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Article

Innovation today: the Triple Helix and research diversity

Triple Helix

Provided in Cooperation with:

Triple Helix Association (THA), Rome

Suggested Citation: Rieu, Alain-Marc (2014) : Innovation today: the Triple Helix and research diversity, Triple Helix, ISSN 2197-1927, Springer, Berlin, Vol. 1, Iss. 1, pp. 1-22, <https://doi.org/10.1186/s40604-014-0008-8>

This Version is available at:

<https://hdl.handle.net/10419/188941>

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RESEARCH

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Innovation today: the Triple Helix and research diversity

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Abstract

Innovation policies are considered the long-term strategy to overcome the present systemic crisis. But this crisis is questioning such policies, their presuppositions and institutional arrangements. This questioning includes the Triple Helix theory and its impact on research and innovation policies. The goal is to examine how this theory can respond to theoretical and practical challenges, how the theory needs to evolve in order to fit the present context. The criticism focuses on growing worldwide standardization of research and innovation policies and their long-term impact on innovation. Restoring and increasing research diversity is urgent for sustained innovation. One solution is to add 'society' as a fourth helix. The problem is to clarify what 'society' stands for in this context. The paper studies three different institutional arrangements, France, Germany, and Japan, because these three cases can learn from each other and contribute to progress in the Helix theory itself. Potential reforms are summarized in some policy recommendations.

Keywords: Triple Helix; Fourth helix; Research policy; Innovation territories; Institutions; Diversity; Governance; France; Germany; Japan

Multilingual abstracts

Please see Additional file 1 for translation of the abstract into the five official working languages of the United Nations and Portuguese.

Background

The Triple Helix theory in a new context

The crisis, which erupted in 2007, is systemic because it has been and still is financial, economic, social, political, and monetary. It also transformed the international and regional balance of power and generated new insecurities and uncertainties. It is finally systemic also because it cannot be isolated from intensifying environmental constraints, from rising costs of energy to climate change. In fact, this situation is not a *crisis* because no one can expect to return to a new version of the initial situation. It is a *transition* toward a new, still largely unpredictable, situation. This conjuncture deeply transforms the performance and reliability of economic policies and theories, as well management methodologies at the level of firms, governments, and international institutions. This highly complex situation does not only question the theoretical and practical presuppositions of these policies and practices but also their institutional environment, the conditions of their performance. In this context, the established

conception and role of innovation policies, the relevance of innovation theory, and even the role of innovation in the evolution of industrial societies have become a growing object of inquiry and scrutiny. Innovation is often used as a magic wand to solve all problems. It is expected to restore or sustain the competitiveness of firms and nations in the hope of devising a new positive cycle: the emergence of new companies and even industries, creating new jobs and high employment, leading to new taxes on these profits and salaries in order to finance social programs as well as research and innovation policies. Innovation is our present panacea.

In his latest work, Godin (2008) explains that innovation is a recent collective passion, that this passion might be an intellectual trend dissimulating the intricate problems facing industrial societies. Benoît Godin does not mean that innovation is an ideology that should be discarded or can be replaced. Because no alternative theories are readily available to respond to the present situation, research and innovation processes and theories need to be reexamined within the present context. This paper concentrates not on innovation itself but on the Triple Helix theory because it provides a concept and an institutional arrangement designed to describe and foster innovation processes. The Triple Helix (TH) theory never really was a magic wand: it was a method for studying highly complex processes taking shape in given social systems. One reason, among others, for this disenchantment with innovation is found in some counterproductive effects of the TH theory. The intent of the paper is to examine the present state of the theory and its uses.

As metaphor, the TH theory can be summarized as the DNA of advanced industrial societies, of those industrial societies, which have been since the 1980s responding to increased competition and other constraints (including environmental) by intensifying innovation processes. In this type of society, innovation is not reduced to technological innovation or scientific progress, to any linear process from discovery in laboratories to applications in the market. Innovation is a complex institutional process: it names the emerging effects of interactions between universities, government, and economy, the three spheres of activities where these interactions take place. This theory is both a conceptual construction and a model of management and reform of these three institutions in order to intensify their interactions. This model has been adopted and adapted by a growing number of governments, nations, and regions since the mid-1990s.

The present systemic crisis is further reinforcing interest in the model and criticism of the theory. Both the theory and the model raise many problems at different levels, mainly at the conceptual, empirical, and political levels. The main problem is the requirement to take into account the institutional and historical context in which this arrangement is emerging because this context has obviously a strong impact on the implementation of the model. A major step forward for solving this problem was the idea raised during the 2002 Triple Helix conference in Copenhagen to introduce 'society' as a fourth helix. Adding this new helix expressed the institutional recognition achieved by science and technology studies and their growing role in policy design. The report by Leydesdorff and Etzkowitz (2003), the two originators of the theory, discussed this idea and this discussion opened a new range of debate and research on the helix. The problem was and still is to establish what 'society' really means, or stands for, in a reformed Triple Helix model and theory.

This paper further elaborates this issue in the context of the present systemic crisis. Introducing ‘society’ raises a problem without any easy solutions. ‘Civil society’, ‘social impact’, and ‘social problems’ have always been major concerns. But, more generally, ‘society’ stands for the context of formation of the TH arrangement, its context of adoption and adaptation for best performance. At stake are the particular conditions and level of implementation of such an arrangement in a given social system. The theory itself can only develop on the basis of the different cases it can describe, explain, and compare. This is the reason why this paper tries to further research the theory by comparing three cases, France, Germany, and Japan, because they are *responding* to each other. Studying and comparing cases in order to rebuild the theory is a departure from a former conception of the theory taking for granted that Silicon Valley was the typical model of interactions between university, government, and industry. This was the theme of the 2011 Triple Helix conference in Stanford: ‘Silicon Valley: global model or unique anomaly?’ The overall answer was that, in this present evolution, Silicon Valley is neither unique nor an anomaly^a. It is not a norm but a case among others. The present skepticism about innovation requires setting the theory and its model in different contexts and perspectives. Finally, TH theory is a typical Schumpeterian innovation: it keeps a strong heuristic value but new versions need to be extracted from cases formulated and debated. Research simply has to progress. Some policy recommendations conclude the paper.

Results and discussion

The case of France

The case of France is of particular interest because it is furthest removed from Silicon Valley, which remains until today a sort of French utopia^b. What fascinates the French in Silicon Valley is in fact an ideal type of Triple Helix. Paradoxically, no reference to the TH theory is explicitly made in French policy debates in innovation and competitiveness^c. Few researchers even show real interest for the theory, and most of them are related to the Ecole des mines in Paris^d. The reason for this apparent lack of interest is well known: until today, the French state apparatus^e controls research activities, their budgets, and even the careers of researchers, through its monopoly of universities and through its extensive range of public research institutions. These public institutions are first of all training institutions: the best known are the ‘*grandes écoles*’, highly selective national professional schools^f. Secondly, the major public research institutions are the CNRS (Centre national de la recherche scientifique), the INRA (Institut national de la recherche agronomique), the INSERM (Institut national de la santé et la recherche médicale), the CEA (Commissariat à l’énergie atomique^g), and many others, including their legions of state engineers and public researchers. These public institutions cover all fields of research, from physics to public health, agriculture, communication, and energy, including human sciences. These two types of public institutions have historically given birth, and are still closely related, to all major industries (mining, transport, energy, etc.) and industrial firms or conglomerates. These institutions are not only part of the state apparatus but they constitute its hegemony on French economy and society. They are an expression of French sovereignty: they are sovereign institutions intertwined with sovereign industries.

In such an institutional framework, innovation is certainly not ignored: national power, industrial development, and economic progress have been the goal of this apparatus since the early 19th century. But, beyond common rhetoric, there is both a divide and close relation between these teaching and research institutions and industry. Students from the '*grandes écoles*' are trained in science in order to later 'apply' their competence to industry. By contrast, innovation processes are considered the responsibility and role of industries. According to this imagined and official 'linear model', state research institutions are in charge of 'science', the source of 'basic' or 'fundamental' knowledge, which is made available and distributed in various stages throughout the French economy and society. Even today, innovation tends to be still treated as 'application'. This conceptual and institutional framework is organized according to a center/periphery model. The center, research, and its peripheries, applications, i.e., innovation, are treated as two distinct types of activity developed and organized according to different values, goals, and methods. They belong to two different cultures unified by the same conception of the nation and the state, with two radically distinct experiences of economic competition. At best, innovation processes are considered a field of interactions and mediations between research and industry, public and private institutions, the state, and the 'market'. How these interactions really happen is considered obvious and largely left unknown^h: people just move from one to the other.

This conceptual and institutional framework has well-known negative effects still strong until today. Either large firms have developed their own research and development activities - in this case, they often associate, even integrate, public researchers and laboratories according to their internal interests and strategies - or large firms suppose that public research institutions should provide access to their basic research because it is *public* and financed by taxes on their revenues. This framework reproduces the divide between science and technology, public and private, and research and innovation. The structure of knowledge activities tends to reproduce the structure of the state apparatus. This framework is an obstacle to the level of interactions driving both research and innovation activities today in effective knowledge economies. In France, two worlds, two different sets of values and conceptions of knowledge, and two epistemologies, are in conflict with each other.

This is well known and well denied at the same time. The Triple Helix theory has precisely the goal to address this situation and search for solutions and reforms. This double denial is reinforced in France by the social sciences, which are considered having full legitimacy in explaining and managing the French situationⁱ: political science (public policy studies in particular), sociology, economics and to a lesser degree history, and philosophy of science and technology. They do not reach the 'deep state', the level at which the state apparatus operates. These disciplines and their institutionalized demarcation reproduce the denial. They have been strongly criticized by researchers like Michel Callon and Bruno Latour, who explained that investigation and innovation processes should be analyzed in a completely different conceptual framework. What is both well known and denied is clear: through these public research institutions, some of them prestigious, the French state apparatus controls the long-term evolution of the French economy and society. This established network of power is reproducing itself over time at the expense of economic development and social progress. This network of power tends and tacitly intends to reduce the disruptive potentials of research and

innovation processes. It has become strongly counterproductive and even highly corrupt.

At a certain age and level of recognition, through various rewards and honorary positions^j, public researchers in France integrate a network of power associating top managers of big firms, the high administration of strategic ministries, and the scientific community elite. Coming from the same national professional schools (*grandes écoles*), they tend to converge at a given moment of their professional life^k. This power network is embedded within the state apparatus: it reinforces and legitimizes its control on the economy and society. This explains why the state apparatus is in the position of macro-managing the interactions between research institutions and the main firms framing the whole economy and presiding over its evolution. It also explains the strong divide within the French economy between the large national companies, today largely privatized^l, and its periphery of medium and small size companies, which do receive the same assistance from government, but do not have access to the same level of technological, financial, and legal resources as large companies at the center of the French economic system. They do have the same status but do not share the same privileges, even if they provide around 65% of employment in France. This explains why high-tech companies and new companies in general do not find in France the proper financial and fiscal conditions for growth. They do not belong to the same economy and do not play by the same rules.

In this situation, reform carries a high political cost. It is difficult to imagine that the French state apparatus would soon renounce its power to control the evolution of the nation, which is the source of its legitimacy. Without any doubt, the power of the state apparatus over the production and distribution of knowledge explains the present lack of competitiveness of the French industry and the relative weakness of its small and medium size companies, which do not have the same level of recognition and support than the firms associated to national networks of power. But this also explains why French major companies (EDF, Schneider, Areva, Total, Saint-Gobain, BNP-Paribas, Lafarge, etc.) are very successful outside of France where they have developed partnerships and participate in projects free from national administrative constraints and power structure. This situation also explains that graduates from the best schools tend or wish to emigrate in order to create their companies and develop their careers outside French constraints.

Finally, this close network associating the high administration, top management of big firms, and head of the scientific community, explains the decision taken in the 1970s to create a national system of nuclear energy facilities with the goal to assure France's long-term energy independence and sovereignty^m. The level of investment has been so high that it drastically reduced public and private investment capacity in the 'new technologies', which were picking up in all industrial nations, including France, in the late 1970s and early 1980sⁿ. After the pressure of the energy crisis all along the 1970s, with the promise of a secure supply of electricity by nuclear plants, the incentive to design energy-saving policies and processes, to invest in alternative energies, lost urgency. Private companies and public institutions could no longer consider these fields of R&D as profitable long-term investment. The consequences of these decisions, the responsibility of these aggregates of power, explain the present situation of the French economy combined with the state of research in France. The French nuclear energy

establishment is presented as an irreversible condition beyond any retrospective debate over the misleading vision of the late 1960s and the post-Fukushima debate.

Situating the present analysis is important. French science is known for the quality of its researchers in mathematics, biology, economics, or physics. But, this is today a partial and misleading epistemology. In the present knowledge regime, top researchers do not compensate for either the weakness of the French national system of innovation or the weakness of the French industry measured every month and for years by its trade deficit. The tall trees of Areva, TGV, and Airbus cannot hide the meager innovation forest. Once again, this situation is perfectly well known. But successive presidents and governments have been unable and finally unwilling to confront this situation, to establish a research and innovation policy targeting specifically French small and medium enterprises (SMEs). They all tried and finally renounced. In order to stay in power and govern ('to steer the country'), they cannot afford to confront the combined power of the high administration and top industries, which are driving the long-term evolution of the whole nation. They learn to take into account and then follow their aggregated interests. The political risk has always been too high because students, professors, and their syndicates are also against any reforms, which would transform in depth the *status quo*. The tacit hope of the best students is to join the power structure (or leave the country). Any strong reform would reduce their specific interests and their potential access to the French power structure.

After an initial trial period intended to show the population that its vote is respected, governments finally convert to the established hierarchy of influence and interests. The government is reduced to the role of interface, adjustment, and negotiation between the population, the economy, and the administration. There is therefore a sort of French Triple Helix. But this French version is reduced to the interaction between government, the state apparatus, and the economic system^P. In this distorted type of Triple Helix, two major instances and sectors of activities are absent and repressed: first, research, innovation, and education activities; secondly, French civil society. The first one, the knowledge sector, is under the control of the state apparatus; the second is supposed to be expressed by the political process. Reforming France does not suppose a social movement but major epistemological progress based on effective knowledge of the French system of power.

In contrast: the case of Germany

Therefore, in its standard definition, the Triple Helix theory is highly disruptive regarding France's institutional system. TH theory supposes the existence of an advanced social system in which three distinct *strings* or specific *spheres* are interacting with each other: information circulates between these spheres and these exchanges generate new knowledge (innovation) in each sphere and in the system itself. TH theory is just a conceptual construction. But this construct carries a theory of society and a program to analyze social systems and their evolution regarding knowledge activities. TH theory cannot be dismissed because it is built-in in the evolution of advanced industrial societies. In the case of France, repressed but not ignored, TH theory adequately describes the directionality of recent reforms of universities and research institutions, their relations to industry and to local economies. It explains the search at the local level for an increased degree of 'autonomy' from the Ministry of Higher Education and

Research and stronger interactions with industries and local economy. This direction explains also the limitations and final failures of these reforms. In its official sense, 'autonomy' means a more effective local management of resources but no real emancipation from central administrative control. It explains why these reforms are inadequate by comparison with those made on other nations in the last 15 years, in fact since the 1980s when the function of universities in social systems started to change.

From this point of view, the case of France needs to be contrasted with the case Germany. Referring to Silicon Valley might provide some ideal standard, but it surely hides the present state of France, as well as the ongoing evolution of the San Francisco Bay area. France needs to be compared to Germany in order to learn from it. The main difference is the institutional system, mainly the difference between the French regionalization and the German federal system. Regionalization in France replicates at the level of regions the same national institutional model; a federal model belongs to a different logic. Due to its federal institutional structure established after 1945, Germany is today composed of sixteen *Länder*, each with a strong historical and economic identity, with different but also shared interests, with a common vision of Germany, of its power and destiny. Today Germany is free from a centralized state apparatus having as its goal to rule the nation according to its own interest and perspective. As explained by Ulrich Hilpert³, within each *Land*, local characteristics and interests have made possible collaboration, interaction, and negotiation between universities, government, and industries.

A sort of spontaneous version of Triple Helix theory was already in place when the German federal government under Chancellor Gerhard Schröder decided in the late 1990s to reshape the German social and economic system in order to overcome the transition period opened by Germany's reunification, to stabilize the adaptations and reforms, which had been necessary in order to organize a new and extended version of the German state. Politicians did not have any helix in mind. Because economic disparities and psychosocial resistance were still strong between former Eastern and Western Germany, the challenge was to find the right level and establish the right local platform for rebuilding a competitive economy, to create competence and jobs. The selection of education, innovation, and research proved to be an optimal choice for reconstructing a local endogenous economy merging progressively into the national economy. Nobody pretends that TH theory brought the solution but it can certainly explain it. This complex transition is not yet completed and inequities between *Länder* still exist. Conflicts of power exist in Germany as everywhere else: the problem is the level at which such conflicts are expressed and solutions negotiated. But what made the management of this transition successful has been the tacit understanding and agreement that German long-term economic and social reconstruction would be built on continued interactions between universities, industries, and local governments within a regulation by a higher political order and federal incentives.

In each *Land*, the population understands the role of research and innovation processes, even if education remains a difficult challenge to create jobs and have access to these jobs. This development path creates social problems of its own, but it also created a tacit local consensus. This dynamics had one positive aspect: it transformed the conception and role of competition between *Länder* because each *Land* is responsible for establishing and implementing local conditions for growth, employment, and collective

welfare. The role of the federal government has been and still is essential. Its role is to stimulate local TH-type initiatives and to regulate at the same time this new German social and economic system within its geopolitical environment, within the European Union, and with the main partners of this new Germany in Eastern and Western Europe, Russia, the USA, China, and India. Based on a network of powerful nationwide public and private foundations, the Berlin government has been able to explain, promote, and finance continuous TH-type reforms at the level of the *Länder*, sustained by massive federal investment targeted toward 'centers of excellence', laboratories, research chairs, and emerging fields of research. Germany is a paradigmatic case of a federal regulation of local industrial competitiveness based on research and innovation processes. From the start of the present systemic crisis, this policy has been reinforced as the best response to overcome the crisis. This is summarized by Germany's official 2009 slogan '*Mit Forshung und Innovation aus der Krise*' (overcoming the crisis with research and innovation)^f.

The case of Germany is a powerful version of Triple Helix theory. It deserves to be carefully studied and debated by each *mature* economic and social system, certainly by French specialists in science and technology policy. 'Regionalization' has been a major policy in France since the late 1960s. It was the last reform introduced in 1969 by General de Gaulle. It was rejected by popular vote and de Gaulle chose to resign. The French population voted against this project because the majority of the voters did not consider that these *regions* would have the resources to develop economically, that inequities between regions would rise, and that it would also reduce the capacity of the central government to balance these inequities. The *Loi Deferre*, the decentralization law voted in 1982, was a real transfer of sovereignty to the regions. Local governments were established. But this administrative transfer never went so far as to create or induce locally the will to establish the conditions for an endogenous regional dynamic, adapted to the local economic fabric and contrasted (not disconnected) from national policies. These French regions did take into account their specific geo-economical environment, but with the exception of Alsace, they always stayed in the end within the framework of a national sovereignty. They never converted to the establishment of a full real trans-border growth area based on research and innovation activities, as exemplified by the *Knowledge triangle Eindhoven-Leuven-Aachen*. Soon, regional politics obscured the ambition and benefits of effective research policies. The French regions have reproduced the national political debate and administrative model. They seem unable and unwilling to emancipate from this model. They are for the moment unable to establish a regional Triple Helix, to establish research and innovation activities as a common regional platform for economic and social development⁵.

Of course, whatever their history and culture, nothing proves that existing administrative entities are the best territory to establish a successful research, innovation, and training (RIT) policy. The future might be full of surprise. In the case of France, the key model for such emancipation is the formation of a trans-regional TH policy, an extended version of the German example, with probable success if fully experimented and effectively implemented. Some French regions are ideally situated for this quantum leap because it is part of their long-term history and present economy. These trans-regional collaborations are well known: Northern France with the Flanders and Holland, Alsace with Bad-Wurttemberg and the Basel region, the

Region Rhône-Alpes with French-speaking Switzerland and the Italian Piedmont around Torino, the historical relations between Toulouse and Barcelona, etc.[†]. The French government would need to take the lead and reorganize the state apparatus in order to reduce administrative control. Beyond the case of France, this carries another map of Europe, based on the subsidiarity principle, which contradicts the French state and its power over French destiny. Still, the cases of France and Germany need to be contrasted and complemented in the last part of this paper by the case of Japan, which adds another dimension to the debate. But before reaching this point, it is necessary to summarize why these two cases lead to a new version of the Triple Helix theory, why some counterproductive effects of the standard theory need to be explained and reformed.

Problem: growing standardization

The cases of France and Germany prove the descriptive and heuristic value of the Triple Helix theory. They also contribute to a better understanding of its limitations and presuppositions. Explicitly or not, TH theory is still inspiring strong debates, many research, and potential institutional reforms. But the adoption and adaptation of the model has also transformed this conceptual construct into an international norm. The counterproductive effects of this norm have become clear and serious. To modify the theory is to open new research and further reforms.

The first problem is an increased standardization of research, a serious problem in time of systemic crisis. For research and other upstream activities, universities as well as national and regional research policies, competition has greatly intensified since the 1980s. 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 tend to become very similar. The short-term and long-term consequence of this situation is a growing standardization. This is a paradoxical situation: research intensification reduces its diversity and innovative potentials. This reinforces another trend: science might be universal and technology generic, we observe the emergence of various types of 'knowledge economy' not only in the USA and Japan as well as in Europe, but also in China, Singapore, Korea, even slowly in Russia, and Brazil. These various types of knowledge economy are competing with each other. But this intensified competition is further reinforcing standardization. These problems express the mutation of the conception, organization, and role of all knowledge activities in advanced industrial societies since the 1980s, the new 'regime of knowledge' in which our societies develop. All major research institutions now have the same priorities and objectives. 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. But this convergence and search for 'excellence' also increase frauds and misconducts.

But this standardization creates two problems: underneath global and even 'open' cooperation, it intensifies competition between laboratories and 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 of universities and *national systems of innovation*, which can be observed since the 1980s, tend to replicate the same model and therefore intensify the mimetic effect (Rieu 2008). It further intensifies standardization. From the point of view of the two main challenges, intensified environmental constraints and systemic crisis, results are below expectations. Established conceptions of innovation and research policies do not adequately respond to the present conjuncture. Research itself and research institutions are following a potentially dangerous path. This is the second problem: by reducing research and innovation diversity, self-reinforcing standardization will have a negative impact on research and innovation evolutionary potentials and therefore on long-term progress. This does not mean that standardization sterilizes research but reducing its diversity generates a long-term path dependency on established patterns. It seems strange to defend biodiversity and at the same time be blind to the necessity of sustaining and even increasing research diversity.

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 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 circulation of researchers. These positive elements cannot be ignored when humanity is facing increased challenges; diseases; food, water, and energy shortages; mass unemployment and unfulfilled jobs; unequal access to education, information, and technological expertise; and industrial pollutions and climate change, not to mention international security issues. The positive elements need today to be evaluated in this context. This context is radically transforming the context for science and technology policies, the goals of research and innovation.

Counterproductive effects have become an urgent issue. The first issue is the redistribution of research and innovation territories since the early 2000s, accelerated by the present systemic crisis. One observes a level of concentration of financial capital; of legal, financial, and management expertise; and of advanced research institutions (universities) attracting the best experts and graduate students from around the world, creating innovation ecosystems in which large companies grow larger and in which also innovation and new companies can breed. These world attractors are surrounded by scientific and technological peripheries as well as innovation deserts. Since the 1980s, this convergence has not only intensified, but it has also mutated: it might not fit the present conjuncture. This dynamics is driven by intensified competition between economies and societies. The problem is that the USA, Japan, Singapore, South Korea, and each West-European nation have been sharing the same diagnosis on the present world conjuncture and have one after the other implemented a similar response to growing environmental constraints and to the globalized competition. Since the 1990s, it is official policy that the long-term future of each advanced industrial society has to be found in its capacity to generate new knowledge and to translate innovation into new companies and new products, which would create growth, jobs, and state revenues for financing welfare policies and infrastructures as well as research and innovation policies. This was theorized and popularized by the pioneering work of Michael Porter since the early 1980s. This hope for a new positive cycle is our common mythology.

The resulting increased standardization is reducing research diversity and in the end science and technology's productivity. It is becoming a trap.

Solution: to restore and increase research diversity

Reversing the trend toward standardization has for its goal to restore and possibly increase research long-term productivity in order to meet present challenges. The problem is to organize and sustain research diversity. Modern science, soon after birth, became the monopoly of the modern nation state^u and to alter this historical trend is a major challenge. Contrasting France and Germany proved how a reformed TH theory could participate in the identification, formation, and organization of different RIT territories^v. Sterling (2007) proposed a conceptual framework for studying and managing diversity: 'Diversity concepts employed across the full range of sciences (...) display some combination of just three basic properties: (...) "variety", "balance" and "disparity"'. The variety of research traditions depends on their historical, social, cultural, and even economic contexts. But today, saving this diversity does not mean securing or protecting an imagined historical scientific or technical identity or tradition (disparity). It means producing new knowledge and to innovate in a world of intensified and mimetic competition. It means overcoming this competition by developing different perspectives or alternatives. 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.

Once extracted from neoliberal restrictions, the Triple Helix theory is able to provide responses to this situation, as proven by the cases studied before. This interpretation of the theory supposes that research universities do not bow or surrender to their interactions with firms under the control or guidance of government. On the contrary, in full compatibility with the TH theory, universities fulfill their duty when asserting and exploring their full role and responsibilities. Institutional innovation is certainly required, but this does not mean that a research university should be organized and managed like a firm as it is still frequently supposed. It simply requires stressing the requirements of research and innovation, of teaching and training, and of the various time frames of these activities and their specific institutional constraints. Diversity is as important for progress in science and technology as standardization. Of course, adjustment between the two might be difficult to manage, but the risk to *differ* and to develop new fields and hypotheses are also a fundamental duty and responsibility of research communities. Economics of knowledge is a branch of economics studying the conditions and economic impact of innovation processes. But it cannot be extended to the life and organization of laboratories or universities.

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 for complementary and cumulative objectives. New modes of collaboration and *positive competition* can be imagined and can also be observed in a federal system

of research and innovation, connecting different local Triple Helix arrangements under a regulative entity, either national or regional. Germany is a good case of such an institutional arrangement, but it does not provide a model to be easily replicated. An institutional arrangement is not a matter of choice but the outcome of a singular evolution. *Collaborative competition* has become a key issue. Positive competition does not (should not) reduce diversity but on the contrary reinforce diversity and intensify global progress and common knowledge. In the present crisis, in order to confront rising environmental constraints, better and shared knowledge of innovation processes, including a reformed version of the Triple Helix theory, leads to a conception and practice of collaborative competition. It seems a big step when it is in fact a small change of perspective. To compete is also to collaborate: what is at stake is the productivity of these interactions in terms of discovery, innovation, and dissemination. The capacity of local or regional entities to respond to these interactions is a political matter, which the Triple Helix theory clarifies by providing a frame of negotiation and organization.

Porter's (2011) conception of 'competitive advantage' does not contradict this conception of the Triple Helix. His theory includes implicitly this different angle. Developed in the 1980s, in the period when neoliberal policies were implemented, his problem did not concern the local arrangements at the source of the *comparative* advantage. It was focused on the advantage itself at the level of firms capable of translating this advantage into a product or service introduced in different markets. The emergence of this advantage and its translation into a product or service developed by a firm were left in the shadow. In this neoliberal context, creation of SMEs, industrial development, and economic growth were the only concern. Markets had to be opened or created, extended, and penetrated. Economic globalization is an outcome of this neoliberal paradigm. It revolutionized the world, but it also turned into the present situation.

The questions today are more inquisitive and more urgent also. A proof of Porter's theory compatibility with a new version of the Triple Helix theory is the important role played by the idea of 'differentiation.' This notion encapsulates the competitive advantage. What is really the difference expressed in a new product? Where does it come from? How is it translated into potential competitiveness? Can it be reduced to a higher performance and cheaper cost? Looking for the source of the *difference* is an endless and useless task. The problem is not the source but the context in which a difference becomes an innovation, how it takes shape and is finally translated into a new product or service reaching a different need or expressing a desire in a population. This context has certainly many layers and parameters. But some interactions generate a pattern and *compact* between at least three distinct types of activities, knowledge, experience and expertise, a type of exchange and enterprise, and a common or collective institution. Among many others, these interactions transform a difference into continuing innovation between various fields within a social system. This simply means that the Triple Helix theory has a heuristic and epistemic function: it makes possible an analysis of an emerging innovation and of the various interactions transforming this innovation into an artifact embedded in a society.

In the present post-neoliberal period, one way to reverse standardization and negative competition is to restore and intensify diversity. It is easier said than done. I am trying to formulate a version of the Triple Helix adapted to this specific conjuncture. The

present period does not so much expect 'new discoveries' than search for multiple innovations in many different fields: technological innovations as well as social, institutional, ethical, managerial, legal, financial, or cultural. The idea is simple: multiple innovations will at some point aggregate and lead us all beyond the present systemic crisis. This search for new sources of innovation has been clearly expressed since the 2002 Triple Helix conference in Copenhagen. An idea was to introduce a *fourth helix*. This new helix was identified with 'society' and 'civil society' in a typical science, technology, and society (STS) approach. This solution was also expressing the growing role of social sciences in the knowledge of science and technology processes, of their interactions within their social, political, and economic environments. Introducing a *fourth helix* in the triangle made by government, universities, and firms was to create a different method to analyze innovation processes. This method was in the end leading to a different analysis and conception of society.

Giving a real content to this *fourth helix* is a question, which proved more difficult than expected. First of all, the fourth helix could not be reduced to 'culture', to national scientific and technical traditions, because it explains little besides what history and sociology of science have been studying for years. To reduce this fourth helix to 'society' raises the problem of what 'society' really means in this case. Multiple answers are available, all fully justified: connecting to civil society, solving social problems, answering social needs, reducing inequities, easing everyday life, developing public infrastructure and services, creating jobs and employment, and establishing a clean and safe environment as well as sustainable social and economic development. Other perspectives need to be taken into consideration, in particular Latour's (2005) analysis of how the 'social' is constantly made and reinvented at the level of individuals and groups in their own agency. In the end, what is at stake is a different conception of democracy.

The answers are many. Introducing a *fourth helix* transforms the theory in many ways. What is expected from this supplementary helix? Its function is to study, organize, and regulate the social system in which operate interactions between universities, government and the state administration, firms, industries, and their related services. This also includes industrial property rights and the legal structure according to which knowledge is produced and circulates. Furthermore, the fourth helix satisfies a real *political* function situated outside established political institutions. In this sense, it manages the governance of a social system driven by a Triple Helix arrangement. This political function regulates and reconfigures the relations between politics and technology, research and economics, civil society and research, and politics and economics. This new political function is not a dream or utopia: it is a virtual response, an urgent one, when our social systems need to learn how to respond to environmental constraints, which deeply transform their structure and affect the life of individuals and groups^w. The virtual function anticipates institutions, which are still to be imagined. At the same time, this mutation was actually quite predictable and is obviously required: when science and technology concern all aspects of life in society, the way we are educated and the way we work, commute, communicate, and even reproduce, a major mutation is bound to take 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. This mutation is the *social turn of science and technology policy*.

Japan was the first nation to explicitly formulate this problem and to search for a solution. The fourth helix is not an answer but the name of a great variety of problems without any clear solutions for the moment. It names an open set of problems, which questions the helix theory itself within the theory itself. *Differentiation* seems to be a solution to be researched case by case. The helix theory has for goal to analyze and explain what generates innovation within a social system and how this social system is transformed by this innovation.

Escaping from the mimetic trap: the case of Japan

In the late 1970s, Japan was the first nation to respond to the 1973 energy crisis by transforming its industrial policy in order to design a high value-added economy, which could neutralize the increasing costs of energy and natural resources in general. When in the early 2000s, Japan's power structure realized that most industrial nations were replicating a similar pattern, Japan was the first nation having for goal to escape from this mimetic trap^x. Japan's third and fourth Basic Plans for science and technology are the best and only cases of such a 'social turn'. In order to learn from them, both plans need to be rapidly put in their context. In the early 1990s, the 'bubble' crisis forced the administration to restructure Japan's research system. The proliferation of programs during the 1980s proved costly and the results were far below expectation. Because of the amount of partners (ministries, companies, universities, etc.) involved and the fields of research concerned, two large programs were organized in 1992 and 1993: the *Industrial Science and Technology Frontier Program* and the *New Sunshine Program* for new energy sources and environmental technologies. The divide between these two large-scaled programs indicated that Japan's long-term priority was to respond to environmental constraints by articulating green research and industry with the goal to reshape its social and economic system.

This restructuring led to a final reform, intended to establish a new and coherent *national system of research and innovation*. The goal for Japan was far more ambitious than a comprehensive 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 objectives of this policy. In 1995, a *Basic Law for Science and Technology* was voted: research and innovation were established at the core of Japan's institutional system. Based on this law, three basic plans have been developed from 1996 to 2011. Spending on science and technology increased from 12.6 trillion yen in 1995 to 17.6 trillion for the first plan, 21.1 trillion for the second plan, and 21 trillion for the third plan. As usual, budgets teach little about the plans themselves, their construction, intentions, and performance.

The first Basic Plan, from fiscal 1996 to 2001, had as its goal to open a new phase: it increased the public budget for science and technology by around 60% in 5 years. In spite of Japan's systemic crisis, adequate budget was always granted. The priority was to modernize research infrastructures and create new ones. The second Basic Plan, from 2001 to 2006, had for objective to reform in depth universities and the university system by drawing a demarcation between public and private and national and local universities: their ambition and role were different but complementary. Public universities received financial and administrative autonomy: they had to become accountable for their management, for their research and teaching performance. To stimulate research and open new fields, a Center of Excellence (COE) program was established to provide, on a competitive

basis, financial incentives for innovative projects. Even if the effective outcome of such reforms is regularly below expectation and criticized, this COE program has indeed stimulated innovative interdisciplinary research projects in many fields.

The first two basic plans had as their goal to reform Japan's *national system of innovation*. Since 2006, a Japanese version of the Triple Helix theory was under construction. In 2003, the *National University Corporation Law* was voted, and in 2006, amendments to the 1947 *Fundamental Law of Education* led to the possibility of establishing an 'industry-university-government' alliance. The third Basic Plan, from 2006 to 2011, was launched in March 2006. Its conception and goals were quite different (NISTEP 2005) from the first two plans. It was based on a large inquiry to identify the worldwide state of research but also to take into account the effective needs of Japan's population. Japan's Triple Helix had from the beginning a fourth leg. The goal was to respond adequately to Japan's economic and financial situation and its social constraints^y: the aging of the population, the demographic decline and low birth rate, the rising cost and scarcity of energy, climate change and other environmental constraints, the increased competition with the Chinese economy, and growing international instability. The infrastructure of the daily life of the Japanese was taken into account in order to be reshaped.

The third plan was disrupted at mid-course by the 2007 systemic crisis. Japan was hit where it hurt the most: its economy was partially restructured, and since 2004 and 2005, it had started to grow again. 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 message was brutal and clear, without easy solution: an export-oriented economy based on higher value-added industries and products could not anymore sustain Japan's long-term economic and social development. Either Japan's research system had failed to generate and distribute adequate innovation or this conception and role of innovation dating back to the 1980s was outdated^z. As mentioned before, geopolitical perspective shows that all industrial nations, including recently the USA, had been implementing the same strategy, which would soon become a dead end. Japan found itself caught in a mimetic trap it had entered earlier than the others. Japan had now to escape from it first. The goals of the plan, its methodology, and the conception of research and innovation had to be adapted to this situation. These revisions and reforms led to the conception of the next plan, the fourth Basic Plan. The third plan expressed what should be called the *social turn* of science and technology policy in Japan; the fourth Plan was supposed to reach a step further by including a Japanese version of a fourth helix.

The fourth Basic Plan was ready to be officially launched in April 2011. It was suspended because of the 11 March 2011 Kanto and Tohoku earthquake, revised during summer, and voted again in late August 2011. A major political change had happened in between: the Democratic Party of Japan had won in August 2009 the general election, and a Japanese version of social democracy was experimented. In this political context, because of the systemic crisis, discussions have been more inclusive. This fourth plan had to make a difference in order to justify the same level of public funding. The population would have to see the difference in its daily life, its standard of living, and its level of public services. The third plan's orientation toward solving pressing social problems was reinforced. A 'society of users' was no longer an adequate

solution. Small and medium size companies and even new industries, jobs, and services responding to the needs and lifestyles of Japan's population were supposed to be created or further developed. The fourth plan was raising high expectations, at least in political and administrative circles. It had to respond to the growing disappointment toward science and technology policies according to a criterion of 'social accountability'. In summary, innovation had to 'make sense', to produce growth, to create jobs, and to satisfy real needs but also new attitudes, desires, and values. *Social* problems were extended to *societal* issues. Beneath marketing and political slogans, a real problem was raised: the systemic crisis was requiring a deep revision of the economic strategy based on scientific progress and technological innovation designed in the early 1990s. In the mind of many Japanese researchers and officials, a solution was to reconnect to 'society', to envision innovation from the point of view of society.

Intense debate had been taking place since 2008 and a consensus was emerging^{aa}. The idea of a *societal turn* was opening new perspectives worth exploring. According to this 'new paradigm of innovation,' in order to benefit the Japanese people, research and innovation policies had to learn how to articulate and manage different goals within the same policy. They have to respond to practical problems and at the same time sustain world-class research. This required innovations in research governance, a new way of conceiving, organizing and managing research, and innovation. 'Society' was the name of a search for new interactions between universities, firms, and the state from the point of view of the population. Documents, debates, and reports^{ab} show that the goal was not to put new products on the market in order to respond to a potential demand expressed in buying power. The goal was to identify social needs and societal demands, to try to satisfy these needs and lifestyles in order to create new products and open markets from these new products and services. In this perspective, the neo-liberal 'market' was not considered anymore the center of the social system. 'Society', people in their daily life and problems, were becoming the center of the social system. The problem was not anymore to reform the 'national system of innovation', to implement a Triple Helix, but to understand innovation from the point of view of individuals and groups, to redesign the helix theory itself. In the early 2010s, debates and research show that the problem was to negotiate and organize the emergence of a new 'innovation ecosystem' within society itself and from the point of view of society.

In this extended and revised version of the Helix theory, these issues and notions were expressing a *virtual* evolution, real but still not implemented. To respond to severe and multiple constraints, many Japanese researchers but also (younger) administrators and politicians were ready for a real experiment: to learn how to associate into a constructive debate various actors and partners from very different sectors and with different interests and values. The 11 March 2011 Kanto and Tohoku earthquake and the Fukushima catastrophe have obviously reinforced and justified the need for such an evolution. But the Fukushima catastrophe, its impact on Japanese society and economy, are so deep that the whole nation is transformed and transfixed. The complexity of the new situation is so high that it is still today difficult to imagine where it could lead. The catastrophe became institutional when the intricate networks of interests, which made it possible and so severe, were revealed (Rieu 2013). The divide between the population and its institutions is so deep that the basic compact and trust holding a society together is profoundly shaken. Still, life continues but no

government seems able to withstand an institutional catastrophe of such magnitude. In December 2012, a general election brought the Liberal Democratic Party back to government. The conservative prime minister engaged strong proactive policies designed to overcome the endless systemic crisis and set the Fukushima catastrophe in the past. These policies intend to bring growth at any cost and, with growth, confidence in the future.

A social scientist expresses the truth of this critical moment in Japanese history: Kobayashi Tadashi, director of the *Center for Communication Design* at the University of Osaka, a well-known specialist of sciences studies and deliberative democracy^{ac}. In June 2012, the Prime minister from the Democratic Party of Japan decided to organize a nation-wide inquiry on the future of nuclear energy in Japan. It considered necessary that the Japanese public reach an informed decision about nuclear energy as a basis for a new energy policy. Kobayashi Tadashi and other specialists under the direction of Sone Yasunori^{ad} organized in a few weeks a National Deliberative Poll. Registered voters (6,849) were selected at random and from them 285 participants were selected as a representative sample of this group according to their demographic, geographic, social, and educational background. The participants met at Keio University, Tokyo, on 4 to 5 August 2012. Following rigorously James Fishkin's procedure (CDD 2012), the result was a typical case of 'informed decision': between 60% and 70% of the participants declared supporting 'a society less dependent on nuclear power plants' (Kobayashi 2012). Based on this study, the Japanese government decided on 14 September 2012 to end all nuclear energy production by 2030^{ae}.

But the government changed three months later: the new prime minister objected to the study, which justified the decision of its predecessor, and announced that his government would restart all nuclear plants when in agreement with the safety regulations established after the accident. Ironically, it was announced early July 2014 that nuclear plants would not produce electricity this summer and that no shortages were expected. No one knows how many nuclear plants will be restarted, for how long, and if any will ever be restarted. But what matters is different and reinforces my argument: a nation-wide helix agreement has been reached in Japan. This agreement associates a majority of civil society, politicians and members of the administration at the national and local level, members of the academic community, and a large number of business people, from the media to high technology. This aggregate is a political arrangement between different helixes, like a reshaped DNA in an advanced industrial nation. The message is clear: a new and extended version of the helix theory is potentially, already, at work at the core of our social and economic systems.

Conclusions

Policy recommendations

The following remarks concern each case studied in this paper. These remarks do not come from economics, sociology, or government studies. They come from science studies, in a perspective strongly influenced by the work of Michel Foucault. Concerning France, the power structure controlling research and teaching activities will not change in the near future. There is not even a will to study the situation with appropriate conceptual means. The taboo is the centralized national republican ideal. Science and technology policy and university reforms remain a domain managed in the end

according to national interest and sovereignty. The various projects to organize regional poles or communities of research, innovation, and teaching have failed and will fail in the near future because they intensify conflicts of interest and power at all levels.

The best solution is to learn from the case of Germany. The idea is not to replicate the German model but to evaluate the German example and to learn from this evaluation. What is at stake is to find and negotiate the appropriate level of a spontaneous Triple Helix, the level at which a positive negotiation and cooperation become possible between the administration (elected and non-elected officials), the research and higher education institutions (universities, professional schools in business, engineering, etc.), and the business community in its diversity. This local Triple Helix is the active core of a 'cluster'.

Administrative divisions or cultural history do not define in advance this appropriate local level. These 'clusters' are not predetermined territories: they are established around a local Triple Helix. Because this local TH is new, an ongoing negotiation, it can have partners outside its geographical location. This is clearly a version of various economic discourses dating back to Alfred Marshall. It is different from Italian 'industrial districts' often anchored in a long history. This is not the level at which large and well-established firms usually operate, but they often maintain a strong local commitment. On the other hand, small and medium firms operate at this level: they are created at this level and they require strong collaboration with all people and organizations involved in a local helix arrangement. Finally, at the level best fitted for an innovation policy, all Triple Helix have a fourth helix and even many other helixes. In order to keep its heuristic value, the Triple Helix should simply become the Helix theory.

In the perspective of this paper, a lot can be learned from the case of Japan. In many ways, Japan is a continuous experiment, often against its own will. An interesting change and experiment happened between 2006 and 2008. As explained above, it became clear that innovation policies undertaken since 1996 had to be reoriented. The search for competitiveness was endless, mimetic, and in the end counterproductive. The imagined potential consumer somewhere in this world, reduced to its buying power, might belong to the past. The solution was to search for new conditions and sources of innovation and to turn to the local level, to society and everyday life, to the real needs and desires of consumers, and to the changing lifestyles and collective problems of the Japanese population. Responding to these needs, behaviors and desires had the potential to profile new products and services, which could be designed, produced, and sold worldwide. This experiment was suspended, but not forgotten, after 11 March 2011. This Japanese experiment (and others) remarkably fits the role of local TH arrangements. A similar awareness and method should guide those who understand the role and responsibility of local TH arrangements, the research and debate it requires.

Because of its territorial, cultural, and economic diversity, France could greatly profit from this approach. It would directly confront its political and administrative structure. It would entail that research and innovation activities reshape their relations with politics and the economy. The point is that a new level of collaborative activities specialized in research and innovation is emerging, with its own geography and requirements. But Japan could also profit from the cases of France and Germany. Germany could learn from the case of Japan that its real long-term

markets and research collaborations are to be found in these new territories of innovation. Finally these 'clusters' should tend to create their own networks in order to stimulate innovation: what counts is not the information, which circulates, but the capacity of *local* Helix arrangements to transform information into innovation for a population.

Methods

The method is first qualitative in a conceptual frame derived from the present state of science, studies focusing on the impact of the institutional environment in the context of the present systemic crisis and the constant call for innovation. The Triple Helix concept and related problems are derived from the work of H. Etzkowitz and L. Leydesdorff. In this study, the use of this concept includes the research field opened by Michel Foucault, mainly his conception of "power" and "governmentality". Secondly, the method is to analyze in this conceptual frame the case of France by setting it into comparison. The Triple Helix concept is not taken as a norm but as a heuristic model under constant revision. The case of France is confronted with the case of Germany. Thirdly, the method is to draw conclusions in order to lead the research further. Comparing these two cases opens a criticism of the standard Triple Helix theory when it is used as a norm to study, manage and reform innovation processes. Typically a crucial debate in the Triple Helix theory is to include « society » as a fourth helix. The problem is to define what "society" really means in this context. An answer is found in studying the evolution of Japan's research policies since 2008. As conclusions, the policy recommendations show how the three cases under study benefit from such an analysis. It also concludes that the Triple Helix theory might be turning into a Helix Theory.

Endnotes

^aA recent *Accenture report* by Harris and Junglas (2013), 'Decoding the contradictory culture of Silicon Valley', compared its ecosystem to Tasmania or Madagascar in order to reinforce its exceptionality.

^bLocal replica have been experimented, the best known is *Sophia Antipolis*, close to Nice in Southern France. France has many different high-tech valleys, corridors, and one plateau, the *Plateau de Saclay*, often called in France the 'European Silicon Valley.' Silicon Valley is a compulsory pilgrimage for French high officials.

^cSee *Examens de l'OCDE des politiques d'innovation: France*, summary in English (OECD 2014). This report is based on the National System of Innovation theory, not on the Triple Helix theory. It generally confirms my analysis, but does not provide an effective explanation of French shortcomings because it does not take into account the impact of 'power networks.' The report is concerned with *governance*, not with *governmentality* (in a sense derived from the work of Michel Foucault), which introduces a perspective taking into account power networks and their strategies. But this report provides a detailed description of French research, education, and innovation institutions.

^dFor instance at the 1998 Triple Helix Congress in New York. Most authors of the above OECD report are from the Ecole des mines.

^eAll the various institutions compositing the state and expressing its various functions and range of interests in a given society.

^fThe *Ecole Normale Supérieure, Ecole polytechnique, Ecole centrale*, etc.

^g« et aux énergies renouvelables » (*and renewable energies*) was added in due time.

^hMichel Callon's *Center for the Sociology of Innovation* at the Ecole des mines in Paris had for goal to bring light in this black box.

ⁱThis includes the OECD (2014) report *Examens de l'OCDE des politiques d'innovation: France*. The French state apparatus has even created its own 'science' and 'technology'. The *Ecole nationale d'administration* (ENA) is a professional school dedicated to teach the grounds, the organization, the methods, and the values of the French state apparatus and to train students in its management.

^jElection to national academies, consultancy jobs for government and international institutions, prestigious nominations, etc.

^kSee for instance the composition in this Spring 2014 of the Research Strategic Council (Conseil stratégique de la recherche): http://www.oecd.org/france/2014.07%20Better_Policies_Series_France.pdf. Each individual member is of course highly respectable but, because of its composition, the conclusions of such a council are necessarily so broad and general that the high administration controls in the end the policy.

^lExemplified by Airbus, the SNCF and its TGV, the nuclear and other utilities companies, like EDF, Vinci ('world leading concession *and* construction group'), etc.

^mSee Hecht (2004). Nuclear plants produce around 75% of electricity in France and around 23% in Japan before Fukushima.

ⁿSee the *Nora-Minc Report* (1978), commissioned by President Giscard d'Estaing (1974 to 1981).

^oIn search of economic growth and political support, President François Hollande decided on 10 January 2013 to allocate 150 million Euros for « disruptive innovation » (*innovations de rupture*). On 8 April 2013, the government created a commission on innovation under the direction of Anne Lauvergeon, former student at the Ecole des mines and former president of Areva, now board member of various big firms. In the report published on 18 October 2013 (<http://www.direccte.gouv.fr/consultez-le-rapport-lauvergeon.html>), the two pages on innovation are pure rhetoric and the seven development targets for the French economy are those found in all other industrial nations. See also two reports under the direction of Louis Beffa: with minor adaptations, they simply justify the existing situation.

^pSee *Journal officiel* (2010).

^qI follow various studies by Hilpert (2003, 2006, 2014).

^r<http://www.bmwi.de/EN/Topics/Technology/hightech-strategy.html>.

^sThe Région Rhône-Alpes may be the most interesting case in France. Grenoble is an effective successful case of Triple Helix arrangement. See Vincent Mangematin's workshop with Henry Etzkowitz, *The micro-foundations of Triple Helix*, Grenoble Business School, 26 to 27 May 2014.

^tWhat is at stake is the historical trajectory of the French state, which constructed itself in order to counterbalance these centrifugal forces.

^uConcerning the rivalry between England and France and its consequences, see Hahn (1971).

^vThe theory of *reverse innovation* (Huet 2014) shares the same concern with diversity. Helix arrangements are the acting core of a national system of innovation and of local 'clusters' (Forest and Hamdouch 2009). Because they are connective and flexible, they convey diversity.

^wFor instance, the causes and consequences of the Fukushima catastrophe are so wide and deep, of such a high level of complexity, that it is clear that a reformed political function is necessary to manage the situation. See Rieu (2012b, 2013)

^xFor a more precise analysis, see Rieu (2012a) 'Beyond neoliberalism: research policies and society. The case of Japan'.

^ySee NISTEP website: www.nistep.go.jp/.

^zThe most accurate diagnosis and detailed analysis is a study by Watanabe (2009).

^{aa}I have drawn from articles, discussions, and presentations by Arimoto Tateo, director of the *Research Institute of Science and Technology for Society* (RISTEX), Japan Science and Technology Agency, and by Mrs. Harayama Yuko, Tohoku University, former OECD vice-director for science and technology and advisor to Prime ministers Koizumi and Abe. See Arimoto (2006).

^{ab}See the RISTEX website: <http://www.ristex.jp/EN/>.

^{ac}Concerning the work of Kobayashi Tadashi, see Michel Callon in Callon et al. (2001, 2009).

^{ad}Director, Center for Deliberative democracy, Keio University, Tokyo.

^{ae}See CDD (2012) for links with various newspapers articles.

Additional file

Additional file 1: Multilingual abstracts in the five official working languages of the United Nations and Portuguese.

Competing interests

The author declares that he has no competing interests.

Received: 2 June 2014 Accepted: 22 July 2014

Published online: 10 December 2014

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doi:10.1186/s40604-014-0008-8

Cite this article as: Rieu: Innovation today: the Triple Helix and research diversity. *Triple Helix* 2014 1:8.

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