Japan's Innovation Systems at the Crossroads: Society 5.0

René Carraz and Yuko Harayama

INTRODUCTION

This paper intends to address the changes that have occurred in Japan's innovation system at large, and how they have impacted the formulation and implementation of the country's Science, Technology and Innovation (STI) policies in particular. It can be argued that Japan's industrial system after the Second World War has emerged at the crossroads between the old and new technological paradigms (Imai, 1992). The old paradigm is an extension of the mechanisation process, familiar since the second industrial revolution; the mass production of standardised technologies and innovation processes was orchestrated by large companies, which relied on vertically organised technological and industrial developments (Fransman, 1999; Goto and Odagari, 1997). In the new paradigm, a more decentralised process fuelled by a strong and ever-expanding base linked to the digital economy emerged; multiple actors such as universities, public research institutions, public sector agencies, entrepreneurial companies and citizens play a more decisive role (Motohashi, 2005; Okamuro et al., 2011; Fukugawa, 2016).

In a narrow sense, innovation policies often tend to mitigate market failure consequences by providing government support for business research and development (R&D), and government investments in basic R&D, knowledge infrastructures, education and skills. Nevertheless, innovation often goes beyond the mobilisation of science and technology as it involves a wide range of assets that extend beyond R&D (Von Hippel, 2006). In that respect, the *OECD Innovation strategy 2015* suggests that the improvement of the governance and implementation of innovation policies is one of the five priorities for policymakers for a comprehensive and action-oriented approach to innovation (OECD, 2015). While framing innovation policies, policymakers need to recognise that they operate in a complex, dynamic and uncertain environment, where governments are increasingly asked to act as

facilitators in the face of these constantly changing conditions. Their mission therefore is to enable closer coordination between individual economic agents as well as foster greater experimentation in the wider economy and society. This includes greater emphasis on building networks, improving coordination and regulation, as well as promoting guiding strategies to deal with global challenges through STI policies and actions.

This paper suggests that, while the Japanese system of innovation is still dominated by a centralised culture where big companies and ministries have a central position in the decision making process, their influence over national innovation policy since the 1990s has been supplemented with new actors and mechanisms. The system moved away from an emphasis on supporting domestic industrial capacities through a "big science" research agenda. Instead the focus was to strengthen budgets and public infrastructure for publicly supported research while fostering university-industry collaborations. In the latest phase, the policy orientation saw a shift away from a traditional technology-driven approach to a more society-centred and challenge-driven innovation policy. A signpost to this trend is the creation and deployment of the concept of "Society 5.0" as a foundation for future economic growth and the basis for a multi-level innovative ecosystem. Broadly defined, Society 5.0 is an STI policy proposed by the Japanese government to gather momentum around Japan's unique position and role in mastering the challenges of digitalisation and connectivity to raise economic growth prospects and solve societal challenges. The goals are not solely technological. The moves should rather be seen as a way to push for fundamental reforms of Japanese economic and social institutions by giving more weight to society in the innovation process.

This paper is structured in three sections. The first section analyses the change of paradigm that the Japanese innovation system has undertaken. The second section presents the evolutionary path of the Japanese STI policy framework strategy laid out by the government since the enactment of the Science and Technology Basic Law in 1995. The third section shows the steps that led to the introduction of Society 5.0, and outlines its conceptual definition.

1. HISTORICAL PERSPECTIVE ON THE JAPANESE INNOVATION SYSTEM

"Big project" research agenda

From an innovation perspective, Japan has been successful from the 1960s through to the 1980s when it was trying to catch up with more technologically advanced

nations; "big project" research programmes initiated by the government were an important part of the story. One of the most successful examples is the Very Large Scale Integrated circuit (VLSI) project, designed to help Japan catch up in semiconductor technology. The project, conducted between 1975 and 1985, had a budget of ¥130 billion (EUR 1.01 billion) of which 22% was financed by the government. All of the major national industrial players were part of the project, and gained world leadership as a result (Sigurdson, 1998). But as many industries caught up to and reached the technological frontier in the 1980s, the need for changes in STI policies became apparent. Indeed, it is often argued that the closer a country is to the technological frontier in a given field, the more difficult it is to tap the technological pool of knowledge. A result of this is that it becomes harder for the government to design and manage new research projects.

A good example of this issue is given by Fransman's (1995) account of the Fifth Generation Computer Project, a large-scale programme devised by the Japanese government in the 1980s to develop a totally new kind of computer, allowing Japanese companies to undermine IBM's supremacy. However, in strictly scientific terms, the outputs of the programme were meagre as the beliefs on what computing was all about were changing during the Project's realisation driven by breakthroughs in microprocessor technology. This rapidly rendered the Project's goals obsolete, showing the limitations of the "big project" research agenda model. Since the 1990s, Japan's R&D projects display a decline in the government's direct interventionist capabilities as many sectors of the country's industry moved from follower position to technological pioneers. Sakihara (1997) concluded, in his large-scale survey of government-sponsored R&D consortia in Japan, that in the 1990s the government lost its edge in signalling and directing the development of important research fields, as the goal was no longer to transfer and adapt Western technologies.

Prioritisation of science-based technologies

Moving up the technological ladder, the Japanese government has been increasingly targeting "science-based" industries to counteract the "hollowing out" of manufacturing jobs in more labour-intensive sectors, such has the machinery industry, which lost 750,000 jobs in the 1990s (MEXT, 2004). Essentially, science-based industries are characterised by strong linkages with scientific knowledge. In these sectors, the main source of technology resides in the R&D activities of the firms. Meanwhile this R&D relies on the development of science in universities and public laboratories, with which these firms maintain close collaboration (Niosi,

2000). This new framework was a challenge for domestic firms, as they had to move from a catch-up strategy to a search for innovative technologies and outside knowledge partners. This orientation shift implied changes not only in R&D-targeted fields, but also in the way R&D was conceived, planned and managed, so that the "big project" agenda, the reference point of the Japanese research system, had to be restructured.

Firms have coped with this demand for "science-based" technologies not only by building up substantial research capacities, but also by increasing research cooperations with universities and other external research institutions. As a consequence industrial research in these sectors is linked with the increased contribution of academic research to industrial R&D and product developments. What is new here is that the decentralisation of the innovation process became apparent in these industries with a growing reliance on external partners.

2. PARADIGM CHANGE: A NEW POLICY PERSPECTIVE

Since the bursting of the financial and property bubble in the 1990s the Japanese economy has been confronted by an economic slowdown, the hollowing out of some of its production facilities, demographic challenges, and increased economic and technological competition from other countries, especially in other parts of Asia. In order to address these issues, one of the main strategies mobilised by Japanese policymakers has been to concentrate efforts on STI policies and increase public expenditures in that area as part of a long-term strategy to support economic growth.

Science and Technology Basic Law

In its search for a novel growth model, the Japanese government has emphasised the need to promote domestic science and technology (S&T) since the 1990s. The first step was the revision in 1992 of the "General guideline for science and technology policy" of 1986 based on the recommendation of the Council of Science and Technology (CST). The enactment of the *Science and Technology Basic Law* on 15 November 1995 (hereinafter referred to as "the Basic Law") symbolised a firm commitment towards the promotion of R&D, determined its basic principles, and required the Japanese administration to raise science and technology-related spending. The Basic Law requires the Japanese government to develop and implement a five-year *Science and Technology Basic Plan* (hereinafter referred to as "Basic Plan"). Looking at the successive Basic Plans, it is clear that they are not intended

to define priorities in R&D on a detailed level. Rather they can be seen as the government's broad identification of important research fields, actors and framework conditions, hence framing the domestic aspirations and expectations of the actors of the system.

Science and Technology Basic Plans

The First Science and Technology Basic Plan (1996-2000) expressed the goal to energetically promote a "new R&D system for the country". This goal was achieved mainly through an expansion of the existing research apparatus. Major measures that were implemented are the strengthening of university-industry linkages, the expansion and financial support for international exchange programmes, the commercialisation of "intellectual assets", support to young researchers (especially post-doctoral fellows) and increased funding of competitive research grants, all at a total budget of ¥17 trillion (EUR 132 billion). The expansion continued with the second Basic Plan (2001-2005). Competitive funding was doubled, the commitment to basic research was strengthened, and societal goals were included such as improving the communication between society and science. For all this the government assigned a budget of ¥24 trillion (EUR 187 billion), a 36% increase over the First Basic Plan. More importantly, from a policy perspective, the second Basic Plan offered a vision to apprehend technological and societal changes.

The vision lies in the prioritisation of a limited number of research fields and subjects. The objective was to promote R&D activities that are in line with policy priorities in resolving national and social issues. These include the enhancement of international competitiveness, countermeasures against environmental problems, ageing and the low birth-rate of Japanese society. The ambitious Plan aimed to foster emerging S&T fields that were expected to be developed rapidly in the future, while at the same time, secure proper resources to promote basic research. In practice, four priority domains were to be encouraged by the government: life sciences (including biotechnology), IT, environmental sciences and nanotechnology and new materials. R&D funding was to be mobilised to promote these four domains.

The third Basic Plan's (2006-2010) design reflected the need for Japan to put in place an environment more inclined to help scientists to achieve high-quality research results, to cultivate a highly competitive research environment, and to advance science while continually promoting innovation. For instance, measures were put in place to support the autonomy of young researchers, reform graduate education, and increase competitive funding. Despite the stringent fiscal climate,

the Plan continued to push for a slightly increased budget and proposed to allocate ¥25 trillion (EUR 194 billion) in total R&D investment over its five-year duration.

The Fourth Basic Plan (2011-2015) laid the foundation for an issue-driven formulation of the innovation strategy that pushed forward the use of STI to address social and economic challenges. A large portion of the Plan targeted initiatives for the "recovery and revitalisation" of Japan as a response to the 2011 Great East Japan Earthquake as one of its four major challenges to be overcome for sustainable growth and prosperity. It was a departure from previous Plans, where the focus had been on strengthening particular fields of S&T, a technology-driven approach.

3. A MORE COMPREHENSIVE INNOVATION STRATEGY, TOWARDS SOCIETY 5.0

Empowerment of the Council dedicated to Science, Technology and Innovation

In terms of supervision of the Japanese S&T policy, the Council of Science and Technology passed the responsibility to a new Council for Science and Technology Policy (CSTP), which was situated in the cabinet office above individual ministries. Thus the CSTP was equipped with wider competences in 2001, just before the launch of the second Basic Plan. As stated by the second Basic Plan, "The CSTP will act as a control tower and direct the multi-fold processes of S&T policy implementation. In addition to formulating promotion strategies on prioritised areas, principles of resource allocation, and guidelines for project evaluation, the Council will strive to promote S&T activities."[1] The CSTP formulated and coordinated all of the nation's S&T policies.

In 2013, under the newly formed Abe Cabinet, the CSTP was assigned to formulate the so-called "Science, Technology and Innovation Comprehensive Strategy" (hereafter "STI Comprehensive Strategy") by the Prime Minister, in view of the formulation of Japan's New Growth Strategy. The first STI Comprehensive Strategy was adopted at a Ministerial Meeting in June 2013, and it was revisited the following year, to take into account the changing environment surrounding innovation and to better respond to policy challenges. Thus, Japan acquired a new framework for STI, alongside its overarching five-year Basic Plan, which provides basic orientation for S&T policies. Indeed, the STI Comprehensive Strategy was expected to function as a complement to the five-year Basic Plan, by providing actionable policy

[1] Second Basic Plan, http://www8.cao.go.jp/cstp/english/basic/index.html, accessed 24 October 2018.

recommendations, which could take into account the country's evolving societal and political needs.

The STI Comprehensive Strategy 2013 was guided by three principles: (i) act smart; (ii) implement a thinking system; (iii) think global, and is composed of the following three pillars:

1. Grand policy challenges
2. Structural reforms of the national innovation system
3. Empowerment of the CSTP

Regarding the third pillar, the CSTP proposed to equip itself with a new competency, by designing and implementing programmes promoting innovation with its budget, with the aim to better drive efforts made at the ministerial level. It required a revision of the Act for Establishment of the Cabinet Office, the legal basis of the CSTP. In May 2014, the Parliament voted on proposed amendments to enlarge CSTP's competencies and to change the name of the CSTP to "Council for Science, Technology and Innovation (CSTI)". Thus the mainstreaming of "Innovation" became apparent, with CSTI as a guiding body.

The CSTI moved one step further in 2014 with its STI Comprehensive Strategy. The roadmaps of grand challenges to be addressed were updated and consolidated around the newly created programme "Cross-Ministerial Strategic Innovation Promotion Programme (SIP)". With regard to the structural reforms, CSTI proposed to take action to enlarge opportunities for "challenges" and "interactions", by bridging ideas, facilitating the mobility of people, and creating different types of innovation hubs. The CSTI also tried to promote disruptive thinking, putting a newly created programme, "Impulsing Paradigm Change through Disruptive Technologies Programme (ImPACT)", at the heart of its policy tools. ImPACT aims to generate ground-breaking innovation, which will bring drastic changes to industries and society if realised. Through ImPACT, the CSTI expected next-generation innovations to be created by investing in high-risk, high-impact R&D. Through these two programmes, the CSTI became equipped for policy experimentation, and this capacity will play an essential role for the forthcoming "Society 5.0", by trying to trigger paradigm changes though disruptive research.

Fifth Basic Plan and the inception of Society 5.0

The preparation of the Fifth Basic Plan was initiated with a new methodological approach, which consists of brainstorming discussions among CSTI's executive members, with a view to identifying shared guiding principles upon which the Fifth

Basic Plan will be founded. This runs in parallel to a formal assessment of 20 years' worth of experiences of Basic Plans and benchmarking exercises of STI policies around the world.

Recognising that the world is increasingly becoming interconnected beyond traditional borders at a pace we have hardly experienced before, and evolving at an accelerated rate fuelled by digital transformation, the executive members have identified the "preparedness" for this unpredictable and unforeseeable near future as the most fundamental challenge to be addressed throughout the Fifth Basic Plan. The capacity to design future industry and society will be instrumental, and to this end, investing in people and providing the space to test their ideas will be the key. What we observe here is the shift from the traditional technology-driven to a more society-centred and challenge-driven innovation policy.

Four pillars have been identified to structure the Fifth Basic Plan:

1. Preparing the next generation: Future industry and society
2. Addressing socio-economic and global challenges
3. Investing in "fundamentals": People and excellence
4. Better-functioning STI systems

The first pillar naturally became the nursing ground for the inception of Society 5.0. Behind the eye-catching titles and programme initiatives – such as Third Industrial Revolution (Rifkin, 2011), Fourth Industrial Revolution (Schwab, 2017), Industry 4.0 (Kagerman et al. 2013), "e-Estonia" Programme, "Smart Nation" (Singapore), or the FIWARE open source platform supported by the European Union – lies a fundamental shift in how economies may be structured in the future as industries, academia and governments create, store and integrate various data streams into daily production processes to provide goods and services.

Society 5.0 is not an exception. But beyond this shift, Japan is facing a set of pressing challenges, such as its ageing population, labour shortages and weak nominal growth prospects. Just as Industry 4.0 was a tentative response to the digital transformation of manufacturing, Society 5.0 emerged from the need to master the challenges of digitalisation and connectivity across a wide range of platforms in particular and more generally across all levels of the Japanese society to achieve the digital transformation of society itself.

Indeed, in today's information society, the weight of added values generated by connecting intangible assets is likely to surpass the added value generated by the manufacturing sector (Haskel and Westlake, 2017). Also we may expect that this ongoing digital transformation will have an amplified impact on economic and social

systems and even on our social values. In fact, Society 5.0 is an attempt to capture this expectation by inviting all citizens – including game changers such as entrepreneurs and non-government organisations (NGOs) and a wide variety of actors that in the past have only participated in non-visible ways in the innovation process – to take part in shaping our future society, while respecting the values of openness, sustainability and inclusiveness, and acting accordingly and in a responsible manner. Therefore, Society 5.0 has to be nurtured, tested and developed in order to become an operational concept. This approach implies the need to secure a space for accommodating various bottom-up ideas, which has proven to be a big challenge for formulating the Fifth Basic Plan.

Definition of "Society 5.0"

Officially the term "Society 5.0" was introduced and coined in the Fifth Basic Plan by the CSTI and approved by Cabinet decision in January 2016**.** In the Fifth Basic Plan, Society 5.0 is defined as follows:

> a society that is capable of providing the necessary goods and services to the people who need them at the required time and in just the right amount; a society that is able to respond precisely to a wide variety of social needs; a society in which all kinds of people can readily obtain high-quality services, overcome differences of age, gender, religion, and language, and live vigorous and comfortable lives.[2]

The outline of the Fifth Basic Plan described Society 5.0 as "an initiative merging the physical space (i.e. the real world) and cyber space by leveraging ICT to its fullest, where we are proposing an ideal form of our future society" with "a series of initiatives geared toward realising this." Society 5.0, by proposing to further the potential of data-driven technology and application while enhancing the quality of life of all citizens through a "super smart society", has the potential to be a core notion of Japan's STI and growth strategy.

It could be argued that this wide-ranging STI policy goal is a departure from the traditional technology-driven approaches pursued so far, and it relates to the strategic planning orientation taken by the CSTI. Rather than setting rigid Plans centred on how technology is likely to evolve in the next five years, the essence of the Fifth Basic Plan is rather to prepare the Japanese STI system for an unforeseeable technological future. This should be achieved by securing public investment in

[2] 5th Basic Plan, http://www8.cao.go.jp/cstp/english/basic/5thbasicplan.pdf, accessed 24 October 2018.

R&D to a target level of 1% of GDP, by investing in the development of high-quality human resources, and promoting an open-innovation framework and open science to facilitate the exchange of intellectual assets. Additionally, technological domains considered as fundamental for the promotion of interconnected systems that facilitate the use of data should be promoted and aligned with fundamental technological fields where Japan is in a leading position, such as robotics and human interface technology, or where it should build up technological strengths, such as cybersecurity, Internet of Things (IoT) system architecture technology, and big data analytics, as these fields are considered critical to implementing secure and reliable data platforms. In order to implement this vision, a common platform called "Society 5.0 Service Platform", through collaboration between industry, academia and the relevant government ministries, is envisaged by the CSTI.

This systemic approach for the development of an innovation ecosystem is in our view pivotal to the overall strategy. It is necessary to incorporate these new technologies and data usages in all industries and social activities in order to promote parallel economic development and bring about solutions to social problems. For instance, in order to create value in the field of "intelligent transport systems", with the prospect of autonomous driving, it is important to promote a standardisation of technological interfaces and data formats, and to develop common security technologies shared by all actors, human and non-human. Additionally, collaboration between industry, academia, government and society is of the utmost importance as usage and acceptance of the systems developed is likely to be shaped by users and citizens.

Acceptance and usage of "Society 5.0"

The concept of Society 5.0 has been incorporated in the Ministry of Economy and Trade's (METI) "New Industrial Structure Vision", which projects the evolution of industry up to 2030 by identifying and finding ways of overcoming systemic challenges to the realisation of Society 5.0. In March 2017, METI announced the policy concept of "Connected Industries" where industrial players will integrate the various technologies needed for the realisation of a "human-centred" Society 5.0.

From the private sector, Keidanren, Japan's most important business federation, endorsed the concept of Society 5.0 in its policy proposal "Toward realisation of the new economy and society" as early as April 2016. In February 2017, Keidanren published a comprehensive action plan to rebuild Japan with Society 5.0 as its key concept. Also, industrial players such as Hitachi, NEC, Fujistu, Toyota and Panasonic, among others, integrated Society 5.0 as part of their overarching strategies.

Moreover, Society 5.0 plays a pivotal role in the recently updated growth strategy of the Japanese government. The Prime Minister's Office released Japan's Growth Strategy 2017, which lays out a strategic blueprint for Japan's Society 5.0, including specific plans for the deep integration of cutting-edge technologies to solve economic and social problems. Approved by the Cabinet in June 2017 under the title "Future Investment Strategy", the government sees the efforts undertaken towards Society 5.0 as "the key to break secular stagnation and achieve mid- and long-term growth."[3] Japan is promoting Society 5.0 by introducing digital technologies in a variety of platforms, as well as accelerating its implementation to achieve a society in which all citizens have the potential to be engaged in the system.

CONCLUDING REMARKS

The role of governments is no longer confined to identifying promising technologies, but to improving the overall environment for innovation. This assertion can help us to apprehend the changes that occurred in the governance of science and innovation in Japan. As Japan moved up the technological ladder, it had to reorganise its innovation system. Pursuing incremental innovation based on imported technologies was not a solution anymore. Challenged by the economic crisis of the 1990s, the Japanese government had to find a way to regain momentum. One of the paths followed was to invest massively in R&D spending and to revise its S&T policies. These changes can be traced back to the 1995 Basic Law, which stated the strong commitment of the government toward S&T with the aim of positioning the Japanese economy at the forefront of science-based industries, and more recently to the Fifth Basic Plan structured around the concept of Society 5.0.

Looking at the strengths of its innovation system, Japan seems capable of taking the lead in the realisation of Society 5.0 due to its abundance of well-documented physical data, advanced manufacturing technologies and pressing societal issues. The question then is whether the concept will gather enough traction to gain commitment from key stakeholders and help to induce societal transformation to achieve the government's vision of Japan being the "most innovation-friendly country".

Japan, having experienced the effects of mechanisation and industrialisation, and now under the sway of digitalisation, has an imperative to find ways to gain maturity as an open, innovation-friendly society, reaching beyond the sole pursuit

[3] http://www.kantei.go.jp/jp/singi/keizaisaisei/pdf/miraitousi2017_summary.pdf, accessed 24 October 2018.

of economic growth. As such, the inception of Society 5.0 can be seen as an invitation to all stakeholders to think about the future of Japanese society, in an inclusive manner, with a particular eye on the advancement of STI. By and large, the latter is expected to bring prosperity to the society; however, economic and technological historical accounts demonstrate that this is not always the case. The creative destruction dynamic of innovation, dystopian technological changes and unintended scientific consequences may all be the collateral of a new economic system based on and nourished by the ever-increasing digitisation trend envisioned by Society 5.0. Therefore all stakeholders of the innovation process are expected to assume social responsibility when moving in that direction, in order for Society 5.0 to thrive and gain public acceptance. Under the flagship programme of Society 5.0, a society-wide experimentation is underway in Japan, putting the transformative power of STI policy to the test. The key to the success of Society 5.0 may lie in the learning capacity of Japanese society to embark on this innovative journey.

Rene Carraz is a Lecturer at Tokyo University, Japan. He holds a PhD in Economics and teaches and researches on science, technology and innovation, creative cities and urban studies using an economic perspective. His recent work includes studies of university-industry linkages in Japan and Asia, innovation, and urban creativity.

Yuko Harayama, Professor Emeritus of Tohoku University, is the former Executive Member of the Council for Science and Technology Policy, Cabinet Office of Japan. She is the former Deputy Director of the Directorate for Science, Technology and Innovation, OECD. She combines academic and policy expertise on the topics of innovation policies.

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