RESEARCH AND INNOVATION POLICIES IN THE NEW GLOBAL ECONOMY

An International Comparative Analysis

Edited by
PHILIPPE LARÉDO
and
PHILIPPE MUSTAR

CENTRE DE SOCIOLOGIE DE L’INNOVATION
ÉCOLE NATIONALE SUPÉRIEURE DES MINES DE PARIS, FRANCE

NEW HORIZONS IN THE ECONOMICS OF INNOVATION

Edward Elgar
Cheltenham, UK • Northampton MA, USA
CONTENTS

Contributors vii
Acknowledgements ix

1 General Introduction: A Focus on Research and Innovation Policies
   Philippe Larédo and Philippe Mustar 1

2 The US National Innovation System after the Cold War
   David C. Mowery 15

3 Research Policy Trends in the United States: Civilian Technology
   Programs, Defense Technology and the Deployment
   of the National Laboratories
   Barry Bozeman and James S. Dietz 47

4 The Structure and Perspective of Science and Technology
   Policy in Japan
   Yukio Sato 79

5 The Research, Development and Innovation System in Korea
   Sung Chul Chung 115

6 The Emergence of a New European Union Research
   and Innovation Policy
   Paraskevas Caracostas and Ugur Muldur 157

7 The German Innovation System
   Frieder Meyer-Krahmer 205

8 The United Kingdom National System of Research, Technology and Innovation
   Luke Georgiou 253

9 The Netherlands: Science Policy by Mediation
   Barend van der Meulen and Arie Rip 297

10 Science, Technology and Innovation Policy in Finland
    Erkki Ormala 325

11 The Spanish System of Research
    Emilio Muñoz 359

12 Science, Technology and Innovation Policy in Italy
    Alberto Silvani and Giorgio Sirilli 399

13 French Research and Innovation Policy: Two Decades
    of Transformation
    Philippe Larédo and Philippe Mustar 447

14 General Conclusion: Three Major Trends in Research
    and Innovation Policies
    Philippe Larédo and Philippe Mustar 497

Index of Boxes, Figures and Tables 511
Index 515
CHAPTER 1

GENERAL INTRODUCTION:
A FOCUS ON RESEARCH AND INNOVATION POLICIES

PHILIPPE LARÉDO AND PHILIPPE MUSTAR

The analysis of science and technology policies is now an exercise of some long standing, having been initiated by the OECD at the beginning of the 1960s. Reading these first analyses today, one can see the extent to which they anticipated the conceptual developments of the 1980s and, in particular, the pioneering works of Freeman and Lundvall on national systems of innovation (Freeman, 1987 and Lundvall, 1988). These authors have rekindled interest in international comparisons, a primary result of which was the collection edited by Richard Nelson in 1993 (Nelson, 1993). Since then, the 1990s have been characterised by contradictory changes: the emergence of Europe is offset by the break-up of the Soviet Union and the pronounced “Balkanisation” of the former Eastern bloc countries; the end of the Cold War (and thus of the military imperative which underpinned a significant proportion of the public intervention relating to R&D) is a concomitant of the increased involvement of Western countries in a growing number of local conflicts (from Kuwait to Kosovo); and the “globalisation” of firms and markets (which requires previous notions of “multi-nationalisation” to be reconsidered) is associated with growing “sub-national” public interventions, particularly those related to innovation, which are becoming stronger almost everywhere.

The authors of this book have therefore considered it both opportune and necessary to re-examine the analyses conducted a decade ago. They have
chosen to adopt Nelson’s method, favouring national approaches (later we will explain the selection of countries made – and, in particular, the inclusion of a specific chapter on the European Union). Consequently, it has been necessary to establish a methodology and an experimental approach, which clearly identifies and emphasises the points of comparison, and ensures that the reader will come across them in each chapter. Finally, it goes without saying that such a work had to take into account the numerous lessons accumulated on systems of innovation, which brings to mind the title of the collection edited by Edquist (Edquist, 1997). These lessons have led us, as this Introduction will explain in greater detail, to a reorientation, which is described by the very title of this book, *Research and Innovation Policies*.

**FROM NATIONAL SYSTEMS TO RESEARCH AND INNOVATION POLICIES**

The shared thesis conveyed by the notion of a national system of innovation is that each country can be characterised by a particular body of sectoral specialisations, of rules and routines, of institutional organisations, and also of achievements. Works referring to what has now become a concept of the economics of innovation, emphasise the learning process and the institutional, social and political factors. In so doing, they are akin to a somewhat forgotten earlier development, proposed by a French economist, J. Weiller, who in 1949 put forward the concept of “national structural preferences”, that is to say “preferences regarding the utilisation and construction of the productive forces within each country”. Built on the basis of work on international exchanges and the “problems of international economics” (the title of his manual published at the same time), this concept aimed to explain the persistent disparities between countries, less in relation to international exchanges or growth, than to the choices of political economy implemented and state intervention. Contrary to Schumpeter, for whom “all economic argument almost completely loses its interest, in the context of the nation” (Schumpeter, 1962, p. 110), the nation for him is an “operational concept” of economics. In a world which is increasingly transnational, it should be understood as a “zone of structural preference and balance of power” (Weiller and Desroussilles, 1974, p. 167). This notion, formulated in this way, assumes its full meaning when “the most express reservations towards the idea of a worldwide generalisation of a certain type of progress”, that is to say “of a certain type of economic organisation” (ibid., pp. 179-180), are put forward.
Two dimensions are thus emphasised, “operational” and “doctrinal”, which are involved in the adoption of the term “national system of innovation”.

No sooner had the concept of a national system of innovation been put forward than debates began to proliferate on the exact meaning of this combination of three constituent concepts. By insisting on the notion of system, authors emphasise the role of “agents, policies and institutions supporting the process of technical advance in an economy” (Bozeman, Chapter 3). They underline, subsequently, the importance of the processes leading to current organisational arrangements. At the core of their analysis are the history and the trajectories, the interactions between actors, and the roles of institutions and organisations. It is thus not surprising to see the nation, taken in the sense proposed by Weiller, occupying a central position, even if the “transnational” dynamics, which have been in operation for a long time, continue to reinforce the importance of the interactions between systems in their respective evolutionary developments.

But what system is under discussion? The analysts propose two versions of it: “Scholars looking at the ‘narrow’ NIS focus on organizations and institutions involved directly in the processes of scientific and technological exploitation. The ‘broad’ NIS concept includes all economic, political, and other social institutions affecting learning, searching, and exploring activities” (Bozeman, Chapter 3). Nelson stresses the importance of the second approach, bearing in mind that specialists in innovation tend to “play down the existence of active coherent industrial policies” and of a “well-structured and thought through general policy” (Nelson, 1993, p. 515). From the fifteen national studies carried out, he sees an imperative emerging: the existence of “strong firms”, in other words, firms that are capable, whatever their size, of being competitive in global markets. While it is clear that they must make the “the bulk of the effort” themselves, the studies carried out did “indicate strongly that aspects of the national background in which firms operate matter greatly” (ibid., p. 511). It is therefore appropriate to concentrate attention on this “infrastructure” which is important for the competitiveness of firms and also largely falls within the competence of public policies. This choice has been explicitly made in this book.

It is then necessary to define the relevant dimensions for such an analysis. Nelson distinguishes three principal components. He gives priority to the “package of fiscal, monetary and trade policies” which make exporting attractive or difficult. He goes on to underline the importance of the education system and, more particularly, of “the responsiveness of university systems to the training needs of industry”. Finally, he questions the actual role
of “dedicated government policies”. All the country studies carried out share the characteristic of having “significant pockets of government overview, funding and protection”, which include defence, space, electricity and telecommunications. He underlines that all the countries share a common investment – clearly of varying degrees of importance – in basic research. Lastly, he cites the impact of the Japanese model in the development of policies directly dedicated to civil technologies: “The rise of Japan as a model has enhanced the belief that an explicit national technology policy can be effective; indeed it is now widely argued that a nation will fall progressively behind if it does not have an explicit technology policy” (ibid., p. 17). It drives him to “first acknowledge the wide range of policies targeted at technological advance” and then to conclude one page later that “because they are so diverse, I cannot see any strong generalizations that can be drawn” (ibid., p. 512). Such a conclusion is the reverse side of the approach adopted by this comparative study. The “broad” approach of the systems of innovation considered has limited the capacities for analysis of the diversity of public interventions in favour of innovation. We have thus chosen to concentrate this book on the “institutions and policies that affect the creation, development, commercialization, and adoption of new technologies within an economy. As such, a national innovation system includes not just the institutions performing R&D and the level and sources of funding for such R&D, but policies – such as antitrust policy, intellectual property rights, and regulatory policy – that affect technology development, the training of scientists and engineers, and technology adoption” (Mowery, Chapter 2). The title adopted – *Research and Innovation Policies* – reflects this choice.

THE COUNTRIES CONSIDERED

What policies should be considered? Three principles and one constraint explain the selection made. First, the constraint: to focus attention on research and innovation policies (which should be clearly located in the overall national landscape) paradoxically leads to longer analyses – consequently, there are two chapters dealing with the United States. To keep the book to a reasonable length (500 pages even so) required that the number of countries under consideration be limited to around ten. The three principles guiding the choice of countries can be summarised as: continuity, diversity of sizes and trajectories, and the importance accorded to the European Union. The objective of continuity is to allow the reader comparisons over time, with the books
previously published on the science policies of Western countries. This explains our first group: the United States, Japan, Germany, the United Kingdom, Italy and France. The diversity of sizes and natural resources are two aspects underlined by Nelson and Rosenberg (p. 19). We have brought them back into focus with the choice of Finland and the Netherlands. The maintenance of a certain equilibrium between established industrialised countries and newly industrialised ones is also a dimension emphasised by Nelson. He sees it as a way in which to assure, in the analysis, a significant presence of those innovations, which economists would describe as incremental. This led us to add Korea, and also Spain, the rapid growth of which is a concomitant of its entry in the larger context of the Common Market, and subsequently the European Union.

With seven out of the ten countries included amongst its 15 members, the European Union, which is our third choice, is intentionally over-represented. This stems from a hypothesis of the editors of this book, although it would be improper to consider it as shared by all the contributing authors. This hypothesis can be expressed in a few simple words: the European Union is on the way to becoming a system of innovation, or to employ the terminology proposed by Jean Weiller, a veritable zone of structural preference and balance of power. This is why we were anxious to include a specific chapter on its research and innovation policy. It is up to the readers to form their own opinion, comparing it to the national studies of the seven member states.

THE APPROACH USED AND THE CONSTRUCTION OF THE BOOK

As with Nelson’s book, the comparative element is largely implicit. It is up to the reader to take responsibility for carrying out his or her own analysis while reading the chapters. The editors will allow themselves, by way of conclusion, to make a preliminary suggestion, which is both limited to a few main characteristics and quite obviously provisional.

For this comparative analysis to be possible, it was necessary both to identify a series of points, that the national analyses should tackle and to devise an experimental protocol, which enables the feasibility of a comparative analysis to be tested.

This dual approach has been rendered possible by the project of the Commissariat général du plan, to study, at the request of the French Prime Minister, the challenges facing research and innovation in France. In the
broader context of this work (cf. the global report by R. Majoie, Majoie, 2000), we proposed to the Commissariat to carry out a benchmarking exercise on the French situation. The procedure adopted was as follows. A working group was convened under the presidency of J.J. Duby with the two editors acting as rapporteurs. It was composed of about 20 representatives of a range of French institutions (universities, public organisations, technopoles, firms, technical centres, the government). A number of experts – the authors of this book – came to present the developments in progress in their respective countries.1 Each presentation and the ensuing discussions generally lasted a good half-day. These exchanges had a dual effect. On the one hand they effectively allowed the working group to progressively identify five core issues for France (cf. the report made by J.J. Duby: Duby, 2000) and for each of them to carry out an actual comparative analysis, thus reinforcing the approach adopted by the editors. On the other hand, they brought out numerous aspects, which were not dealt with or were dealt with only briefly by the experts, or were not made sufficiently explicit for a reader who is not au fait with the current national situation. In so doing, they initiated a genuine joint effort between the editors and each author, conducted through numerous electronic exchanges and visits by the editors. This book is thus the outcome of a project which spread out over almost three years: initiated in mid-1998, the hearings took place in early 1999 and the exchanges involved in finalising the different chapters took two years.

SIX CENTRAL QUESTIONS

What consequently is the series of points that the authors were systematically asked to consider? There are six.

All the works on national systems of innovation give a central place to the education system, more particularly to the universities, to their development and to the relations that they maintain with the economic world. This constitutes an important part of all the national analyses carried out. Both the growing importance of universities within national systems, the exponential

---

1. It goes without saying that there was no presentation and debate on the French situation (Chapter 13). This was the same for the chapter on European policy, but it should be noted that P. Caracostas was a member of the working group and participated in all the debates.
development and the diversity of their links with firms, and the extraordinary variety of the institutional arrangements, which govern these developments, can be seen.

Among the policies specifically dedicated to technological progress, Nelson underlines the place occupied in a number of countries by defence and by large civil programmes, which concern space, telecommunications and energy. This clearly has a quite specific resonance for the French editors of this book, with France being described in the majority of analyses as an extreme case of voluntarist policy structured around this approach. In most countries, with the possible exception of the United States, one can see that there have been particularly important reorientations in this regard. These include the very significant decrease in expenditure on military research, and also, with the exception of space, the considerable withdrawal of public authorities from this type of intervention. They also emphasise the growing importance of the European dimension. In effect, it is on the European level, notably via the European Space Agency, that national investments are decided and organised. Similarly, when it comes to the changes observed in telecommunications, electricity, the postal system or transport, it is impossible to avoid the question of the role of the European Union and of the common rules that it has progressively adopted with regard to “public services”.

The third aspect brought out by Nelson concerns “explicit national technology policies”. It seemed necessary to us to distinguish two realities in this formulation. On the one hand, there are the types of incentives for research and industrial innovation. It can be seen that numerous countries have active policies to support the innovation efforts of firms, particularly SMEs, whether these interventions are direct (project support) or indirect (fiscal deductions or public procurement policies such as SBIR in the United States). On the other hand, these interventions often take the form of “priority programmes” which seek, in domains such as biotechnology or information and communication technologies (ICT), to mobilise all of the public and private actors involved. For Nelson “a strong case can be made that such technology and industry-oriented public programs have made a big difference in many fields” (p. 513). They should therefore have witnessed their importance grow or at least remain constant. This has quite clearly not been the case. The national analyses, in effect, bring out their limited importance (cf. the marginal significance of the Advanced Technology Program in the United States) or the very appreciable decrease in the place they occupy in national policies. For European countries, this decrease is due less to their disappearance than to their progressive transfer away from the national level (but which is often
not expressed as such). These latter now constitute the core of European Union interventions. Also evident is a second source of investigation of the emergence of a European system, all the more relevant given the recent reorientation of the Framework Programme and its shift in focus to societal problems, resulting in a significant change in perspective.

In all countries, universities are an essential component of the basic research landscape, which, in all countries, is largely financed by the public authorities. However, they do not act alone. All countries, led by the United States, have also gradually established numerous “government” or “national” laboratories. Certain of these, such as the CNRS in France or the Max Planck Gesellschaft in Germany have been created to carry out fundamental research. However, for the majority, the missions for which they have been created were “targeted”. Various works\(^1\) have shown that, with the help of time, it is no longer possible to take this description at face value and that it is necessary to question the often significant changes experienced. We have asked the authors to describe the changes in this second component, which, together with the universities, constitute public sector research. We have also asked them to examine the composition of the whole of public sector research, its recent changes, and also the importance and the modalities of its public financing. The studies confirm that everywhere the scales tilt increasingly in favour of the universities, but also that everywhere public organisations remain in existence, even in the United Kingdom where only some of them have been privatised. However, governments everywhere have sought to bring about changes in their laboratories, particularly to promote or renew their links with the economy and with society. Consequently they constitute, despite an ongoing decrease in their relative importance, an enduring component of national systems.

In the introduction, we have underlined at what point the national–global dichotomy seems to us to be simplistic. It has led us to provide the reader with a chapter specifically on Europe. However, it has also led us to examine the sub-national dimension and the involvement of regions or states in the support of firms’ innovation capacities. The analyses show a growing role of the regions, both because in those places, where regional or state involvement has existed for a long time, such as in the United States or Germany, they have increasingly seized on these issues, and because, in other

\(^1\) See amongst others the works by Crow and Bozeman in the US and their recapitulation in Crow and Bozeman, 1998, or Boden et al., 1998 for UK or Joly and Mangematin, 1996 for France.
countries, such as France or Spain, their recent creation has been accompanied by rapid and significant activity. The construction of a favourable background is no longer only the business of national policies but of a whole set of public interventions, which, in Europe, mix regions, nations and the European Union in an increasingly intimate manner.

Consequently, it has been important to resume Nelson’s line of enquiry, on the global coherence of public interventions. A particular emphasis has thus been put on public governance, on the mechanisms and processes which prepare and follow through public interventions, on the modalities of co-ordination between public policies on the national level, but also between public authorities. This has brought out great differences in the role of “advisory bodies” from one country to another, the growing place of foresight activities in the very large majority of the countries studied, and the accent which is increasingly often placed on evaluation as a central means of retroactive effect on the conduct of activities and the formulation of public interventions. In the majority of countries, the co-ordination of interventions is currently a central issue which has led, in the case of Japan, to a deep reform of the whole of the public structures associated with higher education, research and innovation.

STRUCTURE OF THE BOOK

Moving on to the national chapters, each chapter is, of course, introduced by a presentation of the overall landscape and a setting in historical perspective, without which it is difficult to position research and innovation policies as well as the evolutions that they have witnessed. It finishes with a “prospective” reflection by the authors who highlight the challenges which will confront the country in the next five to ten years.

The first two chapters are devoted to the United States. David Mowery, and Barry Bozeman and James Dietz have shared this task. David Mowery puts forward a perspective on the American innovation system, before focusing his attention more closely on the overall organisation of federal intervention, university research and on aspects connected with intellectual property issues relating to the knowledge produced by public sector research. Barry Bozeman and James Dietz go back over the three paradigms (market failure, mission, co-operative technology) which have organised American public policy before turning their attention to defence research, national laboratories, federal support for technology and state intervention.
In many aspects, Japan in the 1990s has experienced a unique dynamic in its research and innovation policy. The accent has been placed more on research than on innovation, with a doubling of the public budget over five years. Yukio Sato presents the far-reaching reform in the public sector which has been initiated. This is leading, on the one hand, to a restructuring of ministerial structures and advisory bodies and, on the other hand, to a reorganisation of the public research system with autonomisation of public laboratories and exposure of the universities to the economic world.

Sung Chul Chung emphasises the extraordinary growth in Korean investment in research and innovation, largely carried out by firms. He underlines the initial role, then the progressive marginalisation of public research institutes, paralleling the continuous growth of the involvement of universities in research. Quite evidently, one cannot fail to question the future of this situation in the wake of the crisis, which, besides the question of industrial involvement, paradoxically brings out the weakness in the co-ordination of public interventions.

The reader enters next into the eight European chapters. We have chosen to start with the chapter on the innovation and research policy of the European Union. Paraskevas Caracostas and Ugur Muldur put into perspective the challenges facing Europe as a whole. They underline the extent to which the investments in research and innovation are inferior in comparison with the United States and Japan. They bring out the “European paradox”, that is to say the discrepancy which exists between the role of Europe in global scientific production and its place in the production of patented inventions. They introduce us into the dynamic of the European construction and into the importance that innovation has progressively taken within it. They analyse the growing financial involvement of the Framework Programme and its impact on national systems, but they also show the role of other instruments, both regulatory and financial, with the Structural Funds, which support the efforts of the less-developed regions of Europe. Finally, they highlight the strong reorientations of the Fifth Framework Programme, which covers the transition to the third millennium, and the priorities of which, as much as the modalities of adoption and implementation, appear to them to promote renewed forms of co-operation between member countries and the Commission.

The analysis undertaken of the strengths and weaknesses of the German system by Frieder Meyer-Krahmer enables the reader to better understand how the federal and state systems complement each other, and why the accent is so strongly placed on technology on the federal level. It shows
the multiplicity of modalities of public intervention in a system where two-thirds of research and innovation effort have, for a long time, been the preserve of firms. The central points of debate concern the flexibility of the system, that is to say, on the capacity of German firms to position themselves in emerging sectors. The author also considers that one of the challenges concerns the atomisation of university research. This poses the question of the restructuring of public research in its entirety. He underlines the change of context, which sees questions relating to public problems, such as the environment, growing in importance. Finally, it seems to him that the major challenge resides in the definition and implementation of technology policies and their co-ordination with the different spatial scales.

There is a marked contrast with the presentation of the United Kingdom provided by Luke Georghiou. In this case, the full extent of the centralisation of a national system articulated around its processes of foresight and evaluation is considered. The combined movements of privatisation and of budgetary restrictions have provided an impetus for a convergence of all the public research actors in a “contractual research space”. Finally, the question is posed of the means of public intervention with regard to innovation, while the gap between public research capacities and industrial capacities for innovation is considered as the major problem of this country.

Barend van der Meulen and Arie Rip present, with the case of the Netherlands, a radically different system of operation. They oppose “steering” from above which in their view characterises the United Kingdom with the specific institutional competences developed in the Netherlands to define policy priorities. This capacity for aggregation rests on a “densely populated intermediary layer” between the government and research institutions, which, lacking financial responsibilities, promotes public debate and mutual adjustments. This is, it seems to them, the principal force, which allows flexibility and adaptability in the European and global environments, which directly confronts Dutch firms.

Erkki Ormala shows us the voluntarist approach of Finland, which, since the end of the 1980s uses the concept of national system of innovation to discuss, devise and implement its research and innovation policy. The reorientations in the public governance system, with the role and operation of the Science Policy Council, the reorganisation of research organisations, the evolution of the mode of operation of the agency supporting technology and innovation accompany the model repositioning of the Finnish economy.

This description could, in part, be that of one large region, such as a German Land or the Spanish Basque Country and its exemplary policy for
the promotion of firms’ innovation capacities. The growing role of the Spanish regions, reinforced by the progressive transfer to them of the responsibility for universities, is clearly brought out by Emilio Muñoz. He underlines the recent features of research and innovation policies, the difficulty of government co-ordination, despite the existence of national plans, and the disparity that currently exists between those sectors that are major providers of jobs and the competences of public sector research. In this discrepancy, he sees one of the major challenges confronting the country.

Such analyses could be carried out on Italy, where the dynamism of its industrial districts has played a central role in the considerations of analysts of innovation. However, Alberto Silvani and Georgio Sirilli have chosen to bring to light the profound changes in the conduct of research and innovation policies. These range from a reshuffle of governmental organisation, via the development of new instruments to support university research projects and the follow-up of university activities (evaluation), and focus on “simple to implement” procedures in supporting industrial research and innovation.

These changes characterise a strong transformation in the approach of research and innovation by public authorities. The analysis that we propose brings out the reverse transformation that France has undergone in the 1990s, which has moved it significantly away from the Colbertist model of a powerful and centralising state described by Chesnais in Nelson’s book. The near disappearance of large programmes and the growing role of European Union programmes in information and communication technologies, the strong and continuous decrease in military research, the rapid increase in the research capacities of universities and their move closer towards the CNRS, and the involvement of the regions in support for innovation in SMEs are some of the traits which explain this repositioning. It is reflected in a double movement: a reorganisation of the ministerial machinery and a centring of research and innovation policies on public sector research. New challenges follow from this, largely underlined by the strategic exercise recently conducted by the Commissariat général du Plan, linked to the “good formatting” of public sector research, as well as to the capacity to provide impetus and co-ordination of multiple public participants.

This brief journey underlines a series of convergences that, in particular, concern the growing role of the universities, governments’ disengagement from industry with the virtual end of large programmes and the less central role of defence policies. Are these moves likely to reduce the interest of approaches concerned with systems of innovation? The response is far from being obvious, since these changes in national policies also relate to the
appearance of and the growing role of other public powers. These latter, which encircle governments (at least in Europe) seem destined for a bright future. More than national or federal governments, the regions and the states seem to be closer to actors and their problems and specific needs (in this respect the country-regions of Europe, such as Finland, are particularly rich in lessons). When the debate moves to the global level, it is striking to see that the de facto delegation to the European Union (whatever mechanisms are adopted) does not concern only the global organisation of markets or societal responsibilities (such as climate change), it also concerns, through the Framework Programme, preparation for the future. We will tackle these points later by way of conclusion.

REFERENCES

Duby, J.F., 2000, La politique française d’innovation face à la concurrence internationale. Cinq meilleures pratiques étrangères pour la recherche française, in J. Majoie, op. cit.
Weiller, J., 1946 (tome 1) and 1950 (tome 2), Problèmes d’économie internationale, Paris: PUF.
The previous chapters allow the importance to be measured of changes, which, in less than a decade, have radically transformed the landscape, which had resulted from World War II. From the analyses of specific research and innovation policies presented in this book, the editors draw out a number of changes which lead to the identification of three major transformations. First, the repositioning of the technological interventions by public authorities and the end of large programmes, the priority given to SMEs and the marked changes in the role of defence research in a number of countries are all aspects of the progressive establishment of new relationships between international competitiveness and public policies. Second, the focusing of public activity on universities and the reorganisation of government laboratories have given pre-eminence to public sector research in many countries. These two transformations, which are a priori opposed to each other, confront public policies with a third tension between, on the one hand, the globalisation of activities and, on the other, the emphasis on specificity and the effects of proximity. How, if this is the case, can public interventions be developed, which are capable both of promoting the development of local links and of contributing to the organisation of a global framework? This conclusion presents our views on these transformations.
TOWARDS NEW RELATIONS BETWEEN INTERNATIONAL COMPETITIVENESS AND PUBLIC POLICIES

As was the case at the time of the comparative study edited by Nelson, the same preoccupation with international competitiveness is evident in all the national analyses. However, the extent to which the economic context has evolved is assessed. It is not necessary to set out in detail the idea that growth depends on the existence of “strong firms”, which are capable of positioning themselves in the global market. Rather, it is taken as read in all of the national analyses carried out. Likewise, it goes without saying that for firms to be large they must be multinational. In the majority of the analyses, the term “global” is essential. Firms disengage themselves from their national context in order to become directly established on the global level: what is good for General Motors is perhaps no longer so for the United States. There is, therefore, a tendency for policies to distinguish increasingly between the research and innovation activities of firms which are often classified by surveys under the label of the said country (as in Fortune magazine’s classification of the world’s top 500 firms), and the industrial research activities which are carried out in that country. There has been an increase in the number of studies which calculate the relative weight of “foreign” firms in the industrial R&D of a country. For instance, it amounted to 11% of all US industry expenditure in 1995 (cf. D. Mowery, Chapter 2). It is also possible to find evidence of this in the active participation of Thomson and Philips in the American digital television programme and of IBM in the European information technology programme.

The increasingly evident globalisation of large firms has been coupled with the growing role of industrial research in the national R&D effort. Consequently, the share of industrial research has increased, quite spectacularly, in the majority of those countries where the state plays a central role. In less than a decade, it has gone from 50% to 63% of GERD in the United States and has increased by 10% in France (from 43% to 52%). This increased capacity probably explains a large part of the contraction, or at least the complete redefinition of public intervention with regard to “large programmes”. Countries such as the United Kingdom, which is a precursor in this matter, or, subsequently, France, have completely stopped the majority of the large civil programmes which characterised their public intervention in the 1970s, ranging from civil aeronautics to computers, via telecommunications and energy. The efforts made in American policy for technological catch-up, first in the context of the National Cooperative
Research Act (1984) then more directly through Clinton’s Advanced Technology Program and the Technology Reinvestment Program, have been toned down for a number of years. Even the very rapid increase in European programmes in the 1980s, which offset the on-going disengagement of member countries (we will return to this point later), has progressively led to a stagnation (certainly at a high level) and, in particular, through the Fifth Framework Programme, as P. Caracostas and U. Muldur show in their chapter, to a change in orientation, with societal problems occupying an increasingly significant, not to say dominant, place. Even in Japan, large programmes, such as the Fifth Generation Computer Programme, are widely deliberated (S. Callon, 1995), and have given way to interventions which focus on public centres of excellence and networks of co-operation between public and private actors in basic technologies.

The decline of explicit technology policies is widespread. Everywhere, direct public interventions are linked increasingly to socio-economic objectives. This does not mean that governments have suddenly lost interest in the international competitiveness of their industrial fabric. Quite to the contrary, although they are using other instruments and other foci. Instruments of the “large programme” or “national programme” type presuppose a strong national capacity for anticipation and co-ordination. This can currently be found more readily in “country-regions” such as Finland or the Netherlands, than in others, where public and private actors are more numerous than 20 years ago. It is, therefore, not surprising to see that in a number of countries, there is greater emphasis on the conditions for technological competitiveness than on competitiveness itself, which is considered as the responsibility of firms themselves. Industrial property, sources of finance (particularly legislation on risk capital), taxation, the functioning of universities to promote links with the economy and society, are among renewed approaches to the same questions. However, these no longer rely on technology policies as such, but mobilise “other” policies to the benefit of the technological competitiveness of the industrial fabric (cf. D. Mowery on the United States). In the same way, the instruments which have gained importance in the implementation of technology policies, as underlined by A. Silvani and G. Sirilli, are characterised by their automatic attribution and by the simplicity of their implementation (linked to the existence of simple criteria or to the greater proximity of the actors targeted). In numerous countries, these instruments have seen a strong increase in their importance among public interventions more generally. They also have the advantage of better corresponding to the new focal point of industrial policies: SMEs.
If there is one point shared by the countries studied, particularly those in the European Union, it is clearly the priority accorded to SMEs. All the governments agree in recognising their importance in creating employment and their role in the development of new activities. SBIR and other long established “manufacturing extension programs” in the United States, ANVAR and the tax credit for research in France, Technology Resource Centres in the Nordic countries, assistance for researchers and engineers in Germany, and fiscal support for investment in Italy are among the types of interventions which have been adopted in numerous countries to create frameworks of active interventions to promote the development and innovation efforts of SMEs. Since the beginning of the 1990s, they have been complemented, and sometimes surpassed in importance, by the numerous mechanisms aiming to promote the creation of technology based firms. The rapid development of these new firms in the United States is developing the role of risk capital. Numerous countries have sought to promote its emergence, both by indirect and direct measures. However, they soon realised that, in their countries as in the United States, the initial phase of the creation of such firms, which is rooted in university life and in public research, requires a bundle of public interventions. Ranging from nurseries and incubators to seed money, via the provision of incentives for firm creation by academics, researchers, even doctoral and postdoctoral students, the number of programmes and actions to promote the creation of high-technology firms, principally in information technologies and biotechnologies, have multiplied. It is possible to note, as F. Meyer-Krahmer does, a fashion for such activities and the imitative behaviour that have affected numerous countries, to the extent of forgetting the invariably central role of other SMEs in economic activity, particularly the employment they create.

These developments underscore the enormous convergence of countries, which is becoming apparent. However, a decade earlier, the liberal model adopted in the United Kingdom and the United States (which B. Bozeman and M. Crow have termed “market paradigm”) was opposed to the centralised “Colbertist” model of France, with a strong degree of public intervention, also shared by Japan and Korea. Ten years later, this contrast is now quite distant, although one aspect of it remains and continues to play a central role, that concerning defence. However, the situation has greatly evolved. Ten years ago, Germany and Japan, with their weak defence activities, could be contrasted with the United States, the United Kingdom and France, where military research represented between one-third (France) and a half (the United States and the United Kingdom) of public research and development
effort. Today only the United States, despite the decrease in the relative weight of military research and the very strong growth in health research, is distinguished by having extensive military research. B. Bozeman and J. Dietz emphasise its pervasiveness: “75% of all federal money spent on development, 75% of all federal money going to industry, support to university equal to NSF and NIH, 50% of federal money in federal labs and 56% of all funds to FFRDCs”. Furthermore, this does not include DARPA and its role in strategic technologies. In France, to the contrary, there has been a strong and steady decrease in military research expenditure throughout the 1990s, which is now solely focused on specific military technologies and on exclusively military firms, thus losing any “pervasive” role. If there is any opposition of models, it is now between, on the one hand, the United States, where the only co-ordinated and centralised research activity is in the hands of the military, and, on the other, Europe, via the Framework Programme, and Japan, through reform in the public administration of research, where there is renewed co-ordination in place. We will examine this in due course, after having tackled what seems to us the second principal movement detected by the national analyses.

EDUCATION, UNIVERSITIES AND PUBLIC SECTOR RESEARCH

In the majority of the countries studied, higher education and training have become a clearly displayed priority and a central topic of interest. It was a question both of increasing resources (of which France and to a lesser extent the two other Mediterranean countries provide evidence) and of bringing academic research closer to the economy and society (as illustrated by the British LINK programme or the Finnish policy). It has been a matter, finally, of better organisation, by promoting the establishment of centres of excellence (Nordic countries) or of mixed research units (France), the critical mass of which is a result of bringing university researchers and CNRS researchers closer together. The generality of this trend is underlined by the United Kingdom, with its “research assessment exercise”, linking government support for university research to the international recognition acquired by “research units”, Japan with Monbusho’s policy of “centres of excellence” (following the ERATO programme), and Germany, which openly poses the question of the reorganisation of its universities (cf. the conclusion by F. Meyer-Krahmer). The quality of a country’s university research is without doubt considered by most developed countries as a key strength of its
system of innovation. Even in the United States, D. Mowery emphasises the importance of the structural changes in progress together with the continued growth in the contribution of universities to the overall national effort, and above all the continued drop in their dependence on federal government funding. Numerous national analyses (in the Netherlands, Finland, and France, to name but a few) stress the significant developments experienced over two decades, trends which combine both more pronounced international academic integration and a multiplication, not to say an explosion, of the links between university research and the socio-economic world. This is what we have sought to articulate, by speaking of a new paradigm and by proposing the term "collaborative academic research".

This priority should not overshadow the very different modalities of organising and steering this research. In certain countries, the universities fall under the national responsibility, in others, such as Germany, they are the responsibility of “states” or “regions”. Whatever the preferred form of organisation, in most of the countries studied, growing regional intervention can be observed. Indeed, for certain of them, such as Spain, a progressive transfer of responsibility from the central or federal state to the regions is visible. Despite these differences, it is striking to see the importance that all central or federal governments attach to university research. In this respect, the modalities of intervention still differ greatly from one country to another: the strong financial autonomy of the universities in Germany, can be contrasted with the two very different models of the Anglo-Saxon “research councils” on the one hand, and of the French CNRS on the other. In the former case, financial support is awarded to individual projects, selected after frequently discipline-specific calls for tender. In the second, the CNRS provides human and structural support for joint projects by means of mixed units, created on the basis of a “bottom-up” initiative and after a disciplinary evaluation. In this sense, the French CNRS can be distinguished, to a large extent, from its counterparts in Germany (Max Planck Gesellschaft), Italy (CNR) and Spain (CSIC) by the fact that the near totality of its researchers work on university campuses in mixed teams. It constitutes, in a way, an original response to the question of the long term management of public research competences. This question is increasingly clearly posed and to which RIKEN in Japan offers a different response, by increasing the number of visiting positions for academics.

This widespread emphasis on university research has gone hand in hand with the reform of “government laboratories”, most of which are dedicated to research in line with a specific mission and which have progressively
increased in number in all countries. The 1980s have been characterised by the two contrasting routes taken by France and the United Kingdom in their respective reforms. In both these cases, it was a matter of strengthening their autonomy and of dissociating them from the Ministries, which had originally set them up. In both cases, the intention was to open them up more widely towards society and the economy, and to question their “sectoral monopoly” substituting it for open contractual relations. However, the paths followed have been very different. In the United Kingdom greater importance has been attached to the creation of “agencies” oriented towards the service of their operational clients, while, in France, the emphasis was on the professional nature of their research activities, giving researchers from these organisations the same status as those in the CNRS. Even if this has led, 15 or so years later, to very different profiles, these organisations still constitute an important part of the national public research potential in both countries. Numerous other countries have not eluded this trend, such as Spain (with the status of OPI, cf. the developments by E. Muñoz), or Italy with the reform of several sectoral institutions, while certain others, such as Finland, have chosen a third path, as illustrated by the German Fraunhofer Gesellschaft or TNO in the Netherlands, which combines basic public support and strong socio-economic involvement. Japan is also affected by this trend, and is marking its entry into the third millennium with a complete overhaul of the status of both its researchers and organisations. In the United States the debate on the national laboratories has been important, although to a limited extent, since, as B. Bozeman and J. Dietz point out, the status quo has prevailed and the measures taken (CRADA) have had little effect on their trajectory. Thus, these institutions, whose role and activities have been under careful examination for some time, have emerged renewed, stabilised, and in certain countries, strengthened from the troubled times of the 1980s and the beginning of the 1990s. This “renewal” probably stems to a large extent from their capacity to offer “independent expertise” faced with the growth in the political importance of health problems, and also faced with an increasing number of food and environmental crises and the public debates they have generated. Moreover, these organisations appear as a way to restabilise public relations, which are absent in the new organisation of largely deregulated public services which are operated by “global” enterprises, as witnessed in the cases of communications and energy.

To an extent, these movements contradict the analyses carried out by the proponents of the “new knowledge-based economy”. The “new mode of knowledge production” (Gibbons, 1994) has not limited the role of the
universities by making them a partner amongst the others. By transforming their practices, in developing their organisation, universities appear to have had their centrality strengthened in the majority of national system and policies. To grasp their role, it is necessary to implement a small shift in Arrow’s theory of the public reservoir. It is no longer a public reservoir of knowledge, where firms come to fish for the knowledge they need, but a public reservoir of competences mobilised by actors in society, both public and private, to help them resolve the problems they face. The evolution of the “government laboratories” shows that this reservoir is not just limited to “the university sector” but that it also encompasses “sectoral” research institutions and agencies. The majority of these have undergone changes in their operation to constitute what is increasingly appropriately named as “public sector research” (Senker et al., 1999).

FROM NATIONAL POLICY TO THE CO-ORDINATION OF PUBLIC INTERVENTION

The repositioning of technological interventions, the marked evolution of the role of defence research in several countries, the focus on universities and the reorganisation of public sector research reflect the importance of the changes that have been in progress for less than a decade, and that are radically transforming the landscape which resulted from World War II. To us, these transformations seem to embody two tensions, which, at first sight, are opposed to each other. On the one hand, they emphasise the globalisation of activities, which may concern firms or basic research, as witnessed by research on climate or the sequencing of the human genome, and indeed even abortive projects such as ITER. On the other hand, they accentuate the specificity and proximity, which may affect SMEs or universities, of which, in the vast majority of cases, the pool of attraction rarely extends outside the region where they operate. How, then, can public interventions be developed, which are capable both of promoting greater links on the local level, of which work on the Italian industrial districts has underlined the results, and of contributing to the organisation of a global framework, to enable the promotion of the global competitiveness of national firms? The federal countries, the United States and Germany, have de facto proposed a path, which has been followed by numerous European countries.

Two key words describe this: decentralisation and subsidiarity. The first accentuates the need to transfer actions to public structures close to the territory of operation. Spain, France and Italy have consequently favoured
the birth of new territorial organisations. These have very quickly adopted education and research as the two principal priorities for the activities which they may have been delegated. Other countries, such as the United Kingdom and Japan, have sought similar effects through a decentralisation of the administration. Even small countries such as Finland have placed emphasis on territorial organisation of public support for the innovative capacity of firms. The concept of subsidiarity, in this respect, has been mobilised in Europe to take account of the redistribution of responsibilities between member states and their joint establishments, the European Union and Commission. Interest in the concept of subsidiarity relates, to a large extent, to its ambiguity and the capacity for learning that it has enabled and still enables. It has often been considered that the community level should deal only with matters that have not been dealt with by member nations and their governments or which have been explicitly delegated to it (such as common agricultural policy). Over time, the acceptance of the concept has evolved to reflect the existence of an “optimal level” of treatment for each problem, that is to say, of a public authority, which better enables others to intervene in an efficacious manner. For research and innovation policies, there are two significant, dimensions, which are still only just emerging. On the one hand, there is recognition of the plurality of interventions and of relevant public authorities. Strong and symbolic evidence of this can be seen in the fact that, for the period 1999-2003, the Structural Funds (that is to say the funds destined for the lessfavoured regions of the Union) are, for research and innovation policies alone, more significant than those for “direct” technology policy in the Fifth Framework Programme. On the other hand, there is the awareness that responsibilities are not allocated for once and for all. The issue of the “adequate” level, or more exactly of the “good allocation of public responsibilities” requires ad hoc answers and has, thus, to be reconsidered for each new problem. There is no easy path, although there are numerous examples to show that advances have been made in this trend. As a result, the Union has progressively taken a de facto leadership, which is currently uncontested, in public interventions to promote information and communications technologies. As a counter-example, when considering the way in which public interventions on genome sequencing have been organised, it is possible to assess the way ahead. Similarly, in most places, and in particular in the United States and in Germany, states and regions have strongly invested in support for SMEs, even if they were previously not interested or had no institutional responsibility for it (as in France). These few examples, drawn from various countries, show that it is more and more difficult to group public
intervention and national policy together. Consequently, the issue arises of the coherence and co-ordination of public interventions. In the very large majority of the countries, the “governance” of the public systems has thus become a central preoccupation. This has led, in the majority of countries, to profound reorganisations, both in structures and steering instruments.

The only exception is the United States, as underlined by D. Mowery in his conclusion: there has been a “remarkably limited extent of any change in the structures and institutions through which science and technology policy is formulated” while “virtually all the central components of the innovation system that emerged in the post-war US economy are undergoing change”. Furthermore, D. Mowery mentions the potential importance for the functioning of the various public components of the “government performance and results act” which is still in its “early stages”. In several countries, the beginning of the 1990s is characterised by the development of closer links between the Ministries in charge of research and those managing higher education. This trend was initiated by Germany with the transformation of the BMFT into the BMBF, and was then followed by France. It continued with the creation or the overhaul of the Ministries in charge of higher education and research in countries like Italy and Korea. Finally, a similar amalgamation of the Science and Technology Agency and Monbusho, which is in charge of education, will, in 2001, complete the profound administrative transformation being undertaken in Japan. This latter is accompanied by an overhaul of the central advisory structure close to the Prime Minister, of which Y. Sato details both its former role and its place in the shift from a sectoral to a national policy for research and innovation. Similarly, E. Ormala brings out the importance of the Science and Technology Policy Council in the transition that Finland has undergone, in moving from an economy based on natural resources to an economy based on new communications technologies. In both these cases, this steering structure, under the direct chairmanship of the Prime Minister, brings together those responsible in the Government and external personalities, building communication between the political world and the world of research and innovation. This approach, which involves all the Ministries concerned, seems to have been more productive than approaches favouring the existence of an administrative co-ordination structure, generally placed close to the Prime Minister, as this has been the

---

1. A Ministerial change at the beginning of 2000 has reintroduced two different Ministries, while retaining only one administration.
case notably in Spain and the General Secretariat in charge of implementing the National Plan for Research. Other countries have chosen not to tamper with pre-existing structures, probably because they have already experienced the limitations of administrative transformations linked to short-term policy objectives. Their preference has been to emphasise tools to promote concertation between the actors involved and an appreciation of the effects of public activities. The United Kingdom has thus been an instigator in Europe of the evaluation of research policies and then of foresight approaches. The United Kingdom Foresight Programme currently constitutes backbone of a coherent development of public interventions, leading to what L. Georghiou terms “foresight culture” in analysing the transformations induced. Similarly, since the 1970s, the Japanese have been anticipating and preparing for the future, by renewing their foresight exercise and enlarging its horizons every five years. The Netherlands, with the body of councils and other structures which populate what B. van der Meulen and A. Rip term the “intermediary layer”, offer another institutional arrangement, which promotes the “bottom-up aggregation” of interests and anticipations, facilitating co-ordination between actors and preparing the articulation of the policy.

This convergence is not concerned only with the central operation of the Government, which is too often sliced into “sectoral” policies, which simply add together rather complementing each other. It also concerns the different levels of intervention. In their chapter, P. Caracostas and U. Muldur present the development of the preparatory procedures of the European Framework Programme, and bring out the importance of its constituent consultations. They underline, in this development, the challenge of co-ordination between national policies and European policy: it is not sufficient for the principles to be embodied in treaties (as has been the case since 1987) in order to achieve co-ordination. It has been built up progressively, and in the majority of European countries, the preparation of the next Framework Programme has become a significant aspect of national policies. The same trend can be observed in the relations between government and regions. Germany has a long tradition of concertation between the Federal Government and the Länder for all shared policies, of which higher education is part. Spain, with the autonomy of the regions, has witnessed a progressive transfer towards the regions of the responsibility for universities. Similarly France has accompanied its decentralisation with the use of plurianual contracts between the regions and the state to co-ordinate their interventions. Largely centred on transport infrastructures, the contrats de plan État-région (which have existed since the beginning of the 1980s and were
renewed in 2000 for seven years) have progressively accorded an increasingly important role to higher education and to research.

The co-ordination of public interventions has thus become a central question on the policy agenda of all the countries studied in this book, with the exception of the United States. However, B. Bozeman and D. Mowery both agree in saying that the stability of the organisational arrangements allow intersectoral activities, as in the case for the Presidential initiative promoting “information highways”. It is possible to see here the other side of the same reality, since in one case, there is an established institutional framework, operating for more than half a century, while in the other, Europe, where the framework is not yet fully built, its construction entails a complete redesign of the structures and a redefinition of the very concept of national policy.

Such issues challenge the perspective of the system of innovation, founded on the triangular relations between university, government and industry, often known as the “triple helix”. This line of inquiry is commensurate with the re-examination of each term used here. We have attempted to show that it was, without doubt, necessary to substitute the notion of university, with a richer and also more polysemic notion of “public sector research” embracing universities and other public research institutions (the famous “government laboratories”). Likewise, the analysis of the interventions promoting industrial development, shows a growing differentiation between, on one hand, a limited number of “global” firms, which are less and less connected to any particular nationality, and the rest of the industrial fabric, which is largely constituted by SMEs, most notably in the local territorial area.

Finally, the analysis of a Europe, which is still under construction clearly exposes the limits, at least with regard to research and innovation, of the nation-state, tucked tightly between a “continental” level, which is in a better position to tackle the questions of the worldwide organisation of exchanges and to deal with the problems considered as truly global (such as climate change), and a “regional” level, which is more appropriate for taking charge of the problems of “small” individual actors (such as SMEs) or collective actors (such as the municipalities and the universities). This analysis could be made more complex still, if one takes into account, as we propose in the analysis of the French situation, the new collective actors, such as the patients’ associations or other non-profit organisations. This is probably another significant lesson of this book, which is to re-examine the simplifications made, which have difficulty in grasping the richness of the present dynamics of change.
RESEARCH AND INNOVATION POLICIES AS KEY TO THE DOOR

Throughout this work, as in this conclusion, we have collectively endeavoured to remain focused on public policies. It is these that have led us, through their transformations, via the evolution of the questions that they deal with, and via the web of relationships that they weave, to the analysis of the different components of what can conveniently be called a national system of innovation or more simply a system of innovation. We feel, quite obviously, that we have left aside many important questions, such as those of the financing of firms, or the global organisation of markets; but equally we are certain, at least in part, of having brought out the very significant transformations which seem to us to characterise the 1990s and which lead those areas studied to convincingly distance themselves from the model inherited from World War II. Similarly, it is striking to see how much Nelson’s critique that analyses “play down the existence of a … well-structured and thought through general policy” no longer seems to apply, and that the search for coherence and the creation of a co-ordinated approach to interventions have become central in the political agendas. Without doubt, the critique has turned out to be profitable, and has led the advisors to our current policy makers to become more concerned with it. The analysts also have an indirect look-out role, endeavouring to highlight the changes, which are now only faintly sketched out, but which seem to them to have to play a strong role in the coming years. Each of us in our own way, the authors in concluding their chapters, and the editors in this conclusion, we have sought to draw attention to them.

REFERENCES