Chapter 1

ICT in Japan and the World

This chapter is the introduction part of the Special Theme, which outlines the current situation of ICT in Japan and the world. In the world's ICT market, dissemination of artificial intelligence (AI) and the internet of things (IoT) is making progress. Comparison is made on the state of ICT investment, contribution of ICT capital stock to GDP growth, and innovation acceptance in Japan and the United States.

Section 1 Trend of ICT Markets in Japan and the World

1. Expansion of Data Traffic

With the progress of AI and IoT in recent years, data distribution is increasing globally. The growth rate of mobile data, in particular, is expected to exceed the growth rate of the whole data traffic.

2. Rapid Spread of IoT Devices

Against a backdrop of the evolution of Internet technologies and various sensor technologies, we are embarking on an IoT age where in addition to existing terminals such as personal computers and smartphones, various things including home appliances, automobiles, buildings and factories around the world are hooked up to the Internet. The number of IoT devices is about 27 billion in the world in 2017. It is expected to reach 40 billion in 2020. Looking at the trend in the number of IoT devices in the world, the largest number of such devices was operating in "communication" including smartphones and other communication devices in 2017. However, because the market is mature, it is expected to grow relatively slowly. In the future, high growth is projected in "automobile/transport machine" where IoT is expected to make progress with the spread of connected cars, "medical care" where the market for digital health care is expanding, and "industrial use (factories, infrastructure, and physical distribution)" where smart factories and smart cities will expand.

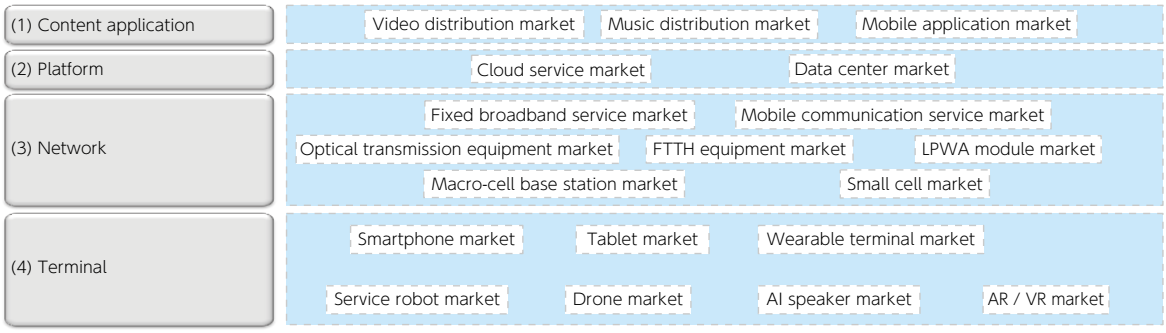
3. Market Trend by Layer

Here, we will give an overview of the trend of ICT markets of the world including Japan in recent years, based on layer classification of the markets to (1) content application, (2) platform, (3) network and (4) terminal (Figure 1-1-3-1).

The market size of cloud services, which support AI/IoT services, is predicted to continue expanding to reach about 1.9 times the 2017 level by 2020. On the other hand, there are markets such as the smartphone market which have shifted to stable growth as a result of achieving widespread dissemination.

Overall, the lower layer markets of network and terminal, especially fixed/mobile network services that have already spread around the world, are big in size. However, the growth rate is low, particularly for the "terminal" layer. Devices for "people" represented by smartphone have grown rapidly but the growth is expected to slow down in the future. On the other hand, the market sizes of upper layers – "content application" and "platform" – are smaller than the lower layer markets but

Figure 1-1-3-1 ICT Markets by layer



(Source) Survey and research on the present state of ICT in Japan, MIC, 2018

their growth rates are high. Therefore, it is likely that added value will generally shift to businesses related to the upper layers.

Section 2 Data-related Systems in Japan and the World

1. Domestic Trend after Development of a Legal System

The environment for data distribution has been rapidly improving in Japan. Especially over the past years a fundamental legal system has been developed, including full enforcement of the revised Act on Protection of Personal Information in May 2017 and promulgation and enforcement of the Basic Act on the Advancement of Public and Private Sector Data Utilization in December 2016. In response, improvement of the environment is promoted for further encouragement of data distribution based on the acts.

(1) PDS /Information Bank/ Data Trading Market

a. Study at the National Strategy Office of Information and Communications Technology, Cabinet Secretariat

Improvement of wired/wireless broadband networks, spread of smartphones and IoT devices and the evolution of AI are creating a technical environment for efficient distribution and utilization of vast amounts of data including behavioral history of individual persons. In terms of legal systems, it is expected that the introduction of anonymously processed information scheme in the revised Act on Protection of Personal Information will expand utilization of personal data. In addition, how to distribute personal data safely and to promote distribution of non-personal industrial data are challenges for development of a comprehensive data distribution environment.

In order to develop an environment to address these challenges, the National Strategy Office for Information and Communications Technology of the Cabinet Secretariat has been holding "Study Meeting for Development of Data Distribution Environment" since September 2016. "The Working Group on Data Utilization in the Age of AI and IoT" set up under the meeting conducted intensive discussions on new mechanisms for data distribution, which are PDS (Personal Data Store), information banks (credit banks for utilization of information) and data trading markets, and published an interim summary in March 2017.

In various fields including tourism, finance (FinTech), medical/nursing/health care and human resources, information banks are expected, by supporting utilization of personal information by the person based on his/her intention and returning the benefits to the person, to contribute to expansion of "Appropriate Utilization of Public and Private Sector Data by a Wide Variety of Actors with Participation of Individuals" as set forth in Article 12 of the Basic Act on the Advancement of Public and Private Sector Data Utilization. Data trading markets are expected to vitalize trading of personal data accumulated in the information banks, industrial data held by various companies and other data to establish the base of data distribution across companies and fields.

b. Study at the Ministry of Internal Affairs and Communications and the Ministry of Economy, Trade and Industry

In response to the discussions at the Study Meeting for Development of Data Distribution Environment, Subworking Group (SWG) on Data Trading Market, etc. was set up under the Basic Strategy Working Group, IoT Policy Board, Information Communication Policy Committee, Information and Communications Council, MIC, in February 2017. The SWG published a summary in June 2017[2]. The SWG recognizes that: for the information banks to fulfill the so-called information trust function, which means judging appropriateness of provision of data to a third party on behalf of the data holder and providing the data based on the agreement with the person on data utilization, it is necessary to establish a system to ensure the reliability of the information trust function. Based on the recognition, SWG concludes that it is desirable that private entities build a voluntary system to authorize business operators who meet specific criteria including management stability, security system and the contents of contract with data providers.

Based on this conclusion, MIC and METI have been jointly holding "study meeting on a desirable authorization scheme for the information trust function" since November 2017. In June 2018, a guideline was made public on a system of voluntary authorization by private entities, etc. including authorization criteria of persons performing the information trust function, matters to be included in a model contract and an authorization scheme. In order to further expand data distribution through information banks and other systems, since November 2017, MIC and METI have been jointly holding "research and examination meetings on data portability" which is advancing research and examination. Data portability enables returning of personal information held by the public/private sector to the relevant person in an easy-to-reuse digital format, and transferring of personal information from one service to another.

c. Establishment of Data Trading Alliance

Toward formation of a data trading market, dozens of companies actively working in the data trading business set up the Data Trading Alliance[3] in November 2017.

[2] Summary by the Sub-Working Group (SWG) on data trading markets, etc., Basic Strategy Working Group, IoT Policy Board, Information Communication Policy Committee, Information and Communications Council, MIC: http://www.soumu.go.jp/main_content/000501149.pdf

[3] Data Trading Alliance https://data-trading.org/

The alliance started initiatives toward private-sector-driven development of a system for authorization of data trading businesses. The alliance has four committees: "Operation Standards Committee", "Technology Standards Committee", "Data Utilization Committee" and "Certification and Audit Committee" to discuss items desirable for data trading businesses to meet as the basis for both data providers and users to safely participate in data trading, as well as specific operation of the authorization system. Discussions have been conducted with participation from the industry, the government, academic experts and others.

(2) Utilization of Open Data

a. Development of Basic Policy on Open Data

Based on "Open Government Data Strategy" formulated by the IT Strategic Headquarters, Cabinet Secretariat in July 2012, Japan has been taking measures for promotion of publication and reuse of data held by the government, incorporated administrative agencies, local governments, utilities and others. As the Basic Act on the Advancement of Public and Private Sector Data Utilization established "Easy Use of Public and Private Sector Data Held by the State and Local Public Entities (Article 11)" as a basic policy, the IT Strategic Headquarters published "Basic Principles on Open Data (BPOD)[4]" in May 2017. Based on the concept of "Open Data by Design" that plans, develops and operates entire information systems and administrative procedures assuming that public data are open data, BPOD presents principles which include: data held by each ministry and agency - including data that has been the basis for policy planning and making - must be published as open data; the data published on ministry and agency websites shall be subject to the Government of Japan Standard Terms of Use and the secondary use of published data shall be actively encouraged and; Data for publication shall have a structure and data format that is machine readable.

b. Promotion of Open Data through Public-Private Dialogues

The National Strategy Office of Information and Communications Technology, Cabinet Secretariat set up "the Open Data Working Group" in October 2016 under the "Study Meeting for Development of Data Distribution Environment" mentioned above to promote measures of ministries and agencies and support open data measures of local governments and other entities. In order to advance open data initiatives that better meet the needs of the private sector, the office has been holding "the Public-Private Roundtable on Open Data[5]" since January 2018 for dialogue between private companies wishing to use public data and ministries/agencies, etc. holding public data. In response to specific requests from private companies at the round table, ministries and agencies are already working for new data release and standardization.

2. International Trend

From 25 May 2018, the EU Data Protection Directive has been replaced by a direct application of the new "General Data Protection Regulation (GDPR)." Along with the cross-border personal data transfer restrictions over the past few years, especially in emerging countries, data localization ("data localization") regulation seeking domestic installation of used server equipment, etc. is expanded.

Section 3 Current State of ICT Investment in Japan and the United States

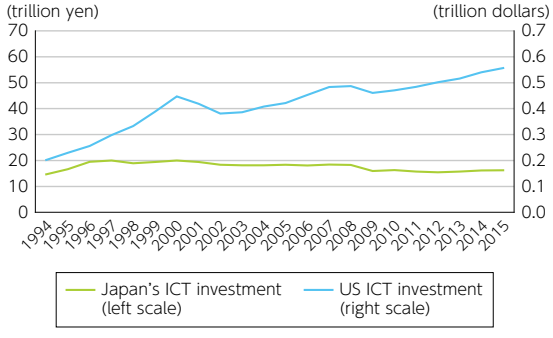
1. Transition in ICT Investment in Japan and the United States

(1) Transition in ICT Investment Amounts in Japan and the United States

For analysis of the contribution of ICT to economic growth, we compare ICT investment amounts in Japan with that in the United States.

Looking at ICT investment amount (nominal) from 1994 to 2016, the amount in Japan increased during the period from 1994 (14.6 trillion yen) to 1997, but slightly decreased or remained flat in the following years and the amount was 15.8 trillion yen in 2016. In the United States, ICT investment amount has maintained an upward trend with exceptional drops in 2002 and 2009. The amount almost tripled from 202.4 billion to 575.5 billion dollars in the 20 years (Figure1-3-1-1).

Figure 1-3-1-1 Transition in ICT investment amounts (nominal) in Japan and the United States

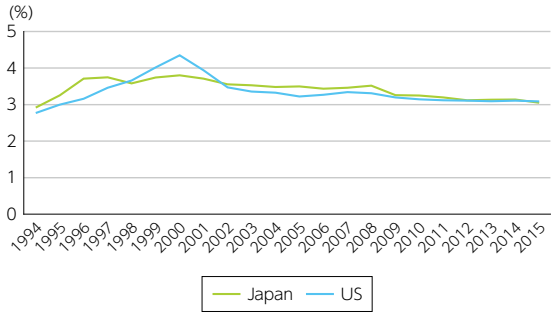


(Source) OECD Stat

[4] "Basic Principles on Open Data" Approved by the IT Strategic Headquarters・Strategic Committee for the Advancement of Utilizing Public and Private Sector Data (May 30, 2017) https://cio.go.jp/sites/default/files/uploads/documents/data_shishin.pdf

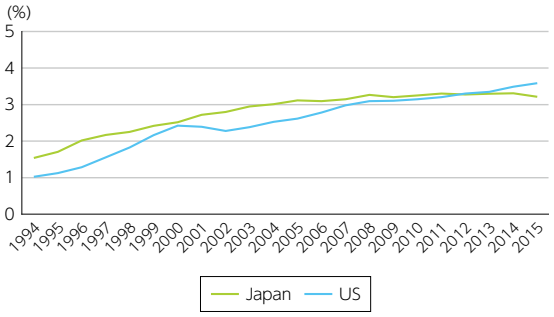
[5] For implementation status of the Public-Private Roundtable on Open Data see the following page provided by the National Strategy Office for Information and Communications Technology, Cabinet Secretariat: https://www.kantei.go.jp/jp/singi/it2/senmon_bunka/data_ryutsuseibi/kanminrt_dai1/gijisidai.html

Figure 1-3-1-2 Transition in ICT investment ratio to GDP (nominal) in Japan and the United States



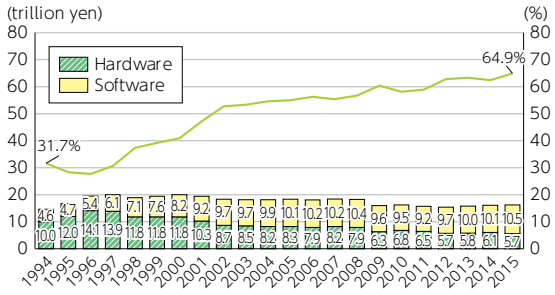
(Source) OECD Stat

Figure 1-3-1-3 Transition in ICT investment ratio to GDP (real) in Japan and the United States



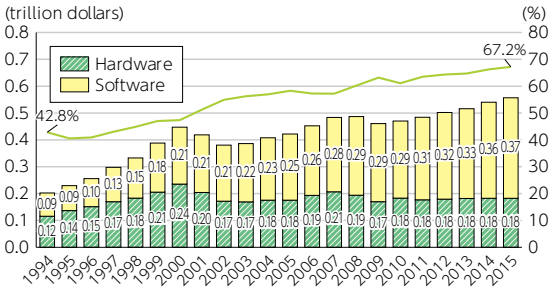
(Source) OECD Stat

Figure 1-3-1-4 Transition of ICT investment breakdown (nominal) in Japan



(Source) OECD Stat

Figure 1-3-1-5 Transition of ICT investment breakdown (nominal) in the United States



(Source) OECD Stat

The ratio of ICT investment to GDP on a nominal basis during the period is roughly 3 to 4% for each year both in Japan and the United States (Figure 1-3-1-2). On a real basis, the ratio was on an increasing trend in the two countries up to around 2010 but the slower growth of real ICT investment in Japan since the mid-2010s resulted in a difference between the two countries (Figure 1-3-1-3).

Considering that the amount that can be invested by a country depends on the amount of added value in the long term, it may be difficult for Japan to make ICT investment greatly exceeding 3 to 4% of its nominal GDP mentioned above for a long period of time. Though the ratio was similar for Japan and the United States, both GDP and ICT investment continuously grew in the United States for the past 20 years, whereas they have remained almost flat in Japan. Based on the fact, we can say that ICT investment grew at a sluggish pace in Japan because the effect of ICT capital stock to create added value was too weak to lead to new strong ICT investment.

ICT investment can be divided broadly into hardware investment and software investment[6]. Japan's ICT investment (nominal) has been slightly decreasing or flat since 1997. While hardware investment decreased from 13.9 trillion yen in 1997 to 5.7 trillion yen in 2015, software investment increased from 6.1 billion to 10.5 billion (Figure 1-3-1-4). In the United States hardware investment that was 120 billion dollars in 1994 increased up to 2000 and then remained flat at around 180 billion up to 2015, whereas software investment quadrupled in the 20 years from 90 billion dollars in 1994 to 370 billion dollars in 2015 (Figure 1-3-1-5).

As a result, the ratio of software in ICT investment (nominal) has been increasing both in Japan and the United States. In Japan the ratio increased from 31.7% in 1994 to 64.9% in 2015 (Figure 1-3-1-4). In the United States the ratio increased from 42.8% in 1994 to 67.2% in 2015(Figure 1-3-1-5). The shift of ICT investment from hardware to software during the 20 years has become clear both in Japan and the Unites States.

2. ICT's Contribution to Economic Growth

(1) Growth Accounting Analysis

Generally, economic growth (increase in added value) can be divided into the part represented by the increase in capital and labor which are production factors and the part represented by the increase in Total Factor Productivity (TFP). Capital and labor represent the effect of in-

[6] Data of ICT investment and capital stock of sourced OECD Stat is obtained from data of Japan from the Economic and Social Research Institute, Cabinet Office, and data of the United States from the Bureau of Economic Analysis (BEA), Department of Commerce. Japan's hardware is computers and attachments, communication machines and consumer electronics equipment, while hardware of the United States covers computers and peripheral equipment and communication equipment. Software covers order-based software, general purpose software and software developed in-house both in Japan and in the United States.

put on the increase of added value, while TFP represents the effect of the quality of production. TFP is a non-production factor contributing to increase of added value. Specifically it may include advancement of technology, accumulation of intangible capital and efficiency improvement of management and organizational operation. In the medium- to long-term, considering that labor supply is limited by population and investment forming capital stock will be within the range of the added value, it is necessary to increase added value by increasing TFP in order to make the economy of a country to grow.

In production activities of enterprises, capital equipment and labor are invested to create products and services, and the profits made through the activities constitute added value. Production of added values will increase GDP of the whole country leading to economic growth. Even with the same capital and labor inputs, technological innovation enables yielding of more added values, which increases added value per preproduction factor (capital and labor). This is why technological innovation is thought to be a source of productivity improvement. Here, ICT contributes to economic growth through capital accumulation by ICT investment and increase in TFP through technological innovation in ICT fields.

Figure 1-3-2-1 shows how ICT contributes to economic growth (increase in added value) and labor productivity, as well as the relationship between capital, labor and TFP.

Figure 1-3-2-2, by using uses growth accounting analysis, a method to measure contributions of capital (by ICT capital and non-ICT capital), labor[7] and TFP to the growth rate of real GDP, illustrates of factors contributing to growth rate in Japan and the United States in four 5-year periods from 1996 to 2015.

As described above, ICT contributes to economic growth through capital accumulation by ICT investment and increase in TFP through technological innovation in ICT fields.

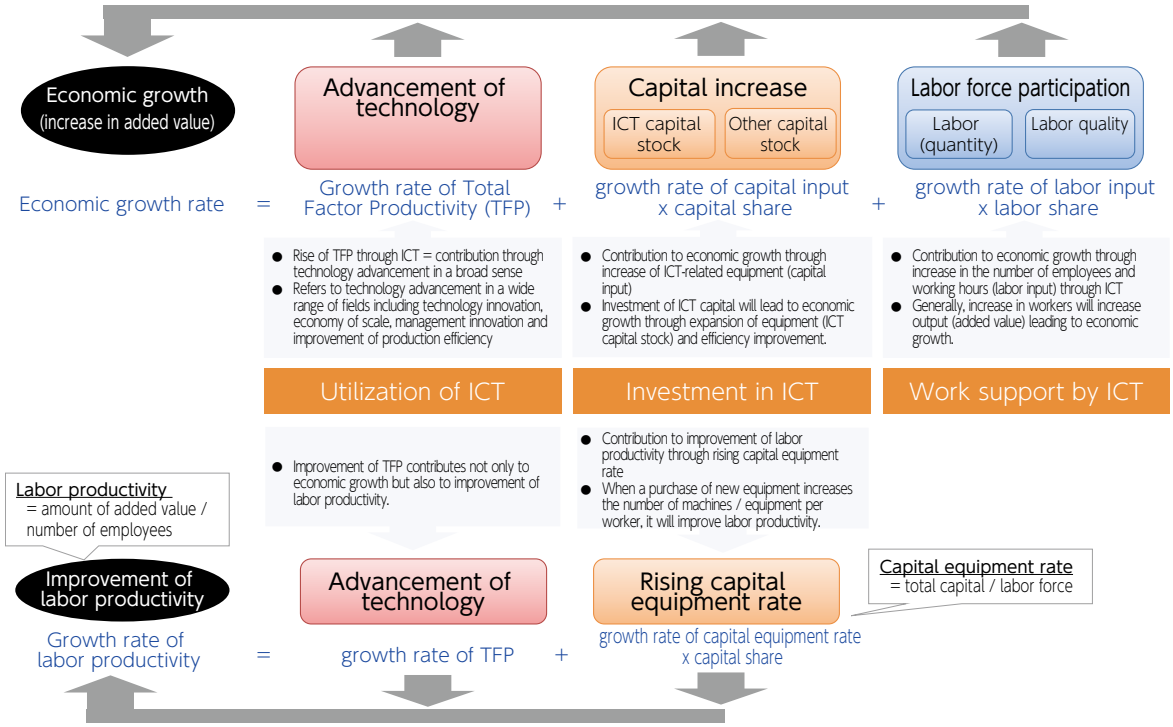
Figure 1-3-2-2 shows that TFP and ICT capital accumulation have a positive impact across the periods, which indicates that ICT investment and utilization make a certain contribution to economic growth also in Japan. Compared with the United States, however, the contribution was at a low level up to 2010.

From 2011 to 2015 Japan's TFP was higher than the TFP of the United States. However, because this can be a reaction to the low TFP of the preceding periods, it's not yet known whether the trend would continue.

Next, in order to search for the cause of Japan's low growth rate and TFP compared with the United States, Japan's industries were grouped into information communication industry[8] and other industries (industries using ICT) to see changes in factors contributing to growth rates of the five-year periods (Figure 1-3-2-3).

When the Information communication industry is compared with other industries using ICT, the value of TFP of the former is positive in all four periods and rela-

Figure 1-3-2-1 ICT's contribution to economic growth and labor productivity

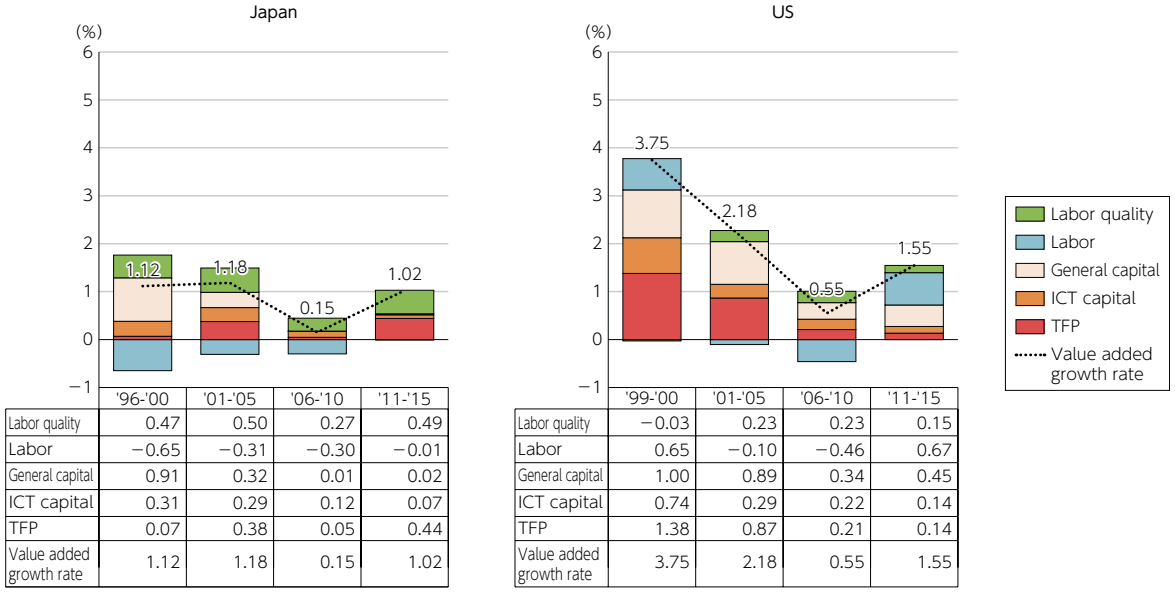


(Source) Created based on 2016 White Paper Information and Communications in Japan

[7] Here, labor is divided into quantity and quality of labor. Labor quantity refers to hours of work input, while labor quality refers to quality improvement through better academic background, continued service, etc.

[8] Here, values of the Information communication industry is the total of Electronic components and devices, Electrical machinery, equipment and supplies, Information and communication electronics equipment and Information and communications of Gross Domestic Product classified by Economic Activities of National Accounts for 2016.

Figure 1-3-2-2 Growth accounting analysis of Japan and the United States

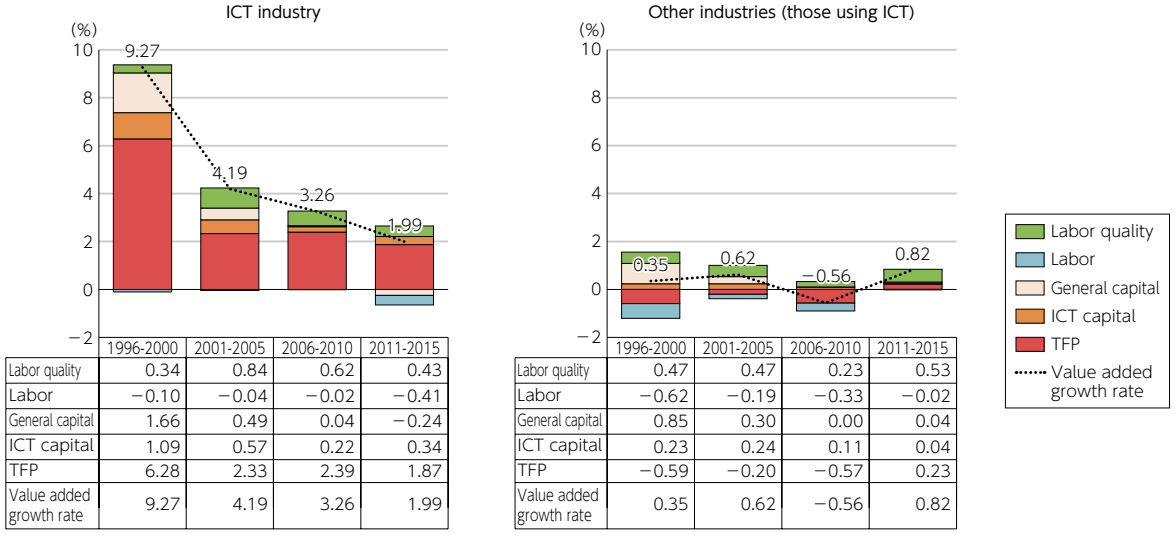


Japan	'96-'00	'01-'05	'06-'10	'11-'15
Labor quality	0.47	0.50	0.27	0.49
Labor	−0.65	−0.31	−0.30	−0.01
General capital	0.91	0.32	0.01	0.02
ICT capital	0.31	0.29	0.12	0.07
TFP	0.07	0.38	0.05	0.44
Value added growth rate	1.12	1.18	0.15	1.02

US	'99-'00	'01-'05	'06-'10	'11-'15
Labor quality	−0.03	0.23	0.23	0.15
Labor	0.65	−0.10	−0.46	0.67
General capital	1.00	0.89	0.34	0.45
ICT capital	0.74	0.29	0.22	0.14
TFP	1.38	0.87	0.21	0.14
Value added growth rate	3.75	2.18	0.55	1.55

(Source) Survey and research on the present state of ICT in Japan, 2018, MIC

Figure 1-3-2-3 Growth Accounting analysis of Japan (ICT industry and other industries using ICT)



ICT industry	1996-2000	2001-2005	2006-2010	2011-2015
Labor quality	0.34	0.84	0.62	0.43
Labor	−0.10	−0.04	−0.02	−0.41
General capital	1.66	0.49	0.04	−0.24
ICT capital	1.09	0.57	0.22	0.34
TFP	6.28	2.33	2.39	1.87
Value added growth rate	9.27	4.19	3.26	1.99

Other industries (those using ICT)	1996-2000	2001-2005	2006-2010	2011-2015
Labor quality	0.47	0.47	0.23	0.53
Labor	−0.62	−0.19	−0.33	−0.02
General capital	0.85	0.30	0.00	0.04
ICT capital	0.23	0.24	0.11	0.04
TFP	−0.59	−0.20	−0.57	0.23
Value added growth rate	0.35	0.62	−0.56	0.82

(Source) Survey and research on the present state of ICT in Japan, 2018, MIC

tively large, while the value of TFP of the latter is small or negative.

It is necessary to promote introduction and utilization of ICT in industries using ICT to bring about growth of their TFP, which will lead to economic growth (increase in added value) of the country.

Section 4 Current State of ICT and Innovation in Japan and the United States

1. Increase of added value through ICT

(1) Industry structural change and importance of innovation

From 1994 to 2015, GDP rose on a sustainable basis in the United States, while it remained flat or increased slightly in our county. It can be seen that there was a difference in the economic power to increase the added value of both countries. In this regard, in the 1990s, in the United States, ICT generated new goods with high growth in demand, while in Japan, ICT was primarily intended for investment not consumption. Although ICT was introduced on the supply side, it has been pointed out that review of various mechanisms such as review of operations / organization and re-training of human resources did not proceed.

It is said that the significance of innovation, especially new ties, is rising again in recent years as division of labor and collaboration progress.

(2) Comparison of degree of innovation realization between Japan and the United States

Based on the results of questionnaires to Japanese and US companies, when comparing the degree of realization of innovation in the past three years (including organizational innovation and process innovation more than three years ago) at large enterprises in Japan and the United States, you can see that there are more US companies in every innovation.