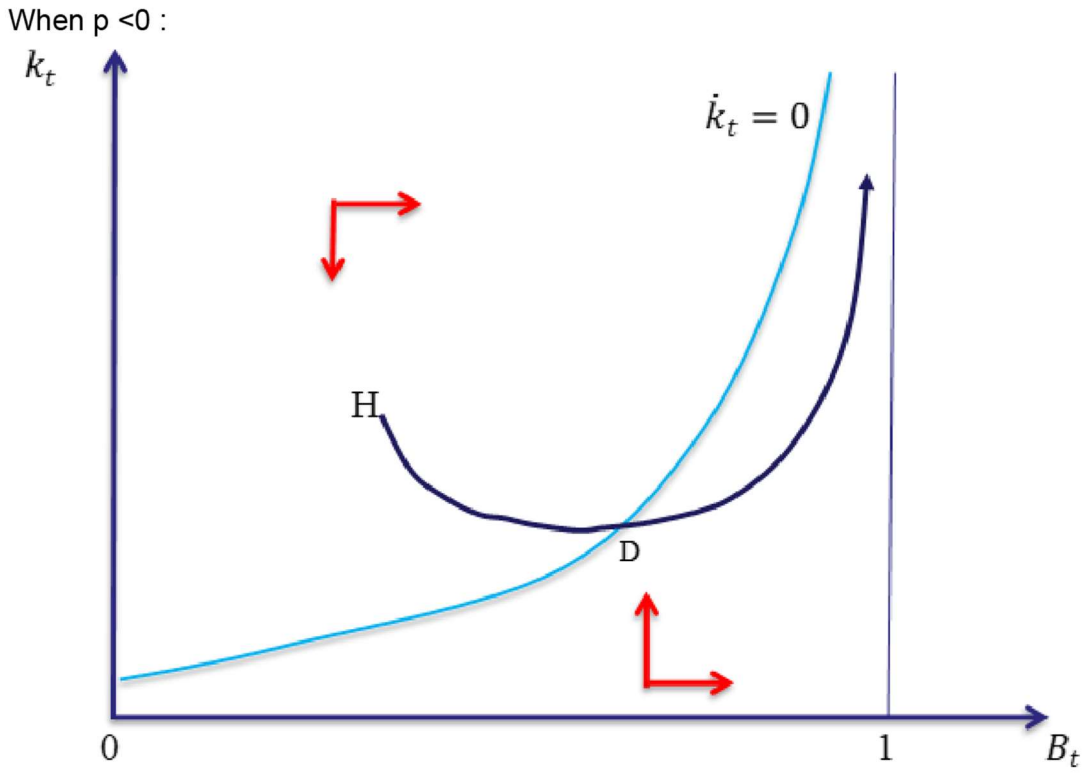

Figure 2-5-1

can continue the economicgrowth sustainably. The growth rate will be as below, regardless if its relationship is alternative or complement. As can be seen from the following equation, the growth rate is more positive than the assumption that productivity is sufficiently high.

$$(\text{Growth Rate of Capital per capita}) g_k \equiv \frac{\Delta k_t}{k_t} = sA - n$$

Second, what happens to the economy if automation doesn't progress completely and stops to some extent? When B_t reach the upper end $\bar{B}(< 1)$, the movement of capital per capita is determined as follows.

$$\frac{\Delta k_t}{k_t} = \frac{sy_t}{k_t} - n = sA\frac{\left(\bar{B}^{1-\rho}{k_t}^{P} + (1-\bar{B})^{1-\rho}\right)^{\frac{1}{P}}}{k_t} - n$$

The proof will be discussed in the Appendix, but in this case, the process of economic growth will vary greatly depending on whether the relationship between the input factors is complementary or alternative. First, economic growth stops if the relationships between factors are complementary. If productivity is low enough, the economy may shrink. In other words, high productivity is necessary to prevent the economy from shrinking and stagnating. On the other hand, when the relationship between the factors is alternative, the economy can continue to grow sustainably as in the above-mentioned case where the upper limit is 1 if the economy is sufficiently productive. However, when the relationship between the factors is alternative, the process where the economy shrinks will not appear even if productivity is low[6].

4. Distribution ratio

How will the distribution to each production factor change as automation progresses? The price of each production factor is determined by its marginal product as the Solow model assumes that firms act competitively, Specifically, the wage rate is determined by the marginal products of labor, and the interest rate, which is the price of capital, is determined by the marginal products of capital. In addition, all the added value of the enterprise is distributed to labor and capital so that the production technology is constant return to scale. Therefore, the labor share and the capital share add up to 1.

Let me now explain how labor and capital shares are

determined in the Solow model presented in the previous section. The change in labor share depends on when the upper limit of automation is less than 1 (incomplete automation) and 1 (fully automated), and whether the relationship between the factors is alternative or not.

First, it can be seen that the labor share will continue to fall, or at best remain at certain value, regardless of the relationship between the factors if automation is incomplete

Let's look at the complete automation case. The labor share will converge to 0 (capital share will converge to 1) if the relationship between automated and non-automated tasks is alternative. In other words, all the share of output is acquired by automated machinery and capital. This is because the need to use labor is not so high and production can be carried out with capital as the relationship between automated machinery and labor is alternative.

If the relationship between automated and non-automated tasks is complementary, the labor share may converge to 1 (capital share may converge to 0). The conditions are as follows.

$$(*)\ (1-\rho)a+\rho g_k<0$$

Here, *a* is a parameter representing the new speed of automation. The first term on the left-hand side of equation represents the speed of progress of automation and the second term represents the speed of capital accumulation. Each is them multiplied by a parameter indicating the degree of substitution between the factors to take a weighted average. This condition means that the share of labor will rather increase when 1) automation is progressing not very fast, 2) economic growth is high, and 3) the relationship between tasks is much more complementary, if the relationship between automated and non-automated tasks is complementary. This is because the necessity of the production factor called labor is also increased as automation progresses. Therefore, we cannot judge whether or not workers will suffer disadvantages only by the progress of automation using artificial intelligence.

5. Conclusion

This paper explains how to model the process of automation by artificial intelligence, and discusses what the growth process based on it would be. It is shown that the relationship between input factors used in production, especially whether the relationship between tasks that have been automated and that have not is complementary or alternative, is important when modeling. The results showed that economic growth would continue in a process where automation fully progresses. On the other hand, it shows that the sustainable growth of the economy will stop, and in the worst case, the economy will shrink if the automation is incomplete. Next, the paper shows that the labor share will not continue to rise in cases where automation is incomplete, but will turn out to be paradoxical results in cases where automation is complete and no labor is required. If the relationship between automated and non-automated tasks is complementary, the labor share will eventually be 1. The reason that the share of labor is 100% even though there are few tasks that use labor is because the work that is put into non-automated tasks is complementary, in other words essential, to the work (task) by the automated machine.

An important issue, not addressed in this paper, is unemployment. This paper assumes that workers who left the work (task) replaced by the machine are employed by the remaining tasks. However, workers who left work are not always immediately employed. Know-how on new jobs will be needed before getting hired again. Therefore, workers may become unemployment during the period they change their career. It is an important task to analyze this point. Another challenge is to internalize the process of automation. As described in this paper, it is workers involved in research and development and engineers who develop artificial intelligence and decide how to use it. It is also important to model their behavior by describing it. The last task is to explore the possibility of balanced growth. In this paper, only the case where the condition (*) is not true with the equal sign is analyzed. However, there may be the possibility of balanced growth when micro-foundation is applied. These are important issues to be analyzed in future.

[Appendix 1] Phase Diagram

The following is established by the dynamic equation.

$$\frac{\Delta k_t}{k_t} > 0 \Leftrightarrow sA\frac{\left(B_t^{1-\rho}{k_t}^{\rho} + (1-B_t)^{1-\rho}\right)^{\frac{1}{\rho}}}{k_t} > n$$

$$\Leftrightarrow \left(B_t^{1-\rho}{k_t}^{\rho} + (1-B_t)^{1-\rho}\right)^{\frac{1}{\rho}} > \frac{n}{sA}k$$

$$\Leftrightarrow B_t^{1-\rho}{k_t}^{\rho} + (1-B_t)^{1-\rho} > \left(\frac{n}{sA}\right)^{\rho} k^{\rho} \; if \; \rho > 0$$

$$\Leftrightarrow B_t^{1-\rho}{k_t}^{\rho} + (1-B_t)^{1-\rho} < \left(\frac{n}{sA}\right)^{\rho} k^{\rho} \; if \; \rho < 0$$

$$\leftrightarrow k^{\rho} < \frac{(1-B_t)^{1-\rho}}{\left(\frac{n}{sA}\right)^{\rho} - B_t^{1-\rho}} \; if \; 1 > \rho > 0$$

$$\leftrightarrow k^{\rho} > \frac{(1-B_t)^{1-\rho}}{\left(\frac{n}{sA}\right)^{\rho} - B_t^{1-\rho}} \; if \; \rho < 0$$

The graph on the right-hand side is the upward-sloping graph in Figure 2-5-1 of the main text. Therefore, this graph forms the boundary that determines the increase or decrease in capital per capita. The direction of the inequality sign is different in the last relational expression when ρ is positive and negative, but the expression represents the same relation for the positive or negative of the sign of ρ itself. That is, capital per capita decreases in the area above the graph on the right side of the relational expression (the downward red arrow in Figure 2-5-1), and capital per capita increases in the area below the graph (the upward red arrow in Figure 2-5-1). Thus, capital per capita represents the movement described in the text.

[Appendix 2] Growth Process when Automation is Incomplete

The increase or decrease in capital per capita is determined by the following relationship :

$$\Delta\, k_t \underset{<}{\overset{\geq}{}} 0 \leftrightarrow sA(\bar{B}^{1-\rho}{k_t}^{\rho} + (1-\bar{B})^{1-\rho})^{\frac{1}{\rho}} \underset{<}{\overset{\geq}{}} nk_t$$

When the relationship between factors is complementary (ρ<0), the relationship can be modified as follows.

$$\Delta k_t \underset{<}{\overset{\geq}{}} 0 \leftrightarrow [(sA)^{\rho}\bar{B}^{1-\rho} - n^{\rho}]{k_t}^{\rho} + (1-\bar{B})^{1-\rho} \underset{>}{\overset{\leq}{}} 0$$

When $(sA)^{\rho}\bar{B}^{1-\rho} > n^{\rho}$, the economy would continue to shrink as $\Delta k_t < 0$ is always true. On the other hand, when $(sA)^{\rho}\bar{B}^{1-\rho} < n^{\rho}$, $\Delta k_t = 0$ is true to a certain k^{*}. Therefore, there's a steady state in which the growth of the capital per capita stops. Therefore, sustained economic growth will cease. Since ρ is negative, we can see that the economy is at least not catastrophic when its productivity is relatively high.

When the relationship between factors is alternative (0<ρ<1), the relationship can be modified as follows.

$$\Delta k_t \underset{<}{\overset{\geq}{}} 0 \leftrightarrow [(sA)^{\rho}\bar{B}^{1-\rho} - n^{\rho}]{k_t}^{\rho} + (1-\bar{B})^{1-\rho} \underset{<}{\overset{\geq}{}} 0$$

When $(sA)^{\rho}\bar{B}^{1-\rho} > n^{\rho}$, the economy will grow sustainably as $\Delta k_t > 0$ is always true. On the other hand, when $(sA)^{\rho}\bar{B}^{1-\rho} < n^{\rho}$ there is a steady state in which the growth of the capital per person stops, as$\Delta k_t = 0$ is true to a certain k^{**}. Therefore, sustained economic growth will cease. In summary, economies can grow sustainably when there is a high degree of substitution between factors and economic productivity. As in the alternative case, the higher the productivity of the economy, the better the performance of economic growth.

[Appendix 3] Distribution Ratio

The rate of wages, or the marginal product of labor, is as follows.

$$w_t(\text{Wage rate}) = A\left(B_t^{1-\rho}{K_t}^{\rho} + (1-B_t)^{1-\rho}{L_t}^{\rho}\right)^{\frac{1}{\rho}-1}(1-B_t)^{1-\rho}{L_t}^{\rho-1}$$

Therefore, the labor share can be calculated as follows.

$$\text{Labor share} = \frac{wL}{Y} = \frac{A\left(B_t^{1-\rho}K_t{}^{\rho}+(1-B_t)^{1-\rho}L_t{}^{\rho}\right)^{\frac{1}{\rho}-1}(1-B_t)^{1-\rho}L_t{}^{\rho-1}\times L_t}{A\left(B_t^{1-\rho}K_t{}^{\rho}+(1-B_t)^{1-\rho}L_t{}^{\rho}\right)^{\frac{1}{\rho}}}$$

$$= \frac{(1-B_t)^{1-\rho}}{B_t^{1-\rho}k_t{}^{\rho}+(1-B_t)^{1-\rho}}$$

$$= \frac{1}{\left(\frac{B_t}{1-B_t}\right)^{1-\rho}k_t{}^{\rho}+1}$$

When automation is incomplete, the change in the denominator is ultimately determined by the movement of capital per capita. When automation is complete, several factors determine the change in labor share.

When the relationship between the factors is complementary (ρ<0), the labor share will be as follows. When$(sA)^{\rho}\bar{B}^{1-\rho} > n^{\rho}$, the labor share will decrease and eventually will be 0 as the economy continues to contract. On the other hand, when $(sA)^{\rho}\bar{B}^{1-\rho} < n^{\rho}$ the labor share converges to a certain value as there is a steady state in which the growth of capital per capita stops.

When the relationship between the elements is alternative (0<ρ<1), the labor share will be as follows. When$(sA)^{\rho}\bar{B}^{1-\rho} > n^{\rho}$the labor share will decrease to 0 as the economy continues to grow. On the other hand, when$(sA)^{\rho}\bar{B}^{1-\rho} < n^{\rho}$, the labor share converges to a certain value as there is a steady state in which the growth of capital per capita stops.

Next, let's examine the case where the automation process is complete. First of all, it is important to note that the economy grows sustainably in both alternative and complementary cases. In the alternative case ($0 \leq \rho < 1$), the denominator of the labor share equation rises infinitely, so that the labor share converges to 0.

Next, in the complementary case (ρ<0), the term affected by automation increases infinitely with the progress of automation (Bt1).→ On the other hand, the term affected by capital accumulation infinitely close to 0 as the capital increases （$k_t \to \infty$） . So, the result depends on whether the speed of automation or the speed of economic growth is faster. Let's consider the following automated process as a specific example.

$$\dot{B}_t = a(1-B_t)B_t$$

This formula means the following. The left-hand side represents the speed of automation. The speed is determined by two factors. First, progress of automation is the effect of increasing the speed of automation. B_t on the right-hand side represents that. This is the externality of the automation process. The second is the effect that the progress of automation becomes more difficult as it progresses. The $(1-B_t)$ on the right-hand side represents that. This differential equation can be solved, and the solution is as follows.

$$\frac{B_t}{1-B_t} = \frac{B_0}{1-B_0}e^{at}$$

In this equation, B_0 is the initial level of automation progress. Therefore, when the following inequality$(1-\rho)a + \rho g_k < 0$ is true, $\left(\frac{B_t}{1-B_t}\right)^{1-\rho}k_t{}^{\rho}$drops and converges to 0. Therefore, the labor share increases and converges to 1. If the inverse inequality is true, the labor share converges to 0.

[Note]

1) The Race between Man and Machine: Implications of Technology for Growth Factor Shares, and Employment, D. Acemoglu and P. Restrepo, AER, 2018, vol.108 (6)
2) It was Mr. Hirofumi Uzawa who proved this. H. Uzawa, 1961, Neutral Inventions and the Stability of Growth Equilibrium, Review of Economic Studies, vol. 26, no. 2, pp. 117-124.
3) J. Zeira, 1998, Workers, Machines, and Economic Growth, Quarterly Journal of Economics, vol. 113, issue 4, pp. 1091-1117.
4) P. Aghion, B. Jones, and C. Jones, 2019, Artificial Intelligence and Economic Growth, in The Economics of Artificial Intelligence: An Agenda, A. Agrawal and A. Goldfarb, editors, NBER, Chicago UP..
5) In the following description, it is assumed that tasks exist continuously for the sake of simplification of calculation and notation, but the same is true even if tasks exist discretely.
6) In the case of incomplete automation, contraction growth and sustainable growth occur because the Inada condition is not satisfied in the case of CES-type production functions.

[Part 2] Chapter 6: The Fourth Industrial Revolution

Naoki WAKAMORI[ix]

[Summary] 1)

The Fourth Industrial Revolution has created platform companies. Platform companies mediate a huge number of transactions on a daily basis. In recent years, the attribution of personal data collected by the platform companies and the abuse of a dominant position to their business partners have been a problem. If such platform companies merge with each other, would that lead to socially desirable consequences? What would be the policy concerns in that case? This paper also discusses how the researchers (both theoretical and empirical industrial organization economists) who play the role of conducting economic analysis, in-house economists, and policy makers should adapt to the 4th Industrial Revolution in the environment where platform companies have emerged.

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1. The Fourth Industrial Revolution and the Rise of Platform Companies

The services provided by a group of companies called GAFA (Google, Amazon, Facebook, Apple) have deeply rooted in our lifestyles. Checking Gmail and Facebook on your iPhone as soon as you get up, having a breakfast while watching YouTube, and checking Amazon for items that were advertised in the middle...I guess you're also living such a life[2]. GAFA and the tech companies that have been experiencing rapid growth in recent years (Uber, Airbnb, etc.) are characterized by the fact that they provide a platform for mediating transactions between fundamentally different types of economic entities (e.g., buyers and sellers) online, where network externalities can work better. Therefore, we call them platform companies[3]. For example, on Rakuten Ichiba operated by Rakuten,Inc. (Rakuten), a leading platform company among Japanese companies, registered proprietors can sell goods and services to consumers who visit the Rakuten Ichiba website. If there are many potential consumers on Rakuten Ichiba, the proprietors' benefits of getting goods and services up on Rakuten Ichiba will increase. On the other hand, if there are many proprietors, the consumers will be more attracted to Rakuten Ichiba. These effects are referred to as (indirect) network effects, and platform companies Platform companies are thought to be increasing their value by making full use of information technology to enhance network effects[4]. The concept of such a platform company was first conceived in economics in the early 2000s and was established by a series of studies by Rochet and Tirole (2003), Caillaud and Jullien (2003), and Armstrong (2006). Research on its properties has been advanced rapidly since then[5].

These platform companies are thought to be closely related to the 4th Industrial Revolution. Let's explore their relevance to the 4th Industrial Revolution by considering what kind of services and companies had been platforms before such companies emerged. Online shopping malls such as Rakuten Ichiba and Amazon Marketplace, for example, are considered to be evolution versions of physical shopping malls. However, compared to physical shopping malls, there are no restrictions such as land restrictions. Therefore, large numbers of stores can be opened there. From the perspective of consumers, they can visit and enjoy various types of stores. From the proprietors' point of view, they can sell goods and services not only to local consumers but also to more people (economies of scale and scope). While there are much more stores than physical shopping malls, it is easier to find, browse and compare products (less search costs) on online shopping malls as they have less physical distance or better search functions. In addition, matching efficiency between buyers and sellers has improved by platform companies providing information such as recommendations based on purchase history on online shopping malls (matching friction reduction). In this way, the development of information technology through the Fourth Industrial Revolution has succeeded in minimizing the speed and the marginal cost of transactions to the utmost limit by enabling processing a large amount of information and eliminating all the intermediaries that existed between sellers and buyers, and making it easier for consumers to search for products. The platform is considered to exist as exactly one market.

Even one such platform company has a large number of business partners and mediates a large number of transactions on a daily basis. In recent years, the attribution of personal data collected by the platform and its superiority over business partners has come to light as a problem. Under these circumstances, if such platform companies attempt to merge, would that be acceptable? Section 2 of this paper considers what is expected to occur as a result of the merger of such platform companies, and what are the competition policy concerns in that case from an economic perspective. In addition, Section 3 discusses how the researchers (of theory of empirical industrial organization) who play the role of conducting economic analysis, intra-corporate economists, and policy makers will adapt to such changes in such environmental change.

2. Adaptation of Competition Policy to the 4th Industrial Revolution

Competition policy is the rule of competition among companies to make the market economy work and is one of the policy groups that form the basis of capitalism. The Antimonopoly Act is at the center of Japan's competition policy, and the platform companies that emerged along with the Fourth Industrial Revolution discussed in the previous section, are believed to be encouraging changes in competition policy. For example, on December 17, 2019, the Japan Fair Trade Commission (JFTC) revised the "Antimonopoly Act Guidelines on Abuse of Dominant Positions in Transactions between Digital Platform Business Operators and Consumers Who Provide Personal Information" as guidelines for transactions between platform businesses and

consumers, and revised the “Guidelines to Application of the Antimonopoly Act Concerning Review of Business Combination” and the “Policies Concerning Procedures of Review of Business Combination.” This section considers with regard to the "abuse of dominant bargaining position" mentioned in the Antimonopoly Act and the "bargaining power" that is a concept in economics and is thought to be possessed by platform companies. Section 2-1 and section 2-2 considers how competition policy should adapt to the 4th Industrial Revolution using Rakuten Ichiba as an example in section 2-1 and the merger of LINE Co., Ltd. and Z Holdings (parent firm of Yahoo! Japan) in section 2-2[6].

2-1 Issue of Free Shipping on Rakuten Market and Abuse of Dominant Position

On February 10, 2020, the Japan Fair Trade Commission conducted an on-site inspection of Rakuten office on suspicion of violating the Antimonopoly Act, in particular, "abusing a dominant position." This is because Rakuten has announced a policy of offering free shipping (except for some regions) from March 18, 2020 on purchases of 3,980 yen or more on Rakuten Ichiba, which is operated by Rakuten. The shipping fee differs depending on the online stores. It is difficult for consumers to know the final payment price until the order is confirmed. This has been causing confusion among consumers. In order to rectify this problem, the Rakuten side has announced a policy to offer free shipping at the online stores’ expense on orders of 3,980 yen or more at one store. However, some Rakuten’s retailers have asked the Fair Trade Commission to investigate, saying that Rakuten’s forcing free shipping would violate the Antimonopoly Act.

Abuse of a dominant position means ‘business operator in a dominant bargaining position in transactions cause disadvantages to the counterparty in transactions unjustly in light of normal business practices.’ If Rakuten’s case is interpreted according to the Japan Fair Trade Commission's guidelines, a platform company is recognized as a business operator in a dominant bargaining position if the following conditions are met. That is, (1) stores are highly dependent on platform companies for transactions[7], (2) platform companies have a high status in the market[8], (3) stores are unlikely to change their business partners, and (4) there are concrete facts that shows need to deal with other platform companies. If those conditions are met, Rakuten is deemed to be in a dominant bargaining position toward the online stores, and if this conduct (free shipping) is deemed to cause undue disadvantage in light of normal business practices, it will be a breach of the Antimonopoly Act [9].

Such free shipping policy may be maximizing social welfare (I. e., the sum of consumer surplus and profits of the online retailers and the platform). This is because simplifying complex payment structure and free shipping will reduce consumer search costs. As a result, consumer surpluses of consumers who are already customers will increase. The number of new consumers using Rakuten Ichiba will also increase. Therefore, as a platform company, Rakuten is likely to enjoy higher profits, and social welfare may be increasing because the increase in consumer surplus and platform profit may exceed the burden on the online retailers. However, the burden on the online stores is thought to be heavy especially for the online retailers who have low per-customer spending. For such online shops it would be good if they can observe a sales increase exceeding the burden. If not, it would be said that they were given an unreasonable disadvantage in light of normal business practices. In my opinion, the essence of this problem is considered to be price discrimination and negotiation power in economics. In other words, the problem is thought to have arisen as Rakuten changed the contract as if forcing the online shops to accept uniform pricing for shipping charges that were previously decided at the discretion of the stores among which there were heterogeneity in terms of average per-customer spending (that is, some online retailers have high per-customer spending and some have low per-customer spending). If Rakuten Ichiba had expressed free shipping from the beginning and had signed a contract with online stores to cover the shipping cost at their expense, the problem would not have got complicated. In that case, however, many small online retailers would not have joined Rakuten. Rakuten Ichiba may not have become an attractive platform for consumers and might not have grown as big as it is today. In other words, it is a matter of price discrimination. At the same time, change in dynamic bargaining power is also a major factor (discussed again in Section 2-2).

After many twists and turns, on March 6, 2020 March, Rakuten withdrew the decision of free shipping due to the "impact of the new coronavirus." The issue was settled when Rakuten announced that free shipping would be introduced from the stores which have become possible to introduce it and that Rakuten would consider supporting measures in the event that sales declined due

to free shipping. However, it will be necessary in the future to examine whether Rakuten was really in a dominant bargaining position in transactions (though platform companies are generally considered to be in a dominant position in business) and whether free shipping would have caused disadvantage for many online retailers. And, as this Rakuten case illustrates, a change in one contract alone can have a tremendous impact due to the size of platform companies. In case of a merger between such platform companies, the merger review is considered to be more difficult. Let's see it in the next subsection.

2-2 Mergers and Acquisitions between Platform Companies and Bargaining Power

Mergers and acquisitions are an important factor in changing market structure, and horizontal mergers of relatively large firms are generally considered carefully. This is because a merger is said to have two conflicting effects and has to be decided after assessing each effect. The first effect is to be able to provide goods and services at a lower price than before through the synergy between companies to be merged and to be able to provide new goods and services through the advancement in research and development. It can also be said to be the effect to improve efficiency because the merger will increase corporate profits and social welfare. Another effect is that market power of the companies will increase as competition is eased after the merger through a decrease in the number of companies. This effect is called the competition restriction effect, which lowers social welfare[10]. Since such trade-offs exist in a merger, the Competition Authority (the Fair Trade Commission in Japan) usually review the mergers (business combination) and decides the pros and cons of the merger taking into consideration the respective effects[11]. How should this review be done in the case of mergers between platform companies? Since it is generally difficult to assess the impact after mergers between platform companies, this section summarizes and presents the points of contention through the example of retail settlement (consumer settlement method).

The year 2019 was the year when various cashless payment methods became popular, and the year was called the first year of cashless payment. In October 2019, the government initiated cashless and point refund service started. Before and after that, various payment method providers carried out a series of campaigns. As a consumer, it was a very happy year as we could always receive benefits in some campaign if we used the cashless payment system. In such a year, LINE Co., Ltd., which operates LINE Pay, a QR code-based payment service, and Z Holdings, the parent company of PayPay Co., Ltd., which also operates PayPay, a QR code-based payment service merged[12]. Each method of settlement is considered to be a platform that connects consumers as buyers and stores as sellers. This is because the more consumers have those means of payment, the more desirable to the stores as potential customers will increase. Similarly, the more stores accept the means of payment, the more incentives consumers have to have the means of payment. What is expected to happen if LINE Pay and PayPay which are such payment platforms merge?

Let’s consider the consumer market, which is one aspect of the merger. Currently, there are no fees for any of these services, and both the membership registration fee (initial cost) and the fee for settlement (charging according to usage) are free. In general, while usage fee is not required of one side of the business in platform business (it is likely to set a price below zero with points etc.), economic agents on the opposite sides are required to pay a price. That is known to be easy to achieve in terms of balance. Therefore, even if LINE Pay and PayPay are merged, it is expected in economic theory that the membership registration fee, which is the initial cost, and the usage fee of the usage portion will be kept free. If they are not platform companies, the discussion will be over. However, the reason why it is difficult to review the merger of platform companies is that it is necessary to consider the impact not only on the consumer side but also on the merchant side that accepts the payment method.

Now let's consider another side of the merger, that is how prices will be set for merchants. As of May 31, 2020, according to the LINE Pay website, there are three types of fees that merchants pay: (1) introduction fee, (2) monthly fee, and (3) settlement fee, which are 0 yen, 0 yen, and 0%, respectively. However, the proviso is added to the settelement fee that “Until July 31, 2021. After August 2021, it will be 2.45% [tax not included].” Similarly, according to the PayPay website, there are three types of fees that merchants pay: (1) introduction fee, (2) operational cost, and (3) settlement fee. It also says that the introduction fee and operational cost are free, and that the settlement fee is about 0 to 3.74%. However, the proviso is added that the settlement fee varies depending on operators, but when using PayPay, the fee is free until

September 30, 2021.

In the case of LINE Pay, there is already a future pricing plan, but in the case of PayPay, it is not clearly specified (at least on the website). The author is concerned that there will be discussions similar to Rakuten's free shipping in the future[14]. If LINE Pay and PayPay were merged, the number of consumers using the service would be greater than the total number of existing users of LINE Pay and PayPay, because, from the point of view of consumers, the number of places where the service is available would increase and convenience would be improved (and usage fees would remain at 0 and be unchanged). In addition, the platform that have a larger customer base could require merchants to pay higher usage fees than traditional usage fees. However, we must remember that a large number of merchants would accept payment methods behind the fact that the platform can get a large customer base. Not all the surplus gained from the growing number of consumers using the platform should be attributed to the platform. A "bargaining game" is often used in Economics as a framework to think about such distribution of surplus[15]. What is important in doing so is the "threat value" incurred in the event of a breakdown in negotiations, which is considered to correspond to (3) the possibility of a change of business partner for the merchant in the guidelines for abuse of dominant bargaining position mentioned above[16].

The above-referenced “Guidelines to Application of the Antimonopoly Act Concerning Review of Business Combination” and the “Policies Concerning Procedures of Review of Business Combination” published by the Japan Fair Trade Commission clearly state that such a multifaceted analysis is to be made. However, it is not yet known how the judgment is to be made in practice. In addition, abuse of the dominant bargaining position by platform companies has become a keyword in recent years. Attention has been focused not only on review of merger but also on how to manage abuse of the dominant bargaining position. The Fair Trade Commission’s abuse of “abuse of the dominant bargaining position” may discourage corporate activities, so it should be carefully managed. However, the increased market power leveraged by the merger of platform companies also cannot be overlooked. At present, empirical research on bargaining power is in progress in the industrial organization theory, and the knowledge obtained from such research should be utilized for the recognition of a dominant bargaining position. In order to improve social welfare, the researchers of the empirical industrial organization theory will need to share the problem consciousness of the policy-makers and conduct research in line with practical problems[17].

3. Adaptation of Economists, In-House Economists and Policymakers to the Fourth Industrial Revolution

The preceding sections have discussed the platform companies that have emerged with the Fourth Industrial Revolution and how competition policy will adapt as these companies emerge. To conclude this paper, this section discusses how economists (mainly conduct an empirical analysis), in-house economists (or data scientists), and policy makers should adapt to the competitive policies and environment that change with the Fourth Industrial Revolution.

3-1 Adaptation of Economists to the Fourth Industrial Revolution

The empirical analysis methods in economics are traditionally classified into structure estimation approach and experimental/inductive approach (hereinafter referred to as inductive approach)[18]. In general, the two approaches are often sorted out by whether to determine the fundamental parameters of the economy by formulating and solving the optimization problem of each economic agent and using the answer directly or indirectly to make an estimation[19]. The field of the empirical industrial organization theory, which deals with competition policy discussed in the previous section, has developed since the 1990s with a focus on structural estimation approach. Behind this was the lack of accumulated micro data that can be analyzed in companies and the limited amount of computer calculation. Even if the micro data had existed, it would have been very difficult for economists (who are outsiders to companies) to access in-house data[20]. In such a situation, it was necessary to set relationships between variables derived from economic theoretical models in the data generation process in order to understand corporate behavior using limited data (e.g., aggregated data such as market share and the number of companies in a market) or to evaluate policies. For this reason, it is believed that the structure estimation approach has spread rapidly[21].

However, the Fourth Industrial Revolution has created high-performance computers that can record data of astronomical numbers and analyze terabytes of big data. And now, many tech companies are conducting a

cooperative research with economists, and the situation where only limited data can be accessed as in the past has been greatly improved. Today, with such a wealth of data, the necessity of adopting only the structure estimation approach as economic analysis lessens. Researchers of empirical industrial organization theory will be required to have a good knowledge of the inductive approach and research ability to apply it. It should be noted, however, that this does not necessarily mean that there is no need to study or educate structural estimation approaches. This is because, as discussed in the previous section, it is expected that the development of the Fourth Industrial Revolution will inevitably bring about unknown problems. The pros and cons of regulation for the platform companies and mergers between platform companies are the best examples. To approach such an unknown problem, a structure estimation approach in which one considers how economic agents change their behavior from the ground up by going back to the basic economic theory model is often a powerful tool, rather than an inductive approach in which one needs some exogenous policy change. Based on the above, it will be important for economists to be familiar with both approaches in the future.

3-2. Adaptation of In-House Economists and Policymakers to the Fourth Industrial Revolution

What kind of skills will be required of economists / data scientists in the companies? For them, the inductive approach is expected to be more important than the structure estimation approach, but what is more important is the "machine learning approach" which is newly added as an economic analysis method in recent years. For example, there is an auction (competitive bidding) behind the display of Internet advertisements. The auction design and the bidding strategy for the advertisement of a company are supported by economic analysis. Therefore, the underlying algorithm is not expected to change for a certain period of time. However, since consumer preferences change over a relatively short time span, tuning of parameters such as bidding strategy and what kind of advertisement is targeted for what, needs to be done frequently. When an economist estimates the demand function of a commodity in writing a paper, he often does not think that the shape (parameter) of the demand function changes every day or day or every week due to restrictions on data. However, companies that advertise on the Internet need to completely capture changes in consumer demand. Under such circumstances, it is necessary to update the data sequentially to create a new demand prediction model. In such a situation, a machine learning approach would be a very powerful analytical tool.

Nevertheless, the structural estimation approach and the inductive approach are important for in-house economists. This is because many industries are not monopolized. Similar companies develop and sell similar products. Even if they have a wealth of their own micro-data, it is difficult to determine their own strategies without the data of other companies. In such a situation, it is natural to analyze how other companies respond to one's pricing strategies using a structure estimation approach. It is necessary to know well the inductive approach when planning and implementing A/B tests that are frequently used in marketing. Therefore, it is also necessary to be familiar with other methods though the machine learning approach is a bit more important.

Moreover, in response to changes in economists and corporate economists' methods, policy makers will also need to change their methods. In recent years, "Evidence Based Policy Making" (EBPM for short), which means policy-making based on evidence, has become a major trend. When considering such evidence, it will be important to be familiar with various methods, and also to have a good understanding of the advantages and disadvantages of each method, and to be able to interpret it appropriately. When implementing a policy, it is desirable to conduct tests such as A/B tests conducted by companies. However, unlike ordinary companies, it is difficult to conduct experiments. So, it is sometimes necessary to use the structure estimation approach. It will also be necessary to scrutinize the micro-data and economic analyses submitted by companies in the aforementioned merger review and the recognition of the abuse of the dominant bargaining position in corporate transactions. In addition, when examining digital cartels that are not covered in this paper, policy makers may also need to closely analyze the programs for pricing setting that companies determine. The machine learning approach may also be important in that case. Therefore, policymakers need to deepen their understanding of each method.

As mentioned above, given the permeation of economic analysis into corporate and policy makers, we economists will be required to make changes not only in research but also in education. The theory of industrial organization, which has been taught in universities since

around 2000, has emphasized theoretical aspects based on micro-economic theory (mainly game theory). In the future, the need to promote education that includes empirical analysis (not only teaching methods but also making actual estimation using data) in addition to conventional theoretical discussions will be increased.

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[Note]

1) I received useful comments from Mr. Takanori Adachi in the preparation of this paper. I'd like to express my gratitude.
2) Even if you don't use Amazon's online shop, many Internet services have recently been provided using Amazon Web Services (AWS), the world's largest cloud service, and we often use Amazon without realizing it.
3) It is also called platformer in Japanese. There have also been attempts to define platform companies more accurately, and three requirements for being a platform company are listed in Weyl (2010).
4) There is a concept of direct network effect as opposed to indirect network effect. For example, in the case of a platform such as telephone or e-mail, the more people use it, the more convenient it is when using it. Such case is called a direct network effect. In the case of Rakuten Ichiba, from the online stores' point of view, an increase in the number of consumers creates a positive indirect network effect due to an increase in potential customers. On the other hand, an increase in the number of competitive online retailers creates a negative direct network effect due to a loss of customers. Thus, network externalities to the same side of the platform are called direct network effects, and network externalities to different sides are called indirect network effects.
5) Chapter 7 of Part II of this report is also an example. For a more detailed theoretical discussion, including the definition of platforms, see Chapter 7 of Part II.
6) In addition to these problems, there are other problems such as the emergence of digital cartels and the handling of personal information. However, due to the lack of space in the paper, these problems will be omitted.
7) The transaction dependency in this case is calculated by dividing the sales of an online store on Rakuten Ichiba by the total sales of the store.
8) In this case, market share of Rakuten Ichiba and ranking in the market are considered.
9) More precisely, the following are prohibited : (a) causing the counterparty in regular transactions to purchase goods or services other than the goods or services pertaining to said transactions; (b) causing the counterparty in regular transactions to provide for oneself money, services, or other economic benefits; (c) refusing to receive goods pertaining to transactions from the counterparty to the transactions, causing the counterparty to the transactions to take back the goods pertaining to the transactions after receiving the said goods from the said party, delaying the payment of the transactions to the counterparty, or reducing the amount of the said payment, or otherwise establishing or changing trade terms or executing transactions in a way disadvantageous to the counterparty.
10) The competition restriction effect is classified into the unilateral effect which the merged enterprise carries out alone, and the coordinated effect by the merged enterprise and the enterprise which was not merger party but existed in the same market.
11) More specifically, the commission makes a decision as to whether or not they will be the subject for the review of business combination. If so, the commission will confirm certain fields of trade, and examine comprehensively whether or not to substantially restrict competition in each field of trade from unilateral and coordinated effects.
12) This paper focuses on the aspect of retail settlement. The difficulty of this merger review is that while Z Holdings Inc. provides Yahoo! JAPAN's search engine and other services, LINE Co., Ltd. mainly provides LINE, a type of SNS service. They will share personal information collected by each service, thereby increasing its market dominance in

the advertising market.

13) For example, Armstrong (2006), a paper that is also the cornerstone of platform research, shows that the side which enjoys more indirect network effect pays more to the platform to achieve a balance. Subsequent studies show that the price of one side may be zero.
14) There is a possibility that the future price is just not specified on the website and is written in the contract with each store.
15) Since PayPay's future rates are variable, PayPay could discuss usage fee on a case-by-case basis (or depending on company size and industry) rather than setting a single price.
16) With this in mind, Adachi and Tremblay (2020a, 2020b) made a good model. his paper They succeeded in constructing a theoretical model and drawing policy implications.
17) Considering a one to-one bargaining game between individual stores and platform firms, it is likely that the newly generated surplus will be returned to the platform firms. It may be necessary to consider a model in which multiple economic entities are negotiating in parallel (see, for example, Collard-Wexler, Gowrisankaran, and Lee (2019)).
18) The latter is often separately defined as "experimental approach" and "inductive system approach". They are often defined separately. We may now add a "machine learning approach" to these categories of analytical methods, which are discussed in Section 3-2.
19) See Nakajima (2016) for examples of more precise classification and analysis, and for a discussion on the two approaches that occurred around 2010.
20) In labor economics and other fields, panel data that tracks individuals and households over a long period of time have been developed and accumulated, and inductive approaches that have a high affinity with such rich micro data (in terms of information quantity) have often been adopted. Therefore, it is thought that econometric techniques belonging to the inductive approach have been developed.
21) For example, Berry (1994) and Berry, Levisohn, and Pakes (1995), which are often used in estimating demand functions, make an estimate so that the expected market share, which is the sum of the probability of choice obtained from discrete-choice models, matches the actual market share, assuming that individuals choose their options to maximize utility. The Olley and Pakes (1996) method, which is often used to estimate a production function, theoretically shows that companies that invest more this term receive a shock of better productivity (which is not observed in the data) compared with companies that invest less. The method makes it possible to estimate a function by using the relationship well.

[Part 2] Chapter 7: How Platforms, the Sharing Economy, and P2P Trading Change the Market Economy?

Tetsuya SHINKAI[x]

[Summary]

This article outlines the changes in the Japanese economy and society from the period of Japan's high economic growth in the middle of Showa and the period of product differentiation and increase in variety to the period of economic globalization after the collapse of the bubble economy in the early Heisei period and more than 20 years of stagnation of the Japanese economy, and from the late Heisei period to the period of Reiwa in which the trade by the platform sharing economy develops. In addition, this paper outlines the changes brought by these changes, which have taken place in the Japanese economy and society, in the distribution structure and market transactions from the production of goods and services to the delivery to consumers. Based on that, the paper explains how changes in the method of transmitting information by advertising from producers of goods and services to consumers and changes in the composition of marginal costs have effect on distribution structure of market transaction value obtained by companies, consumers, etc. at each stage to each transaction participant. Graphics are used in the paper so that the explanation is intuitively understood.

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1. Introduction - What is a platform company? ~

In recent years, Google, Apple, Facebook, Amazon.com, Netflix, Microsoft, and many other large companies, also known as Big Tech and GAFA, have made enormous profits in the business world, and their actions have drawn attention from companies in other industries, consumers, governments around the world, and competition authorities. Many of those giant companies are called platform companies.

Even in Japan, there are many such platform companies around us. Those include BizReach, a career-change support service provider that connects those who want to change jobs with companies that are looking for excellent human resources who can be immediately assets, and SHIRU CAFEs that are located near famous universities and connect students with companies that want to hire excellent human resources from the students. Mercari is also a platform company that connects people who want to sell their unwanted goods and handmade goods with people who want to buy used goods and handmade goods at low prices.

Platform companies have three characteristics: 1) they provide different goods (products) and services to two or more different user groups; 2) they can determine the price of goods and services to be provided to all group users; and 3) the utility (benefit) of a user belonging to one user group depends on the number of users belonging to the other user group (network externality).

In fact, the prototype of the platform company with these characteristics appeared in the Japanese business world from the middle of the Showa period.

In this article, I would like to avoid the explanation by the theoretical economics model, which is my main business, and consider a platform company by paying attention to the big flow of economic change in each era of Showa, Heisei, and Reiwa that I have experienced as consumers. In particular, the Fourth Industrial Revolution, which is the theme of this study group, has caused innovative changes in the economic system. By focusing on structural changes in distribution systems and changes in marketing systems that capture consumers' preferences and likings for goods and services, this paper tries to explain how the innovative changes had impact on the distribution of wealth from the perspective of marginal cost. By doing so, this paper considers how platforms, the sharing economy, and P2P trading, which characterize the modern economy, can change market trading and affect businesses, consumers, and society.

2. High Economic Growth, Formation and Development of Mass Consumption Society, and Platform Enterprise as Consumer Credit

As was the case with the economies of Western capitalist countries that achieved economic growth after the second World War, the Japanese economy, from the chaotic period after the defeat in the war, saw an increase in exports of industrial products due to special demands from the Korean War. That led to an increase in demand for industrial and manufacturing products, and the second industry that produced and supplied these products developed. As a result, labor demand in the manufacturing industry increased. Taking this opportunity, there has been a population migration from the rural areas where people are mostly engaged in the first industries, such as agriculture, forestry and fisheries, to near-by cities where these goods are consumed, since the middle of the 1950s, when I was born in this world. Many workers get jobs and settle in cities, and their incomes rise. Demand for goods and services as well as demand for the service industry, which is the third sector, also rises. The increase in income from life without goods after the second World War gave people the opportunity to consume goods and services to satisfy their strong desire. Large domestic markets for goods and services were created in cities and their surrounding areas, and Japanese companies mass-produced a wide variety of goods and services and supplied them to the market. That generated the mass consumption society.

People always lived in some areas in cities and knew who each other was from where. Then people from many regions moved in and did not know who each other was from where. Local societies where they had face-to-face relation were transformed into urban societies where they don’t have that relation. During the period of high economic growth, the population concentrated in the city. The number of small-scale manufacturers of goods, retail stores selling those goods to consumers, and the service industry of the food services of individual sales also increased, as entry into the market is easy if the market size of many kinds of goods and services continues to grow.

In addition, the progress of motorization through road improvement and the construction of national expressway networks, and the increase in the movement of people through the improvement of Shinkansen bullet trains, airports, and air routes, brought about further development of the market.

The increase in transactions with people without having the face-to-face relation has called for consumer credit and cashless settlement efficiency to support safe transactions. The development of information networks through the development of computer technology and data communication technology has created platform companies called credit card companies. The companies mediate transactions between consumers and businessmen who want to purchase goods and services

cashless, and companies and retailers that sell and supply them through a consumer credit system.

Over the past 20 years, when Japan's economy was relatively stable thanks to employment security through high economic growth, the middle-class income bracket of a large number of workers was brought to Japan's society and economy. An active demand from the middle class has led to the creation of credit-card companies, which offer installment sales of high-priced consumer durables and automobile loans. It is believed that these credit-card companies have also functioned as platform companies.

From the 1970s to the first half of the 1980s, the Japanese economy experienced a recession due to the business cycle, but in the medium run, high economic growth continued. At that time, the population was growing and the society was not aging. So domestic demand grew steadily. For this reason, if people joined a company immediately after graduating from high school or university, they would often work for the same company until they retire. If they worked hard, they would be able to buy a house. Such seniority-based pay scale and lifetime employment system were believed. In addition, it was believed that professional craftsmen other than salaried workers would be able to become independent with their own shops and factories if they joined a long-established store after graduating from school, polished their skills, and practiced for a long time. That was actually possible at that time.

3. Increase in variety through differentiation of products and services and platform companies

From the latter half of the 1980s to the Bubble Era, in the economies of each country that achieved high economic growth, the consumers of the middle class (middle-income bracket and above) with a strong consumption appetite had obtained almost all the necessary goods (products) and services. They began to attach importance to the taste and quality of goods and services However, although the information network of banks using large-scale computers was developed, consumers did not have smartphones, tablet terminals, PCs, etc. at that time as they do today. The Internet communication technology connecting this information on consumers' tastes with marketing companies was not developed. However, the capitalist society needed to create new consumption in order to seek further additional value and growth. In addition, as shown in Figure 2-7-1, the distribution system from producers of goods and services to consumers was mediated by many wholesalers. Goods and services were sold to consumers through retailers, resulting in the inefficiency of multiple limits. It is believed that consumers purchased high prices of goods and services, and the consumer surplus was small. On the other hand, due to the high economic growth and expansion of domestic demand by population, jobs and income were guaranteed to the people working for these middlemen. In such a vertically long distribution system, if the manufacturers are the furthermost upstream, each intermediary manages the inventory of goods purchased at the purchase price from the upstream company, and sells them to downstream wholesalers and retailers by setting their own wholesale prices, taking into account inventory management costs, adjustment costs to place and receive orders, cost for transportation of products, manpower costs, and others. Some people including Isao Nakauchi of Daiei Inc., tried to shorten the chain of distribution aiming at eliminating the multiple limitations in order to sell goods at low prices to consumers at supermarkets by eliminating middlemen. However, goods and services that companies aimed at selling at high prices through quality improvement and differentiation were not sold in supermarkets, and the conventional multi-stage distribution system as shown in Figure 2-7-1 was maintained and functioning.

In particular, the baby boomers who were born in the period known as first baby boom after World War II, grew up affluently on the wave of high growth, and reached their youth and adolescence around this time, created a huge market. In order to generate new or replacement demand in these young people’s markets, companies had to find out what kind of products and services they wanted by dividing consumers' markets according to their tastes and differentiating them. In fact, as the baby boomers age, advertising agencies such as Dentsu Inc. and Hakuhodo Inc. attempt to differentiate their products from other goods and services that the baby boomers may want depending on the age and Platform companies that have contributed to this are fashion magazines for clothing and specialty magazines for goods. (For example, fashion magazines include MENS CLUB, anan, Nonno, etc.) Other non-fashion magazines include POPEYE, Olive, and HotDog Press) These magazines cover a wide range of goods and services, including fashion brand products, restaurants, and accessories, which are differentiated by lifestyle and taste for the baby boomer generation who purchase them, and provide information on these goods and services, and earn advertising revenue from companies. The publishers and advertising agencies that publish these magazines are platform companies that sell separate services to the two-sided market, which have markets for both businesses and consumers in differentiated and segmented markets.

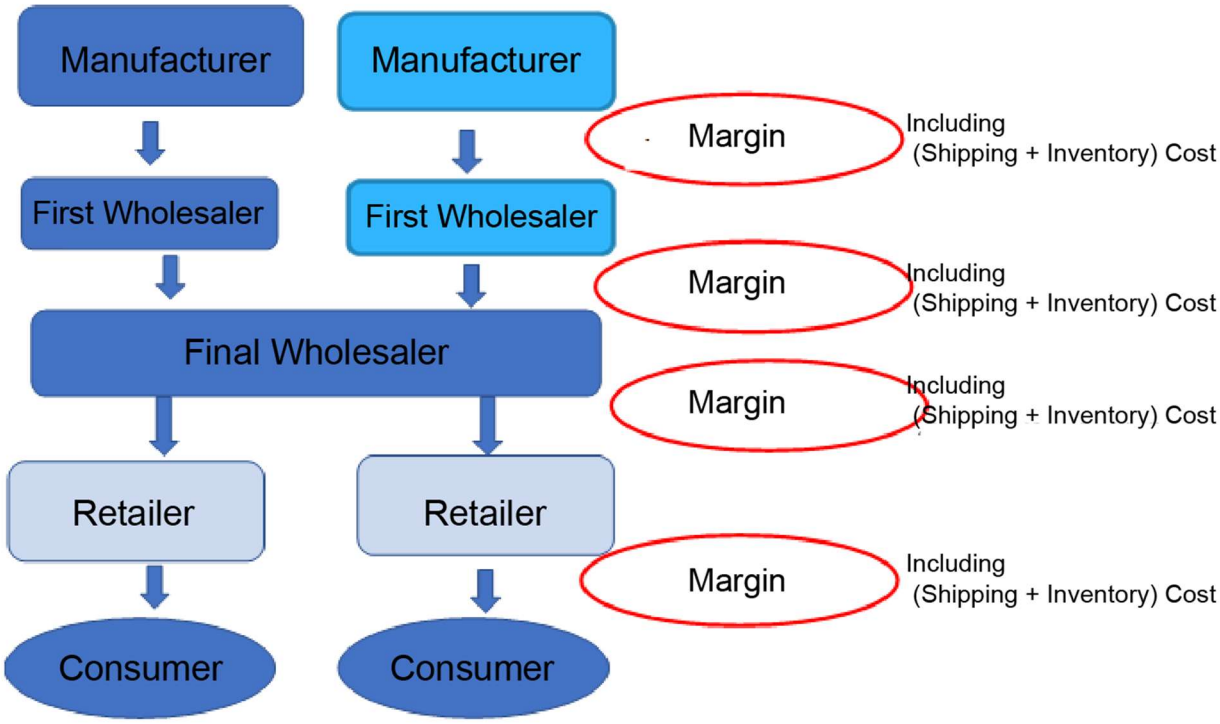

Figure 2-7-1 Traditional Distribution System Structure of Goods and Services and Multiple Limitations

to make advertisements and create fashion.

However, in order for the production and supply companies of goods and services to differentiate their products and services according to consumer preferences and to segment their markets, the first step was for these companies to order advertising plans to advertising agencies. Through the agencies many industries, including platform companies such as specialized magazine publishers, television commercials, television stations, newspaper companies, photographs, models, graphic designers, art directors, printing companies, Tohan which is a company in the distribution of publications, bookstores, and retailers that actually sell apparel and accessories, were involved and connected to consumers. Therefore, a huge advertising cost was required. In general, the profits of these media companies, publishers, and advertising agencies, and the salaries of their employees were higher than those of manufacturers. Companies producing goods and services required high marginal costs, including those marketing costs. Consumers had to buy expensive goods and services, and a significant portion of the price of goods and services could be the sales of advertising agencies and many industries involved in segmentation, as well as from the incomes of the people who worked there. In addition to the multiple limitations imposed by firms that stand between the sale and distribution of goods from producers to consumers, the multiple limitations imposed by information and systems that enable producers to identify and differentiate consumer preferences have lifted prices of goods and services. However, it is thought that these factors have also contributed to the growth of the national economy as a whole by serving as a source of profits for the firms involved and income for the people working there (Figure 2-7-2).

In the field of theoretical economics, progress has also been made on the basis of the development of information economics and game theory. In the field of microeconomics, new industrial organization theory has been developed. In the field of business, strategy management has been developed. In the field of macroeconomics, the research on endogenous economic growth theory has also been developed. The theory says that an increase in the variety of products increases the utility of consumers, and an increase in the demand for new and differentiated products and services give profits to companies and leads to economic growth.

In addition, the stabilization of employment and the increase in income of the baby boomers due to high

economic growth contributed not only to the increase in goods and services but also to the increase in domestic demand for owner-occupied housing rather than for rental housing.

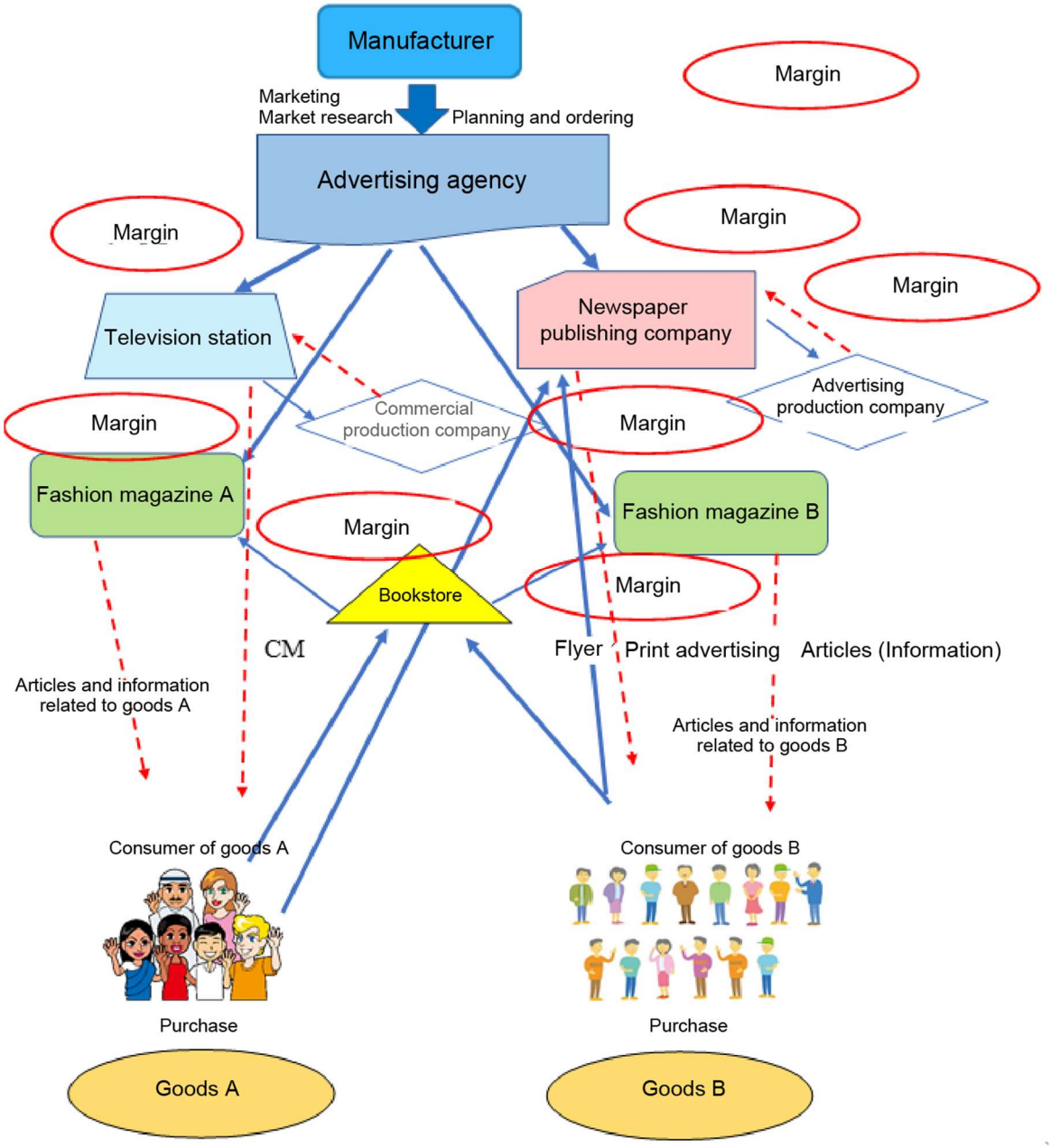

Figure 2-7-2 Product Differentiation, Multi-Commodity Producers, Mass Media and Advertising Agencies, and Multiple Marketing Limitations

There are real estate developers and real estate agents who want to sell newly built apartments and houses built for sale, as well as the Recruit Group, which plays a role in linking individual lenders of buildings,

The Japanese economy entered a bubble period.

Real estate and stock prices soared, and domestic demand peaked. As a result, young people and the baby boomers continued to consume goods and services vigorously on the basis of this "commitment to goods" and differentiation strategy until the end of the 1980s.

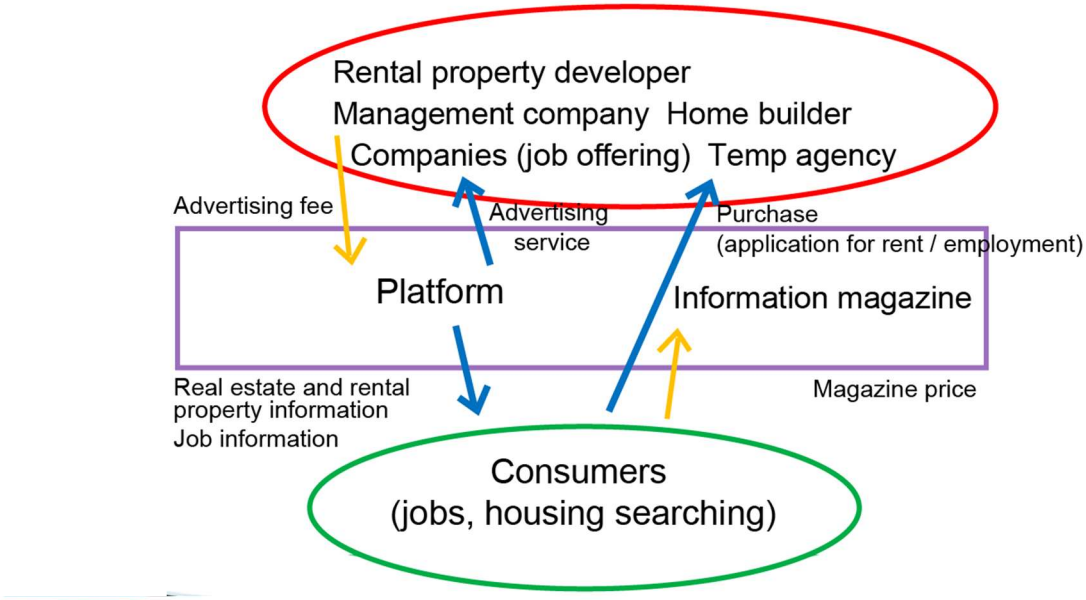

Figure 2-7-3 Late Showa Era: Platform Business Concept in the early Heisei period

4. The bursting of the bubble economy and the loss of the Japanese economy for the past 20 years, and a sluggish domestic demand

Since the collapse of the bubble economy in early 1990, the growth of domestic demand has slowed, making it difficult for Japanese companies, which had been supported by strong domestic demand, to hire new graduates as regular employees until their retirement. Therefore, the companies have increased the number of non-regular and temporary employees from temporary staffing companies to make labor costs variable and cut expenses. The number of those employees can be adjusted according to the production and supply volume. Social insurance for regular employees or reserve fund for retirement allowance, which will be fixed costs, are not required for those employees. As a result, the purchasing power of Japan's middle class has declined, and the domestic market, in which Japanese companies mainly provided goods and services, has shrunk significantly compared to the bubble period.

Many of Japan's leading manufacturing companies (manufacturers) of automobiles, home appliances, and other products tried to find a way to make up for the decline in sales due to the contraction of domestic demand by exporting products to China and ASEAN countries, where growth continues, and to North America, where economic expansion continues.

Demand for automobiles and home appliances in emerging countries, especially China at the time, was strong. However, in these growing markets, consumers with a high appetite for spending were different from consumers in Japan's market which was mature and differentiated by taste and quality and they wanted low-priced products with basic functions rather than ones with high quality, new functions, and beautiful designs. Japanese companies brought high-priced products with high quality, beautiful design, and multiple functions into market. As a result, they have lost out in price competition against manufacturers in South Korea, Taiwan and other countries and lost the market share.

In order to compete in overseas markets and to reduce production and transportation costs, Japanese companies began to directly invest overseas and produce locally. In Japan, the hollowing out of industries, mainly in manufacturing industries, and the reduction in employment by reducing the number of new graduates hired, as well as restructuring early retirement of older employees under the seniority-based wage system (in particular, the reduction of regular workers with high wages, including those for fixed costs) advanced.

After this trend continued for more than 10 years, many young workers became non-regular employees. The number of people who get married decreased due to uncertainty over their life in the future. Society faced later marriage and dwindling birthrate. The structure of the productive workforce in the company also changed, resulting in acceleration of demographic aging. Society changed from the 100 million, all middle-class society to society where the gap between the rich and the poor is created. The income of the young is particularly low, and

the elderly have money saved up thanks to the high economic growth. The elderly consumes less compared to the time when they were working as their income is less due to retirement and they are concerned about their health in the future. This resulted in a decline in demand for high-priced products and services in the market before the bubble economy. In addition, most of the industrial products are imported at low prices from China and other emerging countries. The demand for low-priced products such as the one sold at 100 Yen Shops (including Daiso, etc.) has increased in Japan where incomes have become low. As described in the previous section in Figure 2-7-2, the business model of the differentiation of products involving multiple limitations that cost advertising spending, has disappeared as consumers' demand for high-priced products was replaced by demand for low-priced products. The business model was created by many Japanese goods and services industries in the 1990s. In addition, the increase in the number of low-cost imported industrial products from overseas accelerated the elimination of the middleman in the multi-stage distribution system of goods and services involving multiple limitations as shown in Figure 2-7-1. That distribution system remained until the 1990s.

5. Development of Internet and communication system technology, development of online transaction using mobile information

Since the middle of the Heisei era, as the Internet and communication technologies have advanced. When mobile communication devices such as mobile phones and smartphones became popular, many of the transactions of goods and services have been replaced by transactions through the Internet instead of face-to-face transactions between customers and physical stores. In particular, bookstores were severely affected. In the past, there were small bookstores in our neighborhood and large bookstores in urban areas. However, when purchase and delivery services of books through the Internet such as Amazon.com became available, these bookstores could no longer carry on the business solely by selling books and they could not survive without selling goods other than books, such as stationery, rental videos, rental music CDs, game software, etc. As Amazon. com and Rakuten expand their sales of goods and services other than books through the Internet, many department stores (Sogo) and supermarkets (Daiei) in Japan went bankrupt. Sears Holdings Inc. in the United States, which was established in the late nineteenth century, went out of business in October 2018. As shown in Figure 2-7-1, the collapse of the traditional distribution system and structural changes in the distribution system are progressing. During this period, the Japanese economy was in a deflationary trend, and prices and the income level of workers continued to fall.

At the same time, the price of goods imported from abroad has fallen due to economic growth and industrialization in the core nations. As a result, even if the price paid by consumers for goods and services fell due to the loss of margins that the middlemen in each distribution stage in the past system had made in transactions, the companies producing and supplying goods and services could barely survive by lowering marginal costs by procuring goods and services that had been produced in Japan from abroad or by shifting production bases overseas through direct investment.

In recent years, thanks to the spread of the Internet and smartphones to men and women of all ages, online businesses such as games, online shopping, e-books, video and music distribution, various introduction and reservation sites, sharing economy (for example, ride sharing), and advertisement have been expanding, and they have been taking a large share in the industrial structure.

6. How Has the Growth of the Internet and Mobile Devices Changed the Distribution System and the Distribution of Transaction Value?

How did these new changes in economic transactions affect the distribution system for goods and services? The business model of Amazon.com is a good example of this change. Originally started as a business using the Internet for book sales and distribution systems, Amazon is now developing a big business around the world that handles everything from consumers' Internet orders for a variety of goods to collection of payments, inventory adjustment, and delivery.

Amazon offers two types of services: FAB service for large customers (selling 50 items or more each month) and service for small customers (selling up to 49 items each month). The service fee for the FBA (Fulfillment By Amazon) service for major customers consists of a fixed monthly fee of 4,900 yen and two-part fees that are inventory storage fees and fulfillment fees. The inventory storage fees are a fee charged for the storage service for the time period from posting one's products on the Amazon.com site, sending them the warehouse and distribution center called Amazon Fulfillment Center to selling them on the site. The fee is classified by the size and weight of the products and charged for the specific storage days (the number of days products are stored until they are sold and shipped). The fulfillment Fee is charged for packing and shipping of the products and customer service based on pay-as-you-go system. A Fulfillment fee is charged for the packing and shipping of the products and customer service is based on a pay-as-

you-go system. (cited from Fulfillment by Amazon (FBA) - Price Plan - Amazon.co.jp). Also, if a product of a seller under the FBA system is sold on the Amazon site, and if a consumer, who is a purchaser, is an Amazon Prime member (annual membership fee 4900 yen), the "Amazon Prime Eligible Item" is displayed on the site. The item will be shipped to the purchaser and basically arrive next day (one-day delivery). The delivery fee is free.

On the other hand, about the items of sellers who do not use FBA system regardless of whether large or small, even if the price of the items is low, the shipping charge to be paid by the buyer is determined according to the category of the items. Therefore, the seller has to decide the selling price considering the difference between the shipping charge and the actual shipping cost (mostly higher than the shipping charge specified by Amazon). Consumers also have to decide which items to buy from which company by comparing the prices of the items and the shipping fees specified by Amazon.

Due to this inconvenience, most buyers who are Amazon Prime members buy Amazon Prime Eligible Items which will arrive next day for free shipping. (I am a member of Amazon Prime because I often buy foreign and Japanese books due to my job.) The buyer (consumer) pays the price to Amazon with a credit card, etc., and the delivery is also done by Amazon. So, there is no risks associated with relying on the transaction, such as that the items didn't arrive even though the payment was made. About the performance and usability written on the site for the purchased product, etc. can be evaluated by the purchaser. The purchaser can freely post the information on evaluation system and the customer review. Therefore, if the seller lists inferior products, the purchaser, who is a site user, avoids the purchase of the products listed by the seller. So, there is no bait advertising in the system. Amazon puts together purchase amount collected from customers every month, deducts the FBA fee, and then pay to sellers and businesses. It is well known in the field of industrial organization theory and economics that the two-part fee system is a type 2 price discrimination scheme in which the average price per unit becomes lower as the sales volume increases.

On the other hand, there is no fixed monthly fee of 4,900 yen for sellers who sell fewer than 49 items per month. The shipping fee specified by Amazon, and the selling fee (the basic fee of 100 yen for each item) and the referral fee depending on the category of the items (8% to 15% of the product price (product price + shipping fee)) are charged by Amazon. Even for sellers who sell fewer than 49 items per month, the shipping fee paid by the buyer is determined by Amazon. So, the sellers need to determine a selling price on the site by estimating the difference between the actual shipping fee and the fee Amazon determines as costs. In the case of sellers who sell fewer than 49 items per month, as in the case of major sellers and companies using FBA system, Amazon receives all the money paid by consumers on the Amazon site. The amount after deducting the basic fee of 100 yen per piece and the referral fee will be paid to the account of sellers.

The emergence of Amazon as a platform company created retail arbitrage (a kind of arbitrage trading in which people make profits by buying at low prices and reselling at high prices) which is a second job for individuals. Individuals who were not in the distribution system shown in Figure 2-7-1, could newly enter the trading market. It is still fresh in our mind that such arbitrage transactions were frequently carried out on Internet sites for masks and alcohol disinfectants, which are currently in short supply due to the novel coronavirus.

In addition to Amazon, regarding other services such as Airbnb, hotels, babysitters, various cleaning services, new economic transactions have been created by the platform companies through the Internet. The distribution system of goods and services are also undergoing structural changes. (See Figure 2-7-4)

The traditional vertical distribution system (left side of Figure 2-7-4) remains, but its gaining seems to have gradually declined. As shown in the right side of Figure 2-7-4, Amazon and other platform companies are involved in transactions that go beyond the vertical structure. Through their platform sites, they carry out advertising, sales, inventory management and delivery services, and collection of sales, which have been done individually by middlemen in each stage. Platform companies such as Amazon have set these service charges, and through a price discrimination strategy based on a two-part fee system, many of the transaction value seems to be reduced by the marginal cost of the platform company and its profits are increased. Trading opportunities and profits are also distributed to sole proprietors who make a profit through arbitrage or prosumers. Those were not in the traditional distribution systems. Consumers who become Amazon Prime members seem to be able to buy products at prices generally lower than the retail prices in the traditional distribution systems.

7. How Have Platform Businesses such as Google Changed the Product Differentiation, Advertising, and Marketing Strategies of Companies?

As shown in Figure 2-7-2, in order to differentiate consumers based on their preferences and to segment the market and discriminate on price, companies had to pay high advertising fees to extract information about consumers' preferences and likings. Companies spent a

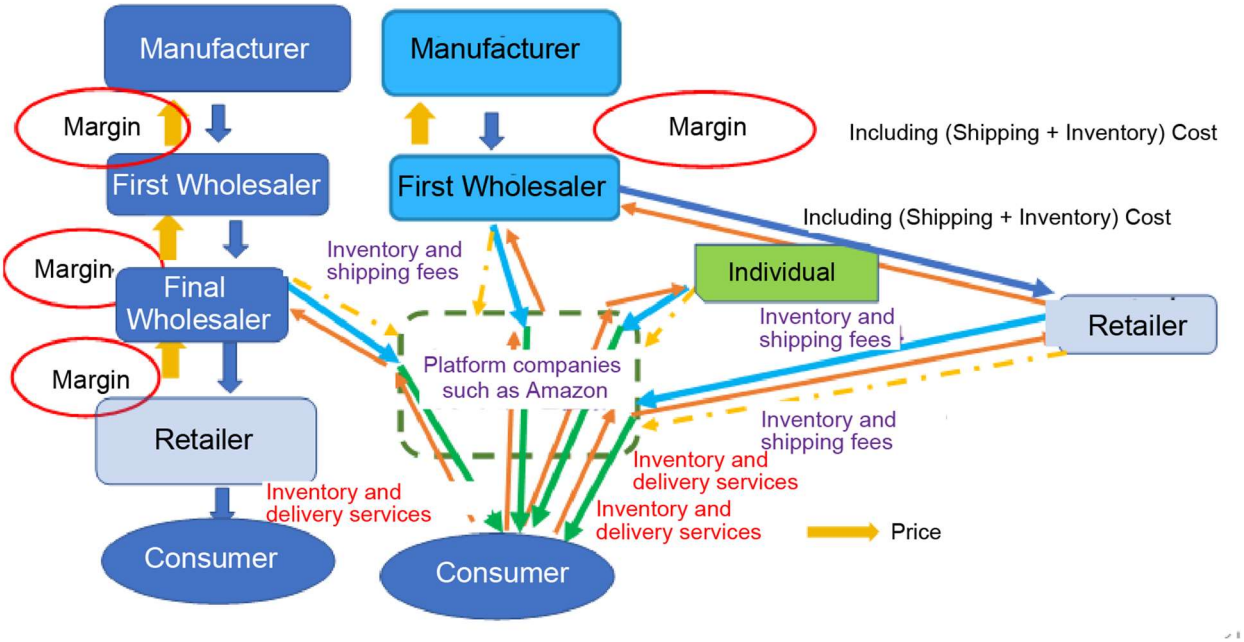

Figure 2-7-4 New Distribution System Changed by Platform Providers such as Amazon

lot of money on advertising expenditures to develop new products through market research by advertising agencies, advertising on television, newspapers, and other mass media, and sending product information to consumers through magazines tailored to consumer tastes and lifestyles, and monitoring responses (such as taking data on magazine subscriptions and sales of items put in magazines). As shown in Figure 2-7-2, the cost required for such marketing supported the employment of many people involved, such as mass media, advertising agencies, magazine publishers, photographers, and stylists. A large proportion of the transaction value as a result of selling high-priced products was distributed as sales in these marketing industries.

However, the development of the Internet, online network communication technology, and mobile communication information technology, and the spread of personal computers to consumers, the spread of smartphones, and the development of search engines such as Google have reduced information search costs. Consumers have been able to access the information which could not be obtained without reading a magazine and spending time and money searching for things, places, and things that they were actually interested in only by searching for using a PC, smartphone or tablet computer. Platform companies such as Google play a role in linking consumers' search behavior and service providers' advertising activities through SNS on the platform. Consumers search for their tastes and hobbies. For service providers, the action will be useful information on a question, “Which website did the user of this device browse in his/her search?" In other words, the service provider can obtain information on consumer preferences and personal information of the user of the terminal from his/her advertisement browsing data and purchase history. As a result, the service provider can deliver more finely segmented advertisements tailored to the needs of consumers, and can conduct efficient marketing.

Google, which is a platformer with the dominant communications network called the Internet, has two means to make a profit. The first revenue-generation opportunity is AdWords. The system is that from Google, the service provider buys keywords that would be more likely to lead consumers to click the service provider’s name. Another is ”Ad sense" advertising. The system of this advertisement is that a company that is an advertiser purchases a keyword and pays Google an advertising fee of 30 yen per click. The company can include links to the related website of the company in the space of “ads by Google” on YouTubers’ or bloggers’ sites that are relevant to the key word. When a consumer who visits the YouTube or the blog websites clicks on such included links and sees the advertisement of the company on the company’s product page, the company will pay Google some money per click. When that consumer purchases

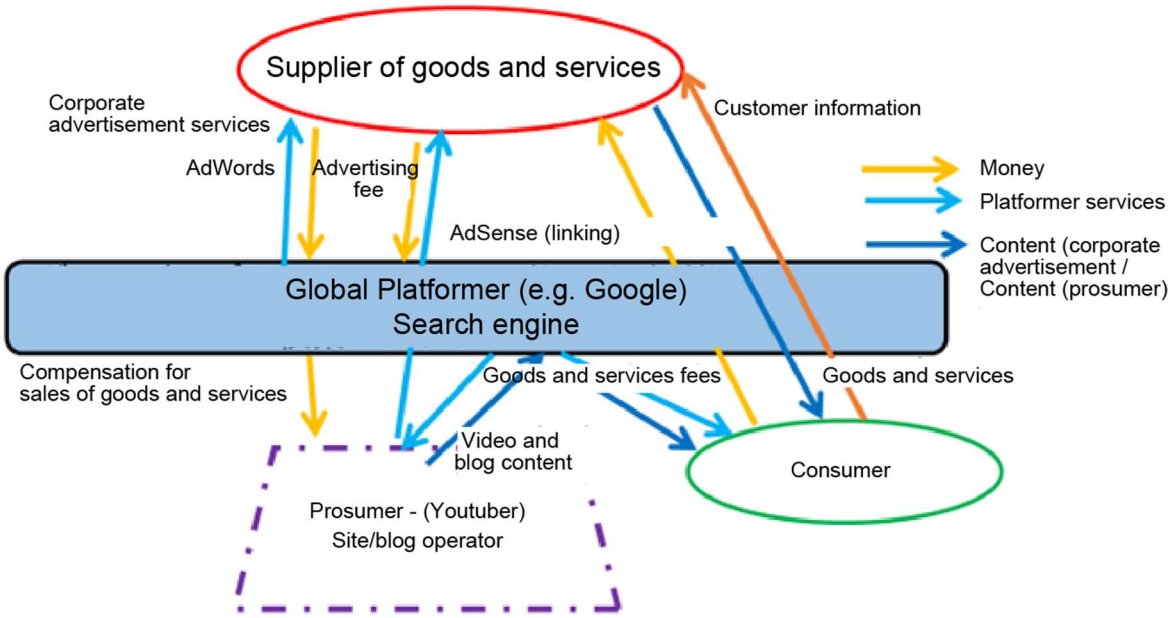

Figure 2-7-5 Corporate Differentiation and Marketing Structure Following the Spread of the Internet and Mobile Devices

the product, Google will pay a portion of the revenue to the video and blog operators. Google makes money from the difference between advertising revenue from its sponsors and sales fees paid to its prosumers. (See Figure 2-7-5)

Unlike the conventional product differentiation strategy of advertising agencies, mass media, and magazines shown in Figure 2-7-2, consumers directly click on advertisements from lifestyle blogs and video sites they are interested in. It is much cheaper than investigating the relationship between TV ratings/newspaper subscriptions and purchases of one's own products. Therefore, it is possible not only to directly grasp advertisements and purchase histories in quantitative terms, but also to obtain detailed information on customers, such as asset information, by linking with electronic money, credit card information, etc. Google can provide these services to consumers, prosumers and businesses at ridiculously low marginal costs. Therefore, companies' expenses of advertising in the mass media, magazines, and newspapers, which had profits from a large amount of trading value as shown in the old Figure 2-7-2, has decreased. As a result, advertising revenue of TV stations, newspapers, and magazines has decreased. Companies' advertising costs in their marginal costs of their products are likely to decrease significantly. In terms of information acquisition, it seems that more and more consumers are enjoying content through videos and articles on YouTube and the Internet rather than newspapers, magazines and TV. That is, the changes in product differentiation, advertising, and marketing practices of enterprises due to the spread of the Internet and the emergence of platformers have clearly resolved the inefficiency of multiple limitations as seen in Figure 2-7-2. It seems that platform companies such as Google and prosumers, who supply content to YouTube and Web sites, have received a significant share of the transaction value of advertising as a result.

8. Conclusion

In this paper, the impact by the development of the Internet and mobile communications are examined not by theory but by experience in the changes of the Japanese economy in the past a few decades and a simple diagram, focusing on the changes in the structure of the product differentiation and advertising and marketing activity systems of enterprises caused by the distribution systems of goods and services production and supply enterprises as well as the appearance of platform companies. Cost structure will change with changes in the process in which goods and services supplied by companies are supplied to consumers. I tried to explain in an easy-to-understand way how the distribution of value to which traders in economic transactions has changed through such changes.

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https://services.amazon.co.jp/services/fulfillment-by-amazon.html Viewed on June 13, 2020

Activities of the Study Group

First Meeting

Date: Friday, June 29, 2018, 13:00 - 17:00

Content: Takamitsu Sawa, "Adaptation to the Fourth Industrial Revolution - Reorganization of the Socioeconomic System -

Second Meeting

Date: Thursday, August 2, 2018, 13:00 - 17:00

Content: Koichi Futagami "The Race between Man and Machine: About the Implications of Technology for Growth Factor Shares, and Employment by D. Acemoglu and P. Restrepo AER, 2018, vol. 108 (6)"
Masaharu Miyawaki "Technology Development and Copyright Law"

Third Meeting

Date: Friday, September 14, 2018, 13:00 - 17:00

Content: [Guest Speaker] Naonori Ueda (Vice Director General, Special Laboratory Director, RIKEN Center for Advanced Intelligence Project, NTT Communications Communication Science Laboratories) "Technical Scenarios of the Fourth Industrial Revolution and Their Social Impact: The Arrival of an Artificial Intelligence Society"
Fumio Sasaki "Fluctuation of the concept of' ownership' : minimalist, share, Mercari"

Fourth Meeting

Date: Friday, October 26, 2018, 13:00 - 17:00

Content: Tetsuya Shinkai: "How does the platform business change the market? - P2P Transaction, PF Business and Analysis of Market Economy -
Naoki Wakamori, "Demonstrative Industrial Organization Theory and the Fourth Industrial Revolution"

Fifth Meeting

Date: Friday, November 30, 2018, 13:00 - 17:00

Content: Takanori Ida “Platform Economics: Why do they be the sole winner? Think about the secret of Google and Uber Business”
Koichiro Onishi, "Intellectual Property System and its Effects, Problems in the ICT Field"

Sixth Meeting

Date: Friday, January 25, 2019, 13:00 - 17:00

Content: [Guest Speaker] Akinobu Shuto (Associate Professor, Graduate School of Economics, The University of Tokyo) Fourth Industrial Revolution and Accounting Research
Ken-Ichi Shimomura, "The Role and Corporate Group of Japanese TV Stations in the Fourth Industrial Revolution"

Seventh Meeting

Date: uesday, March 12, 2019, 13:00 - 17:00

Content: [Guest Speaker] Hiroyuki Odagiri (Professor Emeritus, Hitotsubashi University, Adviser, Fair Trade Commission) "Platform Economics and Competition Policy”
[Guest Speaker] Toyoaki Nishida (Professor, Graduate School of Information Science, Kyoto University) "What Artificial Intelligence is Bringing"

Eighth Meeting

Date: Friday, April 12, 2019, 13:00 - 17:00

Content: Koichi Futagami "Risk Avoidance and Economic Growth in an Aging Society"
Masaharu Miyawaki " The subject of copyright infringement"

Ninth Meeting

Date: Friday, May 24, 2019, 13:00 - 17:00

Content: Tetsuya Shinkai "Causes of Apple's Poor Business Performance -The Agony of High-Spec Pursuing Manufacturer -"
Naoki Wakamori "Adaptation of Competition Policy to the Fourth Industrial Revolution - Digital Cartel and Declining Industries"

10th Meeting

Date: Friday, June 28, 2019, 13:00 - 17:00

Content: [Guest Speaker] Yusuke Zennyo (Associate Professor, Institute of Business and Accounting, Graduate School, Kobe University) "Multi-Sided Platforms "
Koichiro Onishi, "Innovation and patent rights in the ICT field"

11th Meeting

Date: Friday, July 26, 2019, 13:00 - 17:00

Content: Takanori Ida: "Smart Grid Economics: Evidence Policy led by Field Experiments, Behavioral Economics, Big Data"
Naoki Wakamori "Adaptation of Competition Policy to the Fourth Industrial Revolution - Digital Cartel and Declining Industries"

12th Meeting

Date: Friday, September 20, 2019 13:00 - 17:00

Content: (Guest Speaker) Susumu Sato (Graduate School of Economics, The University of Tokyo, Institute of Social Sciences) "Business Model of Platforms and Competition Policy"
Ken-Ichi Shimomura "About Voluntary Provision to the Video Sharing Sites"

13th Meeting

Date: Friday, November 8, 2019, 13:00 - 17:00

Content: [Guest Speaker] Daisuke Kanama (Associate Professor, Department of Management, School of Economics, College of Human and Social Sciencese, Kanazawa University) "Demonstrative Research on Outcomes of Japan's Industry-Academia Collaboration Activities and Factors to Promote (Inhibit) Open Innovation"
Masaharu Miyawaki, "Problems over the Use of Trademarks on the Internet", "Right to Be Forgotten"

14th Meeting

Date: Friday, January 24, 2020, 13:00 - 17:00

Content: [Guest Speaker] Ryosuke Shimizu (Graduate School of Economics, Kyoto University) "Does automation technology reduce wage?"
[Guest Speaker] Kohei Okada (Graduate School of Economics, Osaka University) "Interrelationship between Mechanization and Economic Development"

15th Meeting

Date: Friday, February 14, 2020, 13:00 - 17:00

Content: Report and Study Group Meetings in Fiscal 2020

* All meetings are held at the International Institute for Advanced Studies.

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Representative

Takamitsu Sawa, Vice Director, International Institute for Advanced Studies,Professor Emeritus, Kyoto University

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Naoki Wakamori, Assistant Professor, Graduate School of Economics, The University of Tokyo

* Positions are as of April 1, 2020.

Founding Philosophy

Humanity is currently facing a number of challenges to its continued existence caused by a range of factors. Can we or future generations continue to live on this planet in the same way and with the same values we've held up to now? How can we resolve such problems that have historical and social origins? And in the 21st century, what form should our culture, science, and technology take? There are no set methods for developing ideas when it comes to such challenges.

The founding philosophy of the International Institute for Advanced Studies (IIAS) is to "conduct research for the future and happiness of mankind" and we address these issues through fundamental research based on cooperation among government, industry and academia. By consolidating wisdom from around the world and taking research forward, we aim to produce new directionality in academic research or orient ourselves towards creating new concepts, and contribute to the development of academic research culture.

Mission

Our society has reached a turning point where we veer off the path of "single-minded pursuit for development and efficiency" and follow the one of "peaceful and sustainable coexistence of all mankind." Along this new road lie fundamental questions that need to be answered in order to secure the future and well-being of mankind. IIAS takes it on as its mission to explore those questions, uncover new problems and present our "findings" to the world. We are committed to leading in-depth discussions and shedding light on the discovered paths towards solution.

History

IIAS was established in August 1984 as an incorporated foundation strongly supported by entities from industry, academia and government that agree with its founding philosophy outlined above, and has since been running on donations from major companies and philanthropists across Japan. In October 1993, IIAS opened a research facility in the Keihanna Science City (officially known as Kansai Science City) on a land granted by the Kyoto Prefectural Government. The Institute serves as the central research organization or the "brain" of the Keihanna Science City.

CORE PROGRAM REPORT

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- Reorganization of the Socioeconomic System -

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