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# ERAWATCH Analytical Country Report 2007: France

**Antoine Schoen, Gerard Carat, Jan Nill**

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# Executive summary

Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU's economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs. This aims to increase and improve investment in research and development, with a particular focus on the private sector.
As part of ERAWATCH, the JRC-IPTS is producing analytical country reports to support the mutual learning process and the monitoring of Member States' efforts. The main objective of the reports is to characterise and assess the performance of national research systems and related policies in a structured way that is comparable across countries. In order to do so, the analysis focuses on key processes relevant to system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. This analytical approach was tested in 2007 by applying it to a number of countries, of which France is one. This report is based on a synthesis of information from the ERAWATCH Research Inventory and other important publicly available information sources.

Strong scientific traditions and a sustained public support for research have created favourable framework conditions for the French R&D system. The French system has been marked by some quite specific responses to generic challenges, as summarised in the table on its strengths and weaknesses below.

| Domain | Challenge | Assessment of system strengths and weaknesses |
|---|---|---|
| Resource mobilisation | Securing long-term investment in research | Well established mechanisms and high volume of public long-term investment in R&D |
| | Dealing with barriers to private R&D investment | Private resource mobilisation for R&D is stagnating and still mainly dependent on a few large companies, a pattern reinforced by public funding |
| | Providing qualified human resources | Unattractive career prospects for researchers may discourage good students from choosing a scientific career and thus weaken the human resource base |
| | Justifying resource provision for research activities | Strong public debate on, and support for, resource provision for R&D |
| Knowledge demand | Identifying the drivers of knowledge demand | Strong mechanisms to identify knowledge demand drivers |
| | Channelling knowledge demands | The main sectors' established knowledge demands are well covered by public support mechanisms, but limited capacity for strategic steering and co-ordination of knowledge demands is restricting adaptation to changing needs beyond established strategic areas |
| | Monitoring demand fulfilment | If fully implemented, the use of evaluation (of research programmes and research units as benchmarks in the contract process between the State and research organisations) could strengthen the research system |
| Knowledge production | Ensuring quality and excellence of knowledge production | Domains of world level scientific and technological excellence exist, but are often specialised in stable/mature research fields |
| | Ensuring exploitability of knowledge | Sector-specific research institutions ensure that knowledge production links up with economic uses in those sectors, whereas mechanisms to ensure the exploitability of general scientific knowledge production are less well developed |

| Domain | Challenge | Assessment of system strengths and weaknesses |
|---|---|---|
| Knowledge circulation | Facilitating circulation between universities, public research organisations and business | Poor knowledge circulation between academic research (universities/CNRS) and business |
| | Profiting from international knowledge | High degree of internationalisation of scientific research |
| | Enhancing the absorptive capacity of knowledge users | A highly qualified labour force is available; however, the entrepreneurial and innovation culture, as well as SMEs' participation in R&D, are limited |

There are highly centralised mechanisms of resource mobilisation for R&D by central government and a few large firms. Knowledge demands and the production of excellent and economically useful knowledge have tended to focus on a relatively small number of strategic fields and sectors.
However, a changing environment and rigidities in the existing system mechanisms have also revealed some weaknesses, such as a recent stagnation of private resource mobilisation, a poor outlook for boosting human resource mobilisation for R&D, scientific and technological specialisation in somewhat mature fields, and weak knowledge circulation beyond strategic sectors. Several assessments have expressed a need for a reform for the French research system. And indeed a consensus on the need for reforms has emerged.

In the last few years, a range of governance changes and new policies have been implemented, which have created opportunities for new and better responses to the weaknesses and specific challenges described (see overview table below).

| Domain | Main policy-related opportunities | Main policy-related threats |
|---|---|---|
| Resource mobilisation | - Additional public funds, mainly through increased competitive project funding<br>- New incentives to support young firms performing research | - Measures might not be sufficient to reach Barcelona/Lisbon objective for private R&D |
| Knowledge demand | - Enhancement of strategic steering, e.g. through the increased role for the Ministry of Research and Higher Education, could help channel and meet society's demands more effectively<br>- Improvement of research programming e.g. through the new Agency for Research and an increase in project-based competitive funding so as to enhance openness to changing needs | |
| Knowledge production | - Combination of new network oriented instruments, competitive basic research funding and modernisation of university management to strengthen excellence and increase the effectiveness of public funding<br>- Competitiveness clusters strengthen orientation of knowledge production towards economic uses beyond strategic sectors | - Complexity and strong thematic focus of policy measures might not be beneficial for excellence emerging from new cross-cutting scientific opportunities and the research community may not cooperate wholeheartedly in implementation<br>- Policy measures oriented towards existing regional strengths might not be sufficient to prevent a loss of leadership in the fast growing technological areas |
| Knowledge circulation | - Newly created Competitiveness Clusters and Carnot Institutes may bridge the persistent gap between academia and business | |

The policy priorities set out in the Pact for Research are consistent with the analysed strengths and weaknesses and also with the research related objectives of the Lisbon Strategy. The transformation of the governance structures is being spearheaded by the Ministry of Research and Higher Education, which has been given a bolstered role. The way in which knowledge demands are channelled is increasingly based on competitive project funding, which is being implemented by new agencies. Combined with the new unified Agency for Research Evaluation, this also introduces new or improved quality assurance mechanisms for scientific knowledge production. This has very recently been complemented by giving universities increased autonomy, which should allow them to better adapt to these changes. The changes are enhanced by additional public funds and accompanied by a range of new instruments which try to ensure knowledge excellence, exploitation and circulation beyond targeted sectors.

A policy-related threat in the domain of resource mobilisation for R&D is that the very ambitious policy goal of achieving a private R&D funding intensity of 2% of GDP, which implies a break with recent trends, seems difficult to achieve with the present measures. Other policy-related threats are related to the knowledge production domain.

# TABLE OF CONTENTS

# Chapter 1. Introduction

## 1.1 Scope and methodology of the report in the context of the European Research Area and the Lisbon Strategy

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs. This aims to increase and improve investment in research and development (R&D), with a particular focus on the private sector. One task of the JRC-IPTS within ERAWATCH is to produce analytical country reports to support the mutual learning process and the monitoring of Member States' efforts. The main objective of the reports is to characterise and assess the performance of national research systems and related policies in a comparable manner.

To ensure comparability across countries, a dual level analytical framework has been developed and applied. On the first level, the analysis focuses on key processes relevant to system performance in four policy-relevant domains of the research system:

1. Resource mobilisation: the actors and institutions in the research system have to ensure and justify that adequate public and private financial and human resources are most appropriately mobilised for the operation of the system.
2. Knowledge demand: the research system has to identify knowledge needs and how they can be met, thus determining priorities for the use of resources.
3. Knowledge production: the creation and development of scientific and technological knowledge is clearly the fundamental role of any research system.
4. Knowledge circulation: ensuring appropriate flows and distribution of knowledge between actors is vital for its further use in the economy and society or as the basis for subsequent advances in knowledge production.

These four domains differ in terms of the scope they offer for governance and policy intervention. Governance issues are therefore treated not as a separate domain but as an integral part of each domain analysis.

| Resource mobilisation | Knowledge demand | Knowledge production | Knowledge circulation |
|---|---|---|---|
| • Long-term research investment<br>• Barriers to private R&D<br>• Qualified human resources<br>• Justifying resource provision | • Identification of knowledge demand drivers<br>• Channelling of demand<br>• Monitoring and evaluation | • Quality and excellence of knowledge<br>• Exploitability of knowledge | • Inter-sectoral knowledge circulation<br>• International knowledge access<br>• Absorptive capacity |

On the second level, the analysis within each domain is guided by a set of "challenges", common to all research systems, which reflect conceptions of possible bottlenecks, system failures and market failures (see list above).

The way in which a specific research system responds to these generic challenges is an important guide for government action. The analytical focus on processes instead of structures is conducive to a dynamic perspective and eases the transition from analysis to assessment. Actors, institutions – and the interplay between them – enter the analysis in terms of how they contribute to performance in the four domains.

Based on the above framework, the analysis here proceeds in three steps. The first step is to analyse the characteristics of the current research system; the second step is to analyse recent changes in policy and governance. The third step in the analysis aims at an evidence-based assessment of the system's strengths and weaknesses and its policy-related threats and opportunities in the light of the Lisbon process ("SWOT" analysis).

The national research system is defined in functional terms as an open system comprising actors, institutions and the processes by which they interact to contribute to the production and circulation of scientific, technical and related knowledge, as well as to the mobilisation of resources and articulation of demand for R&D. Thus, the research system also includes research policy actors, together with actors and institutions at the interface with the wider innovation system. The national dimension remains important, but it has to be seen in the broader context of an increasingly open system. The report focuses here on the European context of the national research system. Many of the challenges analysed also reflect important concerns of the European Research Area (ERA). Where interactions with the EU level are relevant in addressing domain challenges they are explicitly included in the system characteristics and trend analysis – insofar as the information is readily available. In addition, the jointly agreed research-related EU Lisbon Strategy goals serve as a key reference for assessing recent trends and policy developments.

This report is based on a synthesis of information from the European Commission's ERAWATCH Research Inventory[1] and other important publicly available information sources as of autumn 2007. In order to enable a proper understanding of the research system, the approach taken is mainly qualitative. Quantitative information and indicators are used, where appropriate, to support the analysis. After an introductory overview of the structure of the national research system and its governance, chapter 2 analyses resource mobilisation for R&D. Chapter 3 looks at knowledge demand. Chapter 4 focuses on knowledge production and chapter 5 deals with knowledge circulation. Each of these four main chapters contains a subsection on relevant recent policies in the domain. The report concludes in chapter 6 with an overall assessment of the strengths and weaknesses of the research system and governance and policy dynamics, opportunities and threats across all four domains in the light of the Lisbon Strategy's goals.

[1] ERAWATCH is a cooperative undertaking between DG Research and DG Joint Research Centre and is implemented by the IPTS. The ERAWATCH Research Inventory is accessible at http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home. Other sources are explicitly referenced.

## 1.2 Overview of the structure and governance of the research system

At government level, the Ministry of Higher Education and Research coordinates research policy. Six other ministries have competences for certain areas of research. Inter-ministerial co-ordination takes place formally in the Inter-Ministerial Committee for Scientific and Technical Research (CIRST, *Comité interministériel de la recherche scientifique et technologique*), run by the Ministry for Research and chaired by the prime minister. There is also a range of consultative bodies (see figure 1 below). Besides the Ministry of Higher Education and Research, the Ministry of Economy, Finances and Employment, which is responsible for industrial research and energy research, has a specific role to play in relation to research through the agencies that are under its auspices. These are:

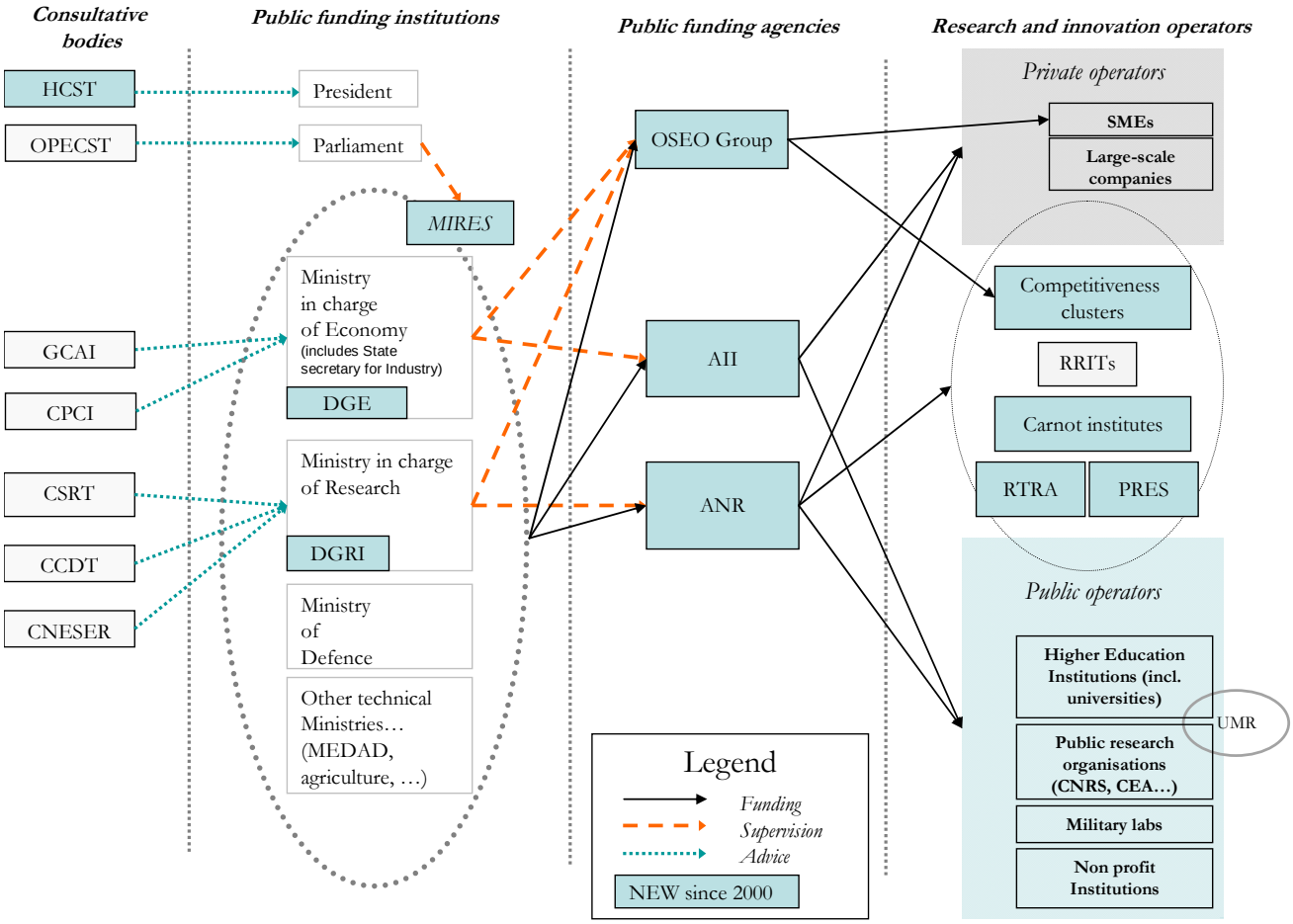
- The National Agency for Research, which was created in 2005[2] to fund basic research projects on a competitive basis. It is under the aegis of the Ministry of Higher Education and Research, but the Ministry of Education, the Ministry of Health, the Ministry of Budget and the Ministry of Economy, Finances and Employment are represented on the Executive Board.
- OSEO Anvar, which provides SMEs with support for R&D and innovation projects. In 2005, the National Agency for Innovation (ANVAR) merged with the Bank for Development of SMEs (*Banque de développement des PME*) to form the OSEO group. OSEO group is a state-owned holding company mainly reporting to the Ministry of Economy, Finances and Employment. OSEO Anvar has the status of a private company with a mission of public interest and is controlled by the OSEO group.
- The Agency for Industrial Innovation, which was created in 2005 in order to strengthen cooperation between large firms and SMEs on pre-competitive research activities. Formerly under the aegis of the Ministry of Economy, Finances and Employment, since the end of 2007 it has become a part of OSEO Anvar.

The most important research performers in terms of funds are higher education institutes, which comprise 86 universities (as counted by the Mission of Research and Higher Education) and the “grandes écoles” (See section 2.1.3).
Alongside the higher education institutes, research is also carried out by public research organisations (PROs). PROs were given their specific status in 1982 by the Law of Orientation and Programming of Technological Research and Development (*Loi d’orientation et de programmation de la recherche et du developpement technologique*), which has subsequently been amended several times. PROs are divided into two categories, EPIC (*Etablissement public à caractère industriel et commercial* – Industrial and trade-related public institute) and EPST (*Etablissement public à caractère scientifique et technologique* – Scientific and technological public institute). The main principle is that the PROs are under the supervision of one Ministry, in accordance with the research area, that is in charge of orienting its strategy.
The main PRO is the National Centre for Scientific Research (*Centre National de la Recherche Scientifique* – CNRS). The CNRS is a publicly-funded research performing organisation that defines its mission as producing knowledge and making it available to society (See also section 2.1.1). Other large PROs include the National Institute for Agronomic Research (*Institut national de la recherche agronomique* -

[2] The decree of August 1, 2006 defines its organisation and functioning. On January 1, 2007, the ANR was made an administrative public institute (EPA - *Etablissement public administratif*).

INRA), the National Institute for Computer Science and Automation (*Institut national de recherche en informatique et en automatique* - INRIA), the National Institute for Health and Medical Research (*Institut national de la santé et de la recherche médicale* - INSERM), and the Atomic Energy Commission (*Commissariat à l'énergie atomique* - CEA).

**Figure 1: Main institutions of the French Research System**




Source: ERAWATCH Research Inventory, Technopolis France

For acronyms used in the figure which are not explained in the text see the list of abbreviations:

The relationships between the State and the regions are organised through the State Region Plan Contract (*Contrat de Plan Etat Région* – CPER) which covers a period of several years. During both the negotiation phase and the follow-up of the Contract, the State is represented by the Secretariat General for Regional Affairs (*Secrétariat Général pour les Affaires Régionales* - SGAR). The Plan Contracts define the financial aid provided by the State in accordance with its objectives. Research forms an explicit chapter in these contracts, which have been renewed for the period 2007-2013 under the name State-Regions Project Contracts. In 2003, the regional budgets for R&D accounted for 4.1% of total public R&D expenditures.

# Chapter 2. Resource mobilisation

The purpose of this chapter is to analyse and assess how challenges affecting the provision of inputs for research activities are addressed by the national research system: its actors have to ensure and justify that adequate financial and human resources are most appropriately mobilised for the operation of the system. A central issue in this domain is the long time horizon required until the effects of the mobilisation become visible. Increasing system performance in this domain is a focal point of the Lisbon Strategy, guided by the Barcelona objective of a R&D investment of 3% of GDP in the EU as a whole and an appropriate public/private split.
Four different challenges in the domain of resource mobilisation for research can be distinguished which need to be addressed appropriately by the research system and research policies:

- Securing long-term investment in research
- Dealing with uncertain returns and other barriers to private R&D investment
- Providing qualified human resources
- Justifying resource provision for research activities

## 2.1 Analysis of system characteristics

In terms of R&D expenditure, France has the second largest research system in the EU. France's GERD amounted to €36.4 billion in 2005, which accounted for 18.1% of EU-27 expenditure in this field. France belongs to a group of Member States which experienced declining average R&D intensities between 2000 and 2005 (European Commission, 2007a)[3]. However, with a ratio of GERD to GDP of 2.13% (2005), France is still above the European average (1.84%), although the R&D intensity is considerably lower than in the early 1990s (e.g. 2.38% 1992). An increasing percentage of (2004) 8.8% of France's GERD is financed from abroad.

### *2.1.1 Securing long-term investment in research*

While financing 37.6% of all R&D performed in France, the Government is still the main actor in mobilising resources for long-term investments in research and corresponding infrastructures. All public resources for higher education and research are secured in the form of yearly inter-ministerial budgets. In 2006, for the first time, the State Budget was defined according to the 2001 Constitutional bylaw on the Finance Acts (*Loi organique relative à la loi de finances* - LOLF), including the setting of objectives and corresponding missions and programmes. As far as research policies are concerned, the Constitutional bylaw on the Finance Acts identifies one inter-ministerial mission (MIRES: Inter-ministerial Mission for Research and Higher Education - *Mission interministérielle recherche et enseignement Supérieur*).

Contractual arrangements between the State and universities or public research organisations have traditionally been an important funding mechanism for securing long-term investment in research. These contracts guarantee resources for four years and a statute whereby most of the researchers at the PROs whose mission is mainly scientific and teacher-researchers have life-long contracts. An important share

[3] Other countries in this group are: the United Kingdom and the Benelux countries of Belgium, the Netherlands and Luxembourg.

of publicly financed GERD[4] is performed by the government sector (37% in 2004), while that performed by higher education was 47% and the share performed by the business sector was 15%. Figure 2 below illustrates the important role of the government sector and its components on the basis of disaggregated national data on expenditures of the public sector in 2003[5]. CNRS is the largest of the EPSTs and also the largest PRO in Europe, with 30,000 employees of which 26,100 are CNRS tenured employees (11,700 researchers; 14,400 engineers and support staff), and an annual budget which represents a quarter of French public spending on civilian research. Another established mechanism for securing long term investments have been large research programmes (see also section 3.1.2).

**Figure 2: R&D expenditures of the Public sector in 2003 (million €)**

| | | | |
|---|---|---|---|
| **Government expenditures** | | **5,767** | **45%** |
| | S&T public institutes (EPST) excluding CNRS and Institutes | 1,365 | 11% |
| | Industrial and Commercial public institutes (EPIC) | 3,156 | 24% |
| | Administrative public institutes (EPA), excluding "*grandes écoles*" which are not under the aegis of the Ministry of Education | 151 | 1% |
| | Ministerial services | 102 | 1% |
| | Defence | 993 | 8% |
| **Higher education** | | **6,693** | **52%** |
| | CNRS and institutes | 2,136 | 17% |
| | *Grandes écoles* | 202 | 2% |
| | Universities and other higher education institutes | 4,356 | 34% |
| **Private non profit** | | **463** | **4%** |
| **Total** | | **12,923** | |

Source : MENESR - DEP B3

French recipients received about €1.654 billion for the European 6th Framework Programme (ANRT, 2007) as a whole[6]. According to MENESR-DEP data, European Union funding represented 14% of funding from abroad in 2003 (€406 million) and hence only around 1% of total R&D funding. France is also a major stakeholder in shared research infrastructure facilities such as ESA, the European Space Agency (as one of its ten founding members), CERN, etc. This is reflected in the fact that funding from other international organisations exceeded the EU funds and represented 24% of funding from abroad in 2003 (€675 million).

To sum up, basic mechanisms for securing long-term investment in research in France are well established and functioning effectively. This is also underpinned by the government appropriations for R&D. In 2005, in France, GBAORD, expressed as a percentage of GDP, amounted to 0.93%, well above the European (EU 25) average (0.75%). Also the moderate growth in the share of basic research over the period 1993-2003, reaching 24.1% of GERD in 2003, points in this direction

[4] i.e. funded by the government plus the higher education sector
[5] latest available figures on this level of disaggregation
[6] For comparison, according to ANRT (2007) Germany, UK and Italy received respectively for the same period: €2.512 billion, €1.635 billion and €1.163 billion.

(ERAWATCH Network, 2006). However, total public funding of R&D has only grown very moderately over the last 10 years, with growth being restricted to research performed in the higher education sector.

### *2.1.2 Dealing with uncertain returns and other barriers to private R&D investment*

In 2004, the private sector financed 51.7% of GERD in France, a share which has declined since 2001, however, and is lower than in countries such as Germany, the UK and the US. As large firms can cope better with the risk and long time horizon of R&D investments, it is not surprising that business R&D is concentrated among large companies, as shown in figure 3 below. According to data from the French ministry, more than 75% of R&D is performed in firms with more than 500 employees and more than half (56%) is conducted by companies with more than 2000 employees (which represent 3% of the workforce). According to the 2006 EU R&D Investment Scoreboard, the top French R&D investor is Sanofi-Aventis, followed by Renault, Peugeot (PSA) and Alcatel (European Commission, 2007). SMEs - which represent nine tenth (90%) of the industrial structure - performed one quarter (24%) of the total business R&D expenditures. If the European definition of a SME is used, the share shrinks to 14.1% (2002) which is below EU25 average.

**Figure 3: BERD and size distribution of firms in 2003**

| Number of employees | % of total | R&D expenditures | % of total R&D expenditures | Public funds | % of total public funds |
|---|---|---|---|---|---|
| Less than 500 | 90% | 5 290 | 24% | 405 | 17% |
| 500-999 | 5% | 2 173 | 10% | 86 | 4% |
| 1000-1999 | 3% | 2 047 | 9% | 310 | 13% |
| 2000-4999 | 2% | 4 323 | 20% | 770 | 32% |
| 5000 or more | 1% | 7 812 | 36% | 873 | 36% |

Source: MENESR – DEP

R&D investment by large multinational firms plays an important role in resource mobilisation. Despite a slight decrease in its share of the world's total (from 8.8% 1995 to 8.2% in 2001), France has remained an attractive location for investments in manufacturing R&D by firms under foreign control (OECD 2005). More than 10% of business R&D is financed from abroad (10.3%, 2004).

Other non-State financing mechanisms, such as venture capital or foundations, have for a long time played a minor role, but are increasing in importance. In 2006, funds raised through venture capital-investment have reached a volume of €536 million, steadily increasing since 2003 (SESSI, 2006). The European Innovation Scoreboard 2005 figures on early-stage venture capital put France 14% above the EU average. Nevertheless, the French figure (0.029% of GDP) is below that of Sweden, Finland or Denmark (0.081%, 0.065% and 0.063%, respectively, in 2003) (European Trend Chart on Innovation, 2006).

In order to help businesses deal with the uncertain returns from R&D investment, government support for private R&D is well established, both in the form of public funds and tax incentives. Public funding of R&D executed by business amounted to €2 billion in 2004, although it represented less than 10% of total BERD (ERAWATCH

Research Inventory, 2007). Public funding of BERD in 2001 was predominant in three sectors: aerospace, machinery and instruments (ERAWATCH Network, 2006). This is partly related to defence. However, the share of defence related R&D has fallen considerably the last 20 years. Defence contracts used to represent 18.5 % of BERD in 1982, but this had dropped to 13.3% by 1992 and was only 7.4% in 2003. The distribution of public funds is clearly biased towards the largest companies, to the detriment of small businesses: SMEs received 17% of public funds whereas they performed 24% of companies' R&D, while companies with more than 2000 employees captured two thirds (68%) of public funds (see figure 3).

The Research Tax Credit (*Crédit d'impôt Recherche* - CIR) is a key measure in supporting R&D investments within companies. The Research Tax Credit is a horizontal measure, non-discriminatory across sectors of activity, which is aimed at supporting corporate R&D investments through tax incentives. It was originally implemented in 1983 with the objective of promoting research activities by firms across sectors, without discrimination. It was a response to an identified weakness characterising the French research and innovation system, namely traditionally weak private R&D expenditure.
The Research Tax Credit underwent significant changes in 2004 when it was renewed indefinitely and modified to include a volume component in its calculation. These changes were introduced following the "Consultation" that took place in 2003 and are expected to double the amount of tax credit granted (European Trend Chart on Innovation, 2006). The main reform was the introduction of a volume-based scheme (5% of all R&D expenditures, since 2006 10%) and the reduction in the scale of the incremental scheme for additional R&D expenditures (from 50% to 45% and later to 40%). A ceiling of the maximum amount credited prevented that the CIR would mainly benefit large firms. In addition, specific tax incentives for young firms have been introduced (see section 2.2). Since 2004, the tax credit also makes a new series of expenses eligible. Since 2006, staff expenditures related to PhD holders are eligible for a deduction of twice their value in the first year of the recruitment (for work contract of undetermined duration). Patent protection costs (up to a limit of €60 000) are eligible, as well as spending on technology watch activities. For 2007, the amount of foregone tax income is estimated at €900 million (Ministry of Education, Higher Education and Research, 2007). An evaluation has found positive effects on firms already doing R&D, but it was not found to act as an incentive for firms to start R&D activities (Larrue et al., 2006).

In 2003, the legal framework governing 'Research Foundations' was modified in order to strengthen the position of existing foundations and to support the creation of new foundations devoted to research. For instance, 60% of donations by individuals to Research Foundations may be deducted from income tax up to the limit of 20% of taxable income. As far as companies are concerned, 60% of donations are eligible up to the limit of 0.5% of their turnover. Furthermore, in order to simplify administrative procedures for the creation of a Research Foundation, status models were designed for the General Assembly and for the Monitoring Council.

To sum up, private resource mobilisation for R&D relies to a significant extent on a few large, often partly state-owned, companies. Low private R&D investment – at least in comparison with other leading research systems - has been assessed as weakness of the French system for quite some time (e.g. Eparvier, 2007) and has subsequently been addressed by policies. The share of GERD financed by the

business sector as a percentage of GDP amounts to 1.11% (2004), above the EU 27 average of 1.01% (2004) but has been declining recently, due to a near stagnation of private R&D funding between 2001 and 2004.

### *2.1.3 Providing qualified human resources*

In 2004, the number of students enrolled in the higher education system reached about 1.5 million, a figure which has risen by about 3% since 1999. Within this overall rise, it is possible to distinguish between a growth of 18% for the engineering degrees, growth of just 1% in generalist university education and a decrease of 1% at some technical institutes (IUT: *Instituts universitaires de technologie*). Social and Human Sciences attract the bulk of this still growing population of students. They account for about 943,000 students, whereas 543,000 persons were studying natural sciences (including life sciences) (OST, 2006a).

Compared with the EU 25 average, France has a high proportion of S&T graduates, with more than 20 graduates per thousand population aged 20-29. However, for reasons discussed below this does not translate into a similarly high share of S&T related PhDs. In 2004, the French higher education system awarded about 9300 PhD degrees, as compared with 23 000 in Germany and 15 000 in the UK and 91 000 in the EU 25 as a whole (OST, 2006a).
At the doctorate level, France appears to be relatively attractive for foreign researchers as 25% of PhD degrees are awarded to foreign students.

In 2003, the number of researchers in France (in full time equivalent terms) reached almost 200,000, which represents a rise of 35% on the figure 10 years ago. Researchers working for the private sector represented 52.2% of this growing population of knowledge workers, compared with 46.5% ten years earlier (OST, 2006a).

Despite this expansion, French governments have regularly emphasised (for instance in the recent Pact for Research, which sets out the main challenges that the research system is assumed to be facing) the need to provide researchers (particularly young researchers) with good conditions in which to work in the public research system, as many people find research careers unattractive.
This lack of attractiveness is partly due to a characteristic specific to France, namely the dual tertiary education system – in science, engineering and management - with universities on the one hand and *grandes écoles* on the other. The "*Grandes écoles*" are uniquely French institutions that offer specialised education of a high standard. This high standard is reflected in the strict admission requirements. The *grandes écoles* generally offer high-quality educational programmes and excellent career prospects. Some of the *grandes écoles* are also planning to run doctorates. However, their role in research and innovation is limited compared to that of universities (Veltz, 2007).
The outlook for a young person with a university degree in science, engineering and management is on average much less favourable than that of someone leaving the education system with an engineering or business school qualification acquired in a *grande école*, especially one of the leading *grandes écoles*. One result of this is that French firms are not in the habit of employing PhDs, preferring instead to recruit graduates from the leading *grandes écoles*. The situation is quite different in the health sciences, in the humanities, in law or in the social sciences, however, where universities are the leading teaching institutions. The five larger institutions of higher

education in engineering – INPG, INPL, INPT, Insa Lyon and UT Compiegne – operate as universities although they select their students in the same way as the *grandes écoles*.

There are also a range of measures in place to address the human resource mobilisation challenges, e.g. CNRS PhD grants for engineers or post PhD recruitment (*Recrutements de post-doctorants*) at the CNRS. In order to induce companies to support research by young researchers and technicians', specific instruments have been implemented, too, such as the support for the recruitment of PhD candidates on an applied research project within an enterprise - CIFRE convention. Initiatives in this area also include a post- PhD initiative programme (*Programme initiative post-doc*), which started in the wake of the innovation plan to support French PhDs obtaining a postdoctoral fellowship abroad to ease their return to France.

### *2.1.4 Justifying resource provision for research activities*

Like most developed countries, economic development is one the main stated goals of the French government to justify public support for R&D. And science is considered to be instrumental in achieving this goal. The central role played by science in France in military and nuclear matters should not be overlooked, however. This was recently illustrated by the strong effort made to ensure the ITER reactor would be developed in France[7].

In the past, successive conservative governments have increased the emphasis put on research policies, continuing the process begun by the Socialist Government in 1997. The reform of the research and innovation system was one element of the Government's overall reform strategy. It is worth noting that research policy matters have recently been high on the government agenda, especially with the 2006 Law for Research which provides measures to enforce strategic orientation capabilities by creating a High Council for Science and Technology and bolstering the powers of the existing National Agency for Research. The fact that the research portfolio has been promoted - after the 2007 presidential election - within the remit of a fully-fledged Ministry (Ministry of Higher Education and Research) may be confirmation that R&D policy is now taking a central position within the French Government's priorities.

This political focus on R&D public support stems largely from a national movement, called 'Let's Save Research' ('*Sauvons la recherche*'), kicked off in 2003. Concerned by the perceived decline of the French research system, some researchers chose to voice their worries to the press and to put pressure on the Government regarding the design of the promised Law for Research. In 2004, PROs' directors launched national discussions in order to gather researchers' and ordinary citizens' concerns and suggestions. Discussions and meetings organised from March to October 2004 culminated in the publication of a report aimed at synthesising research community's point of view on research policies (Etats Généraux de la recherche, 2004).

The importance accorded to research is also reflected in the share of GBAORD in the total government budget (1.81% 2005), which is higher than the EU-27 average of 1.57% (2005), although no increase can be observed here.

[7] ITER is a joint international research and development project that aims to demonstrate the scientific and technical feasibility of fusion power (see http://www.iter.org).

## 2.2 Analysis of recent changes and policies

Originally, a reform of the research system, which was first outlined in the Innovation Plan presented by the Ministry Delegate of Research and New Technologies (now called Ministry of Higher Education and Research) in 2003, was expected to be launched in the second quarter of 2005. Neither the resignation of the Government nor the change of Minister for Education, Higher Education and Research or of the Minister Delegate of Higher Education and Research in May 2005 modified the content of the reform, even though the bill was slightly delayed from the original schedule. Two of the six priorities of the Pact for Research relate to resource mobilisation challenges, aiming at supporting enterprises' research efforts and making scientific careers more attractive. One element of this reform, which culminated in the 2006 Law for Research, was a commitment to increase public R&D funding and to achieve the 3% goal by 2010 (Republique Francaise, 2006). The achievement date of this target was delayed two years to 2012 in the course of 2007.

For the 2007 budget, the overall picture has been €1bn public resources growth for the third consecutive year for higher education and research, reaching €23.9 bn in 2007, representing a 5% increase on 2006. This includes the MIRES (Inter-ministerial Mission for Research and Higher Education) budget, the funding agencies, and also the estimated volume of fiscal measures. The MIRES budget allocation is €21.3 billion, with an increase of 2.8% from 2006. This encompasses 13 programmes split into 3 groups:

1. Programmes under the aegis of the Ministry of Research and Higher education, mainly bringing together the PROs (EPST and EPIC) along with the Agency for Research, with a budget of €6.3 bn. The funding agencies' budget was increased by €280 million: €235m for ANR (with a €825m budget), and €45m for OSEO Anvar (which has a €160m budget).
1. Higher education, university research, and student life (€12.5 bn) with a budget increase of 5.71% compared with 2006. The part on higher education and university research (excluding student life) increased by 2.82%.
2. Programmes under the aegis of other ministries than the Ministry of Research and Higher Education (€2.5 billion).

The results of the 2007 presidential and parliament elections have confirmed the conservative majority. The foreseen allocation for MIRES in the 2008 finance bill published at the end of September 2007 was €23.3 billion, which is an indication of a sustained commitment.

Modifications of the Research Tax Credit were mentioned in section 2.1.2. Further changes which abolish the incremental part of the incentive and substantially raise the absolute ceiling to the benefit of large R&D performers were passed in the autumn of 2007 and take effect in 2008. All these changes, which are expected to triple the amount of foregone tax revenue, are expected to increase its leverage on private R&D expenditures. In addition, a new 'Young Innovative Company' status was designed in 2004, which has since begun to be implemented. The idea is to exempt eligible companies from tax on profits during the first three financial years in which they make a profit and to reduce the tax by 50% for the following two financial years of profit. To be eligible, companies need to be less than eight years old and have a level of R&D expenditures equal to 15% of their turnover. The measure responds to one identified weakness of the French system and provides an opportunity to broaden the base of private R&D funders by fuelling the growth of small R&D intensive firms. With the focus on already commercially successful firms,

however, the scheme provides fewer incentives for early R&D stages. The total value of tax incentives is expected to reach €1.7 billion per year (Republique Francaise, 2006).
Another renewed mechanism aimed at increasing R&D activities and leveraging R&D funding of companies has been a series of large pre-competitive programmes for industrial innovation (*Programmes Mobilisateurs pour l´Innovation Industrielle* - PMII) which are supported by the Agency for Industrial Innovation. The main purpose has been to support large firms in launching major R&D programmes in areas that go beyond their core activities. With this focus, the measure strengthens a well functioning element of private resource mobilisation rather than addressing the size composition weakness (see also Eparvier, 2007). In April 2006, the first five programmes were selected. Being above a threshold of €10 million, they have been notified to the European Commission.
However, all these measures seem to be insufficient to achieve the ambitious French objective, set in accordance with the Barcelona target and the Lisbon Strategy, of having two thirds of GERD financed by private enterprise by 2010 (Republique Francaise, 2006).

A number of policy measures are in the pipeline or have already been taken to address the human resource mobilisation challenge. For instance, the 2005 reform of the Research Tax Credit means companies may be eligible for a tax credit equal to twice the expenses involved in recruiting a PhD holder for the first year (providing that there has been no decrease in staff numbers and the PhD is not on a fixed-term contract). As a follow up to the Pact for Research, PhD fellowship remunerations have been increased. Moreover, an agency will systematically monitor employment and careers of PhDs in both the public and private sectors. This agency will be given the responsibility for assessing future researcher needs in each scientific field. Distribution of PhD fellowships between scientific disciplines will be adapted accordingly. Furthermore, the role of doctoral schools (*Ecoles Doctorales*) will be reinforced in order to improve doctorate training. These schools will be evaluated on the basis of several criteria, including scientific achievement, quality of mentoring and job-market access for PhD holders. Assessment outcomes will be taken into account in the contract process between the State and Higher Education Institutes.

## 2.3 Assessment of resource mobilisation

The main strengths and weaknesses of the French research system in terms of resource mobilisation for R&D can be summarised as follows:

| STRENGTHS: | WEAKNESSES: |
|---|---|
| - Well established mechanisms and high volume of public long-term investment in R&D<br>- Strong public debate on and support for providing resources for R&D | - Poor career prospects for researchers may discourage good students from choosing a scientific career and weaken the human resource base<br>- Private resource mobilisation for R&D is stagnating and still mainly dependent on a few large companies, a pattern reinforced by public funding |

In the light of the Lisbon Strategy, the main opportunities and threats for resource mobilisation in France arising from recent policy responses can be summarised as follows:

| OPPORTUNITIES: | THREATS: |
|---|---|
| - Additional public funds, mainly through increased project funding<br>- New incentives to support young firms performing research | - Measures may not be sufficient to achieve the Barcelona/ Lisbon objective for private R&D |

# Chapter 3. Knowledge demand

The purpose of this chapter is to analyse and assess how knowledge demand contributes to the national research system's performance. It is concerned with the mechanisms used to determine the most appropriate use of, and targets for, resource inputs. Main challenges in this domain relate to governance problems stemming from specific features of knowledge and the need for priority setting. These include:

- Identifying the drivers of knowledge demand
- Co-ordinating and channelling knowledge demands
- Monitoring and evaluating demand fulfilment

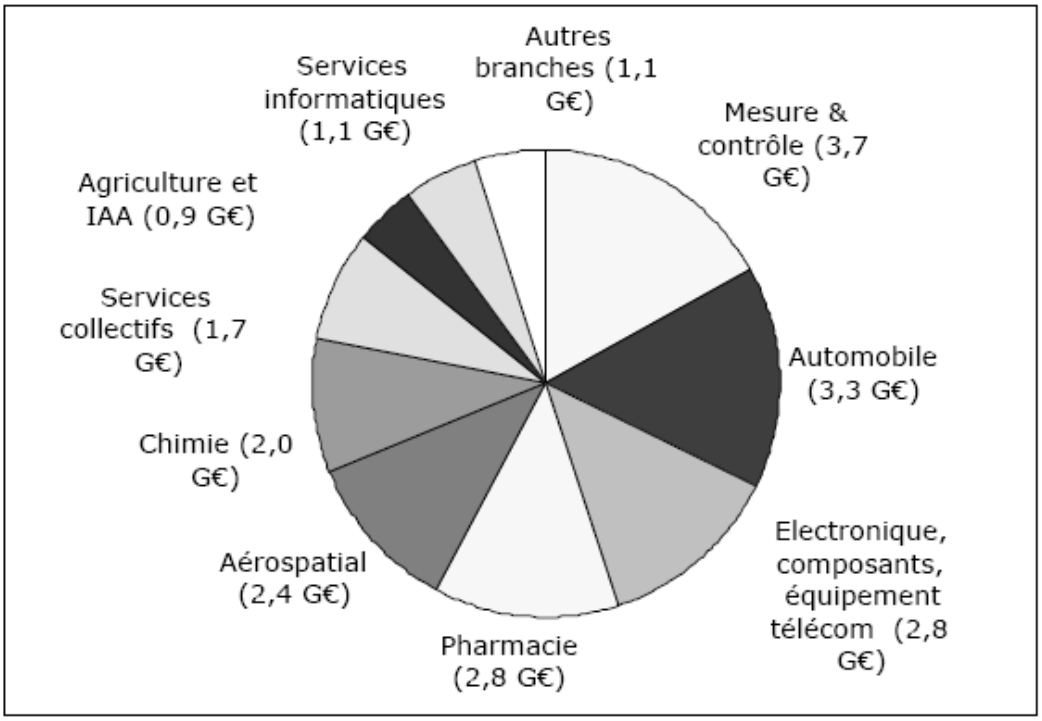
Responses to these challenges are of key importance for the more effective and efficient public expenditure on R&D aimed at in the Lisbon Strategy Integrated Guideline 7.

## 3.1 Analysis of system characteristics

The sectoral structure of the economy is an important determinant of knowledge demand. France is characterised by a relatively large share of high-tech in manufacturing BERD (44.6% in 2002, above the EU average of 41.4%). The most important R&D performing sectors are instruments, electronics, pharmaceuticals, ground transport, chemicals and aerospace (see figure 4 below). This share is supported by a sophisticated consumer demand: 59% of French consumers are favourable towards innovative products and services, a share which is among the highest in the EU and significantly above EU average (European Commission 2005). While the share of medium-high tech in 2002 was comparatively low (42%, EU=47.7%), the share of medium-low tech was 13.4% (EU=10.9%). The share of BERD performed in services is somewhat low, at 11% in 2002, which is below the EU average of 15%.

As one indicator of the structure of public knowledge demand, the breakdown of GBOARD by socio-economic objectives shows that the majority (about two thirds) of the Government R&D budget can be attributed to specified socio-economic objectives while non-oriented objectives represent about a third of French GBAORD. Relative to the EU 15, between 1993 and 2003 France increased its GBAORD specialisation in the fields of Energy, Space and the Environment, while it decreased its specialisation in Defence and Human health. A sharper decline in specialisation can be observed in agriculture, where France became unspecialised over the course of a 10 year period (ERAWATCH Network, 2006).

**Figure 4: Business sector knowledge demand according to sectors**




Source: Operation FutuRIS (2005b)

### *3.1.1 Identifying the drivers of knowledge demand*

Several actors and institutions contribute formally to the identification of drivers of knowledge demand. The High Council for Research and Technology (*Conseil superieur de la recherche et de la technologie*, CSRT) is a consultative body set up in 1982 under the aegis of the research ministry, bringing together stakeholders of the scientific and technical communities and research partners. The Centre for Strategic Analysis under the prime minister, which replaced the *Commissariat General du Plan* in 2006, also contributes to the definition of long-term strategies relating to research and innovation (e.g. Lallement and Paillard, 2003). Reports are also produced by the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST). Although the afore-mentioned bodies have political visibility, the major actors in identifying knowledge demand drivers remain the Research Ministry and its strategy department, and the ANR.

Business knowledge demands are articulated formally and informally. The formal consultation bodies are the Consultative Committee on Technological Development (CCDT) of the Ministry of Research, consisting of experts in the field of applied research, innovation and business creation, as well as the Permanent Commission for Consultation with Industry (CPCI) advising the Ministry of Economic Affairs, bringing together experts from this and other ministries, industry representatives from the enterprise association MEDEF and other stakeholders. Ad hoc consultative bodies producing reports on specific issues on behalf of the prime minister, and often chaired by industrialists, are another important mechanism. One example is the report by Christian Blanc (see 4.2) which initiated the creation of Competitiveness Clusters.

In recent years, the processes identifying and shaping knowledge demand have broadened. FutuRIS, the first systemic foresight exercise on research and innovation was launched at the end of 2001. It is co-financed by government and R&D performing enterprises. In 2005, it became the prospective strategic service of the National Association of Technological Research (ANRT). FutuRIS has elaborated a synthesis report whose conclusions contributed to the drafting of the 2006 Law for Research and therefore to the reorganisation of the system. A contribution to the debate was also made by the *'Etats Généraux de la recherche'*, following the movement to save research initiated by researchers.

### *3.1.2 Co-ordinating and channelling knowledge demands*

French research policy was for a long time characterised by a tradition of large "top-down" sectoral public R&D programmes uniting large state PROs and state-owned firms in domains such as aerospace, nuclear energy or ICT. Since the 1990s, priority setting has become more bottom-up and some of the "large programmes" have disappeared, to be replaced by network-oriented funding (Mustar and Laredo, 2002). The Government has increased the number of research funding mechanisms based on competitive calls for proposals, although in 2004 the share of public expenditure that was project-based was still less than 10%. This opened up the mechanisms with which priorities could be changed. Recently, agencies were created for this purpose (see section 3.2). Although decreasing, the GBAORD share of defence related public R&D is still above 20%. In 2000, 38% of public funding was still spent in the form of military and large technological programmes (€5.30 billion of which €2.3 billion was on civil programmes, Operation FutuRIS, 2004a).
The political channelling of knowledge demand seems to respond well to knowledge demands from the dominant sectors. The bulk of public funding of business R&D is oriented toward the aerospace industry, which received 34.6% of public funds earmarked for research in enterprises in 1999. This fact resonates with the high specialisation of BERD in the sector compared with the EU 15 average (ERAWATCH Network, 2006). The same appears to hold for two other sectors that receive large shares of government funding, such as the instruments and electronic equipment. However, this relationship does not hold for the machinery sector.

France is a country which plays an active part in European co-ordination and priority setting mechanisms. According to the Pact for Research, the articulation of national research policy with European research policy is one of the main aspects of the reconfiguration of the French research and innovation system. The Government's point of view on the European Research Area (ERA) is that Europe can offer a comparative advantage in structuring research systems. One way in which it is envisaged that this might be achieved is by stepping up national participation in European Technology Platforms, and Joint Technology Initiatives. Also France's participation in ERA-NETs confirms this high degree of European involvement. With 9.8% of participations, it is only slightly behind Germany (10.6%) and ahead of the UK (6.7%) (Horvat, Guy et al., 2006).

Along with the Ministry of Research and Higher Education, six other ministries are involved in priority setting and channelling knowledge demands: the Ministry of Economy, Finance and Employment (energy research and industrial research), the Ministry of Ecology, Sustainable Development and Town and Country Planning, the Ministry of Agriculture and Fisheries, the Ministry of Defence and the Ministry of

Culture and Communication. Inter-ministerial co-ordination and priority setting takes place formally through the Inter-Ministerial Committee for Scientific and Technical Research (CIRST, *Comite interministeriel de la recherche scientifique et technologique*), prepared by the Ministry for Research and chaired by the prime minister. In practice, this is only rarely used. The Court of Auditors even concluded that the Ministry of Research did not have any real power to steer government research policy (*Cour des Comptes*, 2004). Also the Futuris report has strongly stressed in 2006 - as did the French Technology Academy (*Académie des technologies*) previously in 2003 - that there was no relevant location in the French institutional landscape where the prioritisation between fields of research could be studied. This is a feature that FutuRIS has assessed to be a weakness of the strategic steering for the French research and innovation system (Lesourne and Randet, 2006).
With the implementation of the 2001 Constitutional bylaw on the Finance Acts (*Loi organique relative à la loi de finances* - LOLF), in 2006 the coordinating role of the Ministry of Research with regard to civil research budget priorities was formally strengthened. There is now one inter-ministerial mission (Mission of Research and Higher Education), which involves several Ministries through 13 programmes. This mission, which replaces the former Civil Budget for R&D, has been seen as a means to give the Ministry of Higher Education and Research the ability to truly orient research policy. MIRES also monitors the programmes performance in a yearly report ("*Projet annuel de performances*"), listing all the credits allocated to research programmes for all PROs and universities.

An assessment by the Futuris project highlighted that the functions and responsibilities relating to setting strategy, programming and performing research are not distributed and separated in a satisfactory way within the system (Lesourne and Randet, 2006). Large institutions like CNRS usually combine responsibilities for strategic planning, programming with a role as research performers. And other large research performers like universities lack a level of strategic steering. This situation, which creates the need for ad hoc adjustments on a case by case basis for institutions eager to develop collaborations, is not considered to be sustainable. Indeed, it has been classed as a "systemic dead end". A reorganisation is therefore felt to be necessary to improve the channelling of knowledge demand.

### *3.1.3 Monitoring and evaluating demand fulfilment*

With regard to evaluation of policies and programmes, the evaluation culture has changed significantly in France since the mid-1990s. As well as evaluations by the Court of Auditors, which mainly focus on financial flows, policy evaluations are now also conducted. One example is the recent evaluation of the research tax credit (Larrue et al., 2006). As part of the LOLF, performance of each programme is evaluated on the basis of three criteria: social and economic effectiveness, quality of service and efficiency. Practically, each programme lists several specific results to which the programme managers commit themselves. It reports appropriations, main goals, performance indicators, expected results and financial data. Public performance and efficiency will then be based on performance measurements.

The evaluation of researchers and research units has a longer tradition. Currently, evaluation of teachers-researchers and of research units are performed by the National Council of Universities (*Conseil national des universités* – CNU) and the Scientific, Technical and Pedagogical Mission (*Mission scientifique, technique et*

*pédagogique* – MSTP), respectively, during the negotiation phase of the four-years contracts between the State and the Universities. Evaluations of Higher Establishments are performed by the CNE, the National Evaluation Committee (*Comité National d'Evaluation*)[8].
In the case of the CNRS, the National Committee of Scientific Research performs an evaluation of researchers and research units, including the Mixed Research Units (*Unités Mixtes de Recherche* – UMR) which bring together researchers from a University and from a Scientific and Technological Public Institute (EPST).
In a report published in 2005, the Court of Auditors advocated a unification of evaluation mechanisms and committees because of the excessive number of research evaluation procedures and research evaluation structures, and because of a lack of coordination between these structures (Cour des Comptes, 2005). Those recommendations were fully acknowledged by the governmental authorities and as a consequence the 2006 Law for Research endorsed the creation of the Agency for the Evaluation of Research and Higher Education (see also section 3.2).

The aim of updating the research evaluation system is to set up an evaluation system for every scientific activity. The Government stresses the need to assess research programmes, research units and researchers on a regular basis. Evaluation reports will be taken into account in the contract process between the State and research organisations. It should be noted that this element is the real novelty since evaluations have already been created in the past 15 years, but the Court of Auditors underlined in 2003 that, despite their high quality, the National Council for the Evaluation of Research (*Conseil national d'évaluation de la recherche* – CNER) evaluation reports were not really used by the Ministry in charge of research. It seems, however, that things are changing, as the 2005 annual report of the CNER (published in June 2006) emphasises that three evaluation studies that it has published from 2002 to 2004 were actually taken into account. Some of the report's recommendations were subsequently followed.

## 3.2 Analysis of recent changes and policies

Two of the six priorities of the Pact for Research respond to challenges in the knowledge demand domain, namely reinforcing strategic orientation abilities and building a unified research evaluation system. Recent governance changes in May 2007 have strengthened political control over research policy by introducing a specific Ministry for Research and Higher Education. This has been complemented by the creation of a high level council, the High Council for Science and Technology (*Haut conseil de la science et de la technologie* - HCST), which was created in June 2006 to advise the president and provide recommendations on national research and innovation strategies. Up to now its activity was limited. Critics like "*Sauvons la recherche*", however, point out that its dependency on political spheres may bias its recommendations and that civil society is not represented (Wikipedia, 2008).

The growing importance of competitive research funding mechanisms was underlined by the creation of two new agencies in 2005, the National Agency for Research (ANR) and the Agency for Industrial Innovation (see section 2.2 and 5.2). The Government's goal is to reach 20% project-based funding by 2010[9] (Republique

[8] In 2007, CNE was incorporated in AERES (cf. 3.2).
[9] In 2004, most of the public funding to businesses was project-based, but less than 3% of PROs funding was project-based (excluding international, European or industrial contracts). The objective to

Francaise, 2006). The mission of the ANR is to fund exploratory research projects open to all types of research performers according to the thematic priorities identified by the Government. The National Agency for Research's calls for projects are organised around seven themes. These themes are Biology and health; Ecosystems and sustainable development; Sustainable energy and the environment; Materials and information; Human and social sciences; Non-thematic or transversal programmes; and Partnerships and competitiveness. In 2005, the ANR budget reached €350 million. The majority of funding (80% in 2005) was dispensed through calls for project proposals. The remaining 20% was distributed among the specific actions to which the State had committed itself. In 2005, the top beneficiary of the National Agency for Research funding was the CNRS (30%). Enterprises received 18%, the majority of which went to SMEs. As far as basic research is concerned, this implies that a funding system based on projects is coupled to the traditional funding system based on research institutions (such as the Universities and the scientific research umbrella organisations).

The Law for Research passed in April 2006 enacted a change in the evaluation system with the creation of the Agency for the Evaluation of Research and Higher Education which will, among other things, unite the missions that were formerly in the hands of the CNE and the CNER.

In order to assess the expected impact of new policy measures, a working group on new instruments was set up in 2006 within the framework of the FutuRIS initiative, and it presented its conclusions at a working session in June 2007. It has assessed the new policy measures and instruments implemented in France since 2005. The main issue addressed in the assessment was the extent to which measures would be likely to enhance the transition of the French research and innovation system from a hybrid model, in which there is little separation between defining research strategy and programming and performing research, towards a system where institutions are generally specialised in just one of these functions and can be explicitly evaluated accordingly. The main recent policy initiatives could indeed be classified as enhancing strategic steering and improving research programming.

## 3.3 Assessment of knowledge demand

The main strengths and weaknesses of the French research system in terms of knowledge demand can be summarised as follows:

| STRENGTHS: | WEAKNESSES: |
|---|---|
| - Strong mechanisms to identify knowledge demand drivers<br>- Established knowledge demands by main sectors well covered by public support mechanisms | - Limited capacity for strategic steering and co-ordination of knowledge demands limits adaptation to changing needs beyond established strategic areas |

In the light of the Lisbon Strategy, the main opportunities and threats for knowledge demand in France that arise from recent policy responses can be summarised as follows:

double project-based public funding would be linked to the increasing budgetary power of the ANR which would raise PROs' project-based funding to 10% of PROs' national resources.

| | |
|---|---|
| OPPORTUNITIES:<br>- Enhancement of strategic steering, e.g. through the increased role for the Ministry of Research and Higher Education, could help channel and meet society's demands more effectively<br>- Improvement of research programming e.g. through the new Agency for Research and increase of project-based competitive funding enhances openness to changing needs | THREATS:<br>- Effectiveness of new institutional arrangements (so far a limited role of the HCST) remains to be proven |

# Chapter 4. Knowledge production

The purpose of this chapter is to analyse and assess how the research system fulfils its fundamental role of creating and developing excellent and useful scientific and technological knowledge. Any response to knowledge demand has to balance two main challenges:

- On the one hand, ensuring knowledge quality and excellence is the basis of scientific and technological advances. It requires considerable prior knowledge accumulation and specialisation as well as openness to new scientific opportunities, which often emerge at the frontiers of scientific disciplines. Due to the expertise required, quality assurance processes are here mainly the responsibility of scientific actors, but may be subject to corresponding institutional rigidities.
- On the other hand, there is considerable interest in producing new knowledge which is useful for economic and other problem solving purposes. Spillovers which are non-appropriable by economic producers as well as the lack of possibilities and incentives for scientific actors to link to societal demands lead to an exploitability challenge.

Both challenges are addressed in the research-related Lisbon Strategy Integrated Guideline.

## 4.1 Analysis of system characteristics

### *4.1.1 Ensuring quality and excellence of knowledge production*

France's academic knowledge production has been characterised by a split between universities and large public research organisations such as the CNRS. However, most research at public research organisations is now performed in around 1500 jointly funded mixed research units. These are run jointly with universities and often located in them (e.g. 80% of CNRS staff). This has increased the role of universities in research, although management is complicated. Researchers at public research organisations enjoy life-long employment and a high degree of freedom in setting their research agenda. Excellence and quality assurance mechanisms are mainly left to knowledge producers' self-governance mechanisms.
The national scientific profile is specialised in stable research areas. The most important scientific fields measured in terms of publication numbers are clinical

medicine, physics and chemistry. The main areas of scientific specialisation, compared with the EU 15 average, are mathematics, physics and geosciences (ERAWATCH Network, 2006). France publishes 7.4% of the world's articles in mathematics, but it only contributes 3.7% of articles in applied biology and ecology, while accounting for 4.7% of the total number of world publications in 2004 (OST, 2006b).

The dominant block funding for academic research in France is to a certain extent linked to evaluation mechanisms related to knowledge production, as described in section 3.1.3. Universities conclude four-year performance contracts with the Ministry for Higher Education, which include funding on the basis of ex-post evaluation. In practice, the Court of Auditors noted in a report on University research in 2005 that, in the context of the negotiation of the four-year contract with the State, although teachers-researchers have to write a note describing their past research activities, the impact is only for their research teams and not for themselves (Cour des Comptes, 2005).

A slight drop has been observed in the French contribution to the global creation of new scientific knowledge: in 1999, France accounted for 5.4% of world publications and for 4.9% of worldwide citations. In 2004, France accounted for 4.7% of the total number of world publications and 4.4% of citations (OST, 2006b)[10]. This decline seems to be largely the effect of the emergence of new large scientific publishers (e.g. China and India) and should not be only interpreted as a decline of French scientific research: during the same period, the two year impact factor for national publication rose from 0.91 to 0.94. Publication output stands at 741 per million population, which is only slightly above the EU-25 average of 664 (ERAWATCH Research Inventory, 2007). Reasons cited include the large share of publicly funded non-academic technical research by EPICs, and features of the way research is organised, such as the opaque recruitment system of researchers by cooption by colleagues which, although in theory providing freedom to explore new pathways, in practice tends to favour proximity networks than multidisciplinarity, scientific openness and originality (Lallement and Paillard, 2003).

### *4.1.2 Ensuring the exploitability of knowledge*

Patent law and other intellectual property rights intended to enhance the creation of economically useful knowledge have a long tradition in France. Nevertheless, ensuring exploitability of knowledge for economic and other societal goals remains an important objective for the French research system.

With regard to linkages between the production of scientific and technical knowledge and possible economic uses, until the early 1990s the focus was on a few strategic sectors and mainly organised in form of large programmes (see section 3.1.2). An important role is played by specific sectoral public research institutions (EPIC). The main EPICs include the CEA, CNES (*centre national d'etudes spatiales* – space research centre), IFREMER (*Institut francais de la recherche pour l'exploitation de la mer* – sea exploitation research). And they also include the agronomic research institute INRA and the INSERM (*Institut national de la sante et la recherche medicale* – health and medical research institute), which are both fully publicly financed EPST.

[10] The EU 25's corresponding contributions amounted to 34.2% and 33.8%.

This is reflected in a good fit between BERD and value added specialisation in some sectors such as air transport, instruments, petroleum, pharmaceuticals and agriculture. In certain other sectors, however, the match is not as close (ERAWATCH Network, 2006).

Apart from the strategic sectors and institutions, in France, as in many EU countries linkages between academic and industrial knowledge production are somewhat weak. An initiative to strengthen these links was taken in 1999 by the Law for Innovation and Research in order to incite researchers to exploit ("valorise") the results of their own research within existing or new companies. The Innovation Plan has also tried to reinforce relations between public research organisations and companies in general.

In the past decade, several initiatives have been run with a view to strengthening links between public and private research activities in order to enhance the industrial use of scientific knowledge. In 1998, the Research and Technological Innovation Networks (*Réseaux de recherche et d'innovation technologiques* – RRIT) were designed to couple public research and enterprises on priority fields assessed by the State where the effort achieved by usual structures is deemed insufficient: information and communication technologies, health technologies and life sciences, environment technologies and other fields such as transport, materials, batteries, aeronautics. Projects in RRITs usually involve public research laboratories, SMEs or start-up companies and industrial groups. At the end of 2004, 15 networks were running. In total, from 1998 to 2004, 964 projects were funded, with a total budget of €398 million.

The National Centres of Technological Research (CNRT- *Centres nationaux de recherche technologique*) are another instrument being used to create stronger links between public and industrial research and as a vector for technology transfer. From July 2000 to December 2004, 20 CNRTs were created in the context of the State Region Plan Contracts which formalised the relations between the State and the Regions. While RRIT include SMEs as stakeholders, CNRTs mainly involve large companies. Each Centre is dedicated to a specific scientific thematic area, corresponding to those regional competences matching national research priorities. The partnerships have an ad-hoc legal structure, depending on the needs that exist.

With the creation of more recent instruments (see 4.2), especially Competitiveness Clusters with strong political backing, it is possible that the CNRT and RRIT subsist on a more pragmatic stance, i.e. successful networks or centres will either keep working or become integrated in new instruments.

An overall assessment of the French research system with regard to the exploitability of knowledge is therefore difficult. While there are historical strengths in some specific sectors, the overall picture is less positive. If patent data are used as indicator of the creation of economically useful knowledge, France scores only slightly above the EU average: In 2003, applications to the EPO were 149 per million inhabitants for France, and 128 for the EU-27. In the European patent system France displays a specialisation in the fields of machinery, mechanics and transportation (with a world share of 7.4% and a specialisation index of 1.31) and in the field of consumption and construction (with a world share of 7.1% and a specialisation index of 1.27, OST, 2006b). According to the ERAWATCH specialisation report on France, the country appears to have increased its specialisation over the period 1993-2003 in the case of almost all benchmarks in the medium–low growth sectors (ERAWATCH Network, 2006). In the fast growing sectors, the only notable exceptions are pharmaceuticals, which increased in specialisation in patents and value added, and transport services, which increased their specialisation in BERD and employment.

## 4.2 Analysis of recent changes and policies

Four main changes can be highlighted which may contribute to improving the quality and the exploitability of knowledge produced by the French system of research and innovation.

The first is the launch of the ANR, which is aimed at developing research quality through an increase in competitive funding (see section 3.2). However, some research actors have expressed their concern that the growing budgetary power of the ANR, which is under direct ministerial control, as well as other new instruments (see below) would eventually be detrimental to the multidisciplinary nature of EPSTs like the CNRS, and would allow the Government, rather than the research community, to pick and choose new areas of research (Sauvons la recherche, 2006). A further shift between block funding of research institutions and competitive project-based funding is expected to encounter some resistance from parts of the scientific community seeking to ensure that the shift does not lead to reductions in block grants.

The second change is the strengthening of research capabilities and excellence by Research and Higher Education Clusters (*Pôles de recherche et d'enseignement supérieur* - PRES) and Thematic Advanced Research Networks (*Réseaux thématiques de recherche avancée* - RTRA). Both will foster public research actors on scientific projects. Participants of the Clusters or of the Networks will be given extra resources. The logic is to increase research excellence and reverse the fragmentation of research activities. The statutes of these two regional instruments, which were introduced by the Pact for Research, were published in May 2006:

- The PRES is an instrument pooling the resources of what are currently often small higher education or research organisations (public or private), in relatively close geographical proximity, in order to boost efficiency at the regional level, and raise the international profile and attractiveness of the French research and higher education system. Their legal form can be flexible and their status and activities are not limited in time. In December 2006, there were nine PRES and further five under preparation.
- RTRA also aims at federating resources but with a focus on scientific excellence with international recognition. Its thematic nucleus of research units must also be geographically close[11]. Selected projects will be given the status of Foundation for scientific cooperation (FCS – *Fondation de cooperation scientifique*). The criteria for the creation of a RTRAs are: (i) a critical mass of very high level researchers, superior or equal to the best world research centres in a given field; (ii) Plurality of specialisation within a given theme; (iii) a strong international dimension; (iv) openness to other disciplines and/or the socio-economic sectors; and, (v) definition of a common strategy. Thirteen RTRA were selected in October 2006, some of them having links to Competitiveness Clusters by working on a related theme).

The third change is the creation of Competitiveness Clusters (*pôles de compétitivité*) that pool public and private resources on specific research areas, jointly addressing excellence and exploitability in specific regional clusters. The logic of Competitiveness Clusters is to create regional poles of excellence in accordance with regional strengths. Industry and public research institutions identify collective

[11] In the Law for Research that was passed in April 2006, the Thematic Networks for Research were called Campuses of Research (*Campus de recherche*).

innovating projects with an international dimension and are supported by public funds. In the European cooperation context and in the context of international competition, Competitive clusters should reinforce the attractiveness of the areas concerned by bringing together their public research units, training centres and enterprises on projects, whether focusing on emerging or more mature themes. This project was born in September 2004, following a report from Christian Blanc, a former Air France CEO. The French Prime Minister launched a call for proposals entitled "growth ecosystems". In this context it was decided to implement structures to reinforce innovation and particularly in relation to research units. The overall objective is to improve French competitiveness and therefore to improve the quality of employment. In July 2005, the Government identified 67 Competitiveness Clusters from among 105 proposals submitted in response to a call for projects. The list of the 67 selected poles covers a large range of disciplines, including nanotechnologies, microelectronics, aeronautics, telecommunications, health, agriculture, oceanography, chemistry, risk management, and cosmetics. Out of the 67 clusters, 16 have or will have a global vocation. The Government encourages Competitiveness Clusters to be actively involved in European research programmes. Since July 2007, there are 71 clusters. Together these clusters are due to receive funding of €1.5 billion between 2006 and 2008.
In 2006, ANR was among the main funders of Competitiveness Clusters with a contribution of €176 million, broken down as follows: 242 research projects were submitted by 51 clusters for total funding of €169.2 million, which represented 15% of the 1622 projects financed by ANR in 2006; the partners involved in the clusters were public laboratories (57%), businesses (35%[12]), other organisations such as associations and technical centres (8%); complementary funding of €5.7 million euros for new cluster projects; a €1 million support to global clusters. In July 2007, 5 new clusters were announced, along with added flexibility regarding geographical coverage[13].

These policy measures are very recent, so their impact is difficult to assess. In 2005, the General Inspectorate of the Administration of Education and Research (*Inspection générale de l'administration de l'Education nationale et de la recherche*) underlined the complementarity of the Competitiveness Clusters and the Research and Higher Education Clusters and the need not to strengthen one to the detriment of the other. While it may be anticipated that increased co-operation between public and private actors will enhance the production of internationally exploitable knowledge, the reinforcing of regional strengths might not be sufficient to enhance leadership in technological areas that are fast growing but not necessarily locally clustered. The added flexibility reflects this.

Still more recently, an ambitious programme of university reform has been announced, focusing on increasing universities' autonomy. This is one of the new government's first reforms. A controversial law on university reform was adopted by the French parliament on 1 August 2007. The reform, to be implemented over the next five years, aims to:

- Grant universities more autonomy to decide their budget and staff, allowing universities to create foundations, to collect money and put in place their own

[12] Out of which 14% for SMEs and 21% for other businesses
[13] A new system of "twinning" (*endossement*) allows geographically remote research centres to join existing clusters

recruitment processes; in particular, it includes the possibility of proposing short-term contracts to researchers;
- Give universities more competence in opening their administration to external staff, allowing, for example, representatives of the business world to take part in university governance;
- Strengthen the state's legal control.

In general, the law brings the status of France's universities closer to that of those in other European countries, but is opposed by researchers' organisations. Increased autonomy is a necessary condition for the effectiveness of a range of the competitive new instruments. However, the French Science Trade Union (SNCS) argues that the text does not consider the needs of universities in the research area. In particular, the possibility of offering short-term contracts to researchers would be contrary to the nature of research activity (Inter syndicale Enseignement Supérieur-Recherche, 2007).

## 4.3 Assessment of knowledge production

The main strengths and weaknesses of the French research system in terms of knowledge production can be summarised as follows:

| STRENGTHS: | WEAKNESSES: |
|---|---|
| - Domains of world level scientific and technological excellence<br>- Sector-specific research institutions ensure that knowledge production links up with economic uses in those sectors | - Specialisation in stable/mature research fields<br>- Mechanisms to ensure exploitability dimension of general scientific knowledge production less developed |

In the light of the Lisbon Strategy, the main opportunities and threats for knowledge production in France arising from recent policy responses can be summarised as follows:

| OPPORTUNITIES: | THREATS: |
|---|---|
| - Combination of new network oriented instruments, competitive basic research funding and modernisation of university management is bolstering excellence and increases effectiveness of public funding<br>- Competitiveness clusters strengthen orientation of knowledge production towards economic uses beyond strategic sectors | - Complexity and strong focus of policy measures on priority areas may constrain excellence emerging from new cross-cutting scientific opportunities and implementation may partly be blocked by the research community<br>- Policy measures oriented towards existing regional strengths might not be sufficient to prevent a loss of leadership in fast growing technological areas |

# Chapter 5. Knowledge circulation

The purpose of this chapter is to analyse and assess how the research system ensures appropriate knowledge flows and sharing between actors. This is vital for its further use in the economy and society or as the basis for subsequent advances in knowledge production. Knowledge circulation is expected to happen naturally to some extent, due to the mobility of knowledge holders, e.g. university graduates who go on to work in industry, and the comparatively low cost of reproducing knowledge once it is codified. However, there remain three challenges related to specific barriers to knowledge circulation which need to be addressed by the research system in this domain:

- Facilitating knowledge circulation between university, PRO and business sectors
- Profiting from access to international knowledge
- Enhancing the absorptive capacity of knowledge users

Significant elements of Integrated Guideline 7 relate to knowledge circulation. To address them effectively requires a good knowledge of the system's responses to these challenges.

## 5.1 Analysis of system characteristics

### *5.1.1 Facilitating inter-sectoral knowledge circulation*

In line with the sector specific patterns of knowledge production (see section 4.1.2), the links between (some) public research organisations and industry are stronger than those between universities and industry. Correspondingly, in 2004, the business sector funded 6.4% of Government research, a figure slightly higher as the EU 27 average of 6.1% for 2004, but only 2.7% of Higher education sector research (6.7% for EU 27 in 2004). In interpreting the comparison with the EU average, the comparatively generous public funding of research has to be taken into account, as it reduces public research institutions' need for private funding.

Nevertheless, inter-sectoral knowledge circulation and R&D collaboration have been considered sub-optimal in the French research system since at least the 1999 Law for Innovation and Research. Among other things, it has provided measures pertaining to the mobility of human resources from the research world to business and cooperation between public research and enterprises.
For a long time, for instance, French universities used to have to resort to associations to develop their research results. These associations were in charge of managing laboratories' agreements with enterprises. It was therefore important to put in place a legal instrument allowing universities to have their own internal services, with adapted rules and the ability to lead the policy of development of universities' research results. Specifically to strengthen university and PRO-industry links, the 1999 Act created the SAIC, Industrial and Commercial Activities Services (*Services d'activités industrielles et commerciales*) within Universities. Launched in 1999, the Industrial and Commercial Activities Services take charge of all industrial and commercial activities that are not performed by a company or a group of companies. This includes research convention management with enterprises, development and exploitation of patents, licenses, intellectual property rights, room rental or services

delivery, excluding on-going training. These services also propose a development policy and therefore the drafting of price scales for industrial and commercial services. In addition to tax breaks worth €23 million, funding of €150,000 has been earmarked for each SAIC.
In 2002, three years after their creation, there were only a dozen SAICs in place. There was a need to further clarify the re-allocation of patent royalties; to unequivocally designate project leaders in research partnerships; to implement best practices during contract negotiations between research units; and to redefine their fiscal and legal framework (Ministry of Higher Education and Research, 2002).

The objective of strengthening links between universities, PROs and industry was underlined again in the 2003 Innovation plan. The plan intended to encourage the better use of research results by means of public/private partnerships, by the application and exploitation of a portfolio of patents and by the creation of young innovating enterprises.
The Technological Platforms (*Plates-formes technologiques* – PFT) have the purpose of facilitating transfers of technology from public Higher Education Institutes to firms. Again, the management of the Platforms is embedded in the State Regions Plan Contracts. There were 77 Platforms in December 2004.
A recent assessment has confirmed the weakness of knowledge circulation from universities and the CNRS to the business sector and is sceptical about the effectiveness of the existing measures to strengthen science-industry links (IGF, IGAENR, 2007). However, the study has received some criticism in the academic debate (Eparvier, 2007).

### *5.1.2 Profiting from access to international knowledge*

International cooperation has been a part of science since its beginnings. Co-signed articles (co-publications) can serve as an indicator of features of this cooperation in the production of scientific knowledge as it takes place among researchers from various countries. Within the European Union the share of a nation's publication output that can be attributed to international collaboration varies widely from member to member. In 2003, France' share (23.2%) was slightly above the EU-15 average of 22.9%, and above the share of the other largest publishing countries in Europe (OST, 2006b)[14]. Beyond institutional support, access to international knowledge is also supported by the Cultural areas (*Aires culturelles*) programme which hands out fellowships to PhD students for a scientific visit in any country lasting from three to 12 weeks.
Participation in EU Framework Programmes is another indication of France's strong presence in international networks and the country has emphasised the importance of European collaboration. Since 2006, France has had a global share of 10.8% of participation in the FP 6 and a particularly strong presence in aeronautics and space (20.5%)[15]. Additionally, there are a large number of international S&T agreements in force.

The openness of the French research system to the inflow of European and international knowledge has been bolstered by the increased role of project funding.

[14] The respective shares are: Germany 21.0%, Italy 22.7%, Spain 21.8% and United Kingdom 18.9%.
[15] Since 2006, Germany accounts globally for 14.8% of participations in the 6th FP and the UK accounts for 11.2% of participations.

For instance, for all the 2005 ANR projects, the proportion of non-nationals was 18% for experts and 10% for members of evaluation committees.

### *5.1.3 Enhancing the absorptive capacity of knowledge users*

With regard to knowledge users' absorptive capacity, the picture is mixed. On the one hand, entrepreneurial and innovation culture, as well as SME participation in R&D (see section 2.1.2), are limited (Eparvier, 2007). This is reflected in CIS4 data which show that only one third of enterprises can be characterised as innovative, while the EU27 average stands at almost 40%. On the other hand, there is a highly qualified labour force available. The number of higher education students and S&T graduates is high and rising (see section 2.1.3). Correspondingly, France ranks 5th in Europe in terms of the number of scientists and engineers in the labour force, with a figure of 6.9 per thousand (2006), compared with a EU 27 average of 5.4 ‰ people in the labour force.[16].

Several instruments have been designed to provide companies (including SMEs) with technological services, such as:

- The Regional Innovation and Technology Transfer Centres (*Centres régionaux d'innovation et de transfert technologique* – CRITT). More than 200 Centres are disseminated in the French territory in order to sensitising SMEs to innovation and/or to provide them with technological services according to their needs.
- The Technological Development Networks (*Réseaux de développement technologique* – RDT). Created in 1990, these networks have the mission of supporting the development of SMEs by networking public actors (regional actors and regional delegates of governmental ministries).

Financial and other support for SME R&D and innovation projects is provided by OSEO Anvar. Its main instruments for intervention are loans, but also include subsidies and expertise.

## 5.2 Analysis of recent changes and policies

The issue of the circulation of knowledge between academic and business actors was given high priority in the Pact for Research and in the 2006 Law for Research, which represents the legislative part of the Pact for Research.

Two main measures aiming at improving this collaboration are:

- The Agency for Industrial Innovation, which was put in place in order to support and subsidise large pre-competitive programmes for industrial innovation. Networking between large firms and SMEs has a crucial role. Apart from these actors, the Agency had also the task of enhancing public and private co-operation in the field of research.
- The Competitiveness Clusters that pool public and private resources on specific research areas depending on regional strengths (see section 4.2 for details).

Another new measure to improve inter-sectoral knowledge circulation, building upon the model of the German Fraunhofer Institutes, was the creation of Carnot Institutes in 2006[17]. These have the following characteristics:

[16] Finland, Sweden, Denmark and Belgium are the countries showing the greatest density of researchers in the workforce, with 14.7, 10.3, 9.1 and 7.4 per thousand workers respectively.
[17] The first call for applications was launched in October 2005

- A clearly defined research structure (partners, activity, critical mass)
- A clear research strategy (technological challenges, competitive positioning, partnership strategy)
- Clearly defined governance and organisation (budget allocation, strategic orientations, human resources)
- Demanding quality criteria
- A strong partnership spirit with the private sector, with at least 10% private funding
- Management of IPR on behalf of partners.

A federal structure makes collective actions on behalf of the Carnot institutes on IPR advice, marketing and prospective actions, technology watch, support to project management, best practices, information for partners and clients, internal and external communication on both national and international bases. The Carnot quality stamp (Label Carnot), granted for a 4-year period, was granted to 20 research structures in 2006, rising to 33 in 2007. The budget available from the State in 2007 was €60 million.

While the SAIC (see 5.1.1) is a legal structure helping out with logistical and administrative matters to foster *any* university/PRO - industry links, the Carnot quality stamp rather aims at research excellence and visibility. This suggests that the focus is now on the new Carnot instrument, which benefits from stronger financial and political backing.

As a new means to improve access to European and international knowledge the ANR and the AII are encouraged to support projects that may be put forward by research actors to benefit from European funding.

## 5.3 Assessment of knowledge circulation

The main strengths and weaknesses of the French research system in terms of knowledge circulation can be summarised as follows:

| STRENGTHS: | WEAKNESSES: |
|---|---|
| - High degree of internationalisation of scientific research | - Weak knowledge circulation between universities/CNRS and business |

In the light of the Lisbon Strategy, the main opportunities and threats for knowledge circulation in France arising from recent policy responses can be summarised as follows:

| OPPORTUNITIES: | THREATS: |
|---|---|
| - Newly created Competitiveness Clusters and Carnot Institutes may bridge the persisting gap between academia and business | - |

# Chapter 6. Overall assessment and conclusion

## 6.1 Strengths and weaknesses of research system and governance

Strong scientific traditions and sustained public support for research have created favourable framework conditions for the French R&D system. The French system has been marked by some quite specific responses to generic challenges. There are highly centralised mechanisms of resource mobilisation for R&D by central government and a few large firms. Knowledge demands, together with the production of excellent and economically useful knowledge, have tended to focus on a small number of strategic fields and sectors. Corresponding governance structures and institutions often combined steering, policy implementation and performance of research. This is complemented by a strong role for the CNRS, which is a relatively autonomous actor, in general scientific knowledge production and also, to some extent, in channelling knowledge demands.

However, a changing environment (e.g. new knowledge demands, global competition) and rigidities in the existing system's mechanisms have also revealed some weaknesses, such as the recent stagnation of private resource mobilisation, a poor outlook for enhanced human resource mobilisation for R&D, a scientific and technological specialisation in somewhat mature fields and weak knowledge circulation beyond strategic sectors. Several assessments have expressed a need for a reform of the French research system. The table below summarises the system's main strengths and weaknesses. According to FutuRis, French research may be even become trapped in a systemic dead end if no major reorganisation across system domains is carried out, with the change of governance and co-ordination of knowledge demands as main point of departure. And indeed a consensus on the need for reforms has developed and considerable transformation of the French research governance structure is on the way.

| Domain | Challenge | Assessment of system strengths and weaknesses |
|---|---|---|
| Resource mobilisation | Securing long-term investment in research | Well established mechanisms and large volume of public long-term investment in R&D |
| | Dealing with barriers to private R&D investment | Private resource mobilisation for R&D is stagnating and still mainly dependent on a few large companies, a pattern reinforced by public funding |
| | Providing qualified human resources | Bleak prospects for researcher careers may prevent good students from choosing a scientific career and weaken the human resource base |
| | Justifying resource provision for research activities | Strong public debate on and support for resource provision for R&D |
| Knowledge demand | Identifying the drivers of knowledge demand | Strong mechanisms to identify knowledge demand drivers |
| | Channelling knowledge demands | Established knowledge demands by main sectors well covered by public support mechanisms, but limited capacity for strategic steering and co-ordination of knowledge demands limits adaptation to changing needs beyond established strategic areas |
| | Monitoring demand fulfilment | If fully implemented, the use of evaluation (of research programmes and research units as benchmarks in the contract process between the State and research organisations) could strengthen the research system |

| | | |
|---|---|---|
| Knowledge production | Ensuring quality and excellence of knowledge production | Domains of world level scientific and technological excellence, but often specialisation in stable/mature research fields |
| | Ensuring exploitability of knowledge | Sector-specific research institutions ensure that knowledge production links up with economic uses in those sectors, whereas mechanisms to ensure the exploitability of general scientific knowledge production are less well developed |
| Knowledge circulation | Facilitating circulation between universities, public research organi-sations and business | Weak knowledge circulation between university/CNRS academic research and business sector |
| | Profiting from international knowledge | High degree of internationalisation of scientific research |
| | Enhancing the absorptive capacity of knowledge users | A highly qualified labour force is available; however entrepreneurial and innovation culture are limited, as is SME participation in R&D |

## 6.2 Policy dynamics, opportunities and threats from the perspective of the Lisbon agenda

In the last few years, a range of new policies and changes in governance have been implemented which have created opportunities for new and better responses to the weaknesses and specific challenges discussed here. The policy priorities set out in the Pact for Research are consistent with the analysed strengths and weaknesses and also with the research-related objectives of the Lisbon Strategy. The transformation of the governance structure is being spearheaded by a strengthened role of the Ministry for Research and Higher Education and a new high level council advising the president. The mode of channelling knowledge demands is increasingly based on competitive project funding by new intermediary agencies. This has very recently been complemented by increasing the autonomy of universities, which should allow them to better adapt to these changes. The increasing funds programmed by the Agency for Research and the new unified Agency for Research Evaluation also introduce new or improved quality assurance mechanisms for scientific knowledge production. This is accompanied by an extensive and also somewhat controversial public debate.
The changes are being boosted by additional public funds. In parallel, a range of new instruments have been introduced which try to ensure knowledge excellence, exploitation and circulation beyond the traditionally focused sectors, such as the thematically advanced research networks, which may provide interesting tools for overcoming fragmentation, the competitiveness clusters and the Carnot institutes. Competitiveness clusters and strengthened tax incentives may leverage private resource mobilisation for R&D.

However, a policy-related threat in the domain of resource mobilisation is that the very ambitious policy goal of a privately funded R&D intensity of 2% of GDP, which implies a break with recent trends, does not seem feasible with current measures. Other policy-related threats relate to the knowledge production domain. The set of new measures is complex and adds to existing mechanisms. Effective implementation of some of the "top down" changes might be blocked by the research community. Moreover, the strong focus on existing regional strengths might not be sufficient to prevent a loss of leadership in the fast growing technological areas. The following table summarises the main policy-related opportunities and threats.

| Domain | Main policy-related opportunities | Main policy-related threats |
|---|---|---|
| Resource mobilisation | - Additional public funds, mainly through increased project funding<br>- New incentives to support young firms performing research | - Measures might not be sufficient to reach Barcelona/ Lisbon objective for private R&D |
| Knowledge demand | - Enhancement of strategic steering, e.g. through the increased role for the Ministry for Research and Higher Education, could help in more effective channelling and better answering of societal demand<br>- Improvement of research programming e.g. through the new Agency for Research and increased project-based competitive funding enhances openness to changing needs | |
| Knowledge production | - Combination of new network oriented instruments, competitive basic research funding and modernisation of university management is strengthening excellence and increasing the effectiveness of public funding<br>- Competitiveness clusters are strengthening the orientation of knowledge production towards economic uses beyond strategic sectors | - Complexity and strong thematic focus of policy measures might not be beneficial for excellence emerging from new cross-cutting scientific opportunities and implementation may be hindered by the research community<br>- Policy measures oriented towards existing regional strengths might not be sufficient to prevent a loss of leadership in the fast growing technological areas |
| Knowledge circulation | - Newly created Competitiveness Clusters and Carnot Institutes may bridge the persisting gap between academia and business | |

The articulation of French research policy with European research policy has always been strong and is seen as one of the main aspects of the ongoing reconfiguration of the French research and innovation system. The French government has embraced the ERA concept and has recently also made a commitment to the research-related Lisbon Strategy goals. Efforts are being made to increase French participation not only in traditional instruments but also in new European initiatives such as ERA-NETS and Joint Technology Initiatives.

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# Abbreviations

AERES: Agence d'évaluation de la recherche et de l'enseignement supérieur (Agency for the Evaluation of Research and Higher Education)
AII: Agence de l'innovation industrielle (Industrial Innovation Agency)
ANR: Agence nationale de la recherche (National Agency for Research)
ANRT: Association nationale de la recherche technique (National Association of Technological Research)
CCDT: Comité consultatif pour le développement technologique (Consultative Committee for Technological Development)
CGAI: Comité de gestion des aides à l'industrie (Managing Committee for aid to industry)
CIR: Crédit d'impôt recherche (Research Tax Credit)
CIRST: Comite interministériel de la recherche scientifique et technologique (Inter-ministerial Committee for technical and scientific research)
CNE: Comité national d'évaluation (National evaluation committee)
CNER: Conseil national d'évaluation de la recherche (National Council for the Evaluation of Research)

CNESER: Conseil national pour l'éducation supérieure et la recherche (National Council for Higher Education and Research)
CNU: Conseil national des universités (National council of universities)
CPCI: Commission permanente de concertation avec l'industrie (Permanent Commission of Consultation with Industry)
CSRT: Conseil supérieur de la recherche et de la technologie (High Council for Research and Technology)
DGE: Directorate General for Enterprises
DGRI: Directorate General for Research and Innovation
EPIC: Etablissement public à caractère industriel et commercial (Public institute with a industrial and trade focus)
EPST: Etablissement public scientifique et technologique (Scientific and technological public institute)
ERA: European Research Area
HCST: Haut conseil de la science et de la technologie (High Council for Science and Technology)
LOLF: Loi organique relative à la loi de finances (Constitutional bylaw on the Finance Acts)
MEDEF: Mouvement des entreprises de France (Enterprise association of France)
MIRES: Mission interministérielle sur la recherche et l'enseignement supérieur (Inter-ministerial Mission for Research and Higher Education)
OPECST: Office parlementaire pour l'évaluation des choix scientifiques et technologiques (Parliamentary Office for Evaluation of Scientific and Technical Choices)
PRES: Pôles de recherche et d enseignement supérieur (Research and higher education centres)
RRIT: Réseaux de recherche et d'innovation technologiques (Research and Technological Innovation Networks)
RTRA: Réseaux thématiques de recherche avancée (Thematic Networks for Advanced Research)
SAIC: Services d'activités industrielles et commerciales (Industrial and Commercial Activities Services)
SNCS: Syndicat national des chercheurs scientifiques (national researchers union)
UMR: Unités Mixtes de Recherche (Joint Research Units)

**European Commission**

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**Abstract**

**The main objective of ERAWATCH analytical country reports is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. The reports support the mutual learning process and the monitoring of Member States efforts by DG Research in the context of the Lisbon Strategy. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. This analytical approach has been tested in 2007 by applying it to six countries, one of which is France. The report is based on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.**