Chapter 2 Road Map to Economic Growth and a Global Trade Structure That Will Adapt through Innovation

Section 1 Technology and trade

The development of information and communication technology is having a major impact on the economy and people's lives. For example, it is enabling people to communicate instantly across vast geographical distances, and e-commerce services to be provided both domestically and internationally. In addition, recent advances in digitalization and automation have enabled tasks to be subdivided, given rise to freelance platforms, and brought dramatic leaps forward in machine translation that have made it possible to outsource tasks unhindered by language barriers, with cross-border outsourcing of services progressing more and more as a result. In particular, while the severe restrictions on behavior brought by the COVID-19 pandemic have reduced opportunities to travel for pleasure and business, on the other hand, demand for technology-driven e-commerce has increased, and remote work and the use of web conferencing systems has spurred on the diversification of work styles.

Besides improving the efficiency and ease of individual processes, by encouraging globalization and reshoring, digital technology could also change the trade structure. Moreover, the spread of emerging technologies has the potential to create new markets and jobs. While digital technology is advancing and spreading with remarkable speed, and people being able to benefit from the use of new goods and services created as a result, concern is also mounting over the negative impact it is having on labor markets, such as polarizing them and widening the skills-related wage gaps. The digital platforms underpinning digitalization also make it easy for network effects to come into play, and this is opening the door to market monopolies and oligopolies. Ways are therefore being discussed to rectify the unhealthy aspects of the competitive environment that will impede investment in and the creation of innovation for the future.

In order to give an understanding of these trends in the digital economy, this section summarizes the framework of digital trade, and discusses the impact of emerging technologies on trade and labor markets. It also analyzes their impact on gaps and inequality, and presents directions to take in order to mitigate it.

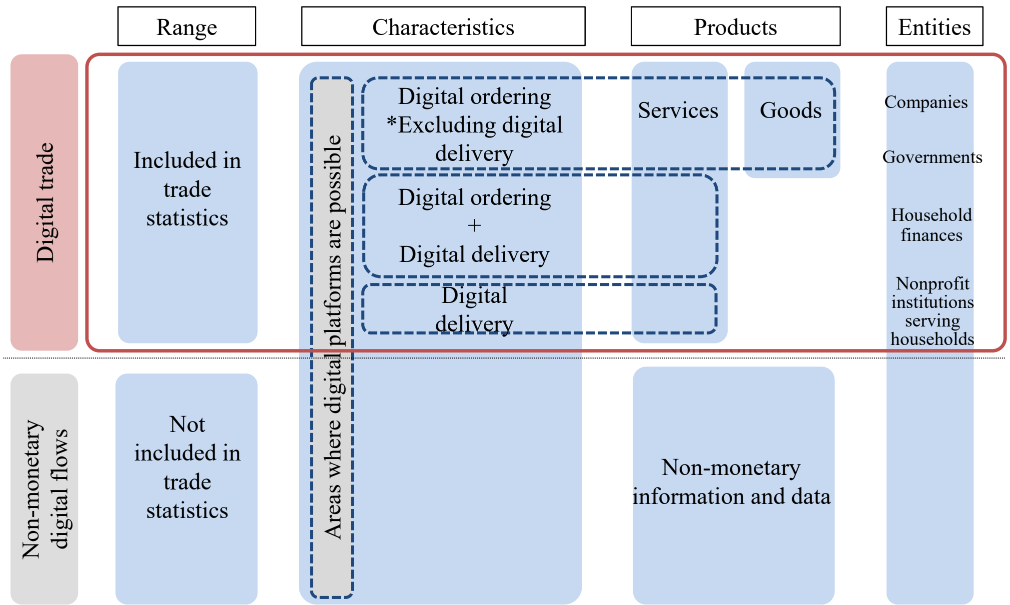
1. Trends in digital trade

(1) The concepts of digital trade

Digitalization of various goods and services is progressing rapidly in economic activities, and it is becoming increasingly important to understand the actual state of such economic activities. On the other hand, it is difficult to clarify the overall picture because technology plays a large role in economic activities which can change the situation greatly. In light of this situation, discussions on digital trade frameworks are progressing internationally in order to understand the reality of transactions involving international goods, services, and data that are further being digitalized. Although the White Paper on International Economy and Trade 2018 presented examples of digital trade by the OECD, the international definition of digital trade was not clarified[103]. The OECD, WTO, and IMF then organized the definition and concept of digital trade and compiled it into a report.[104] The report defines digital trade as the trade in goods and services that are ordered and/or delivered digitally. Here, "transactions ordered digitally" is defined as "the international sale and purchase of goods and services through a computer network in a manner designed specifically for the purpose of receiving or placing orders[105]," and "transactions delivered digitally" is defined as "international transactions by delivering to remote locations in electronic format using a computer network designed specifically for the applicable purpose."

Given the above definition, a conceptual diagram of digital trade can be shown as follows (Figure II-2-1-1)[106].

Figure II-2-1-1. Conceptual diagram of digital trade



Source: *Handbook on Measuring Digital Trade* (OECD, WTO and IMF).

The upper half of the figure below is included in the trade statistics. On the other hand, the lower half of the figure is a non-monetary digital flow that includes information and data and is not included in existing trade statistics, but it is important for understanding the actual state of activities. Economic activities through digital platforms cover both these areas. The upper half of the figure above is composed of four categories: (A) goods of "digital order / non-digital delivery," (B) services of "digital order / non-digital delivery," (C) services of digital order / digital delivery," and (D) services

103 *White Paper on International Economy and Trade 2018* (Ministry of Economy, Trade and Industry, 2018).
104 *Handbook on Measuring Digital Trade* (OECD, WTO and IMF, 2020) (https://www.oecd.org/sdd/its/Handbook-on-Measuring-Digital-Trade.htm).
105 Definition of e-commerce in the OECD.
106 Concepts and measurement methods of digital platforms and non-monetary information and data are still being discussed.

of "non-digital order / digital delivery." These can be broadly captured from the existing framework of trade statistics and the uses of e-commerce.

On the other hand, it is difficult to capture non-monetary digital flows because the transactions of goods and services described above do not occur directly. There are also challenges in measuring the activities of digital platforms. For example, when a digital platform provides a place for users to trade goods and services, the fees paid by users of the platform can be captured through existing corporate statistics, but it cannot directly capture the consideration for transactions of goods and services conducted between users. In addition, when cross-border transactions are carried out through digital platforms, new challenges will arise. For example, when considering a case where the provider of goods and services resides in country A, and the digital platform is also based in country A, and the buyer resides in country B, the transaction of goods and services will be a cross-border transaction between country A and country B. However, only the sales of the fee for the platform based in country A is captured in statistics. Since the actual activity of the cross-border transaction is not captured, it will lead to underestimation of the scale of trade.

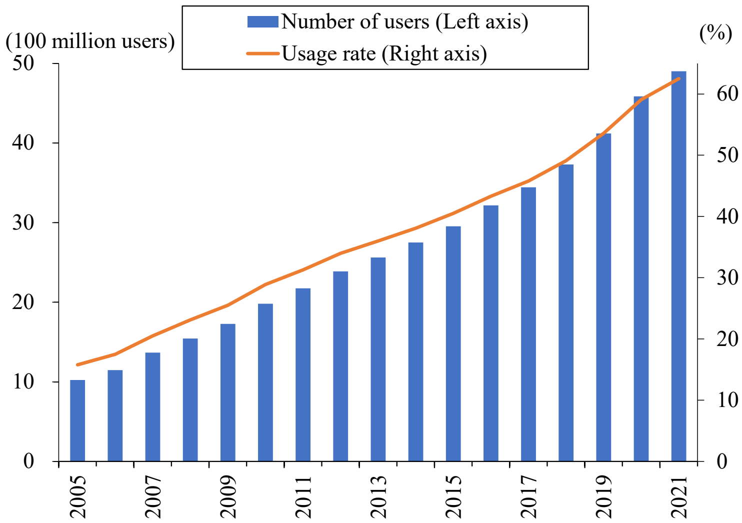
Thus, while conceptualization of digital-related economic activities is progressing, the handling of information and data that are not subject to direct trading and the estimation of the scale of a cross-border transaction remains a challenge in the future. For this reason, there is a need for a wide range of approaches, including the development of new estimation methods for non-monetary digital flows, the use of private data, and the use of administrative data such as tax information.

(2) Data flow trends

Based on the aforementioned digital trade frameworks and challenges, we will look at trends in data flows around the world. Data flows deal with information on transactions of goods and services such as e-commerce and contents distribution, and also enable capturing the scale of activities of information retrieval services and communication tools that have been free of charge. Therefore, it can be said that the trends in data flows are important from the viewpoint of capturing the actual status of digitalized economic activities.

First, looking at the usage of the Internet, which is a data distribution network, the global user population is increasing year by year, exceeding 60% in 2021 (estimated value) (Figure II-2-1-2).

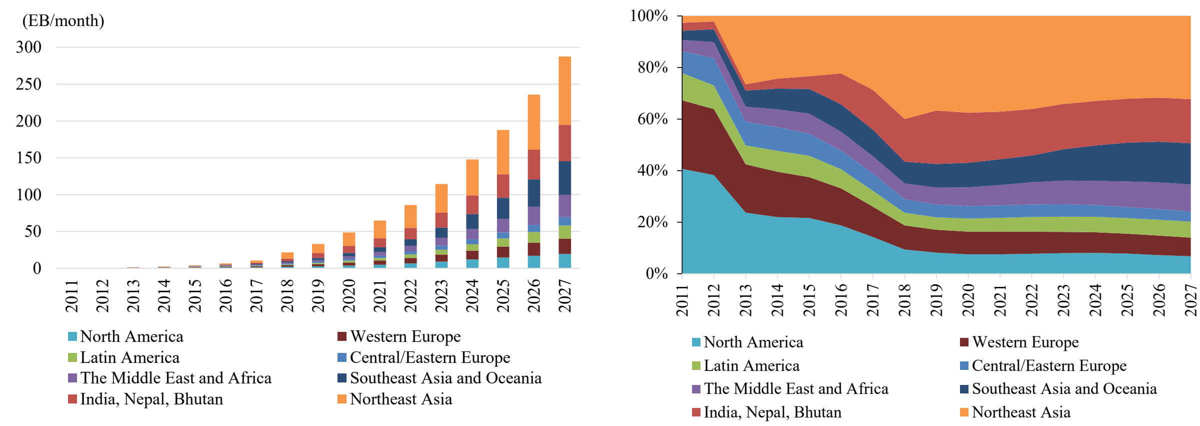
Figure II-2-1-2. The population and proportion of individuals who use the Internet



Source: ITU. (https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx).

As the population of Internet users increases, data flows around the world are also on an increasing trend. According to Ericsson, mobile data traffic is increasing year by year, coupled with advances in communications technology, and the total volume in 2027 is estimated to be about 300 EB (exabytes) per month, about 4.5 times greater than in 2021. Looking at the share by region, North America and Western Europe accounted for 68% of the total in 2011, and fell to 17% in 2021. India, Nepal, Bhutan, and two locations of Northeast Asia have expanded to 55%. In the future, the share of Southeast Asia, the Middle East and Africa is expected to increase along with population growth and economic growth (Figure II-2-1-3).

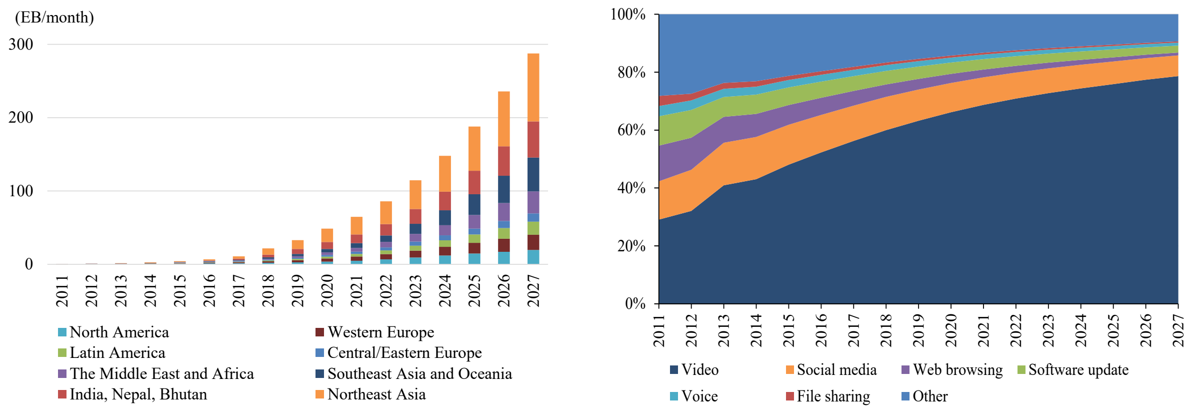
Figure II-2-1-3. Trends in global mobile data traffic by region and composition ratio



Source: Ericsson (November 2021).

Next, looking at the share by content, video accounted for 29% in 2011 and 69% in 2021, and is expected to increase further by 2027, accounting for 79% of the total (Figure II-2-1-4).

Figure II-2-1-4. Trends in global mobile data traffic by content and composition ratio

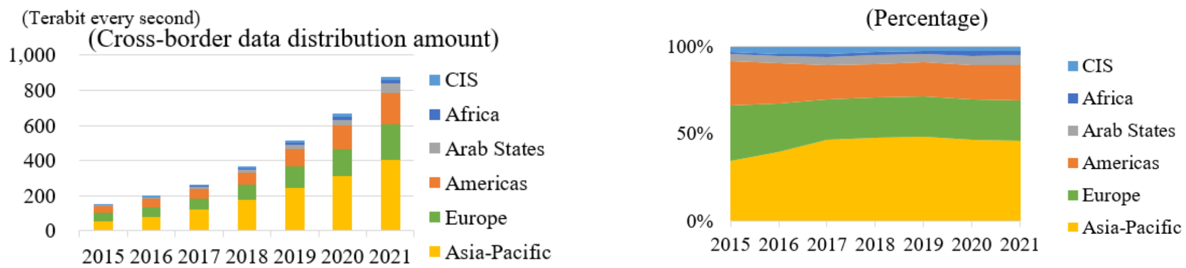


Source: Ericsson (November 2021).

In the future, as the development of higher-speed communication infrastructure progresses, the amount of data used will increase, and the scale of the data flow is expected to expand further, considering the creation of new markets such as industrial applications of IoT and metaverses.

Next, we will look at trends in cross-border data flows. The distribution amount of cross-border data is as follows (Figure II-2-1-5).

Figure II-2-1-5. Trends in cross-border data distribution amount by region



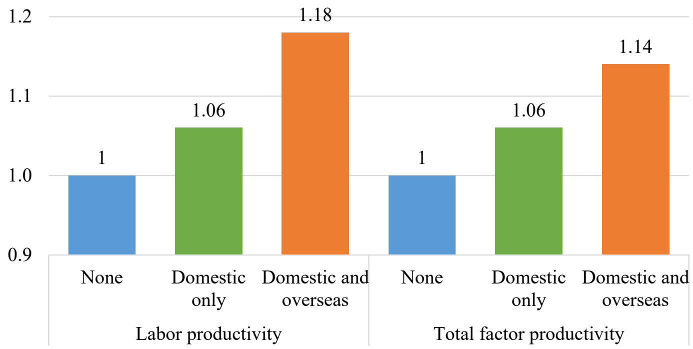
Note: Regional classification according to ITU[107]. Values for 2021 are estimated values.
Source: ITU.

In the figure above, Asia and Oceania accounted for less than half of the total in 2021, and Asia and Oceania, the Americas, and Europe accounted for about 90% of cross-border data flows.

In addition, it is important for cross-border data flows to capture the value of the information traded in addition to the distribution amount shown above. E. Tomiura, B. Ito, and B. Kang, (2019) analyzed the relationship between productivity and the situation in which companies collect data domestically and overseas. The analysis shows that the productivity of companies collecting data domestically and overseas is the highest, followed by the productivity of companies collecting data only domestically, and the productivity of companies not collecting data is the lowest (Figure II-2-1-6).

[107] *Economy classifications* (ITU) (https://www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx).

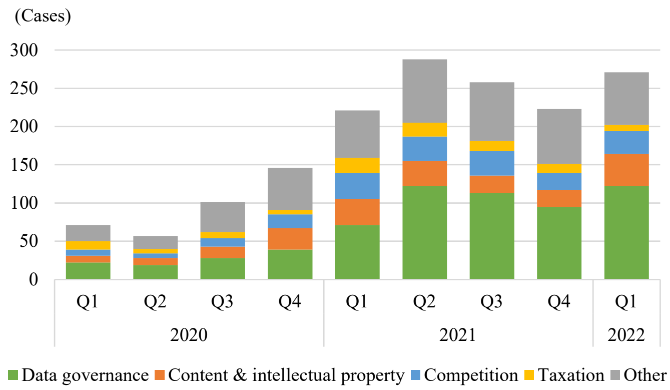
Figure II-2-1-6. Relationship between data collection and productivity in companies



Note 1: Labor productivity is the amount of added value per employee. Total factor productivity is the residual of the production function with capital and labor input.
Note 2: All values are shown by average magnification with companies that are not engaged in data collection set as 1.
Source: Tomiura, E., B. Ito, and B. Kang (2019).

E. Tomiura, B. Ito, and B. Kang (2019) also show that companies acquiring data overseas are more affected by data-related regulations such as the General Data Protection Regulation (GDPR) in Europe and the Cybersecurity Law in China. The number of introductions of such digital regulations is on the rise worldwide (Figure II-2-1-7).

Figure II-2-1-7. Number of introductions of digital-related regulations



Source: Digital Policy Alert.

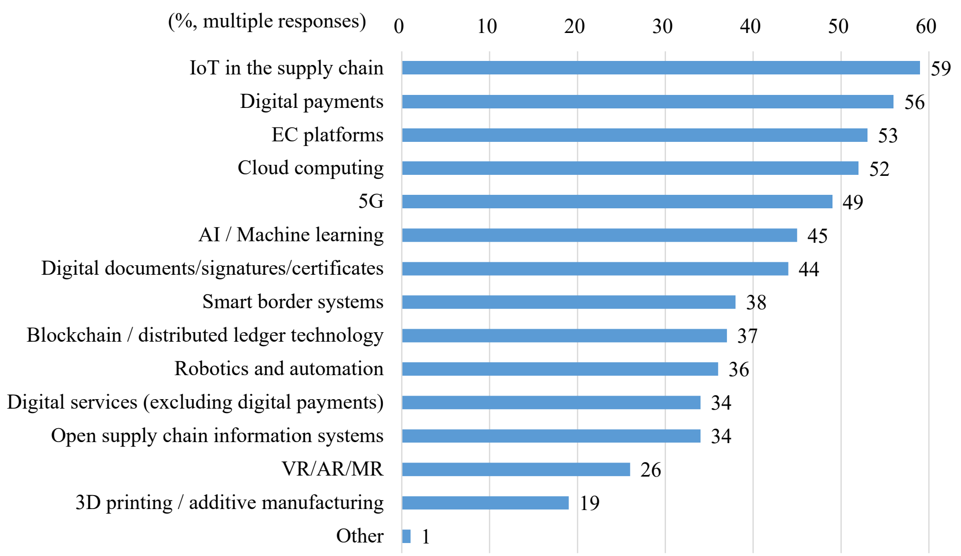
Looking at the breakdown of regulations that have been introduced, there is a particularly large number of regulations on data governance and intellectual property, etc., suggesting that awareness of the value of these cross-border transactions is increasing worldwide. If the trend of digital-related regulations continues to increase in the future, it may have a greater impact on cross-border data transactions inside and outside companies. Therefore, future trends in digital-related regulations need to be closely monitored.

2. The impact of emerging technologies on trade

(1) Overview of TradeTech

The preceding paragraph discussed an overview of digital trade as a framework for grasping the reality of international transactions of goods and services that emerging technologies have promoted digitalization. Emerging technologies that support digitalization are also changing the structure and mechanism of trade. The WEF (World Economic Forum) set "a series of technologies and innovations to make trade more efficient, comprehensive and equitable" as "TradeTech," and compiled it into a report[108]. According to results of a survey of managers and officers, etc. of companies engaged in international trading operations, technologies recognized as the most innovative TradeTech technologies were: IoT in the supply chain, digital payments, e-commerce platforms, cloud computing, 5G and more (Figure II-2-1-8).

Figure II-2-1-8. The most innovative TradeTech



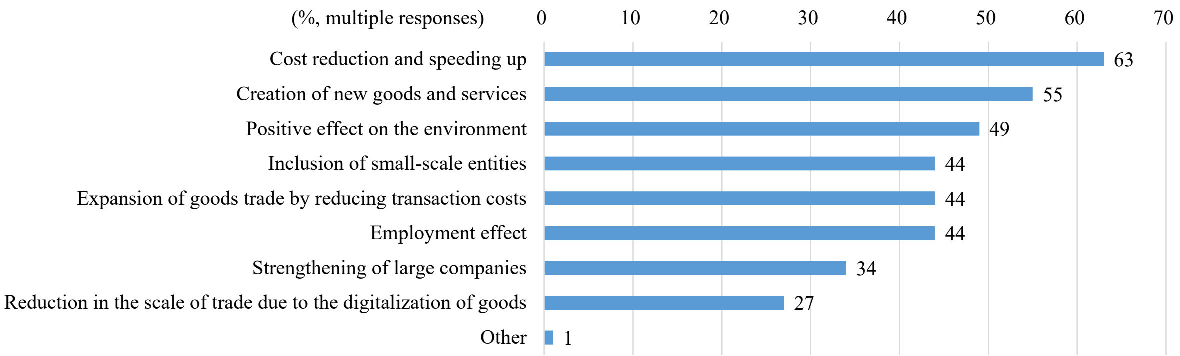
Source: *Mapping TradeTech: Trade in the Fourth Industrial Revolution* (WEF).

As TradeTech, for which there was a large proportion of survey responses, there are many elemental technologies that have already been put into practical use. However, technologies following those mentioned above: AI/Machine learning, digital documents/signatures/certificates, smart border systems, blockchain / distributed ledger technology, robotics and automation, VR/AR/MR, and 3D printers / additive manufacturing, and more have been expected to be used as TradeTech in the long term, but have become elemental technologies that have high technical barriers and takes time to be implemented in society.

[108] *Mapping TradeTech: Trade in the Fourth Industrial Revolution* (World Economic Forum, 2020) https://www.weforum.org/communities/tradetech).

The main impacts of such TradeTech on trade include: Cost reduction and speeding up, creation of new goods and services, positive environmental impact, inclusion of small-scale entities, expansion of goods trade by reducing transaction costs" (Figure II-2-1-9).

Figure II-2-1-9. The main impact of TradeTech on trade



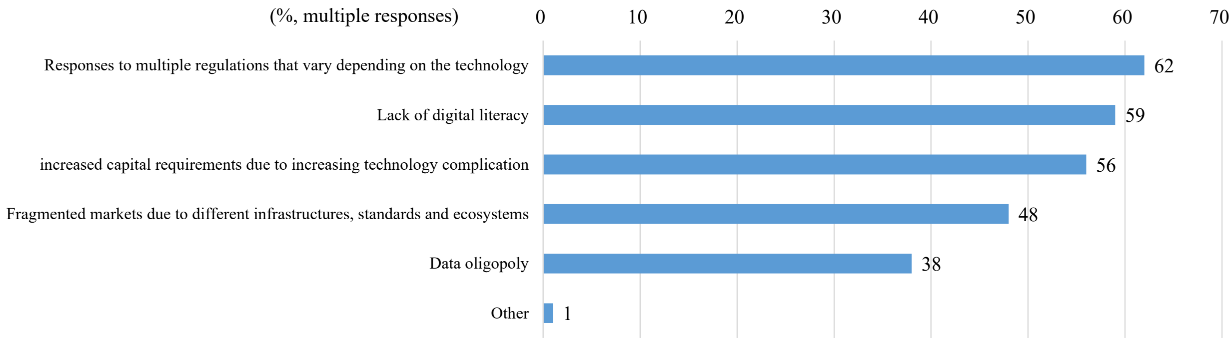
Source: *Mapping TradeTech: Trade in the Fourth Industrial Revolution* (WEF).

For example, video and music contents have traditionally been delivered to consumers through store sales of recording media, but with the development of communication and cloud storage technologies, there has been a shift from store sales to e-commerce. The transformation from recording media to data distribution is the creation of new goods and services, and can be said to be an example of a reduction in the scale of trade due to the digitalization of goods. In addition, the development of technologies of robotics, automation, 3D printers, and additive manufacturing will promote reshoring of intermediate goods production, which have previously been outsourced overseas, which may lead to cost reduction and speeding up throughout the entire manufacturing process.

On the other hand, concerns have been raised about the negative effects of the introduction of such TradeTech, which are the employment effect and strengthening of large companies. These impacts have also been studied as key technology issues. For details, please refer to "3. Emerging technologies' impact on employment through trade and investment" and "4. Impact on gaps and inequality" described below.

While the introduction of TradeTech promotes efficiency and optimization from various perspectives, the following issues have been pointed out (Figure II-2-1-10).

Figure II-2-1-10. Issues related to TradeTech



Source: *Mapping TradeTech: Trade in the Fourth Industrial Revolution* (WEF).

The answer which is the most frequently referred to issues on TradeTech is "responses to multiple regulations that vary depending on the technology." This is largely due to differences in digital protection attitudes and regulations by region and countries, such as cross-border transfer of data including personal information, and data localization where servers are installed in the country where economic activities are carried out. The answers which were second and third most frequent are "lack of digital literacy" and "increased capital requirements due to increasing technology complication." The common point of these is the increasing sophistication and complication of technologies. As technology itself becomes more sophisticated, the level required for investment and acquisition of literacy is increasing[109]. In addition, integrating multiple elemental technologies requires a higher level of technology than individual technology use.

In introducing TradeTech, it is necessary to grasp the potential of each TradeTech and its impact on trade and labor markets. Assuming these technologies advance further and rapidly, it can be said that while advancing the introduction of each elemental technology at an early stage, it is important to determine continuous value and cross-border usage.

(2) Elemental technologies of TradeTech

Next, we will look at how to use the elemental technologies included in TradeTech, the impact of their introduction, and issues. Utilization examples and issues related to AI, IoT, robotics and automation, 5G, blockchain, and 3D printers are summarized as shown below (Table II-2-1-11).

Table II-2-1-11. Overview of TradeTech

	Utilization examples	Issues
AI	· Creation of new goods and services ·Improvement of quality and efficiency · Replacement of low value-added routines (Competition with labor-intensive	· Development of an international AI framework and rulemaking

109 Refer to the "Emerging technologies' impact on employment through trade and investment" section below for more information on the occupations and skills that will be required in the future as technology advances.

	service offshoring)	
IoT	· Real-time tracking of deliveries · Monitoring of the condition of perishable foods · Security monitoring (grasping information related to customs and thefts)	· Vulnerability of IoT network security · Limitations of processing by a centralized management model
Robotics and automation	· Optimization of logistics and work processes	· Impacts on labor markets (shortage of skilled workers and replacement of existing workers)
5G	· Increase of the sophistication and speeding up of digital services trade (e-commerce) electronic payment, video conferences, online education)	· Rise in political tensions mainly in the United States and China over 5G
Blockchain	· Secured storage and transmission of data · Creation of a single window for trade-related procedures	· Information protection and transparency control of data · Interoperability between blockchains
3D printer	· Creation of new goods and services · Shortening of the supply chain and reduction of inventory management	· Changes in the industrial and trade structures due to a decrease in the production of intermediate goods · Redefining of supply chain management

Source: *Mapping TradeTech: Trade in the Fourth Industrial Revolution* (WEF).

(A) AI

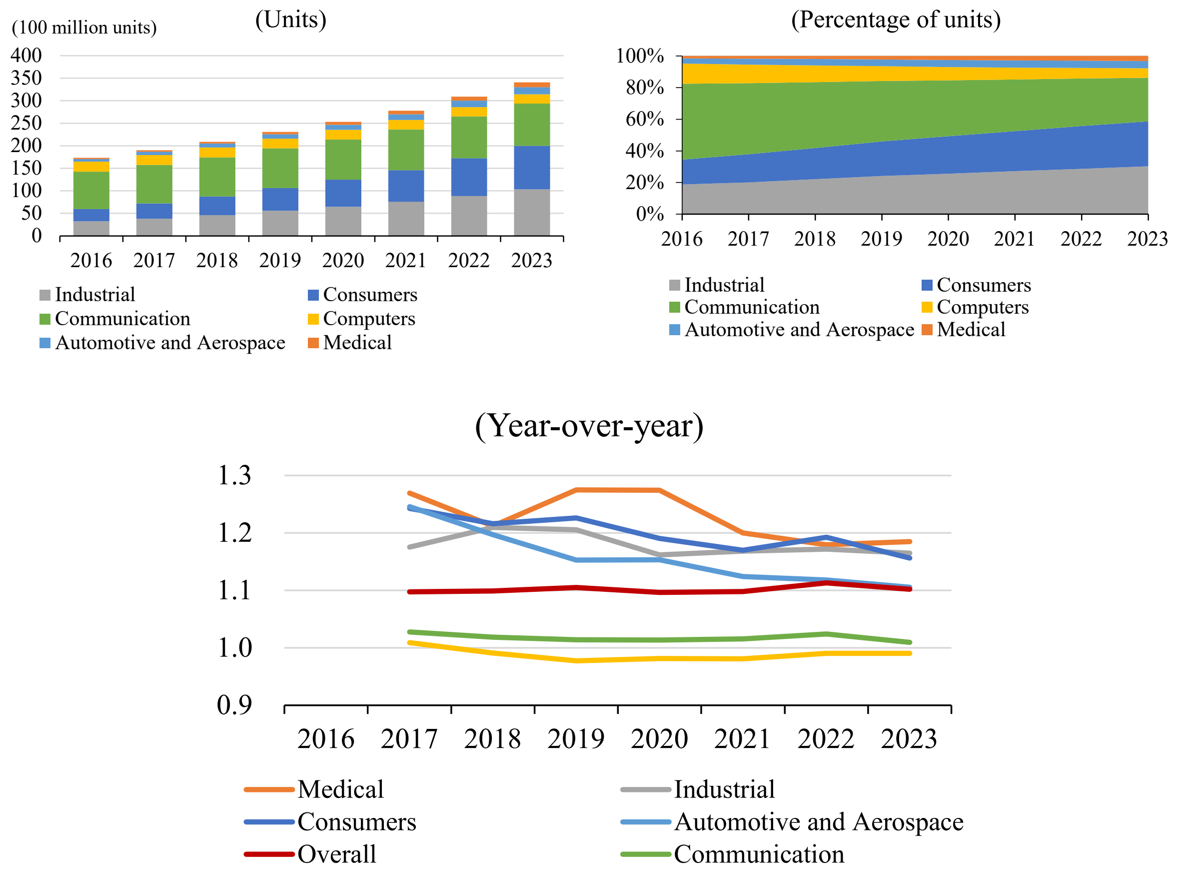
AI can contribute to the creation of new goods and services, improvement of quality and efficiency. In addition, AI has the potential to accelerate the offshoring of labor-intensive manufacturing processes and services that have previously been conducted overseas, as it has the potential to automate business processes, especially replacing low value-added routines. In recent years, the technological barriers necessary for the introduction of AI have become lower, and it is expected that the proactive introduction of AI will continue to be promoted from the perspective of improving productivity and strengthening competitiveness in the future.

(B) IoT

By acquiring physical information through a large number of sensors and sharing it over a network, IoT enables acquiring information that was previously checked by humans or difficult to confirm. For example, it enables real-time tracking of the location of deliveries in trade and monitoring of the condition of perishable foods.

Trends in the number of IoT devices is on an expanding trend as a whole. Looking at trends by industry, "communications" for smartphones, communication devices, and other devices accounted for a large part, but looking at the proportion of the number of devices for the future, the proportion of "industrial" and "consumer" devices is projected to increase (Figure II-2-1-12).

Figure II-2-1-12. Trends in the number and IoT devices and prediction by industry



Note: An IoT device is a device that has a unique IP address and can connect to the Internet, and a terminal used as a sensor network end. The range of each category is as shown in the footnote[110].

Source: *2021 WHITE PAPER Information and Communications in Japan* (Omdia, Ministry of Internal Affairs and Communications).

Looking at the year-on-year trends in the number of devices, the number of devices is expected to increase in the medical, industrial, consumer, and automobile/aerospace sectors.

While IoT is expected to be used in a wide range of industries, security vulnerabilities have become an issue for networks necessary for IoT devices. In addition, as the number of IoT devices increases in

[110] Communications: Fixed communication infrastructure and network devices, cellular communication in various bands of 2G, 3G and 4G, and wireless communication infrastructure and terminals such as Wi-Fi and WiMAX. Consumers: Consumer electronics (white goods and digital), PC peripherals such as printers, portable audio devices, smart toys, sports- and fitness-related goods, etc. Computers: Computing devices such as laptops, desktops, servers, workstations, mainframe computers, and supercomputers. Industrial applications: Devices for industrial applications other than automation, such as automation (IA/BA), lighting, energy, security, inspection and measurement devices. Medical: Diagnostic imaging and other medical devices, consumer healthcare devices. Automobiles and aerospace: Devices that can be connected to the Internet in control and information systems of automobiles (passenger cars and commercial vehicles), and military and aerospace devices (e.g., military surveillance systems, electrical and instrumentation devices for aircraft cockpits, passenger system devices).

the future, the limitations of centralized management by the conventional server/client model have become a technical issue. As mentioned above, companies that collect data both domestically and internationally are more productive than those that do not. It can be said that it is important to proceed with the active introduction of IoT devices and use them to quantify, visualize, and optimize business processes while paying attention to cybersecurity.

(C) Robotics and automation

Robotics and automation contribute to the optimization of logistics and work processes. At present, only 3 percent of container terminals are automated, leaving much room for technology introduction, according to the report. Robot and automation technologies are concerned not only with the effects of improving productivity and solving labor shortages, but also with the negative effects on the labor market, such as the shortage of skilled workers due to the rapid introduction of the technologies and the replacement of existing workers. For example, when it comes to the impact of the trade structure related to robots, Obashi & Kimura (2021) noted that the introduction of industrial robots in the manufacturing industry in emerging East Asian countries has been increasing, and thereby trade in parts and consumer goods within the regional production network has been promoted[111]. In addition, Faber (2020) also said that the introduction of industrial robots has reduced processing trade with Mexico in the U.S. manufacturing industries, suggesting that there was a negative impact on employment in the Mexican labor market, and robot and automation technologies could replace the global value chain[112].

(D) 5G

5G is a communication technology[113] that achieves ultra-high-speed communications, ultra-low latency communications, and multiple simultaneous connections at the same time. It is expected that EC, electronic payment, video conferences, and online education, which have been used in 4G communications, will become more sophisticated and faster mainly in the service sectors. In addition, as utilization examples, trucks in ports are automatically driven, and optimal route planning and transportation are conducted unmanned, by using 5G in combination with AI, robot and automation technologies. With regard to 5G, there is growing political tension, mainly in the United States and China, and it has been pointed out that it may affect not only the introduction of 5G but also the establishment of a competitive advantage for 5G-compatible services.

(E) Blockchain

Blockchain is a technology that allows data to be stored and transmitted in a decentralized and secure manner. It is expected to be used as a secure and efficient management of trade-related data

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[111] Obashi A. and F. Kimura (2021), "Production Networks: Impact of Digital Technologies," *Asian Economic Journal*, Vol. 35, Issue 2, 115-141.

[112] Faber, Marius (2020), "Robots and Reshoring: Evidence from Mexican Labor Markets," *Journal of International Economics*, Vol. 127, November, 103384.

[113] *2021 WHITE PAPER Information and Communications in Japan* (Ministry of Internal Affairs and Communications, 2021).

across various sectors, such as the centralization of trade-related procedures (creation of a single window). While the use of blockchain technology increases the transparency of data transmission, appropriate protection of information, including personal information and trade secrets, has become a challenge in the operation of services. In addition, interoperability between blockchains has become a technical issue, and it is expected that the convenience will be further improved if the issue is solved.

(F) 3D printer

3D printers have been used to manufacture custom-made equipment, medical equipment, test equipment, and emergency housing, etc. This could have a significant impact on the scale and structure of trade in goods and services in the long run. Regarding trade in goods, it has been pointed out that there may be a shift from trade in final goods to trade in materials for 3D printers, and that there may be a decrease in the production of intermediate goods. On the other hand, service transactions related to design data necessary for manufacturing goods using 3D printers may increase.

The impact of 3D printers on the trade in goods has the potential for both a decrease and an increase in trade volume. Regarding the decrease in trade volume, it is estimated that if half of the goods produced in the manufacturing industry are replaced by 3D printers due to the spread of 3D printers, a quarter of the trade in goods will be reduced by 2060 compared to the cases without 3D printers[114]. On the other hand, according to C. Freund et al. (2019), the increased use of 3D printers in the production of hearing aids significantly increased trade volume[115]. In addition, C. Freund et al. (2019) points out that weight and logistics costs per goods are factors for the shift to 3D printing.

While this suggests that 3D printers may contribute to an increase in trade volume in the short term, they are expected to contribute to a decrease in total trade volume in the long term. In addition, changes in the trade structure due to the spread of 3D printers will drastically change the positioning of types and inventories in the manufacturing process, suggesting the possibility that supply chain management will need to be redefined.

(3) Future TradeTech

In addition to the emerging technologies shown so far, we will look at the positioning and potential utilization of the metaverse and telepresence as TradeTech, which are being invested not only by IT companies but also by retailers and a wide range of industries in recent years.

The metaverse is a coined word combining "meta" and "universe," meaning an online virtual space. Although the concept of the metaverse is not clearly defined internationally, a survey conducted by the Ministry of Economy, Trade and Industry in fiscal 2020 described it as "a virtual space in which services and contents in various areas are provided from producers to consumers in a single virtual space[116]." The concept of the metaverse has garnered much attention since Facebook (now Meta

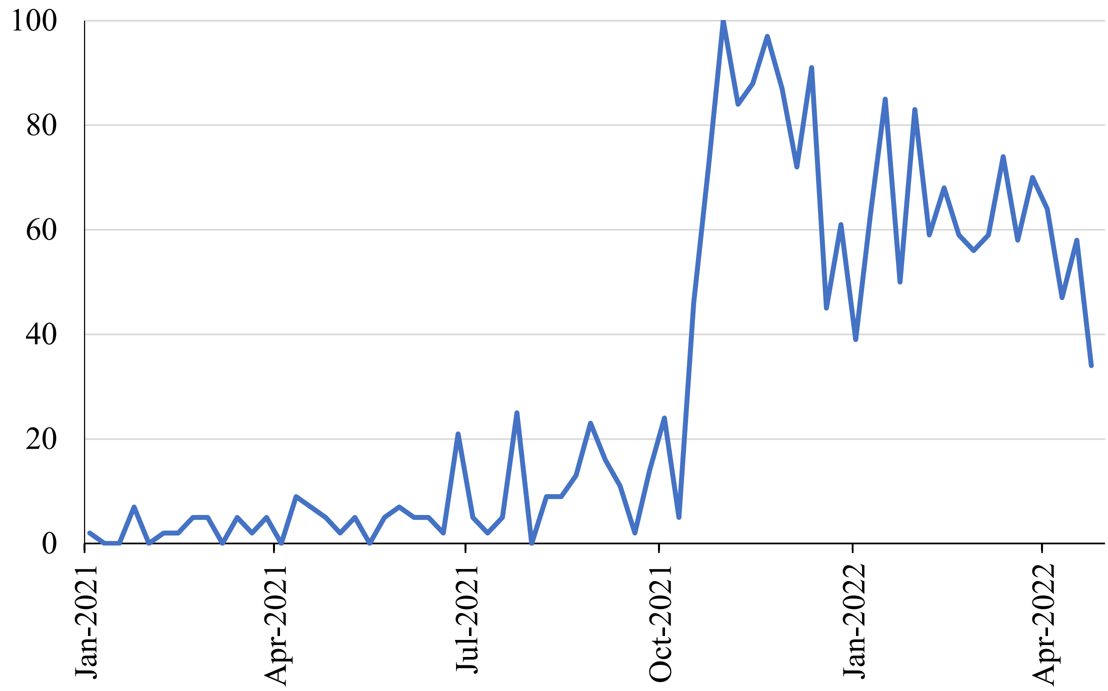
[114] Leering, Rauol (2017), "3D printing: a threat to global trade," ING.

[115] Freund, Caroline; Mulabdic, Alen; Ruta, Michele, (2019) "Is 3D Printing a Threat to Global Trade? The Trade Effects You Didn't Hear About," *Policy Research Working Paper*, No. 9024, World Bank, (https://openknowledge.worldbank.org/handle/10986/32453).

[116] 2020 Content Overseas Business Expansion Promotion Project (Project for Research and Analyses Concerning Future Potential for Virtual Spaces and Challenges therein) (Ministry of Economy, Trade

Platforms), which has been mainly engaged in the social media business, announced that it will deal with the metaverse as its core business in the future, and later changed[117] its name to Meta Platforms, Inc. on October 28, 2021 (Figure II-2-1-13).

Figure II-2-1-13. Trends in the number of searches for the "metaverse"



Note: Set the search keyword as the "metaverse." The value represents the relative value of interest in a search based on the highest value on the graph for a set time period. A value of 100 indicates that the keyword has the highest popularity in the same period, a value of 50 indicates that the keyword has half the highest popularity, and a value of 0 indicates that there was not enough data for the keyword.
Source: Google Trends.

The metaverse is considered to play a greater role as a platform in a virtual space that can change the way various activities are performed, rather than as an elemental technology for using specific functions for a specific process. Examples of its utilization methods as TradeTech: Using it as a cross-border e-commerce platform that sells products at stores on the metaverse that mimics the real world; creating opportunities for providing new cross-border services such as store employees serving customers as avatars on the metaverse; and consequently enabling the provision of a customer experience that was difficult with existing e-commerce. In the metaverse, by positioning it as a platform[118] with real-world geographic information or as a digital twin linked with information such as ports and warehouses, it is possible to construct a mutually evolving system that simulates the

and Industry, 2020)
(https://www.meti.go.jp/policy/mono_info_service/contents/downloadfiles/report/kasou-houkoku.pdf)

[117] The company's name on the U.S. stock exchange is registered as Meta Platforms.

[118] *Project Plateau* (Ministry of Land, Infrastructure, Transport and Tourism) (https://www.mlit.go.jp/plateau/).

optimization of logistics processes in the metaverse that is a virtual space, utilize the results in the real world, and feeds back the results to the metaverse design again. Given such a wide range of utilization examples and relationships with existing technologies, the metaverse can be regarded as a higher-level concept that abstracts multiple existing concepts, rather than a concept that had never existed before.

Next, we will look at telepresence, contrasting its concept with the metaverse. Telepresence is a platform that allows you to feel as if you are at the site, even if you are in a remote location. Telepresence has a wide range of elemental technologies and applications, including web conferencing systems, communication tools using mobile robots, arm-type robots, and remote control systems with interfaces to operate them. For example, communication like the above has already been put to practical use through video and audio, but going forward, there will be a need for manual manufacturing processes that require skills. It will also be possible to provide maintenance and inspection in factories and warehouses, medical and nursing care services such as palpation and surgical operations, both domestically and internationally without the need for direct travel. It is not difficult to imagine that the use of telepresence will remove the restrictions on movement and contribute to improving the efficiency of goods production and the quality of services.

Comparing the metaverse and telepresence, the metaverse can be contrasted as a concept focused on the virtual space, while telepresence is a concept focused on the real space. However, as mentioned above, it is possible to apply the metaverse in conjunction with the real space, such as the urban interlocking metaverse, so it is difficult to clearly separate these two concepts. It can be said that it is important to combine these concepts and elemental technologies and utilize them to achieve goals. Since the metaverse and telepresence are platforms that can be formed by integrating various elemental technologies, it is not easy to estimate the market size. However, it is estimated that the metaverse market will reach $1 trillion by 2025, and virtual game revenues will reach $400 billion by 2025[119].

The creation and expansion of new markets through the metaverse and telepresence, etc. will create new business opportunities. On the other hand, the metaverse and telepresence can unconstrain time and space, create value in the virtual space, and enable you to achieve your goals without having to travel. It can be said that there is a need to redefine the value of real space and traveling. These are elements that did not exist in existing businesses, and companies that do not use the metaverse or telepresence will need to capture these characteristics and reflect them in corporate activities in the future.

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119 *The Metaverse -Web 3.0 Virtual Cloud Economies* (Grayscale, 2021) (https://grayscale.com/wp-content/uploads/2021/11/Grayscale_Metaverse_Report_Nov2021.pdf).

3. Emerging technologies' impact on employment through trade and investment

(1) Impact on the total number of jobs

In the previous section we focused on TradeTech, a set of technologies that can improve the efficiency of the trade process and create new goods and services. Here, however, we will consider the concerns regarding how TradeTech affects employment.

First, we will look at how general technology investments affect employment. We analyzed how capital investment and R&D expenses of overseas affiliates affect future employment, by industry and by region, using the data from the Basic Survey on Overseas Business Activities.

The results of the analysis by region are shown in the following figure (Figure II-2-1-14).

Figure II-2-1-14. Employment growth rate of overseas affiliates after four years if their capital investment and R&D expenses increased by 1% (by region)

	Capital investment	R&D expenses
Asia	-0.918 (3.493)	3.481* (1.477)
Oceania	27.726* (12.724)	17.525 (15.357)
Latin America	-7.597 (9.304)	-27.686 (41.035)
Middle East	-4.264 (26.878)	-
North America	-10.992** (3.603)	-0.450 (5.456)
EU	-23.510** (7.283)	-24.242*** (3.930)

Note 1: * = significance level of 5% while ** = 1% and *** = 0.1%.
Note 2: Refer to the footnote for the analysis method[120].
Note 3: R&D expenses of the Middle East is excluded due to the sample size being too small and figures not being disclosed.
Source: *FY2021 Global Economy Survey for Formulating an Integrated Domestic and External Economic Growth Strategy (Survey on the Impact of Robots, AI, and Other Cutting-edge Technologies on Labor Productivity and Global Value Chains).*

Looking at the analysis results, both capital investment and R&D expenses in Europe have had a negative effect on future employment which suggests the possibility that investment in labor-saving automation technologies such as robots. On the other hand, capital investment in Oceania showed positive effects, suggesting that the capital investment they have made assists with human labor. It is

[120] Analyzed how capital investment and R&D expenses affect employment in overseas affiliates using the data from the Basic Survey of Overseas Business Activities based on the following model:
$\Delta Y_{ht}=a_h+a_t+b\times I_{ht}+c\times X_{ht}+e_{ht}$
With h = overseas affiliates, t = year, ΔY_{ht} = time difference of employment (logarithm) of overseas affiliates (the outcome indicator), a_h = fixed effect that controls the unobserved characteristics of overseas affiliates, a_t= fixed effect that controls the time trend, .I_{ht} = variable related to technology investment, such as capital investment and R&D expenses, X_{ht} = control variable, and $e_h t$ = error term. Based on the statistical data from 2007 to 2019.

also important to note that while the statistical significance is low, capital investment has a larger negative effect as a whole compared to R&D investment which confirms that capital investment tends to have a labor-substituting effect.

Next, let's look at the results of the analysis by manufacturing industry in the following figure (Figure II-2-1-15).

Figure II-2-1-15. Employment growth rate of overseas affiliates after four years if their capital investment and R&D expenses increased by 1% (by industry)

	Capital investment	R&D expenses
All industries	-5.105*** (1.037)	-4.533*** (0.935)
Food	16.843* (7.580)	6.972 (10.217)
Textiles	-6.145 (9.528)	6.101 (22.238)
Chemicals	-19.606+ (10.610)	-34.758*** (8.486)
Ceramics, stone, and clay ~~products~~	40.802 (34.179)	3.099 (9.694)
Steel	-27.200** (8.781)	-14.047* (4.244)
Non-ferrous metals	39.874 (25.375)	-32.517+ (14.275)
Metal	2.979 (12.785)	-8.826+ (4.541)
Other manufacturing industries	-1.023 (16.567)	-24.719*** (4.055)
Agriculture, forestry, and fisheries	29.432* (11.049)	-22.573 (31.855)
Information and communications	-20.877* (7.932)	-69.453** (18.315)
Transportation	-2.440 (7.685)	-7.225+ (2.894)
Wholesale	-8.613 (7.250)	-0.986 (3.027)
Retail	-3.254 (17.483)	-96.231 (45.507)
Services	-2.939 (7.980)	-24.683* (9.300)

Note 1: + = significance level of 10% level while * = 5%, ** = 1%, and *** = 0.1%.
Note 2: Using the same analysis method as the one used in the analysis by region.
Source: *FY2021 Global Economy Survey for Formulating an Integrated Domestic and External Economic Growth Strategy (Survey on the Impact of Robots, AI, and Other Cutting-edge Technologies on Labor Productivity and Global Value Chains).*

From the second analysis results we can see that both capital investment and R&D expenses have negatively affected employment in all industries with capital investment having a greater negative effect. The analysis by industry shows that investment in the chemicals, steel, and information and communications industries have all had a negative effect on employment, suggesting that technology investment within these industries tend to substitute labor. Capital investment in the food industry and agriculture, forestry, and fisheries on the other hand caused employment within the industries to increase significantly. This suggests that these industries tend to make capital investments that assist with human labor such as those for conveyor belts, etc., compared to other industries. These results suggest that; depending on the region and industry, technology investments can have differing objectives where they are made to either assist or replace human labor while also having varying degrees of effect on employment.

The impact of technology on the labor market has been discussed since the early 2000s when there were discussions surrounding the computerization of work[121]. Previous discussions have brought up the fact that labor demand for routine work has decreased due to more technology being introduced while labor demand for non-routine work (analytical, managerial, and service-oriented work) has increased. Empirical research has been conducted in recent years on how the use of industrial robots has affected labor markets in terms of the tasks performed by human labor and capital, and skills required for the tasks (Table II-2-1-16).

Table II-2-1-16. Previous research on the impact of robots on employment

Author	Research subject	Outcomes	Explanatory variable	Summary of results
Autor and Salomons (2018)	OECD (national and industrial level) 1970 – 2007	Employment, working hours, wages, income, labor share, etc.	Total factor productivity	· Decreased employment in industries that have experienced increased productivity due to more robots being used. · Positive spillovers in other industries, increased overall employment. · Labor share decreased.
Dauth et al. (2018)	Germany (regional labor market level and individual worker level), 1994 - 2014	Regional employment, regional wages, working days, personal income, etc.	Exposure to Robot, changes in industrial robots' stock	· No impact on total employment. · Every robot takes away two jobs in the manufacturing industry. · Labor share decreased.
Graetz and Michaels (2018)	EU KLEMS (national and industrial level) 1993 – 2007	Labor productivity, wages, time of employment by skill	Robot density (number of robots / 1 million working hours)	· 15% increase in productivity due to more robots being used. · No impact on total working hours. · Reduced the low-skilled workers' share of working hours.

[121] Autor, Levy, and Murnane (2003)、Brynjolfsson and Hitt （2003）, etc.

Acemoglu and Restrepo (2020)	The United States (commuting areas) 1993 – 2007	Employment and wages	Exposure to Robot （Exposure to Robot）	· An increase of one robot for every 1,000 workers caused employment ratio to decrease by 0.2 percentage points and wages by 0.42%.
Adachi, Kawaguchi, and Saito (2020)	Japan (industrial level and commuting areas), 1978 – 2017	Number of robots in use, hiring	Price of robots	· If the price of robots decrease by 1%, the use of robots increased by 1.54%, employment increased by 0.44%. · A 1% increase in the use of robots increases employment by 0.28%.

Source: Adachi, Kainuma, Kawaguchi, Saito (2019), report on the *FY2021 Global Economy Survey for Formulating an Integrated Domestic and External Economic Growth Strategy (Survey on the Impact of Robots, AI, and Other Cutting-edge Technologies on Labor Productivity and Global Value Chains).*

The use of robots has both a positive and negative effect on employment according to the aforementioned research mentioned previously. For example, while research done in America showed that an increase of one robot for every 1,000 workers caused the employment ratio to decrease by 0.2 percentage points and wages to decrease by 0.42%, empirical research in Japan showed that if the price of robots decreased by 1%, the use of robots increased by 1.54% and that employment increased by 0.44%. This suggests that the use of robots caused businesses to expand or increased their productivity which leads to increased employment. Based on these results, it is difficult to clearly conclude what the impact of the use of industrial robots has on employment.

It is important to analyze labor shortage as perceived by companies and industrial structure that differ by region, as well as the difficulty of tasks performed, the labor intensity, current labor productivity and other various elements in each industry, when empirically analyzing the impact of robots on employment. Moreover, it is also important to keep recent technological trends in mind to understand its impact on the labor market. The use of robots often meant the use of industrial robots in direct manufacturing processes in the manufacturing industry. In other words, it has meant taking processes that can be automated and replacing human labor with industrial robots. Across the globe, however, the development and use of service robots has seen rapid progress over the years. More collaborative robots are also being used in indirect manufacturing processes of manufacturing industries and have been seen in indirect manufacturing processes, as well as in the service industry, agriculture, and forestry, showing how collaborative robots can safely coexist with humans. It is therefore important to note that collaborative robots are not only used to substitute human labor but also to assist it.

Furthermore, the use of robots not only in the manufacturing industry but also in the service industry will lead to discussions surrounding services such as robotic process automation (RPA) using software, including AI, which has often been discussed as a different elemental technology up until now. Using RPA enables the use of automation, which originally required a high level of programming skills, by using low-code or no-code for basic processes. This lowers the skill barrier required to use technologies which in turn increases the demand for them and accelerates automation. This can be viewed as an analogy with the popularization of graphical user interfaces (GUIs) when

CUI (command user interfaces) was mainly used in PCs. Collaborative robots that we have looked at previously have also brought similar changes to industrial robots by enabling basic operations to be done with low-code, no-code, and direct teaching, making it easier to implement automation.

Robots have been used in industrial applications for decades, but with the development of emerging technologies such as IoT and AI, the number of applications and users is increasing through their integration. One must look at the impact of these emerging technologies on employment with a cross-sectional perspective to understand it, taking into account not only how technologies such as robots and AI can be used to replace human labor, but also how they can be used to assist human labor, and how they can be integrated with multiple elemental technologies.

(2) Impact on how workers are matched with jobs

In the previous section we looked at how trade and investment in technologies such as robots and AI affect the total number of workers. In this section, we will first look at digital labor platforms that emerging technologies have brought to the digital economy and trends in the digital platforms that match workers. After which we will examine the occupations and skill sets that will be required in future labor markets through these changes in employment patterns and the development of emerging technologies.

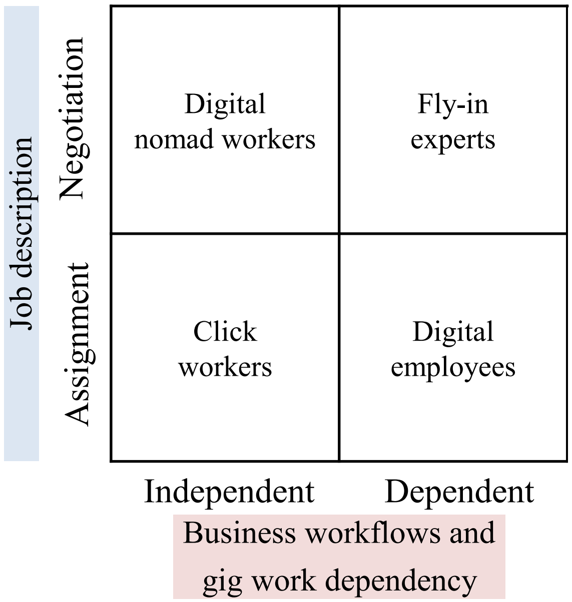
Let's first look at digital platforms in the labor market which have been expanding in recent years. The ILO (2021) classifies digital labor into two broad categories in terms of places where services are provided: online web-based and location-based platforms[122]. On online web-based platforms, tasks or work assignments are performed online or remotely. This could include creating documents and programs or providing labor through consulting. It also includes freelance and contest-based platforms, competitive programming platforms, and microtask platforms. Since labor is provided online, matching workers with clients is possible regardless of where they live. Especially with machine translation developing rapidly in recent years, it has become possible to outsource tasks without worrying about language barriers, and it is becoming possible for workers that live overseas to perform tasks that were originally handled by domestic workers.

The tasks on location-based platforms are carried out in person in specified physical locations by workers, and include taxi, delivery and other local services.

These digital platforms have brought many "gig workers" that are looking for labor opportunities through matching platforms. Gig workers can be classified into the following four categories in terms of what they do and their relationship with companies (Figure II-2-1-17).

[122] ILO (2021), "World Employment and Social Outlook," (https://www.ilo.org/global/research/global-reports/weso/2021/WCMS_771749/lang--en/index.htm).

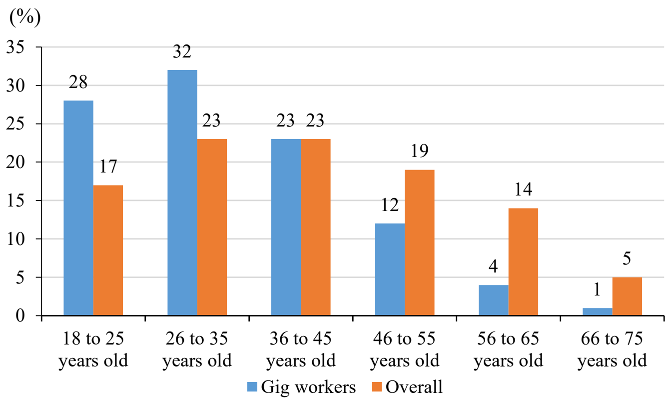
Figure II-2-1-17. Gig worker classification



Source: *FY 2020 Global Economy Survey for Formulating an Integrated Domestic and External Economic Growth Strategy (Globalization and Labor Markets).*

As shown in the figure above, there are many types of gig workers that are linked to the workflow of a company, from those who are assigned jobs through digital platforms to those more skilled that negotiate with clients to get jobs. About 60% of gig workers are 18 to 35 years old, showing a larger proportion of young gig workers than young people who partake in the labor market as a whole (Figure II-2-1-18).

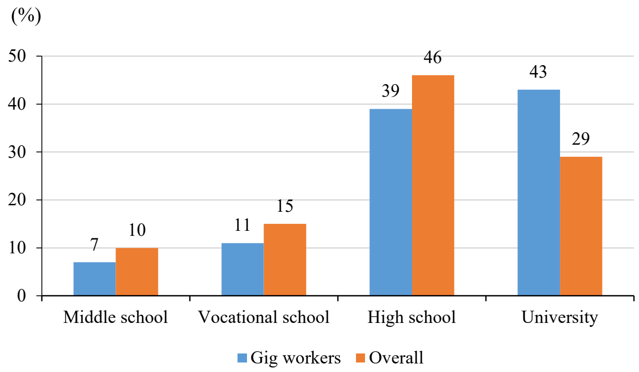
Figure II-2-1-18. Proportion of gig workers by age



Source: *FY 2020 Global Economy Survey for Formulating an Integrated Domestic and External Economic Growth Strategy (Globalization and Labor Markets).*

About 30% of workers in the labor market have gone to university, while more than 40% of gig workers have. (Figure II-2-1-19).

Figure II-2-1-19. Proportion of gig workers by educational background



Source: *FY 2020 Global Economy Survey for Formulating an Integrated Domestic and External Economic Growth Strategy (Globalization and Labor Markets).*

Depending on the job, gig work can require a wide range of skills and has become a labor market that can meet the various needs of workers. It also enables companies to get workers that have the skills needed at the time which reduces the usual burden of needing to train workers. Gig work does have its disadvantages though, with no guarantee of stable work opportunities making it hard to have a stable income, and having no opportunities to improve skills through training, as gig workers are assumed to already have the necessary skills. Companies also have to face the risk of information being leaked and employees choosing to work as gig workers (Table II-2-1-20).

Table II-2-1-20. Major advantages and disadvantages of gig work for companies and workers

	Advantages	Disadvantages
Companies	· Can flexibly adjust the workforce · Reduced fixed costs associated with employees · Can flexibly acquire skilled workers · Can be used as trial periods · Reduced burden of needing to train workers	· Risk of information leaks · Paying more to high-skilled workers than what is paid to employees · Risk of employees leaving (to become gig workers)
Workers	· Can flexibly choose what job they want to do · Can work without being bound by companies · Can do multiple projects and jobs simultaneously · Can control their carrier path	· Unstable income and uncertain working environments · No benefits such as retirement benefits from working long-term · Competing with low-cost workers overseas · Can't receive training as clients assume that they already have the required skills

Source: *FY 2020 Global Economy Survey for Formulating an Integrated Domestic and External Economic Growth Strategy (Globalization and Labor Markets).*

As with gig workers in the discussions above, the skills used by workers depend on what type of worker they are. The OECD's definitions of skill levels are often used in these kind of discussions on worker skills (Table II-2-1-21).

Table II-2-1-21. OECD's definitions of skill levels and examples

	High Skill	Medium Skill	Low Skill
Definition	Work that requires an honors degree or a undergraduate degree or equivalent	Work that requires a specific level of secondary education	· Work that requires the knowledge and experience required to perform simple tasks · Work that involves manual labor
Examples	· Legal professionals · Bureaucrats · Managers · Professionals · Engineers	· Clerks · Workers in the service industry · Sellers in stores and markets · Skilled farmers and fishermen · Craftsmen and assemblers · Plant and machine operators	· Security guards · Cleaners · Laundry workers · Workers that do simple work or manual labor in the mining, agriculture and fishing, construction and manufacturing industries

Source: *OECD Glossary of Statistical Terms* (International Standard Classification of Occupations (ISCO), *FY 2020 Global Economy Survey for Formulating an Integrated Domestic and External Economic Growth Strategy (Globalization and Labor Markets).*

According to these definitions, high skills, medium skills, and low skills are classified mainly by their associated educational background such as a university, graduate school or a secondary education. When discussing the impact of the emerging technologies we have looked at previously, such as robots and AI, we first need to touch on how we think about skills. Artificial intelligence and robotics researchers have observed that it is comparatively easy to make computers outperform humans on intelligence tests or playing checkers, and difficult or impossible to give them the skills of a one-year-old when it comes to perception and mobility. This is known as Moravec's Paradox[123]. These perception and mobility skills are not part of the skill levels' definitions mentioned earlier. It would be fair to say, however, that many of these skills acquired by humans through their development are possessed by every individual in each skill level.

When talking about the industries, tasks, and skills that will be replaced by robots and AI, we need to look at existing classifications as well as take into consideration the necessity of human perception and mobility skills. With recent developments in the field of machine learning, we have seen more examples of image recognition that exceeds the accuracy of humans. This has progressively helped to overcome the technical barrier that made automating inspection processes like inspecting for

[123] *Mind children*, Hans P. Moravec (1988), Harvard University Press.

scratches, dents, and discoloration on products difficult in manufacturing processes. Conversely, in addition to the aforementioned image recognition technology, physical inspections that involve processing and assembly, where human perception is essential, require sensing and control technologies that substitute and assist manual work.

For example, the manufacturing process of a wire harness (also called the veins and nerves of a car), which was exemplified as an automobile part in paragraph 5 of Section 2 in Part 1, Chapter I, is complicated and requires the perception and skills humans excel at, as mentioned before. That is why wire harnesses are often labor intensively manufactured overseas. AI and robots would struggle to replace the process as it involves workers using their hands to carefully manipulate the flexible wire while being aware of how it moves and how much it is bent. With that said, progress has been made in research and development to replace and assist with these kind of technically difficult processes as seen in national projects[124] and in startups[125]. If new automation technologies are put into practical use even for tasks with these high technical barriers, it could change trade structures, such as reshoring the production processes of intermediate goods that were originally produced overseas. It could also have a significant effect on the skill set required of workers. The wire harness manufacturing process is only one example of this. Looking ahead, it is important that we continue to pay close attention to the trends in research and development of emerging technologies in order to understand trade structures and the skill sets required for workers to adapt them to educational curricula and skills education for not only the manufacturing industry but also the service industry.

As we've seen, emerging technologies have had an impact on trade and employment through trade and investment, giving people more options for how they work and what kinds of jobs they can get. In connection with these changes, the U.S. Department of Labor gives projections on employment change by occupation over the next decade (Table II-2-1-22).

Table II-2-1-22. Employment change by occupation over the next decade

(Fastest growing occupations)

	Occupations	2020 Workers (Ten thousand people)	2030 Workers (Ten thousand people)	Growth up to 2030 (Ten thousand people)	Growth up to 2030 (%)	Median of average salary in 2020
	Total	15,353.4	16,541.4	1,188.0	7.7	$41,950
1	Wind turbine service technicians	0.7	1.2	0.5	68.2	$56,230
2	Nurse practitioners	22.0	33.5	11.5	52.2	$111,680
3	Solar photovoltaic installers	1.2	1.8	0.6	52.1	$46,470
4	Statisticians	4.2	5.7	1.5	35.4	$92,270
5	Physical therapist assistants	9.4	12.7	3.3	35.4	$59,770
6	Information security analysts	14.1	18.8	4.7	33.3	$103,590
7	Home health and personal care aides	347.1	460.1	113.0	32.6	$27,080
8	Medical and health services managers	43.0	56.9	14.0	32.5	$104,280
9	Data scientists and mathematical scientists	6.3	8.3	2.0	31.4	$98,230
10	Physician assistants	12.9	17.0	4.0	31.0	$115,390

(Occupations with the most job growth)

	Occupations	2020 Workers (Ten thousand people)	2030 Workers (Ten thousand people)	Growth up to 2030 (Ten thousand people)	Growth up to 2030 (%)	Median of average salary in 2020
	Total	15,353.4	16,541.4	1,188.0	7.7	$41,950
1	Home health and personal care aides	347.1	460.1	113.0	32.6	$27,080
2	Cooks, restaurant	115.3	171.7	56.4	48.9	$28,800
3	Fast food and counter workers	345.6	397.3	51.8	15.0	$23,860
4	Software developers, quality assurance analysts, and testers	184.8	225.7	41.0	22.2	$110,140
5	Waiters and waitresses	202.3	243.1	40.8	20.1	$23,740
6	Nurse practitioners	308.0	335.7	27.7	9.0	$75,330
7	Laborers and freight, stock, and material movers	282.2	307.8	25.6	9.1	$31,120
8	General and operations managers	241.2	263.8	22.6	9.4	$103,650
9	First-line supervisors of food preparation and serving workers	91.5	110.6	19.1	20.8	$34,570
10	Passenger vehicle drivers(excluding bus drivers, transit and intercity)	70.7	88.8	18.1	25.5	$32,320

[124] *European SMEs Robotics Applications,* EU, (https://cordis.europa.eu/project/id/780265), Wire cobots, (https://www.wirecobots.com/en/).

[125] *Q5D is using robots to automate electronic wiring during manufacturing*, TechCrunch (2022), (https://techcrunch.com/2022/02/05/q5d-is-using-robots-to-automate-electronic-wiring-during-manufacturing/).

(Fastest declining occupations)

	Occupations	2020 Workers (Ten thousand people)	2030 Workers (Ten thousand people)	Growth up to 2030 (Ten thousand people)	Growth up to 2030 (%)	Median of average salary in 2020
	Total	15,353.4	16,541.4	1,188.0	7.7	$41,950
1	Word processors and typists	4.5	2.9	-1.6	-36.0	$41,050
2	Parking enforcement workers	0.8	0.5	-0.3	-35.0	$42,070
3	Nuclear power reactor operators	0.5	0.4	-0.2	-32.9	$104,040
4	Processing workers	0.8	0.6	-0.2	-29.7	$31,630
5	Telephone operators	0.5	0.4	-0.1	-25.4	$37,710
6	Watch and clock repairers	0.3	0.2	-0.1	-24.9	$45,290
7	Door-to-door salespeople,newspaper salespeople,and street vendors	5.4	4.1	-1.3	-24.1	$29,730
8	Telephone operators, including answering service	6.0	4.6	-1.4	-22.7	$31,430
9	Data entry	15.8	12.3	-3.6	-22.5	$34,440
10	Switchboard operators	0.5	0.4	-0.1	-21.6	$30,630

(Occupations with the largest job declines)

	Occupations	2020 Workers (Ten thousand people)	2030 Workers (Ten thousand people)	Growth up to 2030 (Ten thousand people)	Growth up to 2030 (%)	Median of average salary in 2020
	Total	15,353.4	16,541.4	1,188.0	7.7	$41,950
1	Cashiers	337.9	304.3	-33.6	-10.0	$25,020
2	Secretaries and administrative assistants, except legal, medical,and executive	205.4	189.7	-15.7	-7.6	$38,850
3	Office clerks, general	53.9	43.8	-10.1	-18.7	$63,110
4	First-line supervisors of retail sales workers	139.1	130.0	-9.0	-6.5	$41,580
5	Miscellaneous assembler and fabricators	126.3	117.8	-8.5	-6.7	$33,550
6	Tellers	43.3	35.9	-7.3	-16.9	$32,620
7	Inspectors, testers, sorters, samplers, and weighers	55.8	49.0	-6.8	-12.2	$40,460
8	Office clerks, general	293.4	287.4	-6.0	-2.1	$35,330
9	Bookkeeping, accounting, and auditing clerks	162.0	157.2	-4.8	-3.0	$42,410
10	Shipping, receiving, and inventory clerks	73.5	69.4	-4.1	-5.5	$35,260

Source: *Employment Projections Program,* U.S. Department of Labor.

Among the occupations in Table II-2-1-22 that are expected to see a large increase in workers include wind turbine service technicians, nurse practitioners, solar photovoltaic installers, statisticians, and physical therapist assistants. The global energy shift toward decarbonization has seen increased employment in related jobs and employment in jobs that include face-to-face services, which are technically difficult to replace, did too. As digital technology continues to develop, the demand for high-skilled workers is increasing. Meanwhile, occupations that are expected to decrease in workers include word processors and typists, parking enforcement workers, nuclear power reactor operators, processing workers and telephone operators. This is mainly due to some jobs' processes, such a checking work, etc., being easily substituted through automation technology.

These changes in occupation that are required by society change the skill sets required for them (Table II-2-1-23).

Table II-2-1-23. The most and least important skills required in 2030

Required	
1st	Learning strategies
2nd	Psychology
3rd	Instructing
4th	Social perceptiveness
5th	Sociology and anthropology
6th	Education and training
7th	Coordination
8th	Originality
9th	Fluency of ideas
10th	Active learning

Unnecessary	
1st	Control precision
2nd	Wrist finger speed
3rd	Rate control
4th	Manual dexterity
5th	Finger dexterity
6th	Operation and control
7th	Reaction time
8th	Arm hand steadiness
9th	Equipment maintenance
10th	Response orientation

Source: *The future of skills: Employment in 2030*, H. Bakhshi, J.M. Downing, M.A. Osborne, P. Schneider. Employment in 2030” .

Looking at Table II-2-1-23, important skills for the future include "learning strategies," "psychology," and "instructing." This suggests that, as required skill sets change with time, it has become more important to learn in new areas and so is learning that includes reskilling. Interpersonal skills such as "psychology" and "instructing" are also becoming increasingly important. Among the skills that will be less important in the future include "control precision," "wrist finger speed," and "rate control." These are all skills in areas where technology such as robots and AI excel.

In response to the development of digital technologies, global trends, and domestic market trends, there is a growing possibility that skills required by society will change, which in turn will significantly increase and decrease labor demand in occupations and industries. Furthermore, while the use of technology eliminates the constraints of not only space and time but also those of the body and brain, etc., it would be better for the labor market to review the existing employment system and increase the autonomy of different workers.

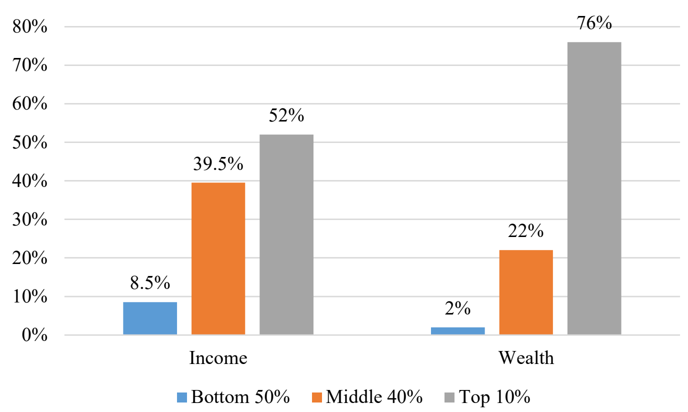
4. Impact on gaps and inequality

In the previous section, we looked at emerging technologies' impact on employment by looking at how the total number of jobs are affected by automation technologies and by looking at new employment opportunities through digital platforms. We saw that the impact of these technologies varies depending on the industry and the skills of workers. This has become one of the reasons why there has been a widening wealth gap where the majority of wealth is held by some individuals and companies. It is also leading to a widening wage gap and a hollowed out demand for middle-skill jobs due to it being rapidly introduced to save and substitute labor. In this section we will consider necessary corrective measures for the future after looking at the reality of gaps and inequalities against the backdrop of digital technology development and how it has spread into society.

(1) Economic gaps and inequality among individuals

It is clear that there is a bigger gap in wealth than in income when looking at the global income and wealth inequality for the bottom, middle and top percent of the global population in 2021 (Figure II-2-1-24).

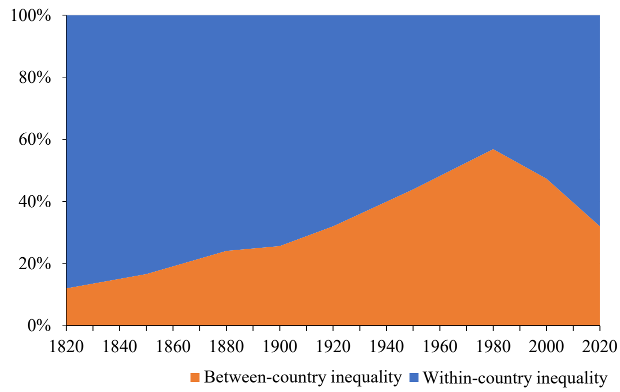
Figure II-2-1-24. Global income and wealth inequality (2021)



Source: *World Inequality Report 2022* (World Inequality Lab).

Looking at the trend of global income inequality through the Theil index[126], we can see that while the between-country inequality has been shrinking since 1980, the within-country inequality has relatively increased (Figure II-2-1-25).

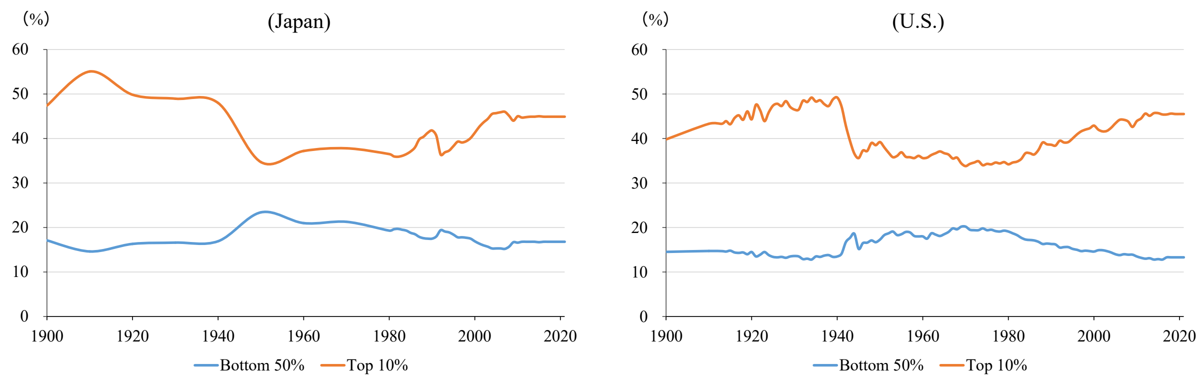
Figure II-2-1-25. Trends in between vs. within country inequality (1820-2020)



Source: *World Inequality Report 2022* (World Inequality Lab).

Let's look at income inequality by country to better understand Japan's relative increase in income inequality. The following chart shows the percentage of income owned by the top 10% and bottom 50% of the population in Japan and the U.S. (Figure II-2-1-26).

Figure II-2-1-26. Top 10% and bottom 50% income shares in Japan and the United States (1900-2021)



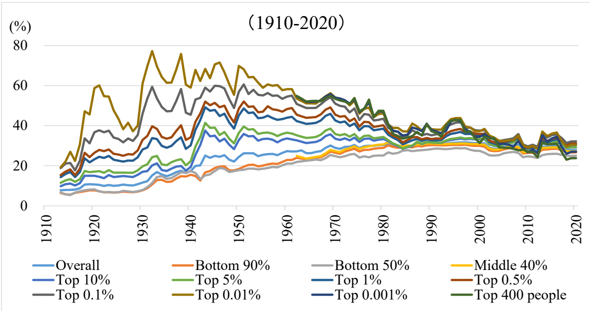
Source: *World Inequality Report 2022* (World Inequality Lab).

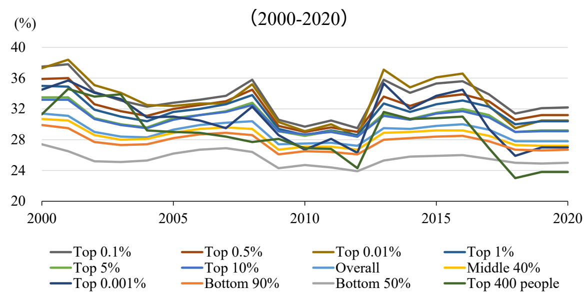
[126] A statistic used to measure economic inequality developed by the Dutch econometrician H. Theil (1924–2000). It can break down a group as a whole into mutually independent elements (sex, income class, etc.). The index is expressed as a value between 0 and 1 with 0 indicating that there is complete equality and anything above that indicating inequality (greater inequality = value closer to 1). Here the income gap is shown as a split between the percentage of within-country inequality and between-country inequality.

The income share of the top 10% increased, and the income share of the bottom 50% decreased in both Japan and the U.S. This trend has continued in Japan since the 1990s and since the 1980s in the U.S.

When looking at long-term data regarding total taxes paid by income group in the U.S., we can also see that the tax burden of lower groups increased while the tax burden of the top groups decreased with the groups converging at around 20% to 30% (Figure II-2-1-27). Meanwhile, if we examine the trends after 2000, we can see that the "Top 0.1%" has paid the most taxes while the "Top 400 individuals" have paid the least. We can also see that the "Top 0.001%" has a lower tax burden than the groups put together (same figure).

Figure II-2-1-27. Trends in total taxes paid by income group in the U.S.





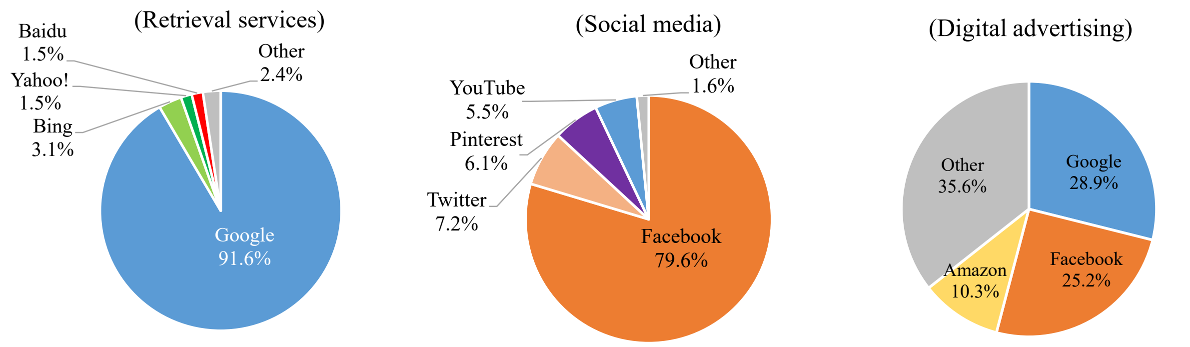
Source: *World Inequality Report 2022* (World Inequality Lab).

As previously mentioned, the income share of the top 10% in the U.S. has been on a upward trend since 1980, while the tax burden has been on a downward trend. With this it can be said that the income gap is being widened further in the U.S. In light of this situation, a tax increase on the wealthy, especially on the super-wealthy that are worth over 100 million dollars is being discussed in the U.S. As there are concerns that public policy with regard to excessive income inequality tends to favor the interests of the wealthy, it would be better to narrow the income gap among individuals in addition to the direct objective of narrowing gaps from the perspective that it will alleviate the concerns which distort public policy.

(2) Gaps and inequalities in corporate activities

More people are asking for the gaps and inequalities that arise from economic activities of digital platforms to be corrected. The business structure of digital platforms is easy to work with thanks to its network effect and there are monopolies and oligopolies among search engine services, SNS, and the digital advertising market as shown in the figure below (Figure II-2-1-28).

Figure II-2-1-28. Share of search engine services, SNS and the digital advertising market



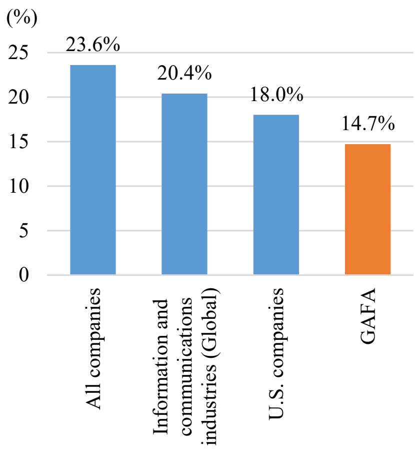
Note 1: Data regarding search engine services and SNS as of March 2022. Data with regard to digital advertising is as of 2020.
Note 2: Instagram is included in Facebook's share.
Source: statcounter, eMarketer, and materials from the Digital Market Competition Council.

Services such as those shown in the figure mentioned below have become essential in our lives. Google has been a digital monopoly with a 91.6% share in the market of Internet services while Facebook (now Meta Platforms and also includes Instagram) has a 79.6% share in SNS. Increasing the share of certain services through the network effect in these kind of digital platforms can lead to improved convenience. On the other hand, it has been pointed out that these sort of markups tend to cause price rigidity in imperfect competitive markets such as monopoly and oligopoly markets and that it can lead to new companies being less willing to enter the market as well as stagnated innovation. According to the IMF (2019), a 10 % point increase in markup results in a 0.3 percentage point decrease in labor share[127].

Furthermore, it has been pointed out that profits obtained by these digital platforms are not taxed appropriately which has caused international debate over whether to revise international tax rules. As mentioned previously, the corporate tax rate for GAFA (Google, Apple, Facebook (at the time) and Amazon), digital platforms that have monopolies or are a part of oligopolies in specific service markets, was at 14.7%, a lower level compared to the global average of all companies (23.6%), the global information and communications industries (20.4%) and U.S companies (18.0%) (Figure II-2-1-29).

[127] *World Economic Outlook*, IMF (2019), (https://www.imf.org/en/Publications/WEO/Issues/2019/03/28/world-economic-outlook-april-2019).

Figure II-2-1-29. Comparison of corporate tax burden



Note 1: Based on the latest financial information as of April 13, 2022.
Note 2: Corporate income tax rates are calculated as (corporate tax) / (current net income before income taxes).
Note 3: "All companies" are 13,184 listed companies found on Speeda. "Information and communications industries" are 954 companies classified as establishments in the Information sector by NAICS 51: Information. "American companies" are 743 companies based in the U.S. GAFA consists of Alphabet Inc. (the holding company of Google), Apple, Meta Platforms and Amazon.
Source: Speeda (Ministry of Economy, Trade and Industry).

Additionally, there have been many cases where multinational enterprises are not appropriately taxed in the market jurisdictions in which they develop as, according to the international tax rules up to now, their business income cannot be taxed if they do not have a physical location in the market jurisdiction. That is why many people have asked for the rules to be corrected for fair competition conditions among companies.

Given the situation, the OECD has proposed a two-pillar solution that will help review international tax rules that come with the economy's digitalization. Pillar 1 of the OECD's current proposal would reallocate the taxing rights of the profits made by multinational enterprises to the market jurisdictions, taking into account the value created by them in the market jurisdiction regardless whether they have a physical location there. Specifically, it reallocates 25% of multinational enterprises' profits in excess of 10% of their revenues to market jurisdictions for multinational enterprises with revenues exceeding 20 billion euros and that have profitability greater than 10%. According to the OECD, taxing rights on more than $125 billion of profit are expected to be reallocated to market jurisdictions each year[128]. The second pillar introduces a global minimum corporate tax rate of 15%. According to the OECD, the new minimum tax rate applied to multinational enterprises with revenue above 750 million euro is estimated to generate around USD 150 billion in additional global tax revenues annually[129]. On

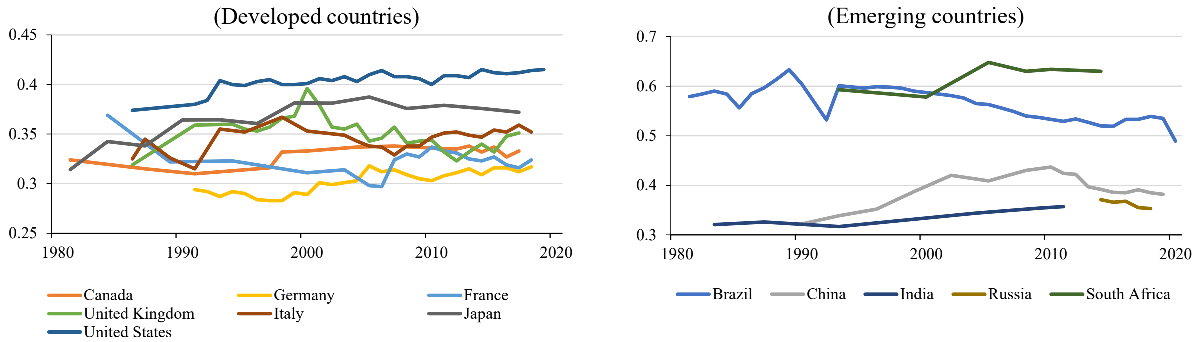
[128] OECD (2021) "OECD/G20 Inclusive Framework on Base Erosion and Profit Shifting (BEPS) Statement on the Two-Pillar Solution to Address the Tax Challenges Arising from the Digitalisation of the Economy, Frequently Asked Questions" (https://www.oecd.org/tax/beps/faqs-statement-on-a-two-pillar-solution-to-address-the-tax-challenges-arising-from-the-digitalisation-of-the-economy-october-2021.pdf).
[129] From the same reference above.

October 8, 2021, members of OECD agreed to the solution with the aim being to bring into law in 2022 and for it come into effect in 2023.

(3) Decomposition of within-country inequality and corrective measures

At the beginning of this section we saw that the impact of within-country inequality in the world is relatively greater than that of between-country inequality. Within-country inequality can be expressed using the Gini coefficient, which is calculated by looking at the relationship between equal distribution of income and its cumulative percentage. The Gini coefficient for developed and emerging countries can be seen below (Figure II-2-1-30).

Figure II-2-1-30. The Gini coefficient of developed and emerging economies after redistribution

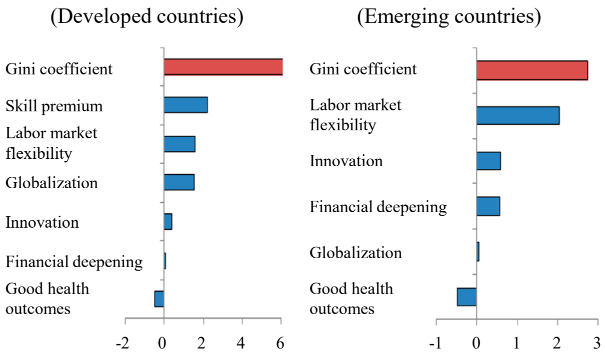


Note: Developed countries are based on G7 data and emerging countries are based on BRICS data.
Source: World Bank, Ministry of Health, Labor and Welfare.

From the above figure we can see that the United States and Germany are on an upward trend among developed countries, while other countries, including Japan, are generally flat. Also, while developed countries are roughly at the same level, the level of emerging countries varies greatly from country to country. While South Africa's and Brazil's Gini coefficient is higher than in developed countries, the inequality gap is widening in South Africa while narrowing in Brazil thanks to Brazil's minimum wage being increased since the 2000s and government support programs which reduced poverty and caused the middle class to grow. While China's Gini coefficient has been decreasing since around 2010, the rural-urban gap has become serious with China trying to narrow the gap in 2021 using "common prosperity" as its slogan.

Next, we will look at an analysis of the Gini coefficient's decomposition of changes which measured within-country inequality. According to an analysis of the Gini coefficient's decomposition of changes by the IMF (2015), skill premium, labor market flexibility, and globalization are the main drivers for change in market (gross) income inequality in developed countries while labor market being main the main driver in emerging countries (Figure II-2-1-31).

Figure II-2-1-31. Decomposition of the change in market (gross) income inequality (IMF (2015))



Source: IMF (2015).

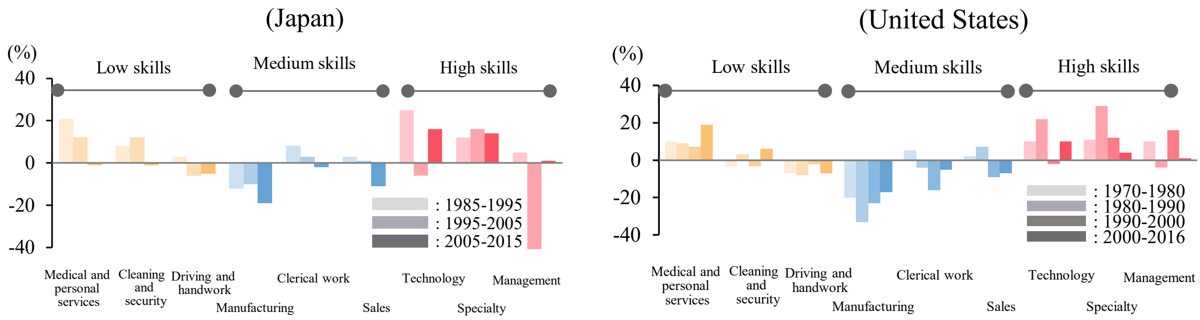
The IMF (2015) has brought up education, labor and innovation policies as concrete issues for future policies to tackle. They have said that raising skill levels is critical for reducing the dispersion of earnings and can also help improve the income prospects of future generations in developed countries. With regard to labor policy they stated that appropriately setting minimum wages, spending on well-designed active labor market policies aimed at supporting job search and skill matching can be important. They also stated that while excessively stringent regulations can weigh on job creation and efficiency, labor market rules that are very weak can leave problems such as poor information which is why labor market policies should attempt to avoid either excessive regulations or extreme disregard for labor conditions. Furthermore, with regard to innovation policy, they stated that it is important to maintain appropriate market competition, reduce the factors that impede technology diffusion and ensure that everyone benefits from innovation[130].

As mentioned in Part I, Chapter 2, Section 2, it is clear that workers in the U.S. labor market tend to voluntarily resign, change their jobs or become entrepreneurs for better salaries or better working environments. It would be fair to say that flexible labor markets are the major reason why options such as changing jobs and entrepreneurship exist. When changing jobs, highly skilled workers are seeking employment opportunities to reduce skill mismatches which is consistent with the fact that the skill premium is a part of the change in the Gini coefficient. In addition, increased globalization which causes less highly skilled workers to be employed at mismatched jobs might in turn cause the skill premium to further grow.

As for skill gaps, polarization between the U.S. and Japan continues when one examines the growth rate of total working hours by occupation categorized by skill level. (Figure II-2-1-32).

[130] Era Dabla-Norris et al. (2015) “Causes and Consequences of Income Inequality: A Global Perspective”, IMF Staff Discussion Note, SDN/15/13, June 2015.

Figure II-2-1-32. The polarizing growth rate in total working hours by occupation

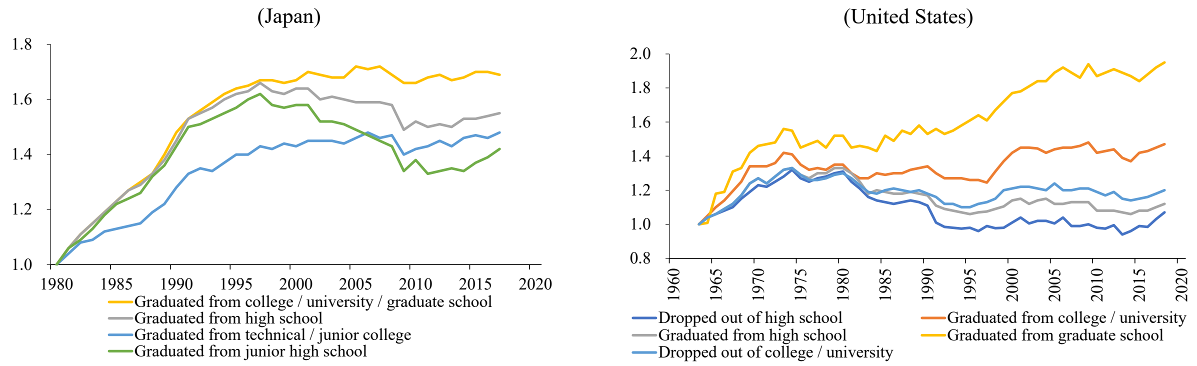


Source: Autor (2019), *FY 2020 Global Economy Survey for Formulating an Integrated Domestic and External Economic Growth Strategy (Globalization and Labor Markets)*, (Ministry of Agriculture, Forestry and Fisheries).

With this, development in technological innovation can polarize labor markets, provide more options for highly skilled workers, and, as mentioned early, reduce skill mismatches. This in turn may cause the skill premium to grow.

Let's look at Japan's and the U.S.' wage gap. Wages for high-skilled workers have not changed significantly since the late 1990s in Japan while wages for low and medium-skilled workers have decreased which has widened the wage gap (Figure II-2-1-33). Meanwhile in the United States, wages for high-skilled workers have increased while wages for low-skilled workers have decreased which has widened the wage gap (Same figure).

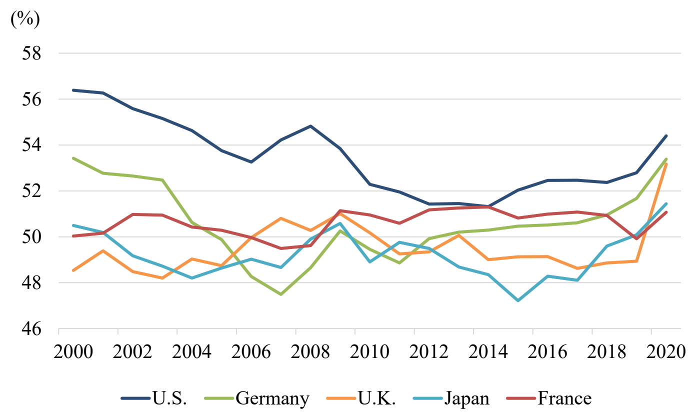
Figure II-2-1-33. Wage gap by skill



Note: Base year set for Japan: 1980 = 100, base year set for the United States: 1980 = 100.
Source: *FY 2020 Global Economy Survey for Formulating an Integrated Domestic and External Economic Growth Strategy (Globalization and Labor Markets)*, (Ministry of Agriculture, Forestry and Fisheries).

Now if we look at the wage gap in terms of labor share, the OECD has stated that the labor share in developed countries has been declining or flat (Figure II-2-1-34). A declining labor share and a widening wage gap by skill suggest that low-skilled workers' labor share is decreasing.

Figure II-2-1-34. Global comparison of labor share



Note: Labor share = compensation earned / economic output produced.
Source: OECD.Stat.

A polarized labor market makes it difficult for low-skilled workers to find jobs that match their skills. Even if they have acquired medium level skills, the number of mid-skill jobs declines in the overall labor market, making it impossible to eliminate mismatched employment. Looking at how labor-substituting technologies have impacted the labor market in terms of profitability and technical difficulty, it would be fair to say that corrective measures are in order as they have had and will most likely continue to have the power to reduce the number of workers in medium-skilled jobs.

Now that we know the reality of the situation, let's explore corrective measures from a macro-level perspective, looking at labor and capital, and from a micro-level perspective, looking at workers' skills and R&D areas. As mentioned previously, the rapid use of technologies such as robots and AI has led to a polarized labor market. There are a wide range of fields in which tasks carried by human labor and tasks carried by capital such as robots and AI compete. Companies determine the ratio at which tasks will be distributed in the areas where human labor and capital compete by directly comparing tax burden and unit price in order to improve productivity.

In light of this situation, there have been discussions on the necessity of investment in human capital and R&D investment. Among these discussions describe investment in human capital as shifting the tasks performed by workers so that they do not overlap with those of capital. This specifically involves acquiring new knowledge and required experience in compulsory and higher education in response to the change in circumstances, as well as developing a recurrent education system that enables lifelong learning, and promoting reskilling and unlearning to adapt to changing times, common sense, and background information.

Previous discussions have also brought up that R&D investment aims to assist with human labor rather than directly substituting it even in areas where labor and capital overlap. It is like increasing investment which improves value added, reduces labor burden, and increases employment opportunities. In a publication made by Acemoglu, D.(2021), these technologies are described as "human-friendly" technologies and include the use of image recognition and AR technologies, online conference systems that promote communication and other technologies that "support" human labor in the manufacturing industry[131]. This also includes machine translation technologies that help compensate for language differences, power assist suits that provide physical strength, remote control technologies that help compensate for geographical distance, and prosthetics to help compensate for physical disabilities.

Although technology has been pointed out as a direct factor in widening gaps, technological advancement can provide many options that can help narrow them as mentioned above. That is why we need to promote innovation in society and reduce gaps and inequality while developing and utilizing technology to have more options in how we work, live, and go through life going forward.

[131] *Remaking the post-COVID world*, Acemoglu, D., (2021), Finance&Development, March 2021, (https://www.oecd.org/naec/events/remaking-the-post-covid-world.htm).