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# Shifts in Science & Technology Policy in Japan and Switzerland

**Dietmar Braun**

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Patrice Hof

Observatoire EPFL Science, Politique et Société
Rue de Bassenges 4 • CH-1024 Ecublens
http://osps.epfl.ch • osps@epfl.ch


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# Shifts in Science and Technology Policy in Japan and Switzerland


## Abstract

This contribution analyses recent developments in science and technology policy in two countries – Japan and Switzerland - that are often assumed to be of very different traditions and structures: politically, economically and culturally. The main argument is to demonstrate that despite of these differences we find an astonishing convergence of science and technology policies since the 90s, though their basic organisational features remain, of course, very different. This is due to major changes in the perception of how innovation comes about, to the rise of generic technologies and a new philosophy in state action. The article elucidates how the two countries have changed their structures of guidance and implementation in research.



## Résumé

L'article analyse les développements récents dans la politique de la recherche et de la technologie de deux pays - le Japon et la Suisse - dont on sait qu'ils ont une tradition et des structures assez différentes, tant au niveau politique, économique que culturel. L'argument principal est que nous trouvons, malgré ces différences, une convergence étonnante en matière de politique de la recherche et de la technologie dès les années 90. Cela s'explique par les changements fondamentaux au niveau de la perception de l'innovation, par l'importance grandissante des technologies transversales, ainsi que par une nouvelle philosophie autour de l'intervention de l'Etat. L'article montre comment les deux pays ont changé leurs structures de gestion et d'exécution en matière de recherche.

# Introduction

As Kriesi mentions in his article on regime shifts and regime stability (Kriesi 2001), Japan and Switzerland are characterised both by similarities and dissimilarities. When it comes to state organisation and policy profiles in Japan, one could point to the strong and bureaucratic-centralist state tradition, to the unitary character, the "bigness" of the country and the "mercantilist" policy style established after the Second World War, while Switzerland reveals a contrasting picture with characteristics of a small and weak state and a very decentralised and federal administrative tradition. Instead of a mercantilist policy style, Switzerland has founded its policies on a "laissez-faire" or "liberal" attitude. We find similarities above all with regard to styles of conflict regulation: neither in Japan nor in Switzerland, a majoritarian and competitive style of decision-making is acceptable. Instead, it is preferred to find an encompassing consensus and integrate as best as possible dissonant voices. Positive sum solutions are preferred to zero-sum solutions.

Pempel has pointed to the far reaching regime change going on in Japan at the moment, meaning a fundamental shift in existing socio-economic coalitions, political institutions and policy profile (Pempel 1997; Pempel 1998). Kriesi alludes to similar tendencies in Switzerland (Kriesi 2001). I will focus in this article on one policy field, science and technology, and ask if and in what way this policy field has experienced similar radical changes during the 90s and, in particular, what differences and similarities in policy strategies emerge between the two countries. Are these changes linked to the globalisation processes being at the heart of the regime shift in both countries? It will be shown that science and technology policies become a key factor for success in today's policy answers of OECD-countries to globalisation but only if countries can successfully reform their existing science and technology systems. Both, Japan and Switzerland, do not profit from a "goodness-of-fit" of their research systems and must overcome organisational shortcomings, but they have embarked in the meantime on promising reform paths.

To answer the questions, I will start with a comparison of the science and technology systems in Japan and Switzerland during the "old regime" up to the 70s, before I will sketch the economic challenges in the wake of globalisation processes and ensuing strategies of Japanese and Swiss governments under the "new regime".

# Two Types of States and the Implications for Science and Technology Policy

Though science and technology policies are most of the time mentioned together, they have traditionally been organised in different sectors and by different organisations within the research system. This is due to one fundamental difference in the character of the knowledge produced within the research process: scientific or basic research is regarded as a non-excludable, public good with no protected intellectual property rights and is most of the time organised within universities and government-financed extra-university research institutes. Technological research innovates products and production processes and usually results in patents conferring the right to claim money if anyone wants to use the knowledge protected by patents produced by technological research. Governmental laboratories or government-financed extra-university research institutes can be engaged in technology research, but industrial laboratories are certainly predominant in this line of research. According to the classical division of labour, the government finances research as a "public good", while industry takes care of knowledge production leading to a "private good". This division of labour is above all due to the risks involved in basic research: there is no guarantee for enterprises that its findings will finally lead to the development of a profitable product though costs for investments are relatively high. The state has, therefore, usually accepted to take the risks of such uncertain investments.

In the classical model of technological innovation one assumed a straightforward, linear relation between basic research and product development: the free and unguided basic research will result in findings that will be taken up by applied-oriented researchers, transformed into knowledge suitable to technology development and, finally, developed into product and innovation processes within enterprises. Though this "science-push model" (Bush 1990) or "tree-model" (Bieri 1988: 153) is heavily criticised nowadays, it has been the practical guideline for policymakers for many years after the Second World War (Elzinga and Jamison 1995; Guston and Keniston 1994; Stokes 1997). At the same time this model has clearly fostered the separation of the two spheres of knowledge production. How have these spheres been institutionalised in Japan and Switzerland under the "old regime"? Do we find any differences?

## Basic Research

To make a long story short, one could say that Japan has for a long time not paid attention to an active and coherent science and technology policy. If activities were found after the Second World War, they were found – due to the preoccupation of catching-up economically with the West – above all in the technological field where the Ministry of Trade and Industry (MITI) was responsible, rather

than in academic science, which was the sole responsibility of Monbusho, the Education Ministry. Education as such has been hold in high esteem in Japan for more than 100 years. A large number of state and private universities are serving to this end. The state of research conditions and research activities in universities[1], however, was, according to several authors, deplorable until the 90s (Sigurdson 1995; Nakayama 1991; Low et al. 1999; Study Committee 2000). Universities were thought of, similar to the old French tradition, as places of scientific debate and education and less as places for innovative research. And their principal task was supposed to educate engineers, administrators and future researchers who could then work in industrial laboratories (OCDE 1967). In addition, one finds, above all after the Second World War, a permanent tension between universities and the Monbusho bureaucracy about the hierarchical stance of Monbusho concerning university affairs with the consequence that universities attempted to maintain as much freedom as possible from state intervention. Investments of the Japanese state in research in general were comparatively low and even more so with regard to universities. The money distributed was, moreover, not allocated according to performance in research but according to rather rigid and equalising formal criteria[2]. The result of regulatory policies and permanent lack of money as well as other organisational features within universities (as for example the very hierarchical relationships at chairs) and the cultural attitude of avoiding open competition, was a strikingly low performance in internationally competitive publications. The major aim of Monbusho, i.e. to create as much Nobel laureates as possible, failed strikingly. As the Economist resumed ironically: "Being an academic researcher in Japan is, even more than in the West, an occupation that is fitted best for zealous masochists" (Economist, May 25th, 1996: 97).

Switzerland has a very different stance in academic science given its firm anchoring in the European, Humboldt-tradition of university development. Basic research is highly esteemed as a "cultural contribution" and the belief in the "science-push model" has strengthened the position of academic scientists in the research system. While universities in Japan are divided along the lines of public and private, in Switzerland we find a territorial distinction between ten cantonal and two federal universities. The latter ones have been set up to overcome shortcomings in traditional university education in matters of engineering and natural sciences. Though universities in Switzerland are, therefore, held in high esteem, financial problems began to emerge with the rise in student numbers at the end of the 60s and cantons had to demand additional money from the federal government (Braun 1999). This has never resulted in dramatic shortages in research facilities and equipment as in Japan, but only because the federal government started indeed – after several difficulties in getting the right confered by the people to do so – to co-finance cantonal universities to some degree.

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[1] Monbusho finances also in part private universities.

[2] "Funds are decided by a standard formula based essentially on the number of researchers, the nature of research – experimental, non-experimental or clinical – and whether the *koza* [i.e. the professor helding a chair; DB] is in charge of graduate courses" (Sigurdson 1995: 69).

While Monbusho and its "Science Council" has had all competencies to determine policies for national universities, federalism in Switzerland has made it difficult until today to develop coherent policies in university matters. As a result, there were almost no policy initiatives concerning universities until the 90s when matters became more urgent. So, each university depended on the willingness and financial capabilities of its canton and of the federal government respectively. Given the high number of Nobel laureates per capita and in many areas an excellent record in international citation indices, Swiss academics have, nevertheless, had adequate opportunities to fight at the forefront of scientific development. One should, however, mention another important distinction in the academic sector between the two countries: Switzerland always had an open door policy with respect to the engagement of foreign scientists at Swiss universities. Today almost 30% of university professors come from abroad. This is in clear contrast to the situation at Japanese universities, even after a more open policy concerning foreign scientists has been introduced in the 90s.

One should add that – again in contrast to Japan – Swiss governments – both at the federal and cantonal level – have always fostered the promotion of academic research as their predominant goal and not technological research which was, because of ideological reasons, mainly left to the enterprise sector. Academic research is financed first of all, as in Japan, by general university funds. In addition, Switzerland has – following the tradition of the United States and many European countries – installed since 1952 an intermediary and semi-autonomous funding agency, the *Swiss National Foundation*, which allocates research money according to competitive formulas. In Japan, the situation was for a long time very different: intermediary agencies between state and society were not regarded as a suitable policy device given the strong steering ambitions of a centralised bureaucracy. The "Science Council" of Monbusho is directly linked to the Ministry and needs the consent of the Monbusho in decision matters. Within the "Science Council", there is a sub-committee responsible for competitive research funding but until the shifts in the 90s, grants-in-aid have had no significant role for research in universities (Sigurdson 1995: 72) and allocation decisions remained utterly obscure for outsiders.

This description reveals the different emphasis Japan and Switzerland have placed in academic research: in policy terms, it was neglected in Japan while it was fostered and highly esteemed in Switzerland. The performance corresponds to this difference in emphasis: a rather poor performance in basic research in Japan and remarkable results in Switzerland. But both countries demonstrated the same organisational separation of the academic field from the technological field that would cause problems in the 90s.

## Technological research

Technology research traditionally fares better than academic research in Japan. This is in part due to the large share of private financing[3] and in part the result of the overall national strategy of economic adaptation since the Second World War.

Japan's strategy of adaptation is well-known and I can be brief about this here. Being a technological laggard and having been obliged to overcome the destructions of the war, Japan sought its advantage in a fulminous catch-up strategy which incorporated the search for comparative cost advantages by buying basic knowledge abroad and investing into technological research and development to improve product quality through process innovation (Study Committee 2000). Within a time-span of 30 years, Japan has become in this way one of the leading technological countries in the world in information, communication and electronic equipment as well as in car manufacturing. While protecting the small and medium enterprises in the domestic sector, the state engaged itself in the project of building up a successful export nation that could guarantee a large degree of economic and social independence with regard to world turbulences. Pempel has characterised this period as "*embedded mercantilism*". Without any doubt, this label fits also very well the strategies of the Japanese government in technology policies. Technology was not yet seen as *the* decisive production factor guaranteeing comparative cost advantages on the world market, but it was an essential element of refining and developing foreign knowledge and transforming it into competitive products on the world market.

States in technology policy can have in principle either of four aims in order to promote the competitiveness in technologies (Freiburghaus et al. 1991: 90-4):

- a "*liberal*" attitude which is built upon the conviction that the market play is the best way to arrive at comparative cost advantages;

- a "*protectionist*" attitude believing that one should as good as possible protect "infant industries" and nascent technologies from foreign competition until they are competitive;

- a "*mercantilist*" strategy that focuses on the strengthening of the export by an active policy directed to material infrastructure, a developed education system, subsidies and risk guarantees given to enterprises and by actively promoting the technological development;

[3] Traditionally the private sector is financing about 80% of all research expenses in Japan. The only country comparable to this high share of private funding is indeed Switzerland with an average of 75%. Under the "old regime", the private sector was financing almost 100% in technological research, financial subsidies by MITI being relatively scarce. The same patterns holds for Switzerland. And, finally, a last common trait of both countries is the concentration of technological research and funding on some large companies in certain industrial sectors (like electronics, chemical research etc.).

- and the "*attractiveness*"-strategy attempting to ameliorate long-term economic, social and economic conditions for investment and production of world-wide operating enterprises. The last strategy is typical for the period of globalisation starting in the 80s.

Japan has, until the 70s and beginning of the 80s pursued the mercantilist strategy. This means concretely, that MITI as the ministry responsible for technology and export policies has not only sheltered the domestic industry from economic foreign competition but has at the same time done everything in order to help enterprises to develop the technological know-how necessary to develop new products or production processes. This was done less in the form of financial subsidies. Subsidies remained comparatively low. The strength of MITI was rather the "corporatist" organisation of technological and development projects, in which MITI laboratories together with industrial laboratories developed technological promising fields under the active coordination of MITI (Weber 1985). There is no need to elaborate the MITI strategy in detail (but see Pempel 1982; Okimoto 1989). The important point is that the promotion of technology was a component of the building of the "export nation" in Japan and that these policies were developed and executed in close-knit and collaborative communities of industrial leaders and MITI administrators. Other ministries and even the Prime Minister Office had almost no say in this process. Technology policy was the fief of MITI and served the export policy and, therefore, economic growth.

Switzerland is similar to Japan in its financing structure of research (low share of government) and in the concentration of technological research in a few multi-national enterprises. In contrast to Japan, Switzerland has, however, not chosen for a mercantilist strategy but kept its liberal policy style also in technology policy-making. Evidently less challenged than Japan after the Second World War, the Swiss state afforded the luxury of almost not intervening at all, not even in terms of regulatory policies. This liberal attitude was linked to the subsidiarity principle underlying the federal state, meaning the federal government should, if possible, leave matters of decision making at those levels of society and the political community respectively, which seem to be the most apt to deal with these questions. Article 27 of the Constitution guarantees in addition the liberty of commerce and industry. A major obstacle was moreover – and here we find a fundamental difference with Japan – that the federal administration has always been very weak, low in numbers and restricted by cantonal competencies. This – and here it should be added that the multinational enterprises active in research have always refused to see the state involved in the funding of technological research - taken together has contributed to the reluctant stance of the Swiss federal government to develop a more active technology policy, though a Commission for Technology and Innovation (CTI) has been installed since the Second World War (Freiburghaus et al. 1991). But this Commission has always functioned very much on the basis of the voluntary participation of scientists, administrators or entrepreneurs and has never had a very strong organisational anchoring nor a sound financial base. Only in the 80s the work of the Commission became more fully recognised and since then a regular and rising budget has been given to this institution.

But even in policies concerning basic science one was looking for a coherent vision. This began to change after the adoption of the Research Act in 1983, which conferred more competencies in research to the federal government.

The technological development was as separated from basic research as in Japan. In contrast to Japan, Switzerland does moreover almost not dispose of extra-university governmental-financed research institutes that could have been used for technology policy purposes as MITI could use its own laboratories.

Despite of the lacking technology policy, Switzerland has been extraordinary successful on the world-market by the development of high-value added products and specialisation in niches on the world market. We find, therefore, different strategies of Japan and Switzerland in technology promotion, quite different institutional embeddings in research systems but highly successful outcomes in terms of comparative cost advantages. The Japanese state has fostered a rather active, regulatory and consensual strategy building on a "mercantilist" policy style, while the Swiss government has leaned on a rather passive and liberal attitude, only occasionally dealing with the promotion of legal conditions of export production. Both countries, however, protected their domestic sector in a very active manner (see for Switzerland: Mach 2001; for Japan: Pempel 1982).

# Changing Economic Conditions and Consequences for Knowledge Production

Both strategies were no longer feasible when globalisation processes became more relevant and other structural changes of importance occurred.

## Changing economic conditions

With the fall of the Soviet Union and the rising global order, the terms of production began to change rapidly. Most OECD countries were confronted with an increase in competition by newly industrialised countries above all in areas of mass production while at the same time a saturation of classical markets set in. In this "post-industrial" or "post-fordist" era, comparative cost advantages were more and more sought for by technological innovation and – in small countries like Switzerland – by finding new niches on the world market. The rising importance of technological innovation was, moreover, brought into the political discourse by the rise of the "endogenous growth theory" which maintained that economic growth couldn't be explained solely by increases in the quantity of labour and capital. Technological innovation has always been an important portion of total factor productivity and it will become the main factor of economic success in the future (Grossman and Helpman 1991; Ministry of Education 1997).

Globalisation provoking falling tariff barriers, high capital mobility and, increasingly so, labour mobility, has made protectionism an obsolete and infeasible strategy nowadays. And what is more, the international competition small and medium enterprises in the domestic sector are now exposed to, forces those enterprises to also look for technological improvements and innovation to become competitive. The small budgets of these enterprises forces the state to engage itself in a more active way and finance at least in part technological innovations in this sector.

Internationalisation has, of course, also had consequences for the export sector. As the big enterprises are most of the time acting on a multi-national base, and moving the production base becomes easier, there is no longer a need for these enterprises to invest their money into research and technology development within their own country. It can be shown actually that both in Japan and in Switzerland export enterprises have – at least for some years – reduced their research expenditures in the 90s, not only because the economic crisis forced them to do so but also because there were more attractive research places abroad.

These tendencies, being a problem for most OECD-countries, have transformed policy strategies in Japan and Switzerland from mercantilist or liberal technology policies to the aforementioned

"attractiveness" strategies in the promotion of economic growth. Technology policy becomes in this way an integral part of industrial (or better "post-industrial") policies.

## Changing technological conditions

The most important change for technology policy is, however, due to immanent changes in technology production. Technology policy is no longer directed to the support of a whole production branch like, for example, the car industry, nor to the funding of certain disciplinary-based key technologies like molecular biology or solid state physics, but to "*generic technologies*" (Sigurdson 1995: 328-332). These technologies – examples are information technology, biotechnology, applied materials, genetic engineering, superconductor technology, microelectronics and nano-technology – have the peculiarity that they can serve as the base for a multitude of developments in a large variety of different sectors of application. The best and well-known example is the information technology, which has infiltrated all production processes, scientific production, households, policymaking etc. Generic technologies have, therefore, an enormous potential for an economy and one finds no OECD-country not mentioning research in these areas as a top priority of science and technology policies.

But choosing for generic technologies engenders important implications for the organisation of knowledge production systems and their funding. Let us come back for a moment to the classic "tree model" of technological innovation: there, the main problem one finds with regard to an effective innovation process is the organisational separation of basic research on the one hand and applied research and development on the other. Each sector produces its own knowledge on the basis of its existing organisational structure while interfaces for the transfer of knowledge are hard to establish[4].

All this has to change if one works with generic technologies. The first thing is that basic research becomes an integral element of technological innovation. As one does not know all possible applications of generic technologies in advance, it is important to have a sound basic knowledge base in generic technology fields which gives the potential to go into different directions of applications, refinement and innovation. But this time, basic research is not regarded in the same way as a "free enterprise" of autonomous academic researchers. Even basic research should be inspired by a problem orientation and with certain ideas in mind what may be needed in society and economy (Elzinga and Jamison 1995). In addition, the linear model is giving way to a more interactive model of knowledge production (Stokes 1997; Gibbons et al. 1994) meaning that both technological knowledge can inform basic research and basic research can have immediate results

[4] Though one should add that, of course, there has always been interaction. Technological advances have influenced basic research and vice versa. But the model and, hence, the belief system has been responsible for the lack of institutional interfaces linking the two trajectories of research.

for technology development. One cannot in advance determine where important knowledge creation for innovation will take place. It is therefore best to organise "interaction spaces" where basic researchers and applied researchers as well as users of future technologies can meet to develop together generic technologies and their diffusion and application in different fields. Interfaces are still demanded in this interactive perspective of technology innovation but this time technological innovation needs the direct contact and the co-operation of actors from all sectors and from many disciplines, given the complex structure of generic technologies. *Horizontal cooperation* becomes a keyword for technology policy nowadays and basic research is one important element within this complex research process. Problems of research are no longer defined by the scientific community but by these "hybrid communities" of producers, users and funding agencies.

The prevalence of generic technologies has another important consequence: the product cycle becomes shorter (Sigurdson 1995: 20). Each new product based on generic technologies may find tomorrow competitive products based on the same technologies, but applied and assembled in a different way. This means rising costs for continuous efforts of technological innovation and at the same time less profitability because the life-cycle of a certain product protected by intellectual property rights diminishes.

## Consequences for research funding

These economic and technological changes have implications as to the way how research should be supported by the state and industry. It becomes imperative to open up universities and academic science as well as extra-university research institutes and industrial laboratories and install interaction spaces for research. This needs a mentality change of researchers both in the academic and technological sector, but also of funding agencies and users. At the same time, there is an overall consensus that without a sound basic science base no competitive improvements in the field of generic technologies can be expected. Further and much more generous investments into basic science are required. The costs of research and development are increasing at such a pace and at such levels that individual and isolated strategies of enterprises are becoming obsolete. Consortia and networks of enterprises, but also horizontal networks of researchers, become a necessary condition of success. The state is required to participate not only in financing big development projects but also to reorganise the organisational landscape of research. The result is that everywhere the state begins to finance more and more "joint research projects" drawing together scientists from all sectors and many disciplines and industrial users.

In sum, then, one sees that globalisation and generic technologies demand far-reaching organisational changes, a change in the mentality of researchers and users, collaborative strategies of enterprises and a more active state that creates the organisational conditions of success and finances, at least partially, joint research projects.

## General implications for Japan and Switzerland

Japan and Switzerland have – as already indicated – not been able to avoid the deep-going reforms necessary to cope with the mentioned challenges. In Japan it became obvious that, first of all, the "catch-up" phase of "imitation" had come to an end in the 80s and that Japan should consider itself a "vanguard" country of technology development (Rogers 1997: 4), as responsible for technological innovation in the world as other big countries and perhaps even more so (Ministry of Education 1997). It became, moreover, clear a switch was needed from process innovation to "product innovation" if Japan would like to play this vanguard role. This required the use of the creative mind and curiosity research of Japanese scientists instead of the application of foreign inventions. The "mercantilist" strategy of MITI was increasingly regarded by the export sector as a brake to industrial development rather than an advantage. MITI began to loose power and influence since the 80s, also because many enterprises were now viable enough to proceed in their own way without the paternalist support of MITI and the corporatist structures set up to implement technology policies. There is an outspoken wish among political and economic elites that Japan should have a pioneering role in the use of generic technologies (Science and Technology Agency - Japanese Government 1992). Only in this way, comparative cost advantages for Japan can rest. In a nutshell – but I will come back to it in the next section – one can maintain that the "mercantilist state" itself, with its centralised bureaucracy, fragmented decision-making and rigid policymaking procedures, was increasingly seen as an impediment to the adaptation of the Japanese industrial sector. Ideas of a more efficient bureaucratic organisation constructed on models of "new public management" pervaded in Japan. Japan decided to accept this challenge and to launch the construction of a competitive "technological state" with all the necessary reforms implied by this choice.

Switzerland had already undergone a serious economic crisis in the 70s when traditional sectors like the watch industry collapsed and caused serious unemployment problems. Other sectors were also loosing their comparative cost advantages in the wake of globalisation. Only the chemical sector retained somewhat its position as a world market leader. It became clear that enormous investments in technological development were necessary. At the same time enterprises were, given the economic crisis of the 90s, reducing their research investments which made it necessary for the federal government to rethink its until then rather passive attitude in technology policies. There were still other problems raised in the 80s and early 90s: Switzerland as an investment place was loosing attractiveness[5] and for the first time it became obvious that the number of new patents was diminishing and the leading position in citation indices was endangered. And, as in Japan, the state itself was accused of hampering a flexible and successful adaptation to the new developments: the rigorous austerity policies introduced until 1983 and again since the beginning of the 90s had led to

[5] One obvious reason was the protectionist strategy of the country. A first attempt to change this situation was the change in the cartel law of the country (Mach 2001).

serious problems of work overload and insufficient research facilities at universities. The fragmentation of federal and cantonal interests as well as the incoherent or almost non-existent technology policy was increasingly seen as a burden. The consequence of these deficiencies resembles the one in Japan: from the mid-80s onwards there was a growing political will to face the new challenges by a profound reform of science and technology policies as well as of the political coordination structures in the research system.

Therefore, since the early 90s, both Japan and Switzerland embarked on a reform path in science and technology policies that demanded a profound reorganisation of the research system and the development of new policies. And both countries had to set their tradition – either mercantilist or liberal – in science and technology policies aside and invent something new, corresponding to the challenges arising from globalisation and technology development.

Globalisation did therefore not only cause a „regime shift" leading to the rise of new socio-economic coalitions profiting from globalisation but had also its immediate effect on the construction of science and technology policies. The new socio-economic coalitions demanded radical reforms of the state apparatus and policies respectively in order to be able to more successfully pursue technology development under the harsh winds of globalisation.

Japan had to overcome the built-in centralisation of its bureaucracy and reflect upon new ways in organising research in part similar to the intermediary structures already put into practice in the West. At the same time it also had to overcome fragmentation, above all between the different Ministries responsible in one way or another for research. But most importantly, it had to change its traditional attitude towards the academic sector by emphasising its importance while, at the same time, making it susceptible to technology development. This needed new crosscutting, co-operative and interdisciplinary structures.

Switzerland also had to overcome serious deficiencies of its university system and had to learn to overcome its notorious lack of coordination in education and research policies while, at the same time, trying to put aside, at least partially, the traditional liberal attitude of policymakers and strengthen the power of the funding bureaucracy. The most serious problem was perhaps to overcome the fragmented nature of the university system protected by cantonal interests and to embark on a joint effort policy getting together the research potential of the whole country in order to develop generic technologies. The state had to learn to give orientation in this respect, which needed again some learning processes.

What exactly have been the policy reforms in both countries, then?

# Reform strategies in the 90s

The strategies of reform in both countries are not very dissimilar and may be seen, moreover, in the light of a converging trend in all OECD-countries attempting to make their science and technology policies fit for the 21st century. One sees certainly the use of different means and instruments, though, given the differences in the structure of the research system and state organisation. One can circumscribe the "battlefields of reform" in the following way: internationalisation (1); rehabilitation of basic research (2); stronger financial role of government in research (3); more coherent policy strategies (4); horizontal cooperation (5); and evaluation (6).

## Internationalisation

Internationalisation of research is seen in both countries as a major requirement for future success. For Japan, the opening of the research system was a consequence of the new vanguard role Japan was supposed to play in the future development of technologies after the end of the cold war but also of the increasing need of international collaboration to finance and organise research in the fields of generic technologies (like, for example, the human genome project). Gradually, Japan began to abandon the idea that it could develop an autonomous position in technological innovation. There was, moreover, a growing awareness that many problems, above all the environmental problem, could not be solved by Japan alone and needed international cooperation. One finds the opening up spirit in Japan in most of the governmental documents from the end of the 80s onwards. Concrete measures were for example the conclusion of a cooperation treaty with the United States, attempts to do likewise with the European Union, more facilities and financing to invite foreign scientists to work in Japan and incentives for Japanese scientists to go abroad.

Switzerland has always had an international oriented scientific community and, hence, there seems to be no need to develop particular policy strategies to increase international contacts. Despite this openness, the federal government was confronted with another problem, i.e. the integration within the European Community research programs. It is well known that Switzerland has not yet entered the European Union. This means that it has had until recently the status of an associated country in research policies. This status did, among other things, not give the right to Swiss scientists to act as directors of projects funded by European research programs. In contrast to other countries, participation rates of Swiss scientists in European research programs were, therefore, rather low. This had the disadvantage according to the federal government that Swiss science was somewhat excluded from important and cost-intensive technological development programs fostered by the European Union. The continuation of such a situation would have seriously jeopardised technological innovation in Switzerland. This is why the Swiss federal government concluded a

bilateral agreement with the European Union in 2000 comprising among other things also a better recognition and a more equal status of Swiss scientists in future European research programs.

Another problem the government has to deal with and which is due to the high mobility of Swiss scientists, above all in direction of the United States, is the "brain drain". The conditions of public sector research in Switzerland are, seen from a comparative view, still of a high standard, but they have been deteriorated given the harsh austerity policies since the beginning of the 90s, which has recently led to a public advertisement campaign by major scientists to ask for a substantial increase in government funding. In addition, there is a serious problem with regard to the career structure of young scientists in Switzerland. The lack of tenure tracks (though recently introduced at the federal universities) and insufficient posts at the rank of professors also induces young scientists to look for better possibilities elsewhere. In sum, though Switzerland has not had to overcome, like Japan, the deficiencies of a "closed research system", it was forced to develop strategies to become better integrated in European research and to find solutions for the "brain drain". With respect to the latter point, the promise to invest more money in the future and the introduction of tenure tracks also at cantonal universities is at the moment discussed.

## Rehabilitation of basic research

The various Japanese governments have clearly recognised in the 90s the need to strengthen the basic science base and, hence, the university system in Japan. In several publications the promotion of "frontier research" and "creativity" instead of "imitation" has become the point of reference for action[6]. This perception has resulted in a multitude of government initiatives and profound reforms of the existing academic system are going on. The first series of reforms concern the infrastructure of university research. The government declared a substantial rise in general university funds in order to ameliorate the deficient research facilities and above all, to augment and train the number of research assistants and technical personnel. The second point of attack concerned rules and regulations at universities. It was realised that the existing organisational structure of universities, which was built upon the old German university model with hierarchical relationships based on chairs and a rigid state-dependent university administration, was a major impediment to the fostering of creativity at universities. This led to plans to replace the *koza*, the chair system, by the American model of departments, thereby also reducing the traditional power of professors to

[6] Among the many examples, just the following (Ministry of Education 1997: 9): "Rapid production increases result not so much from increases in infrastructure and in the workforce as from dramatic improvements in the level of science and technology and from the widespread application of new advances. The keys to this growth are scientific creativity, technical skills, the quality of the labor force, and people's ability to make full use of resources, all of which depend heavily on the spread and advancement of education". And the Study Committee on Strategies for National Industrial Technology states (Study Committee 2000: 7): "If Japan is to seriously promote product innovation – which requires creativity and originality – it must change the functions of industry, academia, and government (which comprise the backbone of the technical innovation

distribute their funds in a hierarchical manner[7]. The administrative structure of state universities should be modelled according to new public management ideas in order to promote a more "responsible decision-making and implementation" (see also Harayama 2000; Study Committee 2000). To do this – I will come back to it below – a profound change in belief systems about the role of bureaucracy had to take place: instead of centralisation and hierarchy, Monbusho has to accept that public-financed institutions received a certain autonomy and room for manoeuvre to decide on their own about the use of financial resources etc. This changing view corresponds to developments in most of the other OECD-countries, but Japan might have more difficulties in implementing the new public management style, given its long tradition of centralist and bureaucratic decision-making. Finally, it was envisaged to break up another structure impeding the creativity in basic research: the prerogative that only professors with life-long appointment could become government officials at universities. In 1997 it became possible for fixed-term researchers to be adopted as government officials and at governmental laboratories fixed-term appointments were increasingly promoted (Ministry of Education 1997).

Mobility became another key word for governmental strategies in basic research. Fixed-term appointments were one way to deal with this question. The promotion of 10000 post-doctoral students by several fellowship programs was another. But perhaps most important was the decision to shift priorities in the dual system of financing universities: though general university funds were to be augmented, competitive grants-in-aid should become a much higher status than before in the financing of research. This has led today to an equal distribution of "block grants" and "competitive grants" at universities. To achieve this end, Monbusho strengthened, with the help of its "Science Council" and its sub-committees, the number of research grant programs that, in part, were priority programs promoting fields of basic research "that require an organized and international approach, that are the focus of very strong social needs, or that require relatively large expenditures for large-scale facilities and equipment" (Ministry of Education 1997: 37). At the same time, the review system was seriously revised, above all to get rid of the lack of transparency in its decision-making: nowadays the decision of reviewers are sent to the researchers and the names of reviewers are published after the decisions have been taken. Criteria of decision-making are standardised.

One sees that, though the description has been brief, that Japan has embarked on a fundamental reorganisation of existing procedures of funding and promoting basic research. The role of universities is revalorised and the system has become much more flexible and competitive than before. Most of the reforms have only yet started so it is still too early to judge, if Japan will eventually succeed in developing the necessary science base for further technological innovation.

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system), and restructure the relationships that exist between the three. In doing so, consideration must be given to basic research….".

[7] Other innovations are the introduction of "research departments" working in an interdisciplinary way.

There are, however, already signs of approval from the academic community concerning the amelioration of infrastructure conditions of research in universities (idem: 120).

Switzerland had no comparable problems of the same magnitude concerning its science base. What plagued Swiss decision-makers was the lack of interfaces between the university and the technological community. An "openness" of the "spirits" of academic researchers towards applications and technological innovation is, therefore, often demanded in governmental publications. There are, however, as already mentioned, deficiencies in research facilities of cantonal universities due to the economic crisis of the 90s, rising deficits and ensuing austerity policies of the federal and cantonal governments. It is evident that this situation will not change as long as the federal government doesl not become a more important investor in university research. There are initiatives at the moment to raise the share of federal money concerning university education and research but there are obstacles to overcome: the federal government demands a stronger say in university decision in exchange for more money and a stronger orientation versus competitive funding at universities. This needs, however, a major institutional reform (see below). Switzerland has since long a dual system of funding with the federal and cantonal governments paying block grants and the National Science Foundation (NSF) and different federal departments offering competitive research grants. The resources for the NSF are, however, from a comparative perspective, rather modest and the most part of university research money comes from block grants. The federal government clearly wants to strengthen the competitive element of resource distribution at universities in order to create more quality of basic research and to enhance the efficiency in the use of resources.

Reforms of basic research in Switzerland are less spectacular than in Japan. Most efforts focus on university-industry relationships rather than on fundamentally reorganising the functioning of universities. There have been, however, similar reforms in the administrative status of universities as they are envisaged in Japan: most Swiss universities have by and large adopted a new status for universities granting more independence but obliging universities to engage themselves in the pursuit of certain assignments fixed in a renewable contract with the canton or the federal government. With a stronger role of competitive funding and new public management based universities in Switzerland, the organisation of basic research in the academic sector in Japan and Switzerland begins to converge.

## Government financing

Investments into basic research and in science and technology policies in general cost money. The Japanese government has, after having received recommendations of the "Science and Technology Council" in the mid-80s, developed ambitious aims in its "*Science and Technology Basic Plan*" from 1996: to raise the share of government financing in overall research expenses from 20% to 40% and to augment overall research expenditures in Japan to 3,5% of GNP. Already today, with a share of more than 3% Japan is the world leader in this respect confirming its willingness to fulfil its role as a vanguard country in technology. Growth rates of government expenditures in research have since then been growing exponentially (in 1998 for example for 38%) despite of the severe economic crisis Japan is suffering from. This demonstrates that after Japan has had its "catch-up" period in technological innovation, it now launches a catch-up process in government financing which is supposed to raise research expenditures of the state to American levels and at the same time surpass each other country with respect to total spending in research.

Switzerland, as a small country, has, of course, no such pretensions. It was realised, however, that austerity policies in science and technology policies couldn't be continued without seriously endangering the existing knowledge stock. From 2002 onwards a 5% rise in research expenditures each year is planned, though new deficits in the wake of "Swissair-crisis" could once again obliterate these plans. There has already been additional money for particular measures like the setting up of networks of excellence at universities and centres of competences at polytechnics. But the room for manoeuvre for the federal government remains small given its limited resources and above all, the overall emphasis on deficit reduction of the government. Given these circumstances, Switzerland tries to focus its spending on several promising priority programs that can help to develop innovations in generic technologies.

## Coherent strategy

The rising importance of science and technology policies in the policy profile of states has made political decision-makers aware of the lack of coordination and, hence, inefficient use of financial resources immanent to the research system. This holds for both countries.

Japan has been notorious for its high degree of horizontal administrative fragmentation in research policies and its strong degree of vertical orientation (see above). MITI and Monbusho were assigned specific areas but had almost no contacts. Other ministries funded their own research programs without any coordination among each other, though the "Science and Technology Agency" had the task to take care of a certain coordination among departments, except for Monbusho. Meanwhile, the government has recognised the need in science and technology policies to act with one voice and united force. The most visible sign of this change in attitude has been the "Science and Technology Basic Law" in 1995 and the set up of the science and technology basic plan in 1996

which will be renewed every five years[8]. The Basic Law fixed generally what the government was obliged and willing to do in the future with regard to science and technology policies. The Basic Plan more in particular stipulated what should be done in the different areas of research funding. A "General Science and Technology Council" was since 2001 made responsible – in direct contact with the cabinet office and the prime minister – to see that the Basic Plan was adequately implemented and to "function effectively in establishing and maintaining close links among all governmental ministries and agencies, as well as among the industrial, governmental, and academic sectors" (Study Committee 2000: 15)[9]. Though this does not change much in the already existing formal structure, it was clear that from now on isolated and egoistic strategies from ministries were no longer tolerated and had to fit within the overall Basic Plan.

The role of MITI was somewhat curtailed. An important decision, for example, was to give Monbusho the authority to administer all public research laboratories. MITI lost in due consequence the right to determine policies in the governmental laboratories associated before with MITI. But the aim was not to replace one ministry with another. Monbusho had at the same time to accept that its authority could not be organised in the same hierarchical way it had managed the universities and its laboratories. Governmental laboratories received a more autonomous state and contracts were concluded with Monbusho stipulating the more precise tasks to accomplish. In this, Japan followed reform strategies concerning extra-university research institutes elsewhere (Braun 2001). In the same vein one can see the strengthening of the position of intermediary and semi-autonomous committees and organisations. The role of the "Council for Science and Technology Policy" was strengthened. The "Agency of Industrial Science and Technology" (AIST), the executive agency of MITI in matters of research and technology (Sigurdson 1995: 45-6), was put under authority of a semi-autonomous organisation, NEDO (New Energy and Industrial Technology Development Organization). The advantage of NEDO is that it can more flexibly spend funding money than a governmental agency. It is envisaged to concentrate even more resources and efforts by putting together Monbusho and the "Science and Technology Agency" and create one Ministry of Eduation, Science and Technology.

One can see, therefore, that Japan is working on its fragmented research organisation by concentrating authority and funding competencies in a few agencies that not necessarily have the status of a ministry. The strengthening of semi-autonomous bodies and advisory bodies breaks with the tradition of a strong and centralised bureaucracy. This is confirmed by the higher organisational

[8] In the Basic Law of 1995 it was stipulated that the government "shall establish a basic plan for the promotion of S&T in order to comprehensively and systematically implement policies with regard to the promotion of S&T" (Chapter 2, Article 9).

[9] And the Study Committee continues to explain: "The Council is also expected to set an accurate course toward the creation of a comprehensive and coherent management system for the implementation of efficient and effective research and development projects that involve the particpation of more than one ministry or agency".

autonomy granted to universities and governmental research institutes. Japan is modernising its bureaucratic relationships in the research system in a radical way. This is also confirmed by another tendency: The new Science and Technology Basic Law was, for the first time, not built upon an initiative of a governmental department or agency, but by the parliament itself. This demonstrates that the heydays of a science and technology policy developed and implemented within the narrow confines of the state bureaucracy are perhaps over. Science and technology policies have become a public concern and this has not only intensified efforts but has also contributed to the radical reforms in the political organisation of the funding of research.

In Switzerland, radical reforms of the state apparatus are much more difficult but there have been serious reform attempts since the end of the 90s. The need for reform is found in the following deficiencies of the system:

(1) Like in Japan, there were complaints that science and technology policy lacked coherence and clear goals because, among other factors, too many political agencies decided in a different way on matters of research. There was no distribution of research money according to a general plan obliging all agencies to respect basic goals and instruments (Bundesamt für Konjunkturfragen 1996: 34-5). A four-year "message" on science and technology policies of the federal government had been introduced with the Basic Law on Research of 1983, but it did not until the mid-90s really lead to a collaborative and harmonised effort of government agencies, above all not in technology policy. There have been in the meantime some minor improvements of the system: authority in science and technology policies are now concentrated on two departments only, the Ministry of Interior and of Economy and more specifically within their federal offices. For the first time, a common budget for research and policy was adopted in parliament at the end of the 90s. Moreover, collaborative efforts have been intensified between the National Science Foundation and the Commission of Technological Innovation. There are even plans to concentrate forces by setting up one common agency responsible for both basic and technological research.

(2) A second problem was – quite in contrast to Japan – the lack of bureaucratic and professional power to deal with technology policy questions. While basic and oriented research has been delegated to the National Science Foundation, technology policy is run by a semi-professional agency (see above) lacking the personnel and the experience to really develop a coherent and forward-looking policy. The weakness of the administrative organisation lends itself to a fragmented policy determined by interest groups looking for money from the state (idem: 35-6). The lack of personnel and the weakness of the federal administration in general inhibit also the possibility of developing own concepts in science and technology policies. If one adds the consensual culture of decision-making, one understands that the development of general plans in Swiss science and technology policies is a long-during process in which a multitude of actors are participating.

(3) Since 1989, there is a State Secretary for Science and Research within the Ministry of Interior, but his position is relatively weak. He runs a small bureau with only a few collaborators and has no hierarchical powers, neither within the federal administration nor with respect to cantonal interests or intermediary agencies. This does not prevent him to develop an overall vision of science and technology policy every four years but it is clear that this vision is the compromise between a multitude of different forces. In Switzerland, we do not find "big players" like Monbusho, MITI or the "Scientific and Technology Agency" in Japan.

(4) But the most important problem in the governmental organisation remains the federalist divide. The federal government cannot develop any coherent vision without integrating a view on cantonal universities and, therefore, without integrating also the cantons in decision-making. Switzerland is lacking, as is already said, extra-university institutes the federal government could use to foster its own interests. Universities remain the main place for research. Until recently, the existing cooperation structures did not suffice to develop a common policy for university research, above all because the federal government was still fighting for a stronger role in the financing of universities and because the existing coordination committee lacked competencies to develop and implement policies. This has changed with the new governmental "message" in 1998 dealing with science and technology policy questions between 2000 and 2003. Here, a reform of the "*Swiss Conference of Universities*" was proposed where the federal government and representatives from cantons are supposed to take – for the first time – decisions together that also have legal binding power. This is a major reform as consultative bodies, intermediary between the federal government and cantons, can until now only report to their governments what has been discussed but have not any legal decision-making powers. This will considerably reduce the time of policy development and foster a more coherent vision for the research system. In addition, the federal government is demanding larger competencies with regard to universities in order to more concretely develop strategies and plans for future development. Revisions are prepared for the new Research Law to be adopted in 2003.

The common concern of governments in Japan and Switzerland to overcome administrative fragmentation is conducive to a stronger integration of science and technology policies within the state apparatus and the concern for a higher administrative efficiency. Both countries show deficiencies in this respect, though based on very different state traditions. Japan has to overcome the fragmented powers of Ministries which are used to decide alone in matters of their competence and which are backed up by a large number of interest groups profiting from the policies of the Ministry in question. The fragmentation stand in the way of a common approach in policies and the hierarchical way of decision-making did no longer correspond to modern knowledge on delivering efficient public services, which demanded rather organisational autonomy of delegated institutions. Switzerland was confronted with a weak but nevertheless fragmented federal bureaucracy and a lack of coordination in the use of funding resources. In addition, federal government lacked

competencies concerning the most important parts of the Swiss research system, the cantonal universities. In both countries, reforms have been made or are under way but it is still too early to judge on the feasibility and success of these reforms.

## Horizontal coordination

The promotion of cooperation projects including industry, governmental laboratories and academic research is one of the pillars of the new science and technology policy in Japan. The initiatives taken are so manifold that it is impossible to describe them all here. Let us take a cursory glance:

First of all, there have been a number of measures aiming to develop universities as focal points of joint research projects with industry (Rahm et al. 2000). This purpose served not only the creation of departments for research collaboration but also the establishment of a large number of "Centers for cooperative research"[10]. The existing law was changed in order to allow "private parties to establish research facilities for joint research development on the premises of national institutes" (Ministry of Education 1997: 90).

Second, regulatory restrictions forbidding university researchers to do research at private facilities were revised. University researchers now can participate for example in joint research programs at facilities of the industry without loosing their position as government officials and by keeping all social insurance provisions delivered by the state.

Third, the difficult question of intellectual property rights was attacked. As said in the beginning of this article, universities are supposed to deliver knowledge as a public good at the disposition for everybody. To keep up this claim would, of course, seriously hamper the collaboration of industrial enterprises, which expect a type of knowledge they can in due time use for patents and profits. The outcomes of joint research efforts, even at universities, must, therefore be treated in a different way than before. This is why the government envisages since the "Action Plan for Economic Structure Reform" (1997) to claim intellectual property rights for research findings in national universities, a decision the American parliament has already adopted in the early 90s (Bayh-Dole-Act) giving intellectual property rights to universities. At the same time, flexible and new systems for the acquisition of these property rights by third parties should be developed (idem and Study Committee 2000).

Fourth, cooperation projects between governmental laboratories and industry should not only be intensified but also have a more long-term character and include more basic research components. MITI was explicitly advised to promote more actively basic research in technological innovation.

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[10] While the number of these centres was 3 in 1985 it was augmented to 49 in 1996 (Ministry of Education 1997: 91).

Fifth, both Monbusho and MITI should develop more and new projects to foster the collaboration between universities, governmental laboratories and industry. Sigurdson maintains that unofficially most major research projects in 1995 had already the character of such joint projects (Sigurdson 1995: 4). An overview of the number of joint research projects with the private sector showed an eightfold increase from 1985 to 1996 (a total of 1704 projects in 1995) and in "commissioned research"[11] a fourfold increase (Ministry of Education 1997: 91-2).

Sixth, tax exemption measures, especially "tax deductions on experimental and research expense increments" were introduced by which it was supposed to encourage the expansion of private-sector research. But these measures were extended to also include joint research between universities and private sector companies.

Finally, an elaborate consultation system concerning research cooperation between universities and the private sector was set up by the "Japan Society for the Promotion of Science", again a semi-governmental organisation situated at Monbusho. The different consultative groups "provide forums for developing new fields for research cooperation between universities and industry" (idem: 96).

Though not all projects are realised yet, one sees that, again, the Japanese government has set in motion a panoply of different measures that aims to overcome the traditional scission between the academic and industrial sector. Regulatory restrictions are removed and interaction space is at the disposal of researchers, while consultative boards engage themselves in the development of future research projects.

Switzerland is also underlining the need to overcome the strong separation of its academic and technological sector. As it does not dispose of governmental laboratories that are often at the interface of both sectors, the policy strategy must focus on a reform of the university system. In contrast to Japan, the Swiss government does not want to play a leading role in all fields of technology or basic research. It suffices to concentrate efforts and to have research of an excellent quality in a number of areas that have to be selected by procedures integrating the propositions of the scientific community and of politics. A politics of selective excellence and knowledge diffusion have guided the measures proposed and adopted in the federal government "message" of 1998.

The first major reform was the decision to construct a network of seven *new polytechnical universities* financed both by the federal government and the cantons. The aim of this measure is obvious: instead of obliging universities to commit themselves to technological research, a new organisation with the explicit task of developing applied and technological research is created. The "Commission for Technological Innovation" will henceforth spend a part of its money to set up and promote

[11] I.e. research that is commissioned by industry or government agencies to universities in order to implement

technological research at the polytechnical universities. The "Swiss Science Council", an advisory body for the government in matters of science, has changed its name into "Swiss Science and Technology Council" to indicate that it will from now on also integrate technological questions and the development of the polytechnics into its observations and recommendations.

The creation of new institutions does not mean that universities could remain unchanged. *Innovation networks* were planned that should directly collaborate with industry.

Both types of universities were moreover asked – and that has been implemented by now – to develop *centres and networks of competence* respectively comprising several polytechnics or several universities. In the polytechnical universities the CTI is required to set up such networks in promising fields of research. Regular contacts with universities should be established in order to guarantee that basic knowledge is diffused within these networks. University institutes can, of course, also participate within these networks. The selection of promising centres of competence takes place in narrow contacts with industry to make sure that there is a need of knowledge diffusion in the areas of research chosen by the networks. And, of course, industry is asked to also participate financially within these networks. *Networks of competence* have also been installed at the university level. Here, it is not only industry-relevant topics that may occur but also any topic of societal, political and economic relevance. The networks that have been selected demonstrate, however, a clear bias in favour of fields linked to generic technologies. Again, the general idea is to have a leading house being the organisational nucleus of the network comprising several institutes and/or researchers at other universities. The main goal of these networks is to produce excellent research but there is a clear concern of political decision-makers to also have these networks firmly anchored within their socio-economic and political environment.

The overall idea is to have a vast array of networks linking all the different kinds of universities (polytechnics, federal and cantonal universities) together and focusing on some promising field of research important for Switzerland as an attractive place of investment in a period of globalisation and knowledge society. In this way, then, it is believed, the fragmentation of universities can be overcome and an interface between the academic sector and society/economy can be created.

These initiatives are perhaps less encompassing and spectacular than in Japan, but they present solutions to the specific problems of Switzerland by respecting the lack of resources. Japan is injecting large amounts of money into the construction of horizontal cooperation projects. Switzerland is investing less but tries to change the existing "working structure" and to concentrate its resources on a few promising technological areas.

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basic research projects (Ministry of Education 1997: 91).

## Evaluation

There is no OECD-country nowadays that can afford the luxury of not evaluating the performance of its research system. Evaluation today does not simply mean the review of some research projects, in particular concerning its scientific merits. The spirit of evaluation today is based on "*efficiency of public resources*". The delegation of organisational autonomy to universities or research institutes is one strategy in increasing efficiency. Ex post evaluation of the performance of these institutions is another component of the efficiency strategy. Evaluation today means, therefore, for example, the establishment of "external advisory boards" at extra-university research institutes, the accreditation of curricula, the setting up of committees accompanying large, joint research projects, the establishment of foresight procedures and advisory bodies besides the continuation of normal review procedures for research projects.

The step to establish new "evaluation devices" was certainly more far-reaching for Japan than for Switzerland (see for example Tanaka 1989). As is already described, reviewing has been for a long time a process with no transparency for the scientists the projects of whom were evaluated nor for outsiders. There was just the decision of the review committee established at Monbusho without any further explanations. In addition, Japan is well known for its informal culture of distributing money, property rights or any other things. This also holds for the evaluation process. Personal relationships and formal positions often determined the reputation of scientists in the system and less the number of publications. The new evaluation system has, of course, to establish transparency and objective criteria needed in order to judge on the performance of research institutes and scientists. It has already been mentioned that the review procedure at Monbusho has been reformed profoundly and that more transparency is now introduced in the system. But more importantly, since the beginning of the 90s, there are the first attempts to set up evaluation committees with international experts that were asked to evaluate the performance of extra-university research institutes. This practice is beginning to be accepted on a wide scale though the former closure of the country still makes it difficult to find sufficient experts from abroad and to make this principle accept even among the scientific community itself. Finally, the more "new public management" contracts are concluded with universities or governmental laboratories, the more ex post evaluation becomes a necessity and will be part of normal practices in the Japanese research system.

By way of new public management, ex post evaluation of polytechnical universities and universities have also been introduced on a wide scale in Switzerland. In addition, there was the recent creation of a semi-autonomous institute of accreditation, being responsible for quality management in higher education. Both, the federal government and the cantons are financing this institute. Switzerland has, moreover, well integrated foreign experts in most of the reviewing processes of the National Science Foundation.

# Conclusions

Shifts in science and technology policies in the 90s must be explained by two factors: The changing economic world order has resulted in new conditions for success in fostering economic growth. One of the most important growth conditions for industrially advanced countries of the OECD nowadays is technological innovation in the fields of generic technologies. This has caused serious pressure of reorganising not only research systems, but also the state organisation that is responsible for science and technology policies. On the other hand – and independent from this development – we see a reorientation both in the belief system on the organisation of public services and in state intervention. Efficiency is becoming the main keyword of public sector reorganisation and network building, moderation and delegation replace former hierarchical and/or corporatist features of state intervention. These new paradigms of state action have equally influenced the reorganisation of research systems and state organisation. While technological innovation has put on the agenda, *what should be done*, the new paradigms of state action have influenced *how it should be done*.

One can state that these tendencies and pressures have not only demanded changes in science and technology policies in all countries but also have shaped possible answers and solutions:

- The paradigms of state action demanded more autonomy of organisations in the form of contracts, more cost-efficiency, an elaborate evaluation system and transparency of procedures;

- The imperative to implement research in areas of generic technologies has favoured interactive models of research between academic and industrial research, national and international network building, a stronger basic science research base and a stronger involvement of the state with higher investments in order to finance expensive research projects.

The problem discussed in this article was, first, how research systems of Japan and Switzerland were equipped to meet these exigencies ("goodness-of-fit"). Though both states have very different traditions in the state organisation, their research system and science and technology policy strategies pursued, they have been able until the 80s to become quite successful on the world market. But it also became evident that the "old research systems" did not suffice anymore to cope with the challenges and to introduce the necessary shifts in science and technology policies.

Japan showed several deficiencies in this respect:

- A mercantilist strategy by a paternalist state promoting the export sector while at the same time protecting the domestic sector is no longer feasible;

- The long tradition of a centralised bureaucracy contradicts “autonomy and delegation”;

- The “fiefdoms” within state bureaucracy and the “division of labour” and uncoordinated authorities in science and technology policies oppose the need for the bundling of administrative forces;

- The strong separation of the academic and technological sector in research and the badly equipped university system are not conducive to the interactive and interdisciplinary model or research;

- The relationships in the academic community are still too hierarchical and personalised while open competition among scientists is lacking;

- Interdisciplinary space at universities is lacking;

- The distribution of research money in the academic system is inefficient and not competitive.

Switzerland had other problems:

- The liberal and passive strategy in technology policy is no longer feasible, the globalisation of competition even for the small and medium enterprises of the domestic sector forces the state to co-finance technological innovation; the predominance of a political strategy improving the Swiss investment and production place needs activities in many fields, above all in technology promotion;

- The federal structure and the ensuing restricted and weak role of the federal administration causes similar problems as in Japan: problems of fragmentation, a strong role of “distributive coalitions” and uncoordinated funding;

- The separation of the academic sector and the industrial sector is a serious problem and is exacerbated by the lack of governmental laboratories;

- There is a lack in interdisciplinary research;

- Finally, science and technology policies in Switzerland are suffering from the strong link between the government budget and the economic business cycle. For the most part since the 70s, austerity measures have impeded a more active science and technology policies in Switzerland.

The political reforms in the 90s have attacked the specific problems of each country in order to implement the necessary changes in the organisation of the state organisation and the research

system. It is yet too early to tell, if the reforms will be successful. One can maintain that both countries have converged in their answers to technological challenges and paradigm shifts of state action, though the state organisation remains very different. But even here one finds converging developments, given the introduction of new public management ideas.

Convergence can be found above all with regard to the:

- General shift away either from a mercantilist or a liberal technology policy to a policy preoccupied with the attractiveness of investment conditions for production on the world market;

- Attempts to unify forces of the state in science and technology policies;

- Strengthening of the role of intermediary and semi-autonomous bodies;

- Stronger importance given to evaluation;

- Rehabilitation of basic research;

- Creation of interaction spaces for generic technology research;

- Stronger emphasis on internationalisation of research and funding;

- General orientation to generic technologies (and to general problems of society and the environment);

- Introduction of medium- term and long-term planning in science and technology policies;

- Stronger role the parliament is playing in the development of science and technology policies.

Differences are nevertheless still to be found, first of all in the ambitions of each country. Japan envisages playing a world leader role in most technological development fields and invests large sums of money despite of a serious economic and budget crisis to arrive at this aim. Switzerland develops strategies according to its size: it more modestly is focusing on developing excellent research in some selected priority areas and is still very reluctant to invest larger sums of money into science and technology development despite a much more favourable balance of the governmental federal budget. Switzerland is basing its reform policies almost exclusively on universities while in Japan governmental laboratories have an important role in the research on generic technologies. And, without any doubt, decision-making processes in an unitary and federal system will never become alike.

In general, convergence is more visible than differentiation in the reform policies of both countries. The regime shift caused by globalisation processes lead, in any case with regard to science and technology policies, to converging trends between both countries. This is not surprising given the structuring of the feasible options of action by generic technologies and new paradigms for state action. All OECD-countries are converging at the moment in the same direction reflecting not only the constraints imposed by these tendencies but also learning processes within the framework of the OECD: most strategies in science and technology policies have been discussed among ministers within OECD, "best practices" have been evaluated and there is in general more knowledge about the strategies in other countries. The Swiss federal government, for example, referred in its 1992 message on science and technology policies explicitly to Japan when defending a stronger promotion of basic research. Finally, one should not forget the United States as the main model of reference for most changes and reforms nowadays. There is, therefore, nothing astonishing in the convergence of science and technology policies between two countries of very different research traditions and political structures.

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