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Overseas Research Report

Support for research-and-development-type startups overseas

Center for Research and Development Strategy
Japan Science and Technology Agency

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Introduction

For the purpose of contributing to policy planning concerning scientific and technological innovation in Japan, we, at the Center for Research and Development Strategy (CRDS), Japan Science and Technology Agency (JST), have surveyed and analyzed trends in scientific and technological innovation of the world's major countries, and released the results. As part of our effort to serve this purpose, we conducted surveys on the state of support for research-and-development-type startups (hereinafter referred to as "R&D startups") in major countries, and this report summarizes their results.

Against the backdrop of recent radical advances in ICT technology, people, goods, money, and information connect spontaneously with each other and produce new added value while people's interest is shifting from "tangible goods" to "intangible goods" and values are increasingly diversified. R&D startups play an important role in driving innovation by advancing research and development activities which entail development risk and creating business models out of their outputs. In Japan, hopes are high that startups will be a pillar of scientific and technological innovation, a key to the country's growth strategy, and continuous development of appropriate environments and foundation for startups is called for.

Two years ago, we looked at representative examples of knowledge transfer systems in Germany, the US, the UK, and France as part of the survey of innovation through knowledge transfer in major countries. This time, we broadened our perspective to learn about situations facing startups of various countries, and put our focus on related basic policies and support programs. We also selected a number of startups and visited their countries to see how they used national support programs. For this purpose, we newly added Israel to a group of our target countries, as it aims to grow its economy with startups at the core so keenly that it is called the "Startup Nation." While China cannot be ignored for its recent fast-paced changes, this report only looks at the situation surrounding Tsinghua University and Shenzhen as case studies. In addition, before this overseas survey, we conducted literature searches and interviews with the parties concerned to learn about the situation in Japan and find what they viewed as problems.

The situation facing startups greatly varies depending on the economic and employment status of their country. The keys to successful startups, especially R&D startups, include availability of various sources of funds according to their development stage which can help continue R&D activities even with development risk, discerning experts who attract such funds, and abundant human resources and networks concerning startups, and each country is making its own effort accordingly. Local governments play significant roles as well. With culture and tradition of encouraging new ventures, some countries such as the US and Israel are one step ahead in developing ecosystems. However, while learning from mistakes and accumulating successful experiences, other countries are also expected to develop reliable ecosystems in which experts are developed and those who succeeded will provide support for future startups.

This survey was intended to provide an overview of situations facing R&D startups in the target countries. We, at CRDS, JST, appreciate your comments on this report as we will also continue to conduct other surveys based on various topics.

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1. General situation in Japan prior to the overseas survey

It has been strongly argued that Japan should make sustainable enhancement of economic competitiveness through creation of innovations so that the country can continue to prosper in the international society which is seeing the rise of emerging economies and increasing uncertainty. While Japan is still the world's third largest economy in terms of nominal GDP (2016), after undergoing a period of stagnation called the "lost two decades," it sharply dropped its position in terms of nominal GDP per capita to 22nd (2016)[1] from 20 years ago when Japan was one of the top five countries. In addition, due to the fast advances in new technologies including AI and IoT, we are entering the era in which conventional models for promotion of scientific and technological innovation alone do not work. As the number of papers, which is a performance indicator of scientific research activities, dropped on and off, Japan's standing fell from second place in the world in the years between 2003 and 2005 to fifth place from 2013 to 2015 according to the benchmark of the National Institute of Science and Technology Policy. Japan also fell from fifth to 10th place in terms of the number of influential theses, i.e., theses which are included in the top 10% in terms of the number of citations.[2] In addition, Japan is a resource-poor country with the issue of self-sufficiency of food and energy, and at the same time it is the fastest aging society in the world. Therefore, Japan should be the first country which seeks innovations for economic development.

However, researchers in universities and research institutions are not highly motivated to start businesses even though they are the major high-tech innovators who are supposed to create business-applicable research seeds which can be likened to "gems." As will be discussed later, the number of startups has sharply dropped from the peak in 2005. From the preliminary survey of the situation in Japan, we found that starting a business either individually or under university management is not yet widely established as a career option for researchers. In addition, Japan is clearly lagging behind in the total investment by venture capital (VC) firms which are supposed to support startups financially as it is around 140 billion yen (2015)[3], only 1/30 of that of the US.

In this survey report, we will first look at the situation in Japan in order to obtain a viewpoint for the overseas survey while defining "R&D startups" as new companies aiming for rapid growth which were established to commercialize highly innovative technology, intellectual property, or a completely new business model created from outputs of research accomplished by universities, research institutions, etc.

1.1. Need for startups

"The 5th Science and Technology Basic Plan[4]" states, "It is hoped that academic startups (originating in universities) can contribute greatly to innovation by generating new businesses and by turning university research findings into novel products or services." Meanwhile, according to "Japan Revitalization Strategy Revised in 2014[5]", "Urging existing companies to reform

[1] Data of countries and regions obtained from the website of Japan External Trade Organization https://www.jetro.go.jp/
[2] Scientific research benchmarking 2017, National Institute of Science and Technology Policy – Change in the world's research activities and Japan's situation found from analyses of papers http://data.nistep.go.jp/dspace/bitstream/11035/3177/15/NISTEP-RM262-FullJ.pdf
[3] "VEC YEARBOOK 2016 / Annual Report on Japanese Startup Businesses", Venture Enterprise Center (2017)
[4] http://www8.cao.go.jp/cstp/kihonkeikaku/5honbun.pdf
[5] http://www.kantei.go.jp/jp/singi/keizaisaisei/pdf/honbun2JP.pdf

themselves alone would be insufficient for promoting business restructuring to shift investment and employment to more profitable and productive areas. It is very important to develop an environment where venture businesses are launched one after another to drive growth areas." The Strategy also calls for establishment of "a Venture Business Creation Council[6] (tentative name), consisting of large companies willing to cooperate in supporting venture businesses" "… in order to promote not only conventional measures, such as those focusing on venture businesses themselves and support for university-launched ventures, but also measures to encourage the Japanese economy as a whole, including existing businesses, to take on bold challenges."

As well, with regard to the enhancement of innovative functions of universities, the Strategy states, "The enactment of the Industry Competitiveness Enhancement Act in December 2013 has made it possible for national university corporations to invest in university venture support funds and the like, and has established systems for strengthening the innovation functions of national universities." As seen in these examples, the importance of support for startups including university startups is recognized and university startups certainly "play important roles in creating new industries, changing industrial structure, and returning outputs of academic research to the society as a driving force of innovation.[7]"

"Comprehensive Strategy on Science, Technology and Innovation 2017[8]," which was adopted at a Cabinet meeting on June 2, 2017, stresses "Training Personnel with an Entrepreneurial Mindset" and "Promoting the Creation of Startups at Universities and National Research Institutes," a clear indication that there are high hopes for startups and new ventures in Japan's science and technology policy.

1.2. The current state of startups

While recognizing the importance of startups as explained above, "The 5th Science and Technology Basic Plan" also points out some issues in Japan's current state by stating the following: "the number of new ventures started by universities has slumped in recent years. Some of the likely reasons behind this are the difficulties involved in procuring funding, in searching for compatible technologies, and in cultivating sales channels both within and outside of Japan, as well as a lack of personnel capable of supporting the business and operational aspects of such ventures. In some cases, even if they get off the ground, some ventures stall for operational reasons" and "… industry–academia collaboration has yet to reach full maturity. Indeed, much of the current industry–academia collaboration is on a small scale, and there is still little mobility for researchers across organizations and sectors. Startup companies and the like have yet to reach the point of structurally transforming Japanese industry. Therefore, we need to clearly recognize that the mechanism for filling the gap between company needs and the knowledge and technology generated by universities has not fully performed its function to date. This is leading to deficiencies in Japan's ability to innovate through science and technology."

As seen in the "Survey of the state of implementation of industry-academia collaboration at universities, etc." (Figure 1) conducted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the number of startups remains stagnant after peaking in 2005.

6 The current Japan Open Innovation Council (JOIC) https://www.joic.jp/index.htm
7 "Japan Way", JST commemorative publication to mark the 20th anniversary
8 http://www8.cao.go.jp/cstp/sogosenryaku/2017/honbun2017.pdf

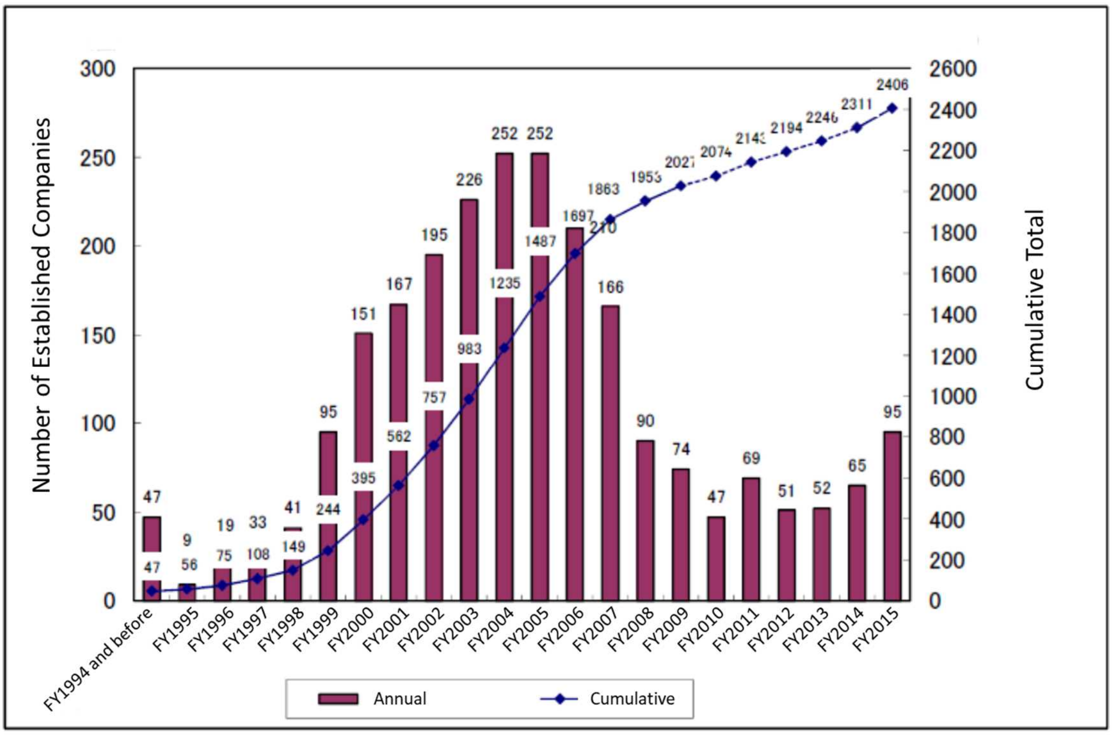

Fig. 1: Number of Established University-launched Startups

Source: Excerpted from "Annual Report on Industry-Academia Collaboration in Japanese Universities FY2015", Office of University Technology Transfer, University-Industry Collaboration and Regional R&D Division, Science and Technology Policy Bureau, MEXT[9]

1.3. History of startup support programs and major laws and policies[10]

The first startup support in Japan was triggered by the establishment of Venture Business Laboratories (VBL) in national universities starting from 1995. VBL aimed to promote R&D programs, develop creative talent, and improve research and education facilities.[11] In 1998, the "Act to Facilitate Technology Transfer from Universities to the Private Sector," so-called the "TLO (Technology Licensing Organization) Act," was enacted. Stating, "The purpose of this Act is to contribute to facilitation of the transformation of our national government's industrial structure, to the sound development of the national economy and to advancement of learning, as a result of efforts to develop new fields of business, improve industrial technologies and revitalize research activities at universities, national colleges of technology, inter-university research institutes and national research and development institutes, etc. through measures to promote the transfer of research results related to technology to the private sector,[12]" this law promoted establishment of TLOs, technology transfer institutions which facilitate patenting and transferring research outputs of researchers at universities to the private sector. It was the "Act on Special Measures concerning Industrial Revitalization" that was enacted in 1999 around the same time as the TLO Act. Based on the Bayh-Dole Act of the US which was established in 1980, this law is the so-called Japanese Bayh-Dole Act. The US Bayh-Dole Act instituted a system which grants

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[9] http://www.mext.go.jp/component/a_menu/science/detail/__icsFiles/afieldfile/2017/03/29/1380185_001.pdf

[10] "A Panoramic View of Science, Technology, and Innovation Policy" CRDS, JST was used as reference. https://www.jst.go.jp/crds/pdf/2014/RR/CRDS-FY2014-RR-05.pdf

[11] Study on measures for promoting the establishment University Spin-Off Companies: Focusing on the survey of the state and issues of Venture Business Laboratories (VBL) of National Universities http://coi-sec.tsukuba.ac.jp/wp-content/uploads/pdf/survey/h13/h13report1.pdf

[12] Act to Facilitate Technology Transfer from Universities to the Private Sector (Act No. 52 of May 6, 1998)

ownership of patents and other rights obtained from R&D activities funded by the government to inventors of the private sector or universities instead of the government, and the Japanese Bayh-Dole Act also includes similar provisions.[13]

In 2000, the Industrial Technology Enhancement Act was enacted, which provides for patent fee reduction or exemption for researchers at universities, etc. by stating in the section of "Special Provisions of Patent Fees, etc." that when a person who should pay patent fees is a researcher at a university, etc. or a person that establishes the university or college of technology or inter-university research institutes and meets certain conditions, the Commissioner of the Japan Patent Office may grant the person a reduction of, exemption from or deferment of the payment of the patent fees. The same year, faculty members of national universities, etc. were allowed to become board members of corporations with or without remuneration, which opened the way for faculty members to concurrently serve as board members, etc. of TLOs based on the TLO Act.[14]

In Japan, support for startups is provided by various ministries and agencies including MEXT, the Ministry of Economy, Trade and Industry (METI), and the Ministry of Internal Affairs and Communications (MIC). In 2016, the Headquarters for Japan's Economic Revitalization established in the Official Residence of the Prime Minister adopted "Venture Challenge 2020[15]," aiming to coordinate policies of individual ministries under the Prime Minister's leadership. The Headquarters has set a target of doubling the ratio of VC investments in venture companies against GDP by 2022.

1.4. Towards the overseas survey

As so far discussed in this chapter, the government has taken various measures to support startups including those launched by universities. However, entrepreneurial activities are slow. From November 2016, prior to the overseas survey, the Overseas Research Unit of CRDS, JST conducted interviews with universities, research institutions, relevant ministries and agencies, and multiple startups in parallel with literature searches. Based on the result, we extracted important points for the overseas survey as follows:

First, we looked at incentives which would entice students and researchers to starting new companies. When we talked with people at universities in Japan, quite a few people were conscious of the social implementation of their research results but did not know how to go about that, and that it might take some time before starting a new company becomes widely accepted as a career option for researchers. This is probably because many universities are not ready to support research which aims for practical application and do not consider poor entrepreneurship as their own problem in the first place. While there are a few cases of active entrepreneurship education as in the "Entrepreneurship Dojo" of the University of Tokyo, "Kigyo-bu" officially recognized by Kyushu University, etc., there are few success stories which feel familiar to researchers and on the whole, Japan is low in the TEA (Total Early-Stage Entrepreneurial Activity) index.[16] Researchers who have abundant competitive funds available tend to consider that the most valuable researchers are those who have written highly-rated research papers and have given many conference presentations, and they are less motivated for industry-academia

13 "Changes in the Japanese Bayh-Dole Act" Hiroyuki Hanawa, Journal of industry-academia-government collaboration https://sangakukan.jp/journal/journal_contents/2007/12/articles/0712-07/0712-07_article.html
14 http://www8.cao.go.jp/kisei/siryo/sassi/13.pdf
15 http://www.kantei.go.jp/jp/topics/2016/seicho_senryaku/venture_challenge2020.pdf
16 "Survey concerning support for startups and venture firms/Global Entrepreneurship Monitor" (Nomura Research Institute, 2016) states that entrepreneurial activities are a process of recognizing a promising business opportunity, putting together management resources including people and funds to take advantage of the opportunity and establishing a new business as a result."

collaborative R&D activities in Japan's current situation. According to the interview with universities conducted by METI, only 13-30% of faculty members take part in industry-academia collaborative activities, an indication that "industry-academia cooperation" is not yet a mission of universities on par with "education" and "research."[17] We, at CRDS, also did a separate interview and found that, at one university, only around 20% of the faculty was interested in startups or industry-academia collaboration. To resolve this situation, concrete measures are planned to be taken in Japan, aiming to design and enhance incentives for universities to strengthen cooperation with businesses. One example is the "Open Innovation Platform" which is set to be established in universities starting from FY2018 as part of efforts to promote management reform of industry-academia collaboration at universities. Aiming to attract greater investment from the private sector, it is expected to work as a focused management system for large-scale joint research which is deeply involved in corporate business strategies.[18]

When we conducted interviews for the preliminary survey, some said that one of the problems was that engineering students were not educated on "creating value" and others argued that entrepreneurship should be taught much earlier than in graduate school. One entrepreneur also said that interdisciplinary classes which were not directly related to his major as well as opportunities where he learned knowhow for starting a business provided him with greater knowledge, which as a result, help him share that knowledge. While we had such an interview with dozens of relevant institutions and parties, a couple of questions occurred to us: How do they train and develop human resources that have an interest in startups in other countries? How are they connecting research seeds to new ventures?

From the perspective of securing human resources necessary for startups, it is also important to learn how they find managerial talent that jointly runs business with researchers in other countries and how they develop such talent if unavailable. An excellent researcher is not necessarily a great business manager, and he/she often lacks experience in managing companies. The most popular opinion we received in the prior domestic survey is that it is difficult to secure excellent managers because conflicts of interest have to be taken care of when research seeds are commercialized. Managing startups requires skills different from those which can be acquired from working for companies. Therefore, we are seeing a demand for people with managerial talent who can take risk in the early stage of a startup as a founder while still understanding technology.

Second, we looked at the influence of VC funds which play a central role in raising funds for startups. In our interviews during the preliminary survey, many pointed out problems of conventional VC firms in Japan were, by then, often affiliated with financial institutions, unwilling to invest in seeds owned by universities. Instead, VC firms often funded businesses right before they went public and recovered funds after their listing or tended to concentrate investments on successful startups. One possible reason is that VC funds do not make aggressive investments in startups at their pre-seed or early stage because of a lack of experts at VC funds or a lack of development of such talent that can understand technology prior to its practical application. For sustainable development of startup environments in Japan, the number of experts as well as entrepreneurs needs to increase. One of the characteristics of Japan's situation is that investment recovery relies heavily on initial public offering and acquisition rarely happens before flotation. Except for special cases, the Japanese market is said to require 10 to 15 years before listing, so it makes sense that VC funds with an ordinary fund duration of 8 to 10 years avoid

[17] "Remaining issues concerning industry-academia cooperation" Industrial Science and Technology Policy and Environment Bureau, METI (January 2012)
[18] "Design and enhancement of incentives for universities to strengthen cooperation with businesses" MEXT, METI (April 2017)/ "State of efforts at MEXT towards increased cooperation between businesses and universities" MEXT (November 2017)

investing in startups at their early stage. In the US, there are specialized VC funds for each phase of startups, from the pre-seed stage to the early stage to the expansion stage, and these VC funds have experts who specialize in particular fields. This makes it possible to support a large number of startups in the US. In addition, American VC firms continuously monitor performance of startups and are also involved in their management.

In general, VC firms in the US are said to provide hands-on support to make sure their investments in early-stage startups succeed so much so that if the performance of a startup falls, they may propose and/or execute manager replacement or sale of the business. In Japan, on the other hand, VC firms were not allowed to have a seat on the board of a startup they funded until 1994 when the guidelines for the Antimonopoly Act were relaxed. Today, more VC funds are actively involved in management of startups they invest in but they are not as many as we want to see. We decided to investigate what kind of investments VC funds were making and what roles they were playing not only in the US but in other countries.

Third, we looked at efforts of organizational support by universities and research institutions for the success of startups. During the interviews as part of the preliminary survey, we recognized that it is indispensable to provide comprehensive, organizational support based on industry-academia cooperation and intellectual property utilization, not just support aimed at merely helping to start new businesses in order to realize effective transfer of knowledge and technology. It is no exaggeration to say that what makes or breaks technology transfer is the performance of intermediary organizations in facilitating application of research outputs in accordance with the demand of the society and the industry.

In fact, it is physically challenging for individual researchers to apply for startup grants after comparing various programs or to find managerial candidates. When doing various activities related to intellectual property at universities, researchers also need support from “professional groups” specializing in IP management. While some universities in Japan are seeing positive results in startup support, most notably, the University of Tokyo which supports establishment of new ventures through three-way cooperation among the Division of University Corporate Relations, approved TLO, and Edge Capital, this movement has not spread across the country. Managing this sort of organization requires funds. Based on the National University Corporation Act, universities in Japan are also allowed to acquire stocks of startups they helped to launch in return for their support. In actuality, however, a notice issued by MEXT[19] requires universities to sell stocks of such startups immediately after they go public even if the stock price is expected to rise soon. Such institutional restrictions may act as a hindrance to universities’ initiative to generate funds by themselves more effectively, and are considered hard to overcome through the effort of individual universities. Coupled with this, there is another issue in that knowhow cannot be accumulated effectively because the staff of industry-university cooperation headquarters or intellectual property centers of many universities are still fixed-term employees, subject to unstable employment, and resign in just over five years.

Based on the understanding of the situation in Japan gained from the preliminary domestic survey, we decided to investigate how support organizations and networks are operated and who plays a central role in other countries.

The mechanism and management of startup creation is heavily influenced by the social, cultural background of a country. We do not give detailed analysis on such social or cultural aspects of target countries in the following chapters which discuss the overseas survey, but present cases of support programs for startups and technology transfer which may provide useful information for Japan or suggestions as to how we should change Japan’s current situation while taking note of environments surrounding startups in the target countries

[19] “Towards full-scale operation of Open Innovation”, MEXT, July 2017

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■ "A Panoramic View of Science, Technology, and Innovation Policy", CRDS, JST
■ "Study on measures for promoting the establishment University Spin-Off Companies: Focusing on the survey of the state and issues of Venture Business Laboratories (VBL) of National Universities"
■ "Legal Reform of Japanese Bayh-Dole Act", Journal of Industry-Academia-Government Collaboration, Hiroyuki Hanawa
■ Council of Industry-Academia-Government Dialogues for the Promotion of Innovation
■ "Stanford University: Leading the 21st Century", Yoko H. Kawashima (2012)

Institutions and companies for the preliminary survey

■ Institute for the Promotion of Business-Regional Collaboration, Hokkaido University
■ Material Solutions Center, Tohoku University
■ Division of University Corporate Relations, The University of Tokyo
■ Engineering Sciences and Design Graduate Major, Department of Transdisciplinary Science and Engineering, School of Environment and Society, Tokyo Institute of Technology
■ Office for University-Industry Collaboration, Osaka University
■ Graduate School of Engineering, Osaka University
■ Venture Incubation Division, Office of Society-Academia Collaboration for Innovation, Kyoto University
■ Global Technology Entrepreneurship Program, Kyoto University
■ Graduate School of Advanced Integrated Studies in Human Survivability, Kyoto University
■ Department of Opto-Mechatronics, Faculty of Systems Engineering, Wakayama University
■ Center for Joint Research and Development, Wakayama University
■ Center for Research Administration & Collaboration, Tokushima University
■ Academic Research and Industrial Collaboration Management Office, Kyushu University
■ Robert T. Huang Entrepreneurship Center, Kyushu University
■ University-Industry Collaboration and Regional R&D Division, Science and Technology Policy Bureau, MEXT
■ National Institute of Science and Technology Policy (NISTEP)
■ Startup and New Business Promotion Office, Economic and Industrial Policy Bureau, METI
■ The Japan Academic Society for Ventures and Entrepreneurs
■ Innovation Center for Technology Transfer and Startups, AIST

- Support for Entrepreneurship Office, JST
- Department for Science and Technology Program Promotion, JST
- Representative Office in Europe, NEDO
- Startup Group, Innovation Promotion Department, NEDO
- Kansai Technology Licensing Organization Co., Ltd.
- TODAI TLO, Ltd.
- Crypton Future Media, Inc.
- Medical Image Lab.
- euglena Co., Ltd.
- Remohab Inc.
- TOKIWA-Bio Inc.
- Photosynth Inc.
- Kyulux, Inc.
- Skydisc, Inc.

2. The United States

Startups are divided into "service-type startups" which provide services and applications based on existing information technology and "R&D startups" which conduct business based on revolutionary technologies developed at universities, research institutions, etc. Exemplified by Airbnb which offers private lodging service and Uber Technologies which provides taxi-hailing service, the former type of startup enables development of products and expansion of business with relatively smaller funds in a short period of time. The latter type of startup, on the other hand, requires significant funds and a longer period of time in technology development, so generous support is necessary.

This chapter first looks at startups in the US and the environments surrounding them, and then provides focused discussion on policies and systems related to R&D startups among all policies concerning US startups. We then explain ecosystems in Boston which has long attracted many university startups and in Austin which is growing fast thanks to the many high-tech startups generated there, and go on to summarize characteristics of US startup environments and support programs.

2.1. The current state of the US and situations surrounding startups

2.1.1. The most entrepreneurial country

As the global leader in entrepreneurship, the US has produced many startups which have grown to be global corporations including Apple, Google, and Amazon. More recently, the country has seen the rise of service-type unicorns (promising startups which are valued at more than one billion dollars even before going public) including Airbnb and Uber Technologies. According to the unicorn world rankings by Fortune,[20] Uber was in first place, valued at 62 billion dollars, and Airbnb third valued at 25.5 billion dollars. Apart from them, Palantir (data analysis software), Snapchat (social media), SpaceX (aerospace), and Pinterest (social media) (total 6 US companies) joined the top 10 of the world's largest unicorns.

These startups rely on abundant VC for their growth. The total VC investment in the US amounted to 5.9 billion US dollars[21] (hereinafter "dollars") in 2015, 30 times as large as that in Japan and at the largest level after 2002. The total VC investment can be divided in different stages (Figure 1): 1 billion dollars for the seed stage (186 cases), 20 billion dollars for the early stage (2,219 cases), 22.2 billion dollars for the expansion stage (1,146 cases), and 15.9 billion dollars for the later stage (829 cases). Investments for the seed stage account for around 2% of the total while those for the early, expansion, and later stages make up around 30% of the total respectively.

[20] Fortune Unicorn list, http://fortune.com/unicorns/
[21] According to the foreign exchange rate of Bank of Japan as of February 20, 2018, 1 US dollar is equivalent to 111 yen.

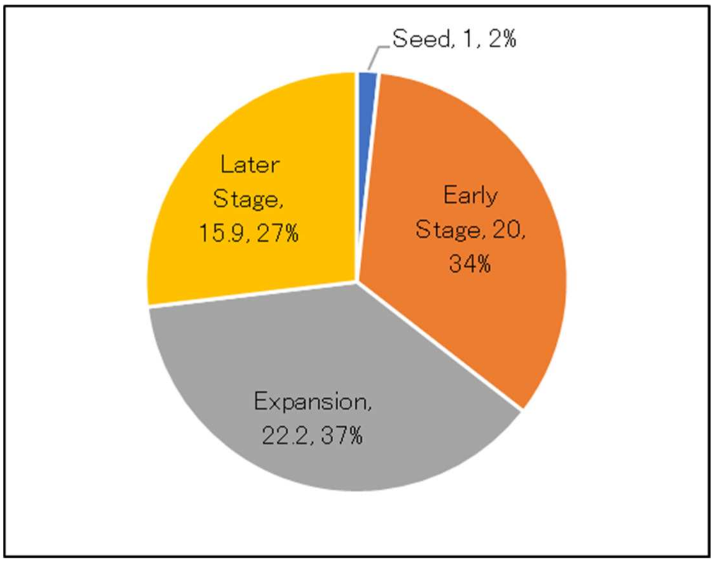

Fig. 1: Venture Capital Investments in 2015 by Stage ($ Billion)
Source: Created by CRDS based on data from National Venture Capital Association Year Book 2016[22]

When looking at the total VC investment by industry sector (Figure 2), software accounted for 40% of the total with 23.5 billion dollars, followed by biotechnology with 7.6 billion dollars, and consumer products and services with 4.8 billion dollars. Industries attracting many startups which are based on academic research or create new systems by combining complicated technologies, namely, biotechnology, industrial/energy, and medical devices and equipment account for 13%, 5%, and 5%, a relatively small percentage respectively.

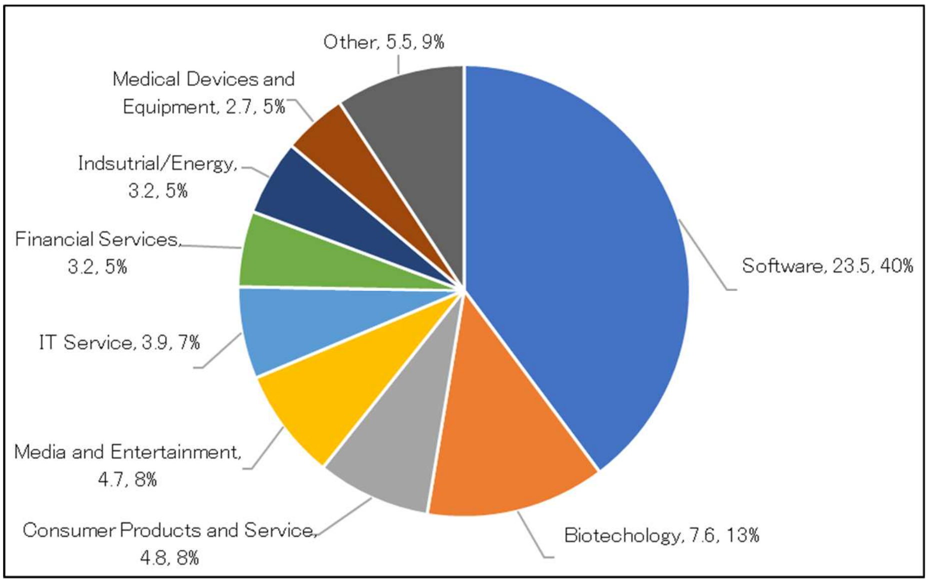

Fig. 2: Venture Capital Investments in 2015 by Industry Sector ($ Billion)
Source: Created by CRDS based on data from National Venture Capital Association Year Book 2016

[22] National Venture Capital Association Year Book 2016 https://nvca.org/wp-content/uploads/delightful-downloads/2016/11/NVCA-2016_Final.pdf

By state (Figure 3), California accounted for 57% of the total with 33.9 billion dollars, 46% of which was invested in Silicon Valley. New York came second (11%, 6.3 billion dollars), followed by Massachusetts (10%, 5.7 billion dollars), Washington (2%, 1.2 billion dollars), and Texas (2%, 1.2 billion dollars). Hence, the top three states of California, New York, and Massachusetts received around 80% of the total US investment.

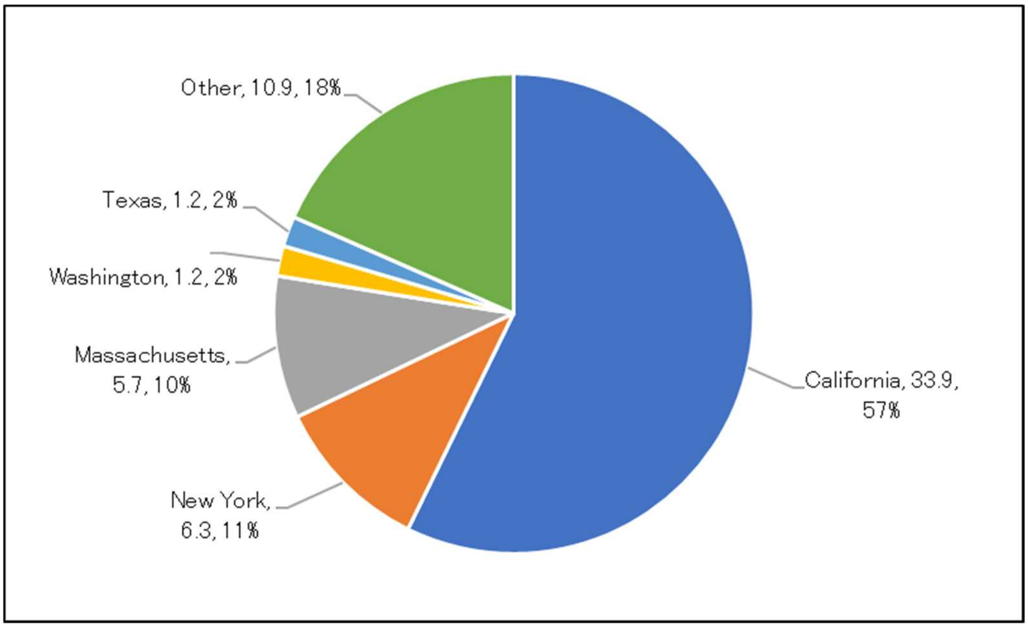

Fig. 3: Venture Capital Investments in 2015 by State ($ Billion)
Source: Created by CRDS based on data from National Venture Capital Association Year Book 2016

2.1.2. Startup clusters and their characteristics

Major US startup clusters are found in Silicon Valley, New York, Boston, Los Angeles, Seattle, and Austin (Figure 4), and startup industry sectors and surrounding environments greatly vary depending on the city.

Fig. 4: Startup Clusters
Source: Created by CRDS based on various materials

The largest venture cluster in the US is Silicon Valley, which has produced many IT-related corporations which have grown to be global corporations. Representative companies include Facebook, Google, and Uber. Around 40% of the total VC investment in the US is targeted at Silicon Valley, 70% of which is invested in businesses related to the internet or mobile/telecommunications.[23] Offering the world's most developed environment for startups, Silicon Valley claimed the top spot in the overall global rankings of the Global Startup Ecosystem Report 2017.[24] It was ranked first in the world in four indices of performance, funds, market access, and startup experience and second in human resources following Singapore.

New York is America's largest commercial city, and has industry clusters of fashion, media, finance, and real estate. Combining these existing industries and information technology, many new businesses are being established in New York which are called "hyphen tech." Especially, fin-tech corporations which combine finance and IT are surging in number, and many startups providing remittance/settlement services, investment/fund management services, and financial advice services are gaining momentum. Around 70% of investments in New York are targeted at internet-related businesses. New York is ranked second in the world in the Ecosystem Report. By index, New York ranks third in performance, second in funds, third in market access, seventh in human resources, and fourth in startup experience. It is relatively weak in the human resources index.

The Greater Boston area has clusters of universities which are home to the world's top level research, hospitals, and major pharmaceutical companies. For a long time, the area has been well known for startup clusters, and is home to many life-science-related startups spun out of universities including the Massachusetts Institute of Technology and Harvard University. Representative examples include Moderna Therapeutics and Editas Medicine, which develop cutting-edge gene therapies. Around 50% of investments targeted at New England, mainly Boston and Cambridge, is made for healthcare-related businesses. Boston ranks fifth in the world in the Ecosystem Report, sixth in performance, sixth in funds, 12th in market access, fourth in human resources, and third in startup experience. Having the largest number of biotechnology researchers in the country helped the city rank fourth in human resources.

Hollywood, close to downtown Los Angeles, is the home of world-famous film studios and has an industrial cluster related to entertainment. Representative startups based here include Snapchat, which developed photo sharing apps, and Hulu, which provides an online video distribution service. The city of Irvine, located around 80km south of Hollywood, also hosts many corporations related to telecommunications, IT equipment, and semiconductors. Los Angeles is also home to the California Institute of Technology and University of California, Los Angeles, which produce excellent engineering talent. Around 60% of investments targeted at the greater Los Angeles area are for businesses related to the internet or mobile/telecommunications. Los Angeles ranks ninth in the world in the Ecosystem Report, rated fifth in performance, seventh in funds, 15th in market access, 14th in human resources, and 11th in startup experience.

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23 Money Tree Report

24 Global Startup Ecosystem Report 2017 -Startup Genome
https://startupgenome.com/thank-you-enjoy-reading/

Seattle is the home of multinational corporations including Microsoft and Amazon and many people start businesses there after gaining experience at these companies. In addition to that, the University of Washington boasts one of the best computer engineering departments and life science departments in the country, producing excellent human resources related to IT and biotechnology. Many startups are established in the fields of cloud computing, games, virtual reality (VR), life science, etc. Around 50% of investments targeted at Seattle are for businesses related to the internet or mobile/telecommunications, 25% for healthcare-related businesses. Seattle ranks 10th in the world in the Ecosystem Report, 12th in performance, 13th in funds, 14th in market access, third in human resources, and sixth in startup experience. Ranked third, Seattle is rated exceptionally high in human resources.

As is evident from the fact that corporations such as IBM, Toshiba, Apple, and Google have their bases in Austin, the city holds a cluster of high-tech industry related to semiconductors and computers. Samsung's largest factory outside of South Korea is also located in the city. The University of Texas at Austin has 50,000 students, producing many excellent engineers. Representative startups include Dell, now a world-leading IT company. Austin is ranked 13th in the world in the Ecosystem Report, 15th in performance, 11th in funds, 18th in market access, sixth in human resources, and ninth in startup experience. Austin's ecosystem is attracting attention as the fastest growing ecosystem in the US.

2.2. Improvement of startup environments

2.2.1. History of policies

The second oil crisis hit the US in the late 1970s, and the country lost competitiveness in auto and electric industries which had driven the US economy since the World War II, resulting in low productivity and a high unemployment rate. In the meantime, Japan saw steady economic growth thanks partly to the export of cars and electric devices to the US, only adding to the US deficit. Under such circumstances, the US government came up with various policies to regain the country's international competitiveness, one of which was the "Cloning Silicon Valley" policy.[25] It was an attempt to roll out development similar to what Silicon Valley had undergone even during stagflation of the 1970's nationwide, and this led to the enactment of the Bayh-Dole Act and the Stevenson-Wydler Technology Innovation Act which promote technology transfer from universities and national research institutions, and to the introduction of the SBIR program which financially supports corporations which make joint R&D activities with universities in a bid to commercialize research outputs. These measures paid off and the number of university startups steadily increased from 275 in 1997 to 374 in 2003 and 596 in 2009. In 2011, then-President Obama argued that entrepreneurs would play a key role in economic growth and employment creation and began the Startup America initiative under the national innovation strategy, thereby promoting improved access to funds, development of entrepreneurs, deregulation, and acceleration of technology transfer. The following presents major policies and programs contributing to improvement of environments related to R&D startups in chronological order.

[25] For more details, see "Daigakuhatsu Baiobencha seiko no Joken (Essentials for success of university bio-ventures)" (Yoshihiro Otaki, Akio Nishizawa, published by Soseisha).

2.2.2. Major policies

2.2.2.1 Bayh-Dole Act

Enacted in 1980, the Bayh-Dole Act promotes transfer of technologies of universities. This law has enabled nonprofit organizations including universities and small and medium-sized enterprises to obtain patents based on results of research funded by the federal government and to provide licenses to third parties (licensing). While part of the income generated from licensing (royalty income) goes to the inventor, the rest can be used by universities at their discretion. This helped increase incentives for universities to transfer out their technologies. As a result, creation of innovations was added as one of the missions of universities, following education and research, and efforts for industry-academia cooperation, technology transfer, and startup creation were accelerated.

2.2.2.2 Stevenson-Wydler Technology Innovation Act

This law was enacted in 1980, the same year as the Bayh-Dole Act. While the Bayh-Dole Act is about how to treat outputs of research funded by the federal government, the Stevenson-Wydler Technology Innovation Act has set rules regarding outputs of research by research institutions affiliated with the federal government. More specifically, the law calls for the maximum utilization of outputs of research funded by the government by actively transferring them to the private sector. To this end, the law requires the following: 1) ministries and agencies which have laboratories allocate 0.5% or more of their R&D budgets to technology transfer, 2) such ministries and agencies establish departments responsible for technology transfer, and 3) laboratories with an annual budget exceeding 20 million dollars hire full-time specialists in charge of technology transfer. Thanks to the enactment of this law, technology transfer at research institutions affiliated with the federal government has accelerated since 1980.

2.2.2.3 Cooperative Research and Development Agreement (CRADA)

Due to the enactment of the Federal Technology Transfer Act in 1986, the Stevenson-Wydler Technology Innovation Act was partially revised to incorporate CRADA provisions.[26] This set the rules regarding joint research between research institutions affiliated with the federal government and partners (corporations, universities, state governments, etc.). The Academic Research & Industry-Academia-Government Collaboration, Nagoya University carried out detailed research on characteristics of CRADA.[27] As partners have an option to choose between exclusive and non-exclusive licenses for intellectual property resulted from joint research based on CRADA, they can have licenses for existing research outputs. Thanks to this, technology transfer based on research outputs by research institutions affiliated with the federal government has become more beneficial to corporations while these research institutions are more likely to gain royalty income efficiently under the R&D management by corporations. As well, it was decided that small and medium-sized enterprises would be treated favorably when signing such joint contracts.

[26] https://www.congress.gov/bill/99th-congress/house-bill/3773
[27] "Risk management in joint research with foreign corporations" 2012 http://www.aip.nagoya-u.ac.jp/industry/consult/docs/1.pdf

2.2.2.4 The Startup America initiative

In 2011, then-President Obama began the Startup America initiative under the national innovation strategy.[28] This initiative aimed to promote new startups for economic growth and employment creation, consisting of five areas: 1) unlocking access to capital, 2) connecting mentors to entrepreneurs, 3) reducing barriers, 4) accelerating innovation from "Lab to Market", and 5) unleashing market opportunities. Figure 5 shows the major programs jointly conducted by the private and public sectors in each area.

5 Areas	Program	Overview
Unlocking access to capital	**Impact Investment Initiative**	Invest up to $1 billion in underserved communities and emerging sectors over the next 5 years
	Early-Stage Innovation Initiative	Invest up to $1 billion in early-stage small businesses over the next 5 years
	Jumpstart Our Business Startups (JOBS) Act	Enable Americans to go online and invest in small businesses and entrepreneurs
Connecting mentors	Green energy accelerator funding	Match green energy startups with experienced mentors, Create mentoring initiatives to many industry sectors and build nation wide network of mentors, accelerators and successful startups.
	Clean Energy Business Competitions	Fund 2 million for national university clean energy business challenges to support student- oriented business creation
	Advancing Youth Entrepreneurship Education	National Education Startup Challenges invites middle/high school students to develop an innovative solution to an education problem, Entrepreneurship education for middle/high school students
Reducing barriers	Faster Patent Applications	Accepts request for prioritized examination of patent applications through fast-track patent processing
Accelerating innovation from "lab to market" for breakthrough technologies	**Innovation Corps**	Prepare scientists and engineers at universities to launch startups, Build nation-wide innovation network
	i6 Challenges	Regional Innovation
	Jobs and Innovation Accelerator Challenge	Sixteen federal agencies support reginal innovation clusters
Unleashing market opportunities	Policy challenge	Calling on the broader public to share their ideas on how to accelerate innovation in healthcare, energy, and education

Fig. 5: Overview of the Startup America Initiative
Source: Major programs excerpted from the website of Startup America

The next section will provide the outline of three programs printed in blue in Figure 5: "Launch of the Impact Investment initiative" and "Launch of the Early-Stage Innovation initiative," which provide large financial assistance to startups, and "I-Corps program," which develops people who are willing to launch R&D startups.

2.2.3. Major programs

Major support programs for R&D startups include SBIR/STTR programs launched as part of the Cloning Silicon Valley policy and I-Corps, an entrepreneurial talent development program introduced under the Startup America initiative.

[28] Startup America Administration Commitments https://obamawhitehouse.archives.gov/economy/business/startup-america/commitments#access-to-capital

2.2.3.1 Small Business Innovation Research (SBIR)/Small Business Technology Research (STTR)[29]

(1) Outline

The Small Business Innovation Research (SBIR) program was launched in response to the enactment of the Small Business Innovation Development Act of 1982. SBIR aimed to facilitate practical application and commercialization of outputs of preliminary research done by small companies, in other words, promising innovation ideas which entail high risk for investors, by providing government funds. Government agencies with a budget of over 100 million dollars for outsourcing research are required by the Small Business Innovation Development Act to allocate 2.5% or more of the budget for SBIR.

Ten years after the enactment of the Small Business Innovation Development Act, the Small Business Research and Development Enhancement Act was established in 1992, which launched the Small Business Technology Research (STTR) program. This program aims to promote cooperation and technology transfer between universities/research institutions affiliated with the government and small businesses, and government agencies with a budget of over one billion dollars for outsourcing research are required to allocate 0.3% or more of the budget for STTR by the Small Business Research and Development Enhancement Act.

(2) Budget

The total FY2015 budget for SBIR/STTR programs in the entire federal government was 2.5 billion dollars. This can be considered as the largest seed fund in the country. By ministry, the Department of Defense accounted for more than 40% of the budget, or 1.07 billion dollars, followed by the Department of Health and Human Service's 797 million dollars, and the Department of Energy's 206 million dollars. The SBIR/STTR programs provided grants to 5,059 cases in FY2015.

(3) Support

While the SBIR/STTR programs were implemented by individual ministries and agencies with some differences in support systems, the basic part is the same across all ministries and agencies. The programs provide support to small and medium-sized US companies with 500 or fewer employees in three stages. In the first stage, as much as 150,000 dollars are provided for a period of 6 to 12 months to help examine feasibility of ideas and formulate business plans. In the second stage, only small and medium-sized companies which did well in the first stage are eligible, receiving up to one million dollars for a period of 24 months for prototype development and other activities. In the third stage, while there is no financial support provided by the SBIR/STTR programs, companies may receive federal funds otherwise or the government may procure products or services from the companies. As support from the SBIR/STTR programs is provided as a grant or through a contract, recipients do not have to repay it.

(4) Results

Many companies have used the SBIR/STTR programs and achieved growth, including Qualcomm, Symantec, and iRobot. Qualcomm, established in 1985 as a company developing

[29] SBIR/STTR
https://www.sbir.gov/about/about-sbir#sbir-program

mobile communication technologies and semiconductors, has grown to be a leading company of next-generation mobile technology. Symantec is a software company established in 1982. It is well known for the development of Norton™, one of the most popular security software programs in the world. Established in 1990 by MIT researchers and others, iRobot develops military and domestic robots. In 2002, the company rose to fame overnight by launching Roomba, a series of robotic vacuum cleaners for household use.

2.2.3.2 Impact Investment Funds and Early Stage Innovation Funds

In the total financial support provided by the Startup America initiative, Impact Investment Funds and Early Stage Innovation Funds, both of which aim for "unlocking access to capital," account for the largest share with an investment target of one billion dollars for a period of five years respectively.[30] [31]

Both funds were managed by the Small Business Administration (SBA) and established as part of the existing Small Business Investment Company (SBIC) program. The SBIC program was established in the 1950s, the early days of VC funds, as a public-private matching fund for providing support to startups in the seed stage and to regions which had less venture capital available than other parts of the country.[32] Startups which received support from the SBIC program include Apple, FedEx, Cisco, etc.

Impact Investment Funds are a public-private matching fund investing in small companies in poor areas or in emerging fields including clean energy, providing a 2:1 match to private capital. SBA has set a target of investing an average of 200 million dollars annually in Impact Investment Funds for five years, providing each fund twice as much as private capital it raised, up to 150 million dollars.

Early Stage Innovation Funds are a public-private matching fund investing in small companies in the early stage where they face challenges in accessing capital. Innovation Funds contribute a 1:1 match to private capital. For Innovation Funds, SBA has set the same target of investing an average of 200 million dollars annually for five years, providing each fund as much as private capital it raised, up to 50 million dollars.

2.2.3.3 The I-Corps program

Failures of startups remained rife in the US as they were not able to overcome the "Valley of Death" between research and innovation even with grants provided through SBIR/STTR programs. That was when the National Science Foundation (NSF) began the I-Corps program which was designed to develop entrepreneurs by teaching methods for commercializing technologies. This program is implemented as a measure for "lab to market", the fourth area of the Startup America initiative.

[30] https://obamawhitehouse.archives.gov/startup-america-fact-sheet
[31] https://www.sba.gov/sites/default/files/articles/SBIC-Early-Stage-Initiative.pdf
[32] http://www.dbj.jp/reportshift/area/losangeles/pdf_all/058.pdf

Made of three layers of teams, nodes, and sites, the I-Corps program teaches university researchers how to turn ideas into reality and commercialize technologies, helping them prepare for starting companies. A team consists of three members: a university professor, a young researcher and a mentor, who aim to start up a new business. Providing a base for educating team members and researchers who are yet to be included in any team, a node is a consortium made up of multiple universities. A site refers to a university which supports the transfer of technology developed by university researchers and creation of innovations. The I-Corps program started from teams, and nodes and sites were established as the number of teams grew. A network of teams, sites, and nodes across the country has been developed, realizing a nationwide innovation ecosystem. The following outlines teams, nodes and sites.

(1) Teams

Teams are the basic units of the I-Corps program and are divided into two types: national teams directly selected by NSF and regional teams selected by nodes or sites at their discretion.

To become a national team, a group of three, a technical lead, an entrepreneurial lead and a mentor, need to apply to NSF. Usually, technical leads are university professors, and entrepreneurial leads are postdoctoral researchers or graduate students who work with the university professors while mentor positions are assumed by local residents that have experience in starting companies or working for companies. It is the entrepreneurial lead who plays the central role in team activities. If the team is approved by NSF, it is provided with 50,000 dollars and the right to participate in the Lean LaunchPad curriculum.

The curriculum offers a seven-week program in which participants learn how to quickly transfer knowledge and ideas generated at labs into products as well as a customer development process. For the first three days, they attend a workshop held at a node to be discussed later, and each team develops a business model. Then, teams go back to the universities they belong to, visit and talk with close to 100 customers (corporations and consumers) over six weeks, incorporate opinions they received into their business models, and develop prototype products. In the meantime, mentors utilize their network, introducing their teams to companies and customers who may develop an interest in the technology or products their teams are working on, and also provide advice accordingly. At the end of the seventh week, all national teams return to nodes and present their results in a two-day meeting. After participating in this curriculum, national teams will be ready to establish startups, make license contracts, and submit proposals to the SBIR/STTR programs.

Just as a national team is, a regional team is a three-member group of a technical lead, an entrepreneurial lead, and a mentor. However, regional teams are picked not directly by NSF but by nodes or sites based on their criteria, considered as “prospective national teams,” so to speak. Teams which were picked by nodes or sites participate in the simplified Lean LaunchPad curriculum which is shortened to 2 to 3 weeks, and learn how to commercialize research ideas and develop customers. Teams which achieved excellent results in this curriculum are able to apply for national teams.

(2) Nodes

Nodes work as bases for offering the Lean LaunchPad curriculum to NSF-selected national teams as well as regional teams they selected by themselves, developing and studying related curricula, and supporting creation of innovations at their local communities. There are nodes in eight locations in the US, each of which is a consortium made up of multiple universities. Nodes take various measures to facilitate commercialization of university research seeds while working with individual sites.

(3) Sites

A site is placed in a single university, providing innovation education and entrepreneurial education, and supporting efforts to create products from promising ideas generated in the university. There are 51 sites in the country. Each site accepts applications for regional teams, providing the selected ones places, funds, and curricula, thereby supporting commercialization of their ideas while training and guiding them to a level at which they can apply for national teams. In cooperation with nodes, sites promote innovative activities in their local communities and thereby contribute to creation of innovations at a national level.

(4) Results

The I-Corps program has so far designated 905 national teams, 361 of which have started businesses (as of February 2017). A survey revealed that teams which participated in the Lean LaunchPad curriculum, a feature of the I-Corps program, are twice as likely to receive startup support funds including those under the SBIR/STTR programs than teams which did not. Some companies started as an I-Corps team and then grew later, including Neon Labs (from Carnegie Mellon University), which utilizes brain science and creates video content that is attractive to web users, Graphene Frontiers (from University of Pennsylvania), which develops graphene sensors and electronic equipment, and Predictronics (from University of Cincinnati), which develops software predicting machinery failures.

2.3. Ecosystems of startup clusters

In this section, we touch on the ecosystem of Silicon Valley, the best known startup cluster, and go on to provide detailed explanation of the ecosystem of Boston where many university startups have long been established and that of Austin which has been growing quickly in recent years.

2.3.1. Silicon Valley

In this report, we do not cover Silicon Valley in detail as it has been the subject of many preceding surveys and academic studies. So, we only outline startup trends in this area as follows:

2.3.1.1 Silicon Valley's startup environment and its characteristics

Silicon Valley refers to an industrial cluster situated in the so-called Bay Area, the bayside area stretching from Santa Clara, Northern California, to San Francisco. It is the busiest startup area not only in the US but also in the entire world. According to the NVCA (National Venture Capital Association) 2017 Yearbook[33], while US venture capital assets under management in 2016 was around 333.5 billion dollars, by far the largest portion of which (181.4 billion dollars or 54%) was used by the State of California, which outdistanced the second place Massachusetts which used around 50.2 billion dollars. VC investments in California in 2016 amounted to around 38.1 billion dollars. As well, corporations established in California accounted for 66% of total venture capital raised in the US, and nine of top 10 US firms in terms of the size of VC fund are established in California.

Silicon Valley has been leading development of future-generation technology since the World War II, as demonstrated by military technology, semiconductors, personal computers, internet, and software, and established a culture of aggressive R&D activities and an ecosystem which has continuously supported such development. Looking at exit value in the US in 2016 by industry sector, 47% of the total or around 33 billion dollars were accounted for by software, and medical/biotechnology followed with around 7.8 billion dollars or 11% of the total. During the third quarter, 2017, investments in California were strong in the fields of AI, digital health, and auto tech.[34]

2.3.1.2 Major universities in California

Stanford University is in the center of the Bay Area while the University of California, Berkeley is situated in the northeast part of San Francisco. Apart from them, several universities ranked 50th or higher in the world university rankings are based in California, including the California Institute of Technology, University of California, Los Angeles and University of California, San Diego, which is indicative of the state's world-class academic research.

Having world-class academic institutions is extremely important in R&D activities. For instance, in 2016 California enjoyed around 9.63 million dollars, the lion's share of support provided by NSF which mainly funds basic research in the US, outstripping the second place New York (around 4.80 million dollars) and the third place Massachusetts (around 4.49 million dollars).[35] In medical research, with a huge annual budget, equivalent to around 3 trillion yen, the National Institutes of Health (NIH) provides the largest financial support for university research. When you look at research support funds provided by NIH in 2016 by state, California received the largest amount, around 3.7 billion dollars, followed by Massachusetts receiving around 2.6 billion dollars.[36] Clearly, California is America's leading medical research center.

[33] NVCA2017 Yearbook
[34] MoneyTree Report Q3 2017 https://www.pwc.com/us/en/moneytree-report/assets/MoneyTree_Report_Q3_2017_Final_Final.pdf
[35] Award Summary: by State/Institution FY 2016 https://dellweb.bfa.nsf.gov/awdlst2/default.asp
[36] Accessed October 16, 2017. RePort NIH Funding Data frozen as of 10/14/2016. Data released on 12/27/2016 NIH Awards by Location & Organization https://report.nih.gov/award/index.cfm?ot=&fy=2016&state=&ic=&fm=&orgid=&distr=&rfa=&om=n&pid=#tab1

The high-level academic research in California, especially in the Bay Area, prominent venture capital, and culture of prior investment in emerging technology fields are considered as environmental factors which contribute to Silicon Valley's leading position in the US startup market.

2.3.1.3 Relationship with Japan

According to a 2016 survey by the Japan External Trade Organization (JETRO), a total of 770 Japanese companies, both large and small, have local offices in Silicon Valley, conducting various economic activities mainly in the field of information science.[37] As well, new publicly financed support programs are underway to build a stronger relationship between Japan and Silicon Valley. MEXT offers a training program for people who want to start companies using outputs of university research, and includes training at Silicon Valley as part of the program.[38] METI provides a training program for entrepreneurs and managers of intra-venture businesses of large corporations, in which participants are dispatched to Silicon Valley after completing a training course in Japan.[39] JETRO also offers opportunities where Japanese companies can give a pitch and receive mentoring in San Francisco under its support program for businesses using intellectual property from Japan.[40]

2.3.2. Boston

2.3.2.1 Boston's startup environment and its characteristics

The City of Boston is situated in the northeast of Massachusetts, the East Coast, with the longest history in the US. It has a population of 670,000. Across the Charles River from Boston is the City of Cambridge with a population of 100,000, a university town known for the Massachusetts Institute of Technology (MIT) and Harvard University. These universities attract high-caliber talent from all over the world, conducting cutting-edge research while many major corporations have their research bases near the universities, seeking research seeds and capable talent.

The Greater Boston area has long been known for its startup clusters, and today the area is home to around 2,900 to 3,900 technology (R&D) startups. The area has its strength especially in biotechnology-related startups, and continues to generate many startups that are competitive in international markets and may create disruptive innovations. It is the innovation ecosystem formed mainly in Kendall Square in Cambridge that has created these startups and supported their growth. Kendall Square is a small area within a radius of two kilometers but is home to Harvard University in the north and MIT in the south. The area between these two universities is crowded with major pharmaceutical companies, VC firms, and startup support institutions, making it possible for universities, corporations, and VC firms to work closely with each other during the process from Proof of Concept (POC) in which feasibility of new technology is examined to research and development to commercialization. Kendall Square is well known as an innovative district with the highest concentration of startups on the planet.

37 2016 Fact-Finding Survey of Bay Area Japanese Companies
https://www.jetro.go.jp/ext_images/_Reports/02/8b7b186d9b99ea5b/survey2016.pdf
38 https://www.ducr.u-tokyo.ac.jp/activity/venture/education/edge.html
39 http://www.meti.go.jp/press/2017/04/20170427003/20170427003.html
40 https://www.jetro.go.jp/services/innovation.html

The following discusses universities, corporations, VC firms, and support institutions, all of which are key players in Boston's ecosystem, and their roles.

2.3.2.2 Major universities in Boston

In the Greater Boston area, there are more than 50 universities including MIT, Harvard University, Boston University, etc. Babson College, a world-renowned college specializing in entrepreneurship education, is also located in the suburbs of Boston. Among these schools, it is MIT and Harvard University that develop researchers with advanced expertise by attracting high-caliber talent from around the world.

(1) Massachusetts Institute of Technology (MIT)

Founded in 1861, the Massachusetts Institute of Technology (MIT) is one of the world's most prestigious schools. With around 10,000 students, this private school enjoys high recognition in education and research especially in the fields of architecture, computer science, information systems, engineering, technology, chemistry, and mathematics, striving to solve the world's problems related to cancer treatment, energy issues, etc. While conducting cutting-edge research, MIT is also actively promoting joint research with and technology transfer to businesses. During the period from 2010 to 2014, MIT created 92 startups, the third most in the US, following the University of California System, which launched 329 startups, and the University of Texas System's 120 startups. Representative examples of MIT-launched startups include A123 System, which developed lithium-ion battery systems, Akamai Technologies, which conducts content delivery network business, Luminous Devices, a high-brightness LED manufacturer, and Momenta Pharmaceuticals, a pharmaceutical product developer.

On the MIT campus, various organizations are providing entrepreneurial education and venture support, including the Martin Trust Center for Entrepreneurship and Deshpande Center for Technological Innovation in addition to the Technology Licensing Office (TLO). To quickly commercialize outputs of research in the university and give back to society, TLO promotes patent acquisition from research outputs, provides licenses of such intellectual property to major corporations and small companies, and encourages staff and students to start businesses based on such intellectual property. Many specialists working for TLO have abundant entrepreneurial experience. These specialists provide staff and students who are considering starting businesses with advice related to protection of intellectual property, business planning, and financing from early on while informing them of various support programs available inside and outside of the campus so that they could build a network with investors and mentors. TLO issues a startup guidebook called "An MIT Inventor's Guide to Start-ups[41]," which presents a roadmap to the start of a business, things to be noted, startup support programs available inside and outside of the campus, and other useful information in an easy-to-understand manner.

In 2016, MIT drew public attention by establishing The Engine[42], an incubator specializing in support for R&D startups. This incubator was established based on the recognition that the current innovation system in the US does not provide enough support for R&D activities concerning complicated technologies which could cause a huge social change in the future. The Engine puts its focus on startup support in the field of technology called Tough Tech in which long-term R&D activities and significant capital are required, e.g., biotechnology, medical equipment, advanced

[41] An MIT Inventor's Guide to Startups
http://web.mit.edu/tlo/documents/MIT-TLO-startup-guide.pdf
[42] https://www.engine.xyz/

manufacturing, clean energy, robotics, IoT, deep software including OS, etc. While providing better R&D development environments to startups in Tough Tech by offering “Maker Space,” “Lab Space,” and “Co-working Space,” The Engine also puts them in touch with mentors and helps them raise long-term funds. It also organizes a Demonstration Day in which entrepreneurs in the university can present their startups or ideas to people from the industrial circle and investors.

(2) Harvard University

Founded in 1636, Harvard University is a university with the longest history in the US, boasting 20,000 students. This private university is highly recognized in the world of education and research, especially in the fields of life science/medicine and social science/management. Harvard creates around 10 startups a year, recent examples of which include Editas Medicine, which develops genome-editing technologies, and Emulate, which develops organs-on-chips.

It is the Office of Technology Development (OTD) that provides support for technology transfer and establishment of startups at Harvard University. By employing researchers that have experience in developing startups, the OTD provides the practical advice and support required during the process from development to commercialization of research outputs. The OTD also issues a startup guidebook, the “Startup Guide[43],” which presents university staff interested in starting venture firms, graduate students, and postdoctoral researchers a roadmap to the start of a business, advantages and disadvantages of starting new businesses, and information on required capital and sources of funds in an easy-to-understand manner. By connecting university researchers and corporate researchers, the OTD provides detailed guidance so that “discovery” at labs can lead to “innovation” quickly.

Inside the TLO at Harvard University is the Blavatnik Biomedical Accelerator specializing in medical science research. This accelerator was established in 2013 thanks to a donation from the Blavatnik Family Foundation for the purpose of bridging the gap between innovative medical science research and successful development of high-impact medical products. The accelerator solicits proposals from would-be entrepreneurs in the university twice a year, providing 500,000 dollars of funds to successful proposals which are decided after screening the documents and selection by the advisory committee. The committee is joined by experts from pharmaceutical companies and VC investors, acting as an established system in which the university, the industry circle, and VC funds cooperate with each other from early on to discover research seeds and examine research directions. The accelerator also introduces promising candidates to VC funds and pharmaceutical companies.

[43] Startup Guide Harvard University Office of Technology Development
https://otd.harvard.edu/upload/files/OTD_Startup_Guide.pdf

2.3.2.3 Pharmaceutical companies

Seeking research seeds of MIT and Harvard University, many pharmaceutical companies have established their research centers in Kendall Square. Novartis (Switzerland), which had the world's second most drug sales in FY2016[44], has established an institute of medical science in Kendall Square while the first place Pfizer (US), the eighth place GlaxoSmithKline (UK), Bayer (Germany), Takeda Pharmaceutical Company (Japan), and Johnson & Johnson (US) also have a base there. These parties keep in touch with Harvard's TLO and discuss the future direction of research for practical application from early on with the university, promoting industry-academia joint research. As well, in cooperation with the incubator and the accelerator to be discussed later, pharmaceutical companies provide mentoring to entrepreneurs and give financial support for commercialization of technology.

2.3.2.4 Venture capital funds investing in high risk research in the initial stage

While there are many venture funds investing in bio-related startups in Boston, what makes the city different from others is that some venture capitalists are specializing in investing in research in the initial stage which is considered highly risky. Representative examples include Atlas Ventures, Third Rock Ventures, and Flagship Ventures. These major venture capital firms used to decide investments through a traditional method, in other words, in response to pitches by companies, but in recent years it is becoming a rule that they proactively search for good investments. They strive to discover research seeds by working with TLOs and accelerators of universities. Venture capital funds in Boston typically hire several people who have experience in R&D activities or business in pharmaceutical companies or who have been involved in starting bio-related ventures. When deciding investments, venture capital funds rely on these experts, who also work as mentors for advanced R&D startups.

2.3.2.5 Incubators and accelerators

As discussed above, MIT and Harvard University have their own incubators and accelerators, thereby supporting university startups. Apart from them, there are close to 50 accelerators and incubators in the cities of Boston and Cambridge. These support institutions provide office spaces and funds to general entrepreneurs and introduce them to mentors and investors. Events held by accelerators and incubators also provide precious opportunities for not only entrepreneurs but also people in the industry circle related to creation of innovations because they can meet entrepreneurs who have innovative technologies. The followings are representative incubators and accelerators in Boston.

(1) Nonprofit organization accelerator: MassChallenge

Funded by the City of Boston and the State of Massachusetts, the accelerator, MassChallenge, was established in 2010. It is now run by a nonprofit organization. While most accelerators demand equity from startups in return for admission to their programs, MassChallenge does not. It offers a four-month accelerator program for selected promising entrepreneurial teams. Through this program, selected startups will receive office spaces, mentoring service and entrepreneurial education. During the program period, three competitions are held and startups that accomplished excellent results in the competitions will win a prize of up to two million dollars from the

[44] World Pharmaceutical Sales Ranking 2016 https://risfax.co.jp/wp-content/uploads/2017/07/World-Drug-Ranking-2016-byKENPharmaBrain1707-1.pdf

government and corporate sponsors. MassChallenge offers support to startups in all industrial sectors including high technology, green technology, and life science. Since the launch of MassChallenge in 2010, 1,211 startups have completed the program, and they have raised 1.8 billion dollars and chalked up earnings of 700 million dollars. These startups created 60,000 jobs (as of 2016).

Under the umbrella of MassChallenge is PULSE@MassChallenge, which is an accelerator specializing in support for digital-health-related startups. It has its own space, separate from MassChallenge, in the Fenway neighborhood adjacent to Harvard Medical School, providing office spaces to promising startups related to digital health, introducing them to mentors, and offering a health-related accelerator program in cooperation with hospitals, industry, and government institutions.

(2) Private accelerator: Techstars

Founded in Boulder, Colorado in 2006, Techstars is one of the most renowned private accelerators in the US. The Boston office was established in 2009, selecting 300 startups every year, and offering them a three-month mentor-led accelerator program. In its final day, the program holds a Demonstration Day in which participating entrepreneurs give presentations to the press and investors. Participating startups provide 6% of their equity to Techstars in return for 120,000 dollars of seed money. One of the advantages of Techstars is the 4,800 mentors and 3,300 Techstars alumni who provide three-month training to young entrepreneurs. During this training, these entrepreneurs gain practical experience while building a network with mentors and alumni to get ready for launching a startup. Techstars has so far supported 1,157 firms, 90% of which are still running a business or have been bought out.

(3) Cambridge Innovation Center (CIC)

Founded in Kendall Square in 1999 by MIT graduates including Timothy Rowe, the Cambridge Innovation Center (CIC) is the world’s largest scale private startup support facility (with a total area of 100,000m^2). Its vision is that startups can grow a society dramatically, and connecting entrepreneurs with each other will accelerate this growth. Based on this vision, CIC provides office spaces and lab spaces which are required during the period from a business launch to growth as well as co-working spaces where entrepreneurs, investors, people from large corporations, and startup supporters get together for networking. Also, at CIC, MassChallenge and Techstars, which were mentioned earlier, and other partners offer accelerator programs. Having cooperative bases with universities, innovation bases of major corporations, and bases for overseas development, CIC is a complex facility supporting startups in various aspects.

Today, CIC Boston is home to 1,500 businesses including startups, laboratories, and innovation departments of major corporations, and their 5,000 employees. Four thousand companies have used CIC services so far, and many of them have grown to be major corporations, including HubSpot, a developer of marketing integrated management software, the accelerator MassChallenge, GreatPoint Energy which develops clean energy, and Android.

2.3.2.6 Success stories of Boston startups

Emulate

Emulate is a startup from the Wyss Institute, Harvard University, established by Dr. James Coon and Dr. Daniel Levner in 2014.[45] Emulate succeeded in commercialization of an "organ-on-a-chip," a small chip that simulates the tissue and functions of organs. With such chips, pharmaceutical companies will be able to drastically reduce the time required for development of drugs by simplifying animal experiments for toxicity tests. Following the commercialization of a "lung-on-a-chip," which simulates the tissue and functions of lungs, Emulate is advancing development of chips for other organs, aiming to connect these chips to develop a "human-on-a-chip" which reproduces functions of a human body on a chip in the future. When it was still enrolled at the Wyss Institute, the team Emulate received 37 million dollars for R&D activities from the Defense Advanced Research Projects Agency (DARPA). After it was launched as a company, Emulate successfully raised total 59 million dollars, and is now growing fast. Twelve million dollars out of the total 59 million dollars was raised in 2014 when the company was established (Series A), another 45 million dollars in 2016 (Series B), and the remaining 2 million dollars in 2017 (as a grant from NIH).[46] The grant from NIH is allocated for development of a "brain-on-a-chip" to be used for brain science research at a space station.

Relationship with startup ecosystems

The Wyss Institute is a research institute established in Harvard University in 2009 thanks to a donation (125 million dollars) from Mr. Hansjörg Wyss, a Swiss business man and entrepreneur. Based on the idea of Mr. Wyss, the institute aims to conduct cross-disciplinary research beyond the boundaries of universities, faculties, and departments with clear exit strategies in mind. As an organization like accelerators specializing in support for business creation based on academic research, this institute provides functions of research, technology transfer, and accelerators. Within the eight-and-half-year period from the foundation of the institute, 1,700 papers were published, 120 patents were established, and 20 startups were launched. Many promising startups have been established from the institute and Emulate is one of them.

The core technology for "organs-on-chips" was discovered by a team led by Dr. Donald Inger, a cell biologist who was the director of the Wyss Institute, and it was published in Science Magazine in 2010.[47] The team then went on to work on commercialization of the technology, and it was the Wyss Institute and the OTD of Harvard University that supported the team through a feasibility study (Proof of Concept (POC)), research and development, and commercialization to the launch of the startup.

Technology transfer specialists at the Wyss Institute, in cooperation with the OTD of Harvard, first ensured the protection of the intellectual property of this technology while hiring entrepreneurs called "Entrepreneur in Residence (EIR)" from the outside and assigning them to the team. When the team was ready for launching their company, the specialists introduced the team to venture capital funds. Technology transfer specialists in Boston have great expertise and abundant experience in startup creation. They have built an extensive network of universities, corporations, and venture capital funds and have no difficulties in finding the right people for startup teams or interested venture capitalists.

EIRs are supposed to provide researchers advice concerning commercialization of technology

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[45] https://wyss.harvard.edu/wyss-institutes-technology-translation-engine-launches-organs-on-chips-company
[46] Crunchbase, https://www.crunchbase.com/organization/emulate
[47] Reconstituting Organ-Level Lung Functions on a Chip, Science 328 (5986), 1662-1668
http://science.sciencemag.org/content/328/5986/1662.full

and product development as well as fundraising, and usually are hired from people with experience in working for corporations or starting businesses. Dr. James Coon, who was hired for the team Emulate, is an entrepreneur with abundant experience including employment at AstraZeneca, GlaxoSmithKline and other major pharmaceutical companies and involvement in the launch of a biotechnology-related startup. When Dr. Coon and the team members left the Wyss Institute in 2014 to establish Emulate, he took up the position of Founder/CEO of Emulate.

2.3.3. Austin

2.3.3.1 Austin's startup environment and its characteristics

Located in Central Texas, Austin is the state capital with a population of around 950,000. The city has grown rapidly in recent years as a high-tech industrial city, seeing a continued influx of population. Prior to 1980, the University of Texas was the centerpiece of the city. But after the city successfully invited SEMATEC, a private joint research consortium for semiconductor manufacturing technology established as part of a national project, and Microelectronics and Computer Technology Corporation (MCC), major IT corporations including IBM, Toshiba, Apple, and Samsung set up their offices in Austin, forming a high-tech cluster under industry-academia cooperation.[48]

Austin also attracts attention as one of the most entrepreneur-friendly cities in the US, and is now home to 1,700 to 2,200 high-tech startups. In 2016, a total of 600 million dollars was invested in 75 startups. Traditionally, startups in Austin were mainly spin-outs of IBM and other large corporations, and spin-outs of Tivoli Systems, which itself was an IMB spin-out. However, since the revision of the state law concerning transfer of university technology in the late 1980s, the number of startups from the University of Texas has surged. In recent years, the number of startups related to green energy and biotechnology as well as IT has been increasing.

These startups from corporations and universities are supported by the local-community-based ecosystem which is mainly made up of the University of Texas, IC2 (Innovation – Creativity – Capital) Institute established in 1977 for industry-academia cooperation and promotion of startup creation, the high-tech industry and individual investors. In this ecosystem, the university which is supposed to create knowledge is a state university, so the roles which the federal and local governments play in improving startup environments are larger than those in large cities such as Silicon Valley and Boston. Although Austin is seeing active startup activities, most of the venture capital is invested in California and Massachusetts, and Texas ranks low in this respect. An important source of funds for startups in Austin is individual investors.

The following discusses key players in the Austin's ecosystem, namely the university, IC2 Institute, individual investors and support institutions.

[48] Spinoffs and Learning Regions in Cluster Formations, Michi Fukushima
http://ci.nii.ac.jp/els/contents110010050943.pdf?id=ART0010619832

2.3.3.2 Major university in Austin

The major university in Austin is the University of Texas at Austin established in 1883. It is a huge university boasting 50,000 students with a proven track record in research and education especially in the School of Business, School of Engineering, and School of Law. Aiming to achieve its ambitious goal of changing people's lives to benefit the society, the whole university is working on entrepreneurial education, commercialization of technology, and enhanced cooperation with local startup communities. Not only the School of Business but also the School of Engineering, College of Natural Sciences, and College of Pharmacy are all conducting their own startup support programs individually, providing support for development of entrepreneurs specializing in particular fields and commercialization of technology.[49]

The School of Business offers a master's program for technology commercialization, in which people working for companies and startups can acquire business skills for creating innovative products and obtain a master's degree through weekend intensive and online classes taught by professors of the faculty of business administration while continuing their employment. As well, the Innovation Center at the School of Engineering has entrepreneurs with abundant experience available, who advise engineering school staff and students and connect them to outside talent to help transform their research projects into startups. The Innovation Center offers several programs. Especially noteworthy is the UT Austin Startup Studio, which supports staff who want to start a new business. This program provides staff who want to focus on business launch activities a two-year leave while securing their position at the university until they return. While it is up to the individuals whether they will return to work or resign and commit themselves to entrepreneurial activities after a two-year stint as an entrepreneur, most of them return to the university and contribute to the development of future entrepreneurs by utilizing their own startup experiences.

One example of cross-disciplinary efforts for entrepreneur development is the I-Corps program of NSF discussed in Section 2 "Major programs." One of the eight nodes in the country has been established in the University of Texas at Austin, offering the I-Corps curriculum to teach knowhow for commercialization of research outputs to young researchers and professors at universities in Texas and the southwestern region. As well, the Texas Venture Labs run by the university is making various attempts to commercialize research outputs and accelerate development of entrepreneurs and business leaders. Texas Venture Labs matches local startups with cross-functional teams of MBA students who aspire to launch businesses and graduate school students of law, pharmacy, natural sciences and engineering, to have student teams propose solutions to challenges facing local startups as semester-long practical training.

[49] A Guide to UT Austin's Startup Ecosystem
https://www.mccombs.utexas.edu/~/media/Images/MSB/Centers/HerbKelleher/Guide%20to%20the%20UT%20Startup%20Ecosystem.pdf

2.3.3.3 Startup support organizations in Austin

(1) IC2 Institute

IC2 Institute is a research institute under the wing of the Vice President's Office, established in 1977 by George Kozmetsky, then-Dean of the business school of the University of Texas at Austin, in cooperation with local governments and the Chamber of Commerce and Industry. IC2 (read "IC Square") is the acronym of "Innovation, Creativity, Capital". Under its philosophy that "technological innovation can catalyze regional economic development through the active and directional collaboration among the university, government, and private sectors," IC2 has worked on attracting corporations, industry-academia cooperation, and promotion of business creation for over 30 years in cooperation with the university, government institutions, and the private sector. Today, its focus is on study and evaluation of innovation ecosystems, provision of entrepreneurial education and opportunities to students and working people, incubation and acceleration of startups, and advancing into foreign markets.

IC2 launched the Austin Technology Incubator (ATI) in 1989, which has offered incubator programs specializing in clean energy, IT/wireless, bio-health, and water technologies to startups inside and outside of the campus and led these ventures to success. ATI supports 20 to 30 R&D startups annually. Nineteen startups which completed ATI's incubator programs in 2016 raised more than 220 million dollars in total, and three of them had exits. One of the three went IPO. ATI is striving to increase competitiveness, especially of entrepreneurs, in the capital market by building long-term relationships with local investor communities, local and national venture capital firms, and sources of funds related to the government.

(2) Network of individual investors in Texas

One of America's finest networks of individual investors is based in Texas. The advantages of this organization include enabling them to work with other investors and jointly invest a large amount as well as enabling them to make better decisions and to expand investment opportunities. In general, an individual investor provides 100,000 to 500,000 dollars for companies in the seed stage whereas a VC fund supplies 2 to 5 million dollars to companies in the early stage. This network of individual investors can fill the gap between individual investors and VC funds by providing 500,000 to 2 million dollars. The Central Texas Angel Network is one of the leading networks of individual investors in the US with 160 members. Having invested 83 million dollars in 142 startups since 2006, this network is an important source of funds for entrepreneurs in Texas.

(3) Private accelerators

Private accelerators include Capital Factory and Techstars Austin, both of which are based in downtown Austin. The former is focused on support for high-tech startups, providing member startups access to co-working spaces, R&D equipment including 3D printers, and virtual reality/augmented reality lab (VR/AR Lab) and holding high-tech-related events and networking sessions with mentors and investors. It offers a six-month accelerator program, in which accepted companies receive focused support for fundraising and customer development. To be more specific, on behalf of entrepreneurs, officials called evangelists promote their venture firms to attract investors and customers while high-level mentors belonging to Capital Factory provide guidance to individual entrepreneurs. Companies accepted in this accelerator program are required to give Capital Factory 1% of their equity.

(4) South by Southwest (SXSW): Startup festival

South by Southwest (SXSW) is a huge event held in Austin every March, combining music, film, and interactive festivals. Starting as a music festival in 1987, SXSW established its current format by adding a film festival in 1994 and an interactive festival for internet-related startups in 1998. The interactive festival has grown to be one for startups with new ideas and technologies as well as those related to the internet. At the venue, multiple startup support institutions in Austin hold exhibitions, lecture presentations, and competitions to boost entrepreneurship.

2.3.3.4 Success stories of Austin startups

Guadaloop

Guadaloop is a startup from the School of Engineering, University of Texas.[50] It is based on the engineering team made for entering the Hyperloop Competition released in 2015 by SpaceX whose CEO is Elon Musk. A Hyperloop is a proposed mode of transportation of the next-generation, aiming to reduce transportation time between cities by enabling high-speed transportation with a vehicle called a “capsule” or “pod” which uses magnetic levitation that is sent through a tube-like transportation space (tunnel) with reduced pressure.[51] More specifically, the project aims to realize a passenger car (minimum 28 passengers per vehicle) which can travel between San Francisco and Los Angeles in 35 minutes one way. To realize this next-generation technology, SpaceX solicited technical proposals in a competition targeted at students not only in the US but around the world. Guadaloop is a company of 20-some employees, mostly made up of those responsible for mechanics, electricity, and system engineering, and those in charge of business strategies. It won an innovation award at the Hyperloop Competition held at SpaceX in August 2017.[52] While many other teams which entered the competition adopted magnetic levitation to avoid frictional resistance with rails, Guadaloop used air bearing technology. Air bearings have weakness in their smaller load capacity, but the company stresses their advantages of being less costly and more energy efficient compared to magnetic levitation.[53]

SpaceX put a priority on speed when it evaluated proposals at the competition in August. In this respect, Guadaloop’s technology did not meet the standard, so the company did not compete in speed. However, the unique characteristics of the air bearing technology discussed above received high recognition in a greater sense of innovation not limited to speed, helping the company win an innovation award. The competition received entries from 150 teams, and 24 of them made it to the competition. Innovation awards were presented to three teams, one of which was Guadaloop.

Relationship with a local startup ecosystem

Guadaloop, a startup from the University of Texas, engages in activities while receiving support from the previously-mentioned IC2, which is a key support provider of the university, and Capital Factory, a major private accelerator in Austin. As Guadaloop is also sponsored by National Instruments, a multinational measurement equipment manufacturer headquartered in Austin, Texas and ThrillBox, a local software company, in addition to Lockheed Martin, it is considered as a startup which takes full advantage of a local ecosystem.

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[50] https://www.guadaloop.com/
[51] http://www.spacex.com/sites/spacex/files/hyperloop_alpha.pdf
[52] https://static1.squarespace.com/static/5918baee20099e96149cc471/t/59a81b82d482e94cd1020a4c/1504189315602/Guadaloop+Press+Release+%283%29.pdf
[53] https://www.guadaloop.com/

2.4. Characteristics of startup environments/support programs in the US

The US invests 503 billion dollars, or 2.8% of its GDP, in research and development activities (according to data of OECD 2015), and as a result, new knowledge and technology are often created in rapid succession. The trend of trying to vitalize the economy by creating innovations from commercialization of such technology is growing, and one way to achieve that is startups.

America's startup environments are characterized by abundance and diversity in the three essentials of all startups, namely, "people (entrepreneurs, mentors), money (funds), and goods (research ideas and outputs)." In the US, multiple support institutions which facilitate business creation by connecting these three essentials are available while there are established local systems in which successful entrepreneurs guide and support future entrepreneurs by assuming the roles of mentors and investors. Entrepreneurs in the US take on the challenge of starting a new business in such entrepreneur-friendly environments. Some succeed and some fail, but people who fail use that experience and strive to succeed in their next startup.

Among the many startups launched every day, only a handful see great success. To raise the startup success rate, the government, universities, industry, and the private sector work together, putting effort into further investments in budding companies, development of high-quality entrepreneurs, and enhanced cooperation with entrepreneurs, mentors and managerial talent.

2.4.1. The world's leading academic research and acceleration of technology transfer

In research and development activities, the US invests 503 billion dollars, triple the amount of Japan's investments.[54] Of total investments in R&D activities in the US in FY2015, 17.2% was invested in basic research, 19.4% applied research, and 63.4% development research. Compared to Japan's R&D investments, 15.2% of which was invested in basic research, 20.7% applied research, and 64.0% development research. Clearly, the US puts more weight on basic research. The US has many universities which attract top level research talent from around the world and conduct cutting-edge research, including Harvard University, Massachusetts Institute of Technology, Stanford University, California Institute of Technology. These universities conduct basic research and applied research while receiving financial aid from the federal government, leading the world in terms of the number of published papers and the number of obtained patents. Universities are accelerating technology transfer while working with corporations in a bid to utilize abundant promising research seeds stored in their laboratories and to give back to society.

It was the enactment of the Bayh-Dole Act in 1980 and the introduction of the SBIR/STTR programs in 1982 by the federal government that triggered the promotion of technology transfer in the US. The Bayh-Dole Act has increased incentives for transfer of university technology, and the SBIR/STTR programs have raised incentives for companies to commercialize innovative technology by allowing grants to be paid out to technology-receiving small companies as well. More than 35 years after the introduction, the SBIR/STTR programs are still running and their total budget of 2.5 billion dollars in FY2016 makes them the country's largest seed fund.

In 2016, US universities granted 5,013 licenses, 70% of which were given to startups and small companies. In return, US universities received total 3 billion dollars in licensing income.[55] The number of university startups grew from 212 in 1994 to 275 in 1997 to 374 in 2003 to 596 in 2009. The growth continued to accelerate in subsequent years and the number reached 1,012 in

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54 OECD Main Science and Technology 2015
55 AUTM FY2016 Licensing Survey
http://www.autm.net/AUTMMain/media/SurveyReportsPDF/AUTM_FY2016_US_Highlights_no_Appendix_WEB.pdf

2015.[56]

2.4.2. Various sources of funds according to the startup’s stage, providing many people opportunities to start a business

In the US, there are various sources of funds available to startups according to their stage, giving many people opportunities to start a business. Figure 6 illustrates the multi-layered structure of such startup funds.

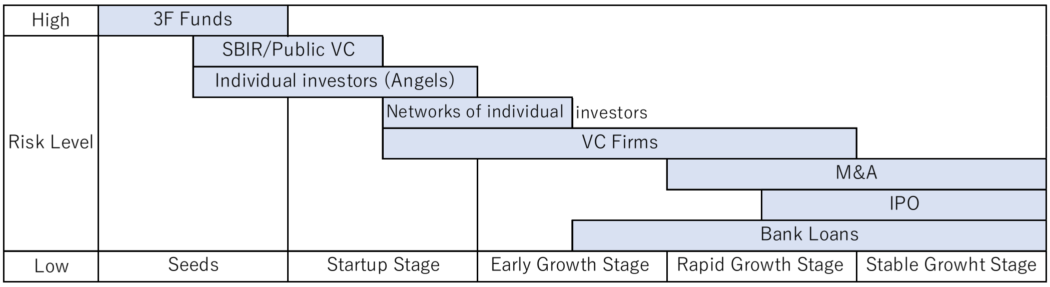

Fig. 6: Startup Funding-Sources and Sequence
Source: Created by CRDS based on various materials

Funds for the seed stage include 3F funds provided by founders, families, and friends, public funds including the SBIR grants, and funds from individual investors. These funds provide high-risk startups a small amount of capital ranging from 100,000 to 500,000 dollars. In recent years, a greater variety of funds has become available, including crowdfunding and a prize provided by the government, corporations, and startup support organizations.

In the startup stage, funds are available from networks of individual investors and VC firms in addition to the SBIR program and individual investors. These funds provide capital of 500,000 to 2 million dollars to companies in the startup stage which entail high risk in both technology development and business. The Central Texas Angel Network discussed as part of the ecosystem in Texas is a representative example of individual investor networks. Individual investor networks mainly offer funds to local startups. In addition, VC firms supporting academic research exist in major cities of the US, funding promising venture firms in the startup stage. Third Rock Ventures and Atlas Ventures discussed as part of the ecosystem in Boston are examples of such VC firms. The startup stage is the period when startups find it hardest to raise capital, but a variety of funds are available including public funds from the SBIR program, funds from individual investors and individual investor networks and VC funds, providing great support to such startups.

Sources of funds for the early growth stage and the rapid growth stage are VC funds, bank loans, M&A, and flotation. Required to develop fundraising strategies, startup founders together with business managers vigorously promote their technologies and business plans and try to secure funds according to their growth stage.

[56] AUTM FY2015 Licensing Survey
https://www.autm.net/AUTMMain/media/SurveyReportsPDF/AUTM_FY2015_Highlights_US_no_appendix_FINAL.pdf

2.4.3. Liberal arts education and various career paths – Development of entrepreneurs

US universities attach importance to liberal arts education, in other words, education in which students study a range of academic disciplines including the humanities, social science, and natural science and develop leadership. For this reason, students are able to take courses that are not related to their major but seem interesting to them during their undergraduate program, and to pursue two majors or a major and a minor(s). For instance, science and technology students interested in launching a business can take an entrepreneurship class, or choose business administration as their minor if they want to study business more seriously.

Graduate programs have also been promoting cross-disciplinary education in recent years, enabling students to take courses that are offered in departments not related to their majors. A broad range of career paths are available to students who take such a variety of courses. In fact, after completing science and technology graduate school, some aim for university teaching posts, some are employed by companies, some start up their own businesses, and others become investors. Clearly, launching a business is established as an occupation option for undergraduate and graduate students after completing their programs. In fact, half of the entrepreneurs in Boston have PhDs.

The Massachusetts Institute of Technology, Harvard University, and the University of Texas at Austin which we surveyed this time all provide entrepreneurship education and hands-on learning opportunities to undergraduate and graduate students of science and technology who are interested and offer a wide variety of startup support programs for students and faculty members. Especially highly suggestive for Japanese universities when considering entrepreneurship education and support are The Engine, which is an MIT incubator specializing in "Tough Tech," the biomedical accelerator of Harvard University, the IC2 Institute of the University of Texas, and the I-Corps program and the EIR (Entrepreneurs in Residence) program introduced across the US.

The EIR program brings in people with abundant business experience including those that have experience starting a new business to institutions (corporations, VC firms, universities, etc.), in which they help launch businesses. Although somewhat similar to intrapreneurship, the EIR program is different in that it invites entrepreneurs not from the inside but from the outside.[57] Many EIRs exist in America's top universities, especially in their startup support offices or business schools. For instance, close to 20 EIRs are working for the Martin Trust Center for MIT Entrepreneurship[58], Social Entrepreneurs in Residence program at Stanford[59], and Harvard innovation labs[60]. The Wyss Institute presented as a case example of Boston also actively hires and makes the most of EIRs.

It is pointed out that the form of actual employment of EIRs varies depending on the employing institution and objectives.[61] They may receive office space at their employing institution, some administrative support, and maybe even a stipend, so they are treated quite differently according to the objectives.[62] As is often the case, EIRs belonging to universities often undertake management-related tasks including market research, business model development, and fundraising while university researchers take charge of research and development activities. Therefore, the EIR program can be understood as a program in which universities recruit

57 http://blogs.itmedia.co.jp/speedfeed/2007/02/eir_entrepreneu_935d.html
58 http://entrepreneurship.mit.edu/coaching/
59 https://haas.stanford.edu/community/social-entrepreneurs-residence-stanford-seers
60 https://i-lab.harvard.edu/meet/office-hours/
61 https://www.forbes.com/sites/neilkane/2014/09/09/what-is-an-entrepreneur-in-residence/#66c6ecf44a74
62 https://www.forbes.com/sites/neilkane/2014/09/09/what-is-an-entrepreneur-in-residence/#66c6ecf44a74

managerial talent that aims to launch R&D startups from the outside.

Some indicate a number of reasons for US universities adopting the EIR program. They want to reform their education curricula required for startup promotion, secure regular access to mentors for students, and improve international recognition by enrolling renowned, experienced EIRs, and most of all, they are interested in the potential income they can gain when a startup “makes it”.[63]

There are many ways to match researchers and business managers, including public funding, incubators, and accelerators but the EIR program is especially noteworthy as it is an effort to support startups specializing in universities’ objectives (creation of commercial profits based on academic knowledge) by employing a wealth of talent on a continual basis.

2.4.4. Formation of startup communities by support organizations

Becoming independent and starting one’s own business is an American dream, and many people in the US hope to launch a business sometime in their lifetime. Some start a business while still at school, others try when they have accumulated experience and wealth by working for a company or university. Support organizations including incubators and accelerators provide co-working spaces and entrepreneurial education programs to these potential entrepreneurs with various backgrounds to help them realize their dreams.

Incubators, accelerators, and other support institutions frequently hold events which gather entrepreneurs, mentors, investors, and people from the industry circle to help them build networks, thereby promoting formulation of startup communities. Some support organizations specialize in particular fields and others do not. For instance, the Cambridge Innovation Center in Boston does not limit fields so that startups from various fields can get to know each other. On the other hand, PULSE@MassChallenge caters only to biomedical-related startups, focusing its support on networking in the biomedical field from its office, just outside of downtown Boston in the Fenway which has Harvard Medical School and many hospitals nearby.

Startup communities play an important role when entrepreneurs meet mentors and investors and build a relationship of trust. The safety net (secure base) for entrepreneurs is nothing but the startup communities where entrepreneurs can encourage each other and grow while being supported by mentors and investors. In addition, as most of major incubators and accelerators have set up offices inside and outside of the country, entrepreneurs can use them as a stepping stone to connect with local communities for expansion into the whole country and overseas.

2.4.5. High mobility of talent

In the US, it is common for people to change jobs for career enhancement and some even move to totally different fields while utilizing the experience they gained at previous employers. For example, some leave successful companies they founded to establish another startup, and others become serial entrepreneurs by running one startup after another.

Some others go on to become individual investors, funding startups of others by using wealth they accumulated while sharing their management knowhow as mentors, and yet some others choose to become specialists at support organizations including university TLOs and accelerators and provide support for next-generation entrepreneurs. Thus, entrepreneurs, after accumulating experience, take positions in various fields, and this is called “career rotation.”[64] The US

[63] https://www.forbes.com/sites/ashoka/2014/10/14/top-10-reasons-why-universities-need-entrepreneurs-in-residence-on-campus/2/#513836f45841

[64] For more details on career rotation of entrepreneurs in Austin, see “The formation of a high-tech cluster and local initiatives” by Michi Fukushima.

entrepreneurial market is characterized by high mobility of talent and the availability of many supporters who are specialists with good understanding of technology commercialization and management, which are keys to the success of many startups.

One example of a serial entrepreneur developing and supporting the next-generation entrepreneurs is Elon Musk's Hyperloop Competition discussed as a success story from Austin. The founder of SpaceX, a rocket developer for space transportation, Musk is a serial entrepreneur, founding Zip2, a provider of online content publishing software, and X.com, the predecessor of the online financial service provider PayPal. He is contributing to the development of the next-generation entrepreneurs by holding a competition targeted at students worldwide from 2015 in which he solicits ideas for development of the next-generation transportation device and awarded prizes to winners. Student teams which rank high in this world competition are socially recognized and attract more funds from VC firms and corporations. This is how the creation and growth of startups are promoted in this competition.

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3. Israel

Israel has developed its economy by promoting research and development with startups at the core so keenly that it earned the moniker of the “Startup Nation.” If one has made a success of a startup, he or she is also widely recognized as a social success. That way, formation of a culture of entrepreneurship is supported recursively. It is foreign funds that support this Startup Nation. Israel is marked by its startup promotion policy in which the country tries to attract funds from other countries, utilize domestic technology and human resources, and expand into international markets through acquisition.

Why are R&D activities active in Israel? Are Israeli startups competitive internationally? This chapter outlines the trends of R&D activities in Israel and looks at the government’s basic policies and support programs, especially those which have built a foundation for the country’s startup environments. Then, we present the country’s startup environments mainly with cases that are closely related to academia. Finally, we analyze characteristic factors of Israeli startups.

3.1. The current state of Israel and situations surrounding startups

In 2016, Israel had a population of 8.55 million, ranked 97th in the world[65], and a gross domestic product (GDP) of around 318.7 billion US dollars[66] (hereinafter shortened as “dollars”), the world’s 33rd largest.[67] Israel is a relatively small country in terms of population, but its economic activities are lively. The number of Israeli startups listed in America’s NASDAQ, the world’s largest stock exchange for fledging companies, is the third largest in the world, following the US and Chinese companies[68], and Israel comes first in terms of the number of startups per capita. The number of exits (acquisition, IPO, buyout[69]) of Israeli tech startups in 2016 was 104, valued at around 10 billion dollars in total. By type, exits are dominated by acquisition with 93 cases (around 8.8 billion dollars) whereas buyout and IPO total only 8 cases (around 1.22 billion dollars) and 4 cases (18.60 million dollars) respectively.[70] Buyers are mainly multinationals from the US, China, Europe, and Japan.[71] As one of their major characteristics, Israeli startups are quick in expanding into overseas markets for fundraising.

As well, according to the OECD data of 2015, Israel’s R&D spending as a percentage of GDP was 4.25%, the highest among OECD nations.[72] This percentage to GDP looks at the sum total of R&D expenditure, which includes not only the government spending but also investments by companies and foreign investors, and thus includes R&D investments in startups from overseas.

65 World Bank Data (2017) Population Ranking Table
https://data.worldbank.org/data-catalog/Population-ranking-table -
66 According to the foreign exchange rate of Bank of Japan as of February 20, 2018, 1 US dollar is equivalent to 111 yen.
67 World Bank Data (2017) Gross Domestic Product Ranking Table
https://data.worldbank.org/data-catalog/GDP-ranking-table
68 Nasdaq Non-US Companies, accessed 28 September 2017 http://www.nasdaq.com/g00/screening/companies-by-industry.aspx?exchange=NASDAQ&market=ADR&i10c.referrer =https %3A% 2F%2Fwww.google.co.jp%2F
https://data.worldbank.org/data-catalog/Population-ranking-table -
69 Buyout refers to a type of acquisition aimed at taking over the control of another firm.
70 IVC Research Center (2017) IVC Israel High-Tech Yearbook, A. R. Printing Ltd. Tel Aviv, p.24
71 Ibid., p.28
72 OECD (2017) Gross Domestic Spending on R&D
https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm

3.1.1. R&D trends in Israel

Before looking at startup environments in Israel, it is important to understand the country's R&D trends. Two characteristics emerge from the chronological change (1991-2013) of the country's R&D funds by source obtained from OECD data.[73] (Figure 1)

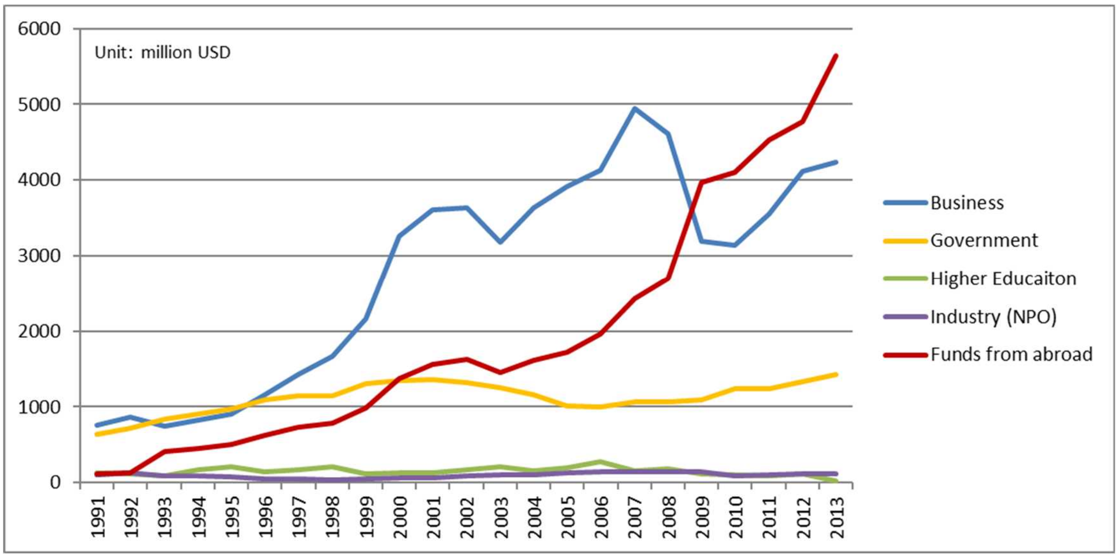

Fig. 1: Gross Domestic Expenditure on R&D by Sector
Source: Created by CRDS based on OECD data

First, it is foreign funds that have accounted for the largest percentage of total R&D funds in recent years. In fact, foreign funds accounted for 49% of the total in 2013. Foreign funds refer to funds that companies, universities, governments, international institutions, and nonprofit organizations in other countries supply to Israel for the purpose of R&D activities.[74] The foreign funds here include overseas funds invested for R&D activities in Israeli subsidiaries in which a foreign multinational owns a controlling interest.

Foreign funds have exceeded R&D expenditure from the government since 2000 and that from domestic corporations since 2009. Compared to other OECD countries where foreign funds account for several percent to around 10% of the total R&D expenditure, Israel is unusual as 49% of its R&D funds are provided by foreign investors. In the meantime, the government contributes 13%, a relatively small percentage of the total R&D funds.[75]

Second, investments from overseas have surged since the beginning of the 1990s. Venture capital promoting startups makes up a substantial part of these investments from overseas. In 2013, Israeli startups received investments of around 2.4 billion dollars from VC firms inside and outside of the country.[76] Of the investments, a whopping 76% came from overseas, in other words,

[73] OECD (2017) Gross Domestic Expenditure on R-D by Sector of Performance and Source of Fund http://stats.oecd.org/Index.aspx?DataSetCode=GERD_FUNDS-

[74] OECD (2015) Frascati Manual 2015 Guidelines for Collecting and Reporting Data on Research and Experimental Development,
Paris: OECD. The Frascati Manual (revised in 2015), which specifies how to collect statistical data of OECD countries, details the definition of foreign funds in Chapter 11.

[75] According to the Central Bureau of Statistics, Israel, foreign funds accounted for 51.6% in FY2015. Central Bureau of Statistics (2017) 'The National Expenditure on Civilian R&D Increased by 2.3% in 2016', Media Release, 15 August, CBS, Jerusalem, p.4

[76] VC investments here refer to investments in "high-tech companies". However, information on how much of investments is spent on R&D activities is unavailable in the following source: IVC Research Center (2017) IVC Israel High-Tech Yearbook, A. R. Printing Ltd. Tel Aviv, p. 31 http://stats.oecd.org/Index.aspx?DataSetCode=GERD_FUNDS-

at least 1.8 billion dollars were provided by foreign VC firms.[77] In 2016, VC investments in the country grew to around 4.8 billion dollars, 87% of which (around 4.2 billion dollars) were invested by foreign VC firms.[78]

By funding country, the country which has invested the largest amount in Israel so far is the US. In recent years, investments from China have been surging. For example, the amount Israeli venture capitalists secured from China in 2014 was five million dollars, which grew to seven million dollars in 2015.[79] According to the data provided by the Thomson Reuters Corporation (data from October 2016 provided by Clarivate Analytics), investments from China continue to accelerate, and 16.5 billion dollars was invested in Israeli startups related to the internet, cybersecurity and medical equipment in 2016, although that was not entirely venture capital funds nor only used for R&D activities.[80] Many people point to an investment frenzy from inland China to Israel for the purpose of economic development through enhanced technological competitiveness, which is happening in parallel with large investments in Silicon Valley by Chinese IT giants.[81]

As discussed above, Israel's R&D environments have grown in a unique fashion since the 1990s. One of the reasons is that the government considered startups as a main pillar of its support measures for socioeconomic challenges the country was facing in the 1980s. The following Sections 2 and 3 will look at these measures.

3.2. Basic policies related to startups

Israel's economy was stagnant in the 1980s. As a background, Horie suggested the following factors[82]: Socialist economic structure under the left-wing administration which continued from the state's founding in 1948, increased military spending for geopolitical reasons, and hyperinflation which occurred in the 1980s. Budget deficits grew so much that corporate tax reached 66.1% in 1985.[83] Privatization of some state-run companies started in the 1960s but it went into full swing only in the late 1980s. That was when the government took measures including introduction of market economy, privatization of state-run companies, tax reforms, and startup support, according to a report by the Israeli Ministry of Finance.[84]

The Encouragement of Industrial Research and Development Law, which provides a foundation for R&D activities in Israel, was also enacted in the middle of the 1980s.[85] This was followed by various government support programs for R&D activities, tax breaks for companies engaged in

77 Ibid.
78 Ibid.
79 Biedermann, F (2017) 'China is Increasingly Becoming Key for Israel's High-Tech Industry', CNBC, 18 July https://www.cnbc.com/2017/07/18/china-is-increasingly-becoming-key-for-israels-high-tech-industry.html
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82 "Isuraeru Keizai no Genjo to Kongo no Tenbo (Current Status and Future Perspective of Israeli Economy)", Masato Horie at Mitsubishi UFJ Research and Consulting (2013)
83 Ministry of Finance (2012) Opportunity Israel: Enhanced Legislation, R&D Incentives, Grants and Support Programs, International Affairs Division, MOF, Jerusalem, P.8
84 Ibid.
85 The Encouragement of Industrial Research and Development Law, 5744 was partially revised in June 2005.

R&D and individual investors investing in R&D, and promotion for immigration to the country for R&D activities.

3.2.1. The Encouragement of Industrial Research and Development Law of 1984 (Law 5744)

The objectives of this law are promoting employment of science and technology personnel in industry, improving the balance of payments by exporting knowledge-intensive products, and aiming to grow the economy through R&D activities.[86] Manuel Trajtenberg, who was the chief economic advisor to the Prime Minister from 2006 to 2009, indicates that the most important point of enactment of this law is that it has led to the creation of an environment where the government shares risk of companies investing in R&D activities.[87] To be more specific, the law provided foundation for establishment of various matching fund programs publicly financed by the government targeted at R&D activities which enhance export competitiveness by companies whether they are startups or major corporations.

Clearly, the law puts a priority on enhancement of export competitiveness. As Israel has a small population and wages are high, the high-tech industry, not labor-intensive industries, is crucial. Many argue that export competitiveness is a decisive factor of the economy of Israel as it was thanks to the surplus from export by the high-tech industry that Israel managed to maintain economic growth even during the world financial crisis.[88]

To achieve the objectives of the law, the government authorized the Office of Chief Scientist (OCS) established in the then-Ministry of Industry and Trade[89] to centrally manage efforts including providing various grants and tax breaks to industry.[90] This law was revised in September 2015, and the OCS was reorganized as an independent administrative institution called the Israel Innovation Authority (IIA) in January 2016. At the root of public support for startups in Israel is IIA, and we will look at details of its various programs in the next section, “History and overview of startup support programs”.

3.2.2. The Law for the Encouragement of Capital Investments of 1959 (Law 5719)

In 1959, the Law for the Encouragement of Capital Investments was established to promote direct investment to Israel.[91] This law’s objectives include attracting foreign capital to domestic R&D activities for enhanced export competitiveness, designating regions, especially those which are lagging in R&D activities (Galilee of northern Israel, Negev in the south, and Jerusalem), as priority investment districts to promote local economic development, and creating nationwide employment opportunities to attract immigrants.[92]

As mentioned previously, the corporate tax reached 66.1%, a record high, in 1985, which was reduced to 36% in 1996 to attract foreign capital[93], followed by phased reductions eventually to 25% in 2016.[94] This law was partially amended in December 2016 as part of the government

[86] Ibid.
[87] Trajtenberg, M (2000) ‘R&D Policy in Israel: An Overview and Reassessment’, NBER Working Paper 7930, National Bureau of Economic Research, Cambridge, p.5
[88] Horie (2013) op. cit, p.2
[89] The current Ministry of Economy and Industry
[90] Ministry of Finance (2012) Opportunity Israel: Enhanced Legislation, R&D Incentives, Grants and Support Programs, International Affairs Division, MOF, Jerusalem, p.16
[91] The Law for the Encouragement of Capital Investments LAW 5719-1959
[92] Ibid.
[93] Ministry of Finance, op. cit., p.8
[94] EY (2016) ‘Israel Reduces Tax Rates Starting 2016’, Global Tax Alert, 7 January,

budget compilation procedures for FY2017 and FY2018. As a result, the corporate tax is set to drop to 24% in 2017 and 23% in 2018.[95] Especially noteworthy reform is that companies which conduct R&D activities are classified as “priority technology facilities” and their profits gained from their R&D activities are treated as “priority profits” eligible for a tax cut. Accordingly, corporate tax of R&D-type corporations will be reduced to 12% in the central part of Israel and 7.5% in priority investment districts in the provinces.[96] As R&D facilities are currently concentrated on specific cities such as Tel Aviv and Haifa, R&D promotion in provincial cities is gaining in importance in terms of tax schemes and grants by public funds.

3.2.3. The Angels Law (Individual Investors’ Law)

The government is pushing tax break measures for individual investors investing in R&D corporations. A law called the Angels Law (Section 20 of the Economic Policy Law) was enacted, valid only for the period from January 2011 to December 2015. Under this law, investors who invested in R&D activities of Israeli corporations during this period were eligible for a tax deduction of up to five million Israeli shekels[97] per year, according to the amount of investment in each corporation, for a period of three years including years when they made investments.[98] This tax deduction was allowed only if 75% or more of expenditure by the investee company was for R&D activities.

Initially, some challenges came up in the operation of this law. As it took a long time for a deduction to be approved, investors were unclear about whether they would get deductions or not for some time. As a result, some say, this law did not see much success in attracting investments.[99] That is why the law was revised in January 2016, making it possible for investors to learn about whether they get deductions or not immediately after they make investments under certain conditions, and it was also extended until December 2019.[100]

3.2.4. Support for immigrants to launch startups and Innovation Visa

While Israel has traditionally promoted settlement of immigrants, this effort is under the control of the Ministry of Aliyah and Integration.[101] It is unique in that the country provides special support for business creation to immigrants who have settled for less than 10 years and Israeli nationals who have returned to Israel after three or more years of absence. Under this program, those eligible can receive up to 85 hours of education necessary for starting a business in Israel. Specifically, support is available for business planning, market research, and relationship building with investors.[102] Participants can also expect support for application procedures for startup support public funds managed by the Israel Innovation Authority under the Ministry of Economy and Industry.

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http://www.ey.com/gl/en/services/tax/international-tax/alert--israel-reduces-tax-rates-starting-2016.

95 Nouman, L (2016) ‘Changes in the Israeli Tax Legislation - Significant Benefits for Corporates’, Lexology Newsfeed, 29 December
https://www.lexology.com/library/detail.aspx?g=606da418-2968-47bc-9113-4eb8ef8ccc19

96 Ibid.

97 According to the foreign exchange rate of Bank of Japan as of February 20, 2018, 1 shekel is equivalent to 0.292 dollars.

98 Yigal Aron & Co (2011) Memorandum: "The Angels' Law" – Israeli Tax Benefits for Individuals Investing in R&D Companies, 31 January, p. 2

99 FBC & Co (2016) ‘Amendments to the "Angels Law"’, Legal Update, February http://www.fbclawyers.com/wp-content/uploads/2016/02/Amendments-to-the-Angels-Law-and-Revisions.pdf

100 Ibid.

101 Startup Israel, New Immigrants and Returning Residents: General Information
http://www.startup-israel.org.il/new-immigrants-and-returning-residents/

102 Ibid.

In parallel, the Innovation Authority and the Population Immigration and Boarder Authority (PIBA) at the Ministry of Interior work together and issue work visas called Innovation Visas to foreigners who support startups.[103] Foreign entrepreneurs who opt to establish a company in Israel and conduct R&D activities will be entitled to this 24-month work visa. These entrepreneurs will be able to apply for additional funds including early-stage startup support grants, which are part of publicly-funded support programs managed by the Innovation Authority. If they are accepted by any of these programs, they will receive an Expert Visa, which will enable them to engage in R&D activities in Israel for up to five years.

3.3. History and overview of startup support programs

According to the breakdown of R&D expenditure of FY2015 by ministry and agency by the Central Bureau of Statistics, Israel, the Ministry of Economy and Industry spent the largest amount, around 2.1 billion shekels, followed by the Ministry of Agriculture and Rural Development which spent 440 million shekels and the Ministry of Science, Technology and Space which spent 330 million shekels.[104] Among these ministries, it is the Start-up Division and the Growth Division of the Israel Innovation Authority (formerly the Office of the Chief Scientist) under the Ministry of Economy and Industry that provide support mainly for startups.[105] The Start-up Division offers a variety of programs including one which funds startups in the pre-seed or initial R&D stage, another for young entrepreneurs, and the Innovation Visa program. Other divisions and bureaus also offer general R&D support programs.[106] (Figure 2)

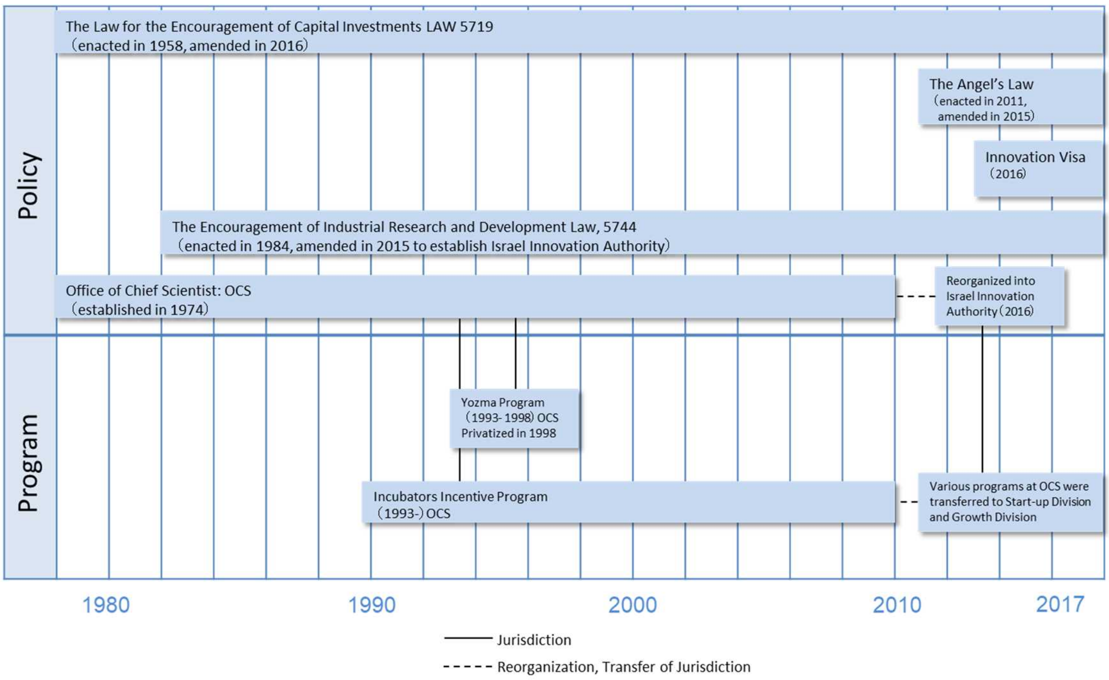

Fig. 2: Startup Support Policies and Programs in Israel
Source: Created by CRDS based on various materials

103 Israel Innovation Authority, Innovation Visas-About, http://innovation-visa.org.il/en/maslul.html
104 CBS (2016) Table.9 Expenditure of Selected Government Ministries on Civil R&D http://www.cbs.gov.il/publications16/1661/pdf/t09.pdf
105 IIsrael Innovation Authority, Startup Division, http://www.matimop.org.il/startup.html
106 For more details of public support programs in Israel, see the following: Griba, G., Zetelny, I., and Ginat, G. (2015) Government Incentives, January, EY Circular http://www.ey.co.il/circular/2015/01/_government_incentives_2015.pdf

Among many programs, we consider two particular public support programs as especially instrumental in realizing Israel's current competitiveness as a prominent startup nation. This chapter looks at them in detail. Both of these programs were started in the early 1990s, and contributed to attracting R&D funds from overseas, formulating the country's VC market, and efficient application of highly skilled talent including immigrants and workers in the field of defense. They epitomize the government's policy of strategically positioning startups as a measure to solve Israel's social and economic problems.

3.3.1. Yozma Program

One of the government's measures which drastically changed startup environments in Israel was promotion of venture capital. This promotion came in the form of the Yozma Program, which was implemented from 1993 to 1998. Israel needed venture capital back then due to the following reasons: While many entrepreneurs aspired to succeed with superior technology, few VC funds were available in Israel in the 1980s, and these entrepreneurs often failed because of a lack of practical knowhow of market development or difficulties in fundraising after establishing their companies. As well, some point out that entrepreneurs back then tended to seek bank loans because selling equity to outside investors in return for funding was not quite established as a fundraising method among these entrepreneurs.[107] However, they faced another issue here, which was a shortage of banks which would lend money to companies with uncertain prospects.[108]

It was Yigal Erlich, then-Chief Scientist of the Ministry of Industry and Trade who was in charge of startup support programs, that determined that promotion of venture capital in Israel would be the solution to these challenges. He argued for the need of a policy to attract private VC funds from overseas because he thought that it was they that had abundant capital, were equipped with skills for market development and management which would develop venture capital in Israel, were able to invest in high-risk R&D activities by raising capital from equity management, and had access to international markets.[109] This is how the Yozma Program was instituted.

3.3.1.1 Program outline

In 1993, the Yozma Program established a 100 million dollar investment company (Yozma Group) with public funds under the OCS. Its investments are designed as follows: 1) 80 million dollars for establishment of 10 private VC funds in Israel, and 2) 20 million dollars of direct investment in 15 companies. Both target early-stage startups.

Here, we look at the details of 1) establishment of private VC funds as it characterizes the program.[110] As preconditions for establishment, VC funds have to take the form of a business partnership with limited liability, and need participation of a managing company which is headquartered in Israel, an Israeli financial institution, and most of all a renowned private VC fund from overseas. The government funding was limited to eight million dollars (or 40% of the total capital raised) for one VC fund (limited liability business partnership). In other words, with the remaining 60% matched by private funds, each VC fund can raise up to 20 million dollars.[111]

3. Israel

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107 Lerner, J (2010) 'The Future of Public Efforts to Boost Entrepreneurship and Venture Capital', Small Business Economy, 35, pp.255-264, p.260
108 Ibid.
109 Erlich, Y (2003) The Yozma Program: Policy and Success Factors http://www.insme.org/files/527
110 Ibid.
111 Avnimelech, G (2009) VC Policy: Yozma Program 15-Years Perspective, SSRN http://dx.doi.org/10.2139/ssrn.2758195 For details of the Yozma Program's quantitative results, see this analysis by

By supporting 10 of such funds, the government support would amount to 80 million dollars in total.

3.3.1.2 Results

Established in 1993, the Yozma Group successfully established 10 VC funds by 1996. Funds were raised mainly from VC firms in the US and Singapore and some came from Japan, Germany and the Netherlands as well. Public funding ended in 1998 and these funds are now privatized.

By 1998, the Yozma Group raised total 263 million dollars from the public and private sectors, and laid groundwork for startup support.[112] The 10 newly established VC funds supported 217 startups in the initial five years, and exited from 56% or 122 of them (by IPO, M&A).[113]

During the period from 1993 to 2000, the rate of exits to the number of startups (2,672) in the whole country was 14% and that to the number of VC-backed startups 27% while the exit rate to the number of startups funded by the 10 venture capital funds established by the Yozma Program was higher – landing at 48%, showing a noteworthy result of the program.[114] During the same period, VC funds of the Yozma Group raised 3.2 billion dollars in total, which is reported to be as much as 48% of the total capital raised in Israel's entire VC market.[115]

Israel's Ministry of Finance argues that the increase in R&D funds from overseas for the purpose of supporting startups resulting from the success in the Yozma Program in the 1990s led to the development of Israel's environment where it spent more than any other country on R&D activities as a percentage of GDP.[116] In 1990, before the Yozma Program, the R&D budget of the OCS in then-Ministry of Industry and Trade was around 140 million dollars and private VC funds amounted to less than 20 million dollars. In other words, the government was the key source of fund for R&D activities in Israel. In 2000, however, the OCS budget was 440 million dollars whereas private VC funds grew to 3.1 billion dollars.[117] Clearly, private funds to support startups have become crucial to R&D activities in Israel.

As a byproduct of the Yozma Program, many point to the effect of cluster formation. As the Yozma Group grew, American manufacturers and pharmaceutical companies such as General Instrument and Johnson & Johnson in addition to IT companies such as Microsoft, Intel, IBM, and Cisco got their investments in Israel into full gear as partner corporations of VC funds of the Yozma Group. Thanks to this trend, Israel's VC market gained international recognition.[118] As well, startup-related businesses including accounting firms, law firms, patent offices, and consulting firms have joined the trend and produced a cluster effect in startup support in Israel.[119]

As of 2016, an overwhelming majority of corporate VC funds in Israel managed by multinationals is American while Asian countries are also increasing their presence. Especially noteworthy are +Alibaba Capital Partners of China, InfoSys of India, Samsung of South Korea, and Singtel Innov8 of Singapore, while Japanese companies such as Sony, Mitsui Global Investment, Yahoo Japan, and Softbank have also set up VC funds in the country.[120]

Avnimelech.
112 Ibid. p.3
113 Ibid. p.7
114 Ibid. p.9
115 Ibid. p.10
116 Ministry of Finance, op. cit.,9
117 Avnimelech, op. cit., p.10
118 The Yozma Group, Overview http://www.yozma.com/overview/default.asp
119 Avnimelech, op. cit., p.15
120 IVC Research Center, op. cit., p.48

3.3.1.3 Reasons for success

There are two main factors for the Yozma Program's success, both of which are related to the design of the program aiming to attract foreign venture capital. The first factor is the design of the matching fund. The Yozma Program enabled VC funds to buy back the government's stake in a fund under the program by paying an interest (around 5-7%) in addition to the initial investment made by the government within five years of the fund's establishment. It is a scheme where foreign VC funds can share the initial funding risk with the government of Israel, and if the established venture capital succeeds, it can buy back the government's investment at a low cost and have all subsequent profits to itself.[121] This made the Israeli market attractive to foreign private venture capital.[122] In fact, 8 out of the 10 private VC funds established under this program took advantage of this buyback scheme.

The second success factor is the development of a tax environment which invites investments from overseas VC funds. The Yozma Program requires participating venture capital to be newly established in Israel by forming a limited liability partnership with a foreign VC fund. Accordingly, the newly established venture capital is registered in Israel as a limited liability business partnership which does not have corporate status. In ordinary circumstances, investee companies (corporations) pay dividends to investors from what is left after they pay corporate tax. Then, the investors pay income tax according to the amount of dividends they received. As a result, profits of venture capital are taxed twice.

However, limited liability business partnerships, which do not have corporate status, are exempt from corporate tax on their profits. Only individuals who receive dividends from profits of a partnership (individuals who participate or individuals who manage corporations which participate in the partnership) are taxed, which makes it possible to avoid double tax.[123] As a result, partnerships can pay more dividends to investors. In addition, limited liability business partnerships enable investors to distribute profits and losses flexibly while, in case of corporations, profits and losses have to be distributed according to the percentage of investment.[124]

This type of limited liability partnership is an established practice usually called a Delaware partnership in the US, and can be construed as a factor which reduces obstacles when foreign VC funds try to make inroads into Israel. Dr. Josh Lerner, who studies cases of publicly funded startup programs of various countries at the Harvard Business School, indicates that the Yozma Program would not have succeeded in attracting funds from foreign VC firms if the government of Israel or the Ministry of Finance had not approved the said tax scheme.[125]

He also notes that it would be difficult for other countries to import such a program as is, and that the result would be largely dependent on their social and economic context. However, from his analyses of the designs of public support programs of various countries, he concludes that whether the government can share risk and attract private funds by providing a matching fund and then get them to lead the startup market will be a key consideration for the government when it develops a policy.[126]

[121] Lerner, op. cit., p.260
[122] Senor, D., and Singer, S (2011) Startup Nation: The Story of Israel's Economic Miracle, Twelve, New York (translated by Kiichi Miyamoto 2012) Diamond, Inc.) p.239
[123] "Pasu Suru Kazei no Arikata (Optimal Implementation of Pass-through Taxation)", Hiraku Hasebe (2007), The journal of National Tax College, vol.56, pp. 67-177
https://www.nta.go.jp/ntc/kenkyu/ronsou/56/02/hajimeni.htm
[124] Ibid.
[125] Lerner, op. cit., p. 261
[126] Ibid.

3.3.2. Incubators Incentive Program[127]

It was also the beginning of the 1990s when Israel instituted the Incubators Incentive Program (1991), which was going to play an important role in the creation of the country's startup environment. Incubators refer to corporations/organizations which are able to provide physical spaces needed for startup activities, practical legal/financial knowledge, and various other forms of support including a matching service between managerial talent and engineers. Incubation is a common program in startup support but Israel back then was in a special context which made incubators especially important, namely, settlement of a huge number of immigrants from member states of the former Soviet bloc and creation of jobs for researchers and developers in the domestic defense industry.

First, regarding the settlement of immigrants, a great many Jewish people from the former Soviet Union countries settled in Israel as a result of the end of the Cold War (fall of the Berlin Wall) in 1989. What deserves attention here is the sheer number of research and development personnel who found a new home in Israel. As Science Magazine reports, the Russian Jewish immigrants started to pour in from right before the end of the Cold War, and immediately after the end of the Cold War the Russian-speaking immigrants already numbered 900,000 in the country which had a population of six million back then.[128] While this influx of immigrants had a serious social, economic impact on the country including heightened unemployment, many of them were highly skilled immigrants with high education, and as of the end of 1991, as many as 53,000 scientists were registered with the Ministry of Immigration.[129] Another statistic reports the settlement of Russian-speaking immigrants from 1990 to 1993, 57,000 of whom were engineers and 12,000 medical doctors.[130] This flood of highly skilled immigrants was especially significant, considering the fact that as of 1989 Israel had 30,000 engineers and 15,000 medical doctors.[131] The government was faced with an immediate challenge of utilizing these highly skilled immigrants in a way that would allow them to contribute to the society and economy.

At the same time, the Israeli government also had to create jobs for engineers in the country's defense department. Because of the repeated Middle East Wars after the founding of the country, Israel's defense spending continued to grow, putting pressure on the state's finances. Because of this, the government had to, for instance, suspend R&D activities for the domestic fighter Lavi and decided to purchase the less costly F-16 from the US in 1987.[132] After that, defense expenditure continued to fall. As a result, the government had to create jobs in industry for engineers specializing in cutting-edge aerodynamics, information science, and electrical engineering.

This is what put the government of Israel into a situation where they had to deal with the massive number of immigrants and to create jobs for engineers working in the country's defense sector. One obvious problem was that coming from the socialist bloc, the immigrant researchers and engineers had expertise in R&D activities but did not have a good command of Hebrew or English or other socially required skills, let alone practical experience in commercial activities.[133]

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127 Israel Innovation Authority, Incubators Incentive Program, http://www.matimop.org.il/Incubators.html
128 Stone, R (1999) 'Israel Hits Rich Seam in Ex-Soviet Immigrants', Science, 285(5416), pp. 892-897 http://science.sciencemag.org/content/284/5416/892.full
129 Ibid.
130 Cohen, S. and Hsieh, Chang-Tai (2000) Macroeconomic and Labor Market Impact of Russian Immigration in Israel
131 Ibid.
132 Ng. T (2014) 'Innovation and Technology Industry and Intellectual Property System in Israel', Information Notes, IN13/13-14, Legislative Council Secretariat, Legislative Council, HK. p.1
133 Trajtenberg, op. cit., p.10

In other words, in those days, Israel needed a system which would teach researchers and engineers to engage in R&D activities with commercialization in mind, train them on practical experience, and provide them opportunities to work with managerial talent. Based on such social demand, the OCS instituted a number of programs in 1991, one of which was the Incubators Incentive Program.

Originally set up by the OCS under the Ministry of Economy and Industry, the program is now under the control of the Start-up Division of the Israel Innovation Authority (IIA). As of November 2017, 19 incubators were providing support to entrepreneurs across the state.[134] Close to half of the startup projects supported by the incubators are in medical equipment, drug discovery, and other life-related fields, other 30% in the fields of information science and technology, and the rest in the fields of clean tech, electronics, etc.[135]

3.3.2.1 Program outline

This program provides support for startups' fundraising and basic startup activities to expand business partnerships through the government-supported incubators, which are organizations (private VC firms and corporations with R&D departments) that can support entrepreneurs. In other words, the program supports startups in their riskiest stage. Incubators accepted in this program are able to operate for eight years with a license from IIA.

Entrepreneurs who wish to use an incubator's service are funded for a launch of their business, 85% by IIA and the other 15% by the incubator. Therefore, they don't have to pay anything when they start a business. The fund provided by IIA, accounting for 85%, is up to approx. one million dollars for a period of two years, which could be extended. If the startup works with an incubator specializing in biotechnology, the one million dollar cap of 85% of the support can be raised up to around 2.3 million dollars for a longer span, a minimum of three years. The other 15% is contributed by the incubator. One of the 19 active incubators in FY2017 is certified as an incubator specializing in biotechnology.

In addition to financial support, by working with an incubator, startups will be provided with physical spaces/facilities required for launching a business, support for various administrative procedures including corporate registration, support for business planning, support for IP-related procedures, legal advice, market research, potential financiers for additional funds and customer leads, and the incubator will secure staff that can take charge of these accordingly.[136] One of the advantages of participating in this program is that establishment of a company is not necessary until IIA approves the applicant's project. So, an applicant is required to establish a business only when IIA has determined that their project is promising.

Regarding the selection process, entrepreneurs first present their startup projects to one of the 19 incubators they wish to receive support from, and then they apply for financial support to IIA for the project the incubator has approved. Entrepreneurs move on to establish their companies as soon as their projects are approved. Projects are screened against the following criteria: being an early-stage R&D startup, innovativeness/uniqueness of the product, potential market competitiveness, and feasibility.[137]

Under this program, each project will be set up as a limited liability company. At this point, an

[134] Israel Innovation Authority, Incubators Incentive Program, http://www.matimop.org.il/Incubators.html
[135] Smoler, Y, Technological Incubators Program, p.15
[136] Pridor, R (2009) Technological Incubators Program, p.11 https://www.infodev.org/infodev-files/resource/InfodevDocuments_709.pdf
[137] Smoler, op. cit., p.11

entrepreneur and an incubator who provides support will agree on rights and obligations. One of such arrangements is about the equity ratio and the entrepreneur is required to have at least 50%. Core members of the startup other than the founder are also required to have at least 10% of the company. Other members who can provide additional funds as well as the incubator are allowed up to 20% of the company. The incubator can transfer their membership, which is based on the percentage of their investment, to external investors.[138] Therefore, incubators are not necessarily involved in the rights and obligations of the company.

3.3.2.2 Results

At the time when the program was established in 1991, the government budget for incubator support was around 5.1 million dollars but there was virtually no private funds available for incubator support. However, partly due to the sharp rise in private venture capital from the aforementioned Yozma Program, private funds to support domestic incubators in Israel also grew in the late 1990s. Accumulated private funds for incubator support amounted to around 250 million dollars in 1998, exceeding the accumulated government fund of around 190 million dollars, and then further increased during the following 10 years through 2008 to around 2.5 billion dollars, about five times as large as the government accumulated fund back then of 510 million dollars.[139] During the period from 2004 to 2008 when private funds surged, there were 342 cases of incubator support provided to startups and an annual total of 50 to 80 million dollars of the early-stage startup fund was successfully raised.[140]

With regard to the degree of involvement of new immigrants in this program, it is indicated that around half of the 200 projects helped by 27 active incubators as of 1997 were proposed by immigrants while around 70% of members of all projects were immigrants.[141] This confirms that funds surged in the late 1990s, during which many immigrants participated in the program.

While this program was a success, investment by incubators inherently entail the highest risk as they support startups in the earliest stage. For this reason, it is reasonable to assume that many projects actually fall through, and therefore Rina Pridor, the first program manager at the OCS, argues that continuous public financial support, even if it is not much, is essential.[142]

As indicated by the two programs introduced in this section, the government support programs of the 1990s played an important role in establishing today's startup environment in Israel. To make the most of the highly skilled talent that came to settle after the end of the Cold War and to mobilize engineers working in the domestic defense sector so that they could contribute to the country's economic growth, the government also introduced the Yozma Program which was designed to attract required private capital and startup trainers from overseas. The cases of these two programs show that the government of Israel effectively implemented the most required measures according to the country's unique social and economic context. The 1990s were crucial years for the Israel of today, which is a highly competitive Startup Nation.

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[138] Pridort, R (1997) 'Technological Incubators Program: Israel', Technology Incubators: Nurturing Small Firms, OCDE/GD(97) 202, OECD, Paris, pp.90-97, p.94
[139] Smoler, op. cit., p.16
[140] Raised in VC investment called Series A rounds, based on the assumption of 3 to 8 million dollars per portfolio company. The amount has grown higher in recent years. Pridor, (2009) op. cit., p.25
[141] Ibid., p.96
[142] Pridor (2009) op. cit., p.21

3.4. R&D startups from universities, related measures and case examples

3.4.1. Mobileye

Mobileye is an important example of an R&D startup in Israel, especially one that is related to a university. As an Israeli startup, Mobileye launched the biggest IPO ever in the US and was later acquired at the highest price ever. Mobileye is also noteworthy in that it attracted attention to how intellectual property should be managed at universities. First, let's briefly look at the company. Mobileye is a startup established in 1991 by Dr. Amnon Shashua of the Hebrew University of Jerusalem together with Ziv Aviram from the industry circle. The company develops advanced driver-assistance systems (ADAS) which contribute to prevention of accidents during driving. The company went public on the New York Stock Exchange (NYSE) in August 2014 and as of August 2017 it is valued at around 14.1 billion dollars.[143]

The founder Dr. Shashua studied at the Tel-Aviv University and the Weizmann Institute of Science, and then went on to the Massachusetts Institute of Technology (MIT) of the US, where he received his PhD in brain and cognitive sciences. He then took up a position at Hebrew University, which led to the launch of the company. He is currently CEO and CTO at Mobileye and at the same time an endowed chair of the school of computer science and engineering, Hebrew University.[144]

3.4.1.1 Core technology

Mobileye provides ADAS technology which helps prevent accidents by detecting obstacles during driving with a mono camera, notifying the driver, and learning the driver's driving patterns. It is a computer chip called "EyeQ" that is the central part of ADAS technology. This technology is considered to play a core part in realizing a future automated driving system, and therefore Mobileye is attracting attention. Automated driving will require sensing technology, high resolution cameras, radars, real-time information processing capabilities in networks of inside/outside of the vehicle, and cybersecurity measures. The company is now working on development of chips with application to Level 5 automation, which is, full automation.[145] The company's technology has been adopted by 27 auto manufacturers (more than 15 million vehicles).[146]

3.4.1.2 Topics

This report presents two topics concerning Mobileye; one is about the scale of the company's IPO and acquisition and the other is about IP management at the university. Mobileye went public on the NYSE in August 2014, raising around 890 million dollars, the largest amount ever in the US by an Israeli startup.[147] Then in March 2017, to accelerate its effort in automated driving, Intel of the US announced that it would acquire Mobileye for around 15.3 billion dollars (1.73 trillion yen), and the deal became the largest acquisition of an Israel startup. Intel is expected to step up its effort in competition with NVIDIA and Qualcomm both of which are making advanced

143 NASDAQ (2017) Mobileye N.V. Quote & Summary Data, Accessed 12 September http://www.nasdaq.com/symbol/mbly
144 Faculty, the Rachel and Selim Benin School of Computer Science and Engineering, Hebrew University of Jerusalem, http://www.cs.huji.ac.il/people/faculty
145 Mobileye, the Evolution of EyeQ https://www.mobileye.com/our-technology/evolution-eyeq-chip/
146 Mobileye, Customers http://www.mobileye.com/about/our-customers/
147 Gensler, L (2017) 'Mobileye Caps Wild Ride On Stock Market With $15.3 Billion Acquisition', Forbes, Investing/#Stockwatch, 13 March https://www.forbes.com/sites/laurengensler/2017/03/13/mobileye-stock-intel-acquisition/#10ec32f34f08

effort for chip development for automated driving.[148]

3.4.1.3 Mobileye and technology transfer at universities

Apart from the large acquisition mentioned above, Mobileye also provides an interesting example of a relationship between a startup launched by a university researcher and their university. As co-founder Dr. Shashua was a researcher of Hebrew University, the relationship between Mobileye and the university drew people's attention. Hebrew University was publicly pleased at the company's global success.[149] However, Israel's newspaper Haaretz reports that the university's revenue from the growth of Mobileye is limited.[150] Upon the establishment of the company, there was an argument concerning treatment of IP between Dr. Shashua and Hebrew University. This is because back then he did his research in a variety of sites and occasions outside of Hebrew University including when he was on sabbatical, at Mobileye itself, and at another university (Israel Institute of Technology), so the situation was too complicated to let them determine that his research belonged to Hebrew University.[151] The university and Mobileye agreed to go to arbitration in the beginning of 2000 and the university gained a relatively small portion of the company accordingly. After Mobileye was floated, the university eventually sold the shares and gained a profit of 40 million dollars.

The same article of Haaretz provides arguments about whether a university should take a stricter approach to the treatment of IP or a more relaxed approach to encourage researchers to found businesses. Eventually, Hebrew University chose to provide an environment that would encourage researchers' initiative. The article also reports that the university rated Mobileye's efforts highly and requested Dr. Shashua to stay with the university.[152] The case of Mobileye is important when trying to understand what a business launch means to universities (securing of funds, patent strategies, availability of TLO, etc.) in Israel which does not have an equivalent of the Bayh-Dole Act.

3.4.2. Patents law and technology transfer at universities

IP management is an important issue in university startups. As Israel does not have an equivalent of the Bayh-Dole Act, IP created by industry-academia cooperation does not automatically belong to the university concerned. For this reason, universities and research institutions set rules on IP management individually based on the Patents Law.[153] Israel's Patents Law stipulates that an invention by an employee shall become the employer's property in the absence of an agreement to the contrary between them. Dr. Hagit Messer-Yaron, who served as the Chief Scientist at the Ministry of Science from 2000 to 2003, points out that as Israel's Patents Law does not cover much academic-research-related content, rules concerning university R&D projects jointly done with industry are left up to individual agreements between a university and a company. In general, outputs of research done by university researchers belong to the university and commercialization of such outputs is centrally managed through a technology transfer corporation of the university. Profits gained from commercialization are distributed to the

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148 Cohen, T., Rabinovitch, A., and Lienert, P (2017) 'Intel's $15 Billion Purchase of Mobileye shakes up Driverless Car Sector', Reuters Business News, 13 March

149 Intel to Acquire Israeli Tech Firm Mobileye for $14.7 billion, JTA News Brief, 13 March 2017 http://www.jta.org/2017/03/13/news-opinion/israel-middle-east/intel-to-acquire-israeli-tech-?rm-mobileye-for-14-7-billion

150 Amit, H. and Zerachovitz, O (2017) 'How Israel's Hebrew University Lost a Mobileye Windfall', Haaretz, 23 March http://www.haaretz.com/israel-news/business/1.779258

151 Ibid.

152 Ibid.

153 Patents Law 5727-1967, a) section 132 Chapter 3

university and the researcher, where the researcher takes around 40 to 60%. If the technology transfer corporation does not apply for a patent, then the researcher is allowed to do so at his or her own expense.[154]

With regard to rules concerning cases where a university takes equity of the company which is newly established based on an invention done at the university instead of patent license fees, demanding a lot of shares in the company will hinder entrepreneurship while requiring too few shares of the company will make little money for the university. Many watch keenly what kind of strategies individual universities will take in terms of promotion of academia startups in the future.

Major universities and research institutions in Israel have outside technology transfer corporations, which undertake IP management and licensing concerning R&D outputs of academia. T3 of Israel Institute of Technology (Technion), Yissum of Hebrew University, and Yeda Research and Development Company of the Weizmann Institute of Science play a key part in technology transfer individually. For instance, the Technion Research & Development Foundation Ltd. which has T3 under its wing and is in charge of financial matters in general of the Israel Institute of Technology made around 29.40 million dollars of commercial profits from technology transfer in FY2014.[155] In our interview for this report, some said that as grants for university operational expenses provided by the government were not substantial, external funds including income generated from technology transfer and donation from overseas were important to universities. In addition, for the purpose of enhancing cooperation among technology transfer corporations, the Israel Tech Transfer Organization (ITTN), a nonprofit organization, is operating to promote development of a network of domestic technology transfer corporations and currently has 12 member corporations on board.[156]

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[154] Messer-Yaron, H (2014) 'Technology Transfer Policy in Israel - From bottom-up to Top down?', 6th Meeting of the European TTO Circle, 20-21 January, Tel Aviv, Israel, pp.18-20

[155] Technion (2015) Report of the President 2015 https://www.technion.ac.il/wp-content/uploads/2015/06/President-Report-Extended.pdf

[156] Israel Tech Transfer Organization http://www.ittn.org.il/index.php

3.5. Characteristics of startups in Israel

This chapter so far has presented how Israel's startup environment grew mainly by looking at the government measures. However, there were multiple other factors in play to realize the superiority of Israel's startup environment over other countries. Among them are the country's R&D quality which is good enough to attract investments from overseas, the conscription system and unique R&D environments in the military, the culture of encouraging entrepreneurs and allowing failures, a variety of players who support startups, and cooperation with international markets. This section provides supplementary explanation of these factors.

3.5.1. What lies behind development of entrepreneurship

There are many other factors which supported Israel's startup environment. One report released by CRDS, JST in 2011 summarizes the background of the development of its highly entrepreneurial spirit as follows:

> "There are few 'stable companies' including large companies as the country has gone through drastic development or few wish to grow their companies large because of the unstable political conditions; the public are eager to take on new challenges as they have a sense of urgency due to the unstable political conditions; a majority of the population are immigrants, including those from the former Soviet Union countries, who do not have stable foundations of their livelihood in Israel, and view a 'business launch' as not a risk but an opportunity and a preferred option; the country had strong potential in technology and infrastructure as they could divert military technology for civil purposes; and there were many startup success stories."[157]

In other words, the report argues that there was no specific factor that single-handedly realized the country's strong entrepreneurship but social, economic and geopolitical environments all played their parts on multiple levels.

3.5.2. The conscription system and R&D activities in Israel

Under the universal conscription system, Israeli men and women have to serve in the army generally for three years and two years respectively. Israel's universal draft has some unique characteristics. First, upon graduating from high school, the most excellent talent from all over the country, especially those who excel at math or physics, are assigned to the R&D department. By placing those first-class personnel to the R&D unit whose aim is to conduct cross-disciplinary research of the problem-solving-type which could be immediately applied to actual warfare, the country secures superiority in military technology, and then people who received R&D training in the unit go on to participate in technology transfer or economic activities in corporations after completing their military service.[158] Because the country is situated in the geopolitically uncertain location in the Middle East and it is therefore indispensable to secure superiority in military technology to make up for the country's small size and population, the Israeli government has been keenly aware of the importance of R&D activities as a national policy.

157 "STI Policy Trend in Israel FY2010", JST/CRDS (2010), CRDS-FY 2010-OR-03 p.11, https://www.jst.go.jp/crds/pdf/2010/OR/CRDS-FY2010-OR-03.pdf

158 Senor, D., and Singer, S (2011) Startup Nation: The Story of Israel' s Economic Miracle, Twelve, New York (translated by Kiichi Miyamoto (2012) Diamond, Inc.) p.101

Technologies derived from the Talpiot program, which recruits the first-class talent in math or physics when they join the Israeli army and conducts cross-disciplinary research, the Unit 8200, which is the elite intelligence corps unit, and cyber units of air force, etc. play key roles in Israeli startups. By working for R&D teams contributing to solving problems of actual warfare, people in these units will develop management skills required for R&D activities aimed at solving civil problems. As pointed out by some people, one of the purposes of many IT multinationals from the US and other countries establishing R&D centers in Israel is acquiring not individuals but a team of highly skilled talent who are part of the network developed by the universal conscription system.[159] For instance, a think tank called Team8, which is made up of former Unit 8200 members who excel at cyber technology, currently receives investments from Microsoft, Google, Cisco, and Accenture in its business model where it undertakes in endeavors ranging from strategy development to startup financing.[160]

3.5.3. Culture of allowing failures

A book titled "Secrets of Start Up Nation Israel," which discusses Israeli startups in a comprehensive way, explains how those who failed once try again in Israel.[161] First, the book points out that after serving the army, those who aspire to engage in research and development have career options, say, going on to university, starting a company, taking up a position in a global corporation's R&D department or working part time in a global corporation's R&D department while they are still in university. If they start a venture from the R&D department of a corporation, and the startup does not work out, they can return to the same corporation or get a position in another firm's R&D department as a "normal career path".[162]

The book stresses the importance of such an option being actually secured to those who failed, and indicates that without it, starting a business would not be as easy in Israel. In other words, many people embark on their entrepreneurial journeys, not just because they are eager to take on new challenges or were taught entrepreneurship but because they have options to avoid actual economic risk available.

3.5.4. Variety of players who support the startup environment

Apart from domestic and foreign VC funds, individual investors (angels), the army, the government, and universities, various players are making important efforts in supporting Israel's startup environment. This chapter looked at incubators as part of the government support program. Similar to incubators are accelerators which have quickly been growing in number in Israel in recent years. Although details vary depending on the institution, accelerators provide a wide range of support to startups including assistance in management practice, market development, corporate strategy development, and recruiting in addition to provision of physical spaces and funds as done by incubators. However, accelerators differ from incubators in that accelerators typically set a certain support period, provide intensive support (with a strong nature of training) in a short period, and intervene more actively in how startups use their time and resources. Accordingly, accelerators have to bear a heavier burden and thus may apply stricter screening before accepting startups.

[159] Based on our interview for this report.
[160] Team8 https://www.team8.vc/
[161] "Sutatoappu Taikoku Isuraeru no Himitsu (The secret of start-up nation: Israel)", Seiji Kato (2017)
[162] Ibid., p. 35

The number of accelerators in Israel in 2009 was around 20, which grew to 280 in 2016.[163] They include organizations established in higher education institutions and supporting creation of business by students, alumni, and other people related to universities. For instance, accelerators are available at Ben-Gurion University of the Negev[164], Hebrew University[165], Tel Aviv University[166], and Israel Institute of Technology[167]. MassChallenge, the world's largest accelerator from Boston, the US, which supports startups by prizes not investments, also set up a branch in Israel in 2016, running it together with other overseas branches in Switzerland, the UK, and Mexico. The objective of MassChallenge Israel is to bring Israeli companies to the global market.[168]

It is also important to secure office spaces appropriate for startups. Starting a business requires an economical place where a few people can work. WeWork, based in New York, the US, which runs office space rental business globally, currently provides office spaces in seven locations in Israel including Tel Aviv, Herzliya, Haifa, and Beersheba,[169] while Israel's Mindspace currently doing business in London, Berlin, and other cities in total six countries also offers office spaces in its home country.[170] Incidentally, as of November 2017, WeWork rents out office spaces in three locations in Japan, four in South Korea, and nine in China.

The industry circle may not be willing to invest in R&D activities in highly public sectors such as education because of unclear marketability. Such sectors are also difficult for the government to support because it is too large to implement short-term small-scale experimental projects. For this reason, there are non-governmental organizations (NGOs) specializing in support for startups in the fields of a highly public nature.[171] For instance, the Israel Innovation Institute promotes development of education support technology for primary and secondary education, especially for math and science, which lags behind in economic development in Jerusalem. It supports startups which build databases to provide customized study plans and methods for each student through digital technology and develop other related technologies. To be more specific, rather than aiming to fund development of specific technologies, the Israel Innovation Institute supports development of an ecosystem in which people, goods, and money will work together to solve specific problems by providing necessary coordination with educational administration for technology development, grasping the demand of front-line teachers, and supporting networking efforts for fundraising.[172]

Clearly, a variety of players are working at multiple levels to realize Israel's startup environment and their network expands overseas, which adds to the strength of the country's startup environment.

3.5.5. Access to overseas markets

While startups in Israel, which are small in terms of economy, have no choice but to enter overseas markets, there are many projects underway to connect Israeli startups and foreign multinationals and investors. For example, Startup Nation Central (SNC), a nonprofit

163 IVC Research Center, op. cit., p.49
164 BGU Innovation Lab https://bengisc.wixsite.com/bginnovationlab
165 HUstart http://hustart.com/biogiv/
166 Brainboost http://neuroscience-innovation.org/
167 Technion Drive https://www.techniondrive.com/
168 MassChallenge Israel http://israel.masschallenge.org/
169 WeWork https://www.wework.com/l/israel
170 Mindspace https://www.mindspace.me/
171 Israel Innovation Institute https://www.israelinnovation.org.il/
172 Ed.il https://www.edisrael.org/

organization, sends information on Israeli startups to foreign corporations which could potentially acquire or partner up with them. While encouraging networking efforts in Israel, SNC places a top priority on promoting a tie-up with foreign capital. The most important project of SNC is development of a database called Start-up Finder.[173] Here, SNC provides a summary and contact information of startups to interested parties overseas, assisting development of direct relationships and mediating between the two sides. SNC also answers inquiries concerning Israel's startup environment. As a nonprofit, SNC is funded for these activities from the outside, mainly the US.

Israel also hosts some international conferences and events. Digital Life Design (DLD), a startup event which originated in Germany, has been held every year since 2011 as part of the Tel Aviv Innovation Festival, and it is Israel's largest event in this field. Israeli startups, mainly in information technology, financial institutions supporting startup environment, Israeli government, and the public and private sectors from other countries run booths at this event and get to know each other. In the 2017 DLD, incubators from Guangzhou, China, Samsung of South Korea, and French Tech, French-government-funded startup talent exchange program, in addition to US corporations such as Google, Microsoft, Amazon, and Facebook, set up their booths and the number of Japanese participants increased as well.[174] As for medical-related industries, an international conference called National Life Science and Technology Week (MIXiii Biomed) is held. Hosted by the Mayo Clinic of the US among others, this conference holds presentations by many TLOs of Israel's major research-focused universities, and many startups set up their booths as well.[175]

3.5.6. Connection to Japan

With regard to cooperation between Japan and Israel, apart from the Japanese Embassy, the Japan External Trade Organization (JETRO) has established an office[176] in Israel, providing a range of support for not just startups but various efforts between the two countries. JST has also promoted the Strategic International Research Cooperative Program in the fields of life science and information science.[177] New Energy and Industrial Technology Development Organization (NEDO) provides support in the fields of energy, mechanical systems, information technology, and nanotechnology in its international R&D project.[178] As organizations based in Israel aiming to connect Israeli startups and Japan, Samurai Incubate[179] and Aniwo[180] among others create a bridge between entrepreneurs and investors in the two countries. Million Steps Ventures, which is headed by a former Unit 8200 member and headquartered in Tokyo, stimulates demand of Japanese corporations which are not necessarily familiar with Israel's startup environment and provides services connecting the two countries by leveraging a variety of technologies and personal connections available to the Unit 8200 alumni and basing itself in Tokyo.[181] In addition,

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173 Start-up Nation Finder https://finder.startupnationcentral.org/
174 DLD Tel Aviv September 4-7 2017 https://www.dldtelaviv.com/
175 16th National Life Sciences & Technology Week, May 23 - 25, 2017 | David InterContinental Tel Aviv, Israel http://kenes-exhibitions.com/biomed2017/
176 JETRO Tel-Aviv office https://www.jetro.go.jp/jetro/overseas/il_telaviv/
177 JST Strategic International Research Cooperative Program, Israel https://www.jst.go.jp/inter/sicp/country/israel.html
178 NEDO, re: Public solicitation concerning FY2017 "International R&D/Cofounding Project/Japan-Israel R&D Cooperative Program"
http://www.nedo.go.jp/koubo/AT092_100106.html 176 Mindspace https://www.mindspace.me/
179 Samurai Incubate Inc. http://www.samurai-incubate.asia/about
180 Aniwo http://aniwo.co.il/index.html
181 Million Steps Ventures http://millionsteps.vc

at the Embassy of Israel in Japan, the Economic Department, Science Department, and Cultural Affairs Department among others conduct various activities towards enhancement of the startup ecosystems in the two countries.[182]

3.6. Summary

As indicated throughout this chapter, Israel, which is called a “Startup Nation”, is not a country where people are just enthusiastic about launching their own businesses but one which has strategically promoted startups because the country’s economic growth is dependent on nothing else but R&D activities by startups. In other words, Israel found a solution to the problem of the entire country in startups. The country stayed in the economic doldrums since its founding to the 1980s, and the government implemented its basic policies and R&D support programs, aiming to grow the economy in geopolitical uncertainties including the Middle East Wars. As a result of such efforts, the country was able to grow its economy based on the success of startups. For this reason, if one succeeds in a startup venture, they are considered a social success. That way, formation of a culture of entrepreneurship is supported recursively in Israel.

Japan, on the other hand, may be called an “advanced country facing new challenges” as we head into the era of a super-aging society, ahead of other developed nations. If by utilizing startups Japan can show brand new solutions to these challenges, Japan may be able to export Japan’s solution models to other countries when they face similar problems. In fact, using startups to solve Japan’s most serious social challenges may lead to a competitive advantage for Japan in the global market. Deciding how to employ startups to solve the problems Japan faces ahead of other countries is a challenge worth exploring as it makes sense as a matter of policy and helps improve social recognition of startups.

As this chapter discussed, a key effort in designing Israel’s public support programs was attracting foreign funds. The typical flow designed by the government is attracting funds from overseas, employing technology and talent of Israel, and entering international markets through acquisition. Based on the strategy to make full use of financial and human resources not only in the country but in the world, a variety of players inside and outside of the country work on multiple levels to realize Israel’s startup environment. Israel is increasingly employing resources especially from other countries. In Japan’s startup environment, the use of overseas venture capital funds is limited. According to Japan Venture Research, among the top 30 VC investors to Japanese startups, six of them were foreign venture capital firms, investing around 4 billion yen in total in 2013.[183] In the meantime, Israel attracted VC funds equivalent to around 240 billion yen from overseas the same year. In 2017, 97 Israeli startups were traded on NASDAQ, making the country the world’s third largest, whereas Japan had 14.[184] Going forward, we need to analyze institutional problems which make it hard to attract foreign capital that is available for Japanese startup support, and to deliberate on our startup strategies in expectation of future acquisition in overseas markets.

[182] Embassy of Israel in Japan http://embassies.gov.il/tokyo/Pages/default.aspx
[183] Masuda, S. http://jp.techcrunch.com/2014/03/17/jp20140317jvr/
[184] NASDAQ Companies by Region http://www.nasdaq.com/screening/regions.aspx#

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4. The United Kingdom

As expectations grow in the UK for startups as a means to commercialize new knowledge and technology created at universities or research institutions and to implement them in society, people have gradually recognized the importance of spinouts from research outputs and support programs are increasing in number and quality, although not so large. UK universities, however, are not blessed with a budget as ample as their US counterparts, which are able to invest generously in seed-stage research that is considered only slightly promising. For this reason, public institutions and the Royal Society among others provide support to make up for the shortfall.

This chapter explains the current situation UK startups are facing, the government policies, support programs and support institutions, presents cases of R&D startups using seeds from universities, and aims to study their characteristics.

4.1. The current state of the UK and situations surrounding startups

The UK boasts the world's top-level scientific capabilities, and offers good research environments and related support programs to maintain such capabilities. The country's excellence in science is supported by universities, many of which rank highly in the world's university rankings, showing their strong competitiveness. Universities in the UK have traditionally enjoyed a high degree of autonomy, which has helped create a liberal culture, in which high-quality talent from inside and outside of the country have mingled and realized superb research and high-level education.

In the meantime, some are concerned that sufficient systems or measures are not in place to utilize outputs of scientific research by universities for the society and economy through their practical application and commercialization, and the UK government is trying to overcome this challenge. Aware of insufficient utilization of scientific research outputs especially during and after the Blair administration, the UK government has adopted an innovation policy contributing to practical application of research outputs and promoted knowledge transfer from universities to industry. Knowledge transfer here refers to not just unilateral transfer of technology from academia to industry but exchange of knowledge in general, which includes industry providing feedback. In the UK, this concept has been expressed as "knowledge exchange" in recent years.

This is how practical application and commercialization of research outputs emerged as an important topic in universities in the 1990s and thereafter. During the same time, many companies were established to strategically manage IP of universities. Institutions specializing in technology transfer were set up as stock companies inside universities to discover promising seeds early on and to contribute to universities' revenue, development of local economies, and creation of employment. Major ones include Imperial Innovations of Imperial College London, Oxford University Innovation of Oxford University, and Cambridge Enterprise of the University of Cambridge.

Public research funds provided to UK universities are mainly made up of two streams of funds: block grants (equivalent to grants for operational expenses in Japan) distributed through local Higher Education Founding Councils (HEFCs) and competitive research funding provided through Research Councils (RCs). According to the breakdown of revenue in FY2013, grants from HEFCs accounted for 19.8% of total revenue of universities in the UK, second only to tuition fees, which represented 44.5%. Research grants provided by RCs for each project and income from contract research follow, together accounting for 16.5%, and donation and investment income made up 1.1%. Based on this, Figure 1 shows the breakdown of the total income of 30.7 billion pounds[185].

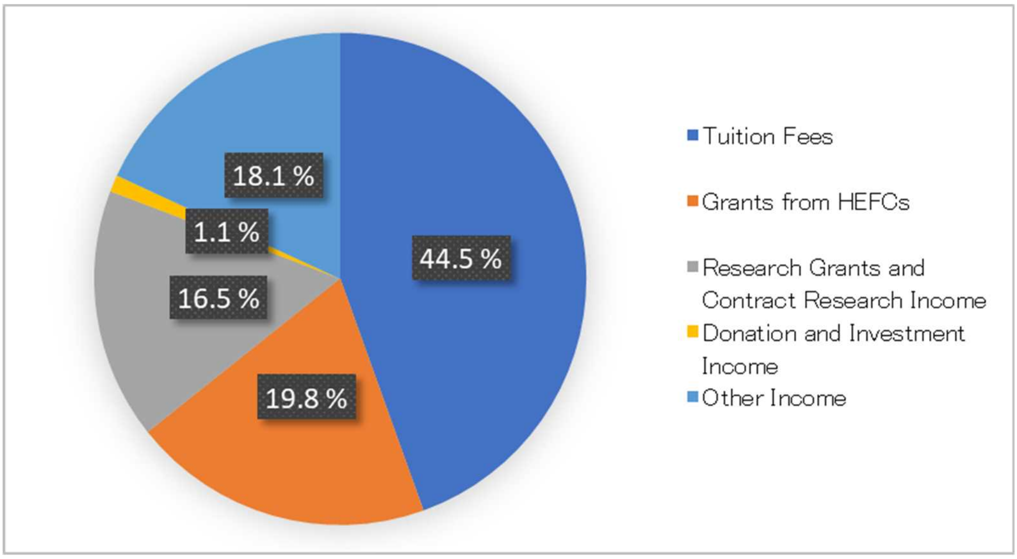

Fig. 1: Breakdown of the total income of Universities in UK (FY2013)
Source: Created by CRDS based on information on the website of the Higher Education Statistics Agency (HESA)

Please note that the revenue breakdown shown in Figure 1 is only the average of all universities, and it does not necessarily include some major research-focused universities. The revenue breakdown of five major universities (University of Cambridge, Oxford University, Imperial College London, University College London, and King's College London) in the golden triangle in the suburbs of London greatly differs from the average of all universities in that, in these five universities, tuition fees account for only 24.5% whereas research grants and contract research make up as much as 37.7% of income. In the meantime, grants from HEFCs account for 17.9%, not very different from the average of all universities.

Block grants from HEFCs are largely divided into research grants and education grants. While the amount of the former remains almost the same, that of the latter has plummeted in recent years. Figure 2 presents changes in the budget of the Higher Education Funding Council for England (HEFCE)[186] which has jurisdiction over England. It clearly shows a huge drop in the amount of education grants.[187] Education-focused universities which are not able to receive a large amount of research grants could not help but increase revenue from tuition fees to make up for the reduced grants. However, annual tuition fees for domestic students at most universities are currently capped at 9,000 pounds, and may be raised up to 9,250 pounds, considering inflation, but do not have much room for further increases.

185 According to the foreign exchange rate of the Bank of Japan as of February 20, 2018, 1 pound is equivalent to 153 yen.
186 In April 2018, United Kingdom Research and Innovation (UKRI), which is a comprehensive funding institution, and the Office for Students (OfS), which is in charge of regulating and supervising the entire higher education sector came into existence. The former HEFCE and the Office for Fair Access were discontinued and many of their functions have been transferred to the newly established OfS under the Department for Education. Seven Research Councils (RCs), Innovative UK, and Research England have come under the wing of UKRI, and under the control of BEIS. Research England has taken over some of HEFCE's responsibilities including research evaluation and distribution of block grants for universities and promotion of industry-academia cooperation.
187 http://www.hefce.ac.uk/pubs/year/2015/201505/

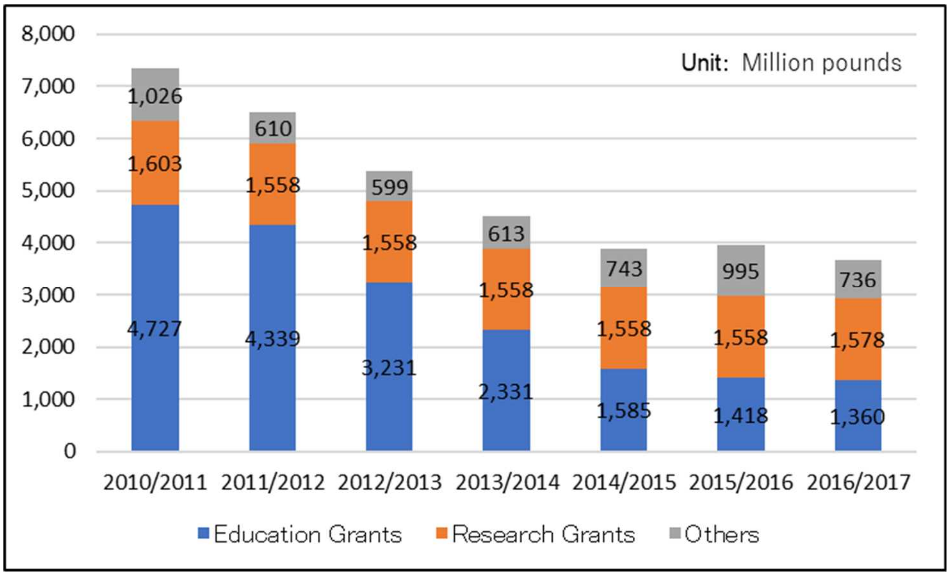

Fig. 2: Changes in the Budget of the Higher Education Funding Council for England (HEFCE)
Source: Created by CRDS based on information on the website of HEFCE

As grants have been on the decline in recent years and tuition fees are not expected to rise very much, universities are increasingly interested in support for and investments in their spinout companies[188] which could contribute to the growth of their revenue. Institutions specializing in technology transfer mentioned above were established largely because they met the interest of universities. The advantages universities gain from promoting startup environments are twofold: first, income from selling shares when spinouts launch IPO, and second, patent royalty income.

In parallel with the above development, the university research evaluation system has been changed to include not only excellence of research but also social and economic impacts of research. The evaluation sheet will include every conceivable matter from prizes won from the outside, to the number of spinouts, to the number of patents granted as research impacts. A university receives research grants from HEFCs which reflect the university's evaluation result. Universities which had their grants reduced may take tough measures including terminating faculties which received low evaluation. Some universities put in a lot of work to provide a complete description of the impacts of their research, which is an indication that universities are very interested in commercialization of their research outputs.

To illustrate one aspect of the current state of the UK, many people cite the industry's proactive effort to strategically utilize universities' wisdom. The UK has been considered to fall behind other major countries in industrial R&D activities. To make up for this, the industry has strived to utilize universities' broad knowledge for its R&D activities by seeking comprehensive knowledge which any single corporation cannot obtain by itself from universities. For example, rather than making investments in universities up front based on the outlook of 10 to 15 years from now, some companies enter into agreements which will enable them to acquire half of the shares of spinouts that will be established based on university research during the same period.

[188] This chapter distinguishes spinout companies (spinouts) and startups. The former refers to spun-off companies with their own IP created from university research and the latter is defined as "new companies aiming for rapid growth which were established to commercialize highly innovative technology, intellectual property, or a completely new business model created from outputs of research accomplished by universities, research institutions, etc.", the definition used throughout this report. A "startup" based on university research outputs may or may not own IP, so it is used as a broader term which includes a "spinout."

By finding ways like this, the private sector invests in universities while justifying risk-taking.

So far, we looked at trends, mainly those of academia. The following will touch on investment environments for startup support in the entire nation.

In the UK, public institutions made direct investments (not only in startups) from the 1970s. But now investments are made not directly but by establishing funds and employing fund managers on a purely commercial basis. Some argue that this is because investments criteria concerning regions and sectors became too complicated and administrative officials in charge lacked experience as investors. Currently, with more than 1,000 small funds available, some entrepreneurs have a hard time choosing the right one to apply for.

To promote investments in startups, tax benefit programs such as the Enterprise Investment Scheme (EIS) and Venture Capital Trust (VCT) were introduced in the 1990s, and another preferential taxation system called the Seed Enterprise Investment Scheme (SEIS) was established in 2012, targeting investments in startups in the initial stage.

In 2013, to finance small and medium-sized companies, the British Business Bank was founded, running a program which provides loans to startups in different stages according to their size and purpose.

While investments by private VC firms in the UK are said to be growing 5% per annum, they still remain at a low level compared to the US counterparts. Startups exit mostly through M&A, and only 5 to 10 companies launch IPO per year. In contrast, most Japanese startups aim for IPO.

Finally, let's take a broad view of the situation in the UK. With regard to the nation's economy, one of the problems is a chronic current account deficit. The UK has continued to see trade loss since 1983 due to an import surplus. In 2016, the British pound plummeted following the UK referendum where people voted to leave EU. Nevertheless, the growth real GDP stood at 1.8% in 2016, although it fell short of the 2.2% growth of the previous year (Figure 3). The UK unemployment rate rose in the wake of the 2008 financial crisis, peaking at 8% in 2011, has declined in recent years and stood at 4.8% in 2016 (Figure 4). Judging from Figure 3 and Figure 4, the economy of the UK seems to have picked up but the public is said to have great resentment against budget austerity and cuts in expenditures which continue from David Cameron's administration into Theresa May's administration.

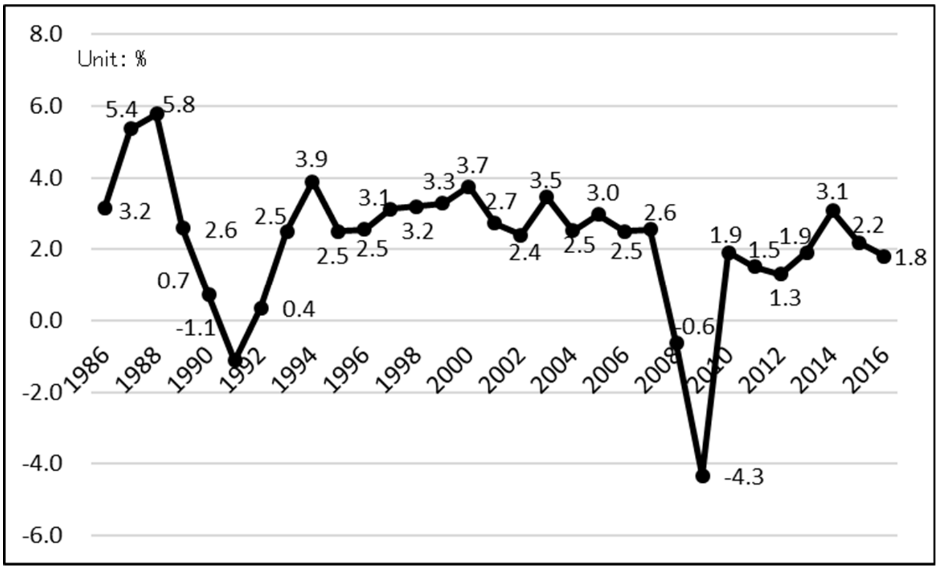

Fig. 3: Changes of the Real GDP Growth Rate in UK (1986-2016)

Source: Created by CRDS based on data provided by the World Bank

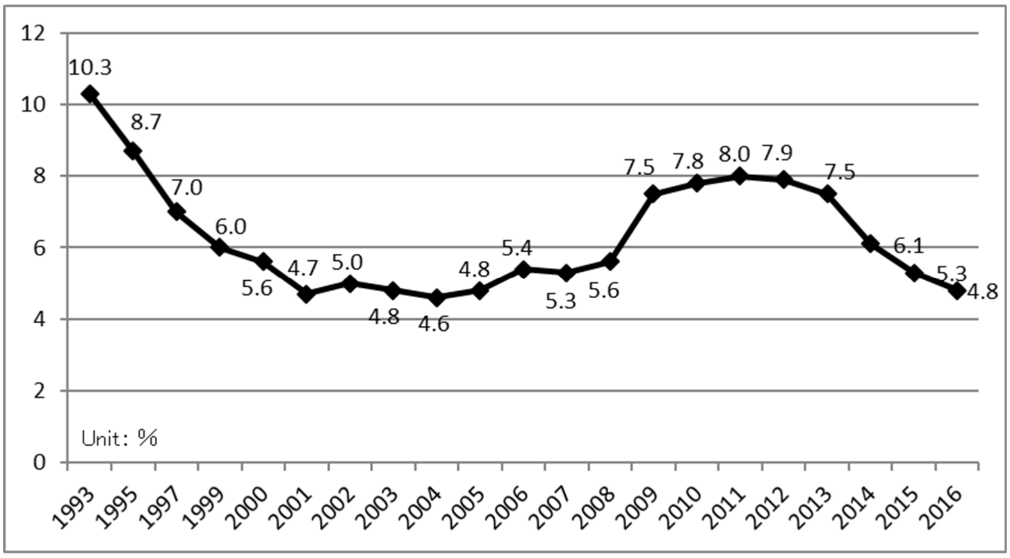

Fig. 4: Changes of the Unemployment Rate in UK (1993-2016)

Source: Created by CRDS based on data provided by the World Bank

In addition to the economic situation discussed above, some say many people in the UK aspire to launch their own companies and that they join large companies just to learn knowhow for their future businesses. The UK does better than Japan in environments according to the World Bank's "Doing Business 2017[189]," which ranks the UK seventh in "Ease of doing business" and 16th in "(Ease of) Starting a business" whereas Japan is placed 34th and 89th respectively.

In particular, London is exceptional. As it is ranked third in the "Global Startup Ecosystem Ranking 2017"[190], the most recent report by Startup Genome, which monitors startup ecosystems around the world, London is highly regarded in terms of startup talent and environment.

4.2. Reports and reviews concerning startup-related basic policies

In this section, reports concerning key basic policies and influential independent reviews related to startups are focused on.[191] The mechanism of recommendations by independent reviews and promotion of reform based on them characterizes the policy formulation process of the UK. An independent review refers to a written report by a council which is established by the UK government for each specific matter. The council conducts comprehensive surveys and evaluation for the matter and includes recommendations for improvement in an independent review. Ministries are not obligated to follow these recommendations but if they choose not to, they have to take some action such as providing a clear explanation as to why they do not follow them. Independent reviews often lead to improvements in organizations or systems.

4.2.1. Related documents

The following provides the main points of one report by the government and three independent reviews in chronological order, followed by another report at the end which served as a

189 http://www.doingbusiness.org/~/media/WBG/DoingBusiness/Documents/Annual-Reports/English/DB17-Report.pdf
190 https://startupgenome.com/report2017/?forward=thank-you-enjoy-reading
191 For more details of these policies and independent reviews, see "Report of trends of science and technology/innovation – UK edition" (FY2014) [CRDS-FY2014-OR-03], CRDS Overseas Research Report. https://www.jst.go.jp/crds/pdf/2014/OR/CRDS-FY2014-OR-03.pdf

springboard for the development of Cambridge.

1) Government report: "Excellence and Opportunity: A Science and Innovation Policy for the 21st Century" (2000)

Recognizing the budding effect of an innovation cycle promoted in the 1990s as a strategic economic policy and resulting increase of university spinouts, this government report issued in July 2000 called for a new policy which would realize the nation's economic growth through formation of high-tech industry in order to accelerate the increase of university spinouts.

In response to this report, the government introduced the Small Business Innovation Research (SBIR) program which had proven to be a success in the US as an innovation program promoting commercialization of advanced research outputs, along with development of infrastructure and human resources, and started running it from 2001. What was happening behind this was some other European countries also started considering introduction of public procurement as a new measure for creation of innovations in the 2000s as they regarded public procurement as highly effective for creation of disruptive innovations as proven by the great success of US SBIR program. The UK introduced an equivalent program under the name of the Small Business Research Initiative (SBRI) ahead of any other European countries.[192] (To be detailed in 4.3.3.)

2) Lambert Review (2003)[193]

Regarding startups, this review mainly provided the following two recommendations:

■ Intellectual property management

Development of model contracts covering the ownership and exploitation of intellectual property could make industry-academia research collaboration easier. The government should newly establish a third funding program[194] to promote knowledge transfer, and allocate funds in a more predictable way by growing the scale of funding from the program.

■ Intellectual property/technology transfer

To overcome obstacles against commercialization of intellectual property of universities, there should be as much flexibility as possible in distribution of intellectual property rights between universities and industry while the quality of technology transfer offices of universities and the recruitment and training of technology transfer staff should be improved.

After the release of the review, regarding the first point, intellectual property management, the Lambert toolkit, a collection of model agreements, was developed and decided to be used. (To be detailed in 4.2.2.) Regarding the second point, aiming to increase functions and quality of their technology transfer offices, universities made individual efforts to promote enhancement of functions and support programs offered by these offices by getting them to grow out of their conventional role and to launch an investment fund or begin startup-related consulting services, for example. (To be detailed in 4.3.5.)

3) Sainsbury Review (2007)[195]

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192 Details of revision of the UK SBRI program were mainly sourced from "Reforming SBRI for Its Retrofit in UK – From Superficial Copying to Substantive Introduction" by Akio Nishizawa, VENTURE REVIEW No.24, September 2014.

193 http://www.eua.be/eua/jsp/en/upload/lambert_review_final_450.1151581102387.pdf

194 As the research funding system for higher education institutions has two streams of funding, block grants distributed through local Higher Education Founding Councils (HEFCs) and competitive research funding by RCs, it is called a "dual support system." In other words, the first funding program is block grants and the second funding program competitive funds from RCs.

195 http://www.rsc.org/images/sainsbury_review051007_tcm18-103118.pdf

Regarding startups and startup support, this review mainly provided the following three recommendations:

■ Implementation of effective knowledge transfer

Through the Higher Education Innovation Fund (HEIF), knowledge transfer support between business-facing universities and small and medium-sized enterprises should be increased.

■ Public support targeted at seed/early-stage high-tech companies

Start-ups in their initial stage need funds until they can raise equity financing but usually face some difficulties in attracting funds, due to risks involved in these investments. Therefore, targeted public support for seed/early-stage startups should be enhanced.

■ Reform of SBRI

Departments should spend 2.5% of their R&D budgets on SBRI-based contracts with small and medium-sized companies, to resemble the successful US scheme. As the core of startup support, the government should drastically reform the SBRI program, which was launched in 2001, in order to realize innovation-oriented public procurement, which was the original objective of the program.

In response to the review's recommendation, the then-Department for Innovation, Universities and Skills (DIUS) announced specific measures in March 2008.[196] Regarding the first point, the Department indicated that the HEIF budget would be increased in the fourth stage which would start from 2008. (To be detailed in 4.3.1.) For the second point, this chapter will not get into the details, but the UK government has instituted various aid programs available to companies according to the size of their employment since 2008. As of December 2017, a government website posted information on 235 schemes[197] available to companies with 9 or fewer employees and 234 schemes[198] to companies with 10 to 249 employees. Regarding the third point, reform of SBRI, the program was modified and the revised SBRI was set to be launched from 2009. (To be detailed in 4.3.3.)

4) Witty's Review (2013)[199]

Regarding commercialization of research outputs and technology transfer at universities, this review mainly provided the following three recommendations:

■ Enhancement of the third mission of universities

As universities have extraordinary potential to enhance economic growth, they should have stronger incentives to engage in their third mission (commercialization of research outputs) alongside the missions of research and education and thereby contribute to economic growth.

■ Support for HEIF

The government should announce a long-term commitment to HEIF so that universities would be incentivized to engage with innovative small and medium-sized companies.

■ Review of the university research assessment system

The impact weighting in the Research Excellence Framework (REF), the assessment system to decide amounts of research grants to universities (to be detailed in 4.3.4), which is to be introduced from FY2014, should be increased to 25% in the next REF in 2021.

Regarding the universities' third mission, the first item, after the release of the review,

196 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/243607/9780108507175.pdf
197 https://www.gov.uk/business-finance-support?business_sizes%5B%5D=under-10
198 https://www.gov.uk/business-finance-support?business_sizes%5B%5D=between-10-and-249
199 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249720/bis-13-1241-encouraging-a-british-invention-revolution-andrew-witty-review-R1.pdf

universities' technology transfer offices enhanced their functions and support programs, although this recommendation was not necessarily included in any specific policy of the government. (Some case examples to be detailed in 4.3.5.) Regarding the second point, grants became annually based from the sixth stage of HEIF that began in 2015, and the amount per year increased. (To be detailed in 4.3.1.) Regarding the third point, deliberation is underway as of January 2018 on the weighting of the "research impact" ahead of the next REF.

5) Mott Committee Report (1969)[200] [201]

Focused efforts on entrepreneurship and startups in Cambridge have been around for 50 years or so. Cambridge was long characterized by unrestricted research and education provided in an exceedingly bottom up style by researchers who became independent. As leadership was not too controlling, it is said that technology and knowledge were scattered across the university. Against such a backdrop, it was a Mott Committee Report commissioned by the government that triggered the building of the foundation for the "Cambridge phenomenon." Issued in 1969, the report called for promotion and establishment of science-based industry, or science-type industry, through academia-industry cooperation.

In response to this report, Trinity College Cambridge constructed a science park in its 11 hectares of land in the 1970s, laying the groundwork for a cluster of high-tech startups in an "autonomous" and "voluntary" manner. It was "autonomous" because startups accumulated and created a cluster naturally without any governmental support, and "voluntary" here means a university drives a project independently or in cooperation with local governments or private businesses.

Cambridge's unique situation resulted from such special consideration for the university. Today, influential university startups are created one after another in Cambridge, where more than 1,500 firms are based. This situation is called the "Cambridge phenomenon," putting the University of Cambridge in a class of its own.

4.2.2. IP management

As the UK does not have an equivalent of the US Bayh-Dole Act, IP resulted from publicly funded research is subject to regulations under the Patents Act of the country. Enacted in 1977, the UK Patents Act has since gone through a number of revisions. According to the Patents Act, an output of research funded by the government is owned by the institution which the person who created the result belongs to.

As recommended by the above Lambert Review, to prevent conflicts concerning ownership of IP created by industry-academia joint research, the UK government has provided the Lambert toolkit, a collection of model agreements.[202] The toolkit recommends that coordination between a university and a company in the phase of actually exploiting the created IP should be avoided to the extent possible because it would be difficult.

With regard to research outputs, each university sets its own rules. For example, at the University of Manchester, university staff is required to enter into an agreement with the university prior to employment that states that the university will have ownership of 20% to 30% of any patent which resulted from research at the university. Accordingly, if a company is spun out from the university using such a patent, the university gains 20% to 30% of profits. The

200 http://ci.nii.ac.jp/els/contentscinii_20171205114445.pdf?id=ART0001561101
201 "Why innovation ceased : crisis of scientific Japan", Ei-ichi Yamaguchi (2016)
202 https://www.gov.uk/guidance/university-and-business-collaboration-agreements-lambert-toolkit

university has a hand in staff's research by making a "non-monetary investment," so to speak.

At the University of Cambridge, on the other hand, the original template of agreement states that the university shall exclusively retain the ownership of research outputs by university staff. However, this only suggests where a negotiation should start between the university, research support institutions, and joint researchers such as corporations, and it offers reasonable flexibility in changing ownership of intellectual property. In such negotiations, however, researchers do not participate directly. As they do not have expertise required in discussions concerning management of joint research outputs, usually special departments or experts in the university take care of such negotiations.

4.3. Startup support programs and support institutions

In this section, we first look at major programs and efforts for facilitating knowledge transfer and creation of businesses at universities in the UK provided by public research funding institutions such as the Higher Education Funding Council for England (HEFCE), Research Councils (RCs) and Innovate UK. The reason we bring up HEFCE programs first is that many university researchers and staff members argue that support from HEFCE is highly effective. We then move on to support of RCs which are used not only by universities but also public research institutions. Finally, we discuss support through Innovative UK which is available to industry as well.

We also present an introduction of a university assessment system, which is considered highly influential in startup support by universities. Introduced in 2014, the system is called the Research Excellence Framework (REF), which has a decisive influence on researchers' motivation for starting businesses.

We also look at technology transfer institutions which illustrate that university startup support programs are sophisticated and solid and then discuss cases of investments promoting university spinouts supported by the private sector.

4.3.1. Higher Education Funding Council for England (HEFCE)

1) Higher Education Innovation Fund (HEIF)[203]

As a funding program to promote university technology transfer implemented by the Higher Education Funding Council for England (HEFCE), the Higher Education Innovation Fund (HEIF) was launched in 2001. Its support is targeted at institutions, not individuals. Its objective is to expand capabilities of higher education institutions to meet the needs of industry and communities, and its support is not limited to startups. However, HEIF has a potential to trigger change in universities' awareness in favor of startups as the program tries to reform culture of universities which have not received significant interest in research by industry by financially incentivizing universities to increase the transfer of knowledge.

HEIF allocates funds based on performance, and higher education institutions making more than 250,000 pounds from the outside per year are eligible. Each higher education institution which applied for HEIF is required to submit its strategy for knowledge exchange.[204]

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[203] http://www.hefce.ac.uk/ke/heif/

[204] The concept of technology transfer made by universities in general has grown to become part of knowledge transfer which includes not just technology but comprehensive knowledge including that of humanities and social sciences. Taking it one step further, people are recently using a broader term, knowledge exchange, meaning social cooperative activities valuing inputs from the general public. Details of HEIF were mainly sourced from "Quaternary higher education innovation fund – Knowledge exchange activities at universities" by Nao Yamada, UK University Scene, the

HEIF changed its system through its stages. In the first stage from 2001 to 2004 (HEIF1), the program funded 77 million pounds, which grew to 396 million pounds in the fourth stage (HEIF4) which started in 2008. A sharp rise in HEIF's budget in each stage in and after HEIF2 was the government's response to the same recommendation by the above three reviews that the new, third stream of funding for promotion of knowledge transfer should be increased and maintained thereafter. In HEIF4, the approach of calculating allocations was changed and 40% of an allocation to a university was decided based on the number of staff members at the university, the remaining 60% on the result of knowledge transfer. As a result, the better a university did in knowledge transfer, the more funding it was granted. Funding became annually based from 2015, and the program is now in its eighth stage (HEIF8) which started from 2017, providing 160 million pounds. Figure 5 provides a summary of HEIF from the first stage to today.

Currently, the UK has 151 recognized institutions which can award degrees, and all of them are either universities or colleges, except the Archbishop of Canterbury. Most of the universities and colleges in the UK used HEIF from 2001 to 2010, but in recent years around two-thirds of them have been funded by HEIF.

In the current stage of HEIF8, higher education institutions receive their allocations based on the allocation method which has been used since HEIF4. The largest amount, which is 3.35 million pounds, was granted to nine universities: University of Birmingham, University of Cambridge, Imperial College London, King's College London, University of Leeds, University College London, University of Manchester, Oxford University, and University of Southampton.

Stage	Period	Budget (Million Pounds)	The number of Higher Education Institutions receive grants from HEIF
1	2001-2004	77	89
2	2004-2005	186	124
3	2006-2008	238	133
4	2008-2010	396	130
5	2011-2015	601	99
6	2015-2016	160	100
7	2016-2017	160	97
8	2017-2018	160	98

Fig. 5: Summary of HEIF

Source: Created by CRDS based on information on the website of HEFCE

Funds from HEIF account for only a small portion of universities' budgets. Once provided, however, funds from HEIF are fairly flexible for universities because they can be used for any efforts that are in line with the objective of knowledge transfer promotion at the discretion of each higher education institution. For example, part of funds obtained through HEIF accounted for 10% of the FY2015 budget of Cambridge Enterprise, the technology transfer company of the University of Cambridge. HEIF is in fact used in various ways to meet the objective of knowledge transfer based on each university's management strategy.

HEFCE commissioned an outside consulting company to write a detailed report concerning

issue of January 2009.
https://scienceportal.jst.go.jp/reports/britain/20090101_01.html

[205] On July 10, 2017, HEFCE announced that it would provide additional 40 million pounds to HEIF for FY2017 to help promote the government's industrial strategy.
http://www.hefce.ac.uk/news/newsarchive/2017/Name,114709,en.html

trends of business creation by students and resulting economic value to communicate the effects of knowledge transfer promoted by HEIF. The report was issued in 2013.[206]

There are similar programs underway in regions outside of England. For example, in Northern Ireland, HEIF is provided by the Department for Employment and Learning and Industrial Development Board for Northern Ireland.

2) iCURe program

Modeled after the I-Corps Teams program, part of the I-Corps program[207] by US National Science Foundation (NSF), iCURe was launched on a trial basis from 2014. The Higher Education Funding Council for England (HEFCE) and Innovate UK contributed 2.8 million pounds and 400,000 pounds respectively to the total 3.2 million pounds initial budget of iCURe.

This project is currently run by SET squared partnership[208], which is a partnership to promote research and commercialization of research outputs between the universities of Bath, Bristol, Southampton and Surrey in Southern England.[209]

In the iCURe program, teams, each of which is made of a postdoctoral young researcher, a senior researcher, and a business advisor, take a three-month startup training course. They are funded for their study of market opportunities and development and proof of concept. They are not obligated to actually form a spinout after the iCURe training program. Each team receives 35,000 pounds at the start of the program.

4.3.2. Research Councils (RCs)

Placed under the wing of the Department for Business, Energy and Industrial Strategy (BEIS), Research Councils (RCs) are granting agencies, distributing competitive funds concerning basic research and applied research. In their functions, they are equivalent to the Japan Science and Technology Agency (JST) plus Japan Society for the Promotion of Science (JSPS). As mentioned previously as part of the current state of the UK, RCs have increasingly attached importance to economic value and contribution to the economy of the UK in recent years, and supported university spinouts while taking into account the possibility of job creation and career advancement of researchers.

Biotechnology and Biological Sciences Research Council (BBSRC), one of the RCs, has conducted various programs helping create new businesses through support for proof-of-concept and development of startup knowledge for more than 20 years. Figure 6 shows major schemes of BBSRC that have been used by a relatively high number of firms. The YES, shown in the first row for example, is a program to make proof of concept easier for young bio-researchers, especially postdoctoral researchers, although the grant is small, equivalent to less than one million yen per person. By and large, researchers who actually used this scheme rate it highly, saying it was useful before launching their businesses.

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[206] http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2015/Student, Start-Ups/2015_student_start-ups.pdf

[207] For more details of the I-Corps program, see 2.2.3.3 of Part 2, the US.

[208] http://www.setsquared.co.uk/

[209] Since the formation in 2003, SET squared partnership has been engaged in creation of high-quality university spinouts, support for promising technology companies, investments in top research institutions, and joint research with overseas institutions. SET squared partnership has a tie-up with the IP Group (to be detailed in 4.3.6), which supports SET squared partnership in commercialization of intellectual property, seed capital financing, and business strategies and financial matters of spinouts. Details of activities of SET squared partnership were mainly sourced from "SET squared Partnership (Industry-academia partnership of four universities in Southern England)" by Nao Yamada, UK University Scene, the issue of July 2007. https://scienceportal.jst.go.jp/reports/britain/20070701_01.html

Scheme	Summary
Biotechnology Young Entrepreneurs Scheme (YES)[210]	・To make proof of concept easier for young bio-researchers, especially postdoctoral researchers ・5,000 pounds will be destributed per person ・Used by 5,000 people as of 2015
Follow-on Funding[211]	・To support activity that will enable commercialisation or other application from a BBSRC-funded project. ・This funding will fill in the Proof-of concepts stage and applicants can pursue the possibility of developing a spin-out company or a licensing agreement ・There are 3 types of schemes. In "Pathfinder Follow-on Fund" anytime applicable amogn them, BBSRC can fund up to 80% of the 12,000 ponds which can be applied in the application form
Royal Society of Edinburgh Enterprise Fellowship[212]	・To support graduates, postgraduates/PhD students, and academic researchers to launch new businesses. Jointly supported by Scottish Enterprise, Science and Technology Facilities Council (STFC), Natural Environment Research Council (NERC) and QuantIC

Fig. 6: Major Schemes of BBSRC for supporting University Startups
Source: Created by CRDS based on information on the website of BBSRC

Together with the Engineering and Physical Sciences Research Council (EPSRC), BBSRC established and funds 13 Networks in Industrial Biotechnology and Bioenergy (BBSRC NIBB), each of which is on a specific topic, for example, anaerobic digestion, bioprocessing, etc.[213] The funds can be used for holding meetings, getting people together, or conducting short-term joint research with corporations by issuing business vouchers.

The funds for these networks play roles that are just as important as support for startups does because these networks create opportunities to gain useful advice or information from entrepreneurs and investors before a business launch or to build connections with startup-related people.

Apart from the above, each RC conducts an award program called Impact Acceleration Accounts (IAAs). This program aims to promote knowledge transfer activities and accelerate research impacts, and funds not individuals but research institutions including universities. For example, the Economic and Social Research Council (ESRC) runs IAAs called “ESRC IAAs.” Today, 24 UK research institutions are funded by this program. Total funds provided from the program’s launch in 2014 to March 2017 amount to 18 million pounds, and additional 7 million pounds are set to be provided by March 2019.[214] These 24 institutions are all universities or colleges, not only in England but across the nation including Scotland and Wales.

Similar to the Higher Education Innovation Fund (HEIF) discussed above, IAAs is characterized by the fund’s extreme flexibility for users. The fund can be used for exchanging or dispatching personnel between the recipient research institution and stakeholders who are users, deepening relationships with the public sector, civil society, industry, and general public, or

[210] http://www.bbsrc.ac.uk/innovation/maximising-impact/biotechnology-yes/
[211] http://www.bbsrc.ac.uk/innovation/maximising-impact/follow-on/
[212] https://www.rse.org.uk/awards/enterprise-fellowships/
[213] http://www.bbsrc.ac.uk/research/programmes-networks/research-networks/nibb/
[214] http://www.esrc.ac.uk/funding/funding-opportunities/impact-acceleration-accounts/

facilitating a change of culture of the research institution in order to promote technology transfer and improve related technology and skills.

4.3.3. Innovate UK

Innovate UK is a research funding institution mainly supporting industry-academia cooperation and innovation activities at corporations. Same as RCs, Innovate UK is also under the wing of the Department for Business, Energy and Industrial Strategy (BEIS), providing functions equivalent to those of the New Energy and Industrial Technology Development Organization (NEDO) in Japan.

Support programs of Innovate UK mainly target companies but also fund some universities and public research institutions as in the case of an industry-academia collaborative project. These programs play a significant role in terms of contribution to practical application or commercialization of research outputs of universities and public research institutions.

1) Small Business Research Initiative (SBRI)[215]

The Small Business Research Initiative (SBRI) is a research funding program to promote innovation by small and medium-sized companies through public procurement. Called UK's SBIR, SBRI started in 2001.

Initially, the government did not reveal details of R&D activities to be contracted out to small and medium-sized companies or a concrete selection process clearly, but just set a numerical target of allocating 2.5% of R&D budget of each department and decided that each department should solicit applicants on its website, leaving the details to each department. For this reason, only a small number of departments joined the program and they failed to meet expectations anyway because they contracted out projects the way they had always done. Based on suggestions for SBRI reform from Sainsbury Review, etc., however, a pilot project was implemented in 2008 to improve the program, followed by full-scale introduction of the revised SBRI in 2009.[216]

SBRI Phase I provides proof-of-concept funding, up to 100,000 pounds for a maximum of six months. Phase II is the stage of prototype creation/development, providing up to one million pounds for a maximum of two years. IP created during the program will be owned by the company which created it and Innovate UK will not retain ownership.

This way, SBRI helps close the seed funding gap facing companies in their initial stage. Through SBRI, innovative solutions can be found for challenges facing the public sector, which may lead to better public services and improvement in efficiency and effects. Startups and small and medium-sized companies account for around 66% of the program participants and they may be able to find opportunities for new business and commercialization of their unique ideas by undertaking a project under a SBRI contract.

Under the renewed SBRI after April 2009, 82 departments and public institutions including the Ministry of Defence and Department of Health solicited participants for 360 projects and signed as many as 3,060 SBRI contracts, which were valued at 470 million pounds (as of October 2017).

2) Innovation Vouchers[217]

Innovation Vouchers are designed to promote industry-academia cooperation and technology

[215] https://www.gov.uk/government/collections/sbri-the-small-business-research-initiative
[216] Details of revision of the UK SBRI program were mainly sourced from "Reforming SBRI for Its Retrofit in UK – From Superficial Copying to Substantive Introduction" by Akio Nishizawa, VENTURE REVIEW No.24, September 2014
[217] https://www.gov.uk/government/news/innovation-vouchers-for-all

transfer between universities/public research institutions and small and medium-sized enterprises so that companies could seek out fresh knowledge from outside of their own networks.

Startups and small and medium-sized enterprises can use these vouchers worth up to 5,000 pounds for payment for expert knowledge or technology they received from universities or public research institutions of their choice. The vouchers are available to startups and small and medium-sized enterprises which have never received them from Innovate UK, and can be used only when the recipient company cannot solve problems without support from an expert whom the company has never worked with. Another key requirement is that ideas proposed by companies must fall under one of the specific areas designated by Innovate UK. Innovate UK solicits projects in designated areas once every three months, and chooses around 100 projects.

4.3.4. Research Excellence Framework (REF)

Grants from the Higher Education Founding Councils (HEFCs), which account for a substantial part of UK university budgets, are made up of research grants and education grants as mentioned previously. As for research grants, based on the idea that they should be allocated based on research quality, their allocations are largely decided based on the results of research assessment of each university.

In 2011, a new research assessment framework called the Research Excellence Framework (REF) was released and assessment results based on this new framework were announced in December 2014. Research grants provided in and after FY2015 reflect REF-based assessment.

REF assesses three elements: “research outputs (65%),” “research environment (15%),” and “research impact (20%).” “Research impact” measures the degree of “benefit to the economy, society, culture, public policy or services, health, the environment or quality of life”, beyond academia. A submission is graded into the following five levels for each assessment element:

- 4: Quality that is world-leading
- 3: Quality that is internationally excellent but which falls short of the highest standards of excellence
- 2: Quality that is recognized internationally
- 1: Quality that is recognized nationally
- Unclassified

Adopting the social/economic impact of university research as one of the assessment elements seems to help incentivize researchers to conduct research that aims to give more back to society. Conducting joint research with companies, accepting contract research from industry, adding economic value to research outputs, and actively supporting launches of university spinouts – all of these contribute to higher assessment of a university, and researchers’ efforts to create impact will lead to organizational profits and eventually to greater public grants for the university as well.

4.3.5. Solid startup support programs of universities

To discover promising seeds early on and to contribute to the growth of university revenue and local economy and to the creation of jobs, the UK has developed organizations and programs specializing in transfer of knowledge and technology through trial and error. While the government is highly interested in making improvements to facilitate commercialization of universities’ intellectual property by these support organizations, universities themselves are proactive in developing their own organizations equipped with advanced expertise. The following will look at two such organizations, Imperial Innovations and Oxford University Innovation, as examples of technology transfer organizations supporting development of seeds of universities.

1) Imperial Innovations[218]

Started as a technology transfer office of Imperial College London, Imperial Innovations is a company which is engaged in commercialization of intellectual property derived from not only Imperial College London, but Cambridge and Oxford universities and University College London. Under the technology pipeline agreement with Imperial College London, Imperial Innovations has the advantage of being able to access and select technologies developed at the College at an extremely early stage, and functions as the technology transfer office granted with exclusive commercialization rights over inventions at the College. Imperial Innovations also acts as a technology transfer institution of National Health Service (NHS)[219] such as Imperial College NHS and London Hospital trusts. With regard to investments in technologies derived from Cambridge and Oxford universities and University College London, Imperial Innovations works with the technology transfer office of each university.

Imperial Innovations has two divisions, startup support and technology transfer. With regard to the former, Imperial Innovations supports and funds creation of spinouts related to seeds of the four universities above. During the 10-year period from 2006 to 2016, over 140 companies were spun out. Imperial Innovations aims to help create value in the long term, and therefore starts its involvement as early as at the time of the establishment of a spinout. Imperial Innovations makes it a rule to send directors to spinouts, and retains a large influence on their management. As well, it is involved in capital policies and fundraising plans of the investee spinouts, and leads rounds to raise additional funds as well. Finding co-investors and inviting partner companies, Imperial Innovations provides overall support for long-term development of investee companies.

Since 2005 Imperial Innovations has raised more than 200 million pounds and invested in many spinouts. From the company's flotation in 2006 to 2016, it invested 160.90 million pounds. In the meantime, it succeeded in raising 750 million pounds for its investees from other investors. As of February 2016, Imperial Innovations invests in 98 companies. It is involved in selection of management personnel and development of business strategies. For management, it often recruits CEOs from outside of the university. Researchers often serve as part-time chief technology officers (CTO).

Imperial Innovations does not form a fund but directly invests in businesses. Exempt from restrictive periods as in funds, direct investments allow longer investing than ordinary private funds can, sometimes for more than 10 years. Even if investee companies launch their IPO, Imperial Innovations does not sell shares immediately, and sometimes keeps them in expectation of further growth in corporate value. Figure 7 shows the portfolio of Imperial Innovations.

[218] https://www.imperialinnovations.co.uk Imperial Innovations was established in 1986 and listed in 2006.
[219] NHS is an institution providing national health service under the wing of the Department of Health. Not only does it provide medical services to the public at NHS hospitals and clinics across the nation, it conducts clinical studies as well. Research funds are also provided by the National Institute for Health Research (NIHR), the research fund distribution institution of NHS.

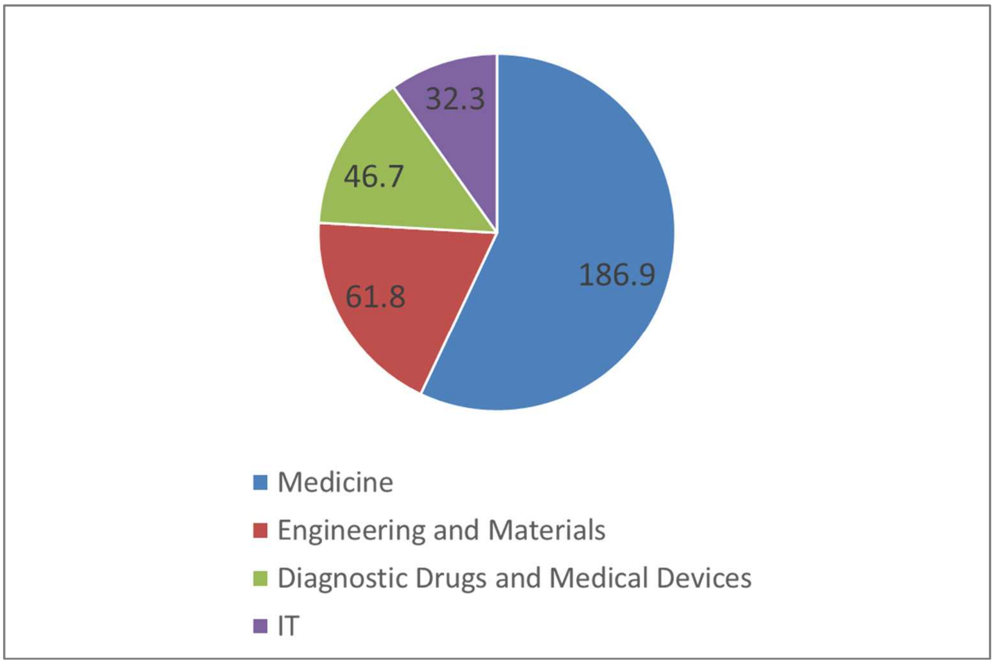

Fig. 7: Portfolio of Imperial Innovations

Source: Created by CRDS based on various materials

Initially, Imperial Innovations was established as an internal department of Imperial College London in 1986. In 2006, 20 years from the foundation, it went public on the Alternative Investment Market (AIM) of the London Stock Exchange (a market where emerging companies are traded), becoming the first public company related to technology transfer of a UK university. Through this flotation, Imperial Innovations raised 26 million pounds to invest in startups that were based on technology from Imperial College London. In 2007, the following year, it successfully raised another 30 million pounds by issuing new shares.

The case of Imperial Innovations is said to be a great success story of a university's technology transfer office becoming incorporated and eventually listed on a stock market. The company has mainly supported foundation of drug discovery companies including a number of large corporations. This example demonstrates that it is possible to direct private funds to long-term investment in university research outputs in their high-risk, seed/early stages and not to rely on public funds.

3) Oxford University Innovation[220]

Oxford University Innovation is a wholly-owned technology transfer company of the University of Oxford, employing around 100 staff members. Leveraging its strength of being a university's technology transfer arm, the company discovers seeds early on, develops strategic plans, and conducts the following three businesses:

■ Licensing and investment for technologies of Oxford University

Oxford University Innovation supports researchers who wish to commercialize their IP through licensing and startup creation support. It also provides entrepreneurs who seek investment opportunities with relevant information and networking opportunities.

■ Consulting service by Oxford University researchers and others

[220] https://innovation.ox.ac.uk

This service is called Oxford University Consulting (OUC), providing a consulting service by researchers of Oxford University. Users of this service have access to over 5,000 researchers in various fields from physics to life science to medicine to social science to the humanities.

■ Training and consulting related to management

This is a service provided by Oxford University Innovation's subsidiary Oxentia. Initially, Isis Enterprise, which was established in 2004, provided the service, and then it was rebranded to Oxentia in April 2017. Oxentia provides training and consulting services related to innovation management to companies, governments, and technology transfer institutions around the world. It provided services in over 50 countries. Apart from the UK, Oxentia has branches in Hong Kong, Spain, Japan, etc. Training programs are custom–made, and provided for small groups for one to two weeks.

With regard to startup support, Oxford University Innovation has been involved in establishment of more than 100 spinouts since 1997, contributing to the growth of Oxford University's revenue and local economy and to the creation of jobs. In the financial year ended in March 2015, for example, Oxford University Innovation helped create 10 companies. Since 2000, Oxford University Innovation has raised more than 266 million pounds and five of the spinouts it helped launch have been listed on the AIM of the London Stock Exchange (a market where emerging companies are traded).

Oxford University was reported to have an R&D budget of 612 million pounds in 2014. Oxford University Innovation has continued to provide investors with opportunities to invest in startups launched to commercialize technology and IP created from such a huge R&D budget.

The company's greatest advantage is that it can discover promising seeds early on. As Oxford University Innovation has no compelling force over researchers, everything starts from when a researcher asks for advice in commercialization of his or her search (disclosure). While seed presentations are held, Oxford University Innovation could not expect researchers to bring in their research outputs for consultation if it does not seek them out.

Oxford University Innovation has a list of 50 to 60 manager candidates. Among them are Oxford University alumni and serial entrepreneurs. They are involved in management usually without pay, betting on the future of startups. Some startups offer stock options to managers. As in the case of Imperial Innovations, researchers serve as chief technology officers (CTO) on a part-time basis.

The website of Oxford University Innovation lists profiles of university startups (certified only if they were launched using IP), and if an investor is interested in them, he or she can ask Oxford University Innovation for more information.

Apart from the above, Oxford University Innovation offers Oxford Angels Network (OAN) as part of its startup support effort. OAN provides investment opportunities to individuals and companies that are interested in investing in spinouts from the University of Oxford. OAN membership is free and members include business angels (BA), private investors, etc. inside and outside of the UK. Members are entitled to privileges such as receiving proposals of business plans developed mainly by startup managers and invitations to regular investment meetings where early-stage startups make presentations. However, Oxford University Innovation retains the right to decide who will receive what kinds of business plans. In addition to that, spinouts are not obligated to receive funds from OAN members.

When Oxford University Innovation creates a spinout, Oxford University has the right to designate nonexecutive directors. OAN members who wish to become directors or to spend time as managers can communicate their intentions to OAN.

Oxford University Innovation is involved in the following investment funds and engaged in investments in startups accordingly:

■ University of Oxford Innovation Fund (UOIF)

UOIF raises money from Oxford University alumni and other investors. Parkwalk Advisors manages the fund and Oxford University Innovation is involved in management as the portfolio advisor.

UOIF I raised and invested 1.25 million pounds in 2014. UOIF II raised and invested 2.15 million pounds in 2015, followed by UOIF III in 2016. Now, UOIF IV is underway.

■ University Challenge Seed Fund (UCSF)

Established in 1999, UCSF is providing proof-of-concept funding. It provides 2,500 to 250,000 pounds per project. UCSF has funded 150 projects since its establishment. It holds shares of 31 companies and has succeeded in raising 110 million pounds from the outside. Three companies the fund invested in have been listed on the AIM (a market where emerging companies are traded).

■ Oxford Invention Fund (OIF)

Modeled after the above UCSF, OIF was established in 2010 and relies on donations to the university for funds. It aims to close the gap between basic research and commercialization. OIF funds proof of concept and prototyping among others. OIF's contract entitles OIF to shares of the counterparty company if it used OIF for its establishment, or part of resulting revenue if use of OIF led to a license-out deal.

Criteria used by these funds to decide investments are sevenfold: scientific novelty, participation of major researchers, strength of IP, commercial feasibility, production/services provided, strong leaders, and prospects of growth, and these funds target niche markets. These funds have also established the Investment Advisory Committee, and all the committee members are concerned with Oxford University. Committee meetings are held regularly, where Oxford University Innovation presents proposals to the committee.

4.3.6. Private investment in establishment of university spinouts[221]

In the UK, there are spinout establishment support companies which invest in commercialization of intellectual property created by university research. One of the largest of such companies is Intellectual Property Group (IP Group)[222], which is listed on the London Stock Exchange. Unlike conventional VC firms, this company provides university spinouts with business expertise and networks and support for recruitment and business strategies, in addition to funds.

The origin of the firm goes back to the year 2000 when a then-financial institution signed a partner agreement on the condition that the financial institution would provide the Chemistry Department of Oxford University with 20 million pounds to be used for construction of a new laboratory in return for the right to acquire up to half of the shares of spinouts to be created from outputs of the same department for the next 15 years. Part of this financial institution became independent as IP Group, and then similar investment firms followed.

When the IP Group was founded, it only had a contract with Oxford University. Today, it has entered into long-term partnership agreements with 16 UK universities. Under these agreements, it is entitled to a certain percentage of shares of spinouts from these universities in return for investments in them to help commercialize intellectual property and to support management (as

[221] Information on investments/support for university spinouts by the IP Group is mainly sourced from pp.46-48 of "Transforming UK universities" (FY2008), CRDS research report. With regard to IP Group's efforts, we thank Mr. Nao Yamada, a freelance consultant based in the UK who has analyzed higher education and science and technology policies of the nation for many years, for his suggestions and advice.

[222] http://www.ipgroupplc.com/

of December 2017). Figure 8 shows the 16 partner universities of the IP Group.

The primary initial investment from the IP Group to a university usually amounts to 5 million pounds and the term of a contract is 15 to 25 years. Whether a contract applies to the entire university or specific departments depends on the conditions of the contract with the university. While the IP Group has usually claimed 10% to 12% of shares of a spinout in return for investments in recent years, it does not disclose all data, and contract details vary depending on the university.

University	Year of Contract	University	Year of Contract
University of Bath	2006	The University of Manchester	2013
University of Bristol	2005	University of Nottingham	2013
University of Cambridge	2013	University of Oxford	2000
Cardiff University	2007	University of Sheffield	2005
University of Glasgow	2006	University of Southampton	2002
University of Leeds	2005	University of Surrey	2006
King's College London	2003	Swansea University	2013
Queen Mary University of London	2006	University of York	2006

Fig. 8: 16 Partner Universities of the IP Group

Source: Created by CRDS based on the website of the IP Group and other various materials

The investment portfolio of the IP Group covers fields of advanced technologies including healthcare, biotechnology, and clean technology, investing in total 100 companies, from budding ones to mature ones. Seventeen of them have been listed on the AIM of the London Stock Exchange, where emerging companies are traded.

4.4. Cases of R&D startups from universities

The following section presents three cases of R&D startups which are based on research outputs of UK universities: Circassia, SSTL, and ARM Holdings plc.

4.4.1. Circassia[223]

Circassia is a public company spun out from Imperial College London, engaged in drug discovery. Founded in 2006, the company conducts research and development concerning respiratory diseases, developing products supporting asthma management (NIOX®) and products for chronic obstructive pulmonary diseases (Tudorza®) among others. CEO Steve Harris, one of the founders, is specialized and experienced in the field of drug discovery, and he grew Zeneusu Pharm into a company specialized in drug discovery and had it successfully acquired by Cephalon[224] before joining Circassia. He also served as Chief Financial Officer (CFO) of PowderJect Pharmaceuticals[225], a UK vaccine manufacturer, for seven years.

The aforementioned Imperial Innovations provided two million pound seed funding in 2007, and then led investment rounds in 2009 and 2011 as well, which was followed by the flotation of Circassia on the main market of the London Stock Exchange in 2014. When it was listed, its market value was 581 million pounds, considered to be the largest flotation ever by a UK bio

223 http://www.circassia.com
224 Cephalon was acquired by Teva Pharmaceutical Industries in 2011.
225 PowderJect Pharmaceuticals was acquired by Chiron Corporation in 2003. Chiron Corporation was then acquired by Novartis in 2006.

company.

While Circassia has its UK head office in Oxford Science Park in the UK, it has overseas head offices in two locations: Morrisville, USA; and Uppsala, Sweden. It also has offices in Germany and China. The company is currently promoting development of products for respiratory diseases (Duaklir® and Tudorza®) jointly with AstraZeneca in the US.

As for the company's net profit (comprehensive income) in 2016, revenue was 23.1 million pounds, cost of goods sold 8 million pounds, and gross margin 15.1 million pounds.

Circassia's success is said to be largely thanks to the previously mentioned Imperial Innovations. The case of Circassia provides a good example of Imperial Innovations making exclusive investments in brilliant seeds at an initial stage and securing long-term growth.

4.4.2. Surrey Satellite Technology Ltd.[226]

Spun out from the University of Surrey in 1985, Surrey Satellite Technology Ltd. (SSTL) is a startup manufacturing small satellites. The company develops the latest low orbit satellites, stationary satellites, and interplanetary platforms, and it is famous for its unique development capabilities of highly cost-efficient responsive solutions.

Mr. (later Sir) Martin Sweeting involved in the company's establishment received his PhD on shortwave antennas from the University of Surrey, and achieved great success in 1981 by launching the first small satellite, UoSat-1, with the help of US NASA. This success proved that a space mission could be successfully carried out by using a relatively small, low-cost satellite built in a short period of time. This led to the establishment of SSTL by the University of Surrey in 1985. It is said that the company was established with only four staff members and 100 pounds of capital. Helped by the achievement prior to the establishment, however, SSTL grew fast. In contrast to the surging demand for small satellite business of recent years, the 1980s were the dawn of the era of small satellites. Nevertheless, the University of Surrey recognized the potential in this field and provided support, which partially contributed to the success of SSTL. Now, with the Surrey Space Centre, the University of Surrey has earned recognition around the world in research and education in the field of small satellites.

Sir Sweeting is well known in the UK as an entrepreneur and researcher who developed SSTL from a small studio venture in the University of Surrey into to a global small-satellite development company. For his achievements, he was awarded the Mullard Award by the Royal Society in 2000 and was elected as a Fellow of the Royal Society in the same year. In recognition of his pioneering work on cost-effective spacecraft engineering, Sweeting was knighted in 2002.

SSTL has been engaged in design and construction of GIOVE-A, the first satellite under the Galileo program[227] of Europe. GIOVE-A is one of the two satellites which make up a key test system for examining the application possibilities of the Galilean satellites. In recognition of this achievement, SSTL received various awards including the Queen's Award for Enterprise in Innovation in 2005 and World Technology Network Corporate Award for Space in 2004.

SSTL sold 10% of its own shares to SpaceX in 2005 and around 80% to Astrium of European Aeronautic Defence and Space Company (EADS)[228] in 2008. Astrium of EADS came under the umbrella of Airbus Defence and Space, an Airbus Group subsidiary, as a result of merger in 2013, which put SSTL under the same umbrella.

[226] https://www.sstl.co.uk

[227] Satellite navigation system jointly run by the European Space Agency (ESA) and EU. It is run in parallel with the Global Positioning System (GPS) of the US and GLONASS of Russia.

[228] EADS is the predecessor of the current Airbus Group. Astrium is the aerospace subsidiary of EADS, providing space systems and services for both military and civilian purposes.

During the 20-year period from the firm's establishment in 1985, SSTL sold 150 million pounds worth of goods and services outside of the UK, contributing to the nation's export. Having been involved in more than 30 satellite launches in 8 sites, the company now boasts a 40% share in the small satellite export market. Employing around 400 staff members, the company is headquartered in Surrey Research Park which is located in the west of the University of Surrey.

4.4.3. ARM Holdings plc[229]

The origin of ARM Holdings plc (hereinafter referred to as "ARM") goes back to Advanced RISC Machines Ltd established in 1990 as a joint venture of Acorn Computers and others. As a background to the foundation of the company, there was a situation in which Cambridge voluntarily started taking measures to accumulate high-tech companies from the 1970s and realized a cluster of over 800 high-tech companies in the city and its surrounding areas by 1990, as previously described.

The developer of ARM chips, on which ARM's technology was going to be built, was Acorn Computers, one of the founding companies, which had been launched as a startup in 1978 by Hermann Hauser together with Andy Hopper, the current head of the Computer Laboratory of the University of Cambridge. Hauser is a world-renowned entrepreneur from Austria, who received his PhD in physics from the Cavendish Laboratory, the University of Cambridge.

Acorn Computers became a subsidiary of Olivetti of Italy in 1988. Under Olivetti's management, ARM's design team developed 32-bit RISC microprocessor chips specialized in low power consumption by following Hauser's advice. Hauser, who wanted to launch a new startup by spinning off Acorn Computers from Olivetti's inflexible management, followed the advice of Sir Robin Saxby, whom he was going to ask to take up the position of CEO of the new startup, approached the former Apple Computer, which back then developed hand-held computers and showed interest in energy-saving ARM chips as their microprocessors, for capital participation, and established ARM (Advanced RISC Machines Ltd) in 1990 as a joint venture of Acorn Computers, Apple Computer, and VLSI Technology.

ARM was launched with a total of 12 engineers from Acorn Computers and an initial investment of 1.5 million pounds from Apple. While Sir Saxby headed the company as CEO from 1991 to 2001, it grew rapidly. In 1998, the company changed its name from Advanced RISC Machines Ltd to ARM Ltd and went public on the London Stock Exchange and NASDAQ. Mike Muller, one of the founders, now serves as Chief Technology Officer (CTO) at ARM. In 2016, ARM was acquired by the Softbank Group for around 24 billion pounds.

In 2015, the company's revenue was 968.3 million pounds and the net profit (comprehensive income) was 339.7 million pounds. Today, ARM is a holding company headquartered in Cambridge, and has offices and design centers around the world including Sunnyvale and Austin, USA; Munich, Germany; Yokohama, Japan; Beijing and Shenzhen, China; and Bangalore, India.

Processors based on ARM architecture are power efficient, suitable for mobile devices. CPU cores based on the so-called ARM architecture, a 32-bit/64-bit RISC CPU architecture widely used in embedded systems and low-power applications, are used in all sorts of electronic devices, from mobile equipment such as PDAs, mobile phones, media players, handheld game consoles, and calculators to PC paraphernalia including hard disc drives and routers.

ARM only licenses out technology as intellectual property (IP), and does not manufacture

[229] Information on the history of ARM and the Cambridge phenomenon was mainly sourced from the following literature:
"Why innovation ceased : crisis of scientific Japan", Ei-ichi Yamaguchi (2016)
The article in Nikkei Technology Online by Ei-ichi Yamaguchi
http://techon.nikkeibp.co.jp/article/COLUMN/20090223/166161

CPUs by itself. This business model was already established in the 1990s. Dozens of companies are manufacturing processors by receiving licenses from ARM.

Many promising startups were spun out from ARM, creating a lot of wealth. This is recognized as a textbook example of an ecosystem with extremely high productivity. Many argue that if ARM had been bought out by a foreign company a lot earlier, its technology would have been lost in the buyer, bringing in little wealth to the UK. ARM has not only created wealth but also helped the development of human resources and creation of businesses. In this sense, ARM is highly productive.

ARM is considered as a hugely successful startup based on research outputs of the Cavendish Laboratory, the University of Cambridge. However, because the company was not licensed by TLO or the like authorized by the university and the university did not receive shares of the company as license fees either, the university does not receive even a tiny share of profits which ARM or startups from ARM make, no matter how enormous they are.

As shown throughout this chapter, the government, public institutions providing research funds, and universities as well have been changed to recognize the economic importance of spinouts from research outputs. The government has adopted a policy to promote social and economic benefit and creation of innovations through transfer of university knowledge. The industrial strategy issued in November 2017 by Department for Business, Energy & Industrial Strategy (BEIS) also positively looked at the possibility of universities promoting research that will produce high economic value through licensing out IP or establishing spinouts. Public institutions providing research funds such as the Higher Education Funding Council for England (HEFCE), Research Councils (RCs), and Innovate UK have also conducted various support programs promoting transfer of university knowledge, creation of university spinouts, and innovations by businesses through public procurement.

Universities are highly interested in support for university spinouts which could bring in income. They seem to have high hopes for a rise in revenue through such spinouts. The case of Circassia discussed previously is a good example of a startup having achieved great success by cooperating with a university TLO, Imperial Innovations in this case. In the UK, each university has a set of rules to manage IP strategically in a flexible manner, striving to increase revenue from spinouts and thereby eventually strengthen its financial basis. UK universities are allowed flexibility in asset management because, unlike Japanese counterparts, UK universities are not required by regulations to sell acquired shares immediately after they become tradable through IPO or other methods.

4.5. Characteristics of the UK

Based on the above, the following two characteristics of the UK can be highlighted:

4.5.1. Diverse public support programs to promote extensive knowledge transfer from universities

Startups have a speculative aspect as no one can be truly sure what exactly will be successful. To make sure any promising seeds never go unnoticed, the UK spreads a variety of small-scale public funding programs and grant programs thinly but broadly, thereby securing a system to lead university research outputs to commercialization smoothly. However, the government considers commercialization or startup creation as just one way to achieve its underlying grand plan which is to return universities' wisdom as profits to the society and to increase economic value of university research outputs in order to eventually contribute to the growth of the economy of the UK.

As discussed in this chapter, under the Higher Education Innovation Fund (HEIF) of the Higher Education Funding Council for England (HEFCE) or Impact Acceleration Accounts (IAAs) of Research Councils (RCs), once funds are allocated to individual universities, they are at the disposal of each university. Accordingly, a university uses them as a key tool to providing bottom-up support for research seeds in a relatively early stage (the proof-of-concept stage) under programs designed to leverage the university's characteristics. It is interesting to note that RCs individually offer funds for networking as well as programs to support proof of concept or development of entrepreneurial knowledge which will lead to creation of new businesses.

Such grants from public institutions supplement universities' insufficient budgets and thereby play a role of effectively connecting fine research ideas and commercialization. Some also argue that the UK's competitive funds are typically large per case and few small funds are available. In contrast, there are small grants for knowledge transfer and startup support.

As mentioned in the history of policies, the government's role is to develop measures to realize flexible and effective knowledge transfer from universities in various forms and to allocate public funds strategically. Neither the government nor universities have a huge budget. Under such circumstances, what the UK government is doing is allocating some funds and thereby providing initial impetus. Introduction of public funds especially to pre-seed, seed, and early stages, which entail high risk, is significant for closing the gap in demand for risk money.

4.5.2. Enormous upfront investments from the private sector to universities

UK universities are actively raising capital from the private sector and overseas investors. According to OECD data, around 20% of R&D expenses in the UK is paid by overseas funds, much of which is directed to universities.[230] This is simply because companies find research capabilities and environments of world's leading universities in the UK attractive for joint research.

This chapter presented the case of the IP Group which provides financial support for university spinouts. Apart from the IP Group, some other UK companies are likewise establishing university spinouts. Unlike ordinary private VC firms, they are considered to be playing a role of establishing companies by providing seed capital prior to the phase where ordinary VC firms normally start investing. For instance, BTG[231], which was originally established as the National Research Development Corporation in 1948 by the UK government to commercialize inventions created by public research institutions including universities and RCs, is said to have brought in more than 13 million pounds of royalty income to UK universities as of 1990. Listed as "BTG plc" on the London Stock Exchange in 1995, the company is now mainly engaged in development of drugs related to the nervous system and cancer and commercialization activities including joint research with partner corporations and licensing.[232]

As clearly indicated by the previously mentioned case of the Chemistry Department of Oxford University receiving 20 million pounds of investment, the scale of investments in universities is huge. In Japan, there have been few cases of full-scale industry-academia joint research. In most cases, universities are said to accept a joint research project for around two million yen, an amount so small that it could be considered as "socially obligated expenditure" of companies. Compared

[230] http://www.oecd.org/sti/msti.htm
[231] https://www.btgplc.com/
[232] Information on BTG was mainly sourced from pp.48-49 of "Transforming UK universities" (FY2008), CRDS research report.

to the situation in Japan, it is surprising that in the UK huge funds are provided by companies to universities in the form of investments that are riskier than joint research.

Clearly, in the UK, mid-ranking companies are willing to take risks and make investments in universities prior to their research outputs becoming ready to bear fruit. Risks taken by universities as well as by companies must be tremendous. This approach, however, is also considered as creative startup support in a sense, and could lead to huge profits to both universities and industry, if it works out. What makes companies make such huge prior investments is UK universities' excellence in research capabilities.

In the UK, investments are usually diversified across the world, so customers' money is invested in different markets of the world. A diversified portfolio allows a portion of money to be invested in risky assets. That way, investments in startups are secured in the UK. In Japan, customers, especially public institutions, are risk-aversive and seek safe investments. However, you cannot grow assets without taking high risk. In the UK, the private sector is willing to take risks and invests in universities, which is a characteristic of the country.

4.6. Things to be noted

Finally, we present the following issues exposed by our interviews with people concerned with universities, with regard to the current state of UK startups.

4.6.1. Difference in awareness of startups among universities

The awareness of startups is not consistent across universities in the UK. Cambridge, for example, has strong values at its foundation that research and education should not be associated with economic value, and some say if you go all out for starting a business, others might look down on you. The general atmosphere seems to encourage researchers to be focused on basic research instead of doing "boring" research with a business launch in mind. On the other hand, as a recent trend, it is true that if you do not start a business, you would be considered lazy, and some are concerned that they might be labeled a non-doer who fails to do any of the many things they could do. Higher-ups of universities are also increasingly promoting knowledge transfer, commercialization of research outputs, and creation of businesses partly because they want more results they could provide regarding research impact on the evaluation sheet of the Research Excellence Framework (REF). For this reason, many faculty members are said to be having a hard time finding a balance between different ends of the spectrum.

Cambridge Enterprise indicates that the university's overall mindset remains unchanged although young generations are increasingly subscribing to the idea of commercializing research outputs and commercialization is becoming a part of the university's activities. As one of our interviewees says, Cambridge, which originally pursued the benefit of society through education and research, still has many researchers who believe that startups are "evil" and it will take some time before the university's mindset changes and a startup-friendly environment is developed.

On the other hand, some universities such as the University of Manchester conduct research based on industry-academia cooperation and startups. Manchester is said to have an entrepreneurship culture with a strong drive for creating goods that will prove successful. For instance, the Manchester Institute of Biotechnology (MIB) was established in a bid to closely collaborate with corporations in joint research. MIB has strength in industrial biotechnology, conducting joint R&D activities to meet the needs of corporations, and it has launched nine spinouts (as of November 2017). In 2013, the government adopted a priority policy (eight great technologies) which included synthetic biology, and the University of Manchester was selected as a site for one of the hubs to be built for this field, and established SYNBIOCHEM, a synthetic biology research center, by obtaining an additional budget. In this research center as well, the university is working together with corporations and creating various chemical substances by using synthetic biology.

As seen in these examples, today, the UK has traditional research-focused universities, such as Oxbridge, which are good at basic research, and at the same time universities leaning towards applied research especially in recent years.

Some university instructors say researchers engage in startups just to satisfy needs or requirements because startups do not make significant profits or loss anyway. In other words, most startups never achieve huge success, considering that a startup's mega-success on the scale of Google rarely happens, only once or less every couple of decades.

It is assumed that discussions will continue on how important spinouts and technology transfer can be as means to increase "earning power" of universities while respecting various perspectives of different universities or researchers.

4.6.2. Regional disparities

The United Kingdom is made up of four countries: England, Scotland, Wales, and Northern Ireland. With 80% of its population residing in England, people and money tend to concentrate in England, especially London.

Scotland, the most populous country apart from England, also attracts a lot of attention as a place where many IT startups cluster together. In 2006, it had incubation facilities in one location, which grew to 16 by 2015. Major startups, although they are not necessarily spinouts from a university, include Skyscanner, which provides air ticket searching services, and Fanduel, which runs fantasy games, both of which are unicorns.

There are many organizations, even in Edinburgh alone, to support transfer of knowledge or technology from universities, including Edinburgh Research and Innovation, the technology transfer arm of the University of Edinburgh, and Old College Capital, the VC fund of the same university; Sunergos Innovations, which promotes commercialization of medical research outputs of the University of Edinburgh; the University of Edinburgh Business School which educates entrepreneurs; Scottish Enterprise, which promotes a policy with four key items of Scottish internationalization, innovation, investment, and inclusive growth, and runs startup investment schemes; and Scottish Investment Bank, which invests in startups and small and medium-sized companies.

While universities are promoting commercialization of research outputs to earn revenue, there have been no cases of huge success as license income or gains from acquisition or IPO exits are not significant.

Some people also say it is hard to secure managerial talent even in Edinburgh, one of the major cities in Scotland, as they tend to concentrate in London and other big cities. Some Scottish startups are run by the management who regularly visit their companies from London where they live. In some cases, they manage by communicating online through Skype or the like. Often in such cases, managers are seasoned entrepreneurs, and if they are pensioners, they may accept stock options instead of salaries.

Scotland is said to be facing challenges of securing managerial talent, discovering seeds early on, and educating entrepreneurs, the same challenges Japan faces.

As seen above, it is important to take note of the difference in the situations facing startups between England and other parts of the United Kingdom.

4.7. Conclusion

Some people say startups are similar to a kind of “gamble” in which nobody knows what will succeed, or even argue that 90% of the world of startups is a lie. What lies behind this is the fact that there are no general criteria against which a startup’s value is measured. So, it is possible for startups to exaggerate their corporate value to attract investments from VC funds, which then make investment decisions while knowing that numbers may have been inflated, as a matter of course.

For example, Cambridge Enterprise claims that it created value, 1.5 billion pounds according to the 2016 annual report[233], through its seed funds. It measures value based on how much venture capital was raised for startups launched by then. Value reflects forecasts and expectations, and moreover, it is not measured in a consistent manner as companies or organizations other than Cambridge may use different standards.

Through our research in the UK, we learned that there are many efforts and examples in the UK which we could take ideas from when we examine Japan’s problems and challenges. While introducing successful US programs such as SBIR and I-Corps on an experimental basis and adjusting them to the UK’s environment, the UK implements its own programs and measures as well. We have much to learn from the UK’s experience when we look into the “earning power” of Japan’s universities.

[233] https://www.enterprise.cam.ac.uk/wp-content/uploads/2015/04/2016_Annual_Report_corrected.pdf

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- HESA：https://www.hesa.ac.uk
- The 5th Science and Technology Basic Plan：http://www8.cao.go.jp/cstp/kihonkeikaku/5honbun.pdf
- SBRI：https://www.gov.uk/government/collections/sbri-the-small-business-research-initiative

5. Russia [Column]

In Russia, it is said that interest in startups is growing especially among young generations. Twenty-five years after the collapse of the Soviet Union, the Russian society concerning startup creation is gradually changing.

5.1. The current state

Today, support provided to startups in Russia is largely divided into five categories. The first category is startup support through Skolkovo. In 2009, then-President Medvedev advocated the establishment of the "Russian Silicon Valley" in Skolkovo, a village in the suburbs of Moscow, and announced the Skolkovo project as the first and foremost measure to modernize Russia. The entire project covers an area of 400 hectares, and the "Skolkovo Foundation[234]" is the principal agency responsible for construction and management of the project, which is on track to be completed in 2020. One of the major missions of the Skolkovo project is providing startup support. Startup support started in 2010, the same year the Skolkovo construction was launched, and is reported to have been provided to 1,774 companies and helped realize a total of 3 billion dollars[235] in revenue so far (as of November 2017). Figure 1 shows the breakdown of startups in Skolkovo by sector. It shows the most popular field is IT with 521 companies, followed by the biomedical sector with 424.

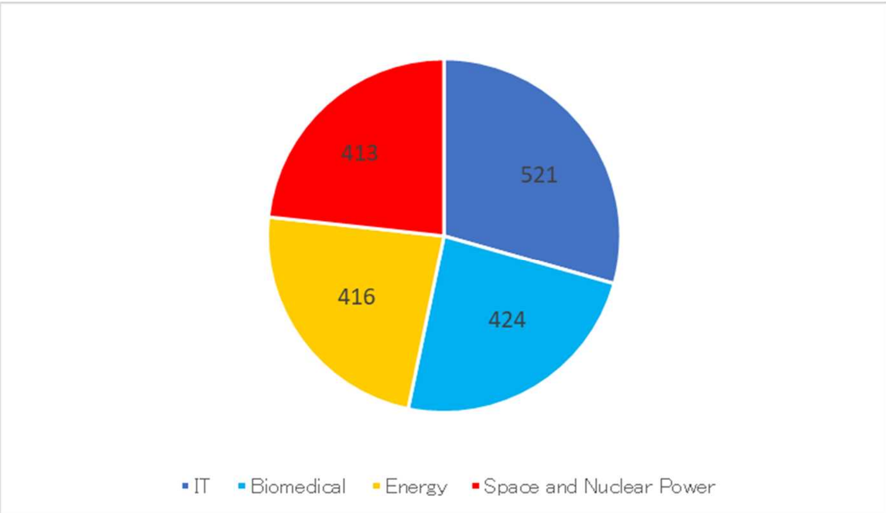

Fig. 1: Startups in Skolkovo by Sector

While various forms of support are available through Skolkovo, the most common is grants. Grants are provided to startups which were screened and accepted by experts in various amounts, from small grants to support a business launch to large project funds (up to four million dollars) for actual R&D activities. A total of 313 million dollars of grants were distributed to support startups from 2010 to 2016. Startups which join Skolkovo are guaranteed various privileges

[234] Skolkovo Foundation is an alias. Its official name is "Foundation for Development of the Center for Elaboration and Commercialization of New Technologies."
[235] According to the foreign exchange rate of Bank of Japan as of February 20, 2018, 1 US dollar is equivalent to 111 yen.

including reduced rate on social insurance premiums and exemption from VAT and various other taxes. Skolkovo also offers a scheme to support participation in overseas training programs as a way to help lead companies' ideas to practical application.

The second category of startup support is provided by the government and venture capital mainly for startups spun out of industry. The third one is direct investment through Rusnano, which specializes in investments in nanotech-related projects. Rusnano is a state-run company in the form of an open joint-stock company which is wholly owned by the Russian government. As the fourth category, there is startup support through a research center under the wing of the Russian Academy of Sciences. The fifth category is made up of support programs to promote university startups. For example, an incubation center or the like which was set up in the premises of a university in a bid to commercialize research outputs is supporting the entrepreneurial environment on campus.

The categories above are not necessarily run independently and in some cases startups are jointly funded through the first, second and third categories of support. On the other hand, public grants for seed-/pre-seed-stage startups by the Foundation for Assistance to Small Innovative Enterprises (FASIE) account for a substantial portion of support to startups from academia covered mainly by the fourth and fifth categories. Support of FASIE is different from that of Skolkovo in targeted stages and scales of funds (FASIE support is dwarfed by Skolkovo). FASIE, however, has backed mainly startups from academia by differentiating itself from investment-type support provided by Rusnano and RVC[236]. Since its foundation in 1993, FASIE has so far supported 6,000 cases of business launches and 30,000 projects. For example, through its pre-seed support program "УМНИК," which provides 500,000 rubles[237] to students and young researchers aged 18 to 30 for two years, FASIE distributed funds to total 16,000 people, and was involved in the creation of 1,000 companies by July 2017.

The following presents information on the "Startup Village," Russia's largest startup festival, which takes place in Skolkovo, the place which is said to have the strongest momentum in today's Russian startup landscape.

[236] Just as Rusnano is, RVC is an open joint stock company wholly owned by the Russian government. As a government fund of funds, RVC has been engaged in development and promotion of Russian VC funds since its foundation in 2006. Since 2015, RVC has also acted as the project office for implementation of the government-led "National Technology Initiative (the long-term national strategy concerning creation of innovations, providing targets up to the year 2035 concerning promotion of technologies that are key to Russia)."

[237] According to the foreign exchange rate of Bank of Japan as of February 20, 2018, 1 ruble is equivalent to 1.95 yen.

5.2. “Startup Village”

Since it was held for the first time in 2013, “Startup Village” has become an annual event in Skolkovo. The last one was held in Technopark Office Center in Skolkovo (Photo 1) for two days from June 6th to June 7th, 2017. This event was originally modelled after Finland’s SLUSH, Europe’s largest startup event. The Russian government clearly has a great interest as well, as evidenced by the participation of key government officials every year. Prime Minister Medvedev visited from 2013 to 2015. Last year, Deputy Prime Minister Dvorkovich, who is in charge of the field of IT and innovation policies, attended the event. Funded by the national government to the tune of hundreds of millions of rubles, “Startup Village” sets itself apart from other events.

Photo 1: Technopark Office Center © Tsuda

In 2017, Startup Village held a national pitch contest where startups who had won local pitch contests, part of a year-long competition tour across the country, competed with each other, a panel discussion which invited venture-related figures from around the world, and practical seminars in a multitrack program. Visitors numbered 20,000 from 80 countries and 4,000 startups and 800 investors participated. Inside the Technopark Office Center, people engaged in business-to-business meetings and business-to-investor meetings, hoping to find partners while startups showcased their technologies and products at their booths and seminar venues at the stages outside of the center.

Photo 2: Session on the Main Stage © Tsuda

5.3. Challenges

As seen above, Russia now seems eager to become a startup powerhouse through the Skolkovo program among others. We do not provide details in this Column but Russia has constructed many techno parks across the country, developing environments favorable to startups outside of Moscow as well. Having said that, startups (especially tech-related ones) account for only a small portion of the country’s economic growth at the moment. While entrepreneurship is growing and people are changing their mindset, it is an undeniable fact that the Russian economy relies on huge state-run corporations in nuclear and space industries. It seems to take considerable time before startups are seriously counted on as bearers of innovation in Russia and become ready to meet such demand.

6. Germany

Germany, a major exporting country, has multiple global corporations in the world-leading sectors of automobiles, chemical, and machinery while more than 99% of companies are small and medium-sized companies; this industrial structure is very similar to that of Japan. As well, Germany has an industrial composition that is quite similar to Japan's, with the secondary industry, mainly manufacturing, and the tertiary industry accounting for around 20% and 70% respectively. The Hightech-Strategy[238], which is the science and technology basic policy, also recognizes that new ventures are indispensable for creation of innovations in order for the country to remain an economic power in the 21st century, and startup support programs are established accordingly. Around 20 years after the US, the German government began startup support slowly from the 1990s, which has produced some results, increasing the number of startups in some limited regions, but all in all, Germany is not a top startup country. This chapter analyzes the current status of German startups from economic and cultural perspectives, and then provides noteworthy programs run by the federal and state governments and case examples.

6.1. The current state of Germany and situations surrounding startups

6.1.1. Basic information concerning R&D activities

Germany is the world's fourth largest economy[239] following the US, China, and Japan, with a gross domestic product (GDP) around 3.5 trillion US dollars (hereinafter shortened as "dollars")[240] [241] in 2016 and GDP per capita around 42,000 dollars. While Germany traditionally has a high level of technology and the government has consistently supported academia and technology development, we had a hard time putting the entire national policy into perspective due to the complicated relationships between the federal and state governments and successive changes in administrations. Since 2006 when the Hightech-Strategy, the federal government's comprehensive strategy for R&D and innovation, was released, Germany has promoted science and innovation policies with this strategy as a master plan. The Hightech-Strategy is also a part of the government's efforts to achieve the R&D expenditure target, 3% of GDP, agreed on by EU countries. In 2010, the government issued the "Hightech-Strategy 2020" as a policy for the second stage, and included various measures to depart from the conventional strategy which stressed technology seeds and to solve social challenges. Supported by the subsequent growth in R&D investments and stable business confidence, the government issued the "New Hightech-Strategy 2014" for the third stage, which is focused more on creation of innovations. The New Hightech-Strategy specifies fields where innovation is already receiving a huge push or innovation is expected, and gives them priority in research. If you rate Germany's science and technology from its ratio of R&D investment to GDP, 2.98% (provisional value of 2015), the country falls slightly behind Japan (3.56% in 2015) and EU's shared target of 3%. However, the federal government's science and technology budget is consistently on the rise. Chancellor Merkel, who is from the former East Germany and has a PhD in physical science, is believed to be sympathetic towards science and technology. Thanks to its strong economy, Germany has shown a prominent growth

[238] Hightech-Strategy 2006
[239] JETRO basic economic index 2016
[240] Nominal GDP based on purchasing power parity (PPP)
[241] According to the foreign exchange rate of Bank of Japan as of February 20, 2018, 1 US dollar is equivalent to 111 yen.

in its R&D budget compared to the stagnant growth of other EU countries. In 2014, the number of researchers per 1,000 employees in Germany was 8.37, higher than 7.23, the average of 28 EU countries.[242]

Research is conducted mainly at universities and public research institutions including the Max Planck Society for the Advancement of Science (MPG). Universities and research institutions which were under pressure of R&D budget cuts due to Europe's economic downturn in the 1980s and the fiscal burden associated with the German reunification in 1990 were forced to find sources of funds outside, which partially contributed to promotion of cooperation with industry.[243] Today, industry provides 1.4 billion euros or around 20%[244] of the total 7.1 billion euros[245] raised outside for research at German universities. This amount is double the amount from the year 2000 (around 780 million euros).[246]

6.1.2. The state of economy and unemployment rate

The number of new companies launched in Germany is not large at all although the country's industry is highly matured and a developed business infrastructure is available including public programs for supporting startups, protection of intellectual property, and existence of many consulting firms, subcontractors, and suppliers. Figure 1 shows that Germany's business startup rate has been a little sluggish over the years compared to other EU countries, although the data shown here is not limited to R&D startups. This low trend is due to the following reasons: the job-offers-to-seekers ratio is favorable especially for highly-specialized talent due to a continued shortage of workers in the robust economy; few tax break schemes are available; and entrepreneurial education in higher education is not popular. According to the World Bank's survey, the cost for starting a business in Germany is extremely high, placing the country quite low in the rankings of ease of starting a business, 114th among 190 countries.

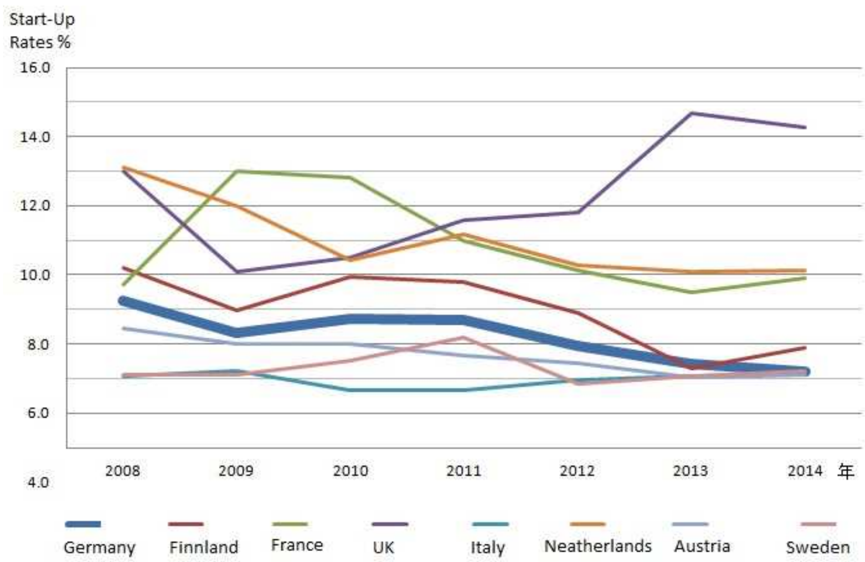

Fig. 1: Startup Rate in Major EU Countries
Source: Commission of Experts for Research and Innovation (E-FI)

242 "A Panoramic View: R&D Strategies in Main Countries", JST/CRDS, CRDS-FY2016-FR-07, 2017
243 "University high-tech spin-off venture", Masayuki Kondo (2002)
244 Higher Education Institutions in Figures 2017 (The German Rectors' Conference (HRK))
245 According to the foreign exchange rate of Bank of Japan as of February 20, 2018, 1 euro is equivalent to 135 yen.
246 Donors' association for the promotion of humanities and sciences in Germany (Stifterverband für die Deutsche Wissenschaft)

Following China and the US, Germany is the world's third largest exporter, exporting 133.7 billion dollars' worth of goods while the country is also the world's third largest in terms of import, following the US and China, importing goods worth 105.5 billion dollars. Export accounts for around 40% of the country's GDP, much higher than Japan's 15% or America's 9%, which clearly indicates that Germany is a trade-dependent country. Germany's economy surged after World War II, and continued to grow steadily from 1980 on. While Germany also went through the recent economic crises such as the global financial crisis following the collapse of Lehman Brothers and the Euro crisis, the country was not affected as seriously as other European countries. As seen in Figure 2, little change occurred to Germany's unemployment rate in 2008 when Lehman Brothers went under and the following year, which indicates that the employment market remained steady. The number of jobs was stable not only in industry but also academia, and in fact the number of positions in universities grew. Under the Excellence Initiatives[247], a university research enhancement program launched in 2005, 5,614 new posts were created by 2013, funded by the graduate school establishment support program (Graduate School) and support for cooperation with external organizations (Excellence Cluster).[248] With funding of 4.6 billion euro over a 12-year period, universities and public research institutions have provided enhanced support to professors, young researchers, and doctoral students, which has reduced the need for business creation by researchers, lowering the startup rate.

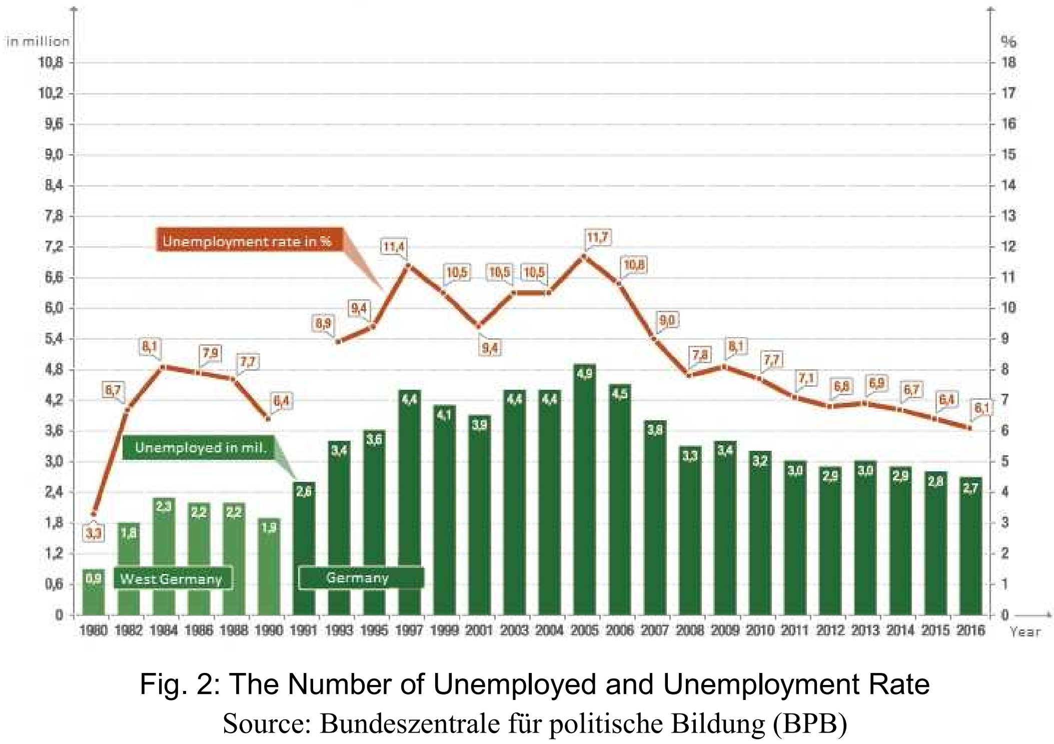

Fig. 2: The Number of Unemployed and Unemployment Rate
Source: Bundeszentrale für politische Bildung (BPB)

247 Exzellenzinitiative
248 Bericht der Gemeinsamen Kommission zur Exzellenzinitiative 2015 - Council of Science and Humanities (WR)/German Research Foundation (DFG)

6.1.3. Social and cultural significance of startups

After the reunification of Germany in 1990, its economy was depressed so much that the country earned the moniker "Sick man of Europe." At that time the government worked on structural reform through promotion of export by the manufacturing industry, especially medium-sized companies called "Mittelstand."[249] Small and medium-sized companies which expanded their business abroad for survival have developed competitiveness so strong that they are called "Hidden Champions," who are not well-known in the world but have high shares in niche markets. Mittelstand firms are said to have contributed a lot to the strong economy of today. They are often family-run businesses and are said to be able to make fast, flexible decisions unlike large companies.[250] As what is required for rapid growth in a niche market is largely similar to conditions for success of startups, Germany, where Mittelstand firms prosper, can be a favorable environment for startups. In the meantime, the audio coding technology MP3[251] developed by Fraunhofer IIS in the 1990s was revolutionary technology, which spread worldwide, but it is not a Germany company that commercialized it. This is an anecdote German people often bring up when they talk about how they are not good at technology transfer even though they have strong capabilities for technology development. The patent for MP3 brought the Fraunhofer Society for the Advancement of Applied Research (FhG) license fees of more than 10 million euros every year for 20 years. However, it was Apple of the US and Sony of Japan that applied this technology to products.

To change such a situation, "EXIST," a startup support program, was launched in 1998. As a result, universities recognized business creation as a methodology for promoting "technology transfer," which is the third objective of higher education institutions, and have gradually prepared various entrepreneurial education programs and startup support funding programs in cooperation with state governments. We will discuss the EXIST program later. Around the same time, the first cluster program was launched in 1996, aiming to promote the commencement of industry-academia cooperation from the research phase, and to support business creation and create regional network hubs in the fields of bio and life sciences. This cluster program is called BioRegio Initiatives. According to the 2017 report of the German Startups Association[252], about half of the 1,837 high-tech startups which responded to a survey had been created from regional clusters. The report lists the city of Berlin, the state of North Rhine-Westphalia, and the state of Bavaria in the descending order of the number of resident startups. In 2001, the first entrepreneurial course was introduced to a German university, for which one professor was employed. As of 2017, all universities in 16 states employ professors teaching entrepreneurial courses or entrepreneurship as a subject, and there are 133 of these professors in total.[253]

In addition, as peripheral support, it is said that startups which made a fortune through the dot-com bubble around the year 2000 have now started acting as angel investors and VC funds.

6.1.4. Germany based on a federal system

Due to its historic background, Germany is a federal state in which state governments have a lot of authority. Rebuilt as a federal republic after World War II, and reunited with East Germany, the country is now made up of 16 states. The Federal government has legislative power in the

249 RIETI "Doitsu Keizai wo Sasaeru Tsuyoi Chusyokigyo Mitterushutando (Mittelstand: Strong SMEs supporting German economy)", Koichi Iwamoto
250 "Hidden champions of the 21st century", Hermann Simon
251 https://www.mp3-history.com/
252 Bundesverband Deutscher Startups "Deutscher Startup Monitor 2017"
253 Förderkreis Gründungs-Forschung e.V.(FGF)

fields of defense, currency, telecommunications, intellectual property, and peaceful use of nuclear energy among others whereas culture, education, and research are in the jurisdiction of each state. Public universities are run by each state government[254], and for a long time the federal government did not have direct authority over university programs. In recent years, however, the federal government has recognized the enhancement of universities and university research capabilities as a top priority, promoting competition between universities and implementing measures jointly with state governments, including providing more funds to education and research. Concerning education and research, Article 91b of Basic Law allows the federal and state governments to cooperate with each other for capital burden and other things based on their mutual agreement, if necessary.[255] The difference in industrial policies among states shows independence of states, and each region has its own characteristics of industry. For example, the state of North Rhine-Westphalia which is home to the Ruhr industrial area has a long history of mining and heavy industries whereas the southern state of Baden-Württemberg is famous for automobile and machinery industries especially in its state capital Stuttgart. These industries are supported in technology development and human resource supply by local state universities[256] and research institutions, both of which implement measures in an integral manner under the state government's strategy. Accordingly, as the state government is in control of support measures for specific industries contributing to local economy and development of industry-academia cooperation clusters, clusters are often managed smoothly. As an especially illustrative example, the Leading-Edge Cluster Competition Program (SCW, 2006-2017)[257], the flagship program of Hightech-Strategy (2006), was a measure not to create a cluster from scratch but to provide funds for research and operation to existing clusters which had been developed by a state and produced good results.

6.2. Startup related laws

6.2.1. Revision of the Higher Education Framework Act (1998)

In terms of higher education, Germany uses an extremely decentralized system in which the federal government's involvement is minimized while authority over education and university research policies is granted to individual states. In response to the tight budgets of state governments and a rise in education budgets due to the increase in the number of students in higher education institutions in the 1960s, the Basic Law for the Federal Republic of Germany, which is the country's constitution, was revised in 1969 to gradually enable grants based on cooperation between the federal and state governments. Following that, the Higher Education Framework Act (HRG)[258] was enacted in 1976, stipulating the framework for university education, research, organizations, management, etc. which was common to all the states. The law was then revised several times and it added an obligation of higher education institutions to promote education and research and to disclose technology transfer in its fourth revision in 1998. This revision is said to have accelerated universities' efforts to secure external funds. Then, in 2007, when the country reformed its federal system, the federal government's authority to enact framework laws concerning higher education was removed from the Basic Law. However, the

254 There are only two universities run by the federal government: University of the German Federal Armed Forces (Universität der Bundeswehr) and German University of Administrative Sciences, Speyer (Universität Speyer)
255 "Doitsu ni Manabu Kagakugijutsuseisaku (STI policies learnt from Germany)", Hiroshi Nagano
256 Universities, hochschule (specialist universities), schools of education, art schools, etc.
257 Spitzencluster Wettbewerb Programme (BMBF). There have been three rounds of competition since 2006, in which total 15 clusters have been selected. Each receives 40 million euros in grants over a period of five years if the cluster secures the same amount or more from companies.
258 Hochschulrahmengesetz (HRG) is a federal law enacted in 1976. Chapter 2 (7) was revised in 1998.

repeal of the HRG has not yet been implemented although it was approved by the coalition government in 2009.

6.2.2. Revision of the Act on Employees' Inventions (2002)

The Act on Employees' Inventions[259], which was enacted in 1957, stipulates rights and obligations of employers and employees and procedures for rights transfer regarding inventions made by employees of private companies established under Germany's domestic laws, employees of public service institutions, or German public servants. Since the 2002 revision, rights which were granted exclusively to inventors (professors, research assistants, etc.) have been shared by employers (universities), and in return, employees have been granted rights to receive 30% of all income generated from their inventions. This change is said to have triggered universities' efforts to promote licensing and led to their active commercialization efforts. Together with the revision of the Higher Education Framework Act, discussed in the previous paragraph, this revision contributed to acceleration of universities' efforts to utilize intellectual property and support the creation of businesses by repealing the so-called "professors' privileges."

6.3. Overview and history of startup support programs

This section looks at some federal-government-funded support programs for university startups and their history. Among them, the central program is the EXIST program run by the Federal Ministry for Economic Affairs and Energy (BMWi).

6.3.1. EXIST (1988 – Now) R&D startup support

Launched in 1998, the EXIST program[260] was formulated by the Federal Ministry of Education and Research (BMBF)[261] in a bid to improve the situation in which there were few startups launched by graduates from German universities; few entrepreneurial courses were offered and universities did not provide much support for creation of startups although universities conducted high-level research; there were few university startups despite the increase in the number of startups in general in the 1990s. Now in its fourth stage, the program, which has been run for almost 20 years since its launch, is in fact a long-lasting funding program compared to other programs in Germany. The initial objectives included creating entrepreneurial environment and culture in universities, realizing technology transfer, which is the third mission of universities, producing good results in startup support, and increasing employment with startups which would create value. The program was available only for universities at first but public research institutions other than universities also became eligible in 2006.

After going through a series of changes and improvements over the past 20 years, including the change of the name from "Business launch from universities" to "Business launch from science[262]" as well as the change of the competent authority from BMBF to BMWi[263], the program has reached its current form. In its fourth stage, EXIST is offering three subprograms.

- Business Start-up Grant (Gründungsstipendium): Grants for individuals and teams
- Transfer of Research (Forschungstransfer): Grants for teams, which are provided after company establishment as well.
- Culture of Entrepreneurship (Gründungskultur): Support for university startup networks

[259] Gesetz über Arbeitnehmererfindungen (ArbnErfG) was enacted in 1957. Article 42 was revised in 2002.
[260] Existenzgründungen aus Hochschulen. It is directly translated as "Business launch from universities."
[261] Bundesministerium für Bildung und Forschung. It was Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie (Federal Ministry of Education, Science, Research and Technology) back then.
[262] Existenzgründungen aus der Wissenschaft. It is directly translated as "Business launch from science"
[263] Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology) as of 2006.

The Business Start-up Grant and the Culture of Entrepreneurship programs have been funded jointly by the European Social Fund (ESF) of EU since 2005 and 2007 respectively.[264]

Support for universities and support for individuals

One of the characteristics of EXIST is that it supported not university startup programs or entrepreneur development programs but universities' efforts to build entrepreneurial networks by mobilizing local infrastructure and industries. In the first round of solicitation in 1996, 12 consortiums were shortlisted for the document-screening stage from 109 applicants, and eventually model initiatives in five locations were adopted. As one consortium was typically made up of a couple of universities and multiple industrial partners, it follows that almost all public universities joined consortiums to enter this grant program. This suggests there were high expectations for startups and new markets caused by the information technology boom of the late 1990s. A majority of universities which were not accepted by the grant program and failed to receive grants from the federal government still received public support from state governments among others because they met application requirements. As a result, momentum for the creation of entrepreneurial environment built up and many universities established startup support departments. Then, in 2000, EXIST-SEED, a startup grant for individuals and teams, was finally launched. This subprogram offered a year-long grant during the preparation of a startup and provided a model for the current Business Start-up Grant program. In its first stage, EXIST targeted mainly undergraduate students and resulted companies were mainly in the fields of information technology and services. The program now is available to graduate students and postdoctoral researchers as well, providing strong support for commercialization of research outputs in fields not limited to information technology.

Program outline

(1) Business Start-up Grant (Gründungsstipendium)

Designed for the period of startup preparation, this scholarship is provided for a year. It targets students and researchers belonging to universities or public research institutions, and alumni who graduated within the preceding five-year period, and they can apply individually or as a team of up to three members. Undergraduate students are required to have completed more than half of the credits needed for graduation when they apply. Just as suggested by its name, the scholarship aims to secure the livelihood of individuals, providing each current student with 1,000 euros, equivalent to 133,000 yen, per month, which roughly equals average living expenses for a month. Master's students receive 2,500 euros (332,500 yen) per month and researchers doing a PhD receive 3,000 euros (399,000 yen). Many PhD students in science and technology are hired by university laboratories or public research institutions as research assistants or fixed-term researchers, and they receive the said amount apart from their wages. In addition, individuals and teams are allowed discretionary expenses of up to 10,000 euros and 30,000 euros respectively. Universities or research institutions which students or researchers belong to must be a member of entrepreneurial networks. While receiving the scholarship, students and researchers can participate in startup seminars and use mentoring services provided through these networks by charging fees to this discretionary expense account. When applying, students and researchers submit ideas for new business to entrepreneurial networks of which their universities or research institutions are members, and also designate mentors. Students and researchers submit interim reports on their business plans in the fifth month from the commencement of payment, and final business plans in the 10th month. Students and researchers can decide whether they will actually launch business and they are under no obligation to do so, even though they have submitted business plans. The number of applications varies depending on the year but roughly 300 applications have

264 The European Social Fund (ESF) is a part of the European Structural Investment Funds.

been received every year after 2007, and about 50% of them have been approved.

(2) Transfer of Research (Forschungstransfer)

This program assumes projects of starting businesses in technically advanced fields and offers support for development of research outputs which will provide a basis for new startups in the said fields. The program is available to teams made up of engineers belonging to universities or research institutions and business managers, and most teams apply with three engineers in charge of R&D and one business manager. Grants are provided in two phases. The first phase provides support for an 18-month period, which could be extended up to 36 months if the need for continuation of focused research is approved. During this phase, teams are encouraged to participate in seminar courses which provide general knowledge concerning business procedures, individual counseling, and external acceleration programs. Teams are allowed to charge wages for student part-time workers to an expense account, and as a rule receive up to 250,000 euros during the program. The second phase of grants is eligible for teams that have completed commercial registration of the company they established beforehand, and covers up to 75% or 180,000 euros under the name of continuation of development or securing of external loans. Compared to the Business Start-up Grant discussed in (1), this program caters to more R&D-based high-tech startups, requiring applicants to submit a written consent concerning patent- or license-use agreement with a university or a research institution, if necessary. According to data from 2007 to 2015, for the first phase grants, 879 draft proposals were submitted, going through an eight-week document-screening stage, and then 350 of them were shortlisted. Then, the selected proposals were referred to an advisory committee of experts (Jury) and the relevant applicant teams made presentations before the committee. The committee gave a “Good” grade to a total of 225 proposals, of which 212 received grants in the end. From the submission of draft proposals to the payment of grants, the process took about 6 months. In the second phase, the advisory committee of experts gave a “Good” grade to 106 of 134 applications, and 95 of them were approved.

Actual case examples concerning this program are provided in the next section, 6.4.

(3) Culture of Entrepreneurship (Gründungskultur)

This longest-lasting subprogram started when EXIST was launched in 1998. It targets universities and research institutions, aiming to create an entrepreneurial culture, to improve relevant environments, and to increase the number of new innovative startups based on R&D outputs. More specifically, the program encourages universities to establish a consulting office that could be called an entrepreneurial network in their industry-academia cooperation office or the like on campus, and to build a framework which helps discover seeds from their research outputs and promotes business creation. After the completion of the first stage of EXIST, it was clear that universities had great interest in startup support. During the first stage, the government explored good ways to support startups and tried to develop model cases. The second stage and thereafter can be classified into a startup-support network expansion phase and a high-tech startup support phase. Since 2006 when BMWi took charge, the policy has gradually changed to put more focus on high-tech startup support. In addition, as research budgets of universities and research institutions are growing under the Hightech-Strategy, they are expected to be under greater pressure of commercialization of research outputs.[265] A total of 12.1 billion euros were provided from 2000 to 2016. Today, technology transfer offices and startup support offices are available in 26 of 29 research-focused universities and 10 institutes of technology[266] among 106 universities, which is a clear

[265] Gründungspotenziale und Gründungsunterstützung an forschungsstarken Universitäten/Fraunhofer ISI 2017

[266] Germany has 106 universities (Universität/Technische Universität), 207 specialist universities, and 51 higher education institutions of art, music, and film (as of the winter term, 2017.) As most institutes of technology have non-engineering

indication that the program has contributed to instituting startup support. However, compared to institutes of technology, research-focused universities are still putting more focus on basic research, and are slow in incorporating entrepreneurial activities in their programs.

Program phase (First year)	Number of applications	Funding as a total
EXIST I (1998)	109	5Networks (20Universities)
EXIST II (2002)	45	10Networks (3 Universities)
EXIST III (2006)	76 (2006) /63 (2007) /46 (2008)	47Projects (86 Universities)
EXIST IV (2010)	124	22Projects (25 Universities)

Fig. 3: The Number of Applications and Funding
Source: Gründungspotenziale und Gründungsunterstützung an forschungsstarken Universitäten/Fraunhofer ISI

As an indirect effect, the start of the Culture of Entrepreneurship program acted as a trigger to establishment of entrepreneurial courses in German universities. Today, almost all institutes of technology and 70% of 29 research-focused universities offer entrepreneurial courses.[267]

6.3.2. Key measures other than EXIST

6.3.2.1 GO-Bio[268], 2005 – Now

This is a startup support program specializing in the fields of bio and life sciences. Just as the EXIST Transfer of Research program is, Go-Bio is made up of two phases. The first phase covers a startup preparation period, providing financial support from two and half years to up to four years. In the second phase after the launch of a business, the program can provide pre-seed funding for three more years. It aims to provide long-lasting public support because implementation and commercialization in the field of life sciences could take longer than in other fields. By 2016, seven rounds of competition were held, and 50 teams among total 600 applicants won grants. This program was created due to the need for a publicly funded institution to evaluate the value of research seeds and IP in the form of grants because many private VC funds did not have discerning experts yet when they began to sprout up, getting R&D startup support into full swing in the 1990s. While the program specializes in the field of life sciences, it is open to a variety of areas in the domain, attracting entries of an extremely wide range of startup ideas from drug discovery, to diagnosis technology, to medical engineering. In the first phase competition round, a judging committee made up of experts placed under BMBF examines applicants' documents and only those shortlisted will have opportunities to present their business plans. So far, 24 firms have been launched and received over 60 million euros.[269]

The amount of grants varies depending on the project, as grants are supposed to cover all costs required for approved projects. According to the guidelines for application for the eighth competition[270], personnel costs alone covers a research leader, two postdoctoral researchers, two doctoral students, two persons not related to research (in charge of management), and one

faculties as well, they are classified as universities.
267 Gründungspotenziale und Gründungsunterstützung an forschungsstarken Universitäten/Fraunhofer ISI 2017
268 Officially known as Gründungsoffensive für Bioökonomie (aggressive bio-economy startup).
269 https://biooekonomie.de/
270 https://www.bmbf.de/foerderungen/bekanntmachung-1285.html

engineer as well, and a grant amounts to 600,000 to 3 million euros depending on the project. Apart from this, covering expenses for coaching, travelling, and clinical trials up to 100,000 euros, GO-Bio is a large funding program.

6.3.2.2 SIGNO, 2008 – 2016/WIPANO

To promote more efficient application of university inventions, the IP utilization support program[271] was developed in 2003 to establish technology transfer institutions (PVA[272]) across the country. The competent authority is BMBF and it provided a little over 22 million euros from 2003 to 2006 and additional 28 million euros during the following three-year period from 2006. While activities and business models slightly vary depending on the region, technology transfer institutions continue to exist today in 22 locations in the country. Apart from universities, Fraunhofer has internal departments for technology transfer and IP management while Max Planck Society has a separate organization Max Planck Innovation (MP Innovation). Helmholtz Association and Leibniz Association manage technology transfer partially by themselves while outsourcing the rest to external technology transfer institutions. In 2008, BMWi took over the program and announced "SIGNO – an intellectual property protection program aiming for commercialization[273]." SIGNO partially covers patent filing fees and payment to patent attorneys in addition to evaluation of university inventions. Then, in 2016, SIGNO was revised to the current form, "WIPANO – a knowledge/technology transfer program based on patens and specifications."[274] Unlike SIGNO, WIPANO provides the same amount of grant to all proposals and does not cover consulting fees or seminar participation fees that would have been covered by SIGNO, and users are calling for improvement of the program. WIPANO is set to provide 23 million euros over a three-year period, until 2019.

6.3.2.3 High-Tech Startup Fund (HTGF)[275], 2005 – Now/Public and private fund

HTGF is a fund specializing in support for early-stage high-tech startups, and its third stage funding started in 2017. HTGF funded 272 million euros in its first stage and 340 million euros in its second stage, and has so far provided 245 million euros in this stage, aiming to provide 300 million euros eventually. This stage aims to raise 70% of funds from the Federal Ministry for Economic Affairs and Energy (BMWi) and the German Reconstruction Credit Institute (KfW) and 30% from 26 private firms. HTGF funds up to one million euros per company, and makes equity capital investment up to three million euros. So far, without limiting industry sectors, HTGF has invested in 460 companies in a wide range of fields from manufacturing, to energy, to life sciences/healthcare, to ICT. HTGF has so far invested total 300 million euros of its own fund in startups, which were generally well received and able to raise about four times as much in the following financing round, or 1.3 billion euros, 70% of which was raised from private investors. The leader of HTGF which continues to have decision-making rights is BMWi.

While proclaiming itself as a public private fund, HTGF is heavily relying on the government and it lacks the latitude and flexibility possessed by business angels. However, HTGF-funded businesses can expect some brand effect and may attract attention from investors. In this sense, investments by HTGF are nothing less than significant even though the amount may be small.

[271] Verwertungsoffensive BMBF
[272] Patentverwertungsagenturen
[273] SIGNO – Schutz von Ideen für die gewerbliche Nutzung
[274] Wissens- und Technologietransfer durch Patente und Normen
[275] Hightech-Günderfonds https://high-tech-gruenderfonds.de/en/

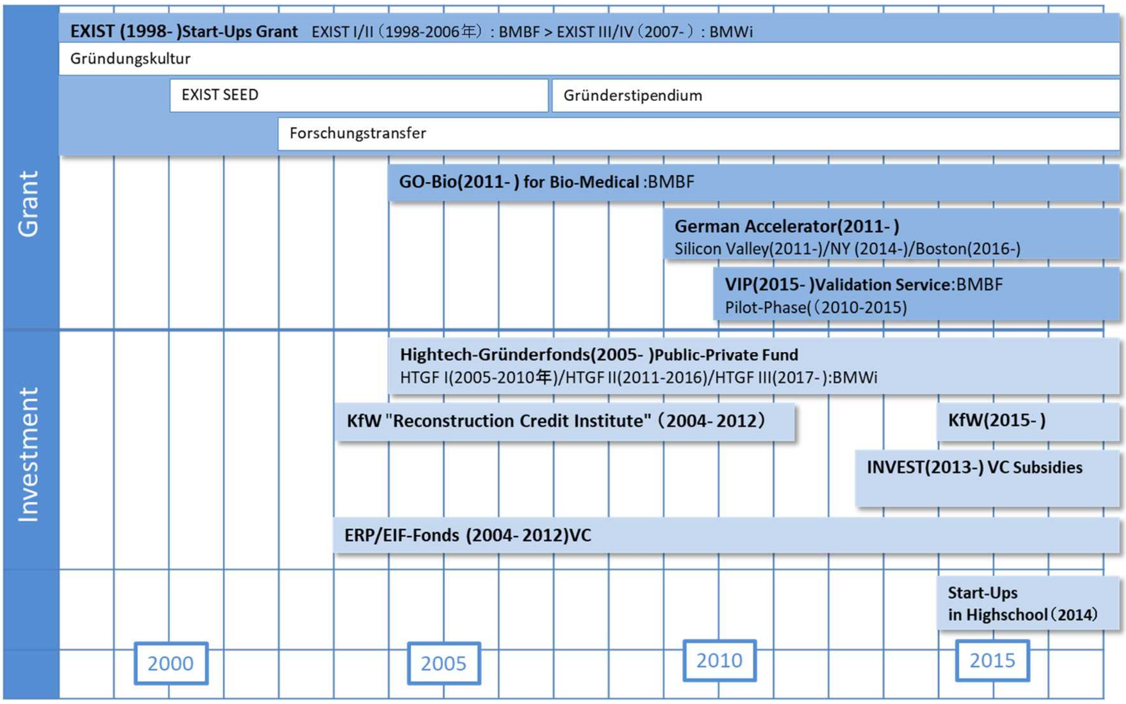

Fig. 4: Overview of Startup Support Programs
Source: Materials from Expertenkommission Forschung und Innovation (www.e-fi.de/) edited by CRDS

Column 1: European Institute of Innovation & Technology (EIT)

Modeled after the Massachusetts Institute of Technology (MIT) of the US, EIT is an organization under the EU which mainly aims to develop entrepreneurial talent in a bid to strengthen capabilities to connect education and research outputs to business opportunities. EIT is implemented as part of the framework program of Horizon 2020 and headquartered in Budapest, Hungary. As of 2017, EIT communities are operating in six areas: climate change (EIT Climate-KIC), digital transformation (EIT Digital), health (EIT Health), food (EIT Food), sustainable energy (EIT InnoEnergy), and raw materials (EIT Raw Material).

EIT's program is implemented by organizations called Knowledge and Innovation Communities (KICs), which have corporate status. KICs have been set up in multiple universities in Europe, where they conduct close industry-academia collaboration by requiring participation by at least one company in each university. The program is long-term, taking 7 to 15 years, and 20% of the entire budget of KICs is accounted for by grants from EIT while the rest is funded by local funding institutions and participating companies.

From 2010 to 2016, 430 new products and services were created from 2,242 ideas and 305 companies were launched. As of the end of 2016, 503 companies including small and medium-sized enterprises, 171 universities and higher education institutions, 146 research institutions and 74 local governments participate in EIT.

For example, EIT Digital offers three education programs, i.e., Master School, Doctoral School, and Professional School. In Master School, partner universities, which are among the best in Europe, prominent laboratories, and influential corporations offer the latest ICT-related knowledge by combining innovation and entrepreneurship training, and students can obtain their master's degrees and EIT diplomas (double degree). We heard that EIT positions itself somewhere between science and technology research programs and MBA programs. More specifically, EIT targets young researchers in science and technology and aims to equip them with management skills which they would not learn without EIT before they complete their programs. Management knowledge offered by EIT falls short of what one would acquire in an MBA program but EIT intends to give future researchers knowledge that they would not gain in their ordinary research activities.

In Doctoral School, students receive practical entrepreneurial education and study theories on business and organizational development. To be more specific, students work on challenges scientifically in cooperation with industry partners at a "Doctoral Training Centre (DTC)." ETI Digital has bases in Berlin (Berlin Node) and Munich (Munich Satellite) in Germany. Berlin Node is placed in the Technical University of Berlin, working on education, industry-academia collaborative research, and startup support by cooperating with nine other bases in Europe. Its partners include Deutsche Telekom AG, Siemens AG, SAP SE, Fraunhofer Society for the Advancement of Applied Research (FhG), and German Research Center for Artificial Intelligence (DFKI). Munich Satellite is based in the Technical University of Munich (TUM), and startup support focused on cyber physical system (CPS) research is provided by fortiss Institute, Siemens AG, CDTM, and the University of Munich (LMU).

Operating funds for EIT and KICs are provided by various sources of public and private funds including EU. EU allocated 387 million euros from 2008 to 2013 for establishment/operation and adjustment of EIT and KICs. Apart from this, the European Commission set aside 1,531.44 million euros from the EU budget for the Framework Programme (FP7) and structural funds while the rest is set to be provided by businesses, member countries, and local governments among others. As an EU organization with a separate corporate status, EIT is able to apply for grant programs offered by EU.

EIT: https://eit.europa.eu/e

"Report of trends of science and technology/innovation – EU edition" (2015), CRDS, JST
https://www.jst.go.jp/crds/pdf/2015/OR/CRDS-FY2015-OR-04.pdf
FY2009 investigation report on overseas technology trends – Europe edition Part I – March 2010, METI

6.4. Cases of R&D startup support

6.4.1. Efforts at the Technical University of Munich

According to the 2016 report of Founding Radar (Gründungsradar)[276], which monitors the state of new business creation from higher education institutions, the Technical University of Munich (TUM)[277] claimed the top position in the overall rankings of the university division. In this subsection, we look at noteworthy efforts made at TUM. TUM was established as an engineering university in 1868 in Munich, the state capital of Bavaria, in southern Germany. The university now has faculties of medicine and economy as well. This higher education institution with a long history is home to 40,000 current students across 167 departments, and has produced 17 Nobel laureates. Of the 2015 budget of 1,329 million euros, external funds for expenditure other than basic expenses amounted to 285 million euros, of which 46 million euros were provided by industry. As a leading university of Germany, TUM is one of the three schools selected in the first selection round of the Excellence Initiatives, a government grant program launched in 2006 aiming to enhance university research capabilities, for the "Zukunftskonzept (future concept)"[278] subprogram, which is the third pillar of the Excellence Initiatives. TUM titled its future concept "TUM. The Entrepreneurial University," aiming to become a university which conducts R&D activities based on exit strategies. UnternehmerTUM GmbH, to be discussed later, was established by the initiatives of enrolled students back in 2002. As a corporation separate from TUM, it offers consulting, mentoring, and incubation services, and has a track record of helping to create an average of 50 companies a year in cooperation with the university authorities. TUM was also accepted to the EXIST Culture of Entrepreneurship program in 2011 and set up a makers space for existing students and graduates in 2015, steadily expanding its range of support.

6.4.1.1 TUM startup support, UnternehmerTUM

UnternehmerTUM GmbH is a limited liability company established in 2002 and wholly owned by Susanne Klatten, a business person and large shareholder of the auto manufacturer BMW, who is sympathetic to the company's prospectus. As an "An-Institut[279]" of TUM, UnternehmerTUM has its office in Garching to the northof Munich. With more than 70 members of staff, it is one of the largest startup support organizations in Europe. It offers university lectures and seminars and runs various projects. As suggested by its budget which is sourced in the proportion 9:1 from private sponsors and the Bavarian State Government, UnternehmerTUM is characterized by its operation style which involves industry-government-academia cooperation. In 2006, TUM came up with concepts "innovation through business creation" and "university management with an

[276] Survey funded by the Federal Ministry for Economic Affairs and Energy (BMWi) and implemented by Donors' Association for the Promotion of Humanities and Sciences in Germany (Stifterverband für die Deutsche Wissenschaft) and Heinz Nixdorf Foundation (Heinz Nixdorf Stiftung). www.gruendungsradar.de/

[277] Technische Universität München / www.tum.de (2017)

[278] "Institutional Strategies" is the official English title of the subprogram, Zukunftskonzept (future concept), and eligible universities are chosen from universities which were selected for both of the other two subprograms, "Clusters of Excellence" and "Graduate Schools." "Institutional Strategies" gives grants available for operational expenditure to differentiate one's university from others and to realize concepts. Universities chosen for the "Institutional Strategies" subprogram are considered to have obtained the title of "University of Excellence."

[279] As "An" of "An-Institut" is a preposition which indicates "adjacent," "An-Institut" is an organization which should be distinguished from "In-Institut" (laboratory in a university). It refers to institutions which are legally independent from universities and allowed to conduct sales activities. Having a close relationship with its home university, An-Institute is often located in the university's premises or a state-run science park. It can take various forms including a foundation, an NPO, a limited liability company, etc.

entrepreneurial mindset" as its strategy. One of TUM's characteristics is that the university has both a startup support framework in a top-down approach and a bottom-up-style activity initiated by students (researchers) such as UnternehmerTUM. It is said that the university's activities today would not be possible without one or the other.

Education program of UnternehmerTUM

UnternehmerTUM started as an education program but gradually expanded into startup support as the number of students who seriously wanted to start their own business grew over the years. Many education courses currently offered by the company focus not only on entrepreneurial education which teaches knowhow for starting a business but also on education to learn skills concerning technology development (Tec-Education). Large corporations did not participate in this program at first but gradually developed an interest in startups or startup projects which slowly came into being and has started working with startups for development or providing funds, thereby expanding their involvement. The program is targeted at interested students and researchers, aiming to attract especially the top-level people. The program has steadily produced good results including the top prize won by WARR[280], a team from TUM supported by UnternehmerTUM, at the Hyperloop competition held by SpaceX of the US in 2017. It could provide a goal that is significant but feels attainable for would-be entrepreneurs since a student-led startup team came in first at an international competition after 18-months of R&D activities. This achievement was also significant in that the team was led by not a professor but students, which has inspired other students to start businesses or to commercialize new technology. TUM has the School of Management in its economics department, where four professors teach entrepreneurship. They teach theories concerning business creation and management while students also learn practical knowledge in courses offered by UnternehmerTUM. UnternehmerTUM develops managerial skills of students, who at the same time study technology not only at TUM but at all higher education institutions and public research institutions in the state including research centers of the Fraunhofer Society and the Max Planck Society. With the increasing number of business angels and VC firms that provide funds, Munich has improved its startup environment.

Acceleration and incubation programs of UnternehmerTUM

The business of UnternehmerTUM includes incubation, acceleration, consulting, investment, and prototyping, apart from education. Especially well known is the company's Tec Founder program, which epitomizes TUM's accelerator programs and invites applications from the outside of TUM as well. It is a four-month acceleration program, offering practical projects to support growth of startups. They are not mock projects for demonstration purposes but pilot projects of large corporations such as BMW, Bosch, and Festo and students actually participate in them. This program is rated highly because students can get involved in projects of actual products and services of the said large corporations as well as receive individual guidance including coaching and mentoring during the four-month period. At the end of the program, Demo Day is held and participants present what they learned over the four-month period. The event also invites business angels and VC funds, providing opportunities to directly meet prospective investors. By leveraging the strength of TUM being a technical university, the program aims to encourage the creation of solid business based on the combination of basic research, engineering, and industry.

[280] http://hyperloop1.warr.de/

UnternehmerTUM specializes in R&D startup support mainly in the fields of ICT, medical engineering, and clean tech. In addition, it established its own VC fund, UnternehmerTUM Venture Capital Partners GmbH[281] in 2011, investing in seed-stage companies and Series A and B rounds. Apart from this, UnternehmerTUM established Talent.Pool, a managerial talent database, thereby matching researchers who have technology seeds with managerial candidates. Today, more than 300 existing students and graduates are registered with Talent.Pool.

6.4.1.2 An-Institut, fortiss GmbH

Distinguished from UnternehmerTUM, fortissGmbH[282], another an-institut, is a corporation specializing in research and development of software and systems, wholly owned by the Bavarian Ministry of Economy, Infrastructure, Transport and Technology. Established in 2008, it aims to bridge academia and industry and thereby encourage bilateral interaction, i.e., not only commercialization from basic research to industry application but also generation of research ideas at universities from industry challenge. It is true that public research institutions in Germany are also in charge of this function, but fortiss tries to respond to market needs in a faster and more flexible manner by providing R&D services as an independent corporation. It is based in the laboratory of professor Manfred Broy[283] of Department of Informatics, TUM, who is a key player in digital strategies of the state of Bavaria.

Roles of fortiss GmbH

fortiss engages in R&D activities ranging from various solutions for automated driving to software concerning automobile driving and aircraft flying. Apart from this, fortiss offers advice for R&D roadmap creation as well as technical consulting. Why is it that researchers of TUM want to do their doctoral programs and postdoctoral activities at fortiss? First, it is because they consider fortiss as the best place to demonstrate their potential by participating in industry projects. Another reason is that they can determine the possibilities of their startups by utilizing fortiss as a kind of an incubator. It is also attractive to young researchers that fortiss functions as a state-, federal-government- or EU-level think tank through its consulting services. Around 60% of research projects are funded by state and federal governments and EU. In addition, fortiss conducts research contracted by industry while some projects are underway thanks to winning competitive funds in competitions. The research budget of fortiss is generally broken down into basic expenses provided by the state government which accounts for 30%, strategic project funding which provides 30-40%, and contract research income from industry which makes up 30%. This is similar to the composition of the budget of research centers of the Fraunhofer Society. However, fortiss is allowed more discretion than Fraunhofer and contract research income from industry and basic expenses are not linked to each other. As fortiss is not an R&D service provider but instead aims to connect top-level research outputs and markets, it does not accept all contract work and secures excellent researchers' potential by closely examining projects. As a rule, software developed by fortiss is released as open source, and IP of software developed through a contract with a company belongs to the ordering company. fortiss obtains patents only as a protective measure when it plans to start a business based on the technology concerned. This is partly because fortiss, as a research center, has many PhDs and thus needs to let them write papers

[281] UnternehmerTUM Venture Capital Partners concluded its first closing with 34 million euros and second closing with 70 million euros.
[282] Forschung und Transfer Institut für Software-intensive Systeme GmbH
[283] Prof. Dr. Manfred Broy / Software & Systems Engineering

as they wish.

Munich as an ICT R&D hub

A Silicon Valley-like startup support environment is being developed in Munich. It is true that the US dominates in the fields of commercial software, the internet, OS, and smartphone platforms but Europe is strong in embedded software and if you take a closer look, there are a number of fields where Germany beats the US, including robotics, automotive systems, etc. The management of fortiss proudly considers the company a rival to the Weizmann Institute of Israel and the Stanford Research Institute of the US. These two research institutes changed the world, so fortiss aims to do the same. In addition, the company stresses the importance of not only research but also application to markets just as Weizmann does. fortiss is also engaged in the creation of local networks of KICs (Knowledge and Innovation Communities) which used to be called ICT Lab under the European Institute of Innovation & Technology (EIT) of EU.

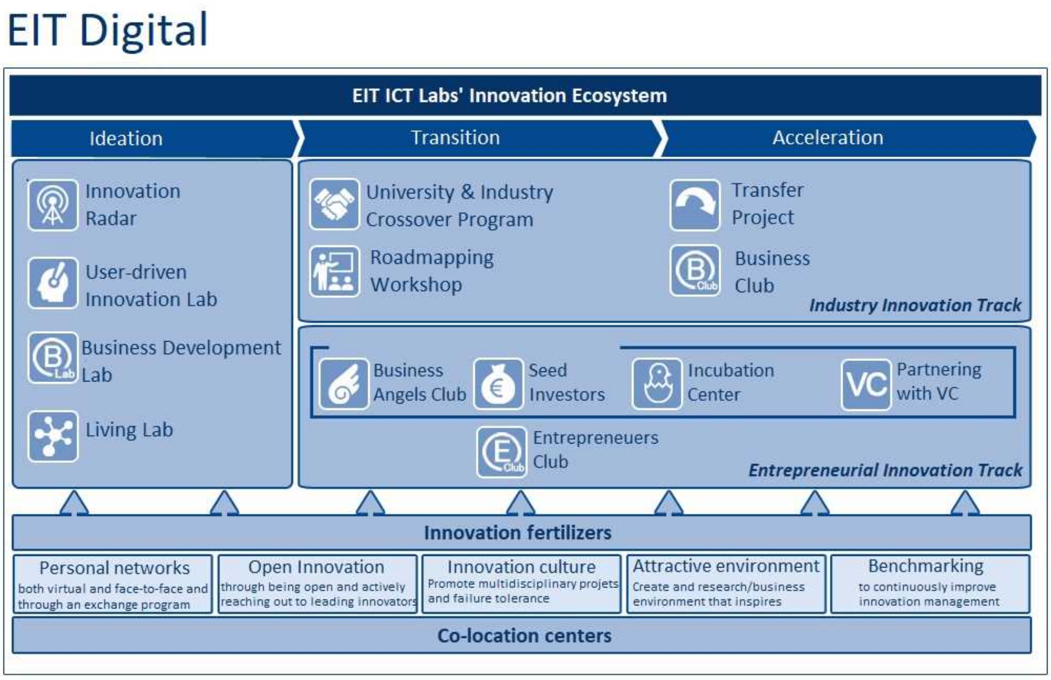

Fig. 5: Concept of EIT Digital

Source: Created by CRDS based on presentation materials of fortiss GmbH

While the university is engaged in education and research, fortiss draws a line, working on research and technology transfer as its mission. Accordingly, fortiss does not provide education or vocational training in the activities discussed above.

6.4.1.3 The Center for Digital Technology & Management (CDTM)

Two universities in Munich, the Technical University of Munich (TUM) and the University of Munich (LMU), are Germany's leading universities with a long history, and they both have been accepted to the Excellence Initiatives program. Competing in the same city, they rarely worked together for a long time. In 1998, however, they jointly set up CDTM[284] to cooperate in developing engineering/management talent and providing startup support. People who advocated establishment of CDTM had recognition that business managers would be required to understand IT going forward not to speak of management and technology for making proper business decisions while students learning software technology could not develop good software with just software development skills unless they understood business. CDTM offers practical programs where students can learn both management and informatics.

CDTM was modeled after the Massachusetts Institute of Technology (MIT) of the US, which is highly recognized for its cross-disciplinary approach in information exchange and networking. However, there were some challenges: 1) CDTM lacked funds required for resembling MIT; 2) Faculties in German universities are fairly independent and do not communicate with each other whereas in the US, each topic-based cluster pursues cross-disciplinary research and education; and 3) Because faculties in universities in Munich are so dispersed that they do not create the image of an integrated campus like universities in the US, it is impracticable to introduce the framework of MIT as is. Therefore, CDTM was instituted after localizing the original MIT model. CDTM is a self-governing organization in which 10 researchers on doctoral programs manage and operate courses. These graduate students take care of daily management of courses while professors from both universities participate as mentors, positions equivalent to the board of directors of a corporation. Graduate students (PhD candidates) teach participants for an average of four years. This is a characteristic of CDTM and the change of staff stimulates the center. Some join CDTM as staff when they complete their courses in CDTM and start their PhD programs and others directly become CDTM staff after coming from different states.

CDTM provides people who have completed its programs with certificates, not official titles such as master's degrees. Courses are taught in English and the application is open to students as early as senior undergraduate students. Many participants are master's students. CDTM accepts an average of 25 students per semester. This term, it selected 25 from 320 applicants. There is a variety of departments including economics, engineering (electricity, information), and media studies. As the courses are offered in three semesters (1.5 years), a total of 75 to 100 students, including those who started at different times, study at any given time.

Course structure

■ Trend seminar (1st semester)

After picking one topic from future challenges concerning digital technology, 25 students are divided into five small groups and take the following steps: 1) extract trends, 2) develop a scenario of around the year 2030, and 3) develop a business model and discuss solutions to the problem. When extracting trends in 1), students make analyses from different angles by taking into account technological trends, social challenges, current business models, political and legal analyses, and external factors such as environmental problems. Finally, at 3), students complete five business models and service models.

[284] Center for Digital Technology & Management

■ Managing product development (2nd semester)
Students are involved in prototyping. Starting from taking a human-centric design approach, students directly communicate with corporate staff and work for three months towards achieving the goal of developing a prototype.

■ Entrepreneurship laboratory (3rd semester)
This is a practical program where students provide strategic consultation to startups. They provide advice to startups when these companies analyze markets and develop action plans. The objective of this program is to learn through practice what it means to start a business and what people need when they start a business by working together with startups.

Over the past 20 years, 600 students completed the CDTM program and launched 120 startups. The original purpose of CDTM was developing managers who can make innovative decisions at all times by employing cross-disciplinary thought. CDTM does not care where such managers utilize their skills, be it a large corporation, political arena, or a startup, but TUM and LMU both have their own entrepreneur centers and they happen to provide startup support there. Effectively, CDTM takes care of human resources development which should take place before they join these entrepreneur centers. The fields of startups range from media industry, to sports industry, to manufacturing and some startups are B2C businesses and others are B2B businesses. There seems to be many B2B startups partly because the State of Bavaria is highly industrialized while there are few life-science-related startups from CDTM. There are more environment/energy-related startups than life-science-related ones, but not many. We gather that these sectors are not very viable in this state.

TUM startup case 1: Dynamic Components GmbH

- Predictive maintenance system by Industry 4.0 technology and edge computing.
- Startup with TUM researchers at its core. Accepted to the EXIST Transfer of Research program.

To commercialize technology seeds owned by fortiss, a team of three researchers from fortiss and one managerial candidate from a corporate consulting firm applied for the EXIST Transfer of Research program, and launched Dynamic Components GmbH in 2016 after a year and half preparation period. The company applies edge computing technology, the company’s strength, to the development of software and devices which enable real-time on-site railway facility maintenance. The company is now receiving second phase funding of the EXIST Transfer of Research program. As a startup, the company had an auspicious start by signing a contract with the cargo department of Deutsche Bahn (DB) while participating in an acceleration program[285] offered by Deutsche Telekom. The company continues R&D activities at its home company fortiss, and is still based in the incubation center of TUM. One business manager was hired under project-based employment by fortiss which was funded by EIT Digital of EU. Dynamic Components is a textbook example of a university-launched startup for the following reasons: this manager received his PhD from TUM, a state university; the company was spun out of an-institut of TUM; the manager was secured by a grant from EU; the company creation was funded by the federal government; and the company aims to expand its business by keeping close relationship with TUM.

[285] Challenge Up! https://www.facebook.com/ChallengeUpAccelerator/ Acceleration program jointly offered by Deutsche Telekom, Intel, and Cisco.

TUM startup case 2: Venneos GmbH

- Bio-measurement device manufacturer based on a patent of MPG.
- MPG researchers and an MBA holder from TUM are the key members. Accepted to the EXIST Transfer of Research program.

Venneos was established based on the technology concerning a brain-computer interface[286] studied by Professor Fromherz of Max Planck Institute of Biochemistry (MPI Bio Chemical), Munich. Venneos applied for the EXIST Transfer of Research program offered by BMWi in 2011 and was approved. Venneos received phase 1 funding of the EXIST Transfer of Research from 2012 to the end of 2014, and phase 2 funding from 2014 to the end of 2015. As establishment of a company is a prerequisite for phase 2 funding, Venneos was registered during 2014 (July). As EXIST is a program promoting creation of business from universities and research institutions, Venneos needed a home institution. When Prof. Fromherz resigned from MPI Bio Chemical (Munich), the research in the same field was closed, so Venneos needed to find a new home institution and moved to the Institute for Intelligent Systems, a peer institute under the Max Planck Society, (MPI Intelligente Systeme, Stuttgart). The founding members are three MPI researchers and one manager from Talent.Pool of TUM who completed the CDTM program of TUM. Based on the technology developed by Prof. Fromherz, the members developed technology to analyze brain neural circuits. When this technology later proved applicable to the analyses of other cells, the MPI researchers decided to establish a company based on this technology in 2011. Venneos aims to first spread this technology in academic fields such as universities and research institutions. If the next-generation device is completed, the company may be able to roll it out to chemical, bio, drug discovery, and other sectors. If the device is downsized in the future to a degree that it could be portable, the company considers it applicable to the field of diagnostics. Venneos is a so-called B2B startup, targeting niche markets where German medium-sized companies are strong.

[286] Venneos has entered into a patent licensing agreement with the Max Planck Society.

Column 2: Startups from public research institutions

Here, we touch on the current state of startups from public research institutions. The federal and state governments jointly provide funds for basic expenses to four pubic research institutions: The Max Planck Society for the Advancement of Science (Max-Planck-Gesellschaft zur Förderung der Wissenschaften e. V.; abbreviated MPG), the Gottfried Wilhelm Leibniz Scientific Association (Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz; abbreviated WGL), the Fraunhofer Society for the Advancement of Applied Research (Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.; abbreviated FhG), and the Helmholtz Association of German Research Centres (Helmholtz-Gemeinschaft Deutscher Forschungszentren; abbreviated HGF). The contribution percentages of the federal and state governments vary depending on the institution; the federal and state governments share burdens equally at 50% for Max Planck and Leibniz while the federal government provides 90% of the funds for Fraunhofer and Helmholtz and state governments take care of the remaining 10%. However, in the case of Fraunhofer, government funds account for only around 30% of the total budget, so the federal governments' burden as a percentage is smaller than in other institutions. To put it bluntly, public research institutions, a pillar of Germany's R&D activities, are influenced by state governments. This is especially the case when public institutions plan to establish new laboratories, as they will be subject to the science and technology policies of the state governments. Laboratories of any of these institutions are mostly located adjacent to a university or inside the premises of a university, and they are often included in the industry-academia cooperative clusters discussed above. In 2001, BMBF issued guidelines concerning startup funding provided by public research institutions.*1 In 2012, the guidelines were revised based on amendments to the Science Freedom Act*2, drastically relaxing requirements for public research institutions' funding for new startups and regulations concerning researchers' side jobs.

Among the four institutions, Max Planck is earning huge revenue from patent licensing and startups, although it is a basic research institution. Since the establishment of Garching Instrumente GmbH, the predecessor of the current Max Planck Innovation GmbH, in the 1970s, Max Planck has managed patents and supported technology transfer for more than 30 years. So far, more than 130 startups have been launched since 1990. Max Planck is said to have recently earned 96 million euros of revenue from patents related to an antibody drug called Suetent developed by Prof. Axel Ullrich of Max Planck Institute of Biochemistry (MPI Biochemie). Commercialized by Sugen, which was later acquired by Pfizer of the US, Suetent is expected to generate patent income of 50 million euros going forward.

Fraunhofer, on the other hand, finds its mission in applied research promotion and technology transfer. As patents derived from research contracted out by companies belong to Fraunhofer in general, the institutions are developing frameworks to provide support for startups ("spinoffs" in its term) in a bid to promote enforcement of patents it owns. In 1999, Fraunhofer established an organization called Fraunhofer Venture and has since provided support for spinoffs by operating multiple programs together including funds organized from MP3 patent income. However, as discussed in chapter 1, German companies are doing great, which means there is strong demand for R&D activities from companies and Fraunhofer receives many contract research orders accordingly. For this reason, the number of startups launched from Fraunhofer is not growing significantly. In fact, when we interviewed multiple Fraunhofer research institutions, some expressed concerns that they could become a rival to their major customers, mid-ranking corporations, by launching a business and that launching a new business and thereby losing high-caliber researchers whom they had managed to secure could deal a blow to Fraunhofer especially because it is receiving so many contract research orders now.

*1: Leitlinien zur Beteiligung von Forschungseinrichtungen an Ausgründungen zum Zwecke des Wissens- und Technologietransfers (2001/2012)

*2: Wissenschaftsfreiheitsgesetz

6.4.2. Reliable creation of startups from industry-academia cooperative clusters

In 1996, BioRegio was launched, which was a cluster program run by the federal government, specializing in the field of biotechnology and aiming for transfer of technology from universities and research institutions. This cluster is known for having provided support for bio-ventures to create innovations in biotechnology as well as promoted biotechnology research and industry at the same time. This program was followed by various cluster programs conducted by the federal and state governments, which led to the Leading-Edge Cluster Competition program (SCW)[287], the flagship program under the Hightech-Strategy (2006). Here, we use the case of a bio-cluster in Munich which was accepted to the BioRegio program to describe the current state of startup support which is provided by clusters and producing good results in Germany.

6.4.2.1 The BioRegio program

The BioRegio program (1996-2000) and its successor program, BioProfile (2001-2005), are highly recognized for creating a startup boom as well as vitalizing German biotechnology industry from the late 1990s to the early 2000s.[288] The BioRegio program's basic principle is "Make the strong stronger," and what lies behind it is the situation Germany was facing in which the country fell behind the US, other European countries and Japan in the drug market even though Germany had highly advanced and specialized researchers for basic research in the fields of biology and medicine and was blessed with a long history of chemical/drug discovery industries. According to a program assessment report issued in 2006, seven clusters[289] accepted to the two programs are high in the numbers of patent applications and businesses launched and low in the number of business closures except the cases of M&A compared to 14 other bio-clusters in Germany. One reason is that as a cluster accumulates more businesses, its environment becomes friendlier to new startups in terms of acquiring customers and venture capital. The fact that 57% of biotechnology-related companies in Germany are concentrated on these seven clusters speaks volumes for the difference in environments. The fact that during the two programs, around 50% of research grants for the fields of biology and medicine provided by the German Research Foundation (DFG) was provided to universities and research institutions in these seven clusters proves excellence not only in industry but also basic research.

The objectives of BioRegio and BioProfile were building local networks in the field of biotechnology and improving the legislation on VC markets, thereby increasing international competitiveness of Germany in the said field and promoting business creation. As for the goal of "creating Europe's number one biotechnology industry," Germany achieved it in terms of the number of companies by 2006, but still follows behind the UK in terms of sales by listed bio-companies. Therefore, the Hightech-Strategy released in 2006 maintained the goal of becoming Europe's number one country in terms of support for, sales of, and the number of employees in the bio industry.

From the State of Bavaria, Martinsried district was accepted to the BioRegio program.[290] This 25,000-square-meter area which is in the south part of Munich was developed as a science park

[287] Another bio-related company BioRN of the Heidelberg region is accepted to SCW, and so is a medical engineering company Medical Valley of the Erlangen-Nuremberg region.
[288] Evaluation der Fördermaßnahmern BioRegio und BioProfile/BMBF contract research, 2006
[289] Bioregio: Munich, Rhineland (Cologne, Aachen, Düsseldorf, Wuppertal), the Rhine-Necker Triangle (Heidelberg, Mannheim, Ludwigshafen), Jena; BioProfile: Niedersachsen (Brunswick, Göttingen, Hannover), Berlin, Stuttgart
[290] FY2015 Report on clusters in Germany contributing to local economic development, Institute for International Trade and Investment

by the state and Munich City, and it is home to the Medical Center of the University of Munich (LMU), the Max Planck Institute of Biochemistry (MPI Bio Chemical), and the Max Planck Institute of Neurobiology (MPI Neurobiology) as well as a startup center[291] built as an incubation facility for startups. This is based on the state's innovation policy adopted in 1991, which designated the fields of bio, IT, aerospace, and environment and energy as the state's priority support sectors. At first, only four companies were based in the startup center, which has now grown to become one of the top bio-clusters in Europe, housing more than 130 companies and 2,800 employees. It is local coordinators responsible for promotion of industry-academia cooperation, IP licensing, and liaising with VC funds that make or break these clusters. For Munich's bio-cluster, an organization called BioM[292] is the local coordinator, and it will be detailed in the following paragraphs.

6.4.2.2 Munich bio-cluster

BioM AG (hereinafter referred to as BioM) was established in 1997, following Martinstried's approval into the BioRegio program. It is playing a key role as a startup support organization, especially an intermediary organization to support local business creation. As a conflict of interest is inherent in technology transfer at universities, organizations such as BioM, which stands on neutral ground between universities and corporations, ask patent experts to coordinate the two sides, allowing for smooth negotiations. Additionally, BioM plays a role of training entrepreneur candidates to have entrepreneurial skills worth investment.

The focus of BioM's efforts is on searching for promising entrepreneurs, especially serial entrepreneurs who have launched a company more than once. BioM hopes that these entrepreneurs find innovation potential among research seeds. BioM is reported to have finally developed a pool of such talent after 20 years of experience. Startup support and entrepreneur education programs offered by BioM include a number of unique schemes in addition to pitch training, pitch contests, exchange of startup experiences and other general programs found in other countries and organizations. For example, "Mentor Circle" is an organization of approximately 50 members who are former researchers, developers, and sales reps who have retired from corporations which provides consultation to those who wish to start a business. These consultants are unpaid volunteers but will be rewarded with rights to become cofounders if researchers and teams they helped have established companies. In fact, when these researchers establish a company alone, sometimes it could be a problem that all the founders are young researchers in their 30s. So, having a senior person on board will give additional weight to the company. BioM launched a gap fund called "BioM Venture Capital Fonds"[293] in 2001, providing seed funds of 200,000 to 300,000 euros. Today, BioM does not make direct investment as more funds have become available, including the High-Tech Startup Fund (HTGF) and other public private funds, Bayern Kapital[294], which is a VC fund affiliated with a financial institution funded by the State of Bavaria, and bio-related business angels.

291 Innovations- und Gründerzentrum Biotechnologie Martinsried mbH (1995)
292 https://www.bio-m.org/
293 BioM Venture Capital Fonds invested in total 40 companies, half of which succeeded, and the other half failed. This is not at all poor performance as investment results, rather its success rate seems higher than normal. The high success rate indicates that the fund invested only in promising startups and did not take risk by investing in innovative cutting-edge seeds. I believe that most of the failures resulted from poor management not poor technology or seeds or poor judgement. It is extremely difficult to assess the personality and skills of a manager. (Interview with Prof. Domdey, CEO of BioM)
294 Established in 1995, Bayern Kapital is a fund specializing in bridge loans, aiming to attract private investments. It initially provided seed-stage funds up to two million euros, and then started providing growth-stage funds up to 10 million euros from 2015. It is a rarity even in Germany that a state-run investment bank provides startup support by establishing an investment firm.

In 2009, Munich's bio-cluster was accepted to the Leading-Edge Cluster Competition program of the federal government as a hub for precision medicine R&D activities[295]. In the meantime, BioM was able to establish an organization which aimed for technology transfer and startup support in the bio-field by receiving 22 million euros from BMBF as a startup support organization development project (Struktur-Projekt/ Project title: Scouting Incubation), a project related to the Leading-Edge Cluster Competition program (SCW). BioM developed a system of cooperation and coordination with technology transfer offices of the Max Planck Society for the Advancement of Science (MPG), the Fraunhofer Society for the Advancement of Applied Research (FhG), the Helmholtz Association of German Research Centres (HGF), and the Gottfried Wilhelm Leibniz Scientific Community (WGL) as well as both universities, LMU and TUM. At the same time, BioM started a pitch contest[296]. Previously, there was a limit to discovery of seeds because it was sometimes hard to get in touch with relevant university professors even though experts from technology transfer offices worked hard. With this pitch contest, researchers voluntarily entered and presented their research outputs, which brought to light seeds that would have otherwise been unknown. This contest has now become a key scouting tool and experts no longer proactively search for good seeds. The m4 Award is held biennially; in one year winners in the fields of bio and drug discovery are awarded in Munich and in the next year winners in the medical engineering field receive prizes in Erlangen. The State of Bavaria has decided to institutionalize and continue this award.

Recently, researchers who think their research outputs could be commercialized and bring in their ideas are recommended to leave their ideas to BioM, the expert, and its network, for objective measurement of their market value (validation), instead of jumping right into starting a company. There, researchers receive payment for their inventions but do not have to take the risk of starting a company. BioM supports roughly 30 startup candidate teams a year, which are slowly growing in number. BioM takes pride in having already made many researchers millionaires. As a state organization, BioM does not pay top-notch salaries to its employees, but they continue to serve the company because, the company believes, its employees can provide researchers with opportunities and witness their success firsthand.

Startup case 3: IMMUNIC AG

- Orally administered small molecule therapeutics for autoimmune diseases
- A spinout of Munich's bio-cluster

IMMUNIC AG is a pharmaceutical startup focused on orally administered small molecule therapeutics for autoimmune diseases, spun out of a relatively large corporation called 4SC AG which manufactures small molecule therapeutics for cancer in 2016. Headquartered in Munich's bio-cluster, 4SC conducts R&D activities, creates substances that are expected to produce good effects in molecularly targeted therapy, and licenses them to pharmaceutical companies. IMMUNIC is funded by HTGF. Its first year budget of 21.70 million euros (financial year ended in January 2017) covered Phase I and II clinical trials of IMU-838 (ulcerative colitis) and Phase I clinical trial of IMU-366 (psoriasis), and the company is now trying to raise an additional nine million euros for Phase II clinical trial of IMU-838 (Crohn's disease). IMMUNIC's characteristics include the following: it is not a startup trying to create market-disruptive products or services with innovative ideas or technologies but a spinout launched from the desire to utilize patents that can be commercialized but are left unexploited; the founder was a researcher who

[295] m4 Personaliseirte Medizin und zielgerichtete Therapien (2010-2015)
[296] m4 Award

had startup experience; it was funded smoothly by VC firms thanks to its clear business plan covering from fundraising to R&D plans; and it is a startup of the "Hidden Champion" type which aims for a large global share in niche markets. For a successful startup, people (teams), goods (technology seeds), and money (VC) are required and Munich has them all. Munich is the number one city in Germany and Europe but still falls far behind Boston. There are high expectations for Munich.

Program	Indication	Preclinical	Phase 1	Phase 2	Worldwide Commercial Rights
IMU-838	Crohn's Disease				Immunic
IMU-366	Psoriasis				Immunic

Fig. 6: Business Pipeline of IMMUNIC
Source: Created by CRDS based on materials from IMMUNIC AG

6.5. Characteristics and challenges of startup support policies

As mentioned in 6.1 and 6.2, universities have now assumed the responsibility of knowledge and technology transfer from universities and research institutions and "professors' privileges" have been removed by the revision to the Act on Employees' Inventions. Against such a backdrop, efforts for technology transfer have been accelerated and various environment improvement measures have been implemented. However, Germany is facing many challenges to solve in terms of education system reform, improvement of the legislation, and IP strategies because companies in general, especially small and medium-sized ones, still tend to avoid the risk of investing in seed-stage technology, and researchers do not have strong awareness of the importance of technology transfer. According to a survey by the German Reconstruction Credit Institute (KfW), the number of new startups in 2015 dropped 17% from the previous year to 763,000[297] due to the strong economy and steady employment environment, and the number of founders who had to start their own business because no jobs were available also fell (by 28%). In the meantime, the number of innovative startups, or so-called high-tech startups, rose 6% to 95,000, which could be attributed to the measures implemented to support startups based on universities and research outputs. In addition, because 20% of people who launched businesses are in the digital-related fields and startups in the digital-related fields do business in international markets, these startups are considered to be contributing to the enhancement of Germany's international competitiveness. Related to this, an increase, albeit slightly, in the percentage of university graduates to the number of entrepreneurs and an increase in the number of newly launched startups suggest that the startup environments in universities and research institutions are improving. This section discusses high-tech startups that are increasing in number, although only slightly, and related support programs.

6.5.1. Multi-layered support from the federal and state governments

Currently, how busy the startup scene is varies greatly depending on the region. Regions where business has flourished since long ago, industry-academia cooperative clusters are strongly promoted as a policy, and various grant programs are available, including Berlin, Hamburg[298], the

[297] KfW-Gründungsmonitor 2016
[298] Berlin, Hamburg, and Bremen are all cities but have the authority on a par with that of states for historical reasons.

State of North Rhine-Westphalia, the State of Bavaria (state capital Munich), and the State of Baden-Württemberg (state capital Stuttgart) have seen a steady rise in the number of startups. Some say Germany's industry-academia cooperative cluster support system, as illustrated by using the case of Munich in 6.4, took the idea from Japan's Promotion Act for Accelerating the Development of the High-Tech Industry Integrated Region (Technopolis-Act/1983) which aimed to develop hubs for knowledge intensive industry in the provinces against the backdrop of Japan's shift from heavy industry to high-tech industry.[299] As discussed previously, Germany is a country under a federal system, which has led to a wide diversity of economic and industrial policies depending on the state. The university system is also under the jurisdiction of each state, and therefore varies across states. For example, Dortmund, North Rhine-Westphalia, which is located in the Ruhr industrial area which has prospered with steel production for a long time, close to Hamburg, one of the main ports in Europe, and the home of Amazon's European hub, still functions as a hub for the distribution/transportation industry. The Technical University of Dortmund in the city offers one of very few logistics courses available in Germany while Fraunhofer Institute for Material Flow and Logistics (FhG IML) bridges industry and academia. In some cases, as in Munich, the state government decides on specific industries to support and develops clusters and science parks accordingly while in other cases, as in Dortmund, an existing industry provides the foundation, on which industry and academia get together and collaborate. The States of Bavaria, North Rhine-Westphalia, and Baden-Württemberg each have a population of more than 10 million, and thus are hard to compare with Japan's prefectures as there are differences in budgets and authority of state/prefectural governments. However, Germany's system is more appropriate for operation of industry-academia clusters. More specifically, Germany has an established framework in which states are responsible for the development of physical hub environments and supply of research talent through university support while the federal government supports industry-academia cooperative clusters through providing R&D funds. The advantage of an industry-academia cluster for startups is that it offers a greater possibility for business expansion after startups have been launched. In an industry cluster, practical support can be provided to companies immediately after their launch because market needs are easy to grasp and human and physical networks can be easily built during a business launch process thanks to the accumulation of businesses. Of course, it does not mean that if an industry is clustered and R&D funds are provided, success is guaranteed. As a matter of course, a clear focus should be placed on startups as early as when a cluster is established, and appropriate organizational management and network building are indispensable, as seen in the cases of Munich's BioM and the federal government's BioRegio program. From the success of BioRegio to the Leading-Edge Cluster Competition, Germany has created as many as 300 clusters of variable size, and they only include those recognized by BMBF. Germany is characterized by its reliable creation of startups with international competitiveness in niche markets based on these clusters.

6.5.2. Support for startups aiming to become Mittelstand

As discussed in 6.3, it is internationally competitive medium-sized companies called Mittelstand that are the pillar of German economy which relies on export. German federal government claims that "the startups of today are Mittlestand firms tomorrow[300]" in its startup

[299] "University high-tech spin-off venture", Masayuki Kondo (2002)
[300] Mehr Chancen für Gründungen, BMBF 2017
While many startup-related measures including the EXIST program are promoted by BMWi, BMBF has long discussed the

support policy. At the same time, the role expected of high-tech startups is to contribute to developing products or business models with new value from research outputs of universities and research institutions by utilizing their imagination. Mittelstand firms are often considered Niche Champions which hold large shares in tiny markets, so they are keenly aware that if they stop providing added value to markets, their products and services will soon become obsolete in markets and existing rivals and companies from emerging countries will catch up with them. Therefore, they tend to eagerly pursue creation of innovations through R&D activities. Unlike large corporations, medium-sized firms cannot afford their own R&D facilities or personnel, so they actively engage in industry-academia cooperation and contract out research to Fraunhofer research centers and other organizations that are applied research institutions. This is nothing but a factor for the success of startups, and it is no exaggeration to say that startup support in Germany means support for Mittelstand. Meanwhile, support for these startups which aim to become Mittelstand firms is quite different from creation of dynamism or disruptive innovations that led to the establishment of new industries represented by Google and Facebook in the US. This is corroborated by the report from the Commission of Experts for Research and Innovation (EFI)[301] as well, which stated that German innovations are gradual.

6.5.3. Summary

There are several issues Germany has to deal with in order to increase the number of R&D startups in a sustainable manner, going forward. First, there is wide disparity between regions. The city of Berlin and the states of North Rhine-Westphalia and Bavaria where clusters have been developed as a policy and many grant programs are available are seeing a steady rise in the number of new startups. The dynamism found in these regions has to spread into other regions as well. Second, according to a questionnaire survey conducted by the German Startups Association, many startups which responded to this survey called for relaxation of regulations, simplification of complicated paperwork, and introduction of tax benefits. These matters all affect the costs of establishing new companies and thus should be further improved. Third, Germany falls behind the US and other leading startup countries in terms of development of venture capital and other financial support. Germany also has to increase the number of business angels and VC firms for each phase, and there is regional disparity in this sense too. Finally, further discussions should be made on the entrepreneur education system of German universities. Similar to the case of Japan, many people in Germany are arguing that classes for entrepreneurship and a social contribution should be provided to students as early as when they are in high school before entering universities. At institutes of technology, the sense of technology transfer has been fostered as they are increasingly cooperating with industry. In some universities, however, quite a few professors still argue that universities (graduate schools) are a seat of research and product development and commercialization should be left to companies. These professors are dealt with by industry-academia cooperative organizations and technology transfer offices of universities. If university authorities, technology transfer offices, corporations, and state governments work together, they may be able to solve these issues gradually.

As a summary, the following are our conclusions concerning German startups:

- The number of new startups is not large at all due to the country's strong economy but some cities are seeing a rise in the number of startups.

need for R&D startup support and is expected to develop a new program as a new administration is inaugurated.

[301] Gutachten 2017, Expertenkommission Forschung und Innovation, 2017（EFI）

- Thanks to startup support institutionalized 20 years ago, university-launched startups have started to become recognized.
- German startups typically aim to grow to be medium-sized corporations that make steady and gradual growth, instead of aiming for disruptive innovations.
- Multi-layered startup support is available from the federal and state governments.
- There is an established system in which reliable startups are created, especially from industry-academia cooperative clusters.

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7. France

In a bid to develop bearers of innovations in the private sector, the French government has continued national efforts to promote investment in the field of R&D for the past 15 years but the growth of R&D investment in the private sector slowed down according to data of 2015. Meanwhile, the French government has recently come under pressure to quickly solve socioeconomic issues including the poorly performing manufacturing sector and a related employment problem. The government has been committed to startup support as a first step toward a solution of both the challenge of developing private innovators and the socioeconomic issues including employment. By the central government, public research institutions, universities, and local governments narrowing down their targets individually, multi-layered startup support programs have been made available.

With regard to startups launched from public research institutions including universities, the 1999 Allègre Act triggered a sharp rise in the number of new startups by researchers. With development of the Technology Transfer Accelerator Companies (SATT) and introduction of programs of student clusters and national student-entrepreneur status (SNEE) as part of the second phase of the "Investments for the Future" program (PIA) in 2014, momentum is gathering for creating new startups from universities.

This chapter first outlines socioeconomic situations facing startups in France, government measures related to startup support, and startup support institutions and programs, presents some cases of R&D startups, and then looks into the characteristics of startup environments and measures in France.

7.1. The current state of France and situations surrounding startups

Recently startups are attracting attention in France and young generations are becoming increasingly entrepreneurial. The country's VC market is growing significantly, although it is nowhere near that of the US, a leading startup country.[302] Startups are established in Fintech and a variety of other fields including IoT, manufacturing, health, clean tech, and mobility, and R&D startups from universities and public research institutions discussed in this chapter account for around 4%-10%.

7.1.1. Politics and policies in the field of R&D over the past 15 years

First, let's take a look at the development in the field of R&D over the past 15 years from the perspective of technology transfer and startup support for the private sector by going back to the enactment of the law on innovation and research of 12 July 1999 (the so-called "Allègre Law"). The Allègre Law aimed to grow the economy and increase employment by transferring public research outputs to private companies, and at the same time made it possible for researchers of universities/research institutions to launch a business while maintaining their status as researchers of public research institutions and to return to public research institutions, the former employer.

Prior to the enactment of this law, the French National Center for Scientific Research (CNRS), the country's largest research institution, which has a focus on basic research, created fewer than 10 startups a year during the 1990s. Apart from the division of technological research at the French Alternative Energies and Atomic Energy Commission (CEA Tech) which was established for technology transfer to the private sector, all in all, the number of new startups from French

[302] https://www.economist.com/news/business/21717411-capital-now-leads-europe-number-venture-capital-funding-rounds-rise

public research institutions was small. Then the Allègre Law was enacted and changed the mindset of French researchers. From the law's enactment in 1999 to around 2010, the number of new startups steadily grew, despite the early 2000s recession after the dot-com bubble, and public incubator facilities were established in various locations.

Then, in 2003, a sharp drop in funds of public research institutions coupled with frustration caused by a lack of research posts for young researchers and difficulties of PhD holders landing jobs at corporations culminated in the "Save Research" movement, which spread across the nation, and researchers took to the streets. This national movement successfully brought the government to the negotiation table, which resulted in the conclusion of an agreement with the government in 2005. Based on this agreement, the law on research planning of 16 April 2006 was enacted. This research planning law indicates the necessity for addressing the challenges of provision of promising research posts, enhancement of innovation, and further cooperation between the public and private sectors, in addition to enhancement of science and technology strategies and efficient application of resources of each research-related institution. According to this research planning law, a public investment bank (OSEO, current Bpifrance) and other research fund distribution institutions which are related to this chapter were established and around the same time competitiveness clusters were established as well.

In response to the "research planning law," SNRI, France's first national research innovation strategy, was formulated in 2009. As the successor of this strategy, FRANCE EUROPE2020 was formulated in 2013, which mainly approached social challenges, in contrast to the predecessor, which was targeted at technology itself. In March 2015, the revised edition, SNR FRANCE EUROPE2020 was released. This strategy continues to look into social challenges including resources, environments, health and welfare, and industry revival. Hopes are high for science and technology overcoming these social challenges.

7.1.2. R&D expenditure/manufacturing sector/industrial structure/employment trends

R&D expenditure – France falling behind leading countries

The growth of private investment in R&D activities in the country is stagnant, and the French government has continued to try to increase private investment for a number of years. In 2015, the private investment in R&D activities in France amounted to 31.8 billion euros[303] (1.45% of GDP), but the Treaty of Lisbon has set a target for EU member countries of investing 3% of GDP in R&D activities by 2020, including investments worth more than 2% of GDP from the private sector. To shore up private investment, the French government has implemented various measures including research tax credit (to be detailed in 7.2.3).

Abnormality of French manufacturing sector

The fields of key R&D in French manufacturing are automobiles, aerospace, and pharmaceuticals. These three sectors account for 35% of private investments in domestic R&D, but their growth is sluggish (automobiles -1.5%, aerospace +0.9%, and pharmaceuticals -1.3%).[304] French manufacturing accounts for 12.6%, a small share, in the country's GDP for its great variety of types that make up the manufacturing sector, the existence of high-level corporations, and advanced research (compared to the UK where manufacturing accounts for 12.5% and Germany 23%).[305]

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303 According to the foreign exchange rate of Bank of Japan as of February 20, 2018, 1 euro is equivalent to 135 yen.
304 MESRI Note Flash No.13, Oct. 2017
305 Notre ambition pour l'industrie, Conseil National de l'Industrie, 20 Nov. 2017
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Manufacturing's abnormality also appears in its employment trends. Figure 1 shows employment trends from 2007 to 2016. It clearly shows a significant fall in employment in the manufacturing sector. If the employment index of the fourth quarter of 2007 is set as 100, that of the third quarter of 2016 is 86.6. French manufacturing traditionally tends to rely on the performance of large corporations, so their sluggish business has a significant effect on quality and scale of innovations and employment.

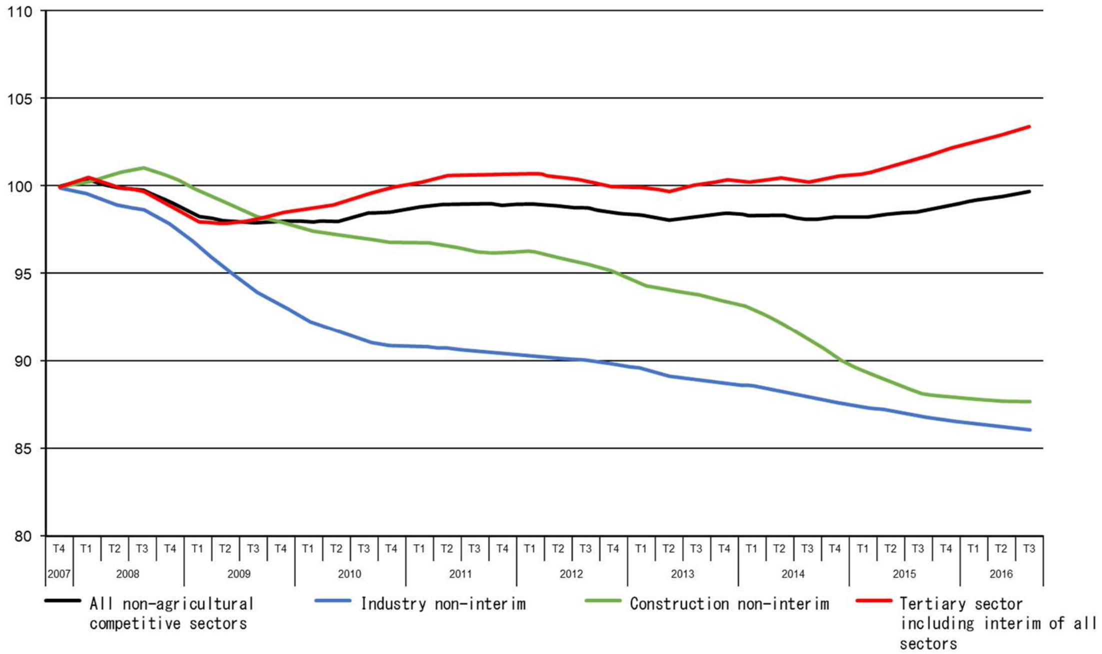

Fig. 1: Employment Trend in France

Source: Created by CRDS based on materials released by the General Directorate of Enterprises of the then-Ministry of Economy, Industry and Digital[306]

Industrial structure of France

The industrial structure of French companies by company size shows bipolar concentration into "Large corporations" and "Micro-enterprises." According to a report of French economic status by the National Institute of Statistics and Economic Studies (INSEE), "Large corporations," of which there are 274, employ 29% of all employees in France whereas "Micro-enterprises," which account for 96% of all companies, only employ 19% of all employees in the country. "Small and medium enterprises" and "Mid-size companies," both of which are faring well in sales and export, employ 28% and 24% of all employees respectively but the number of companies categorized in these groups account for only a few percent of all registered companies respectively. Fast decisions and openness to information sharing during the stage of business expansion are often key factors for innovation. "Small and medium enterprises" and "Mid-size companies" are generally considered more compatible with innovation than "Large corporations" but are clearly weak in the French industrial structure.[307]

_notre_ambition_pour_lindustrie_-_20.11.2017.pdf

306 https://www.entreprises.gouv.fr/files/files/directions_services/etudes-et-statistiques/conjoncture/tbe/2016-12- Emploi-salarie-resultats-3e-trimestre-2016.pdf

307 "Micro-enterprises" refer to companies with fewer than 10 employees and annual sales or annual profits of less than 2 million euros whereas "Small and medium enterprises (petites et moyennes entreprises: PME)" refer to companies with fewer than 250 employees and annual sales of less than 50 million euros or annual profits of less than 43 million euros.

Mr. Faure, Head of the General Directorate of Enterprises of the then-Ministry of Economy, Industry and Digital, in response to the question “Why can small and medium enterprises be a solution to the problem of unemployment?” in an interview in 2014, clearly saw the government’s determination and said, “as small and medium enterprises are launched, each of them creates employment, resulting in many jobs. On the other hand, one large global company rarely creates 1,000 openings. Therefore, the solution to unemployment is helping to create businesses, and helping the growth of small and medium enterprises because startup support is the most effective way to increase jobs. The government, therefore, needs to help entrepreneurs to create innovations, and to find foreign markets they can export their products to. That will be our exit (from the problem).”

An increase of the young working population and the employment issue

As Figure 2 shows, since the global financial crisis in 2009, which originated in the US, France’s unemployment rate has remained high. Having dropped from over 10% in 2015 and 2016 to 9.5% in the middle of 2017, it seems to have hit the ceiling but it is still unpredictable. The unemployment is especially high, 21%, for the age group from 15 to 24, which suggests that it is not very easy to land jobs after completing education.

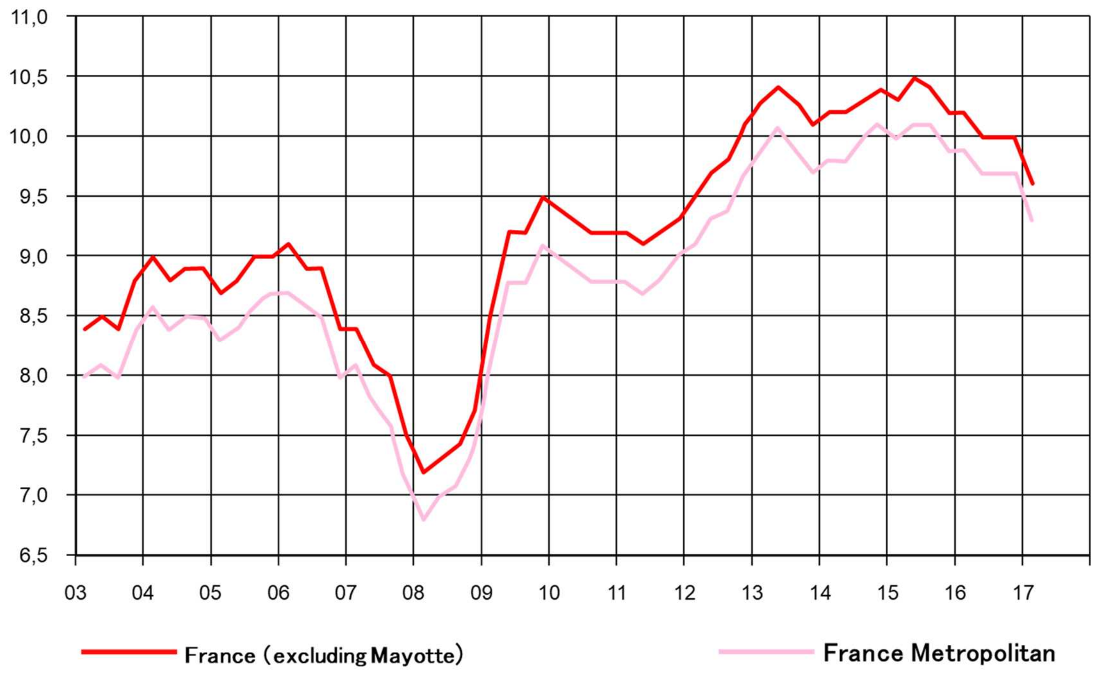

Fig. 2: Unemployment Rate in France
Source: Created by CRDS based on materials from INSEE

“Mid-size companies (entreprise de taille intermédiaire: EMI)” are companies that are not classified as “Small and medium enterprises (PME)” and have fewer than 5,000 employees and annual sales of less than 1.5 billion euros or annual profits of less than 2 billion euros. “Large corporations (Grande entreprises: GE)” are corporations that do not fall under any of the above categories.

Ironically, the success of countermeasures against the decline in the birthrate in France accelerates the issue of unemployment.[308] France's birth rate is the second highest among EU countries. Its increase started from the early 1990s and continued through around 2010, and in 2017, children born in the late 1990s started entering higher education programs and reaching the minimum working age. Higher education institutions are expected to see an increase of 350,000 students by 2025. If they have to be accommodated only by establishing new medium-sized universities, a dozen of such universities will be required. The Ministry of Higher Education, Research and Innovation (MESRI) is stepping up its efforts to lead a flood of incoming students to high-capacity departments while trying not to cause an imbalance in supply and demand in the future labor market.

7.2. Measures related to startup support

Among various measures related to science and technology/innovation taken during the past 15 years in France, it is the law on innovation and research of 12 July 1999 (the so-called "Allègre Law") that became the starting point for business creation at public research institutions including universities. This law triggered the establishment of various measures and institutions.

7.2.1. The law on innovation and research of 12 July 1999 (the so-called "Allègre Law").

While France does not have laws specialized in startup support, the Allègre Law functions as a fundamental law concerning startups. This law aims to grow the economy and employment through transfer of public research outputs to businesses. Thanks to the enactment of this law, researchers of universities/research institutions are allowed to launch a business while maintaining their status as researchers of public research institutions and to return to public research institutions, the former employer.

The Allègre Law provides for the following three conditions from which researchers of public research institutions can choose when launching a business:[309]

- Article 25-1: If a researcher of a public research institution wishes to implement a technology transfer as a president or a partner, they can suspend their service at the public research institution for up to six years, and engage in a business of their new company in the meantime.
- Article 25-2: A researcher of a public research institution can take up the position of a science and technology advisor at a new company, where they can help introduce products which are based on outputs of competitive technology development conducted at the public research institution. They can serve as an advisor for five years and the contract can be renewed. They can hold an interest in the capital stock of the company up to 15%. They can maintain their status as a public servant.
- Article 25-3: A researcher of a public research institution can participate in the undertaking (of a third party) to commercialize research outputs as an engineering expert who has industry knowledge. They can hold an interest in the capital stock of the company up to 5%. They can maintain their status as a public servant.

Fifteen years after the enactment of the Allègre Law, the number of new startups which take advantage of this law is around 100 a year. This law is significant in that it changed the mindset

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[308] France's population stands at 66.99 million (January 1, 2017, INSEE), registering a slight increase. (Around 0.45% per annum)

[309] These provisions were recently incorporated into the code of research (code de la recherché), and the version in effect on December 22, 2017 includes Article 25-1 of the Allègre Law in its Article 531-1 through 531-7, Article 25-2 of the Allègre Law in its Article 531-8 through 531-11, and Article 25-3 of the Allègre Law in its Article 531-12 through 531-14.

of researchers and became a foundation for various subsequent programs to support technology transfer. However, people are divided in their views on the effect of the law, and a report proposing revision of the law aiming to enable more flexible application was submitted in February 2017. The Allègre Law took into account issues related to pension after retirement and enabled researchers to start a company while maintaining their record including years of service, helping to make it easier for researchers of public research institutions to start a business. The Allègre Law is also significant in that it tries to increase personnel mobility between public research institutions and the private sector by encouraging those who have experience in business creation or corporate management to go back to public research institutions, their former employer, and to engage in education of the future generations.

The Allègre Law is also important when researchers consider the risk they have to take when they launch a business. In the Grenoble-Alpes region, which is the second most R&D startup-thriving region after Paris, an overwhelming majority of new startups are created in pursuant to Article 25-2 above, in which risk researchers take is small. In this type of startup, researchers transfer seeds they have found through their research and thereby start a company, but the company is managed by others. Availability of networks which help find human resources who have experience as CEO as well as personnel mobility are key to startup success.

7.2.2. “Investments for the Future” program (PIA)

After the global financial crisis from 2008 to 2009, the “Investments for the Future” program (PIA) was announced in 2009. The 47 billion euro funding program was initiated by then-President Nicolas Sarkozy and based on a report by a committee made up of members from both conservative and reformist camps. The report includes the following proposals:

- Supporting creation of innovative companies and social innovation as a measure to support small and medium enterprises. (500 million euros)
- Making it easier for innovative small and medium enterprises to use financial support (1.5 billion euros)
- Investing in research facilities and supporting innovation in education, thereby increasing the appeal of France as a research location (2 billion euros)

France’s R&D expenditure was traditionally made based on a single-annual-budget principle, so it was hard to provide medium to long-term support for R&D activities as provided to US universities. The fund for PIA launched in March 2010 realized continuous support for growing fields across multiple years, and PIA was divided into the PIA 1 stage to the PIA 3 stage, each of which accepted programs and distributed funds accordingly. The key target fields of PIA are higher education and research, industrial sectors and small and medium enterprises, sustainable development, digital economy, and biotechnology and life science. Out of the total budget of 47 billion euros, some funds were distributed to the following programs that were directly related to startup support in the PIA 2 stage in 2014:

- 856 million euros for development of 14 Technology Transfer Accelerator Offices (SATT)
- 2.6 million euros for establishment of the student clusters (PEPITE) program and the national student-entrepreneur status (SNEE) program.[310]
- 215 million euros for support for French Tech

PIA, now in the PIA3 stage, is expected to end in 2018. In September 2017, Emmanuel Macron’s administration carried out his campaign pledge and announced a new large-scale investment plan, (GPI) 2018-2022. This new plan states that PIA3 will be carried out as planned but only if it meets the new plan’s ideas.

[310] Introduction of these programs was led by the then-Ministry of National Education, Higher Education and Research (MENESR).

7.2.3. Research tax credit (CIR)

Research tax credit (CIR[311]) allows corporations to claim a certain amount of corporate tax credit according to the amount of their R&D investment and aims to increase their competitiveness by promoting their R&D activities. Around 30% of R&D expenditure or 100 million euros whichever is less can be credited against tax and if the R&D expenditure exceeds 100 million euros, 5% of the portion exceeding 100 million euros can also be credited against tax.

Not only startups but all companies are eligible for CIR, and companies in the red can obtain refunds. Startups in which R&D expenditure accounts for a large part of costs certainly find this tax credit program a huge help.

As of 2017, CIR hovers around six billion euros, which accounts for around 12% of the total R&D investments in France. The size of this tax credit shows the government's determination to support private R&D investments. The French government has announced the continuation of this program.

As other advantages, CIR also incentivizes companies to keep their R&D activities inside the country and supports their R&D activities through the "industrial convention of training through research (CIFRE)[312]" program which promotes employment of PhD holders by companies.

7.2.4. Tax program for young innovative companies (JEI)

The Young Innovative Company (JEI) status was introduced based on the Finance Act for FY2004, aiming to help young companies which are strongly committed to R&D activities to survive for a challenging period of several years after their establishment. Innovative small and medium enterprises which meet the following four requirements and have received the JEI status are eligible for a tax cut and exemption of payment of social security contributions to be detailed in the following for seven years after their establishment.

- The company has been around for less than eight years since establishment.
- The company is a small or medium enterprise (with fewer than 250 employees and annual sales of less than 50 million euros or annual profits of less than 43 million euros).
- The company's R&D expenditure accounts for more than 15% of the company's total expenditure.
- The company is an independent enterprise and not one that has been created as part of an extension of activities of an existing company.

Tax cut

Profits of the first business year are all exempt from tax, and up to 50% of profits are exempt from tax from the second year onward. Companies are also exempt from paying annual fixed corporate tax (IFA) as long as their JEI status is valid. Companies certified as JEI are also exempt from paying business tax and property tax on built properties for seven years based on the decision by the municipality where they are located. This tax cut cannot exceed 200,000 euros which is the upper threshold (per three financial years) of support established by the European Commission.

311 CIR: crédit d'impôt recherche

312 CIFRE is a program to encourage students to obtain their PhDs based on activities with companies. It aims to promote employment of PhD holders by companies. The program provides a certain amount of funds to companies which have signed an employment contract with PhD students. Related expenditures of companies are considered R&D investments and are eligible for CIR, too. For more details, see p.71 of "Report of trends of science and technology/innovation – France edition" (2014) [CRDS-FY2014-OR-04], CRDS Overseas Research Report.

Exemption from payment of social security contributions

JEI-certified companies are exempt from paying employers' social security contributions for researchers, engineers, R&D project managers, lawyers concerning project-related industrial property rights/technology agreements, staff involved in R&D activities or pre-competitive testing of new products.

The number of newly certified JEI companies has remained consistent at between 600 and 700 a year since 2008. According to a report issued by the General Directorate of Enterprises of the then-Ministry of Economy, Industry and Digital in January 2015, since the program's launch in 2004, 6,600 companies have used the program, receiving a reduction of tax including corporate tax of total 120 million euros (8 million euros in 2013 alone) and exemption of social security contributions of total 1.05 billion euros (109 million euros in 2013 alone). The burden of social security contributions is extremely heavy in France, so their exemption must be a huge relief for companies.

As shown in Figure 3, 75% of JEI-certified companies are doing business in the fields of digital technology or services for corporations.

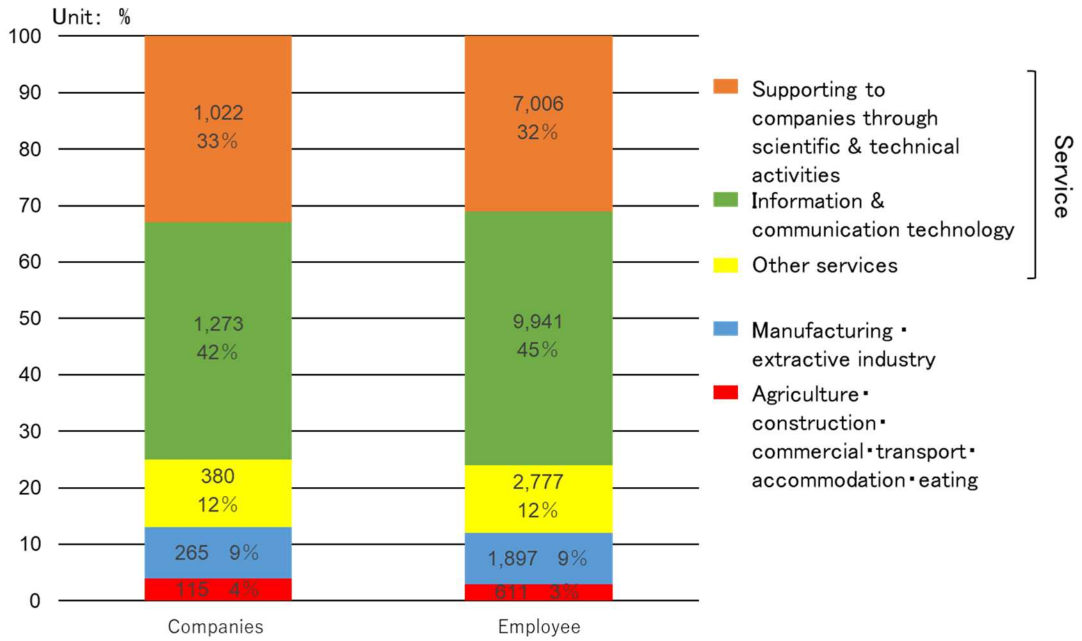

Fig. 3: Proportion JEI by Type of Buisiness

Source: Created by CRDS based on materials reported by the General Directorate of Enterprises of the then-Ministry of Economy, Industry and Digital

JEI companies are concentrated in some regions. For example, 40% of JEI companies and around half of all employees of related companies are in Île-de-France, which includes Paris. Seventy percent of JEI companies and 75% of employees are concentrated in four regions. Based on this, Figure 4 shows the number of JEI companies by region on the map of France.

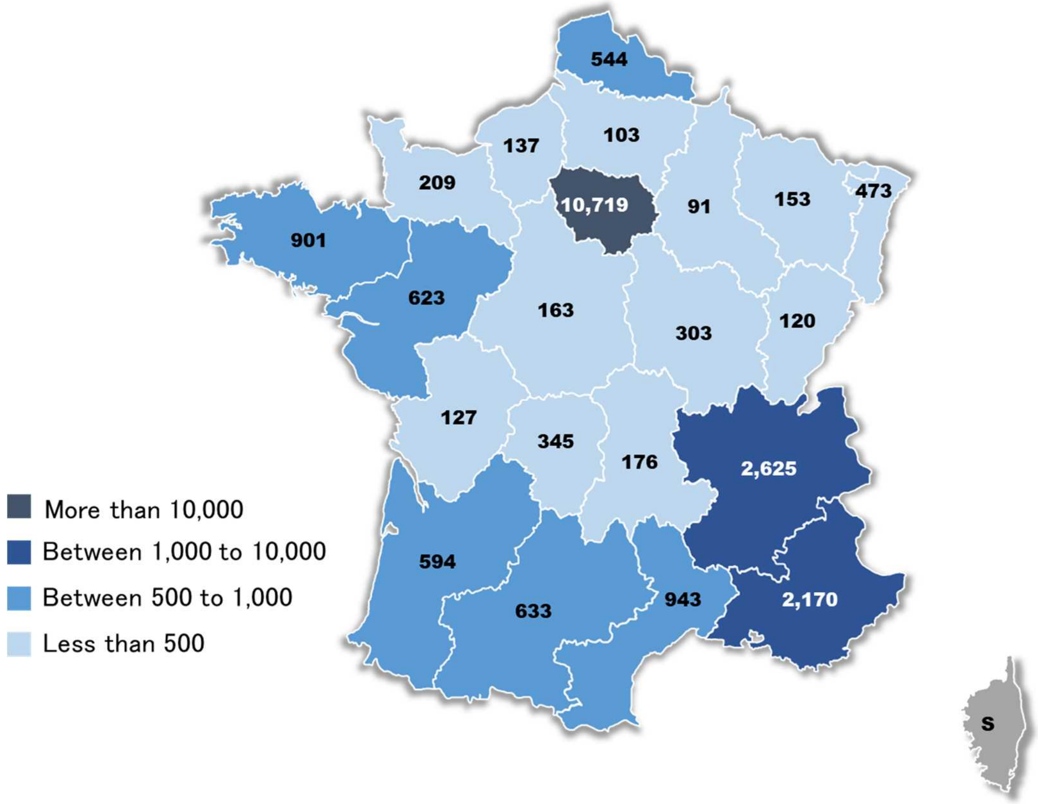

Fig. 4: Distribution of Salaried Workforce of JEI by Regions
Source: Created by CRDS based on materials reported by the General Directorate of Enterprises of the then-Ministry of Economy, Industry and Digital

Companies can claim tax credit through the above CIR while receiving benefits as JEI-certified companies. In fact, two-thirds of JEI companies receive tax credit through CIR, which amounted to 1.31 billion euros in 2011.

7.3. Overview of startup support institutions and programs

Since the enactment of the Allègre Law in 1999, large public research institutions including the French National Center for Scientific Research (CNRS) and the French Alternative Energies and Atomic Energy Commission (CEA) have established their own technology transfer support institutions. In the meantime, universities, etc. fell behind public research institutions in terms of quality and quantity of technology transfer institutions. To improve this situation, Technology Transfer Accelerator Offices (SATT) were established during the PIA 2 stage of the "Investments for the Future" program in 2014 and at the same time the student cluster (PEPITE) program, which aimed for entrepreneurial education, and the national student-entrepreneur status (SNEE) program were introduced. In parallel, each region is trying to supplement these national efforts and to grow local startups into scale-ups, in other words, to develop them into small and medium enterprises.

Figure 5 summarizes the above trends and provides the overall picture of French startup support institutions and measures.

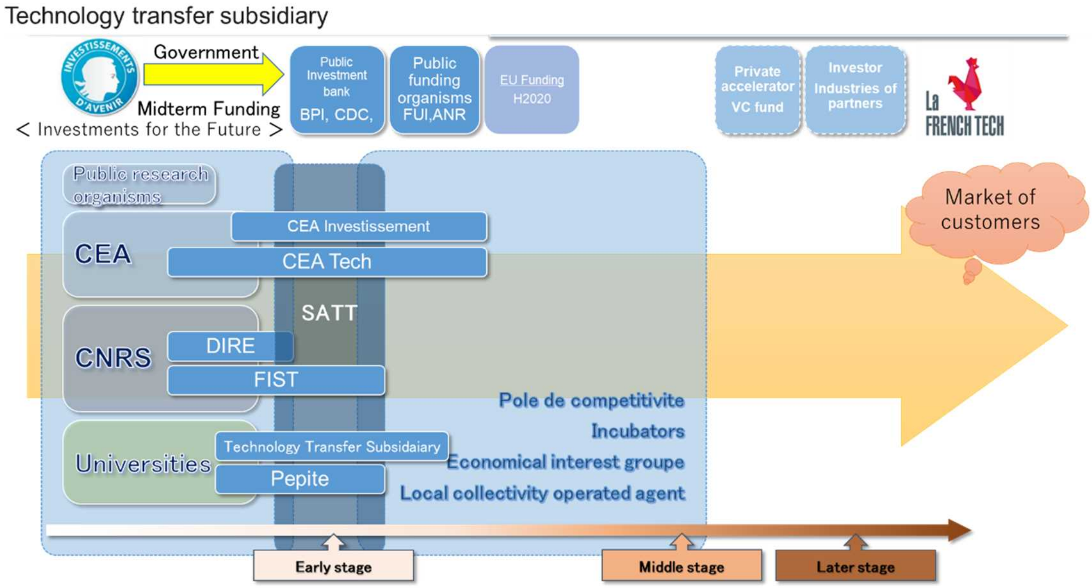

Fig. 5: Startup Support Organizations and Policies in France
Source: Created by CRDS based on various materials

The following discusses technology transfer at public research institutions, support at universities, and complementary regional efforts, in sequence.

7.3.1. Startup support at public research institutions

As public research institutions including the French National Center for Scientific Research (CNRS) are required to contribute to vitalization of the economy as a result of transfer of research outputs to the private sector, they have promoted startup support by establishing their own rules based on the Allègre Law.

Technology transfer support at the French National Center for Scientific Research (CNRS)

The French National Center for Scientific Research (CNRS) is the country's largest research institution, which puts a focus on basic research in not only natural science but the humanities. Although CNRS was assigned to promote transfer of research outputs from the 1980s,[313] the number of new startups did not grow significantly. That is when the Allègre Law was established, which urged CNRS and researchers to change their mindset and opened the way for researchers to start a business while conducting research at CNRS. Technology transfer from CNRS to the private sector takes various forms including a partnership or research-sharing with corporations, transfer of patented technology and licensing, and creation of startups or funding.

According to a study by CNRS, the total number of new startups derived from CNRS research units or joint laboratories between CNRS and academic partners after 1999 reached around 1,300 as of the end of 2016.[314] The rate of continuation is 70% and startups of a spinoff-type account for 60% of the total. On average 54 startups of a spinoff-type (accounting for 60% of the total) are launched every year by 20 to 30 CNRS researchers and 20 to 30 postdoctoral researchers, engineers, and technical staff. It is reported that 3 to 5 startups are launched per year pursuant to

[313] Decret82-993 Nov24. 1982 clearly states to the effect that one of the missions of CNRS is to contribute to the advancement of the economic progress of the country.
[314] Report on technology transfer at CNRS. Le CNRS, un acteur engagé dans la Valorisation 2014/12/09

Article 25-1 of the Allègre Law and 20 to 30 others are established pursuant to Article 25-2 of the same law, which suggests that researchers often bring in seeds as a technology advisor and seek someone else to manage their companies.

Figure 6 shows the chronological change in the number of new startups per year after 1970, launched by researchers who belonged to CNRS. This shows the number of new startups, which remained around five per year prior to 1999, surged right after 1999 due to the enactment of the Allègre Law, and that the number of new startups after 1999 reached 1,026 in total. It plunged in 2004 but hovered around 80 per year after 2007. However, it has been on a decline since 2011.

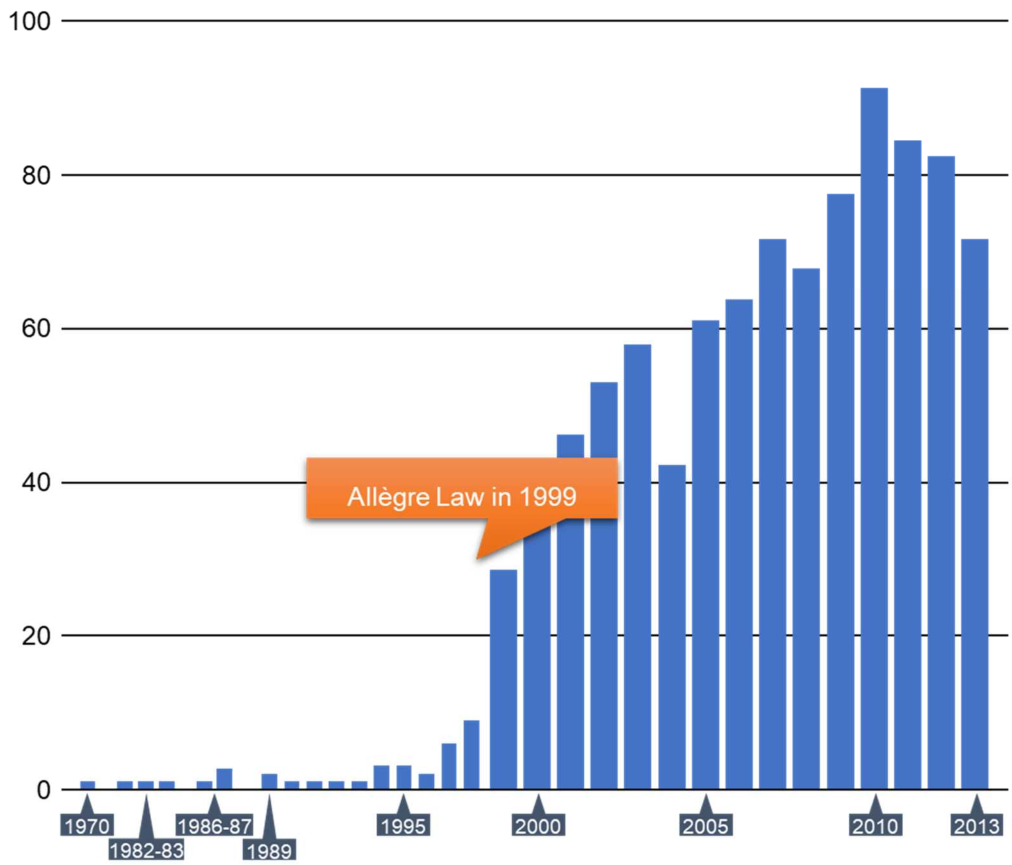

Fig. 6: The number of New Startups Launched by CNRS Researchers
Source: Created by CRDS based on data from the report on technology transfer at CNRS[315]

By sector, the information and communications-related sector accounts for 38% of all startups. Apart from that, biol/health accounts for 24%, chemical/material 19%, environment 6%, and machinery/transportation/energy 6%.

Three quarters of surviving companies are those with 10 or fewer employees. In total, they create thousands of jobs. Companies with sales of one million euros or more account for only 13% of the total.

CNRS has an internal organization called the Innovation and Business Relations Department (DIRE[316]), which manages patents and licenses derived from CNRS, protects IP, coordinates with companies and competitiveness clusters, negotiates upon technology transfer, and supports entrepreneurs. Altogether around 300 people, including around 30 members of DIRE staff

315 Report on technology transfer at CNRS, 2015. Le CNRS, un acteur engage dans la valorization
316 DIRE: la Direction de l'Innovation et des Relations avec les Entreprises

together with staff working at CNRS offices and partners nationwide, are working for technology transfer.

CNRS has another organization called the France Scientific Innovation and Transfer Company (FIST SA[317]) which was established in August 1992 and has around 50 employees. This subsidiary of CNRS is 70% owned by CNRS and 30% by a public investment bank (Bpifrance) and managed by DIRE. FIST SA is mainly engaged in technology transfer of research outputs of CNRS and when CNRS invests in startups, DIRE carries it out through FIST SA. FIST SA does not provide seed funding. From 1998 to 2014, FIST SA obtained shares in 22 startups without monetary funding and the shares are worth three million euros. Twelve of these startups are still around and three of them went public. Another four startups were strategically acquired by other firms, generating income of around one million euros. Since the establishment of the Technology Transfer Accelerator Offices (SATT) in 2014, CNRS has contracted SATT to take care of technology transfer support operations of new startup projects of CNRS, except the following cases. CNRS is a shareholder of SATT as well.

- Joint research with a corporation. In this case, research outputs are owned by the corporation concerned and CNRS.
- Normandy (because no SATT is available.)
- Projects of a university which is a member of Paris Sciences & Lettres (PSL)[318]
- The fields of Strategy Focus 20, which were designated as priority areas by CNRS from 2010 to 2012[319]

Division of technological research at the French Alternative Energies and Atomic Energy Commission (CEA Tech)

The division of technological research at the French Alternative Energies and Atomic Energy Commission is known as CEA Tech outside of the organization. CEA Tech is based mainly in Paris and Grenoble, and has three units: the Research Institute for Electronics and Information Technologies (LETI) specializing in micro- and nanotechnology research, the Laboratory for Innovation in New Energy Technologies and Nanomaterials (LITEN), and the Laboratory for Integration of Systems and Technology (LIST).

At CEA Tech, around 100 employees are working for the technology transfer division (comprised of departments of marketing, IP (patents), contracts, and incubation). With CEA Tech at its core, CEA has been engaged in technology transfer and does not necessarily need the introduction of SATT. That is because the introduction of SATT could run counter to the business model of CEA, and therefore CEA participates in SATT only in limited fields including drugs.

The startup process at CEA Tech is largely divided into four stages: 1) the discovery stage, 2) the maturing stage, 3) the preparation stage, and 4) the company registration stage. During this process, the above technology transfer division provides support concerning patents, licenses, marketing, etc. For example, it is this technology transfer division that supports preparation of application documents for competitions in which winners could receive funding from EU or the national government.

As a rule, the startup period is 18 months, during which a committee made up of unit managers,

317 FIST SA: France Innovation Scientifique et Transfert SA
318 Ecole Normale Superieur, Collège de France, etc.
319 Twenty areas including graphene and nanomaterials (2D), magnetism, spintronics, oncology – immunotherapy, Alzheimer's disease, batteries, solar cells, big data, etc.

and members from the startup team concerning seeds, CEA Investisssement[320], the technology transfer division, and the incubation department holds meetings regularly to check the progress of seeds and decide whether to continue development. Staff from each unit of LETI, LITEN, and LIST attends startups either full time or part time. Usually, CEA Investisssement acquires 15% of the capital of a new company in return for support provided before the establishment of the startup (the maturing stage).

Other support available includes access to research facilities of CEA. Startups can rent laboratories inside MINATEC[321], and the latest equipment/facilities and laboratory staff are also available for a fee.

While being a public research institution, CEA is considered an industrial and commercial public establishment (EPIC) in French governmental institution classification, an organization with a corporate status that has industrial/commercial characteristics. Therefore, it is important to note that CEA is required to pursue commercial profits or targets in some types of activities just as private companies are. As CEA has an EPIC corporate status, its employees are considered non-public servants, who are therefore not qualified for application of the Allègre Law. For this reason, CEA has established and enforced its own startup-related internal regulations that are equivalent to the Allègre Law. In general, CEA promotes collaboration with client companies or partners as its policy but considers spinoff-type startups as an effective option for technology transfer if there are no appropriate customers or existing technology.

Now, let’s take a look at the differences of startup support internal regulations between CNRS and CEA.

Regarding a startup preparation period, CNRS has no rules whereas CEA specifies 18 months, calling for prompt business establishment. Regarding investments in capital of a new company, CEA allows a flexible range of 20% to 30% whereas CNRS allows a modest 15%.

As for salaries, if a CNRS researcher starts a business, CNRS provides an amount equivalent to what they made when they were working for CNRS, during the first year of the new company, letting them fully engage in their new startup. They do not have to repay this first year salary to CNRS. From the second year onward, they can continue to receive their salary equivalent to that of the first year but the salary received from the second year has to be paid back within five years from the company’s establishment. Researchers from CEA, meanwhile, can receive a salary from CEA during the said startup preparation period of 18 months.

Figure 7 compares and summarizes various regulations on startups between the two institutions.

		Needed duration for start up	Tolerence period to return to initilal job(years)	Payment	Initial investment amount (Euro)	Incubation period	Range of Investment
CNRS	CEO	No rule	6	1 〜2 years	100K	300K	up to 15%
	Scientific advisor	No rule	6	1 〜2 years	no	no	
CEA		18 months	4	18 months	15%of equity	200－300K	up to 20-30%

Fig. 7: Startup-related Regulation for Researchers at CNRS and CEA
Source: Created by CRDS based on interviews with CNRS and CEA Tech.

If researchers from CNRS serve as CEO of their startups, and they cannot pay back their salaries provided from CNRS, CNRS helps them in another way. Instead of paying back their salaries, they can transfer some of the equity of their startups to CNRS, which will be credited as

320 CEA Investisssement is a CEA subsidiary in charge of investment.
321 MINATEC is an open innovation campus run by CEA. It follows CEA’s operation rules in cases of CEA employees.

repayment. Only startups whose business outlooks are good are eligible for this support. This sort of settlement is carried out not by an individual researcher and CNRS but by two separate corporations, i.e. CNRS and a startup. While a salary of a CEO is supposed to be paid by his/her startup, CNRS pays it on behalf of the startup, so the startup incurs a debt. Repayment of this debt is carried out by transferring some shares of the startup that are equivalent to the debt to CNRS.

The differences of regulations summarized in Figure 7 above are also related to the difference in policies towards startup support between the two institutions, CNRS and CEA. CNRS is a research institution which puts a focus on basic research, so it encourages researchers to launch businesses but limits its investments in them to the minimum. In contrast, CEA stresses applied research and considers business creation by its researchers as an extension of its business. Startups from CEA result from intentions of both CEA and researchers who launch them. Another reason for more active startup investments by CEA is that the institution is an entity categorized as an industrial and commercial public establishment (EPIC) which has industrial/commercial characteristics, viewing the connection to markets and customers as a key to its business and earnings.[322]

As discussed above, generous startup support is available especially in large public research institutions, including 4 to 6 years of startup leave and capital participation in new companies in pursuant to the Allègre Law. CEA also actively promotes startups launched within. It introduces these startups to industry by holding, jointly with other events, a startup presentation called “Root” for around three days every year.

As for the number of new startups, an average of 72.2 startups were created from CNRS per year from 1999 to 2016 and an average of 9.7 startups were established from CEA per year from 2007 to 2015. As around 100 startups were created in the country per year based on the Allègre Law from 1999 to 2015, development of programs and systems has clearly helped achieve a certain result. On the other hand, the fact that the number of new startups hovers around 100 and does not go significantly beyond this level may suggest limited capabilities to produce seeds, a manpower shortage at technology transfer institutions, or issues of systems. Further flexibility in the legal system is called for.

At CNRS and other national research institutions, researchers are evaluated based on their paper in the first place and the startup rate of projects they were involved in is not taken into account. There is still a lot of room for improvement in environments to entice researchers to actively participate in business creation.

7.3.2. Support programs at universities/public research institutions in the country

7.3.2.1 Universities/COMUE

Based on the Law on Higher Education and Research enacted in 2013, a system called the communities of universities and institutions (COMUE) was introduced. This is a framework to transfer the same part of activities in the functions of different universities/research institutions

[322] The budget of CEA Tech grew 7% a year on average from 2007 to 2015, reaching 591 million euros in 2015. While the government’s subsidy hovers around 150 million euros, the growth is attributed to income from contracts with companies, which increased 100 million euros from 2007 to 2015 and annual allocation of 75 million euros from PIA (2012-2015), topped with an additional 70 million euros from EU and local governments. CEA Tech has claimed the largest portion in the entire CEA budget since 2014. (Source: La Valorisation de la Recherche civile du CEA, Exercices 2007-2015, la Cour des comptes)

to a "community of universities and institutions," a separate entity which has a corporate status that is equivalent to a university. COMUE aims to increase the presence of French universities/research institutions in the world by concentrating technology transfer support institutions and various activities of different universities/research institutions, including awarding degrees and producing papers, in COMUE, an institution separate from individual universities/research institutions.

Here, we look at the case of the University of Grenoble Alpes (UGA)[323]. UGA is a core organization of COMUE UGA, an alliance made up of multiple universities/research institutions which also has a corporate status as a university, and in 2016 UGA was selected as one of the institutions accepted to the Initiative of Excellence (IDEX) program. The IDEX-selected institutions are required to conduct world-class multidisciplinary research. COMUA UGA is a community made up of UGA as a university, the Grenoble Institute of Technology (Grenoble INP), which is a Grandes Écoles, the French National Center for Scientific Research (CNRS), and the National Institute for Research in Computer Science and Automation (INRIA), working with CEA and other institutions.

Figure 8 illustrates the concept of COMUE, in which full-fledged member organizations are highlighted in yellow. Under the name COMUE, these institutions make announcements and compete for competitive funds, and also share support from LINKSIUM by COMUE members funding this local Technology Transfer Accelerator Office (SATT).

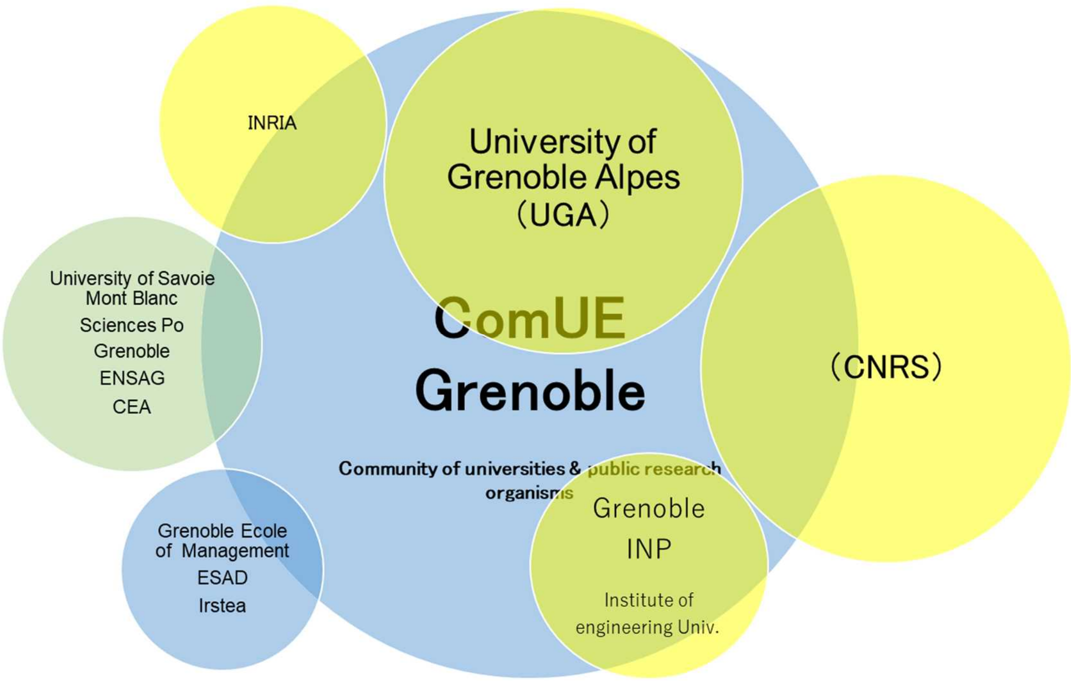

Fig. 8: Conceptual Image of COMUE
Source: Created by CRDS based on information from the website of UGA

The technology transfer department of UGA has control over Floralis[324], a technology transfer

[323] UGA was created in January 2016, through integration of three universities: Université Joseph Fourier (focused on natural science, science and life science and ranked 12th in France in the number of papers), Université Pierre Mendès-France (focused on the humanities and social sciences), Université Stendhal (focused on literatures, linguistic/fine arts, communication). It is currently the fifth largest university in terms of the number of students. After the integration, UGA was accepted to the Initiative of Excellence (IDEX) program.

[324] Floralis was established with capital of 1.5 million euros in February 2004. It employs 80 people. Sales amount to 10

subsidiary of UGA, and Biopolis[325], a medical-focused incubator. With the corporate status of a public scientific, cultural or professional establishment (EPSCP), UGA makes investments in Technology Transfer Accelerator Offices (SATT) or spinoffs through technology transfer subsidiaries such as Floralis. Floralis offers technology transfer support that covers from stages prior to seed conceptualization/maturation or the patent application stage through the stage of product improvement after business creation. By sector, bio accounts for 38%, health management-related 26%, materials, etc. 14%, and digital 12% among others. In contrast, support from SATT covers from the product maturation stage to the business launch stage, and SATT is usually not involved in product improvement after business creation.

7.3.2.2. Technology Transfer Accelerator Offices (SATT[326])

Technology Transfer Accelerator Offices (SATT) are organizations developed through integration of some technology transfer departments of research institutions including universities in each region of France, and there are 14 of them across the country. SATT was established after the announcement of investment of a total of 856 million euros over a 10-year period as part of the PIA 2 stage of the "Investments for the Future" program of 2014.

The government and local universities and public research institutions jointly funded the establishment of SATT, whose main role is to select research outputs of local public research institutions and take them to market promptly. SATT is effectively a breeder. SATT invests in IP protection/licensing and startup fostering while getting involved in support for the maturation of research outputs and preparation for business establishment. Support from SATT is mainly provided in the initial stage; SATT provides on average around 300,000 euros per case as startup support, which is considered as startup investment and is managed in the current account for investment of SATT. This investment is often converted into part of the capital of the new company. Support is provided for around 18 months and SATT employs on average around 30 experts of patents, IP, business and marketing.

Presidents of 14 SATT offices come from various backgrounds, including a former president of an incubator, the head of an R&D department of a private corporation, and a former employee of a large research institution. Some SATT offices provide a greater range of support including support for personnel selection for business establishment and formulation of business plans. SATT supports a variety of forms of seed research including joint laboratories of CNRS and universities, joint research by multiple public institutions, universities, and Grandes Écoles, and joint research by CNRS, CEA and universities.

CNRS and CEA and other large public research institutions had internal technology transfer support organizations for a long time but similar support was not widely spread through universities, joint laboratories, or university hospitals. The introduction of SATT helped create systems in which experienced staff takes care of the transfer of research seeds at these institutions, enabling efficient technology transfer.

According to an announcement issued by the SATT Network (LE RESEAU SATT)[327] in January 2017, so far, the creation of 173 startups has been helped by all 14 SATT offices. Startups eligible for support by SATT are those from public research institutions only, estimated to account for 4%-10% of all the startups in the country.

Through licensing business and investment activities, SATT aims to become financially independent in 10 years but this is expected to be difficult for some SATT offices because

million euros.
325 Biopolis was established with capital of 7.5 million euros in 2006. It is located on the campus of a university hospital.
326 SATT: Les sociétés d'accélération du transfert de technologies
327 https://www.satt.fr/en/about-technology-transfer/

France's industrial structure varies depending on the region and the profitability outlook is unknown under the same business model. In October 2017, the Minister of the Economy and Finance, Bruno Le Maire, and Minister of Higher Education, Research and Innovation (MESRI), Frédérique Vidal issued a directive to "develop concrete proposals for revision of the innovation support system" in the following three months in their joint letter and appointed four committee members accordingly. At the "committee hearing concerning culture, education, and communications" with senators on November 10, 2017, Minister of Higher Education, Research and Innovation Vidal stated, "some SATT offices are realizing economic models whereas others are not," indicating that poorly performing SATT may be discontinued in the future.

In France, there is a variety of technology transfer organizations including those in universities, schools, and public research institutions as well as original technology transfer organizations supported by individual local governments, and they have been growing in number in recent years. This trend is visible in the increase in the number of member institutions of RESEAU C.U.R.I.E, a group made up of public technology transfer support institutions based in France. As of 2017, RESEAU C.U.R.I.E has been around for 26 years and is engaged in the promotion of the role of public technology transfer institutions, their development, and their advance in specialization. It holds member conferences every year. The number of member institutions increased from 70 in 2000 to 162 in 2008, which further grew to around 190 in 2017 by the recent addition of SATT, technological research institutes (IRT), and university hospital institutes (IHU) among others. Figure 9 lists 14 SATT offices.

SATT in the each regions	Investing members
SATT Conectus Alsace	université de Strasbourg, CNRS, université de Haute-Alsace, INSERM, INSA Strasbourg, École nationale du génie de l'eau et de l'environnement de Strasbourg, CDC
SATT Lutech	université Pierre et Marie Curie, université Panthéon-Assas, université technologique de Compiègne, Institut Curie, Museum national d'Histoire naturelle, CNRS, CDC
SATT Toulouse Tech Transfer	Comue université de Toulouse, CNRS, CDC
SATT Ile-de-France Innov	Sorbonne Paris Cité, université Paris Est, université de Cergy-Pontoise, CNRS, INSERM, CDC
SATT Sud-Est	Aix-Marseille université, université du Sud Toulon Var, université de Nice Sophia Antipolis, université d'Avignon et des Pays du Vaucluse, université de Corse, CNRS, INSERM, École Centrale de Marseille, CDC
SATT Aquitaine Science Transfert	université de Bordeaux, CNRS, université de Pau et des Pays de l'Adour, INSERM, CDC
SATT Nord	Comue Lille Nord de France, université de Reims Champagne-Ardenne, université de Picardie Jules Verne, CNRS, CDC
SATT Ouest Valorisation	Comue université Bretagne Loire, CNRS, IRD, CDC
SATT AxLR :	universités de Montpellier, Perpignan, Nîmes, École nationale supérieure de chimie de Montpellier, Montpellier Supagro, CNRS, INSERM, IRD, IRSTEA, CDC
SATT Grand Centre	Centre-Val de Loire université, Comue Clermont-Université, Comue Limousin Poitou-Charentes, CNRS, IRSTEA, CDC
SATT Grand Est	université de Bourgogne, université de Franche- Comté, université de Lorraine, université technologique de Troyes, CNRS, INSERM, CDC
SATT Pulsalys	Comue université de Lyon, CNRS, CDC
SATT Linksium	INP Grenoble, université de Savoie, université Joseph Fourier - Grenoble 1, université Pierre Mendes France - Grenoble 2, université Stendhal - Grenoble 3, CNRS, CEA, INRIA, CDC
SATT Paris-Saclay	Comue Paris-Saclay, CDC

Fig. 9: List of 14 SATT Offices

Source: Created by CRDS based on information from the website of the Ministry of Higher Education, Research and Innovation (MESRI)

Figure 10 plots SATT offices on the map of France. It shows that SATT offices are located nationwide.

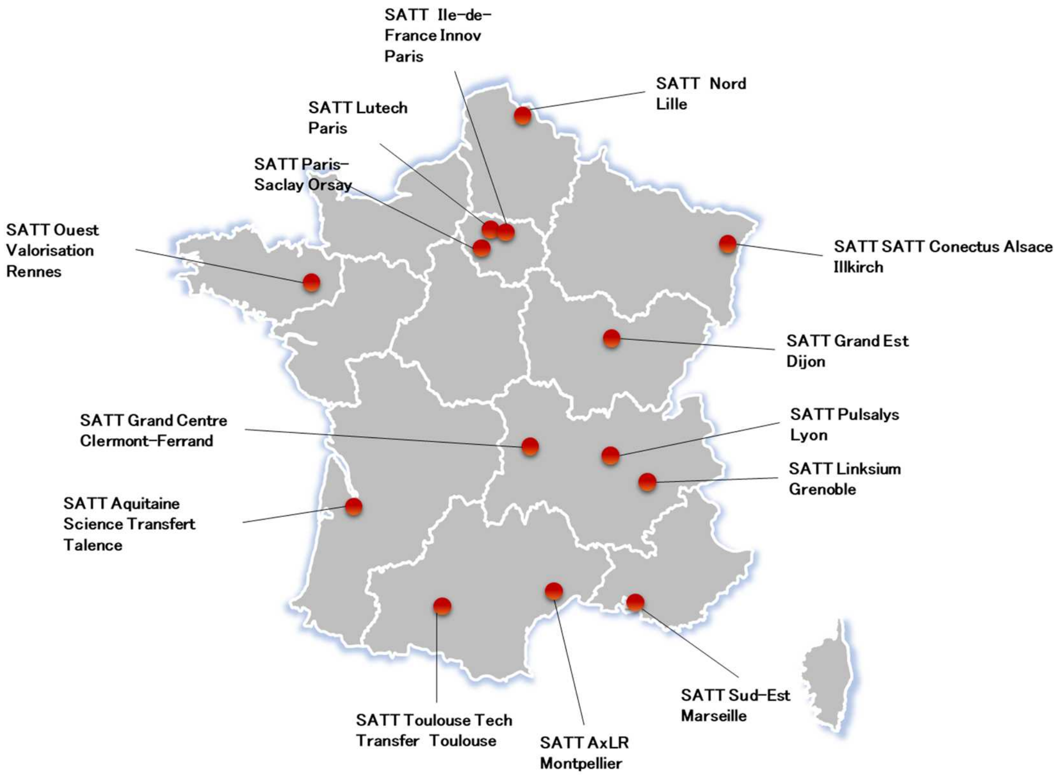

Fig. 10: Distribution of SATT Offices

Source: Created by CRDS based on a figure included in a presentation material of the SATT Network

The following looks at SATT LINKSIUM, as an example of SATT.

SATT LINKSIUM

As one of the 14 SATT offices in the country, LINKSIUM supports project owners who aim to launch businesses based on research outputs of universities and public research institutions (mainly joint laboratories of CNRS and universities) in the region of Auvergne/Grenoble/Alpes in terms of technology transfer and finance. The 30 workforce organization is made up of five departments of 1) Maturation, 2) Incubation, 3) Licensing, 4) Contracts, and 5) Operations, each of which has three to six experts.

LINKSIUM was established from an incubator, the Grenoble Alpes Incubation (Grain), in 2014 by absorbing IP expert staff of the Grenoble Institute of Technology (Grenoble INP). LINKSIUM has so far helped create 15 startups, dealt with 87 projects, and invested 15.3 million euros. Projects are supported in two phases: 1) the maturation stage and 2) the establishment preparation stage.

The total budget of LINKSIUM is 57 million euros (1 million euros as capital, the other 56 million euros managed in the current account for investment), and it is invested in three rounds over a 10-year period from 2014. The budget decision is made at the General Investment Commission (CGI) under the direct control of the Prime Minister, and is subject to an audit every three years. The government funded 33% of capital of LINKSIUM while the other 67% was funded by the University of Grenoble Alpes (UGA), the Grenoble Institute of Technology (Grenoble INP), the University Savoie Mont Blanc (Université Savoie Mont Blanc), the French National Center for Scientific Research (CNRS), the French Alternative Energies and Atomic Energy Commission (CEA), and the National Institute for Research in Computer Science and Automation (INRIA).

7.3.2.3. Student clusters (PEPITE)

As part of the PIA 2 stage of the "Investments for the Future" program in 2014, PEPITE[328], which is a student cluster for innovation, technology transfer and business creation, was organized in universities/schools of each of the 29 school districts across France. It was introduced at the same time as the national student-entrepreneur status (SNEE), which is to be discussed in 7.3.2.4. As PEPITE functions as a source of students for SNEE, the two programs work closely together. Funded with 2.6 million euros by PIA through the Deposits and Consignments Fund (CDC), PEPITE, as its main function, provides students who aspire to start a business with free co-working spaces, access to local startup events and entrepreneur networks, and coaching. Resident staff are there to help students while the steering committee provides comprehensive support in terms of finance, education, cooperation with local entrepreneurs, and business launch. PEPITE virtually functions as a technology transfer support institution for entrepreneurial students who have yet to register their companies and are not eligible for support from SATT.

Student clusters at a university level existed as early as 15 years ago but they worked separately from each other and only inside their communities. These individual student clusters were unified as a national organization by the introduction of PEPITE. The more former entrepreneurs are available and the more actively they are engaged as mentors or other volunteers, the more likely the cluster is to succeed. The budget for PEPITE varies depending on the school district but is roughly 500,000 euros on average. Technology transfer departments of CNRS and CEA, and SATT, which were discussed previously, target working researchers whereas PEPITE functions as preparatory steps for students and researchers aspiring to start businesses in the future.

7.3.2.4. National student-entrepreneur status (SNEE[329]) program

The national student-entrepreneur status (SNEE) program was introduced by the then-Ministry of National Education, Higher Education and Research, then-Ministry of Economy, Industry and Digital, and the Deposits and Consignments Fund (CDC) during the PIA 2 stage of the "Investments for the Future" program of 2014. Working closely together with PEPITE, SNEE targets students who are working towards their bachelor's degrees to PhDs or have already received their diplomas. The SNEE program is modeled after a support program for high-level athletes, and acts as a safety net for students who actually launch startups as well.

Students who aspire to start companies and have applied for the program are screened by the selection committee. Selection is made at PEPITE established in universities/schools of the applicant's district. The selection committee is made up of university-related people, consultants, and entrepreneurs in equal numbers. Screening criteria include the applicant's enthusiasm and aspiration, and their startup project's feasibility.

While continuing their studies at school, if students on this program have to do an internship

328 PEPITE: Pole Etudiant Pour l'Innovation, et Transfert et l'Entrepreneuriat. In some regions, PEPITE is also called PEE or PEIPS.
329 SNEE : Le statut national d'étudiant-entrepreneur

or make other kinds of preparation for launching a business, they can adjust course schedules including examinations as needed. By having this national student-entrepreneur status, they can also take special entrepreneurial training courses and elective courses that are useful for starting a business, and use social security services after graduation. As students who have the national student-entrepreneur status are eligible until they turn 28 for the benefits that are normally unavailable for people who have never worked before, the status helps people who aspire to start businesses after receiving their diplomas. Two mentors (one with startup experience and one professor) are assigned to every SNEE-certified student entrepreneur.

When the SNEE program was introduced in 2014, it was not well known. Now, as successful pioneers are emerging, the Hawthorne effect and the pheromone effect are being seen in student clusters. The number of registered SNEE students in the country was 645 in the program's first year, which grew to 1,556 in 2016, and over 3,000 in 2017. The mindset of people is changing from the traditional idea of "first complete school and then start a business," to "apply what you are learning to start a business." France is a country of diversity and flexibility, in which people defy systems and institutions, take actions on their own initiative, and say whatever they want. Such French characteristics and the drive of young people are receiving complete support from the national government, and that is one contributing factor to the success of this program. Starting one's own business is becoming a familiar choice for the young people who were born around 2000 and later.

Column 1: i-LAB National Competition and PEPITE Contest

The i-LAB National Competition is a national competition started by the Ministry of Higher Education, Research and Innovation (MESRI) in 1999, aiming to support creation of innovative businesses. Since the 2014 introduction of PEPITE during the PIA 2 stage, a new genre of competition for the PEPITE award which targets young researchers and students has been added to the i-LAB competition. For startups, these competitions act basically as sources of seed funding with prize money and also as providers of endorsement which may trigger the growth of award-winning companies. These competitions are called “Tremplin (springboard)” in France.

The i-LAB National Competition supporting creation of innovative startups (1999-)

The i-LAB National Competition has so far helped create 1,800 startups (70% of which continue business today), acting as a springboard for entrepreneurs who aspire to start businesses. In the 2017 competition, 62 startups received awards and 5 of them won top awards. The breakdown of award-winning projects by sector is as follows: medicine 23%, pharmaceuticals/bio 19%, digital/software technology and communications-related 18%, materials/machinery/engineering 14%, chemical/environment 13%, and electricity/sensor-related equipment 10%.

The grant provided through this competition is one of seed funds in France and up to 450,000 euros are provided to startups when they are established. The grant is provided through a public investment bank (Bpifrance), which expects an annual budget of around 12 million euros for this grant.

PEPITE Contest (2014-)

The PEPITE Contest aims to encourage students and young graduates to launch innovation startup projects and to financially support good ones among them. This contest was first started as an addition to the i-LAB National Competition in the PIA 2 stage of the “Investments for the Future” program in 2014. In 2017, 53 startups were awarded, including 3 top prize winners. The three top winners each received 20,000 euros, 20 other winners 10,000 euros and 30 others 5,000 euros. The PEPITE Contest’s prize money is supplied through the Deposits and Consignments Fund (CDC), a financial institution. Apart from this contest, in a bid to support young companies, CDC has recently set up a fund for young entrepreneurs, from which entrepreneurs belonging to a student cluster PEPITE can take out a loan of up to 50,000 euros per project.

7.3.3. Support programs of local governments and public research institutions

Startups from public research institutions jump into a market after completing the Technology Transfer Accelerator Offices (SATT) program and move from the seed stage to the Series A stage[330]. Many startups are then supported by local competitiveness clusters and agents, French Tech and incubators that also act as French Tech platforms, financial institutions and private investment firms. These support institutions have been launched not only in Paris but in various other regions as well. Some of these institutions have long served their communities and even produced results on a par with technology transfer support institutions by receiving support from the central government ministries.

Many of these established programs and institutions have been around since prior to the implementation of the "Investments for the Future" program, providing support for startups by producing combined effects with new programs such as SATT.

Competitiveness clusters[331]

In 2004, it was decided to introduce competitiveness clusters, or industry-academia cooperation hubs mainly led by companies, modeled after the US Silicon Valley and the campus of the University of California, Berkeley, based on the idea proposed by French MP Christian Blanc. After publicly inviting applications, the government approved 71 locations as early as the following year, 2005. Applications were screened based on the criteria of "consistency with local economic development strategies, international promotion capabilities, cooperation with related institutions, and abilities to create synergy with R&D activities and added value."

According to the statistic of 68 competitiveness clusters as of 2017, small and medium enterprises account for 65% of member corporations, large companies 8%, research/education institutions 17%, and the rest is technology transfer support institutions. Member corporations are in the fields of nanotechnology, bio, environment, automobiles, aircrafts, etc. By participating in various activities conducted by competitiveness clusters, including annual regular events, workshops, overseas inspection tours, and training programs, member corporations can exchange information with research institutions/laboratories, promote research projects, and receive education at universities and research institutions. Competitiveness clusters are funded at the national level with the Single Interministerial Fund (FUI) and the budget of the "Investments for the Future" program (PIA) through the French National Research Agency (ANR) among others, and also receive funds from public investment banks and the Deposits and Consignments Fund (CDC). Annual membership fees from member corporations and public subsidies (from regions, municipalities) also make up a part of the budget of competitiveness clusters.

One of the largest responsibilities of competitiveness clusters when supporting startups is serving as a matchmaker between member corporations with different needs by setting up occasions where representatives of those corporations can meet each other. Another responsibility is providing support through a series of steps including labeling to help gain greater public/private support and coaching which is provided until product launch. Competitiveness clusters rate startups based on their accumulated expertise and advice form external experts, and provide their endorsement to promising ones. With their endorsement, startups may receive not only grants

[330] Series A is a name given to a particular stage of startup maturation. Although there are various other ways, Serena Capital, a French private capital fund, classifies startups as follows: Seed Stage (startups capitalized at 300,000 – 1 million euros), Series A (1 million – 5 million euros), Series B/C (5 million – 50 million euros), and Growth Stage (startups which have reached the level of small and medium-sized enterprises).

[331] For more details of competitiveness clusters, see pp.68-69 of "Report of trends of science and technology/innovation – France edition" (2014) [CRDS-FY2014-OR-04], CRDS Overseas Research Report.

from the national government but also additional funds from local governments. This labeling function is the lifeline of competitiveness clusters, and startups are attracted to competitiveness clusters because they want to utilize this function.

Competitiveness clusters also make use of their knowhow when supporting startups by applying the extensive network of contacts built by staff with specialized knowledge in particular fields and employees with abundant experience in industry to put startups in touch with the right persons in charge of competitive funds at ministries and agencies or relevant staff at research institutions.

In the life science-related sector, some competitiveness clusters provide added value by making laboratories of biosafety level (BSL) 2 or 3 available while another cluster in the digital-related sector holds a free event which attracts around 50,000 people every year. When startups from public research institutions overcome the hurdle of winning a national competition or the like, the competent authorities switch from the Ministry of Higher Education, Research and Innovation (MESRI) to the Ministry of the Economy and Finance and that is when competitiveness clusters come in to bridge the gap between the two ministries. Competitiveness clusters work closely with SATT and French Tech as well. Membership has been growing in recent years.

<u>Public incubators developed in the wake of the enactment of the Allègre Law</u>

After publicly inviting applications based on the so-called Allègre Law of 1999, the government established 24 offices for public incubators across the country. Public incubators have the longest history among all startup-related support institutions. The role of incubators of public research institutions is promoting the establishment of innovative companies from public research outputs, and for that purpose, providing support according to the needs of entrepreneurs in their individual projects, including financial, legal, and management-related support (e.g., market analysis, patent applications), offering consulting services and office spaces for the convenience of startups, and helping seed owners to organize companies out of their ideas and projects in a way that is profitable. Here, “incubators” refer to entities which provide entrepreneurs with support for starting their companies, not mere office providers.

The average support period is around 24 months, which varies depending on the sector. In some cases, it is extended for a couple of months, if need be. According to the statistics from 2000 to 2016, public incubators accepted 4,300 innovative seed projects, around 40% of which came from public research institutions and 38% were related to joint research with public laboratories. During the same period, around 3,000 startups were launched.[332]

By sector, life sciences accounted for 31%, information communication technology 37%, engineering technology 28%, and social sciences and humanities 4%. Two public incubator companies, i.e. Pulsalys (Lyon) and LINKSIUM (Grenoble) were integrated into SATT companies when they were launched in 2014. From this fact, it is reasonable to assume that the decline from 2014 was partly due to the introduction of SATT. Figure 11 shows the changes in the number of new startups launched from public incubator offices from 2000 to 2015.

[332] http://www.enseignementsup-recherche.gouv.fr/cid5739/les-incubateurs-d-entreprises-innovantes-lies-a-la-recherche-publique.html

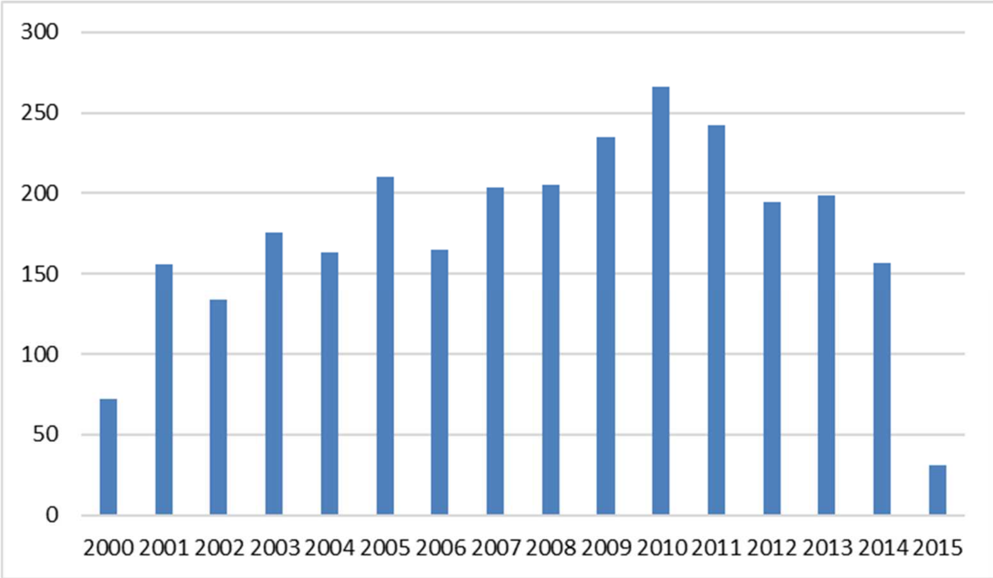

Fig. 11: Number of Startups Launched from Public Incubator Offices

Source: Created by CRDS based on information from the website of the Ministry of Higher Education, Research and Innovation (MESRI)

French Public Investment Bank (Bpifrance)

Bpifrance is a public establishment of an administrative nature (EPCA) dealing with public investments in general, and it has an internal section which supports innovative activities, mainly those of companies. While the French National Research Agency (ANR) funds early-stage research programs and the French Environment and Energy Management Agency (ADEME) is focused on projects related to environment/sustainable development, Bpifrance provides startups, small and medium enterprises and large corporations with grants and a broad range of loans as follows:

- Financing related to R&D activities (grants, loans, no-interest loans, etc.)
- Short-term/medium-term/long-term financing
- Security for bank loan
- Capital investment

In FY2014, Bpifrance provided 877 million euros to innovation activities.

Column 2: French Tech activities

French Tech activities are France's unique startup support. They are carried out by Business France[333] under the Ministry of Economy and Finance, French embassies abroad under the Ministry of Europe and Foreign Affairs, the Chamber of Commerce and Industry, Bpifrance and other financial institutions, supporting companies, and startups. Aiming to increase the presence of existing events related to French startups, these participants have created a logo of "French Tech" as a branding effort, and promoted French startups inside and outside of the country. There are 14 French Tech centers in the country, covering many fields including IoT, manufacturing, health, clean tech, mobility, Fintech, security, food, sports, and tourism. As one of the participants, Business France employs around 1,500 members of staff around the world who are engaged in French Tech activities overseas, helping French startups take part in international events such as the Consumer Electronics Show (CES) in Las Vegas and conducting marketing activities including promotion of French startups to journalists and influencers. Business France in Paris has four full-time members, who are engaged in activities related to events, PR, and French Tech tickets[334] among other things. French Tech was funded during the PIA 2 stage of the "Investments for the Future" program, mainly for the following three purposes:

- Creation of a unified logo for all French startups (using the motif of the Gallic rooster, the country's traditional symbol)
- Promotion inside and outside of the country and 15 million euros of grants for that
- 200 million euros for development of accelerators

As the initial focus of French Tech activities was placed on supporting entrepreneurs in the digital field, much of French Tech activities are still accounted for by Fintech and other digitally-mediated services. But as digital technology is applicable to a diverse range of sectors including agriculture/food, health and life aesthetics, and manufacturing, French Tech covers all kinds of startups in France by working closely with competitiveness clusters and SATT. This can be viewed as an approach from industry or downstream.

[333] Public institution with industrial/commercial characteristics which became independent from the Ministry of Economy and Finance. It is made up of a division which promotes inward investments to France from overseas and another which supports French companies' investments in other countries.

[334] One of the startup support programs, providing various kinds of support including provision of 45,000 euros to each team.

7.3.4. Overview and history of support programs (summary)

France's support programs we have looked at so far can be divided into three different groups based on the law on which the programs were formulated and the time of implementation and they came in three different waves.

The first wave was created by the introduction and enforcement of the so-called Allègre Law, through which incubators were established. The second wave was triggered by the "law on research planning," which opened the way for the establishment of research fund distribution institutions including a public investment bank (OSEO, current Bpifrance) and the French National Research Agency (ANR) and also led to the introduction of the Single Interministerial Fund (FUI). The third wave is the "Investments for the Future" program (PIA) under the Sarkozy administration, establishing Technology Transfer Accelerator Offices (SATT).

Institutions established upon every wave are not necessarily new, and in fact many of them were formed by reorganizing existing organizations. In some other cases, a similar institution was newly created without terminating the existing organization. This resulted in the current multi-layered support programs for French startups and innovation. This complexity is a huge problem of today's French startup scene.

Figure 12 provides the overview of the multi-layered support programs.

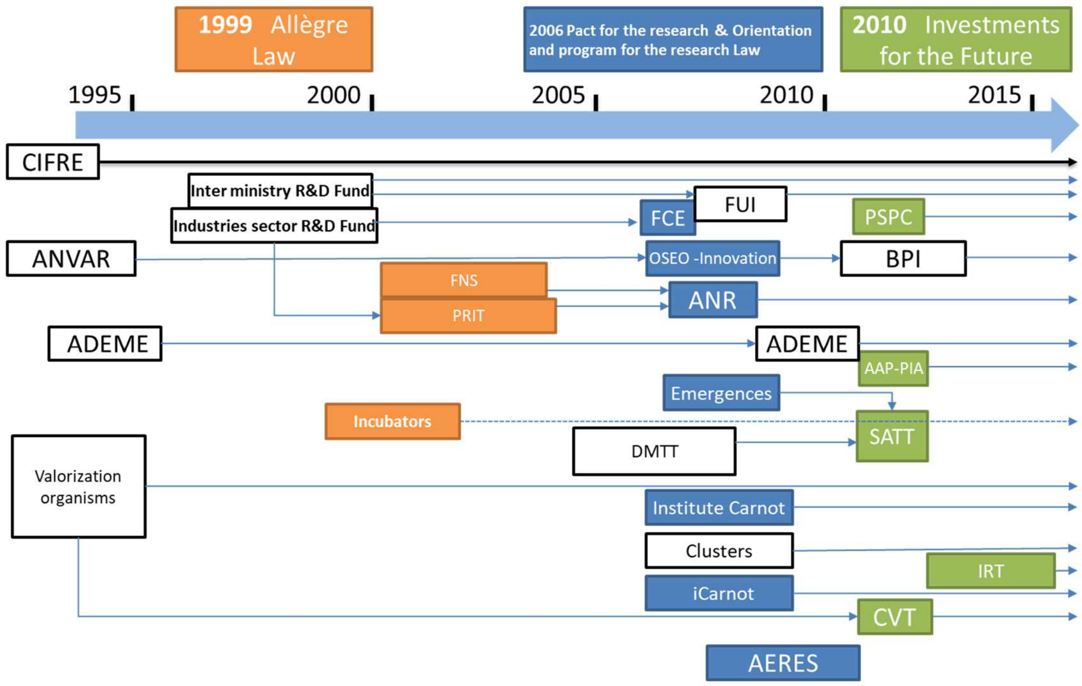

Fig. 12: Overview of the Multi-layered Support Programs

Source: Created by CRDS based on a chart included in "Survey on support programs for research cooperation," a report by the Ministry of Higher Education and Research, February 2013

7.4. Cases of R&D startups and related support organizations

This chapter provides cases of R&D startups in France.

7.4.1. Case (1): Startup support by public research institutions

This section looks at and compares cases of spinoffs, one from the French National Center for Scientific Research (CNRS) and the other from the French Alternative Energies and Atomic Energy Commission (CEA).

1) Startup from a public research institution 1: HPROBE, a spinoff from CNRS (Seed Stage to Series A)

HPROBE is a new startup established in Grenoble in 2017 by receiving support from SATT LINKSIUM. The seeds of HPROBE were derived from Spintec, a CNRS spinoff laboratory (shareholders: CEA, CNRS, UGA).

As a result of 10-year-long research concerning magnetism on silicon wafers, Jean-Pierre Nozieres at Spintec identified an effective measurement method, designed a speedy inspection device applicable to MRAM production lines, and invented a device which would contribute to production throughput. As MRAM is a promising means to solve the challenge of achieving low power consumption (required for storage) which will surface when mobile devices are IoT-enabled going forward, the product is expected to see a sharp rise in sales. Nozieres established HPROBE to propose new products in this promising market. (The company counts IBM, Samsung, and TSMC of Taiwan as promising users.)

In light of the market's fast growth, Nozieres, the seed developer, chose to start a company in pursuant to Article 25-2 of the Allègre Law, and took the seeds to SATT LINKSIUM in 2016. He received support he needed for proof of concept and startup preparation (worth 300,000 euros) from SATT, and launched HPROBE. The company was qualified for another 300,000 euros at the i-LAB National Competition in 2017, and Nozieres received an award at CNRS the same year. He obtained his PhD in physics from the University of Grenoble Alpes and received his engineering degree from the Grenoble Institute of Technology. He is a co-founder and former CEO of Spintec, and had a hand in the establishment of four startups including HPROBE, apart from Spintec.[335] He has also worked for Institut NEEL, which is under the French National Center for Scientific Research (CNRS), IBM-Research, and Applied Magnetics Laboratory in the US.

Laurent Lebrun, recognized for his 10-years of service as president of a cutting machine manufacturer, has taken the helm of HPROBE as CEO.

2) Startup from a public research institution 2: SOITEC, a spinoff from CEA (Listed on Euronext)

Launched as a startup in Grenoble in 1992, SOITEC is a leading company in design and manufacturing of high-performance semiconductor products including SiC and GaN. It now has 950 employees, four manufacturing locations, and 3,000 patents, and 93% of its sales come from overseas. The company has signed partnership agreements with the University of California, Berkeley and many other research institutions, universities, and companies around the world. Founded by researchers from CEA-LETI in Grenoble, SOITEC was funded by CEA from as early as its establishment. Today, SOITEC is one of the most important customers of CEA.

Working for the R&D department of SOITEC, Frédéric Dupont and Fabrice Letertre launched

335 The four startups are Crocus Technology (2006), eVaderis (2014), Antaïos (2016), and HPROBE (2017).

EXAGAN, which develops GaN power devices, in April 2014. Due to the slump in the solar cell market back then, SOITEC, the home company, was unable to make sufficient investments in the establishment of EXAGAN. Those days, SOITEC was jointly developing GaN device technologies with CEA-LETI. Based on such a background, CEA Investissement, CEA's investment arm, made an equity investment when EXAGAN was launched and a research agreement entered into by CEA and EXAGAN ensured a smooth start for EXAGAN. EXAGAN is a startup of both CEA-LETI and SOITEC, so CEA's involvement is believed to have been indispensable for the launch of EXAGAN. EXAGAN is currently based in MINATEC campus, closely working with MINATEC cluster companies such as Minalogic and Tenerrdis.

7.4.2. Case (2): Support for startups from universities/schools

Here, we look at two cases of startups. One is TRUE SPRIT created at Institut d'optique Graduate School, a member school of the University of Paris-Saclay, and the other RHEONOVA launched at the University of Grenoble Alpes.

<u>1) University startup 1: TRUE SPIRIT (Startup development level: Seed Stage)</u>

TRUE SPIRIT is made up of three members, all of whom are alumni of Institut d'optique Graduate School, a member school of the University of Paris-Saclay. When these graduates of the entrepreneur/innovation course (FIE)[336] of the school were still in school, they focused their attention on the fact that wineries contracted out inspection for deterioration of their products during transportation to outside laboratories. While registering six patents, they started their company by developing an optical inspection device which was smaller than the conventional inspection device in size and price and would reduce time and money required for delivery. This project was funded with a total of 13,000 euros by the student cluster of the University of Paris-Saclay from 2015 to 2016. TRUE SPIRIT was also one of the winners of Challenge Startup 2016 held by the University of Paris-Saclay, qualifying for a week-long Silicon Valley training program. More recently, it also won a prize in a contest held in Île-de-France in 2016, qualifying for a six-month incubation at Station F. TRUE SPIRIT initially started off with five members but two of them left during the project to pursue other interests.

It was before registration of TRUE SPIRIT and they were still in school when they started the project, so they were unable to receive support from Technology Transfer Accelerator Offices (SATT). But they made the most of what was available, including support from student cluster PEIPS and Île-de-France, the national student-entrepreneur status (SNEE) program and research tax credit (CIR), and managed to start the company. They also received support from wine producers and experts of inspection laboratories when starting the company. When we interviewed the members of the startup, launching their own business seemed to be a natural course of action for them as they said they had aimed to start a business as early as the beginning of the FIE program and they had not had any other choice. On another note, 15 startups have been created by graduates of the FIE program of the same school. Successful companies include STEREOLABS, which was chosen by director James Cameron for his films, Avatar 2 and 3.

[336] FIE is the entrepreneur/innovation course of Institut d'optique Graduate School. In this course, students aim to actually launch their startups at the time of completion of this two-year master's program. With support from instructors, coaches, and mentors, students learn about what is required of entrepreneurs and how to launch a startup while acquiring skills for analyzing customers and markets, prototyping, securing funds, and developing business models. The school accommodates 37 companies and startups, where they can collaborate and cooperate with each other. The school also has a fab lab, which is necessary for prototyping.

2) University startup 2: RHEONOVA (Startup development level: Seed Stage – Series A)

RHEONOVA is a company established based on the seed that is diagnosis equipment for patients with chronic respiratory diseases, which was brought into an incubator, Grenoble Alpes Incubation (Grain), which was later to become SATT LINKSIUM. RHEONOVA's diagnosis equipment excels at measuring the viscoelasticity properties of body fluids. Patients with diseases of the respiratory organs including lungs develop distinctive characteristics in the viscoelasticity properties of body fluids at the initial stage of the diseases. RHEONOVA focused attention on this fact and conducted development. The potential market is contaminated regions (e.g., China, the US, and EU).

CEO Jérémy Patarin majored in physics (fluid mechanics) and obtained his PhD from the Grenoble Institute of Technology. He made incubation registration with the said Grain in 2013 and launched RHEONOVA with four other people in 2014. The company obtained patents in 2015 and qualified for grants by winning a prize at the i-LAB National Competition in 2017. As of 2017, the company employs 10 people. The company aims to obtain CE marking and FDA approval after going through clinical trials soon and to go public in two years. Some people from the company said that generous financial incentives for startups (unlike the US where large amounts of funds are concentrated on a small number of recipients) and French-style funding which is spread thinly but broadly greatly help the establishment of startups like theirs. A young researcher made an especially memorable comment, saying he had decided to work for RHEONOVA despite relatively low pay because the company would provide opportunities to experience various business fields, which would be impossible at a laboratory of a large corporation, while he was still young, and also because the workplace was vibrant.

Seed development was promoted under collaboration with UGA and CNRS, and the company sought cooperation from Grenoble Alpes University Hospital at the first clinical trial. CNRS and the university hospital of COMUE provide support which is necessary for assessment of prototypes during the clinical trial stage and SATT (which replaced the predecessor incubator Grain at some point) and COMUE are considered to be working as a bridge between these different players.

SATT and COMUE are quite useful for universities which do not have their own large-scale technology transfer institutions unlike CNRS or CEA. In a bid to accelerate creation of startups and employment, the Ministry of Higher Education, Research and Innovation (MESRI) and higher education institutions are also striving to increase the number of new startups without relying on SATT by establishing student clusters such as PEPITE and introducing entrepreneurship courses.

7.4.3. Case (3): Local promotion by competitiveness clusters, public incubators, etc.

Local promotion startup: GENFIT

GENFIT is one of the oldest startups developed in Eurasanté, a competitiveness cluster in Lille, which has now grown to employ 4,000 people and is traded on NASDAQ with market capitalization of 800 million dollars (headquarter in Loos, Hauts-de-France). The company develops therapies and drugs for non-alcoholic steatohepatitis (NASH)[337]. GENFIT received Fast

[337] A fatty liver may lead to liver inflammation if it is aggravated. Due to inflammation, liver cells may be destroyed quickly and stop functioning or accumulate fat, which is a state called "steatohepatitis," which is considered to be the stage prior to liver cirrhosis. Some non-alcoholic fatty liver diseases which are caused by obesity or diabetes are called non-

Track designation (priority review and approval system) of the FDA, the U.S. Food and Drug Administration, in February 2014, when Elafibranor was undergoing Phase II B of the clinical research for NASH patients at 56 clinics (in France, Belgium, the Netherlands, Italy, the UK, Germany, Spain, and Rumania). Elafibranor is attracting so much attention that it was chosen for the topic of the opening lecture at a conference of the American Association for the Study of Liver Diseases (AASLD). As of 2017, Elafibranor is undergoing Phase III of the clinical research.

GENFIT was jointly established by Jean-Charles Fruchart, who was Director of the atherosclerosis department of the Pasteur Institute/the French National Institute of Health and Medical Research (Inserm)/Lille University in Lille and President of Scientific Council at the University of Lille 2 back in September 1999 and later went on to become President/Co-founder of GENFIT from 1999 to 2008, and Jean-Francois Mouney (Chairman and current CEO).

GENFIT was established by receiving complete support from Eurasanté in Lille where it was based from the beginning of the project. Back then, startups would usually seek investment from risk capital funds based in Paris, and GENFIT had its share of difficulty in receiving support from financial institutions. But at the end of 1999, it successfully gained credit with the financial institution Credit Mutuel and entered into contracts which would secure investment for multiple years with four major pharmaceutical companies such as UCB-Pharma, Aventis, Sanofi-Synthelabo, and Lipha-Merck. As of June 2000, not so long after the establishment, the company's capital amounted to 10 million to 13 million francs, and the company had agreements with five other companies: Pierre Fabre, Servier, LFB, Fournier, and Kowa. As GENFIT focused on transferring technology and knowhow created through research to the pharmaceutical industry, it received strong support from Martine Aubry, a Socialist Party heavyweight, who was then the Minister of Employment and Solidarity.

In 2008, after several months of a management feud, co-founder and science and technology advisor Fruchart left the management. He is a renowned person who received various awards including the Legion of Honour. When the Allègre Law was enacted in July 1999, he was 54 before his retirement. The enactment of the law, which would guarantee public servants their status during their entrepreneurial efforts and would make sure that their pension eligibility would not be affected, must have given him a supportive push for starting his own company.

Economic Interest Group (GIE)[338] Eurasanté

Eurasanté, a bio-life park, is certified as both an incubator (certified in 1999) and the "Nutrition/health/longevity" (NSL) competitiveness cluster (2005) by the French government, and has a corporate status of Economic Interest Group (GIE). Located in Lille with Loos (Hauts-de-France, former Nord-Pas-de-Calais) as its south neighbor, Eurasanté is established in one of the largest university hospital campuses in Europe, which is centered around Lille University Hospital. The bio-park is home to around 1,000 companies and 27,500 related employees are working there. Special fibers for healthcare, medical/hospital-related equipment, food and health-related corporate activities are the mainstays of many companies' business activities. Hospitals in the park are equipped with all sorts of medical-related facilities including a genome research center and a blood transfusion center, meeting the needs for degenerative neurological disorders, heart/metabolic diseases, neurosurgery, cancer, infectious/inflammatory diseases, Alzheimer's

alcoholic steatohepatitis (NASH).

338 Economic Interest Group (Groupement d'intérêt économique: GIE) is a corporate status between a stock company and a union. Member companies can engage in joint economic activities for development/improvement of economic activities while maintaining their identities. GIE employees are allowed to work for multiple member companies.

disease, and pediatrics. As for higher education, 20,000 students study at Eurasanté. France's second most medical university students (11,000 students) and third most pharmaceutical students (2,200 students) study and 19 engineering schools are based in Eurasanté.

Together with public funds, the Greater Lille area where the park is located is important. The area, which is home to various private seed funding institutions and many individual investors, is a rarity in France. Today, Eurasanté is an economic park concerning life sciences with 21 years of history, trying to fulfill its mission of supporting spinouts from public research institutions and early-stage startups, adding value to this region, and creating jobs.

The strengths of Eurasanté include a variety of industrial expertise gained through the past cases of support, understanding of potential markets, provision of related information, and access to groups of patients and private medical/bio-related corporations. By accepting projects from Technology Transfer Accelerator Offices (SATT), Eurasanté provides long-term support required by startups related to life sciences. By leveraging its geographical advantage, Eurasanté is preparing to play the leading role in Europe which is becoming increasingly chaotic due to Brexit. Eurasanté is supporting 40 startups as of 2017, and has helped launch 170 startups in the past.

Column 3: Greater Lille

The city of Lille has a population of four million and is geographically located at the border of France and Belgium. Nord-Pas-de-Calais, where the city is situated, is also called Flanders and has northwest Europe's largest coal vein following the Ruhr coalfield in Germany, and it prospered through coal production in the late 19th century. This region is also where France's first textile industry was born. After the coal industry's decline from the 1970s, Nord-Pas-de-Calais suffered the serious economic doldrums and poverty, so it invited the auto industry to replace coal/textile, trying to change its industrial structure.

Under such difficult economic circumstances, this region had a higher incidence of degenerative neurological disorders, heart/metabolic diseases, cancer, etc. compared to the national average. In the meantime, the region had the country's largest blood transfusion center. That was when, in the early 1990s, then-Director of Lille University Hospital and then-Mayor of Lille came up with a vision of developing a technology transfer hub in the fields of life sciences and health out of this local blood transfusion center in Greater Lille. In this vision, the technology transfer hub would also act as a bearer of research and residents in Greater Lille would be viewed as a group of patients (cohort). In 1994, the Eurasanté Association, the predecessor of today's Eurasanté, was formed by the home region Nord-Pas-de-Calais, the cities of Lille and Loos, universities and financial institutions. Eurasanté is a competitiveness cluster which is literally based on the blood of Lille residents.

As discussed above, competitiveness clusters, agents, and French Tech-related offices support the development of startups into small and medium-sized enterprises. By taking various support measures, each region strives to invite businesses and to create employment in a bid to regain once-lost advantage as a place for business activities, and in often cases support measures and performance of regional institutions are on a par with or sometimes superior to those of the central government. Especially noteworthy are competitiveness clusters in the digital field, where the number of startups is on the rise and long-term support is provided to startups related to life sciences and health.

In the meantime, the government's subsidies for competitiveness clusters through competitive funds have been on the decline year after year. Currently, competitiveness clusters are facing the tough job of both realizing support for an increasing number of member corporations and fulfilling their primary role of promoting and revitalizing local economies.

As discussed in 7.1, the French industrial structure needs to be revamped, especially by increasing the number of middle-sized companies compared to neighboring Germany. This is because community-based middle-sized companies are highly anticipated to vitalize their communities.

Scaling up startups requires different levels of personnel and financial management, so it is difficult to implement by startup managers alone. To help startups grow into middle-sized companies, some sort of support enhancement is required. It is an issue directly related to the survival rate of startups.

7.5. Characteristics of startup environments and measures in France

7.5.1. National level startup support with national funds

As discussed in 7.1, solving social challenges through the development of startups is one of the top priorities of France. As indicated by the huge startup support investment through the "Investments for the Future" program (PIA) alone, which amounted to around 1.1 billion euros, the government is committed to promoting creation and increase of startups at all levels such as public research institutions and higher education institutions.

As presented in the overview of the programs, organizational support is characterized mainly by the following: 1) The government makes it easier for researchers and engineers at national institutions to start businesses by guaranteeing their status for a certain period through the Allègre Law; 2) National research institutions directly participate in business creation financially and organizationally, thereby helping launch products in markets; 3) Implementation of measures is ensured no matter whether national institutions/higher education institutions adopt a fixed-term system or a non-fixed term system.

As for 1), researchers of universities/research institutions are allowed to work for companies they established as partners, technology advisors, etc. for a certain period while maintaining their status and this is considered to help motivate researchers and engineers to start businesses. The number of new startups is around a modest 100 a year, but the Allègre Law is considered as a kind of symbol, leading the startup landscape of France in a sense. As for 2), it is about the system of the French Alternative Energies and Atomic Energy Commission (CEA), in which the division of technological research at the French Alternative Energies and Atomic Energy Commission (CEA Tech) provides organizational support for startups while financially investing in technologies developed by its researchers or engineers. This helps commercialization of the organization's proprietary technologies. As for 3), programs such as Technology Transfer

Accelerator Offices (SATT) funded by the “Investments for the Future” program (PIA) from 2014, student clusters and the national student-entrepreneur status (SNEE) helped support to spread through the entire higher education institutions including those which had previously not been covered by support of technology transfer institutions, causing a great change in people’s mindset. In recent years, the French government is faced with a pressing challenge of overcoming socioeconomic problems, so it places importance on promoting transfer of more technologies by lowering the minimum age of the target eligible for support in a bid to solve these problems.

With regard to the startup environment, as in the case of salaries and benefits under a support program based on the Allègre Law, rules are applied in an extremely flexible manner according to the application and negotiation even under national programs. In spite of the rather ambiguous division of roles between different support programs of SATT, competitiveness clusters, and French Tech has paradoxically produced the benefit of flexibility among these programs. Many things are left up to the discretion of the front-line staff. This way, details of startup support provided vary depending on the risk tolerance in each project.

Speaking of the development of the environment, it is indispensable to reform the environment of labor and management in today’s France including revision of the labor code in order to accelerate the creation of startups going forward. The Macron administration’s moves will be keenly watched.

7.5.2. Environment where entrepreneurs choose from various support programs and institutions by themselves

As discussed in 7.1.1, the beginning of this chapter, as a result of the French government’s efforts made through a trial and error approach, many institutions related to technology transfer support, which were established in different periods of time, coexist in the country, and entrepreneurs have to choose ones appropriate for their companies from these institutions.

Available programs and institutions include incubators introduced right after the enactment of the Allègre Law, competitiveness clusters, agents which are funded by regional and EU grants, technology transfer promotion functions and accelerators of individual universities and higher education institutions, and technology transfer institutions introduced by the “Investments for the Future” program (PIA) among others. The entire structure is so complex that people involved make fun of it by calling it “mille-feuille” or “stratum.”

To put it bluntly, however, it is easy to imagine that establishing a new institution by removing another existing one would be quite a challenge in France where building a consensus through the exchange of opinions is indispensable, and in fact, there have been a number of cases where a new institution was established according to the national government’s intention without replacing existing ones. As a result, the current situation where various technology transfer institutions are involved in the same project was created, and it is far from the ideal state both from startups which seek support institutions and technology support institutions or public institutions which aim for license fee income. As mentioned in 7.3.2.1, a revision may be made to improve practicality in the future.

7.5.3. Startups viewed as a means for self-realization especially by young generations

As discussed previously, startup support in France signifies the government’s active policy. What is interesting is that an increasing number of people are starting their own business based on the government’s policy.

The result of a questionnaire survey of students of École Polytechnique, one of Grandes Écoles, taken in 2017 shows that 15% of students want to work for startups in one way or another. The questionnaire result says that students of this school are well aware of problems that arise in large corporations, aspire to propose solutions to them, and wish to realize businesses which have impacts on society and health issues without getting interfered by a hierarchical society and to create jobs by themselves.

As we discussed in this chapter, SATT was introduced to spread technology transfer support to not only CNRS, CEA and other large public institutions but also universities, joint laboratories, hospitals, etc. while PEPITE and the SNEE program were also launched as support for young generations to promote creation of student startups, providing comprehensive startup support in terms of finance, education, cooperation with local entrepreneurs, and business launch. While these support programs encourage enterprise, an increasing number of people, especially young generations, view starting a business as one way for self-realization.

According to the result of a recent questionnaire survey of entrepreneurs taken by SOFRE[339], entrepreneurs today come from various backgrounds, are aged 35 on average, and those highly-educated, who account for around 90%, started their businesses motivated not by money but by more freedom they would have in making decisions at work. According to another questionnaire, it is a higher quality of life and self-realization that these startuppers seek.

7.6. Closing remarks

Care for atherosclerosis and diagnosis equipment for respiratory diseases caused by air pollution, discussed as examples above, are seeds corresponding to issues of today’s society. During our research, we also encountered seeds which would help solve actual social problems facing advanced countries, although we were not able to detail them for want of space. One example is the development of a set of sensors and drive software which monitor large scale infrastructure including tunnels and bridges from fixed locations and predict their sudden fall due to deterioration.

Although the Allègre Law lowers psychological hurdles for enterprise, the law is not perfect as a safety net and, in terms of reputation after failure, France has a long way to go before becoming a society where failure is allowed. The older people are, the more careful the approach they tend to take for starting a business.

We believe that in France, a European country, the goals of startups aimed at by the national government and individuals are, on the whole, improvement in employment, revitalization of national and regional economies, and self-realization through developing one’s strengths.

339 French research firm. It was renamed Kantar TNS in 2016.

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8. China [Case studies]

8.1. Introduction

Now that we are about to see the Fourth Industrial Revolution, major countries have come up with measures to promote the next-generation industrial technologies one after another. These policies call for advances of production technologies of existing companies while hopes are growing that new industries and new business models will be created and startups with high technical capabilities will achieve rapid growth.

Against such a background, thanks to its fast development in recent years, China has equaled the US in terms of investments in startups[340] and has the world's second-most unicorns after the US[341], becoming one of the most active startup countries. In China, if you step into co-working spaces or Makers Coffee[342] which were established by universities, local governments, and major corporations, you would see many young people working hard to start new businesses. You would also find news stories on startups on TV or in newspapers. It is just a part of everyday life.

Chinese startups are formed in various ways; some take the conventional approach, leveraging outputs of university research and bridging the gap with markets or doing something along these lines, some private startups are generated naturally just with their own resources, and others are established by students who studied abroad, fully utilizing incentives and private capital. As industrial clusters vary depending on the region, and universities and national research institutions have their own strong fields, startup types and their business models are quite diversified in China.

This is why it is extremely difficult to properly understand the whole context of the situation in China where a variety of startup conditions and environments exist and at the same time they are changing rapidly. This chapter, therefore, aims to depict part of the dynamism of the country which is emerging as a "startup powerhouse" by providing two case studies of Tsinghua University and Shenzhen city. We picked these two cases not only because they were approved as best practices by the Chinese government but also because we are convinced that learning about the systems and characteristics of these examples will help you gain a better understanding of the startup situation in China.

8.2. The case of Tsinghua University to illustrate startup support by universities

In April 2016, China's state council designated four universities of Tsinghua University, Shanghai Jiao Tong University, Nanjing University, and Sichuan University as model universities for the first startup support program Group. The government is currently trying to spread beneficial experiences gained in these universities to other universities. As the introduction, this section first outlines the historical background of creation of corporations under the wing of universities and the current state, and then discusses governance systems of major university corporations and three types of startup support by closely looking at TUSHOLDINGS, a corporation under Tsinghua University.

8.2.1. Background and the current state of corporations under Chinese universities

Starting from the 1980s, Chinese universities naturally assumed the function to connect research outputs to industry in addition to education and research functions with the following four conditions as a backdrop, and conducted economic activities through university corporations[343].

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340 http://jbpress.ismedia.jp/articles/-/50572
341 http://fortune.com/unicorns/
342 Coffee shops for craftsmen and creators, a kind of co-working space.
343 University corporations here refer to corporations established through direct investment by universities. Initially, they

- Universities were required to have their own sources of funds.
- The policy to promote high-tech industry creation led by the government created opportunities for universities to enter markets.
- Technologies owned by universities increased their market value.
- Corporations had poor R&D capabilities.

Initially, despite being public institutions, universities directly participated in management of their corporations and thereby secured sources of funds for themselves. However, these activities were eventually construed as disturbing the government's market reform initiative, and in 2001 China's state council issued a "Notice of regulating management systems of university corporations under Peking University and Tsinghua University," thereby separating management rights from both universities. This notice was later applied to other universities in the country as well.

Under this policy, growth of university corporations under Peking University and Tsinghua University slowed down temporarily but their corporate activities were resumed through the establishment of university asset management companies which would manage university corporations. Although universities no longer have management rights over their corporations, it can be easily inferred that university corporations and university management are closely communicating with each other just as at the initial stage because this is an issue related to sources of funds of the universities.

As for the scale of university corporations in China, as of the end of 2013, 552 universities in the country had 5,279 corporations under their wing, and total assets of these corporations amounted to 353.8 billion yuan[344].[345] Total assets of corporations under Peking University and Tsinghua University amounted to 117.6 billion yuan and 97.1 billion yuan respectively, and the combined total accounts for 60% of the total assets of all university corporations, which indicates huge disparity in assets among universities. There is no public data available concerning assets of universities other than these two. But to help understand the scale of assets, Figure 1 shows the values of stocks of public companies owned by 15 universities. It clearly shows that Peking University and Tsinghua University are in a different league in terms of amounts of assets.

Corporations owned by universities listed in Figure 1 are not only commercializing research outputs but also are conducting business in publishing, real-estate and other industries. As mentioned previously, China's state council designated Tsinghua University, Nanjing University, Sichuan University, and Shanghai Jiao Tong University (denoted by ★ in Figure 1), which were producing the greatest results in commercialization of research outputs and startup support, as the first stage model universities in April, 2016. Among these universities, the next section will look at Tsinghua University which had the largest assets, how it implements governance, and its leading subsidiary corporations, and then we will discuss three types of support for the startups centered around TUSHOLDINGS.

were often run directly by managers of the investing universities.

[344] According to the foreign exchange rate of the Bank of Japan as of February 20, 2018, 1 yuan is equivalent to 17 yen.

[345] Statistics provided by the Ministry of Education of the People's Republic of China: https://xw.qq.com/mil/20150102009892/EDU2015010200989203

Universities	Market capitalization
Peking University	29.1 Billion CNY（494 Billion JPY）
★ Tsinghua University	18.3 Billion CNY（311 Billion JPY）
Harbin Institute of Technology	7.2 Billion CNY（122 Billion JPY）
Northeastern University	4.0 Billion CNY（68.6 Billion JPY）
Fudan University	1.6 Billion CNY（28 Billion JPY）
Central South University	1.3 Billion CNY（21.6 Billion JPY）
★ Nanjing University	0.9 Billion CNY（16.1 Billion JPY）
★ Sichuan University	0.7 Billion CNY（12.4 Billion JPY）
Shandong University	0.5 Billion CNY（8.3 Billion JPY）
Shanghai International Studies University	0.2 Billion CNY（2.9 Billion JPY）
Nanjing University of Science and Technology	94 Million CNY（1.6 Billion JPY）
★ Shanghai Jiao Tong University	89 Million CNY（1.5 Billion JPY）
Northwest A&F University	60 Million CNY （1 Billion JPY）
Anhui University of Science＆Technology	17 Million CNY（0.3 Billion JPY）
Chang'an University	11 Million CNY（0.2 Billion JPY）

Fig. 1: Values of Stocks of Public Companies Owned by 15 Universities
Source: Created by CRDS based on data from East Money Choice Data[346]

8.2.2. Governance at subsidiaries of Tsinghua University and leading subsidiaries

Under China's Ministry of Education, Tsinghua University together with Peking University makes "Shuāng xióng," the top two Chinese universities. The World University Rankings 2018 ranks Tsinghua University 30th in the world and third in Asia following the National University of Singapore and Peking University.

Tsinghua University set up a number of directly managed corporations starting from the 1980s, which were then organized under TSINGHUA HOLDINGS established in response to the change in the national policy in the beginning of 2000, as seen in Figure 2. While the university holds all shares in TSINGHUA HOLDINGS and retains the right to appoint a CEO, it does not directly participate in management. Subsidiaries of TSINGHUA HOLDINGS are largely divided into three categories: science park operation and management providers, high-tech companies, and investment firms.

TUSHOLDINGS, a science park operation and management provider, is the largest subsidiary of TSINGHUA HOLDINGS. TUSHOLDINGS is a key organization for the creation of new corporations, connecting university research outputs and markets and playing a central role in startup support by coordinating the university, industry, and local governments.

Leading companies of the high-tech company group include TSINGHUA UNIGROUP, which is focused on the fields of semiconductor chips, environment and energy, and life sciences and health and supplies CPU chips for mobile devices and memory chips, TSINGHUA TONGFANG,

346 The table lists 15 universities which own stocks of 26 firms (university corporations) listed on stock exchanges of Shanghai and Shenzhen. (Data as of November 25, 2016)

which excels in electronic information products and information system technologies, as Fujitsu does, CHINERGY, which constructs nuclear power plants, and CAPTALBIO, which produces biochips.

As part of the reform promoted by Xu Jinghong, who became CEO of TSINGHUA HOLDINGS in 2012, TSINGHUA ASSET MANAGEMENT was established as an investment firm, and it is investing in the growth of corporations affiliated with Tsinghua University and acquiring external corporations.

According to financial data as of 2015, TSINGHUA HOLDINGS holds shares of 52 companies, and a controlling interest in 25 of them. Many of TSINGHUA HOLDINGS' subsidiaries are large group companies, and the largest subsidiary, TUSHOLDINGS, for example, has more than 800 subsidiaries of its own. Revenue of Tsinghua University is made up of 1,514 million yuan of dividends from subsidiaries, 1,590 million yuan from contract research from companies, 500 million yuan from technology transfer and licensing, and 500 million yuan of donations.[347]

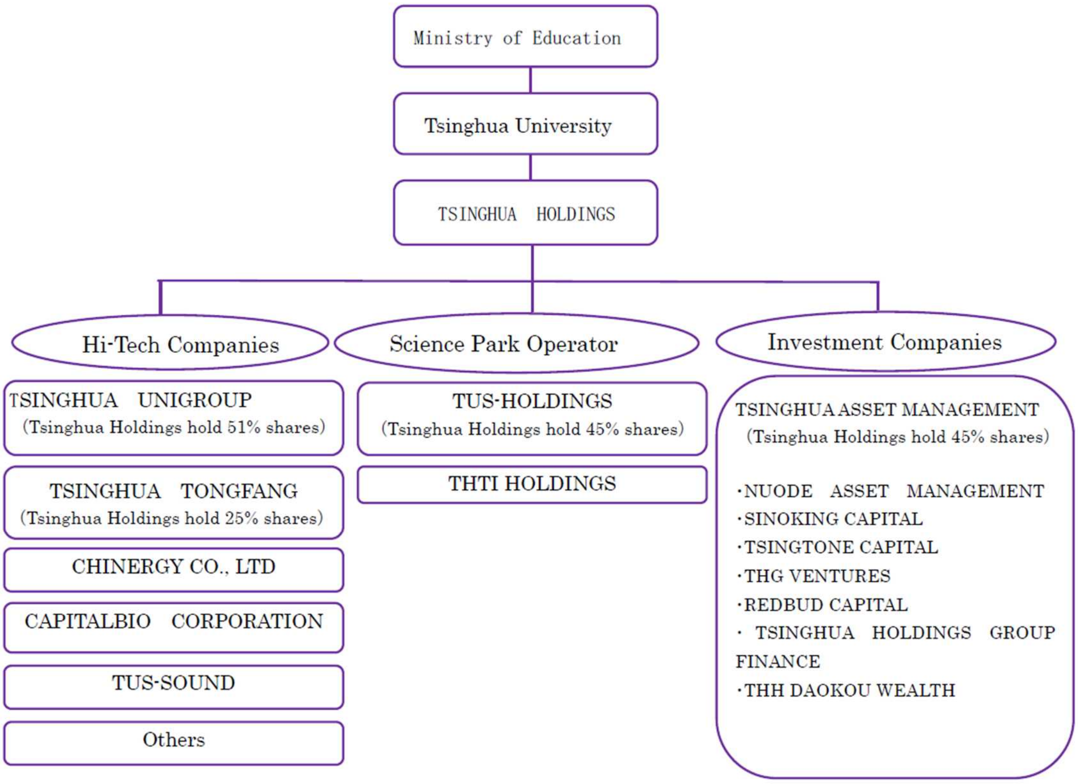

Fig. 2: The Governance of Tsinghua University and Its Affiliated Companies
Source: Created by CRDS based on information from the websites of Tsinghua University and TSINGHUA HOLDINGS

8.2.2.1 TUSHOLDINGS

TUSHOLDINGS was established in 1994, and this large corporation is a leading science and technology service company[348] in China. It is the largest Tsinghua-University-affiliated company

[347] Many donations come from corporations affiliated with Tsinghua University and alumni who achieved success in business.
[348] "科学技術サービス企業 (Japanese translation of "科技服务公司," which is translated into "science and technology

with more than 200 billion yuan in assets (February 2018), operating a group of science parks, which is the largest in the world, and running more than 300 incubation centers across China. Forty-five percent owned by TSINGHUA HOLDINGS, TUSHOLDINGS has 12 listed companies and more than 800 private companies under its wing. Initially established as a technology transfer institution to take research outputs of Tsinghua University to industry, TUSHOLDINGS now also plays a central role in startup support.

When production activities were subject to instructions under the planned economy, division was clear between universities, national research institutions, and companies; they were undertaking personnel development, technology development, and production respectively. Therefore, companies in general did not have sufficient R&D capabilities. When research outputs were transferred to industry, technology seeds would face a high risk of failing at a company unless they were transferred along with researchers.

Today, when semiconductor processing facilities developed at Tsinghua University or advanced technologies such as OLED are spun off to a related local industry cluster, relevant researchers need to be transferred together, and for that purpose, it is necessary to consider how to guarantee a comfortable living for their families as well. That is why TUSHOLDINGS does not only improve environments of science parks across the country but also takes care of establishment of housing facilities, commercial facilities, amusement facilities, nursery schools, kindergartens, elementary and junior high schools, and hospitals. It also aims to provide high-level high-tech industry clusters by emphasizing projects related to environmental conservation, smart cities, clean energy, medical and health care, education, culture and entertainment as well as connecting research outputs to markets and providing startup support.

TUSHOLDINGS also has its own angel funds, VC funds, and PE funds, and invests in teams and corporations inside and outside of Tsinghua University through them. TUSHOLDINGS currently manages 10-billion-yuan investment funds, and reportedly plans to establish a 30-billion-yuan PE fund for M&A in the future.

8.2.2.2 TSINGHUA UNIGROUP

TSINGHUA UNIGROUP is a state-run company with total assets of 37.1 billion yuan. TSINGHUA HOLDINGS owns 51% of its shares while a private company, Jiankun Group, owns 49%.[349] TSINGHUA UNIGROUP is arguably the world's most spotlighted semiconductor company and currently has six subsidiaries: SPREADTRUM, UNIGROUP GUOXIN and Yangtze Memory Technologies Co. (YMTC), which manufacture semiconductor chips, and UNIS, H3C, and UNIS WDC, which provide cloud computing and cloud storage services.

SPREADTRUM, one of the subsidiaries, which boasts the world's third largest share in the mobile chip market, is a company resulted from integration of two NASDAQ-listed companies: Spreadtrum Communications and RDA Microelectronics. It supplies mobile chips to 1,300 companies including Samsung, HTC, Huawei, and Lenovo, and shipped 700 million pieces in 2015.

Another subsidiary, UNIGROUP GUOXIN, develops and manufactures IC cards and FPGA[350] among other things and supplies one billion pieces to industry a year. YMTC is a memory card manufacturer established in Wuhan by TSINGHUA UNIGROUP, the National Integrated Circuit

service company")" is not a familiar term in Japanese. In China, "科技服务公司" is a commercial company which carries out support on behalf of the government by promoting commercialization of research outputs and providing startup support to enhance industry-academia-government cooperation.

349 http://www.thunis.com/drupal/sites/default/files/2017-016.pdf

350 FPGA is an integrated circuit designed to be configured by a customer or a designer after manufacturing, a type of PLD (programmable logistic device) in a broad sense.

Industry Investment Fund, and the Hubei Science and Technology Investment Fund under the national strategic emerging industry policy. It has invested a total of 24 billion US dollars[351] (hereinafter referred to as dollars), aiming for annual shipment of 3.6 million pieces and sales of 10 billion dollars in 2020.

UNIS is a company mainly providing hardware including information systems and storage servers while H3C, which is a limited partnership with HP and was established by acquiring 51% of shares from HP of the US, provides solutions such as cloud computing and cloud storage services to industry. UNIS WDC is a joint company established through a joint investment of 300 million dollars by TSINGHUA UNIGROUP and Western Digital of the US, providing cutting-edge cloud storage systems.

TSINGHUA UNIGROUP is focused on semiconductor chips and cloud storage technologies, strengthens technical capabilities through its own development activities, joint investment, and acquisition, and makes flexible cooperation and coordination with local governments, private corporations, and foreign companies. It aims to raise sales to more than 100 billion yuan and to win the largest share of the world's mobile chip market in five years.

8.2.2.3. TSINGHUA TONGFANG

TSINGHUA TONGFANG is a PC manufacturer established in 1997 through direct investment by Tsinghua University, and it is a subsidiary of TSINGHUA HOLDINGS. Its total assets stand at 56.3 billion yuan and sales at 27.1 billion yuan as of 2016. TSINGHUA HOLDINGS and TSINGHUA UNIGROUP hold 25% and 2.3% of the company's shares respectively.

As one of the giant groups affiliated with Tsinghua University, TSINGHUA TONGFANG has eight public subsidiaries and six private subsidiaries. In the beginning, the company engaged in assembly of PCs and manufacture of LCD televisions and LCD displays. Today, it is the second largest PC manufacturer in China after Lenovo. In addition to PC-affiliated services, the company is striving to diversify its business by utilizing its ICT system technology and entering into various fields such as smart cities, lighting projects, environmental conservation, energy conservation, health and medical care, and finance and insurance.

8.2.2.4. TSINGHUA ASSET MANAGEMENT

Led by Xu Jinghong, who took the helm of TSINGHUA HOLDINGS in 2012, the company came up with investments as its new business line to be added to the conventional lines of high-tech companies and science park operations, and founded TSINGHUA ASSET MANAGEMENT accordingly. The company aimed for rapid business growth through investments. TSINGHUA ASSET MANAGEMENT set up over 30 funds including VC funds, industry investment funds[352], PE funds, mezzanine funds, M&A funds, and funds of funds (FoF), raising total 70 billion yuan.

8.2.3. Three types of startup support at Tsinghua University and case examples

Over the past 30 years, Tsinghua University has developed systems to connect research outputs to markets. Part of such bridging functions is related to startup support and divided into the following three types:

- Support for R&D startups
- Support for on-campus, social-issue-type startups

[351] According to the foreign exchange rate of the Bank of Japan as of February 20, 2018, 1 US dollar is equivalent to 111 yen.

[352] Industry investment funds are considered as a type of VC funds in Europe and the US. In China, they refer to VC funds, especially those which invest in corporations, thereby aiming to change their structure.

■ Startup support for ideas and technologies from the outside

The following looks at how support works and successful cases for each type.

8.2.3.1. Support for R&D startups

Tsinghua University often provides this type of startup support for high technologies which could contribute to stimulation of demand for important products/services in the country and promotion of local economies. This type of support can be classified as the so-called “high-tech push type,” which typically requires long-term R&D activities for technologies, a lot of team members, and a huge amount of investment. Tsinghua University, TSINGHUA HOLDINGS, local state-run corporations, and local governments jointly provide resources; Tsinghua University provides research teams, TSINGHUA HOLDINGS (or subsidiary group corporations) and local state-run corporations investment capital, and local governments factory sites and funds. In some cases, subsidiary group corporations of TSINGHUA HOLDINGS directly work with Tsinghua University or local governments, but TUSHOLDINGS usually comes in to play important roles as a coordinator between universities, local governments, and local state-run corporations by providing places for R&D activities or appropriate living conditions for researchers in cases where technology at the university is not sufficiently mature, local governments are unwilling to invest much, or living conditions are too poor to attract human resources. When TUSHOLDINGS is involved, startup support is provided in the following order:

1) Understand the needs of local governments, local state-run corporations and private corporations through science parks and offices spread across the country and find a good match with existing technologies of Tsinghua University
2) If a good match was found, then a development team formed at the university will develop a prototype, funded by Tsinghua University, TSINGHUA HOLDINGS, or local state-run corporations.[353]
3) When a prototype has been developed, a company together with the research team members will be spun off and move into an incubation center of TUSHOLDINGS in the provinces. At this point, the company will be registered as a corporation. In the incubation center, the company will engage in development of mass production technology.
4) When the prospects of mass production technology development become clear, factory construction will start, funded jointly by TSINGHUA HOLDINGS, local governments, and local state-run corporations. The capital contribution ratio will decide which of TSINGHUA HOLDINGS, local governments or local state-run corporations will become the parent entity of the new company.
5) When the factory becomes ready to operate, the members in the incubation center will move to the factory and recruit more employees to expand the company.

Case: Visionox

Visionox is a high-tech company established as a result of the “next-generation display technology OLED research project” conducted in 1996 by Qiu Yong (the current President of Tsinghua University), who is a member of the Chinese Academy of Sciences. With this research project outputs, Visionox Technology Co., Ltd. was spun off and established in Beijing in 2001 by the researchers concerned and the company successfully developed a prototype of OLED in

[353] It will be discussed who will have the management rights of a new company to be established, and the entity which will have the management rights will usually bear the cost of prototyping. For example, if Tsinghua University creates a high-tech company according to the needs of the national government, then Tsinghua University or TSINGHUA HOLDINGS pays for prototyping. If the project aims to promote local industry based on the request from a local government, then mainly local state-run corporations cover the prototyping cost.

2002. However, no appropriate large sites were available around Beijing for factory construction, so the company had to build a factory in a provincial city. For this reason, the main members of the research team moved into the incubation center of TUSHOLDINGS in Kunshan, Jiangsu Province, and started development of mass production technology for OLED displays in 2003. When the prospects of mass production technology became clear around 2006, the company received joint investments from a state-run company in Kunshan, Tsinghua Holdings Technology Transfer Co., Ltd. (TLO) under TSINGHUA HOLDINGS, and two other companies and established Kunshan Visionox Display Technology Co., Ltd., of which the state-run company in Kunshan and Tsinghua Holdings Technology Transfer Co., Ltd. held 52% and 3% respectively.

With additional support from Tsinghua University such as the supply of personnel and technologies, Kunshan Visionox Display Technology became the largest manufacturer of PMOLED in 2012 in terms of shipment volume, and currently holds 30% of the global market share. In September 2017, the company started mass production of flexible AMOLED and constructed production lines for the 6th generation AMOLED panels.[354] Today, Visionox is China's leading OLED corporation.

Through the support process described in 2), 3), 4), and 5) above, Tsinghua University in cooperation with Tianjin city government established HWATSING, which is mass producing Chemical Mechanical Polishing (CMP) machines which provide the world's top-level performance over the 12-inch wafer process based on CMP technology for semiconductors developed by Jianbin Luo, a member of the Chinese Academy of Sciences, who is a mechanical expert at Tsinghua University.

8.2.3.2. Support for on-campus, social-issue-type startups

Tsinghua University is providing support for on-campus startups/teams aiming to provide solutions to social needs. Typically these startups provide products and services that reflect social needs at first, and then go on to place more importance on technology development to be more competitive. At this point, startups often secure technologies and personnel from members' alma mater, Tsinghua University. The following looks at how this type of support is provided.

1) Undergraduate or graduate students form a research team.
2) The team moves into X-Lab[355] jointly created by TUSHOLDINGS and Tsinghua University School of Economics and Management. While staying at X-Lab, the team analyzes markets and examines details of products to be developed and business plans while consulting university professors, entrepreneurs, and investors.
3) The research team, if promising, may be able to receive funds from X-Lab supplied by angel funds, or may be referred to external angel funds through X-Lab.
4) After receiving funds and starting a company, the team moves into the incubation center of TUSHOLDINGS and continues R&D activities.
5) At the incubation center, the team receives training and support concerning the company's financial management, IP management, and applications for public grants.
6) At the incubation center, the team may be put in touch with VC funds of TSINGHUA ASSET MANAGEMENT or external VC funds.

[354] http://www.qichacha.com/firm_8e641955effe5190922a94cb113f8ab4.html

[355] X-Lab is Tsinghua University's startup education platform established in 2013, offering startup education programs for existing students and alumni free of charge. At X-Lab, participants can connect with 100 mentors and ask for advice on a wide range of subjects including business model development, organizational management, loan, and related laws. Participants also have opportunities to mingle with entrepreneurs by visiting the world's top companies, such as Facebook, IBM, Alibaba, and RISURAERU, free of charge. Through these activities, students can learn more about starting a business and build the required mindset.

7) Startups which have grown further by receiving funds from VC funds move out of the incubation center. Depending on their sector, their new home will vary from places which have a well-developed production environment to regional science parks which invite related industries.
8) At the stage of factory construction, or regional/national expansion, startups receive strategic investment capital and PE capital. At this point, if products or services to be developed are matched to TSINGHUA HOLDINGS' strategy and policy, TSINGHUA HOLDINGS or its subsidiary group company makes a huge investment and becomes the largest shareholder. If not, the startup becomes independent from TSINGHUA HOLDINGS.

Support for on-campus, social-issue-type startups was provided through steps of 1), 4), 5), 6), 7), and 8) above until 2010, so it was quite hard for university student research teams to jump into step 4) and move into the incubation center of TUSHOLDINGS without prior steps. That is why the growth stages of 2) and 3) were added to facilitate business creation by university students.

Case: ChineseAll.com

Tong Zhilei launched a startup providing online books in 2000 when he was a Tsinghua University student, and moved into the incubation center of TUSHOLDINGS. At the center, he received support including preferential tenant fees, tax reduction or exemption, financial management, and referral to investment funds. The company's current main investors are those who Tsinghua University Science Park put him in touch with back then. ChineseAll.com grew by leaps and bounds by receiving funds under the "Diamond Plan[356]" started by Tsinghua University Science Park in 2007. Listed on the ChiNext board of the Shenzhen Stock Exchange in 2015, ChineseAll.com has become China's largest online book provider/publisher with 670 million online readers, more than 2 million online authors, and more than 2,000 famous authors.

As ChineseAll.com was established in 2000, this case did not go through step 2) or 3). It is true that there are few success stories among startups which were launched in or after 2010 and took advantage of 2) or 3) because not so many years have passed since support through these steps began. However, it is highly expected that many unicorns and IPO companies will be established in the future.

8.2.3.3. Startup support for ideas and technologies from the outside

As part of a social contribution, Tsinghua University helps grow excellent technologies and small and medium-sized enterprises outside of the university by inviting them to its science park. This type of support process invites fine outside startups to the incubation center of TUSHOLDINGS, where they can improve their business plans by receiving advice from entrepreneurs and investors. Then, they receive support in the order of 3), 4), 5), 6), 7), and 8) provided in 8.2.3.2.

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[356] The "Diamond Plan" is a five-year support program of a total of 7.5 billion yuan, which funds the top 10 startups selected from 400 every year at Tsinghua University Science Park. Tsinghua University Science Park contributes 200 million yuan and partners including China CITIC Bank, Bank of Communications, China Minsheng Bank, Shanghai Pudong Development Bank, and Bank of Beijing provide the rest. Among the top 10 startups selected under the "Diamond Plan" in 2015, for instance, nine of them have survived, seven launched IPO, and two were acquired by Alibaba and Taiji Computer Corp., Ltd.

8. China [Case studies]

Case: Sense Time

Xu Li, who completed undergraduate and graduate programs of Shanghai Jiao Tong University, began his PhD studies at the Chinese University of Hong Kong, established Sense Time based on technology from the university's laboratory in 2014, and was invited to Tsinghua University Science Park. He moved into the science park mainly because he would be able to secure excellent AI specialists produced by the Tsinghua National Research Center for Information Science and Technology (national laboratory pending approval) and State Key Laboratory of Intelligent Technology and System. While absorbing young, high-caliber talent, Sense Time is focused on R&D activities for high-level computer vision.

In 2014, a team from Sense Time participated in ILSVRC (The ImageNet Large Scale Visual Recognition Challenge), the world's top-class competition in large-scale image processing, and won second place by achieving the recognition accuracy rate of 40.7% in image recognition, only after the 43.9% by Google. Sense Time ranked first in the world in the category of "Object detection from video" in the same competition in 2015 and the three categories of "Object detection," "Object detection/tracking" and "Scene analysis" in 2016.

In 2015, Sense Time was selected by the "Diamond Plan", receiving huge investments from Tsinghua University Science Park and banks. Thanks to the priming effect from the "Diamond Plan," Sense Time successfully raised 10 million dollars from StarVC in the Series A round in April 2016, 410 million dollars from 16 VC funds including CDH and SAILING CAPITAL in the Series B round in July, and 1.5 billion yuan from Alibaba in the Series C round in November. Today, Sense Time is providing business customers with services such as facial detection/recognition and vehicle/pedestrian detection and is attracting attention from the world as a fast-growing unicorn in the field of AI.

Sense Time already began joint development in computer vision with Honda in December 2017. Sense Time also received strategic investment from Qualcomm in November 2017, and they are reported to begin cooperation soon.

Based on the above, Figure 3 summarizes the three types of startup support at Tsinghua University.

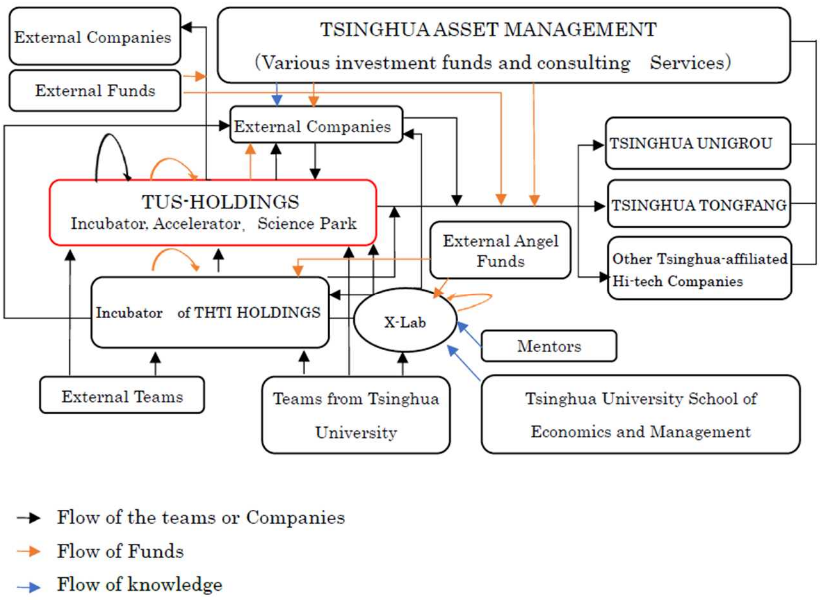


Fig. 3: The Startup Support System by Tsinghua University and Its Affiliated Companies
Source: Created by CRDS based on various materials and the results of interviews

8.2.4. Summary

Since 2015, a wide range of support has been provided for ideas and technologies inside and outside of Tsinghua University according to the “mass entrepreneurship and innovation” policy. The system for connecting research outputs to markets and the system for startup support seem to have merged well and formed a unique support system.

The greatest feature of this system is TUSHOLDINGS strengthening its ties with local governments and industry and thereby having developed its own startup ecosystem while incorporating all factors of startups related to universities and industry into its organization, acting as a hub, and taking advantage of incentives of the government. By placing different factors such as group companies, development of technology and personnel, and various funds (angel funds, VC funds, strategic investment funds, etc.) in the same organization, information related to these factors flows freely and smoothly, which has realized an advantage of faster response without incurring transaction costs. Through this startup ecosystem, university researchers and students can have opportunities to communicate with industry and exit-minded R&D talent can be developed. Talent developed this way is expected to immediately contribute to companies. TUSHOLDINGS is able to claim a certain percentage of shares (usually 10% or less) of startups in return for its various services. TUSHOLDINGS can sell these shares and gain income, and that is how TUSHOLDINGS does not have to seek support from the government in providing sustainable support for startups.

8.3. Startups in Shenzhen

Startups naturally sprang up across China from around 2011 and many strong ones are found in cities such as Beijing, Shanghai, Hangzhou, and Shenzhen, influenced by hugely successful companies such as BAT[357] and Huawei. This section looks at basic conditions of Shenzhen and why the city attracted attention and summarizes the characteristics of startups in the city.

8.3.1. Basic conditions of Shenzhen

Shenzhen is a regional city which was designated as the country’s first special economic zone under Chinese economic reform policy started in 1978, and introduced a market economy ahead of any other part of China. Once a fishing village of several hundred thousand, Shenzhen grew to be a big city with a population of 11.37 million (as of the end of 2015) and a size of 1,996 square kilometers (compared to Tokyo, which has an area of 2,188 square kilometers) in 38 years. With the male-to-female ratio 53.6 to 46.4 and average age 31.2, Shenzhen has one of the youngest populations in China.

Shenzhen is one of the Tier-1 cities in China, along with Beijing, Shanghai, and Guangzhou. As seen in Figure 4, while China’s GDP growth slowed down starting from 2012, Shenzhen maintained 8.8% or higher and is doing far better than Beijing, Shanghai, and the national average, although it has seen a slight decline. The GDP of Shenzhen, which stood at 1,949.2 billion yuan in 2016, is likely to exceed that of Hong Kong and Guangzhou in 2017 by assuming the 2017 growth rate to be 8%.[358]

[357] BAT is an acronym for Baidu, Alibaba, and Tencent.
[358] http://www.mofcom.gov.cn/article/i/jyjl/j/201709/20170902641051.shtml

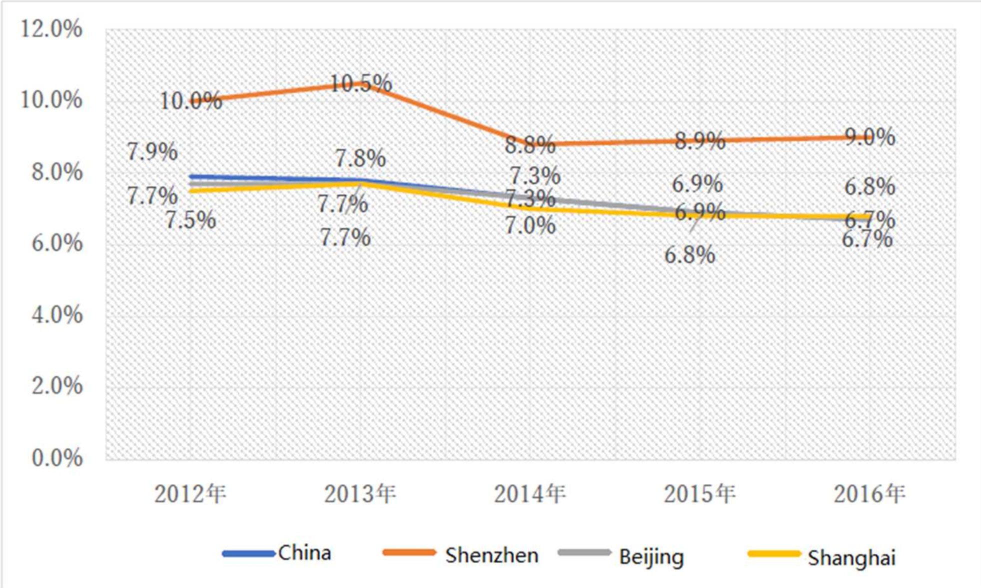


Fig. 4: GDP Growth Rate of the National Average, Shenzhen, Beijing and Shanghai
Source: Created by CRDS based on data from National Bureau of Statistics of China

The creation of industry in Shenzhen started from scratch. With an extremely open attitude, the city government tried to attract foreign companies and in fact Foxconn, a famous OEM for Apple, constructed its first-ever factory outside of Taiwan in Shenzhen in 1988. Backed by generous support from the local government, including provision of sites, buildings, and funds, Chinese domestic companies were also established and Huawei, ZTE, Tencent, and BGI among others became Shenzhen's leading companies. In a bid to create an R&D hub, the city government started inviting China's top universities such as Tsinghua University, Peking University, and Zhejiang University from around the year 2000 and had them open Shenzhen campuses. In cooperation with the Chinese Academy of Sciences and the Chinese University of Hong Kong, the city established Shenzhen Institutes of Advanced Technology in 2006, thereby strengthening R&D capabilities together with Shenzhen campuses of the universities and connecting research outputs to the local industry.

After these processes, Shenzhen today has created the high-tech industry mainly in the fields of communications equipment, computers and electronic devices, machinery manufacturing, new energy, new materials, and bio.

8.3.2. Characteristics of startups in Shenzhen

Characteristic 1: Shenzhen Speed

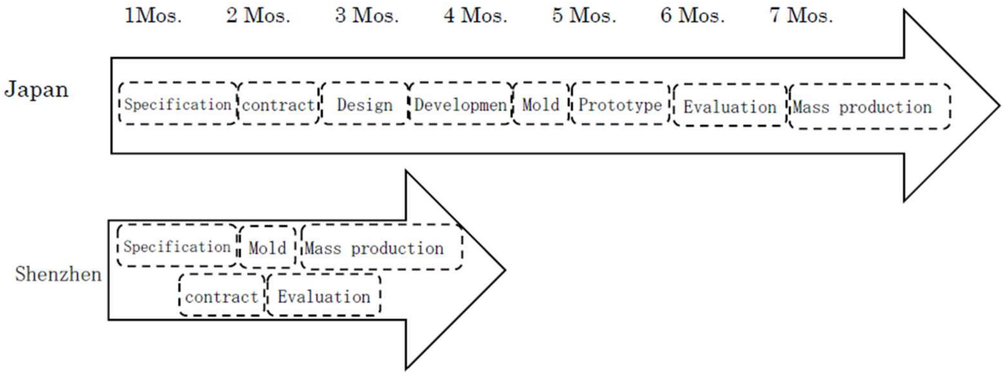
The R&D process in Shenzhen is extremely fast. It is so much so that some comment, "a month in Silicon Valley is equivalent to a week in Shenzhen.[359]"[360] To understand the so-called "Shenzhen Speed," one needs to see the product/service planning process in Shenzhen and the advantages the city offers.

Shenzhen has a host of subcontract factories undertaking projects from electronics manufacturers around the world, and they create a full supply chain for electronic parts. In other

[359] http://www.recruit.jp/meet_recruit/2016/07/gl15.html

[360] Reported by TeamLab, a venture firm from the University of Tokyo. Claiming to be a group of "Ultra-Technologists," TeamLab is made up of experts concerning expression of information including programmers (application programmers, user-interface engineers, DB engineers, and network engineers), robotics engineers, mathematicians, architects, web designers, graphic designers, CG animators, and editors.

words, you can procure all electronic parts you want without stepping out of Shenzhen. Figure 5 compares the time and money required for electronic part manufacturing between Japan and Shenzhen's ecosystem.



Item	Japan Domestic	Shenzhen
Mold Cost	5,000,000 Yen	0 Yen
Software Development	4,000,000 Yen	0 Yen
Board Development	3,000,000 Yen	0 Yen
Certification Cost	1,000,000 Yen	500,000 Yen
Total Cost	13,000,000 Yen	500, 000 Yen
MOQ	10,000	1,000
Per unit price	10,000 Yen	5,000 Yen

Fig. 5: Comparation of Time and Money Required for Electronic Part Manufacturing between Japan and Shenzhen's Ecosystem
Source: Created by CRDS based on materials provided by JENESIS[362]

Convenience in electronic part procurement is not the only advantage Shenzhen offers; the city offers a huge pool of talent for development of hardware and communication technology. While working for companies, many people also form startup teams and engage in startup activities outside of their working hours. They rent economical offices at co-working spaces or makers spaces and develop molds, software, and electronic integrated circuits at an extremely low cost. Then, they pay for certification, raise funds through social media and crowdfunding sites, and place a production order of 1,000 pieces (minimum order quantity). If the product is well received, then they place additional orders while improving the product, hoping to make it a hit. Even if commercialization fails, they are said to have a setback of only one million yen or so.

Until around 2015, large banks in Shenzhen were unwilling to provide loans for mass production, so the commercialization process was not notably fast. However, after the "mass entrepreneurship and innovation" policy encouraged development of crowdfunding platforms and intellectual property assessment/security program was introduced, small firms were able to take out loans far more conveniently and quickly. This helped realize the "speed," a characteristic of Shenzhen.

Startups in Shenzhen have drastically reduced the time required from development to product

[361] "From-scratch development" refers to a method of developing systems from nothing without relying on packaged products.
[362] A company based in Shenzhen providing EMS services for Japanese customers, including Nihon Kotsu Co., Ltd., for which the company manufactures drive recorders on contract. JENESIS was founded by a Japanese national.

launch, and thereby promptly incorporated users' ideas for product improvement into the following version of the product. This way, a cycle of upgrading which involves mass production and sale begins, which eventually leads to a high-quality product. In Shenzhen, developers value the process of improving products and services by receiving direct feedback from consumers through apps and detecting problems of products and services by applying big data analysis to consumption behavior. They attach importance to quickly responding to issues that have surfaced and launching upgraded products and services one after another. This method, called Interactive Process Innovation, is used by many companies, most notably Tencent.

Photo 1: Slogan Expressing the Initial Philosophy of Shenzhen Special Economic Zone
© Zhou

While hardware startups enjoy the convenient environment of Shenzhen, they have to survive fierce competition. To secure competitive advantage, they need to develop proprietary technology or improve products and services and thereby differentiate themselves. People on the frontline voice concerns that if their product or service is not upgraded for 6 months, somebody else will copy it and their company could lose its competitive advantage and market share.

Characteristic 2: Connection to the world

Geographically adjacent to Hong Kong, Shenzhen has long developed a business network with the world through Hong Kong. At the same time, Guangdong province, which Shenzhen is under the jurisdiction of, is one of home provinces of overseas Chinese nationals, so networks have naturally been built with Chinese communities in Southeast Asia, Europe and the US. In addition, more recently, many young Chinese people who studied abroad are choosing to live in Shenzhen when they return to China, and they bring with them networks they built with universities and research institutions around the world. According to the Overseas Chinese Affairs Office of the State Council, as of October 2016, 20,000 foreigners live in Shenzhen, 1 million foreigners stay for a short period, and 7.8 million visit the city a year.[363]

In Shenzhen, there are many corporations with international markets in mind. As Figure 6 shows, Shenzhen is by far the largest city, beating other cities such as Beijing and Shanghai, in terms of the number of PCT patent applications in China. This is largely due to ZTE and Huawei, the world's number one and number two companies in terms of the number of PCT patent applications, as shown in Figure 7.

[363] http://www.gqb.gov.cn/news/2016/1012/40826.shtml

Rank	City	Number of patent applications
1	Shenzhen	19,647
2	Beijing	6,651
3	Guangzhou	1,642
4	Shanghai	1,560
5	Suzhou	1,088
6	Qingdao	906
7	Dongguan	876
8	Wuhan	712
9	Nantong	552
10	Hangzhou	538

Fig. 6: Ranking of PCT Patent Application by China City (2016)
Source: Created by CRDS based on data provided by the intellectual property office of each city

Rank	Campany	Number of patent applications
1	ZTE（Shenzhen）	4,123
2	Huawei（Shenzhen）	3,692
3	Qualcomm	2,466
4	Mitsubishi Electric	2,053
5	LG	1,888

Fig. 7: Top 5 Companies by PCT Patent Application (2016)
Source: Created by CRDS based on a report from WIPO[364]

Another characteristic which contributes to the internationalization of Shenzhen is involvement of experienced people who studied abroad[365]. The city government of Shenzhen was aware that it would need to introduce the world's finest talent and technologies in order to create businesses which could compete with the world's top companies, so it launched the "Peacock Plan," an overseas talent program, in 2010. Application requirements for the "Peacock Plan" are as severe as those for the "Thousand Talents Plan[366]," and only people with outstanding achievements are selected. If selected under the "Peacock Plan", each individual receives 800,000 to 1.5 million yuan and every team receives up to 80 million yuan. The program is reported to have so far invited more than 2,000 talented people from overseas and over 50 research teams directly to Shenzhen and indirectly called back over 10,000 Chinese students overseas to the city. Teams of founders of Royole, a flexible display manufacturing unicorn, and ORBBEC[367], which provides facial

364 http://www.wipo.int/export/sites/www/ipstats/en/docs/infographic_pct_2016.pdf
365 They mainly refer to Chinese nationals who studied at one of the world's top 100 universities and returned to China.
366 The "Thousand Talents Plan" is a national-level program to recruit high-level foreign talent and well known for providing generous allowances and a large amount of R&D startup funds.
367 High-tech company which develops AI chips and competes with Intel in 3D camera technologies.

recognition technology to Alibaba, returned to Shenzhen under the "Peacock Plan" and grew their businesses into state-of-the-art high-tech companies.

The city government of Shenzhen also installed Shenzhen Overseas Chinese High-Tech Venture Park (incubation center) in Nanshan District around the year 2000 to support entrepreneurial efforts by those who returned from overseas study, and invited 919 of them. The park accelerated 693 startups of such former students, of which five launched an IPO and another is preparing for its IPO.

One of the challenges for Shenzhen is that universities and corporations in the city in general only conduct development. As there have been few products which rely on originality and were created from basic research, Shenzhen is not easily comparable to cities such as Boston where high-tech startups prosper. In addition, startups in Shenzhen often use concepts and business models derived from the US, so their originality is still weak.

One exception is Tencent which took the world by storm by creating Wechat with the idea of being the "app of apps[368]" based on its own cutting-edge mobile payment technology. If unique ways of thinking such as this example spread, even if slowly, there is a high possibility that new technologies will be created and support the originality of Shenzhen in the future.

[368] Comprehensive app that acts as if it were an OS for other apps.

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9. Taiwan [Column]

The Taiwanese government started promoting the semiconductor industry under its industrial technology policy in the 1980s. Since then, semiconductor-related startups have continued to emerge for 30 years and have built a semiconductor-industry cluster which holds the largest market share in the world. Taiwan Semiconductor Manufacturing Co., Ltd. (TSMC), which ranked 369th on the Fortune Global 500 list of 2017, was spun off of the Industrial Technology Research Institute (ITRI) in 1987, and has grown to be the world's third largest semiconductor company and the world's largest provider of silicon wafers. In 2016, TSMC invested 2.2 billion US dollars[369] in its R&D activities, which is equivalent to 55.6% of 115.4 billion Taiwan dollars[370] which the Taiwanese government invested in R&D activities. As clearly suggested by this data, TSMC hugely contributes to Taiwan's economic development and R&D activities for industrial technology. In the meantime, Taiwan has been struggling with its low economic growth rate since the 1997 Asian financial crisis. Amid increasingly fierce international competition, Taiwan faces a pressing challenge of how it should redevelop its industrial competitiveness through creation of new industries in anticipation of the post-semiconductor era. Against such a backdrop, in response to the directions of the 9th National Science and Technology Conference held in 2012, Taiwan's Ministry of Science and Technology has implemented the "From IP to IPO Program (FITI)" designed to contribute to connecting university research outputs to markets since 2013, thereby providing startup support aiming to create new industries.

FITI is a program which holds four-month startup training courses and camps for teams of students and researchers of universities and public research institutions in Taiwan and provides financial incentives to those selected. The program's objective is to develop budding entrepreneurs who create new industries. FITI is run by the Science & Technology Policy Research and Information Center (STPI) under the National Applied Research Laboratories (NARLabs). Teams of two to six members who are undergraduate or graduate students or researchers can apply. After examining applications, STPI selects 30 to 40 teams a year. The selected teams first receive incentives of 30,000 Taiwan dollars each and participate in four training sessions and two three-days-and-two-nights camps and then go through three rounds of selections. Teams which passed the first round receive 100,000 Taiwan dollars as an incentive, those which passed the second round are provided with an additional 250,000 Taiwan dollar incentive and the title "Startup Potential Award," and those which passed the final round win the title "Outstanding Startup Award" and the one million Taiwan dollar incentive as well as a donation of another one million Taiwan dollars from private corporations as funds for starting a company.

Under FITI, Taiwanese Silicon Valley entrepreneurs, investment funds, and researchers specialized in the relevant fields act as mentors for participating teams, providing knowledge on financial and legal affairs related to business management and development of marketing, branding, and technical capabilities while giving advice on starting businesses. Teams can also move into Hsinchu Science Park or other high-tech industrial clusters as part of support for prototyping, where they can use space and experimental equipment and receive technical support. They have opportunities to showcase and share their technology at exhibitions such as Taiwan B.I.G Demo and they can also find a good match with angel funds by participating in FITI. Figure 1 summarizes the above.

[369] According to the foreign exchange rate of the Bank of Japan as of February 20, 2018, 1 US dollar is equivalent to 111 yen.
[370] According to the foreign exchange rate of the Bank of Japan as of February 20, 2018, 1 Taiwan dollar is equivalent to 3.774 yen.

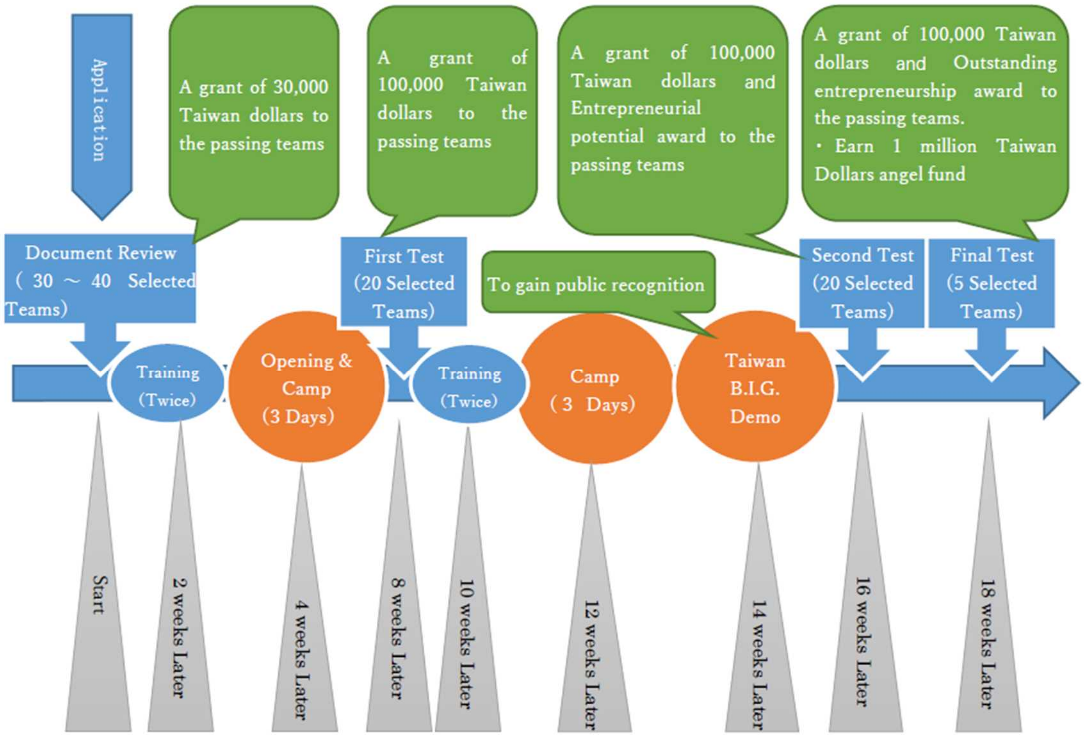

Fig. 1: Startup Support Program: *From IP to IPO* (FITI)

Source: Created by CRDS based on information from the website of Innovation & Startups

After starting companies through FITI, teams which received the “Startup Potential Award” and “Outstanding Startup Award” are required to pay back 5% of their net assets (up to double the total of incentives and startup fund received) of any profitable year between the third and the seventh year after company launch.

FITI provided support to 400 teams by the end of 2017. Among them, 121 teams established companies and received investments of a total of 1.18 billion Taiwan dollars from the private sector. Let’s take a look at a team of National Tsing Hua University as a successful example. This team received support from FITI and established Taiwan Electron Microscope Instrument Corporation (TEMIC), a manufacturer of desktop electron microscopes. The company collaborated with the Industrial Technology Research Institute (ITRI) and developed Neroscope fluid fluorescence electron microscopes in 2015 and is currently exporting them to mainland China.

The Taiwanese government takes the initiative in promoting startups in Taiwan and implements various support measures. FITI is one example. Backed by the governmental support measures, universities and public research institutions are committed to development of entrepreneurs and provision of startup support. Young generations also carry on the entrepreneurial spirit of their parents’ generations and try to create new developments in the conventional startup landscape, which means people in Taiwan are also helping to create an entrepreneur-friendly environment. Tsai Ing-wen’s administration, launched in May 2016, has announced the “Asian Silicon Valley Development Initiative” as the centerpiece policy for creation of new industries and set up a target of creating 100 startups and 3 global large corporations in the field of IoT by 2025. Taiwan is clearly trying to provide something beyond ordinary startup support and puts a lot of hope in the creation of new businesses which will outstrip TSMC.

10. Closing remarks

Through this survey, we looked at the current situations facing startups in major countries, governmental support measures, and characteristics of each country and have learned that there are high expectations for startups as a driver for promoting innovation in all countries and that thriving startups in the US, Israel, and part of China are in fact contributing to the creation of innovations. There is no such thing as a one-size-fits-all model that guarantees startup success. The reality is that each country uses the measures taken in the US, which developed an entrepreneur-friendly environment ahead of other countries and created startups that would later turn into global corporations such as Microsoft and Apple, as best practices and adapts those measures according to its own culture and society. Japan is no exception, and the country has taken a number of measures for startup creation since the late 1990s. Nonetheless, such efforts are not always rewarded because no measure can be free of risk. That is why we believe it is important to have a sustainable ecosystem in which failure could lead to success.

Suggestions gained for Japan's startup support

As discussed in chapter 1, the Japanese government has conducted various startup support programs to facilitate commercialization and social implementation of new knowledge and technology created at various facilities including universities and research institutions. Despite such an effort, the number of new startups has been on the decline since around 2006. Here, we will review some of the efforts of other countries which could provide hints on issues we extracted when we tried to see the general picture of Japan's startup landscape.

1) Issue of human resources

Growing people's interest in starting a business and increasing managerial talent required for a business launch is not an issue unique to Japan. Other major countries are taking various measures for this exact issue because it is recognized as the most important issue. It is the I-Corps program of the US that is especially well known as a managerial talent development program. (See 2.2.3.3.) This program was introduced by NSF based on the recognition that startups failed not because they lacked required technical capabilities but because researchers or engineers did not have knowhow for commercializing technology in most cases. Universities across the US have also introduced the Entrepreneur in Residence (EIR) program (see 2.3.2.6, 2.4.3), in which managerial candidates are employed by corporations, VC funds, universities and other accepting institutions and engage in startup activities. This program enables appropriate startup support according to the needs of accepting institutions by helping to find a good match between researchers and managers and having people with abundant entrepreneurial experiences in the organization on a continual basis. As can be seen from the fact that even the US, a startup advanced country, continues to implement various programs, there is no doubt that human resources development is a huge challenge in the commercialization of research seeds.

One of the measures to increase researchers' interest in starting businesses is the Business Start-up Grant under Germany's EXIST program. (See 6.3.1.) As there are no tuition fees in public universities in Germany, this grant is designed for mainly living expenses. However, it enables students to take courses for management or the like apart from their regular curriculum during a fixed period of time and to explore the feasibility of starting their own businesses. With this grant, researchers do not have to burn their bridges and become entrepreneurs right away, but they can take some time and determine their career path, and this is why the program is still well received today, 20 years after the introduction. Another noteworthy measure, which takes care of not only living expenses but also researchers' careers, is taken in national research institutions in France including CNRS where researchers can start companies while maintaining their status as staff members of a research institution (public servant), and can later return to their research institution or continue to remain with their companies as technology advisors depending on the progress of their business. As France is generally not particularly strong in industry-academia cooperation either, allowing researchers to engage in startup activities while maintaining their status is one of the various measures the country has tried so far to strengthen industry-academia cooperation. As seen in these cases, each country puts some thought into motivating young talent to create businesses. In the meantime, in Israel, which is called a "Startup Nation," the government encouraged the public to start businesses under a national strategy. As a result, the status of entrepreneurs went up year after year and today it is reported that parents want their children to become entrepreneurs more than doctors or lawyers.

2) Lack of financial support for startups

In terms of "discerning experts," the SBIR program of the US is well known. As Yamaguchi points out, the government helps create innovations by funding "obscure scientists who are unknown quantities" under the SBIR program.[371] In addition, the US has plenty of sources of funds apart from SBIR and individual and institutional investors are funding startups at all stages from the pre-seed stage to the business-expansion stage. (See Figure 6, 2.4.2) It would be too much to ask for an environment comparable to that of the US, but efforts of IP Group of the UK are worth noting as support for the pre-seed stage, for example. (See 4.3.6.) IP Group began a new form of investments in which in return for the prior investment in a university, IP Group would gain the right to acquire up to half of shares of spinouts to be created from outputs of the investee university for a certain period, and this investment style is encouraging investments from other private investors as well. Obviously, these attempts alone would not produce substantial results unless they concurred with tax reform and human resources development programs discussed above. It is Israel that solved the issue of insufficient funds in the country by promoting direct investments from overseas. (See Chapter 3.) If Japan's technology is worth it, overseas VC funds will be more interested and their investments may produce priming effects as well.

3) Startup support systems not established in universities or research institutions

For autonomous operation, startup support organizations need a steady income such as patent licensing fees. In Japan, only a handful of universities, such as the University of Tokyo and Kyoto University, see a surplus in their patent licensing account as yet, so autonomous operation of a startup support organization remains practically impossible for many universities. The situation is not unique to Japan and in fact support for startups and small and medium-sized companies requires the involvement of the central and local governments together in other major countries as well except for cases of operation of top private universities in the US and fund management of some universities in China. Nevertheless, we looked at examples of startup support programs which provide not just places for joint research or industry-academia collaboration but also more effective startup support through combined knowledge of TLOs and professionals specialized in industry-academia collaboration. In Silicon Valley, where land price continues to increase due to the strong

[371] "Why innovation ceased : crisis of scientific Japan", Ei-ichi Yamaguchi (2016)

IT industry, it is not easy to set up an office for a new company or secure a site for business expansion. For this reason, many avoid Silicon Valley and turn their eyes to Austin, Texas as an alternative. (See 2.3.3.) Based on the state's support, a startup ecosystem has emerged as the second Silicon Valley with the University of Texas at Austin and IC2 Institute as a hub. Similarly, in the case of Germany, we looked at the steady creation of startups from industry-academia cooperative clusters through top-down-style priority measures and original programs devised by university and research institution authorities based on industrial policies of state governments. In terms of professional groups, we also discussed how profitable startups are slowly being created at universities with high-level research capabilities by looking at cases of strategic IP management by top universities in the UK.

One similar example in Japan is an organic EL research center of Kyushu University, which was founded in a place developed by a prefecture and a city. This research center conducts cutting-edge research funded by the national government, and startups established from outputs of such research are funded by JST. The important thing is not to make this case an isolated incident but follow it by actually creating similar examples.

Closing remarks

We received cooperation from many people who were directly involved in the cases we investigated for the R&D startup support survey. As a complete enumeration was not possible in a short period, please note that this report provides, if anything, cases which we were able to collect data on. Some might say that it is platform-type or service-type startups, exemplified by Amazon, that lead the world's innovation, not R&D startups discussed in this report. However, we would like to point out that this survey was specifically designed to study startups launched from research outputs of universities and research institutions. Finally, we should note that a variety of people from industry, academia, and governments contributed their precious suggestions when we examined the content of this report. We greatly appreciate their understanding and support.

11. FYI: Overview of Japan's startup support programs and introduction of a few startup cases

Prior to our overseas survey, we studied Japan's startup support programs. This chapter summarizes the information we gained from the preliminary survey as follows.

Startup support programs provided by JST under the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and those by NEDO under the Ministry of Economy, Trade and Industry (METI) are targeted at different stages of startups: In general, the former provides support for commercialization such as feasibility tests and practicality evaluation of a joint-research type and the latter covers from practicality evaluation through demonstration experiments for a product/service launch.

- Support programs of JST

In FY1999, JST launched the "Project for commercializing outputs of new-business-oriented R&D." This program aimed to discover usability of fine research outputs from universities, national and public research institutions, etc., solicited R&D projects from teams of a researcher of universities or national and public research institutions and a joint research manager who aimed to create a business from the research concerned in order to promote prompt commercialization of research outputs through the creation of ventures, and conducted up to 3 years of R&D activities for the projects selected by JST. This program was later revised into the "University venture creation support program" which was launched in 2002. Then in FY2009 the new program was again reorganized into A-STEP, which made it possible to provide seamless support from feasibility evaluation of creating a new business from particular research seeds to business development in the pre-venture stage and practicality evaluation after business launch, and solicited applications until FY2014.

The "Program for Creating STart-ups from Advanced Research and Technology (START)" aims to transform technology seeds which have high risk but great potential into a business with a clear idea on markets and exits while developing business strategies and IP strategies by employing talent with commercialization knowhow as business promoters and combining their commercialization knowhow with public funds for R&D/business development as early as prior to the establishment of the university venture. Based on the results of START, "Material Concept Inc." was established in April 2013.

In January 2013, the Cabinet approved "Emergency Economic Measures for The Revitalization of the Japanese Economy," which was followed by the enactment of the Industrial Competitiveness Enhancement Act, which opened the way for investment in VC funds by national university corporations and some National Research and Development Agencies including JST. Aiming to promote joint R&D activities targeted at practical application by the public and private sectors, METI allocated 100 billion yen, 12.5 billion yen of which went to Tohoku University, 43.7 billion yen to the University of Tokyo, 27.2 billion yen to Kyoto University, and 16.6 billion yen to Osaka University. To promptly start joint R&D activities, the Public-Private Innovation Program Section was established in the National University Corporation Evaluation Committee.

In addition, in 2013, the Act on Improving the Capacity, and the Efficient Promotion of Research and Development through Promotion of Research and Development System Reform was revised, enabling JST to make monetary or non-monetary investments in those who utilize research outputs of JST. In response to this, the "Support program of Capital Contribution to Early-Stage Companies (SUCCESS)" was launched in April 2014. This program was started based on the understanding that companies immediately tended to face funding shortages after their establishment because they were risky and private firms and financial institutions were unwilling to finance them. Under the program, JST makes financial investments or provides personnel/technical support to venture firms which aim to commercialize research outputs of JST and thereby aims for "priming effects" or attracting private funds to such venture firms by JST becoming their shareholder. Apart from monetary investments, JST can also make non-monetary investments by offering its own intellectual property, facilities, etc.

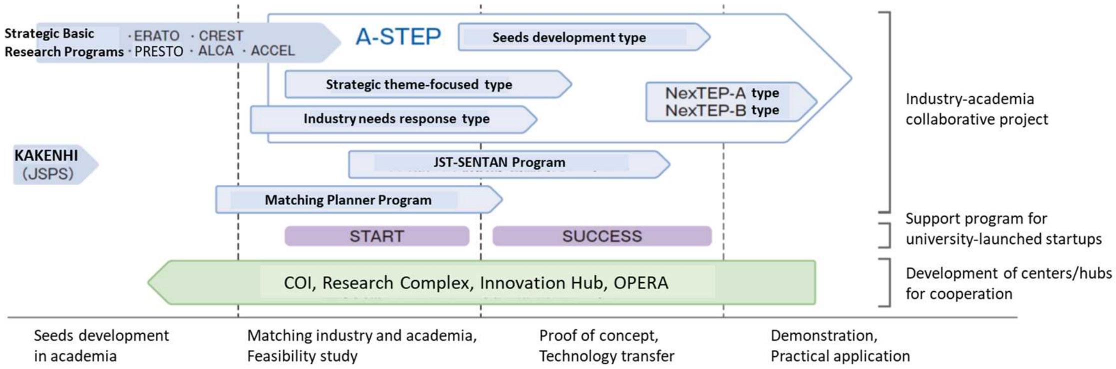

Fig. 1: Support Programs of JST for S&T-driven Innovation
Source: JST summary 2016-2017

JST was also commissioned by MEXT to conduct the Enhancing Development of Global Entrepreneur Program (EDGE Program)[372] from 2015 to 2017. This program aimed to equip participants, mainly graduate students with specialist knowledge and young researchers, with an entrepreneurial mindset, commercialization knowhow, abilities to identify/solve problems, and a wide perspective, and provided support for human resources development efforts through a practical active learning method which is based on participants' initiative. Under this program, JST put a special focus on promoting personal/organizational networking efforts among the parties concerned by not only supporting short-term human resources development programs but also coordinating with venture-related institutions, overseas institutions, and private firms. The EDGE Program accepted 13 universities, among which the University of Tokyo assumed the role of an organizer, and these schools offered various programs, some of which were open to working people. Each university received funds up to 100 million yen in the first year, 95% of the first year fund in the second year and 85% of the second year fund in the third year.

Launched in FY2018, the program called Exploration and Development of Global Entrepreneurship for the NEXT generation (EDGE NEXT Program) is EDGE's successor program, aiming for development of talent who try to start companies based on R&D outputs or to create new businesses independently and development of a venture ecosystem by the people and institutions concerned based on results and challenges that surfaced from entrepreneur education provided by universities across the country including those selected for the EDGE Program. Application for the EDGE NEXT Program must be made by a consortium of three or more domestic universities, etc., one of which shall assume the role of a leading institution and the other two shall participate as teaching institutions. The grant is up to 50 million yen per consortium and five consortiums were selected for FY2018.[373]

- Support programs of NEDO

The New Energy and Industrial Technology Development Organization (NEDO) under METI conducts topic-solicitation-type projects for ventures, small and medium-sized enterprises, and middle-ranking companies as provided in the following chart:

[372] http://edgeprogram.jp/
[373] The leading institutions of the five selected consortiums are Tohoku University, University of Tokyo, Nagoya University, Kyushu University, and Waseda University. https://www.jst.go.jp/shincho/program/edge-next.html

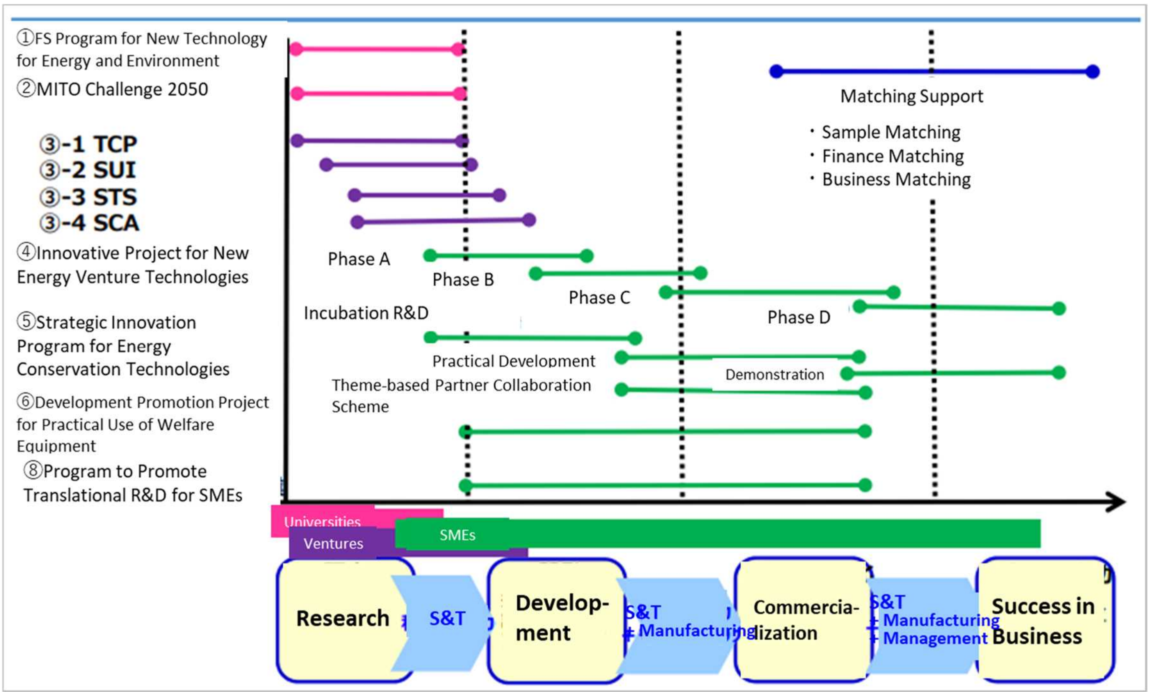

Fig. 2: Support Programs of NEDO from Early Technology to Commercialization (FY2017)
Source: Presentation materials on NEDO's support programs for ventures, small and medium-sized enterprises, and middle-ranking companies

Among programs presented in the above chart, the following five are entrepreneur support programs for R&D ventures:
1. NEDO Technology Commercialization Program (TCP)
2. Support program for entrepreneur candidates (or Startup Innovator (SUI))
3. Commercialization support for Seed-stage Technology-based Startups (STS)
4. Commercialization support for Startups in Corporate Alliance (SCA)
5. NEDO Technology Startup Supporters Academy (SSA)

The SUI project supports activities to launch R&D ventures by providing entrepreneur candidates who have business plans based on technology seeds with opportunities to receive instructions/advice from commercialization supporters (catalyzers). Support is provided for up to a year and capped at 35 million yen, as a rule. The project accepted 10 proposals from 81 applications in FY2015 and 7 proposals from 53 applications in FY2016. (The SUI project closed new applications in FY2016.)

In FY2018, a new program called the NEDO Entrepreneurs Program (NEP) will be launched. This program provides individuals who belong to research institutions or business corporations which have specific technology seeds and would-be entrepreneurs who aspire to start businesses with opportunities to receive instructions/advice from commercialization supporters (catalyzers) and financial support (up to five million yen) for market surveys and design and development of prototypes.

The STS project provides grants for commercialization to R&D ventures in the seed stage which have business plans based on specific technology seeds and receive funds from NEDO-certified VC firms. As of March 2017, there are 24 public and private VC firms that are certified including those from the US and Singapore. The project approved 13 proposals in 2016 and 22 in FY2017.

The "Guidelines for enhancement of joint research under industry-academia-government cooperation [374]" released in November 2016 also include "examples of efforts for

[374] Council of industry-academia-government dialogue for promotion of innovations (Secretariat: Higher Education Bureau,

creation/development of university ventures” as follows:

[Development of talent creating innovations]
- Building programs to enable gifted students who will bear the next generation to develop their interest in creation of innovations and to develop their creativity and entrepreneurship which will lead to the creation of new value
- Working on practical human resources development based on the initiative of participants who are mainly graduate students with specialist knowledge and young researchers in order to equip them with an entrepreneurial mindset, commercialization knowhow, abilities to identify/solve problems, and a wide perspective. Developing talent, especially people who could actually take action, by having them work on actual problems by coordinating with overseas institutions and industry.
- Creating environments which promote understanding and acquisition of skills for development of instructors who could develop innovators and development of innovators inside and outside of campus.

[Enhancement of creation/development of venture firms with a university as a hub]
- Universities, which are supposed to create knowledge, act as hubs for formation of “venture ecosystems” in which entrepreneurs, existing companies, universities, research institutions, financial institutions, and public institutions work together and create ventures one after another based on new technologies and business models, which attract excellent talent/technologies and funds thereby enabling continuous development. It is especially effective for universities, corporations, and VC funds to get together with venture firms and provide full-scale cooperation and business support (so-called “hands-on-type” support) through various measures including investments.
- When creating a world-class university-based venture ecosystem, it is effective to facilitate the flow of funds, personnel, and knowledge on a large scale through coordination with large companies that act as business corporations in the ecosystem.

[Promotion of commercialization of innovative technology seeds and global expansion]
- Developing international support systems for researchers’ efforts of starting companies through which venture support is provided based on the level of support researchers want and researchers are referred to private companies with commercialization knowhow while setting up inquiry desks in universities to give advice for researchers aspiring to start businesses.

- Actual cases of support by public startup support programs

TOKIWA-Bio Inc.[375], a startup based on technology transfer from the National Institute of Advanced Industrial Science and Technology (AIST), conducts R&D activities for technology which can automatically establish iPS cells in a safe and stable manner. Stealth RNA Vector, the company’s underlying technology, can carry and express genes stably in the cytoplasm not in the nuclei of cells, which significantly improves safety as the vector does not get into chromosomes (DNA) in the first place. This technology is highly expected to be applied to the creation of antibodies and vaccines as well as iPS cells and could create influenza vaccines in a month or so as compared to several months under the conventional technology. Dr. Mahito Nakanishi, Director of the Research Laboratory for Human Cell Engineering, AIST, who heads the research concerned,

11. FYI

MEXT; Science and Technology Policy Bureau, MEXT; Industrial Science and Technology Policy and Environment Bureau, METI)
http://www.mext.go.jp/b_menu/houdou/28/12/1380114.htm

375 www.tokiwa-bio.com/

received funds from JST PRESTO (Precursory Research for Embryonic Science and Technology) Program[376] from 1993 to 1996, did research on the mechanism of stable expression of RNA as well, and found a clue to development of an RNA-type independent replicon (unit of replication). To implement technology that could potentially accelerate drug-discovery-based medical care, he applied for START, established TOKIWA-Bio in 2014 with Watervein Partners as a business promotor, and filed a patent the following year. In November 2017, it was decided that the company would raise a total of 330 million yen from JST and Fujifilm Corporation among others by third-party allocation of shares.

- Actual cases of support by public startup support programs

Kyulux, Inc.[377] is a startup which is responsible for practical implementation of third-generation organic EL materials based on TADF (thermally activated delayed fluorescence) which was successfully developed by Distinguished Professor Chihaya Adachi, who heads the Center for Organic Photonics and Electronics Research (OPERA), Kyushu University. TADF realizes low-cost, highly-efficient emission of light by converting electrons to light at the efficiency of nearly 100% without using rare metals and is highly expected as a material which could maximize the freedom in molecular design. TADF can realize Hyperfluorescence, the ultimate luminescent technology which increases color purity, and is attracting attention from the world’s display manufacturers as an innovative technology which will usher in the next-generation organic EL displays. Under the initiative called “Challenge toward Super Organic EL Devices and Required Innovative Materials” (2009-2013), one of the Funding Programs for World-Leading Innovative R&D on Science and Technology (FIRST) of the Cabinet, OPERA, the research center concerned, was developed, which is adjacent to the site of Fukuoka Industry-academia Symphonicity (FiaS), where the Innovative Organic Device R&D Laboratory of the Institute of Systems, Information Technologies and Nanotechnologies (ISIT) is conducting applied research and Fukuoka i3 Center for Organic Photonics and Electronics Research (i3OPERA) of Fukuoka Industry, Science & Technology Foundation (IST) is engaged in practical development and research. Together, these institutions cover research all the way through development under industry-academia-government cooperation. Making the most of this practical implementation system under the industry-academia-government cooperation, Kyulux was established by obtaining exclusive licenses for two basic patents of OPERA and receiving a little over a hundred additional patents from Kyushu University. Thanks to the announcement by Apple of the US in 2015 that it would adopt organic EL displays for its next-generation smartphones, Kyulux succeeded in raising total 1.5 billion yen including 100 million yen from SUCCESS in 2016. The chief researcher, professor Adachi, claims that the idea that has led to the result of this research occurred to him when he was working on the research titled “Development of organic semiconductor laser and clarification of device physics” (Center of Future Chemistry, Kyushu University; 2002-2007) which was part of “Creation of ultra-fast, ultra-low-power, high-performance nanodevices/systems,” a project approved by the CREST program[378] of JST.

Photosynth Inc.[379] is a startup which started from a small wish in everyday life – a wish to open locks with a smartphone instead of physical keys. The company actually created prototypes, produced goods, and took them to market. The company is quickly growing its IoT business without losing the excitement staff felt when their product, Akerun, functioned properly for the first time. In September 2015, aiming to expand its sales strategy according to the market growth and develop new products, the company raised 450 million yen from the four companies of JAFCO Co., Ltd., YJ Capital Inc., Gaiax Co., Ltd. and betaCatalyst Inc. through third-party

376 Program to support individual-type research which creates future innovation based on strategic targets
377 www.kyulux.com/
378 One of the Strategic Basic Research Programs
379 photosynth.co.jp/

allocation of shares. Under the SUI project, companies which raised 100 million yen or more from the start of support are supposed to graduate from the program, and Photosynth became the first to do so.

Skydisc, Inc.[380] is a one-stop solution company providing services such as sensor device development, communication environment development, analysis-cloud development, and AI-based analyses. Skydisc is the second company established by founder Osamu Hashimoto, who is considered one of few serial entrepreneurs in Japan. The company raised total 740 million yen from Nissay Capital Co., Ltd., DG Daiwa Ventures, Energy & Environment Investment, Inc., Yamaguchi Capital, Kaga Electronics Co., Ltd., DOGAN beta, Inc., and Archetype Ventures through third-party allocation of shares in October 2017, which came after another 100 million yen raised earlier in January 2016 from the fund managed by Nissay Capital Co., Ltd., Archetype Ventures, and DOGAN, Inc. While expanding the size of the company by using public funds, Skydisc currently aims to launch its IPO because it considers M&A by a Japanese corporation is unlikely. The company has included future overseas expansion in its business plan since the foundation of the company and the additional funds it raised this time will help it carry out service expansion and overseas roll-out.

- Noteworthy cases

Euglena Co., Ltd.[381] was established in 2005 by young members aged 25-26 on average who were mainly graduates from the Faculty of Agriculture, the University of Tokyo. The startup maintained its research base in the University of Tokyo for several years after its establishment and continued production or culture of euglenas (Japanese name: Midorimushi), a type of microalgae, in Ishigaki Island, Okinawa Prefecture, and related research activities. The company went public on the First Section of the Tokyo Stock Exchange in 2014. The company is engaged in diversified business operations while striving to create new solutions to food and environmental issues. The company is currently conducting business based on more profitable products such as functional food and cosmetics, and is aiming to expand into the fields of energy and environment. The company became the first winner of the Prime Minister's Award in the first Japan Venture Awards held in 2015. Together with SMBC Nikko Securities and Leave a Nest Co., Ltd., a startup accelerator, Euglena also established the Real Tech Fund, one of Japan's largest technology-focused VC funds, providing support for the seed/early-stage startups. This VC fund is certified by the Seed-stage Technology-based Startups (STS) project of NEDO.

Now, take a look at the case of PeptiDream Inc.[382] PeptiDream is a bio-venture which was established in 2006 based on research outputs of the University of Tokyo and went public on the First Section of the Tokyo Stock Exchange in 2013. The company's core technology enables quick and flexible synthesis of relatively small constrained peptides with mRNA as a mold and low-cost screening. Before the establishment of the company, the TLO of the University of Tokyo determined possibilities of the seeds concerned but was unable to find any prospective IP licensees other than US corporations, so the TLO decided to support creation of a new startup in Japan for commercialization of the seeds and even helped the new company to generate leads. Such organizational support can be quite significant for the success of startups.

380 skydisc.jp/
381 www.euglena.jp/
382 www.peptidream.com/

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