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Fourth helix: sustaining research diversity

The social turn of science and technology policy. The case of Japan.

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Keywords: fourth helix, diversity, innovation, positive competition, public space

1. Introduction: the triple helix model in a new context

With the present financial and economic crisis and growing environmental constraints, new versions of the Triple helix model are formulated and debated. It proves its strong heuristic value. From this perspective, Silicon Valley is neither a global model, nor a unique

anomaly. It certainly was an inspiration but constructing Silicon Valley into a model to imitate has proved a vain and costly exercise. Silicon Valley studies led to a more precise understanding of the singular conditions of its emergence and reinvention through time. Since the mid-1990s, the triple helix model proved more and more influential: it gave a method to analyze and evaluate the Silicon Valley phenomenon and it explained how Europeans and East Asians could find their own way and solutions. Still the evolution of Silicon Valley since 2000 and the various debates on the triple helix model allow redefining the model according to some of its implementations and interpretations.

The environmental constraint (energy, global warming, etc) and the present economic crisis have transformed the conditions for research and innovation in all industrial nations. Overall, to describe situations and find solutions, the Triple helix model had and still has a growing influence at the regional, national and local level. Interpretations and implementations of the model differ according to contexts. Today, in this *post-Fukushima* context, comparing various versions of the model opens the possibility to redefine the model itself. Further more, the 2002 Triple helix conference in Copenhagen and the report by Loet Leydesdorff and Henry Etzkowitz, "Can the 'public' be considered as a fourth helix in University-Industry-Government relations[1]?" have opened the way for new research on the helix particularly relevant today in responding to the crisis.

2. Learning from cases

In France, no reference to the triple helix model is explicitly made, probably because the State still controls research and macro-manages the interactions between research institutions and the economy. Still the triple helix adequately describes recent reforms of universities and research institutions, their relations to industry and local economies. It also helps explaining their limitations, why they remain inadequate by comparison with reforms made in Germany in the last ten years. The model remarkably explains local research policies in France. For instance, Cluster policy of the Région Rhône-Alpes had (it ended in 2010) a highly positive influence on the formation of new research communities. Finally, if it was explicitly applied, it would explain why the creation of a new entity, University of Lyon[2],

[1] *Science and Public Policy*, n° 30(1), 2003, p 55-61

[2] http://lyon-university.org/. The French version <http://www.universite-lyon.fr/> shows the scale and style of the project,.

associating eighteen universities and professional schools[3], is reproducing the national French administrative model: it created a bureaucracy with interests and objectives of its own, which is already cut from the life and work of researchers. The only innovation is the creation a global academic structure, without real institutional innovations at the level of research and innovation processes. In such a case, the triple helix opens a description of the situation as well as an evaluation of the response to the situation.

At the level of the European Union, the triple helix is the implicit model for science and technology policies, which are still hampered by the fact that these policies remain for each member states an expression of national sovereignty. This explains the failure of the 2000 Lisbon strategy[4]: the EU was supposed to become in ten years the most advanced knowledge economy in the world, creating jobs and sustaining social cohesion. Well known specialists in Science studies, sociology of science and economics of innovation, including Christopher Freeman, played a key role in the conception of this policy. But politics and national interests could not be overcome: institutional innovations are real but their potentials are still limited.

In Japan, notions of "co-dynamism " and "co-evolution" are versions of the triple helix model. In contrast to France, these notions summarize significant institutional and political reforms made in the last ten years: reforms of the Ministries in charge of research and innovation, university reform, reform of government itself (the Science and Technology Agency is now part of the Prime minister office), reform of Industrial and Intellectual property regime, adaptation of the Basic plans for science and technology to the present situation of the Japanese economy and society[5]. The March catastrophe reinforces this evolution. Presenting the cases of Germany, Switzerland and Singapore would strengthen the following conclusions.

Five points summarize the descriptive and heuristic value of the Triple helix model. It first overcomes the limitations of the "linear model[6]". Secondly it explains how a "national system of innovation" is supposed to be organized, managed, to function and evolve: the

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[3] The "*grandes écoles*" are simply highly selective national professional schools.

[4] See http://en.wikipedia.org/wiki/Lisbon_Strategy. Its implementation was quickly considered « unconvincing ».

[5] See A-M Rieu, "Le Japon comme société de connaissance: quelles leçons pour la France?", in J.F. Sabouret (ed.), *L'empire de l'intelligence: les politiques de recherche japonaises depuis 1945*, Paris, CNRS Editions, 2007, p 210-213. [http://halshs.archives-ouvertes.fr/halshs-00360130/fr/]

[6] Benoît Godin, "The Linear model of innovation: the historical construction of an analytic framework"(*Science, technology and human values*, Sage Publications, vol. 31, n° 6, November 2008, p 639-667) and "National innovation system: the system approach in historical perspective" (*Science, technology and human values*, Sage Publications, vol. 34, n° 4, July 2009, p 476-501). Available at http://www.csiic.ca/

concept is a method of evaluation and of policy conception. Third, it overcomes the opposition between private and public, between private investment in R&D at the level of firms and public policies. It builds a conceptual and practical framework where the two sectors learn how to cooperate in a joint dynamics regulated by political institutions[7]. Fourth, it introduces a new institutional model of organization and governance: ideally, none of the three helixes can or should control the other two. This type of governance is still difficult to conceive and organize. But it leads to institutional innovations and even progress in democracy, which are already explored and conceptualized[8]. In this context, Silicon Valley and the San Francisco Bay remain a reference case for reconstructing the Triple helix into an "ideal type" or theory in a "symmetric epistemology[9]".

3. The problem: growing standardization

The strong influence of the Triple helix model is opening a better understanding of its limitations and presuppositions. Explicitly or not, it is still inspiring strong debates, research and institutional reforms. But the adoption and adaptation of the model has also transformed this conceptual construct into an international norm. This evolution opens new debates and research because some counter productive effects are identified or anticipated. For instance, comparing recent research and innovation policies in European Union and Japan[10] shows what consequences can be observed or predicted with a high degree of probability.

The first problem is an increased standardization of research. For research and other upstream activities, universities as well as national and regional research policies, competition has greatly intensified since the 1980ies. This competition now generates a growing standardization of research and innovation activities. Researchers in advanced industrial societies tend to work on the same fields and the same themes in institutional environments (organizations, hierarchies, even buildings), which to become very similar. The short-term and long-term consequence of this situation is a growing standardization. This is a complex situation. Competition reinforces this pattern of evolution. Science might be universal and

[7] This is best exemplified in the early 1990s by Martin Fransmann, The market and beyond
[8] Callon, Agir dans un monde incertain.
[9] A symmetric epistemology is based on a theoretical construction capable of describing on the same pattern different cases, evolutions and situations.
[10] Mainly Europe's *7th Framework program for science and technology* and Japan's *3rd Basic plan for science and technology*, both launched in 2006. Japan's 4th Basic plan was supposed to be launched in April 2011 but was postponed until the end of August 2011. It had to be revised in order to respond to the March 2011 tsunami and Fukushima catastrophe.

technology generic, we observe the emergence of various types of "knowledge economy", in the US and Japan as well as in Europe, but also in China, Russia or Brazil. These various types of knowledge economy compete with each other. This intensified competition is further reinforcing standardization. Each nation intends to *catch up* to the point there is no leader anymore. Even if they have historical precedents in the 17th or 19th centuries in Europe, these are new challenges. These problems express the mutation of the conception, organization and role of all knowledge activities in advanced industrial societies since the 1980, the new "regime of knowledge" in which our societies develop.

All major research institutions have now the same priorities and objectives. They do not imitate each other but they have entered a mimetic competition process, which is reinforcing itself into a convergent trajectory. The benefits are real: research standardization facilitates worldwide cooperation of researchers, laboratories and research programs. This convergence even reinforces quality standards and hierarchies, the search for "excellence". But this standardization creates two problems: underneath global and even "open" cooperation, it intensifies competition between laboratories, between nations and regions according to their capacity not to generate new research and progress but to transform this new knowledge into innovations, new industries and new products. This situation has obvious positive consequences but the reforms, which can be observed, tend to replicate the model and therefore intensify the mimetic effect. It further intensifies standardization. From the point of view of the two main challenges, the intensified environmental constraint and the economic crisis, results are below expectations. Innovations in the US or Japan do not generate new industries, products and jobs. Established conceptions of innovation and research policies do not fully respond to the present conjuncture.

This situation has also an impact on the other end of the innovation process, on research and research institutions. Because of this cooperation and standardization, where progress really happens in the world is *apparently* becoming secondary. Few laboratories are making a difference between the progress they really make and the progress they participate in. Laboratories and researchers have the feeling to belong to a general progress in science and technology. This evolution is obviously reinforced by the need to respond to the economic and social situation. Research itself and research institutions are following a potentially dangerous path. This is the second problem: self-reinforcing standardization reduces research and innovation diversity. The reduction of this diversity has a negative impact on research and innovation evolutionary potentials and therefore on long-term progress. The present growth of research activities intensifies this negative impact. This does

not mean that standardization sterilizes research but reducing its diversity generates a long-term path dependency. It seems strange to defend biodiversity and at the same time be blind to the necessity of sustaining and even increasing research diversity.

4. The source of the problem: the neo-liberal *tsunami*

The standardization of research and the reduction of evolutionary potentials need to be put in a broader perspective. As mentioned before, the convergence of research fields and research organizations brings obvious benefits: it concentrates and aggregates human capital and financial resources. It rationalizes knowledge production and distribution for economic growth and social progress. This convergence is also the result of scientific methodologies and large-scale communication of data and research outcomes as well as the result of the increased exchange and circulation of researchers. These positive elements cannot be ignored when Humanity is facing increased challenges, deceases, unequal access to food, education and information, energy shortages, industrial pollutions and climate change, not to mention security issues. But these positive elements need today to be reinterpreted according to the present context.

Since the 1980ies, this convergence has not only intensified but it also mutated. The first crisis of energy and natural resources in 1970s was the first sign of the emergence of an environmental constraint and the first proof that it would transform in depth our economies, societies and international relations. Beyond politics and ideology, the neo-liberal theory and its various practices have been a response in the 1980s to this crisis. This explains why today neo-liberal solutions are still implemented in order to solve problems generated by these solutions. In this context, a new "regime of knowledge" has emerged and was identified. But its presuppositions and long-term consequences are not yet fully analyzed and evaluated. The convergence of research fields, R&I models and institutions is certainly driven by the need to produce new knowledge but this need is also driven by an intensified competition between economies and societies. The US, Japan and West-European nations have been sharing the same diagnosis of the present world conjuncture and they have one after the other implemented a similar response to the globalization process: in the 1990s, it became clear that the long-term future of each advanced industrial societies was to be found in their capacity to generate new knowledge and to translate innovation into new companies and new products,

which would create growth, jobs, State revenues for financing welfare policies and infrastructures[11].

In this context, the competition in Science and Technology between all OECD nations intensified. This new wave of industrial and political competition stimulated all activities related to the production and transfer of knowledge. The main actors of this change were not only managers or politicians; they were scientists, researchers, engineers, even post-doctoral students, and also specialists of recent disciplines like science studies and management of technology. Research policies found a new meaning and a new urgency. Until then, these actors were deeply embedded in social and political systems. Now their interests and values, the logic of their activities became more openly asserted. Many reforms of research institutions, universities, national systems of innovation, etc, have been developed in the last fifteen years. This evolution has its ideology: the formation and management of a "knowledge economy" often taken for a "knowledge society[12]". This is at stake in both the EU Lisbon strategy and the EU seven Framework programs for Science and Technology as well as in Japan's three Basic Plans. This is also at stake in the various debates, reports and policies in the US concerning competitiveness and innovation[13]. Silicon Valley remains a model but this model is not an overall solution.

The increased standardization resulting from a shared diagnosis and similar responses has reinforced the hegemony of the nation at the source of this process and most advanced in it: the US. The challenge of sustaining this hegemony is not a recent issue for the US: it dates as far back as the late 1980s[14]. When the level of convergence generates standardization of research fields, institutions and policies, beyond quantitative indexes of scientific progress, leadership becomes sheer hegemony. This hegemony generates negative effects and become unsustainable. Today all industrial nations, including China and India, tend to train their scientists and engineers, organize their research institutions and even their territory according to a model developed in the US. Their basic goal is not to produce new knowledge but to

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[11] Concerning Japan, see A-M Rieu, "Japan as a techno-scientific society: the new role of Research & Development", Tokyo, *National Institute for Research Advancement Review*, Autumn 1996, p 3-6. http://www.nira.or.jp/past/publ/review/96autumn/rieu.html

[12] On the need to draw a distinction between "knowledge economy" and "knowledge society", see A-M Rieu, "What is Knowledge Society?", *STS Nexus*, Santa Clara University, Center for Science, Technology and Society, San Jose, September 2005. http://halshs.archives-ouvertes.fr/halshs-00552293/fr/

[13] See for instance the reports published by the Information Technology and Innovation Foundation (http://www.itif.org) or the role of innovation in President Obama's 2011 State of the Union speech.

[14] The Washington DC Council on competitiveness was founded in 1986. See http://www.compete.org. Its reports tell the story of American anxiety of losing the basis of its post-war economic and military hegemony.

compete with the United States and reduce their hegemony or leadership. This could be accepted as long as it was generating positive effects for all players. But in the face of growing environmental constraints and following the present financial and economic crisis, it has become counter-productive. In the past, competition through collaboration intensified knowledge creation and innovation. Increasing standardization now reduces research diversity and in the end science and technology's productivity.

The triple helix model developed in this context: it was achieving two contradictory tasks. In the context opened in 1980s by the Bayh-Dole Act, it was first explaining how economic growth required a new institutional arrangement in order to strengthen innovation. Universities were decoupled from public policies and connected to business creation and growth. In return, they found in this academic new deal new financing resources for research and innovation: they gain also new responsibilities. But the triple helix model was also explaining how to reach and manage equilibrium between le role of government, industry and universities. The Triple helix belongs to the neo-liberal movement, which changed the world since the 1980s. But the Triple helix was also regulating this movement by explaining that economic development was based on innovation and that innovation processes were based on collaboration and interaction between university, industry and government, each with its own logic and responsibility. The Triple helix is also showing a path beyond the neo-liberal moment.

5. A solution: a fourth helix for restoring and increasing research diversity

Reversing the trend toward standardization has for goal to assure research long-term productivity in order to meet today challenges. The problem is to organize and sustain research diversity. Andy Stirling has built a conceptual and formal framework for studying and managing diversity: "Diversity concepts employed across the full range of sciences mentioned above, display some combination of just three basic properties: (…) 'variety', 'balance' and 'disparity'[15]". The plurality (variety) of research traditions depends on their historical, social, cultural and even economic contexts. But today saving this plurality does not mean securing or protecting an imagined historical scientific or technical identity (disparity). It means producing new knowledge and to innovate in a world of intensified and

[15] "A General Framework for Analyzing Diversity in Science, Technology and Society", SPRU on-line paper n° 156, February 2007, p 9 (http://www.sussex.ac.uk/spru/).

mimetic competition. It means stepping out of this competition by developing alternative or simply different perspectives. There is nothing heroic to this. Restoring or creating diversity depends first of all on the capacity of academic and research communities to conceive and debate their own objectives, methods and values, to find a "balance" between variety and disparity. Institutional innovation and academic autonomy are the key issues in this process. The problem is not to isolate or protect research universities from their economic contexts and social duties. On the contrary, the problem is to give research communities an increased capacity to negotiate with firms and government their priorities and responsibilities.

The triple helix model responds to this situation. It shows that the "research university" is not *submitted* to its interactions between firms and government. It has to assert and play its full role. Institutional innovation does not mean that a research university should be organized and managed like a firm. It simply requires stressing the logic of research and innovation, of teaching and training, the various time frames of these activities and their specific institutional requirements. Diversity is a requirement for progress in science and technology as important than standardization. Of course a balance between the two needs to be found but the risk to differ and develop new fields and hypothesis is also a basic duty and responsibility.

Finally this implies a different conception of competition. To compete within the same model and for the same objectives is quite different than competing on different grounds and for alternative but also complementary objectives. New modes of collaboration and positive competition can be imagined. Collaborative competition is a key issue. Positive competition does not or should reduce diversity but on the contrary reinforce diversity, intensify global progress and common knowledge. The Triple helix model is reaching a point where long-term and collective progress should become a goal for all knowledge-based societies.

Therefore the only way to respond to standardization and negative competition is to restore and intensify diversity. This requires the introduction of a *fourth helix*. In fact, a fourth helix was always in the middle of the triangle made by government, universities and firms. To give a name and content to this fourth helix has become a major question to research and debate in great details. First of all, the fourth helix should not be reduced to "culture", to national traditions because of historical State control over research activities. Various researchers explained in recent debates that a fourth helix should be understood as "society[16]".

[16] What "society" means in this sense is far from clear.

The problem is to define what "society" really means in this context. Various answers and experiments exist and need to be debated: connecting to civil society, solving social problems, answering social needs, reducing inequities and inequalities, easing everyday life, developing public infrastructure and services, creating jobs and employment, establishing a clean and safe environment as well as sustainable social and economic development.

The introduction of a fourth helix transforms the model in many ways. The fourth helix has clearly for role to regulate interactions between universities, government and the State administration, firms, industries and their related services. Industrial property law and technology transfer offices in universities are playing such a role. Finally, the fourth helix is playing a basic political role outside established political institutions. This role reconfigures the relations between politics and technology, research and economics, civil society and research, politics and economics. This mutation was predictable: when science and technology concern all aspects of life in society, the way we are educated, work, commute, communicate and even reproduce, a mutation is sooner or later taking place. All these aspects of life in society become first the target of science and technology policies but they also become the source and inspiration of all these policies. The best example is the "social turn" of Japan's 3rd and 4th Basic plan for science and technology.

This is not enough. The fourth helix needs to receive a practical meaning in order to play its role in relation to universities, government and the economy. It needs to be structured and organized. Various solutions are implemented: on-line survey at the EU, citizen debates, studies on social needs and social problems, etc. These solutions are difficult to evaluate. Further research is needed. To refer to "society" is to indicate the opening of a new or different "public space". Such a public space cannot be reduced to "citizen debates". It is difficult to invoke "society" without referring to the role of human and social sciences. The need to study these issues and problems is a major concern for these disciplines. The need to disseminate their findings is crucial for society. Crucial also is to reform the formation of scientists and engineers at all level so that they see their work not only "from inside out" as they always did but also "from outside in", from the point of view of society. This social turn of science and technology policy is slowly reorienting research toward different local goals and situated priorities. This social turn is also a turn toward growing diversity.

6. Escaping from the mimetic trap: the case of Japan

In the early 1990s, the “bubble” crisis forced the administration to restructure Japan’s research system. The proliferation and disparity of programs in the 1980s were costly and inefficient, far below expectation. Because of the amount of partners (ministries, companies, universities, etc) involved and of the fields concerned, two large programs were organized: the *Industrial Science and Technology Frontier Program* and the *New Sunshine Program* for new energy sources and environmental technologies. Their demarcation shows Japan’s long-term priority was explicitly to respond to the environmental constraint by articulating green research and industry in the hope to build a different social and economic system. This restructuring led to a final reform establishing a new and coherent research and innovation system. The goal for Japan was not simply to have a strong Science and Technology policy: the objective was to build this policy within the institutional system and in return to adapt the institutional system to the role and output of this policy. In 1995, was voted the *Basic Law for Science and Technology*. According to his basic law, three basic plans have been developed from 1996 to 2011. Spending on science and technology increased from 12.6 trillion yen 1995 to 17.6 for the first plan, 21.1 trillion for the second and 21 trillion for the third plan. The size of these budgets teaches little about the plans themselves, their construction, intentions and internal dynamics. The first two plans had for goals to reform Japan’s system of research, innovation and education. The third Basic plan opened a different dynamics: to transform the interactions between research and innovation activities with both society and the economy.

The first Basic Plan, from fiscal 1996 to 2001, had for goal to open a new phase by increasing by 60% in five years the public budget for science and technology. In spite of the crisis, the budget was granted. The plan had for priority to modernize research infrastructures and create new ones. The second Basic Plan, from 2001 to 2006, had for objective to reform in depth universities ad the university system, to draw a line between public and private universities and to give public universities financial and administrative autonomy. Public universities had to become accountable of their management (including profitability) and of their research and teaching performance. To stimulate research and open new fields, a Center Of Excellence (COE) program was established in order to provide financial incentives for innovative projects on a competitive basis. The effective outcome of such reforms is always below expectation and is always criticized. Nonetheless the COE program has indeed stimulated innovative research projects in many fields.

The third Basic Plan, from 2006 to 2011, was launched in March 2006[17]. Its conception and goals were different. It was based on a large inquiry to identify both the worldwide state of research and the needs of Japan's population. The goal was to respond to the economic and financial situation and to take into account Japan's social constraints[18]: the aging of the population, the demographic decline and low birth rate, the rising cost and scarcity of energy and the environmental constraint in general, the increased competition with Chinese economy, growing international instability. At mid-course, the third plan was disrupted by the 2007 crisis. Japan was hit where it hurt the most: its economy was partially restructured and in 2004 and 2005 it started to grow. But the year 2008 proved how fragile were this growth and recovery: high tech industries were far too dependent on foreign markets and global economic growth. The time of an export oriented economy based on always higher added value industries and products could not anymore sustain Japan's long-term economic and social development. But all industrial nations, including recently the US, have been implementing the same strategy, which was also becoming a dead end. Japan found itself caught in a mimetic trap. The resulting adaptation and revision led to the conception of the next plan, the fourth Basic Plan. But this third plan expresses what should be called the *social turn* of science and technology policy in Japan.

The fourth Basic Plan should have been launched in April 2011. Because of the crisis, discussions have been more inclusive because this plan will have to make a difference in order to justify the same level of public funding. The population will have to see the difference in its daily life, its standard of living and public services. According to available documents, the plan will intensify the third plan's orientation toward solving pressing problems. Small and medium size companies and even new industries, new jobs, new services responding to the present needs of Japan's population will have to be created or reinforced. The fourth plan is raising high expectations: it has to respond to the growing disappointment toward science and technology policies according to criteria of "social accountability". In summary, innovation has to make sense, to produce growth, create jobs and satisfy real needs. Innovation is not about the future but the present. Beneath marketing and political slogans, a real problem is raised by Japan's techno-structure: the 2007-2011 crisis requires a deep revision of the economic strategy based on scientific progress and technological innovation designed in the early 1990s.

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[17] See NISTEP Report n° 99, *Comprehensive Analysis of Science and Technology Benchmarking and Foresight*, Tokyo, May 2005.

[18] Reports and studies are available at the website of National Institute for Science and Technology Policy (NISTEP): www.nistep.go.jp/.

Intense debate has been taking place since 2008 and a consensus is now emerging[19]. The social turn has opened new perspectives, which are considered worth exploring. According to this "new paradigm of innovation", in order to benefit the Japanese people, Research and innovation policies have to learn how to articulate and manage different goals within the same policy. They have to respond to practical problems and as the same time sustain world-class research. This requires innovations in research governance, a new way of conceiving, organizing and managing research and innovation. "Society" is a search for new interaction between universities, firms and the State. Various documents, debates and reports[20] show that the goal is not to put as usual new products on the market to respond to demand. The goal is to identify real social needs and to try to satisfy these needs in order to create new products and open markets from them. In this perspective, the neo-liberal "market" is not anymore the center of the social system. "Society", people in their daily life and problems, become the center of society. The problem is not anymore to organize and reform a "national system of innovation". Obviously in Japan today, debates and research show that the problem is to negotiate and organize the emergence of a new "innovation ecosystem" within society itself and from the point of view of society.

This notion had to take a practical meaning and become a social experimentation: to learn how to associate into a constructive debate various actors and partners from very different sectors and with different interests and values. The March 2011 Kanto and Tohoku earthquake and Fukushima catastrophe will obviously reinforce and fully justify this evolution. Japan research policy is reorganized toward the reconstruction not only of the regions destroyed by the tsunami but of the Japanese economy and society as a whole. This reconstruction will be the first full scale experimentation in a fourth helix.

7. Conclusion: irreversibility, risk and democracy

Japan is often considered a dragon of the last century. But by inventing such a solution to its complex crisis, Japan is in advance and a forerunner. It is trying to escape from the neo-liberal endless trap and its "race to the bottom". The present debate in Japan shows that social innovation is of equal relevance than technological innovation. However fuzzy this

[19] I have drawn from articles and presentations by Arimoto Tateo, director of the Research Institute of Science and Technology for Society (RISTEX), Japan Science and Technology Agency, and by Harayama Yuko, Tohoku University and OECD. See Arimoto Tateo, « Innovation policy for Japan in a new era », in H. Whittaker & R. Cole (ed.), *Recovering from success : innovation and technology management in Japan*, Oxford, Oxford University Press, 2006, p 237-254.

[20] See the RISTEX website: http://www.ristex.jp/EN/

conception might seem, it is an alternative to the neo-liberal paradigm and a step beyond the neo-liberal era. Neo-liberal policies implement successive decoupling in search of a ground for rebuilding competitiveness. In the end, this ground is found in research and innovation. But science and technology activities, universities, companies and State institutions have all to be reorganized according this neo-liberal model in order to provide expected results and solutions. In the alternative Research and innovation paradigm experienced in Japan since the 1990s, a decoupling process has emancipated and reformed research, innovation and education institutions. But this decoupling has found a ground. A recouping is taking shape at the level of "society", of a so-called "ecosystem of innovation", which is a platform associating the various components of this system. This solution is not yet clearly defined; it requires intense research in Human and Social Sciences. But a full-scale experiment is taking place in Japan.

Finally, the intellectual competence and the level of financial investment required for designing and implementing such a Basic plan for science and technology are so high that the resulting orientation is, or nearly is, irreversible[21]. Collective time and money spent on these science and technology policies are not anymore available for exploring other solutions. A trajectory path is created and will last. The society, which designs such a large-scale policy, is therefore taking an extreme risk. The only solution to manage such a risk is to share it amongst the largest amount possible of people. To associate the largest amount of people is also to reduce as much as possible this risk. The only solution to manage this situation is to organize such a policy as an experiment in advanced democracy. Citizen debates have become commonplace, with mixed result. These small-scale citizen debates are just a forerunner of a major political reform adapted to the growing environmental constraint, to comprehensive research and innovation policies and to the transformations of our social and economic systems. Understood from the point of view of society, such science and technology policies will soon require new political philosophy and institutions.

[21] Concerning funding, see Arimoto Tateo, "Three viewpoints for the reform of the competitive research funding system", Tokyo, review *Chemistry & chemical industry*, vol. 62, September 2009, p 978-980 (available on the Internet).