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THE JAPANESE INNOVATION SYSTEM 2011 REVISITED

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5.1 Introduction

Due to re-arrangements in the governmental organisation, the year 2001 was a milestone in the Japanese innovation system. Other changes had to follow – they are described in Cuhls and Wieczorek (2010). This chapter reflects the history of the Japanese Innovation System (JIS) from external discussions on the national innovation system approach to the system in Japan itself. In previous discussions of the current JIS, it has become obvious that the models we use to describe such systems are insufficient: it was difficult to fit all actors into the right place, the interaction in the system could not be included and the framework conditions were regarded as "external factors". In Japan, for example, particular difficulties were faced when arguing for the Japanese Agency's or institutions like the AIST (National Institute of Advanced Science and Technology) with their hybrid functions in the innovation system or the specifities of the JIS. Therefore, the second part describes the Japanese Innovation system with the existing model before and after the reforms in 2001.

In 2011, Japan was not only confronted with disasters but had already started to re-orient and reconsider the efficiency of this new innovation system. Revisiting this new system by taking stock of historic and the recent changes, the objective of this contribution is to discuss a potential outlook on further changes.

5.2 History of the national innovation system approach – why was the Japanese innovation system so important in the debate?

The development of the National Systems of Innovation approaches occurred at a time when nations were regarded as the entity to be looked at and compared with respect to their competitiveness. International competitiveness was measured by export data and the success of certain countries was analysed in order to lead markets or to stay in the markets (Freeman 2008, pp. 8ff.; 1988, pp. 31ff.; 1987). The questions behind this were: Why are certain national features better than others? What are the institutions underpinning these and what is the interplay between the institutions? How can the science system and the generation of knowledge be described? The general history of the NIS approach is described in Chapter 1 of this volume. Here we are looking at the background of a country which is often described as "culturally special": Japan. It is open to discussion whether Japan is really special or whether different countries have only different cultural specifities – this contribution does not address this question.

Japan was the first industrial country in Asia and its success story was very much admired because it developed in a very short period of time. During the Tokugawa period (1603 to 1868), the country was completely closed off (*sakoku*, 1633–1853). Trade was only possible with a few countries (China, Netherlands, Taiwan, Korea, Ryûkyû – which is now Okinawa and a Japanese prefecture). Information, especially about science and technology, was filtered into the country via a small island (Deshima) only by the Dutch, the so-called *rangaku*. Nevertheless, even during this time of closure, the country started to flourish, to trade within the country, to develop cultural traits, to establish learning possibilities for everyone, and to build up a new infrastructure, especially as a necessity of the so-called *sankinkôtai* system, which forced every daimyô (noble) of the country to have a residence in Tôkyô as well as in his prefecture and to travel frequently (descriptions can be found e.g. in Hall 1968; Hauser 1997, p. 506.).

After the Meiji restoration in 1867, the structure of the country changed completely in respect to education but also in terms of production and the development of useful things like machines. Japanese engineers were sent to foreign countries to study and very soon Japan changed from a country that was threatened by colonisation into a country that was colonising others. In 1895, Japan won the first war with China and in 1905 the Russian-Japanese war was decided in favour of Japan. The major reason was that Japanese ships and other military equipment were technically much better than Russia's (Inoue 2003).

Japan lost the Second World War but the policy of the US towards Japan was the same as towards Germany: Instead of completely destroying the country, it was rebuilt – both countries were in strategic locations and both were regarded as potential future partners. Again, the country rose economically in a very short period of time (Hentschel 1986; Nakamura 1995) and many of the networks, companies and conglomerations that were established during the war were re-activated or at least provided the backbone for a fresh start (Odagiri and Goto 1993).

Japan's major achievement was its production system. The state supported all purchases of new technology which were needed for export. On the other hand, Japan became even more dependent on exports because it has no natural resources and therefore human resources and their education turned out to be Japan's major capital. Triadisation rather than globalisation could be observed during the 60es to the 80es of the 20th century. The term Triade was coined by Ohmae (1985; 1991), a Japanese-American consultant, to describe the fact that the major exporters and dominating countries in competition with each other were the USA, Germany and Japan. When comparing Japan to the US or Germany (or Europe) – Japan dominated. The innovation system is often used to explain the success factors in these countries.

During the years leading up to the Asian crisis, the debate was dominated by the "threat of the Japanese" (not yet the Chinese), because after the Second World War many Westerners were surprised to see Japan rising to become the first industrialised country in Asia. However, when looking back at history (Hall 1968; Inoue 2003; Linhart and Pilz 1999; Odagiri and Goto 1993), that is not surprising at all. The basis of the success goes back to the Meiji period and even earlier (Sugimoto and Swain 1989). Therefore, the reason for Japan's success is often sought in the innovation system – and this is the reason why many of the first researchers of the National System of Innovation used Japan as an example (Freeman 1987; 1988; 2008; Nelson 1993; Odagiri and Goto 1993; Sigurdson 1995 with his first edition as early as 1984; later: Edquist 1997; Lundvall et al. 2006; Odagiri 2006).

5.3 The Japanese innovation system after World War II

World War II marked a change in the Japanese (Innovation) System that had been in effect under war economy rules from 1938 (with the General Mobilization Law, cf. Nakamura 1995, p. 8) to 1945. For more details about the time until 1945 see Odagiri and Goto (1993). The next changing point in the Japanese Innovation System is marked by the year 2001. There were many other crucial times and crossroads before the 20th century (Sugimoto and Swain 1989). In this contribution, we are looking at the concept of the NIS since the 20th century as the concept as such has not existed that long.

It has often been assumed that a kind of "Corporate Japan" or "Japan Inc" was developed after (and already during) World War II. Japan Inc was the synonym for the interplay of the different stakeholders in the system: A very long-term strategic cooperation between the government and industry, guided by an "invisible hand" (means guided by an unknown coordinator, for a summary see Sigurdson 1995) was assumed. Industrial policy supported these direct links and the financing of such a joint way forward was provided by the famous Ministry for Industrial Trade and Industry (MITI). In fact, this was just an assumption from the outside world. The power of MITI as described in Johnson (1982) was never as strong as assumed and waned with the independence of Japanese companies from export credit signs from the Ministry, the liberalization of markets (Odagiri and Goto 1993) – and of course later on with the introduction of the internet, so that the Ministry's information monopoly was diminished.

The Japanese Innovation System (JIS) developed quickly after 1945 and joined internal forces in an efficient way (Freeman 1987, p. 32). New companies were founded and became the core of the Japanese Innovation System. It was clear that the companies were responsible for innovation and most of the developments took place in the new (e.g. Sony) and old firms (Mitsui, Mitsubishi, Toyota etc.), mainly the larger ones. On the side of the ministries, it was not as transparent: Innovation was mainly the responsibility of MITI (Johnson 1982), because innovations are close to the market and MITI is responsible for "trade and industry", as the name already indicates. For science and technology, the Science and Technology Agency, a quasi ministry under the auspices of the Prime Minister's Office directly, was responsible as well as other ministries (see below).

The ministries acted as moderators in this system. Their extensive knowledge about the companies and instruments forced the companies to adopt the desired policies. But there have always been interesting constellations, in which the companies did not adopt the intended policies or even refused to comply with direct orders, e.g. the famous case of Honda, a motorbike company, which wanted to enter the automobile market and was not allowed to do so by MITI (Sakiya 1987).

The institutions changed after the war – but some remained under new names and the interaction between them that had developed also remained the same. For example, the old conglomerates (*zaibatsu*) that developed in the first half of the 20th century and supported the war economy very efficiently were destroyed officially – but reoccurred as *keiretsu*. Keiretsu are networks of companies, especially large trading companies handling a huge diversity of products, combined with a bank. They are formally interconnected because one company holds the other's stocks and vice versa so that they all have an interest in joining forces. Keiretsu played an important role even in the innovation system of Japan – less as an institution per se but more as the "network" with its flow of information and mutual support. In the institutional model of the Japanese innovation system, they are normally integrated into the category of "industry" (institutional viewpoint), in fact, they represent more than just industry.

The education sector in Japan has always been very strong: people do not intend to enter an academic career so much as to climb up the social ladder by education and to enter a famous company, this was and is still the goal of many people. The selection criteria in this system were and are severe. A huge percentage of Japanese people possess a university degree and regard themselves as "middle class". In Japan, higher education takes place at the national and private universities (for further details see e.g. MEXT 2006). In all cases, tuition fees have to be paid and make up a huge amount of the cost of education for parents.

Science and research were not the task of universities, but were performed in National Laboratories and other research organisations. The laboratories were all under the auspices of a ministry or the Science and Technology Agency (STA, see Sigurdson 1995, p. 41) until 2001. The STA had, as the Environmental Agency, no rank as a ministry, only as an "agency", and was established in 1959, responsible for nuclear energy and energy supply, space research and marine research. In addition, the STA is responsible for the general research overview and basic research.

Six important Councils worked directly under the Prime Minister (Sigurdson 1995, pp. 36ff.). This was first of all the (former) Council for Science and Technology (CST) with the Prime Minister himself, the Minister for Science and Technology (who was the head of the STA), the Minister of Education, Science and Culture (Mombushô), the Minister of Finance, the Minister for Economic Planning and the President of the Science Council plus five experts from science and industry. The CST commented on basic directions in science and research, see e.g. the "Comprehensive and Basic Science and Technology Policy toward the New Century" in 1992.

Separately linked to the office of the Prime Minister was (and still is) the Science Council of Japan, with its 180 so-called "Liaison Committees" (with about 2,370 members) and about 640,000 registered academic scientists. The Science Council is dedicated to the Humanities, Social Sciences and Natural Sciences and is supposed to deal with all research disciplines. Other Councils are the Atomic Energy Commission, the Nuclear Safety Commission, the Space Activities Commission and the Council for Ocean Development.

For pre-formulation and recommendations concerning technology policy and (technology) forecasting (later: Foresight), a very specific National Institute was founded: the National Institute for Science and Technology Policy (NISTEP) which was until 2001 directly integrated into the STA. It was established in 1986 as the reaction to a report of the "Provisional Councils for Promotion of Administrative Reform [...] which pointed out the importance of strengthening and enriching policy research as part of the efforts to strengthen the functions of the Council for Science and Technology (CST)" (NISTEP 1996). The major tasks for NISTEP are advice in technology policy, foresight, human resources, technology transfer, global questions and scientific impact research.

MITI was and is responsible for industrial research, innovation and energy (as application field). The Industrial Technology Council belonged to MITI and worked out the directions for the technology policy of industry. The Industrial Technology Council was involved in the formulation of the famous MITI "visions". The Patent Agency, the Agency of Natural Resources and Energies, which was responsible for the New Energy and Industrial Technology Development Organization (NEDO) belonged to MITI. For the development of new technologies, the Agency of Industrial Science and Technology (AIST) with its 16 national research institutions was, and still is, a very important part of the system (JRDC 1992).

For NEDO and also for AIST, there were research programmes and projects which dealt with future technologies and indirectly implemented the results of the national forecasting activities (AIST 1995). As early as 1977, there was an ad hoc advisory board for the director general of AIST (Working Party for the Formulation of a Long-term Plan for the Development of Industrial Technology) which consisted of university professors, representatives from research organisations, a journalist and people from industry (The Technical Change Centre 1983, p. 8).

Another important Agency for the innovation system was the Economic Planning Agency (EPA), which was responsible for the statistics and the five-year-plans for the economy. One has to bear in mind that these five-year-plans are not static as in most socialist countries, but most of them are changed during the five years. It is a characteristic feature of these plans that they are not fixed plans but provide orientation. If the targets are not achieved, the plan is adapted to reality (and not reality to the plan). EPA also provided lists of new technologies and expected market figures for orientation. Many similarities exist between the content of their lists and the forecasting/foresight studies of NISTEP (especially the Delphi surveys) – and the members of the commissions who formulate the plans were often also members of the Delphi committees.

As already mentioned, most of the research in Japan was and is privately financed. Companies were conducting research and developing their products independently or in co-operations. They "used the factory as a laboratory", and they were able to integrate "between research and development, production management and marketing as a major source of failure, the integrative effect of learning by creative reverse engineering conferred a major competitive advantage on many Japanese firms" (Freeman 1987, pp. 42f.). Many of these co-operations were necessary because the national programmes forced companies to co-operate. Companies participated in a lot of MITI projects (e.g. the 5th generation computer project) in order not to miss any information or to be left behind technologically (Callon 1995). There are obviously projects, in which companies participated voluntarily (The Technical Change Centre 1983, p. 30). In these cases, MITI provided the technical infrastructure and equipment and researchers from industry were sent to this new institute for a certain period of time. This was only possible for specific projects and at the pre-competitive stage. Later on, the (mainly large) companies become competitors again. Therefore, industry in Japan has higher R&D expenditures than industry in other countries but the direct expenditures of the state for industry are rather low (Eto 1984, p. 140, cf. also Odagiri and Goto 1993, p. 103). "MITI's aim is not to reduce competition among Japanese firms but to create the strongest possible companies with the greatest competitive potential" (Freeman 1987, p. 49).

Looking at the functions of institutions, one has to consider that the instruments of MITI and other ministries were and are less "power" or money, but the targeted application of information, which means information generation, analysis, distribution and the function of a "facilitator" for companies in the system (Itoh et al. 1988, pp. 240f.; Hilpert 1993). The high level of trust through formal contacts and the information gathering instruments ("[…] Japanese officials are much better informed, not only about Japanese companies but often about American companies […]") are identified as major success factors by Freeman (1987, p. 36).

In 1996, the government decided a huge enhancement of the budgets for basic science, because Japan was often accused of being a "free-rider" on basic research of other countries (Handelsblatt 1996). This marked a shift from the pure application-oriented research that was necessary in a country that was catching-up and attempted to play in the first league of science. The reason was that in many fields, Japan was already the leading country in research – and therefore needed its own input instead of relying on the basics of other countries.

In these times and contexts, even foresight (at that time "technological forecasting", *gijutsu yosoku*) played a role in coordinating the activities of the different players in the innovation system. Delphi surveys (Kuwahara et al. 2008; Cuhls 1998; 2005) asked about their estimations of future statements, technologies that were regarded as feasible but not yet realised. The results of the surveys that were provided by NISTEP and the Institute of Future Technologies, IFTECH, were widely used by companies as well as by research institutions or the ministries (Cuhls 1998). Also MITI had its own foresight activities and did not only use the above mentioned surveys. There are lists of critical technologies by MITI (Kodama 1991, p. 134) and the famous "visions". They demonstrate guiding principles for the country and were formulated very broadly. They provided rather "informal guidance" (Ehrke 1994, p. 64) for the self-organisation of companies and institutes. The more concrete formulation could be found in the five-year plans of the EPA (for lists of these plans see McMillan 1996, pp. 89ff.).

During the 1950s, the visions were mainly concerned with heavy and chemical industry, during the 60s more with trade liberalisation. In 1963, there was even a very concrete "Long-term vision for the industrial structure" (Freeman 1987, pp. 37ff.) with a shift to "knowledge-intensive" sectors (like electronics) in order to save oil and resources, which seemed to be necessary after the oil shocks. The direct interventions of MITI were rather seen as additions (Ehrke 1994, pp. 62–70; Freeman 1987, pp. 37 ff.; 1988). Table 5–1 and Table 5–2 show an overview of the directions during the 1980s and 1990s. From an MITI point of view, these guidelines and visions contributed mainly to limit fear and the uncertainty about the future (Fuji 1994, p. 150).

Table 5–1: The MITI visions of the 1980s and guidelines for the 1990s

March 1986: General Guidelines for Science and Technology
(Science & Technology Council > Cabinet Approval)
1. Promotion of creative science & technology
2. Balanced development of science & technology in harmony with social progress
3. Development of science & technology from a broad international point of view

September 1988: White Paper on Industrial Technology: Trends and Future Tasks in Japanese Industrial Technology (MITI)
1. More aggressive approach to basic and creative technology
2. Greater international contribution through the R&D process, its outcome and its ripple effect

July 1990: MITI's Visions for the 1990s
(Industrial Structure Council)
1. Strengthening basic and creative R&D
2. Promoting international R&D efforts
3. Developing science & technology in harmony with man and nature
4. Developing technology for regional vitalization

April 1992: General Guidelines for Science & Technology
(Science & Technology Council > Cabinet Approval)
1. Contribute to maintaining mankind's coexistence with Earth
2. Increase of technological knowledge stock
3. Contribute to constructing a society with a safe and enjoyable life

Source: summary of Watanabe (1994, annex p. 8) and Watanabe (1995, p. 39)

Table 5–2: MITI visions for the 1990s

Advancement of techno globalism from a global viewpoint (global activation of science and technology creativity as well as spread and change)
Advancement of research and development with balanced science and technology (advancement of basic, creative research and development)
Advancement of research and development in order to realise a comfortable, prosperous life for the citizens (advancement of excellent research and development for man and nature, advancement of research and development in order to realise a vital regional society)
Basic regulation for the development of science and technology

Source: Tsûshôsangyôshô (1990, p. 8), own translation

The innovation system of Japan is also influenced by the leading industry associations, especially the *Keidanren* or the *Keizai Doyukai*, which have broader actions like the call "Making Japan a Leading Technological Innovator" (Keizai Doyukai 1996, pp. 50–56).

Looking back at the 20th century, Japan developed a new role in the world. Globalisation occurred and the Japanese National System of Innovation was regarded as very efficient and as one of the leading systems in the world. The outside world, however, was not aware of its deficiencies and the Japanese inner world did not want to know. It is obvious that during the 1980s the whole innovation system of Japan worked very well and was admired all over the world. "Japan served as a role model during the 1970s and 1980s. However, it lost its attraction during the so-called "lost decade" of the 1990s, when commentators observed a lack of adaptation and a mismatch with the changing environment." (Storz and Schäfer 2011, p. 34). But when the bubble burst and new rules were introduced into the game of innovation procedures and institutions, when globalisation was realised more and more, the interplay in the Japanese system needed to be adapted and reforms became necessary. Some were made, others are still awaited. The threat that was described in best sellers by authors like van Wolferen (1989) was never that huge.

5.4 The Japanese innovation system after 2001

The year 2001 was a milestone in the changes of the Japanese innovation system. Looking back, in the first decade of the 21st century, the changes and impacts of these changes were severe – but often not acknowledged: Starting with a re-organisation of ministries, a phase of re-orientation of the whole innovation system began. Many of the organisations and institutes started to be more strategically focussed. Some developments in the innovation system bring about greater centralization towards national institutions and government, others tend to have the opposite effect, especially where research institutions are established on a regional basis. This section describes some of these changes and the interplay of the actors involved in the innovation system.

The Japanese innovation system remains highly centralized. Nevertheless, the prefectures and regions have become stronger actors in the system (Fukugawa 2008,

p. 160). The major actors in Japan were and still are the large companies, some of them already multinationals. The government acted more as a mediator than a leader. In many of the future science and technology fields, Japan is among the leading countries worldwide. The expenditures for R&D are still the largest in the world: 3.4 % of the Japanese GDP was already achieved in the year 2004 (MEXT 2006 and earlier White Papers), the general expenditures for science and technology in Fiscal Year 2009 were 3.564 trillion Yen (MEXT 2010, pp. 141f.). The largest share still comes from companies, about 20 % from universities and colleges, less than 10 % from private research institutions (MEXT 2010 and earlier White Papers). The number of researchers in industry as well as in institutions has increased, whereas the number of institutions was consolidated and differed in numbers over time (Table 5–3).

Table 5–3: Number of R&D performing institutions and researchers by kind of organisation

FY	Total		Business enterprises		Non-profit institution & public organisation		University & college	
	Institutions	Researchers	Institutions	Researchers	Institutions	Researchers	Institutions	Researchers
2001	27,061	728,215	22,789	421,363	1,245	47,093	3,027	259,759
2002	22,056	756,336	17,903	430,688	1,138	44,938	3,015	280,710
2003	18,468	757,339	14,258	431,190	1,119	44,845	3,091	281,304
2004	29,663	787,264	25,440	458,845	1,103	44,089	3,120	284,330
2005	28,608	790,932	24,290	455,868	1,089	43,917	3,229	291,147
2006	22,201	819,931	17,764	481,496	1,109	42,959	3,328	295,476
2007	23,204	826,565	18,737	483,339	1,057	42,033	3,410	301,193
2008	26,908	827,291	22,370	483,728	1,040	41,071	3,498	302,492
2009	21,558	838,974	17,029	492,805	1,008	40,322	3,521	305,847

Figures are as of 31 March
Source: MEXT, http://www.mext.go.jp/english/statistics/index.htm (accessed 29 March 2012)

At the beginning of the 21st century, the government ministries were restructured, in particular the ones responsible for science and technology: the Science and Technology Agency (STA), which formerly belonged to the Prime Minister's Office, was integrated into the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and a small section into the Ministry of Trade and Industry (MITI) which was then transformed into the Ministry of Economy, Trade and Industry (METI). The Council of Science and Technology Policy (CSTP) under the leadership of the Cabinet Office was newly established as the major coordinating organ to formulate science and technology policy.

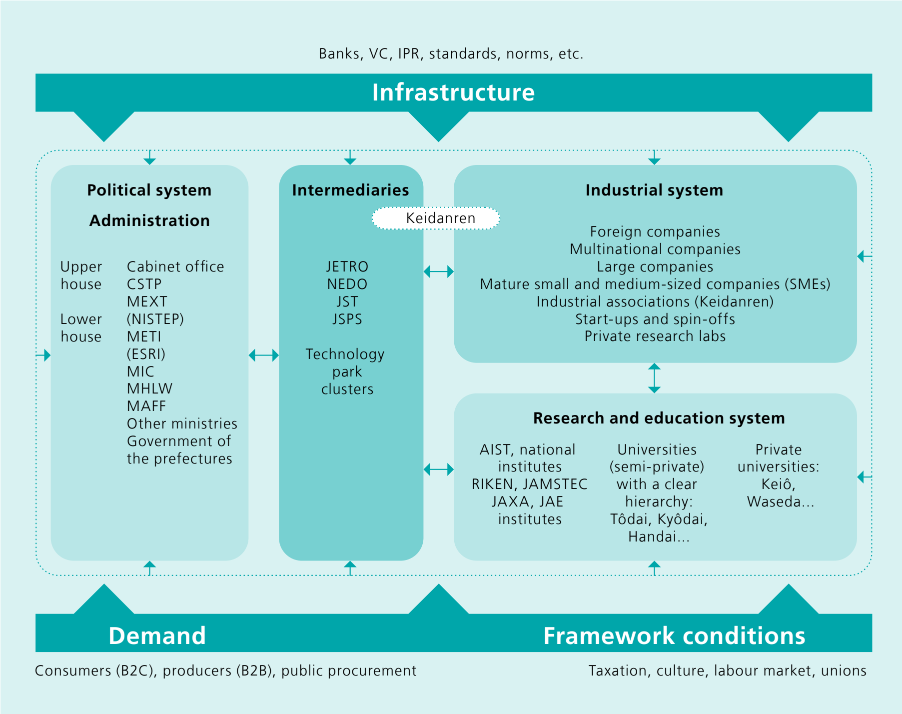
The second large reform concerns the intermediaries. The intermediaries have always played an important role, but now their role has become even stronger. The national laboratories (especially in Tsukuba Science City and other locations) have been integrated under the aegis of the newly structured National Institute of Advanced Industrial Science and Technology (AIST). In a strategic process, they are being re-organized with the purpose of strengthening the ties between public and private research and achieving better knowledge transfer.

The third reform has taken place in the education sector. Since the 1990s, the pace of the reforms in the education sector has accelerated (Eades et al. 2005), which is particularly true for tertiary education. Some of the key words of the reforms taking place are (see e.g. Wieczorek 2001, p. 178): decentralization and deregulation; diversification and flexibility; individualization and internationalization. Moreover, in 2004, the public universities were semi-privatized when they were transformed into so-called "Independent Administrative Institutions" (IAI). This change aims at increased competitiveness in research and education, enhanced accountability together with the introduction of competition, evaluation, and strategic and functional management of national universities (Yonezawa 2008).

A new player in the innovation system is the Intellectual Property High Court. Its introduction in 2006 is a sign that protecting intellectual property rights is regarded as having an important function in the innovation system. IPR questions and strategies are also addressed by the new IPR headquarters at the universities.

The main actors in the Japanese innovation system remain the large Japanese companies, now acting in global markets, but often still doing research at their home base. Some of them have traditionally weak links with political and administrative institutions; others are closely related to ministries. Universities and colleges, political and administrative institutions with their large laboratories are other important actors. A picture of the innovation system is shown in Figure 5–1.

Figure 5–1: Japanese innovation system



Source: Cuhls and Wieczorek (2010), own compilation

New actor: Council for Science and Technology Policy (CSTP)

Meanwhile, the Council for Science and Technology Policy (CSTP; for details see CSTP 2006a) has become a new and strong player in the innovation system. Before the reform of the ministries, Monbushô and MITI both had their own advisory council. In 2001, the CSTP – as well as the Council on Economic and Fiscal Policy or the IT Strategic Headquarter – was established within the Cabinet Office as one of the 73 government top councils based on the "Law for Establishing the Cabinet Office". The CSTP consists of 14 members and the Prime Minister himself, who chairs the council. Six cabinet members are heads of ministries closely related to S&T policy. The CSTP itself represents parts of the innovation system. It has a secretariat with a regular staff of almost 100, most of whom have been seconded from various ministries, from research organisations or companies.

Science Council of Japan (SCJ)

The purpose of the SCJ is to promote the advancement and development of science and its mission is reflected and spread in administration, industry and national life. The SCJ was established as a "special organization" under the jurisdiction of the Prime Minister in January 1949. It is now organized by 210 members representing about 790,000 scientists in Japan. It independently conducts activities to deliberate and implement important matters concerning science, and to promote liaisons between research and science, and to improve efficiency. In April 2004, the "Law to Amend Part of the Science Council of Japan" was enacted. The SCJ was then placed under the authority of the Cabinet Office in April 2005 and its new organisation was inaugurated after implementing operational reforms. In order to contribute to the promotion of Japanese science and technology, in close cooperation with the CSTP, the new SCJ is promoting activities with emphasis on policy recommendations, the coordination of scientists, international scientific exchanges, promotion of public acceptance of science and promotion of scientific capabilities of young people.

The ministries

Nowadays, the ministries have no strong direct power, if indeed they ever have had. After the reform of the ministries and the abolition of some agencies in the year 2000 (discussion see Cuhls 2008), we see a new organisational chart in the administration of science, technology and innovation in Japan (see also CSTP 2006a): the former Environmental Agency has become the MoE; the STA was integrated into MEXT, which is responsible for the national universities and laboratories. The National Institute of Science and Technology Policy (NISTEP) is now also integrated into MEXT. NISTEP is an important actor in the innovation system because it generates indicators for the government, is active in science and technology foresight activities, for which it has an internal center (STFC), and is linked to innovation policy-making. NISTEP is often in charge of informing the CSTP, thus preparing and providing relevant information for the highest science and technology council in Japan. Foresight in NISTEP, which is performed every five years to inform the stakeholders of the innovation system about future occurrences, has even been intensified.

MEXT supervises also other public IAI, such as the Institute of Physical and Chemical Research (RIKEN), or the Japanese Agency of Marine Science and Technology (JAMSTEC).

The second ministry which has always played an important role in innovation, mainly in applied research (but also basic research in selected fields like energy, e.g. for solar energy) is the former MITI. It has been reformed and is now called Ministry of Economy, Trade and Industry (METI). METI is still responsible for the national research institutions headed by the National Institute of Advanced Industrial Science and Technology (AIST) which integrates the large national research facilities under one roof, and for the New Energy and Industrial Technology Development Organization (NEDO), which is the intermediate organisation for energy issues.

METI still plays an important role in the innovation system via the intermediaries, but it has lost its "information monopoly" (assumed e.g. by Freeman 1987, p. 36) and the control over financial institutions such as the Japan Development Bank or the Fiscal Investment and Loan Plan. The large companies only partly care about the policy of METI. They act independently (mainly in global markets) and most of them accept the policy of METI as a framework. Nevertheless, there are still strong interconnections between METI and the companies, often expressed as exchanges on a personal level, which means direct communication or the exchange of personnel for a certain period of time. METI is also responsible for small and medium-sized company policy and provides strategic papers for them (see www.meti.go.jp).

The former Economic Planning Agency (EPA), in earlier times famous for its prognostic studies as preparation for the five-year plans, was integrated into the Cabinet Office and expanded its functions. Parts of the EPA became an institute in the Cabinet Office, the Economic and Social Research Institute (ESRI). As the Cabinet Office's think tank, ESRI links theory with policy.

Even the Japanese External Trade Organization (JETRO) which belongs to METI has to be mentioned as part of the Japanese innovation system. It was founded nearly 50 years ago in order to support Japanese companies when entering foreign markets and to give them access to related information. Therefore, JETRO has often been called the "Japanese spies" who are well informed about foreign innovation plans. In Figure 5–1, they are included in the section of the intermediaries. JETRO has 38 offices throughout Japan which provide information and advice on potential trading partners as well as regional investment environments. JETRO's regional offices work with METI Bureau and prefectural governments on inward investment promotion. JETRO has been reformed and (among different new programmes) JETRO Invest Japan Business Support Centers (IBSC) were established in 2003. The IBSCs are often frequented and it is assumed that this has already led to direct investments in Japan. JETRO is not directly involved in fostering the development of science and technology, but it helps to acquire knowledge from other countries, which is also supposed to lead to innovation. Moreover, they foster cooperation and help to bring innovations to the (export) markets.

International scientific exchange organisations

The Science Council Japan (SCJ) represents Japan through its affiliation with 48 international scientific organisations, including the International Council for Science (ICSU) and the International Academy Council (IAC). It has been striving for cooperation with various countries by actively participating in six international academic cooperative projects, including the International Geosphere-Biosphere Programme (IGBP). The OECD, APEC, ASEAN, IEEE, ISO, etc. are certainly also important regarding internationality. The Science Council of Asia (SCA), an international scientific organisation which aims at promoting collaboration and cooperation among Asian countries in scientific research, convenes annually on the topic of sustainable development in Asia.

Intermediaries

While they have always served to bridge the gap between public and private research, the importance of intermediaries in the Japanese innovation system has increased in recent years. In Figure 5–1 it is rather difficult to represent them because some of them have double functions, for example those institutions which are now "intermediaries" and have already existed for a long time (like the National Institute of Advanced Industrial Science and Technology), but in a different setting. At first, they were organized similar to the headquarters of the national institutes, as pure funding institutions, or even as the network which holds the institutes together. Nowadays, they have headquarters which define visions, missions and strategies in all these cases. On the other hand, these headquarters act as the link and transfer organisation from the ministries to the institutions, sometimes even to industry.

As part of the administrative reform in 2001, the legal status of most national research institutes was changed to Independent Administrative Agencies (IAA). This greatly increases their flexibility in terms of personnel and financial management. Regular evaluations are carried out by the ministries. Some funding agencies as well as some R&D performing organisations have been called Special Public Corporations; in 2003 most of them were also transformed into IAA.

The Japan Society for the Promotion of Science (JSPS, *gakushin*) is an IAA, and was founded in 1932 as a non-profit foundation through an endowment granted by Emperor Shôwa to contribute to the advancement of science in all fields of natural and social sciences and the humanities. It became a quasi-governmental organisation in 1967 under the auspices of the Monbushô, and since 2001 under MEXT.

The Japan Science and Technology Agency (JST, not to be confused with the former Science and Technology Agency before 2001) is an IAA with direct links to and financed by MEXT. Predecessors of this organisation were the Japan Information Center of Science and Technology (JICST) which existed from 1957 to 1996 and which was fused with the Research Development Corporation of Japan (JRDC). It existed from 1961 to 1996, and until 2003 it formed the Japan Science and Technology Corporation. In 2003, it was formed into an "agency". JST also manages a Research Institute of Science and Technology for Society (RISTEX) which aims to promote research and development starting from the needs perspective.

The New Energy and Industrial Technology Development Organization (NEDO) was established by the Japanese government in 1980 to develop new oil-alternative energy technologies. In 1988, NEDO's activities were expanded to include industrial technology research and development, and in 1990, environmental technology research and development. Activities to promote new energy and energy conservation technologies were subsequently added in 1993. Following its reorganisation as an incorporated administrative agency in October 2003, NEDO is now also responsible for R&D project planning and formation, project management and post-project technology evaluation functions. The activities of NEDO are concentrated on different technologies and themes, e.g. in the industrial sector nanotechnology and materials development, biotechnology development, electronics, information and communications technologies development, industrial technology development (machinery, manufacturing and processes, aerospace, etc.), projects related to medical, welfare and ergonomics technology, global environment industrial technology research and development projects, chemicals and others.

In 2003, the Institute of Space and Astronautical Science (ISAS), the National Aerospace Laboratory of Japan (NAL) and the National Space Development Agency of Japan (NASDA) were merged into one IAA: the Japan Aerospace Exploration Agency (JAXA). This agency therefore not only acts as an intermediary but also performs research itself. While space development and utilization, aviation research and development are the measures to achieve the nation's policy objectives, JAXA's contribution is to promote a mission and to develop a vision in space science and technology. As a core organisation for aerospace technology, JAXA will promote consistent activities, from basic research to technology development and utilization.

Research and education system

The Japanese university system consisted of private and public universities. Students had to pay tuition fees at every university, however private universities were and are much more expensive. Compared to Germany, education in Japan is very expensive and people often need a loan in order to be able to afford to send their children to university. The Japanese education system is often called meritocratic (*gakureki shakai*).

Expanding the independence of management in the areas of budget, organisation and personnel affairs, national universities (which account for less than 20 % of the students in higher education, but 80 % of the national budget) and inter-university research institutes were incorporated under the National University Corporation Law in April 2004 and were turned into Independent Administrative Institutions (IAIs). In the mid-term, even the financing of the national universities will change and the government has also sent clear signals indicating that it would like to see the number of national universities decrease in future (e.g. with a centres of excellence program). This has already resulted in some mergers between national universities.

Another major point of the 2004 reforms was the development of a rigorous assessment system. The new reforms were designed to reduce the difficulties in obtaining the external accreditation needed to establish new departments and courses and to replace it with much stringent ex-post-facto assessments. All national universities have been required to produce six-year plans and targets against which their performance will be judged and which will determine their subsequent funding (Goodman 2008). Third-party evaluation agencies, accredited by MEXT, have been set up in order to undertake the evaluation of institutions' teaching and research. A final point in the current reform process has been a greater emphasis on transparency and accountability (Goodman 2008).

In 1995, the Ministry of Education started a special program for Centres of Excellence (COE), which aimed at selectively improving university research environments to world-class level. Annually, around half a dozen new centres were selected and awarded a five-year grant. In 2002, a new COE program was started, the "Center of Excellence Program for the 21st Century". Its focus is to improve doctoral programmes at universities (develop graduate schools in different fields). The aim is to establish 30 centres of excellence nationwide (in 2005, there were more than 600 universities in Japan) (European Commission 2005, p. 82). The background of the new program is a perceived need to concentrate research resources at those universities which have the potential to achieve world-class level in their research. Two-thirds of all grants were divided among 14 universities, which were awarded four or more COEs (e.g. the University of Tôkyô, Kyôto University).

Universities, even after the reforms, are not the major player in transferring knowledge to the market, although their ties to industry are strengthened and there are more and more direct cooperations (Kondo 2005). Especially the huge increase of national funds for basic research during the last 20 years encouraged them to enter the research market. But most of the universities concentrate more on education and less on research. This might be changing in the mid-term future because of their changed status as IAI since 2004.

Academic research in Japan is conducted in undergraduate departments, graduate courses, research laboratories and research facilities at universities, as well as at joint-use inter-university research institutes, which are not tied to a specific university. Research laboratories devoted to research in designated specialized fields have also been established at universities. At the end of FY 2005, a total of 59 research laboratories had been established at national universities, including 20 research institutions for the joint use of the nation's universities (MEXT 2006, p. 294).

Research projects such as neutrino research conducted by the Institute for Cosmic Ray Research (ICRR) of the University of Tôkyô have produced research results of the highest international standards (MEXT 2006, p. 294). Sixteen existing institutes were reorganized into four organisations (National Institutes for the Humanities, National Institutes of Natural Sciences, High Energy Accelerator Research Organization, and Research Organization of Information and Systems) with the corporatization of national universities in 2004. Nevertheless, the inter-university research institutes continue to make significant contributions to research advances in a variety of fields by acting as centres for promoting joint research between researchers employed in universities nationwide, and by providing a place for joint use of facilities, equipment, and materials which are unique or large in scale. Projects such as the B-Factory project of the High Energy Accelerator Research Organization (KEK) and SUBARU, an optical-infrared telescope, a project of the National Astronomical Observatory of Japan (NAOJ) also promote cutting-edge international research. In addition, each organisation is making efforts to create new sectors beyond the framework of existing organisations and sectors by establishing collaborative organisations and facilitating exchanges of researchers in different sectors.

Public and private research institutions

There are many public and private research institutions in Japan. Their programmes, contribute to basic research as well as to innovation. In the following, only those institutions are mentioned which play a large role in the innovation system.

The National Institute of Advanced Industrial Science and Technology (AIST) is not a governmental institution, although it is to a large extent funded by the Japanese government. A large part of the research performed at AIST has direct relevance for industry, but has so far received relatively little financial support from industry. AIST was established in 2001, however, AIST and its ancestors have been active in "contributing to society through continuous advancement in technologies and support to Japanese industries" since 1876. AIST is meanwhile the head of the national laboratories and has started a consolidation process in basic research and the national institutes linked to it, see above. In many cases, AIST acts as an intermediary (cf. Figure 5–1).

The mission of the *Institute of Physical and Chemical Research (RIKEN)* is to conduct comprehensive research in science and technology (excluding the humanities and social sciences) as provided for under the "RIKEN Law", and to publicly disseminate the results of its scientific research and technological developments. RIKEN carries out high level experimental and research work in a wide range of fields, including physics, chemistry, medical science, biology, and engineering, covering the entire range from basic research to practical application. RIKEN was first organized in 1917 as a private research foundation, and re-organized in 2003 as an IAI under the auspices of MEXT.

Under MEXT, there is the Japanese Agency of Marine Science and Technology (JAMSTEC). The title of this agency sounds like that of an intermediary, but like AIST, its status can be seen as an in-between intermediary and research institution. JAMSTEC is more of a research organisation as it hosts different research institutions. The major one is the Marine Technology Center (MARITEC), which has been involved in the development of various leading-edge technologies, aimed at driving forward research and studies which are already underway at JAMSTEC.

There are many independent institutes or university institutes on the research market, e.g. the Kyûshu Institute of Technology (KIT), the Tôkyô Institute of Science and Technology or the Japan Advanced Institute of Science and Technology (JAIST), to name but a few.

The industrial sector

Multinational corporations (incl. R&D centres) remain the main actors in the Japanese innovation system. Their share of R&D expenditures in the country is more than two-thirds. Nearly half of the R&D expenses in the private sector are spent by the top 10 large companies. They have their own research laboratories, where they perform basic research and product development. The central research institutes of large companies have few links with university and public research institutes. In the meanwhile, some of them are no longer domestic companies, but global actors (like Sony, Canon, Fujitsu) with R&D centres all over the world, which still do most of their research at the home base. This turns out to be a disadvantage in times of globalisation. On the other hand, many international companies are also present on the Japanese market, some of which have relocated their R&D facilities to Japan in order to be close to customers and knowledge. And increasingly, the suppliers are following, e.g. the large automobile suppliers (Bosch etc.) are all present in Japan. Some of the companies look carefully at the governmental policy for innovation, science and technology. But most of them are strong enough just to regard this as a framework condition.

The globally competitive multinational corporations coexist with a large number of small and medium-sized enterprises (SMEs), where 70 % of Japanese workers are employed. But these SMEs are currently highly dependant on the Japanese market. In recent years they have been trying to cooperate with companies abroad.

In Japan banks are the main providers of venture capital – and that means start-ups find it difficult to get funding. Previously, Japanese-German foresight surveys often stated that funding was one of the major obstacles in high-technology sectors in Japan (Cuhls et al. 1995; Cuhls and Kuwahara 1994). Since 2000, when it became possible for professors at national universities to simultaneously hold positions in private sector businesses, the number of university-based venture companies in Japan has increased noticeably (from 128 in 2000 to more than 1,000 in 2005), but this is still low by international standards (MEXT 2006, p. 70).

Industrial Associations play a large role in promoting and fostering science, technology and innovation in Japan. One of the very large players is the Japan Federation of Economic Organizations (*Nihon Keidanren*). Nihon Keidanren was established in 2002 by fusing Keidanren and Nikkeiren. Additionally, associations can be found in every large innovation field, from nanotechnology to robots. A few examples are the Japan Robot Association, the Healthcare Engineering Association of Japan, the Japanese Association of Healthcare Information System Industry (JAHIS) or the Support Center for Advanced Telecommunications Technology Research.

Scientific societies also promote science and technology in the innovation system. Some of the well-known examples are the Robotics Society of Japan (RSJ), Japan Society of Mechanical Engineers (JSME), the Japan Society for Precision Engineering (JSPE) or the Information Processing Society of Japan (IPSJ). They also represent the strong thematic fields of Japanese science and technology.

Collaboration between the public and private sectors

Science and technology parks as well as industrial clusters have developed strongly in Japan in recent years. Tsukuba Science City is the best known and well-established science and technology park. A new science park is Kansai Science City between Osaka, Nara and Kyôto. Not all of these technology parks have been that successful in bringing together people from universities, national laboratories and industry. Especially parks that were out of reach were not attractive for researchers (Hokkaidô etc.) at first, but meanwhile it has been possible to establish industrial clusters even in these locations. Cluster issues are: Automobile and Transport Equipment, Pharmaceuticals and Healthcare, ICT (Information and Communication Technology), Semiconductors, Biotechnology, Electronic Components and Devices, Precision Machinery (Robotics, Optics, Precision Instruments, etc.), Life Science etc.

There are also regional incentives for investments: some regions define cluster-like thematic areas and offer incentives for national and international investments to attract foreign firms. These clusters are not only intended to foster production, but also to conduct research and innovation. Some of the science parks have only regional sponsors and some of them even host big science facilities. It is a little known fact that the big synchrotron radiation facility SPRING 8 which is located in Hyôgo prefecture is to a large extent regionally financed (run by the Japan Synchrotron Radiation Research Institute).

In Japan's regions integrated innovation support systems can be found. One of the most traditional innovation support agencies for SMEs in Japan are the so-called kôsetsushi centres. They have been set up and financed by prefectural governments. These centres form a dense network of 172 centres in Japan.

In 2005, a new organisation occurred: 41 institutions were either authorized or accredited as technology licensing offices (TLOs) under the Law for Promoting University-Industry Technology Transfer (1998). In addition, JSPS (supported by METI and MEXT) has sponsored transfer support centres which provide advice on patenting, feasibility studies on technologies as well as financial support for applications for overseas patents. The number of university-based start-up companies totalled 531 as of the end of 2003, steadily approaching the goal of 1,000 such companies set by METI.

5.5 Is the Japanese innovation system at a crossroads?

The JIS is specific, in fact, every country is specific in its NIS because the system does not exist in a vacuum but is embedded in culture, literature, history, economic and the social framework of the country. Especially "history matters" and "institutions matter" (Storz and Schäfer 2011) and therefore, there is a permanent change in any innovation system. The question is rather whether there are evolutions or whether there is a radical shift.

Lee (2006, p. 73) sees Japan in a paradigmatic crisis since the 1990s: In the beliefs held by many Japanese people about their own political-economic system, there is no consensus or underlying common understanding as often assumed by authors of the nihonjinron. Lee defines nihonjinron as a "broadly based ideological stance for Japan's nationalism" between "unqualified ethnocentrism, extolling Japan's cultural genius" and "depressed soul-searching". There are ups and downs in this debate of Japanese uniqueness, more or less nihonjinron. Interestingly, Lee assumes a connection between institutional reforms and nihonjinron: "If institutional reforms in Japan take place only during a period of strong negative Nihonjinron, there will have to be a change from positive Nihonjinron to a negative one before they are undertaken". This means that first of all, a change in the national identity has to take place and after that reforms are possible. This is an interesting thought in relation to the nationalism debate in Japan, which however needs further examination.

Perez suggested that "depressions represent periods of mismatch between an emerging new paradigm and the old institutional framework. Big boom periods of expansion occur when there is a 'good match' between a new techno-economic 'paradigm' or 'style' and the socio-institutional climate" (citation of Perez 1983 in Freeman 1987, p. 76). Currently, Japan seems to be at such a mismatch-point.

Obviously, the perpetual catch-up syndrome that was observed especially between the 1950s and the 1980s with its permanent hunger and restlessness to become no. 1 and gain knowledge came to an end at the end of the century (see e.g. Lee 2006; Odagiri and Goto 1993). In many research fields, Japan is now among the leading countries and the strategies that were successful at a time when the country was catching-up do no longer apply.

Neglecting the debate about the Japaneseness, one can state that the year 2011 with its natural and man-made disasters is a new demarcation line that puts the Japanese Innovation System once more at a crossroads. Especially the sectoral innovation systems (energy, environment) are under pressure and are in question because the events of "March 11" demonstrate the vulnerability in parts of this sector. Even some of the actors in this system are under suspicion. The question is rather *how long it will take* to change such a national and sectoral system – the question is not *whether* it will change.

5.6 Outlook

There are a lot of challenges in Japan – as in other countries. As already stated in Cuhls and Wieczorek (2010) more and more attention is being paid to Human Resources. The high level of education should also enable the Japanese to be more flexible and therefore meet the challenges of the coming decades. Nevertheless, career paths and working environments still need to become more flexible. Reforms in recent years are targeting more creativity and individual empowerment. This is necessary because Japan is facing a huge demographic change which will challenge the availability of well-educated persons.

Mobility and internationality are major challenges for industry as well as for the Japanese education system (see MEXT 2006). Most importantly, the lingua franca English has to become more widespread in Japan.

The high standard of education is one of the reasons for the continuing high quality inside the Japanese innovation system. But Japan's isolation from the outside world is becoming more and more a problem in terms of its research. Scientific publications by Japanese authors are cited internationally only half as often as those by their American or Swiss colleagues. Japanese do not publish in international journals as often as American or European researchers, and hardly ever apply for a patent jointly with a foreign partner. Recent data do not show signs that this situation is improving. Moreover, the percentage of foreign researchers among highly skilled workers is extremely low in Japan compared to international levels. Without opening their innovation system to foreign researchers (or to put it in other words: without attracting foreign researchers), Japan will face a shortage of researchers in the future (foresight figures can be found in e.g. MEXT 2003, see also MEXT 2006 or 2010).

The infrastructure in Japan is very good. General infrastructure for traffic (highways, trains, airports and harbours) is very dense and convenient. IT networks and mobile communication are very well developed – the only challenge here is their maintenance and update.

The Japanese market is over-regulated and fenced in against international competition by barriers for market entry. For example, the licensing procedure for a new business takes an average of 23 days – in France a mere seven. Some sectors are regarded as especially inefficient in Japan, these are: construction, trade, and services.

The Japanese system for venture capital is rather bank-oriented. This is why the whole economy was hit so badly by the bank crises and it remains vulnerable. Also, innovations are more financed by banks than by the real venture capital market (Nabor 2007; Storz and Schäfer 2011).

There are many new laws and regulations in Japan, which all deal with innovation, and transfer of science and technology into the market. They seem to be rather successful in playing a role in coordinating the different actors of the innovation system. The most important one is the Science and Technology Basic Law (since 1995, Legislation No. 130), which is unique. Based on this law, Science and Technology Basic Plans are developed to give a clear framework and fill the law with life, i.e. budgets. Currently the Fourth Basic Plan for the years 2011 to 2016 is in effect. An innovation strategy, further developed from a paper called "Innovation 25" (CSTP 2006b) supports the strategic priority-setting and coordination of actors in the system. Further ideas can be found in Hirasawa (2010).

The major current challenge is to overcome a kind of "depression" that is noticeable in the country since it was hit by the three disasters. The first reaction was to do "business as usual" – that is why Japan was admired for keeping so calm. But there are different possibilities of impacts on the innovation system in years to come:

– The first one is that Japan stays "depressed", the system is not running smoothly and the actors are losing more and more motivation.
– The second one is the opposite: A new euphoria, driven by the disasters similar to the new establishments of institutions after World War II might occur. In this case, the motivation is gained by the necessity of "getting up" and "re-starting" once more, to rise like a phoenix from the ashes.
– In fact, the future reality will be somewhere in-between: The first depression seems to be waning now. Many people are re-motivated and one can even notice a new societal feeling of mutual help and care, at least in some regions of the country. Some economists currently argue that Japan will prosper economically once more – the first signs and signals can already be figured out and measured (see the discussion of the National Bureau of Asian Research, NBR Forum, http://www.nbr.org/, during February and March 2012).

This contribution was written in March 2012, exactly one year after the disasters. The expected sudden changes in the innovation system have not occurred until now – reforms and major changes take their time, especially in Japan and under the circumstances of rather weak political guidance (change of Prime Minister etc.). But looking back at the last 10 years and what in hindsight has already changed, one can be sure that Japan will recover and remain on international markets with its stable innovation system as a backbone – with some cultural specifities, its history and the people who were not only shocked but are used to changes induced by natural disasters (earthquakes, typhoons, floods, heavy rains…). At least, these people will not give up – and remain a huge factor in the globalised world of the future.

The second lesson is that even if everybody is complaining about missing structural reforms, the case of Japan demonstrates how dynamic NIS are in the long run, and that they are steadily changing although this change is not visible at first sight but only when looking back and reconsidering the framework conditions and historical circumstances. Therefore, history matters, circumstances matter, culture matters and systems as well as education and institutions in general matter. This is the reason why we still have a problem to really draw a comprehensive model of the National System of Innovation with its different dimensions, be it in Japan or elsewhere.

As long as we do not have this comprehensive model, we can at least update what we know. Revisiting a changing system at certain points in time is therefore not only worthwhile doing. It is even necessary as time goes by. Only the change itself is permanent – this old saying is inherent in the timescale problem – and remains unsolved in the descriptions of the National System of Innovation in the current static models. Therefore, historic updates – revisits – are crucial.

5.7 References

Agency of Industrial Science and Technology (AIST) (Ed.) (1995): *AIST 1995, Ministry of International Trade and Industry; Industrial Science and Technology Frontier Program ISTF*. Tokyo.

Callon, S. (1995): *Divided Sun. MITI and the Breakdown of Japanese High-Tech Industrial Policy, 1975–1993*. Stanford/California: Stanford University Press.

CSTP (2006a): CSTP – Council for Science and Technology Policy. Online: www8.cao.go.jp/cstp/english/policy/about-cstp.pdf (accessed 29 July 2008).

CSTP (2006b): Innovation 25. Online: www.kantei.go.jp/jp/innovation/dai5/siryou1-2.pdf (accessed 21 July 2008).

Cuhls, K. (1998): *Technikvorausschau in Japan. Ein Rückblick auf 30 Jahre Delphi-Expertenbefragungen*. Heidelberg: Physica (dissertation).

Cuhls, K. (2005): Changes in Conducting Foresight in Japan. In: Hunter, J. and Storz, C. (Eds.): *Institutional and Technological Change in Japan's Economy: Past and Present*. London: Routledge, 188–205.

Cuhls, K. (2008): Änderungen im japanischen Innovationssystem und "neue" japanische Innovationspolitik (changes in the Japanese Innovation System and "New" Japanese Innovation Policy). In: Wieczorek, I. (Ed.): *Japan 2008. Politik, Wirtschaft und Gesellschaft*. Berlin: VSJF, 69–97.

Cuhls, K., Breiner, S. and Grupp, H. (1995): *Delphi-Bericht 1995 zur Entwicklung von Wissenschaft und Technik – Mini-Delphi*, Karlsruhe. Bonn: BMBF.

Cuhls, K. and Kuwahara, T. (1994): *Outlook for Japanese and German Future Technology, Comparing Technology Forecast Surveys*. Heidelberg: Physica.

Cuhls, K. and Wieczorek, I. (2010): Japan: Innovation System and Innovation Policy. The Structure of the Japanese Innovation System. In: Frietsch, R. and Schüller, M. (Eds.): *Competing for Global Innovation Leadership: Innovation Systems and Policies in the USA, Europe and Asia*. Stuttgart: IRB.

Eades, J., Goodman, R. and Hada, Y. (2005): *The "Big Bang" in Japanese Higher Education: The 2004 Reforms and the Dynamics of Change*. Melbourne: Trans Pacific Press.

Edquist, C. (1997): *Systems of Innovation: Technologies, Institutions and Organizations*. London: Pinter.

Ehrke, M. (1994): Industrie- und Technologiepolitik in Japan. In: Fricke, W. (Ed.): *1994 Jahrbuch Arbeit und Technik*. Düsseldorf, 62–70.

Eto, H. (1984): Behaviour of Japanese R&D Organizations – Conflict and Its Resolution by Informal Mechanisms. In: Eto, H. and Matsui, K. (Eds.): *R&D Management Systems in Japanese Industry*. North Holland, Amsterdam, New York, Oxford, 139–238.

European Commission (2005): *European Trend Chart on Innovation, Annual Innovation Policy Trends*, Report for Japan, China, Korea, Taiwan, Singapore, India, Malaysia, Thailand, Indonesia. Brussels: European Commission.

Freeman, C. (1987): *Technology Policy and Economic Performance: Lessons from Japan*. London: Pinter Publishers.

Freeman, C. (1988): Japan: a new national system of innovation? In: Dosi, G., Freeman, C., Nelson, R.R., Silverberg, G. and Soete, L. (Eds.): *Technical Change and Economic Theory*. London: Pinter, 330–348.

Freeman, C. (2008): *Systems of Innovation. Selected Essays in Evolutionary Economics*. Cheltenham, Northampton: Edward Elgar.

Fuji, K. (1994): Industriepolitik in Japan. *Zeitschrift für Betriebswirtschaft*, 64, 150.

Fukugawa, N. (2008): Evaluating the strategy of local public technology centers in regional innovation systems: evidence from Japan. *Science and Public Policy*, 3, 159–170.

Goodman, R. (2008): Understanding University Reform in Japan through the Social Science Prism. *Learning and Teaching: The International Journal of Higher Education in the Social Sciences*, 1, 1–26.

Hall, J.W. (1968): *Das japanische Kaiserreich*. Frankfurt am Main: Fischer Taschenbuch Verlag.

Handelsblatt (1996): Tokio stockt Etat für Forschung auf. Japan, Leistungsprinzip in der Wissenschaft, *Handelsblatt* (25-06-1996).

Hauser, W.B. (1997): Tokugawa Japan, 1600–1867. In: Embree, A.T. and Gluck, C. (Eds.): *Asia in Western and World History*. New York: East Gate Book, 505–513.

Hentschel, V. (1986): *Wirtschaftsgeschichte des modernen Japans 1*, Wissenschaftliche Paperbacks Sozial- und Wirtschaftsgeschichte. Stuttgart: Steiner-Verlag-Wiesbaden-GmbH.

Hilpert, H.G. (1993): Japanische Industriepolitik – Grundlagen, Träger, Mechanismen. *ifo-Schnelldienst*, 17–18, 20.

Hirasawa, R. (2010): "Kagaku gijutsu senryaku honbu (kashô)" no aru beki sugata wo kangaeru (original in Japanese, reflections about the shape that a "Science and Technology Strategy Headquarter [working name]" should have. *Science Journal KAGAKU*, Special Print, 80, 306–315.

Inoue, K. (2003): *Geschichte Japans*, original: Nihon no rekishi (History of Japan). Köln: Special edition Parkland.

Itoh, M., Okuno, M., Kiyono, K. and Suzumura, K. (1988): Industrial Policy as a Corrective to Market Failures. In: Komiya, R., Okuno, M. and Suzumura, K. (Eds.): *Industrial Policy of Japan*. Ithaca.

Johnson, C. (1982): *MITI and the Japanese Miracle The Growth of Industrial Policy 1925–1975*, The Growth of Industrial Policy 1925–1975. Stanford, California.

Keizai Dôyûkai (1996): Making Japan a Leading Technological Innovator – Working for World Harmony and Prosperity. *Science & Technology in Japan*, 55, 50–56.

Kodama, F. (1991): *Analyzing Japanese High Technologies: The Techno-Paradigm Shift*. London: Pinter.

Kondo, M. (2005): Comprehensive Review of the Achievements of Japanese Science and Technology Basic Plans, Presentation to "Evaluation – Connecting Research and Innovation" conference. Manchester, 17 November 2005.

Kuwahara, T., Cuhls, K. and Georghiou, L. (2008): Foresight in Japan. In: Gerhold, L., Cassingena Harper, J., Keenan, M., Miles, I. and Popper, R. (Eds.): *The Handbook of Technology Foresight, Concepts and Practice. PRIME Series on Research and Innovation Policy*. Cheltenham: Edward Elgar, 170–184.

Lee, C.H. (2006): Institutional reform in Japan and Korea. Why the difference? In: Blomström, M. and La Croix, S. (Eds.): *Institutional Change in Japan*. New York: Routledge, 71–94.

Linhart, S. and Pilz, E. (Eds.) (1999): *Ostasien. Geschichte und Gesellschaft im 19. und 20. Jahrhundert*. Wien: Promedia.

Lundvall, B.A., Intarakumnerd, P. and Vang, J. (2006): Asia's innovation systems in transition: an introduction. In: Lundvall, B.-A., Intarakumnerd, P. and Vang, J. (Eds.): *Asia's Innovation Systems in Transition*. Cheltenham, Northampton: Edward Elgar, 1–20.

McMillan, C.J. (1996): *The Japanese Industrial System*, 3rd edition. Berlin, New York: Walter de Gruyter.

MEXT (2003): Science and Technology, Japan's Science and Technology Policy. Tokyo: Ministry of Education, Culture, Sports, Science and Technology. Online: http://www.mext.go.jp/english/org/science/34.htm (accessed 13 March 2009).

MEXT (2006): White Paper on Science and Technology 2006 – Challenges for Building a Future Society – The Role of Science and Technology in an Aging Society with Fewer Children. Tokyo: Ministry of Education, Culture, Sports, Science and Technology.

MEXT (2010): White Paper on Science and Technology 2010 – A New Frontier to Be Extended by Value-creating Human Resources – How Science and Technology Should Be for Japan to Make a New Start. Tokyo: Ministry of Education, Culture, Sports, Science and Technology. Online: http://www.mext.go.jp/english/whitepaper/1302537.htm (accessed 27 March 2012).

NABOR, A. (2007): Finanzierung von Zukunftstechnologien in Japan. In: Moerke, A. and Walke, A. (Eds.): *Japans Zukunftsindustrien*. Berlin, Heidelberg, New York: Springer, 53–79.

NAKAMURA, T. (1995): *The Postwar Japanese Economy. Its Development and Structure, 1937–1994*, original: Nihon Keizai: Sono Seichô to Kôzô, second edition. Tokyo: University of Tokyo Press.

NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY POLICY (Ed.) (1996): *National Institute of Science and Technology Policy, Science and Technology Agency*, (brochure). Tôkyô.

NELSON, R.R. (1993): *National Systems of Innovation: A Comparative Analysis*. London: Oxford University Press.

ODAGIRI, H. (2006): Advance of science-based industries and the changing innovation system of Japan. In: Lundvall, B.A., Intarakumnerd, P. and Vang, J. (Eds.): *Asia's Innovation Systems in Transition*. Cheltenham, Northampton: Edward Elgar, 200–226.

ODAGIRI, H. AND GOTO, A. (1993): The Japanese System of Innovation: Past, Present, and Future. In: Nelson, R.R. (Ed.): *National Innovation Systems, A Comparative Analysis*. New York, Oxford: Oxford University Press, 76–114.

OHMAE, K. (1985): *Macht der Triade: die neue Form weltweiten Wettbewerbs*. Wiesbaden: Gabler.

OHMAE, K. (1991): *The Mind of the Strategist. The Art of Japanese Business*. New York: McGraw-Hill.

PEREZ, C. (1983): Structural change and the assimilation of new technologies in the economic and social system. *Futures*, 15, 357–375.

RESEARCH DEVELOPMENT CORPORATION OF JAPAN (JRDC) (Ed.) (1992): *National Laboratories and Public Organizations in Japan*. Tokyo.

SAKIYA, T. (1987): *Honda Motor. The Men, the Management, the Machines*. Tokyo: Kodansha.

SIGURDSON, J. (1995): *Science and technology in Japan*, Third edition. London: Cartermill International Limited.

STORZ, C. AND SCHÄFER, S. (2011): *Institutional Diversity and Innovation. Continuing and emerging patterns in Japan and China*. Abington, Oxon, New York: Routledge.

SUGIMOTO, M. AND SWAIN, D.L. (1989): *Science & Culture in Traditional Japan*. Tokyo: Tuttle.

THE TECHNICAL CHANGE CENTRE (Ed.) (1983): *A Case Study of Technology Forecasting in Japan. The Next Generation Base Technologies Development Programme*. London.

TSÛSHÔSANGYÔSHÔ (Ed.) (1990): *90nendai no Sangyô Kagaku Gijutsu Bijon* (Industrial Science and Technology Vision for the 90s). Tôkyô.

VAN WOLFEREN, K. (1989): *Vom Mythos des Unbesiegbaren: Anmerkungen zur Weltmacht Japan*, original: The Enigma of Japanese Power. München: Knaur.

WATANABE, C. (1994): Japanese Industrial Science & Technology Policy at a Turning Point – MITI‘s Role and Its New Initiative, Annex 8, International Conference On Unterstanding Government R&D Investment Decisions. Washington.

WATANABE, C. (1995): The Interaction between Technology and Economy: National Strategies for Constrained Economic Environments, The Case of Japan 1955–1992 (= Working Paper of IIASA). Laxenburg.

WIECZOREK, I. (2001): Japans Weg in die Wissensgesellschaft. Teil II: Der Bildungsbereich. *Japan aktuell*, 1/2004, Hamburg: Institut für Asienkunde, 178–185.

YONEZAWA, A. (2008): Quality Assessment and Assurance in Japanese Universities. The Plight of the Social Sciences. In: Manzenreiter, W. and Wieczorek, I. (Eds.): *Social Science Matters: Inquiries into the Current State of the Social Sciences in Japan*: Social Science Japan Journal, 1, Special Issue 11, 69–82.