CREST 3% OMC Third Cycle
Policy Mix Peer Review

Country Report
France

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Contents

1 Introduction

Within the framework of the Lisbon process and the Open Method of Coordination (OMC), the CREST-OMC Policy Mix Expert Group initiated a peer review exercise in some member states. The aim of the peer review exercise is to evaluate the national innovation systems of selected countries with regard to existing or planned/needed policy mixes, in order to stimulate the performance of the innovation systems and to increase R&D intensity.

In the second cycle of the Open Method of Coordination, the R&D and innovation policy mixes were examined in the following member/candidate countries: Sweden, Spain and Romania. The synthesis report to CREST was finalised in January 2006. In the third cycle of the Open Method of Coordination the following countries volunteered to participate actively in the peer review exercise: the United Kingdom, the Netherlands, Belgium, Lithuania, France and Estonia.

The peer review team that was to examine the French research and innovation system was nominated by the CREST-OMC Policy Mix Expert Group. It comprises the following experts:

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The fact-finding mission to France, which took place on 26 – 27 April 2007 in Paris, was the most important part of the peer review exercise. During the mission to Paris, the French Ministry for Higher Education and Research organised and hosted a series of meetings with important stakeholders involved in Science, Technology and Innovation: representatives from policymaking and advisory bodies, governmental and academic institutions, universities, public research organisations, as well as from the business sector (see the programme in Annex A). Thus, the reviewers had the opportunity to discuss issues pertaining to the research and innovation systems in France with a great number of experts and officials.

To prepare for their visit to France, the peers were provided with a background country report written for the purpose of this policy review. The OMC Policy Review Background Report (Annex B) on France provides information on the Science Base, Business R&D and Innovation, Economic and Market Development, Human Resources and the overall Innovation System. The French Ministry provided the reviewers with additional written material for Higher Education and Research on the day they arrived in Paris for the peer review.

This report summarises the observations of the peers. It represents the collective view of the review team but does not represent the official view of any of their host organisations.

After a brief excursion to say what we mean by 'policy mix', the report is structured in three further sections. The first outlines the French research and innovation system and its associated policy mix. In the second section, the review team discusses the most important impressions it gained. Finally, in the third section, a number of recommendations are presented, which, hopefully, may prove valuable input in the French policy process.

2 What Does 'Policy Mix' Entail?

In analysing France's 'Policy Mix' for research and innovation, we have used the heuristic of 'innovation systems' to guide our thinking in order to try to understand the overall performance of the French research and innovation system to make suggestions about how to improve it, based both on theory and on the experience of other countries.

The modern perspective on innovation and research is that these are vital components of socio-economic performance within complex national, international and regional systems. Individual components of these systems – such as companies, universities, institutes, governance, education, tax laws and other 'framework conditions' and so on – need to work well if the system as a whole is to generate economic welfare. Not only the components of the system but the way they are interconnected need to be efficient and of high quality. Correspondingly, the balance among different system components and the policies that relate to them needs to be appropriate and the policies need to be mutually consistent. Achieving this requires appropriate resources and governance, mixing coordination and strategy creation on the one hand with the flexibility and receptiveness to bottom-up initiatives needed constantly to adjust to changing realities. Policymakers and other stakeholders continuously need strategic intelligence about the innovation system, in order to develop open systems able both to reflect on performance (for example through evaluation) and to consider future opportunities in developing policy. These considerations, together with our experience of research and innovation policy, effectively provide our criteria in making this assessment of the French policy mix.

3 French Research and Innovation System Performance

3.1 The Economy Overall

France has a strong, stable economy with a fairly high GDP per capita, equalling the EU-15 average in 2005. It is characterised by a comparatively large primary sector that contributes 15% to GDP but employs only 3.8% of the labour force. Industry generates 33% of GDP, while employing 23% of the labour force, implying that both the primary and the secondary sector are highly productive. With its strong agricultural sector, it is not surprising that the French agro-food industry is the strongest segment in the secondary sector (22% of secondary sector). Correspondingly, with 52% of GDP, the service sector is relatively small compared to other countries (e.g. Netherlands with 70% of GDP).

Labour productivity is one of the highest in the EU. However, France became relatively less productive between 2000 and 2005 and total employment growth

remains low, with unemployment staying above 9% between 2000 and 2005 and standing at 8.3% in March 2007. Unemployment among young people, especially among new entrants in the labour market, is high (17.3% among people aged 15-29 in 2005[1]). This poor labour market performance contributes to a persistent budget deficit, with general government debt rising from 56.6% of GDP in 2000 to 64.5% of GDP in 2005.

3.2 Research and Innovation Inputs

France enjoys levels of basic and higher educational attainment in line with or exceeding the EU average and has a share of science and engineering graduates that is one of the highest in the EU. It puts a relatively high proportion of its population through the tertiary education system (38% of 25-34 year olds in 2004, compared to an EU average of 28%). Its R&D intensity (2.16% of GDP in 2004) is around the OECD average but does not appear to be on a trajectory towards the 3% Barcelona Goal of the European Union. At 1.06% of GDP, public R&D expenditure is high, but if expenditure on defence, space, and nuclear energy is deducted, public R&D expenditure amounts to only 0.6% of GDP, below the OECD average of 0.66%. In the last three years France has increased public funding for R&D by a billion Euros annually in an effort to raise this proportion.

Presumably as a hangover from the former pattern of higher defence expenditure and the very active role of the state in funding major technological developments in infrastructure industries, the proportion of BERD financed by industry is relatively low. Industrial R&D spending is also rather concentrated, with the 13 largest company spenders alone accounting for half of BERD[2]. Of the 55.5% of France's researchers employed in the private sector, the vast majority (90%) are employed in companies with more than 500 employees. Industrial R&D is clearly the province of large companies. In contrast, the level of absorptive capacity among SMEs appears comparatively low.

As is the case with the R&D, the Community Innovation Survey shows that French industry's investment in innovation activities more generally is low measured against that in other comparable countries. However, the venture capital market is well developed and the number of start-up companies is significant.

3.3 Global Competitiveness, Research and Innovation Performance

France benefits from the presence of world-leading companies in various fields and a number of French high-tech industries are clearly competitive on international markets. It does well in terms of indicators relating to high-tech performance, including employment in high-tech services but overall global competitiveness is good without being outstanding: the Global Competitiveness Report 2006-2007[3], published by the World Economic Forum, ranks France at position 18, immediately after Israel, Canada and Austria. The World Competitiveness Scoreboard 2007[4], published by IMD, ranks France 28, compared to 30 in 2006, directly after Belgium,

1 http://www.insee.fr/fr/ffc/chifcle_fiche.asp?ref_id=NATFPS03306&tab_id=312
2 Expenditure on R&D in the Business Enterprise Sector
3 http://www.weforum.org/en/initiatives/gcp/Global%20Competitiveness%20Report/index.htm
4 http://www.imd.ch/research/publications/wcy/index.cfm?bhcp=1

Chile and India, and according to the European Innovation Scoreboard[5], France belongs - together with the US, the UK, Iceland, Netherlands, Belgium, Austria and Ireland - to the group of 'innovation followers', with scores below those of the 'innovation leaders' but above that of the EU-25 as a whole.

France has a fair record on scientific publications and citations, if showing some relative decline (which has to be viewed against the background of new very dynamic countries appearing on the international scientific stage), but performance on these dimensions is rather average and somewhat weaker than would be expected given the amount France invests in research. French organisations patent comparatively little. France's attractiveness as a destination for Foreign Direct Investment (FDI) has been declining in recent years. FDI is increasingly motivated by the quality of life and of French infrastructure and is attracted to do production rather than R&D.

3.4 Characteristics of Public Research and Innovation Performers

Higher education institutions (universities and *grandes écoles*) and public research organisations perform the bulk of publicly financed research.

Higher education institutions have been set up in all parts of France, in order to widen access to higher education. There are around a hundred universities and 200 schools of higher education, but in practice resources are rather concentrated, especially to the Ile de France and Rhône-Alpes. A characteristic specific to France is the dual tertiary education system – in science, engineering and management - with universities on the one hand and *grandes écoles* on the other. *Grandes écoles* are uniquely French institutions that offer specialised education of a high standard and generally provide excellent career prospects. This high standard is reflected in the strict admission requirements compared with the universities. The *grandes écoles* have historically focused on education rather than research but recent reforms mean their role is expanding into granting PhDs.

France has two categories of public research organisations. There are 9 public institutes for science and technology (EPST), and 15 public institutes with a more industrial and commercial character (EPIC)[6]. The largest EPST is the Centre for Scientific Research (CNRS). With around 25,000 employees (around 11,000 of whom are researchers), it represents nearly a quarter of the total civil R&D budget in France.

In the past, large public institutions like CNRS did basic research rather separately from the universities, but that isolation has diminished through the years, in part through voluntary co-operations with universities. Most EPST research is now performed in 'mixed research units' shared with higher education institutions, or in a minority of cases with industry. Currently, 80% of CNRS staff is located within

5 MERIT and Joint Research Centre of the European Commission, 'European Innovation Scoreboard 2006'. Comparative Analysis of Innovation Performance.' 2006

6 EPICs are financed in part by contract research, services to industry, and royalties from IP. However, shares vary according to agency. The Agency for Environment and Energy Management (ADEME), for instance, is fully funded by government, whereas the Atomic Energy Commission (CEA) gets approximately 30% of its funds from industry

universities, so that the role of the universities in research has been increasing. Universities and *grandes écoles* are now the largest research performers in terms of staff and funds.

EPST researchers have a status equivalent to that of civil servants, i.e. they benefit from full-time, lifetime employment. The same is true for researchers at universities, who, however, have a 50% teaching obligation (hence, they are called *enseignant-chercheurs* or teacher-researchers). In contrast, researchers at the more applied EPICs have contracts similar to those used in the private sector.

Researcher careers are often considered to be unattractive. Owing to the massive increase in student numbers in recent decades, teacher-researchers have had to devote a growing proportion of their time to teaching and managing educational programmes and less time to research. However, recruitment and promotion of teacher-researchers is mainly based on research performance, which often leads to conflict with teaching responsibilities. Unemployment rates among young PhDs range between 7% and 17% depending on the discipline. This, together with the opacity of the recruitment system and the low wages further reduce the attractiveness of a research career.

Science – industry linkages have historically been weak, as can be seen in the small percentage of higher education R&D financed by industry (2.7% in 2004). Institutes like CNRS perform some of the basic research that in other countries is done by the universities. Adding this in, industry funds about 4% of the research in the knowledge infrastructure, which is low by international comparison. This suggests that the large, technologically focused French firms rely more on their own efforts, industry and customers, rather than the knowledge infrastructure, for their knowledge inputs than do their equivalents abroad.

3.5 Innovation and Research Policy

Since the 1999 Innovation and Research Act, successive governments have reorganised the state's part of the innovation and research system. Hence, there has been a series of policy changes relating to research and innovation, which aim to address problems in the research and innovation system. Three issues, on which there is general consensus among policy-makers, drove the reorganisations: a need for more strategic direction of research; the need for excellence; and a continuing drive towards regionalisation and decentralisation.

In 2005, the Government prepared the Pact for Research, an action programme reacting to challenges in the French research and innovation system. It has six objectives, namely to

1 Strengthen organisations' ability to set strategies and define priorities
2 Build a research evaluation system that is unified, coherent and transparent
3 Use synergies and facilitate cooperation among (public) research actors
4 Offer attractive research careers
5 Increase the innovation-orientated linkages between public and private research actors

6 Strengthen the integration of the French research and innovation system into the European Research Area

The Research Act, passed in April 2006, implemented the Pact in law.

The most important recent policy developments are in line with the Pact for Research. Many of the policies not only involve the setting-up of new programmes but also of new agencies, resulting in a number of new structures that have been in place only for a short time. Their effects will not be felt completely until in a few years' time.

- The High Council for Science and Technology (HCST) was set up in 2006 to advise the President of the Republic on science and technology issues, in an effort to improve strategic orientation of the research and innovation system and improve coordination
- In order to concentrate public research resources, to increase research excellence and counteract fragmentation of university research activities, two new regionally based instruments have been designed, namely the Research and Higher Education Clusters (PRES) and the Thematic Advanced Research Networks (RTRA). Both instruments encourage public research actors within a geographical area to engage in joint projects. Participants in the clusters and networks will be given extra resources. The two instruments were introduced in May 2006
- Increasing competition in allocating research funds. Traditionally, in France, public research has been funded through contract mechanisms between the State and the research performing institutions, such as universities and public research organisations. The National Agency for Research (ANR) was created in 2005 to distribute research funds on the basis of projects, thus enhancing competition in the research system. ANR puts out thematic calls for projects according to national priorities, without involving the Ministry of Research in selection of the projects. Currently, competitive funds represent a small share of government R&D spending. The proportion of funds distributed competitively is expected to rise to 20% by 2010, but this remains modest by the standards of some countries
- There is a range of policy instruments aiming to increase private investments in R&D, as the share of GERD funded by French enterprises is comparatively low (50.8% in 2003) and must rise in order to meet the Barcelona Goal, which has been endorsed by the French government. The largest instrument to increase private R&D funding is the Corporate Tax Credit for Research Expenses (CIR) [7]
- The Agency for Industrial Innovation (AII) was set up in 2005 to promote the development of industrial activities in high technology sectors, following the recommendations of the Beffa report, which argued in favour of large-scale structural programmes. The AII's mandate is to identify and select so-called Mobilising Programmes for Industrial Innovation (PMII), contribute to their

[7] With a view to improving competitiveness, an important modification of the Corporate Tax Credit for Research Expenses has been enacted for 2008. The tax base will be extended to all R&D expenditures of a company, with a rate of 30% of R&D expenditures, and the cap of 16 millions euros will be suppressed (cf. Crédit Impôt Recherche – CIR – Projet de loi de finances pour 2008 : budget.gouv.fr). The total budget of Tax Credit is to increase from 1.5 billions euros en 2007 to 2.7 billions euros in 2008

funding, evaluation and regular monitoring. These large-scale programmes for industrial innovation are based on multi-disciplinary research and development, and involve pre-competitive development activities

- The OSEO group was established in 2005 to respond to the problem of fragmentation with regard to innovation support for SMEs. It was created by merging the National Agency for Innovation (ANVAR) and the Bank for Development of SMEs (BDPME). OSEO provides SMEs with support for R&D and innovation projects. With 30 regional offices, OSEO works both at regional and national level, with contacts with firms mostly occurring in regional offices. Its main instruments are subsidies, loans and advice. [8]
- Among the many policies targeted at higher education are various initiatives to make scientific careers more attractive. According to the Research Pact, research careers are to be made more attractive by upgrading and improving the doctorate, by facilitating the entry of doctors into research careers and by diversifying the career options of researchers and teacher-researchers. This includes, for example, an increase in the value of PhD fellowships, so that PhD students will be paid better
- Given the traditionally weak science-industry linkages, there is a range of policy instruments seeking to increase the commercialisation of public sector research. These include strengthening collaboration between private and public research and innovation actors, promoting business creation, in particular spin-offs from public research, and encouraging the mobility of researchers, particularly to SMEs
- Introducing systematic, coherent, transparent and independent evaluation: In April 2007, the Agency for the Evaluation of Research and Higher Education (AERES) was established. Its task consists of assessing research institutions and research activities performed by research units, of evaluating curricula and diplomas of higher education institutions, and of validating the procedures of appraisal used for staff in research institutions. Formerly, evaluation was assigned to different organisations, some dedicated to a single research organisation, others to one discipline or technological area, leading to a fragmented evaluation system

4 Observations and Findings on the French Research and Innovation System

4.1 Introduction

Generally speaking, the peers were impressed by the development of the French research and innovation system and the measures that have been put in place to support research, technological development and innovation (RTDI). There was a particularly positive response to

- The importance attached to research and innovation policy and the genuine readiness for reform among policy-makers and stakeholders
- The problem-awareness among policy-makers and stakeholders

[8] With a view to clarifying the organisation of innovation funding and to reinforce public support to large SMEs, the French Government has decided to merge the two main funding agencies dedicated to innovation in 2008: OSEO and the Agency for Industrial Innovation (AII)

- The well-developed system for public funding of research
- The wide variety of instruments in place to tackle the various challenges in the research and innovation system, among them the introduction of project-based funding by establishing ANR; the founding of business-led and regionally anchored Competitiveness Clusters; SME support provided by OSEO

The peers also made a number of observations, which might warrant further attention from French policy-makers and stakeholders. For instance, they were concerned at the rather 'average' scientific performance of the system as a whole, while underlining France's continuing status as scientific and technological superpower. France is still very visible on the global scientific and technological scene, but the peers had a feeling it may be present there mainly due to its size and resources and the existence of a number of significant 'peak performers' rather than because average performance is as good as it should be.

In principle, the research and innovation system seems to be designed in accordance with international practice. The universities and the large research organisations (EPST) focus on basic research and scientific excellence, while the more applied research institutes (EPIC) focus on research closer to the market. However, important issues include: governance; the Universities and Public Research Institutes; industry-science linkages; human resources; and the spatial and international dimensions.

Overall, our impression is that France is working to adjust its research and innovation institutions and governance to important changes in circumstances, notably: globalisation; the growing science- and knowledge-intensity of production and consumption; and the changed role of the state in technological development, in a world where the close state-sponsored customer-supplier 'development pairs' of the past are frowned on by international regulation and where many markets have become so large that a single state can no longer determine what the dominant designs will be. Reacting to these changed circumstances necessarily involves overcoming a number of lock-ins and rigidities in governance and institutions.

4.2 Governance of the State's Overall Role in the Research and Innovations System

Increasingly, following the Finnish model, countries tend to try to create a high-level arena where research and innovation policy is discussed and set in such a way that it addresses overriding national, as opposed to ministry, interests. The ambition is to make policy that is 'joined up' across different sectors of society or that is 'holistic'. In the Finnish example, this involves setting broad directions rather than specifying policy in detail. A key to success is to lift debates to a sufficiently high level that decisions are generally adhered too, and this tends to mean that the prime minister needs to be involved.

France has several high-level advisory bodies. The fact that the CIRST, which coordinates the ministries and is chaired by the Prime Minister, has not met since 1999 appears to be behind the creation last year of the High Council for Science for Science and Technology (HCST). With its reporting line to the President, it has the potential to exercise significant influence but its composition suggests that its primary focus will be on the research base. However, since the Strategy Division of

the Ministry Delegate for Higher Education and Research acts as the secretariat of the HCST, it is likely not to have the full support of other Ministries and Ministers. France therefore appears not to have an effective high-level arena that looks at the policy mix as a whole, despite a number of attempts to create one, and this accounts for the lack of clear strategic direction in the state's part of the research and innovation system. One consequence is a degree of rigidity, as there is no ultimate 'referee' who can resolve disputes and who has the authority to clear lock-ins. A further implication is that it is difficult to develop a national strategy on issues such as the best way for France to exploit the EU R&D opportunities.

While we observed nothing but good will between the Industry and Education and Research Ministries, this weakness of governance at a higher level has far-reaching consequences (mostly negative) in the overall ability to develop a coherent strategy for national research and innovation policy. This issue extends beyond the spheres of the Industry and Education and Research Ministries to include fiscal, employment and foreign policies, among others. While officials indicate that they are able to achieve a measure of coordination, there is little evidence that this can lead to radical changes of direction. Indeed, foreign experience is that it does not tend to do so. There is also no evidence that there is effective coordination at the agency level.

In summary, there seems to be a problem of leadership (in the sense of setting overall directions) as well as of horizontal coordination, with the two problems appearing to be linked.

4.3 The University System

The Higher Education system is in the process of significant reform. New instruments have been introduced to cluster universities on a regional basis, reducing fragmentation. Cities often contain several institutions, often specialised and thus with a limited disciplinary reach and limitations on delivering cross-disciplinary research and teaching. Policy initiatives such as PRES designed to encourage closer working between actors in the tertiary education system can be seen as attempts to embed and support such collaboration more widely across geographic areas. PRES is a valuable tool to overcome the fragmentation and the dualism of the French higher education system (*grandes écoles* and universities) but very little more can be done without more substantial autonomy, which allows universities to develop independent strategies. In governance terms, PRES represents not only a clustering policy that is useful at national level but also an interesting potential link with the regions. This regional dimension probably needs further development to exploit its potential benefits.

Relations between the Universities and the Ministry have been progressively 'contractualised' starting from 1984 (Act on University). Following the LOLF law on public management performance (2005), more New Public Management-oriented contracts containing objectives and performance indicators were established, increasing universities' autonomy to some extent, although their freedom in hiring and firing, pay and staffing levels remained limited.[9]

[9] A new law aiming at increasing the autonomy of universities was passed by Parliament on 10th August 2007 (*loi relative aux libertés et responsabilités des universités*) , the main features of which are: board of administration more open to external stakeholders and with extended

Several factors therefore continue to limit the autonomy of the universities and to hamper their ability to change strategy, so as to be proactive in a changing environment.

- Their inability fully to manage their own human resources, for example by bidding big salaries to attract high fliers (as increasing numbers of universities elsewhere can do)
- Their internal governance structures continue to involve limited participation by external stakeholders
- Presidents are internally elected, so they are constrained by the interests of their constituencies rather than of the University or society
- The very high ratio of block funding to competitive project funding means there is too little external pressure on quality or relevance through the research funding system
- While the EPRIs, notably CNRS, have become much more integrated with the Higher Education system than in the past, the fact that they have their own managements setting priorities and allocating resources, their own IPR and commercialisation policies and so on, mean that it is complex to integrate their activities into university strategies (and vice versa, of course)

As a result, there is limited evidence that universities are becoming as 'entrepreneurial' in adjusting to social and economic needs as those in some other countries.

The limitations on the University system described here are also likely to provide at least a partial explanation of the rather 'average' performance of the research system in terms of publications and citations and they make it difficult for the Universities to respond adequately to changing needs.

4.4 Public Research Organisations

The national research organisations, like CNRS, INRA (National Institute for Agricultural Research) or INRIA (National Institute for Research in Computer Science and Control), conclude performance contracts with the Ministry of Research establishing objectives and expected results for their activities. As with universities, the government maintains tight control over the big public research organisations, mainly through restrictions concerning the status of staff and the allocation of posts. This naturally limits their ability to attract excellent researchers and to adapt to changing research needs. As a result, the impression was that public research organisations continue to have a high degree of inertia.

The applied EPICs are considerably more autonomous of the state than the more fundamental EPSTs and therefore better able to adapt their strategies and work to social and economic needs. INRIA has clearly managed to react better to the new

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responsibilities; President elected by the board for a four-year period, renewable; larger responsibilities of the institution in terms of finance, human resources, appointment of faculty members, repartition of time dedicated to teaching, research and administration, real estate; higher public funding in 2008

challenges (increased funding from external sources, increased technology transfer) than INRA. The smaller size of INRIA (10% of the size of INRA in terms of personnel) and its comparatively larger budget (15% of INRA in terms of budget) may be a clear advantage in this respect.

As in the universities, the ratio of block funding to competitive project funding in the EPSTs is very high, providing too little competitive pressure on performance and probably contributing to the modest performance of the knowledge infrastructure, measured by publications. The difficulties caused by institutional separation between, especially, CNRS and the universities were referred to in the previous section: weak strategic coordination; inflexibility; and incompatibilities in commercialisation activities

Most countries have split the functions between funding and priority-setting organisations on the one hand and research performing institutions on the other. This has the effect of increasing competition and quality by substituting project funding for block funding of research performers and reducing the internal pressures to set priorities that reflect the interests of the research performers, rather than those of society or science as a whole. In France, in contrast, the functions of priority setting and research performance largely remain combined in public research organisations.

4.5 Industry-Science Linkages

The low degree of involvement interaction between industry and the knowledge infrastructure is of concern because of the growing science intensity of production and innovation. Internationally, the links between large companies and the knowledge infrastructure are strengthening as a result, and France is lagging behind.

Several new instruments aim to improve science-industry contacts. The Carnot Institute scheme was very much appreciated. Carnot institutes are supposed to be the French counterpart of the German Fraunhofer institutes. However, the level of industrial funding that qualifies institutes to be considered for Carnot status is only 10%, which is low compared with equivalents abroad. In general, Carnot institutes have 10-40% private income.

OSEO also gave a very positive impression. It provides a continuum of support to SMEs and new start up companies along the innovation chain. OSEO gives out both grants and soft loans. However, budget limitations mean that 80% of OSEO's financing is soft loans. Using this instrument means that OSEO has to focus strongly on success factors. Subsidies are used for very small projects and for project initiation, maximising the number of projects that can be supported. OSEO is aiming at a more balanced mix of loans and grants in future.

The impression gained was that the 71 Competitive Clusters are performing well. The clusters are business-driven and led by company networks, although R&D partners also participate, and have well-developed activities and a strong budget. They bring small and large companies together. The selected clusters seem to be based on already strong (regional) concentrations of companies and competences.

With regard to commercialisation of research in universities and the large research organisations, the creation of spin-offs seems to be well supported by a well functioning incubator system. Figures show that France is doing very well in this respect.

However, the high block funding of the large research organisations (e.g. CRNS, INRIA, INRA) by the state gives weak incentives for cooperation and interaction with industry and society. The peers had the impression – which may be wrong – that the applied research organisations are not perceived as an important part of the research and innovations system and that industrial needs remain a distant concern of the science system. Feedback loops for stimulating leading researchers in universities and large research organisations to be inspired by challenges and knowledge needs in industry and society were not clearly seen. The research system could therefore be considered to be push-driven, in comparison with systems elsewhere. Correspondingly, we did not see, for example, TEKES-style technology programmes aimed across industry and academia to develop complementary capabilities or competence centres. Another part of the policy mix where the peers heard relatively little was in the use of instruments to stimulate the demand for innovation, such as the use of regulation or public procurement, in which there are still opportunities despite the demise of the former style of 'grands projets'.

4.6 Human Resources

It appears that the *grandes écoles* tend to attract and select the most able and highly qualified students, at least in some key disciplines, with the remainder entering the university system. Some anxiety about the quality of the education being provided to university students was expressed during the review: there was concern that, while universities as a whole were required to take all students meeting the entry qualification, funding had not increased in line with the number of students. We were told that, of an estimated 700,000 inflow per year, about 100,000 drop out and about 100,000 fail to find a graduate-level job. This represents an unfortunate degree of inefficiency in the education system.

Employers present at the review expressed concerns about the skills and aptitudes of graduates. Specific concerns were expressed about PhDs: it was often unclear to potential industry employers what PhD students had been taught and assessed against; for example, their knowledge of IP or the process of commercialization as against the specific expertise in their research field. As a result, most companies hesitate to employ PhDs. This quite unique situation may be rendered even more complicated by the fact that the *grandes écoles* are beginning to issue PhDs as well. Indeed, there is reason to believe that employers will prefer to employ doctors with a PhD from a *grande école*. In general, industry representatives are concerned that PhD education produces people with too few general skills (like project management skills, presentation skills, writing skills) and too little understanding of industry.

Regulations and governance structures in universities and public research organisations obviously have impacts on human resources. For instance, they may act both as a deterrent to hiring new staff on permanent contracts – and thus explain the large number of researchers on temporary employment contracts in the EPICs – and as a disincentive for permanent researchers to move on. There are also concerns

about the large proportion of staff in the knowledge infrastructure who were aged 50 and above – although this is partly a broader demographic issue faced to some extent by many Western European countries. The barriers to reallocating resources may also at the margin act as a disincentive for cross-disciplinary collaboration. The lack of flexibility over salaries also may be a barrier to the recruitment of the best researchers, especially from overseas.

What is more, the relatively rigid systems of recruitment and promotion in universities and most research organisations provide little encouragement to students to pursue a scientific career. Nor do they encourage the best researchers. A consequence of this rigidity is a lack of mobility within the public system; at the same time, the risk is that French researchers look for faster progression overseas. The Ministry of Research has responded by offering additional financial support for the best junior researchers.

Given the present incentive systems, the best researchers are likely to seek posts in public research organisations: the terms and conditions are identical to those at universities but members of public research organisations' staff do not have the requirement to spend half of their time teaching. Combined with the fragmented nature of the French university system and the limited incentives offered for better performance – and virtual impossibility of radical action to tackle poor performance – the scope to manage the universities towards high and consistent quality may be limited.

In the past, one way of attempting to introduce some flexibility and change into the system has been to increase the number of researcher posts over and above replacing retirements. In fact, another 3,000 researcher posts are planned. However, there must be limits to this as a policy response because of affordability. A system that includes negative as well as positive incentives will probably be needed.

Manpower mobility, which is crucial both to university performance and to the movement of knowledge and capability among different parts of the research and innovation system, seems also to be limited. Transfer of trained researchers between public and private sectors seems to be rare, with just 0.2% of researchers per year in the publicly funded system leaving to join industry (although 55% of researchers are employed in business). This is despite a strong perception that salaries for researchers in the public sector trail well behind those in the private sector. Increased mobility rates are needed if the research and innovation system is to function well.

4.7 Regions, EU and Internationalisation

The regions contribute a relatively small proportion of the funding for R&D (4%), but the political ambition is that they should play a more important role in the governance of RTDI in France. Their influence was described as being substantial in facilitating or providing leadership to locally based collaborations. Indeed, instruments like PRES, RTRA and the Competitiveness Clusters are outstanding signs that the partnership between central government, stakeholders and regions may bring major benefits. Nonetheless, we gained an impression that regionalisation is not yet part of central government culture, with many government officials failing to

distinguish between territorial delegations of central governmental instances and regional agencies with genuine authority.

Typically, regions perceive Europe as a playground of choice allowing them to show that they can develop their full potential. Indeed, many French regions are active participants in European projects, where they are eager to show they can be first-line players in supporting research and innovation.

France scores well in its participation in the Framework Programmes, which shows that the quality of the best French research teams is good by European standards. The government attaches high importance to the participation of France in the Framework Programme, seeking the wider and often intangible benefits of participation rather than worrying too much about obtaining a *juste retour* in money terms. However, as in many other countries, there is little explicit consideration of the strategic role of EU funds in national research and innovation policy.

It appeared to be difficult to link wider research and innovation internationalisation efforts to the national and European level, in part because bilateral international research agreements are on the 'turf' of the Foreign Ministry and there is no effective way to build a common strategy between that Ministry and other parts of the system. Fortunately, the large research organisations have their own international units, which are autonomous of the Ministries and can therefore pursue their own policies and priorities.

Overall, our impression is that research and innovation policy at the regional, national and international levels would benefit from being more closely 'joined up' and that the limits to coherence among these resulted from an insufficiently 'joined up' governance system.

4.8 Evaluation and Policy Learning

The recent establishment of AERES is a response to the previously fragmented, unsystematic and not very transparent evaluation system. Its purpose is not only to evaluate research institutes and higher education institutions, but also to *evaluate the evaluators*, e.g. the ANR, and the *procedures of evaluation* in the above institutions. Interestingly, the *evaluation of curricula and diplomas* of higher education institutions is included among the main objectives. This should be viewed in light of the general distrust of PhD diplomas and statements of high-level politicians that "the value of the PhD has to be re-established" relative to the high value that is given to diplomas from the *grandes écoles*. The high expectations that are associated with the establishment of AERES are also reflected in its independent status relative to the Ministry.

AERES is to strengthen the assessment of the scientific quality of the public research base. The tools used to monitor and promote quality in other countries (e.g. use of international experts, peer review, etc) are also present in France and have been used for some time (e.g. in research organisations). What is less clear is the strength of the feedback loops into policy and funding decisions, for example the extent to which a given rating for research performance feeds through into universities' and public research organisations' funding allocation. If in future the amount of public

funding will depend on the results of an evaluation, this would, together with more project-based funding, contribute to increasing performance of the public research base and the research and innovation system as a whole.

In terms of more formal post-programme evaluation, France clearly has the analytical capability. However, there appears little evidence of systematic **policy** evaluation. The programme of research carried out to analyse the impact of the R&D Tax Credit is a good example of such evaluation that could usefully be applied to other areas. Also, the proposal to set up an observatory of innovative companies seems very interesting. Nevertheless, there is in general a need for a more structured approach both to policy evaluation and its links to future design. New initiatives at present seem to arise from one-off and/or independent exercises, such as the Beffa report, rather than internal policy improvement disciplines.

5 Recommendations for the French Research and Innovation System

5.1 Overall system

The strong central control that in the past enabled French leadership in many areas of science and technology now brings few advantages because the needs of the research and innovation system have changed. With the disappearance of the close producer-user relations of the past that enabled the state to drive innovation in industries where it was the major customer (e.g. telecommunications, aerospace) the innovation system requires much more flexibility and capacity to adapt to new challenges. Facing globalisation challenges will require more in-depth reflection on the different roles of the French actors: government, research and innovation agencies, research organisations, universities and *grandes écoles* and their respective relationships with large companies and, most importantly, SMEs. New instruments favouring concentration and critical mass are moving in the right direction, but a larger degree of flexibility and, therefore, autonomy is required.

Taking into account the long traditions, human and other resources, size and potential of the country, the peers feel that France ought to have very ambitious objectives to be among the best performing countries in the EU and among the global innovation leaders in the medium term.

Although total government funding for R&D is around 1%, funding of civil research is only 0.6%, i.e. on an internationally low level. The need to increase funding of civil research is clear. Despite the large absolute size of the French R&D budget, sooner or later a choice may have to be made as to what disciplines and areas to support, and a stronger governance system will be needed in order to make and enforce such choices.

5.2 Governance

The model of two powerful and committed ministries (Education and Research and Industry) sharing responsibility for much of research and innovation policy and working in partnership is practicable provided there is commitment and understanding of roles among the two, as well as coordination with other ministries and relevant stakeholders. In order to improve these, France needs a functioning, high-level policy arena above the level of individual ministries that also obtains inputs from wider stakeholders, and a consistent government commitment to the importance of research and innovation policy. Building upon the strength of national analytic and foresight capabilities to build a stronger national vision for research and innovation policy would be a useful way to mark the transition to 'doing business' in a new way that is adapted to current needs and that helps policy escape past trajectories that are no longer relevant.

5.3 Universities

The readiness for reform in higher education and the research and innovation system in France is genuine and not only limited to government. It is being approached carefully and slowly, which in the long run may be more efficient than fast but not thoroughly thought-through changes. However, it needs to be based on a general consensus that central authority and regulation have to be reduced in favour of more

decentralised responsibility and more competitiveness and it is not clear that such a consensus has yet been reached.

In a more mid to long-term perspective, the higher education system should be provided with the appropriate autonomy to develop its own strategy, while using programmatic funding to provide incentives for the universities to work in ways consistent with national policy. Empowering university management and engaging more external stakeholders in governance structures are requirements for the universities to have a more effective role. As a more immediate response to human resource problems, flexibility should be introduced in the proportion of their time that faculty members are required to dedicate to teaching and research respectively.

Changes in the funding system that reward excellence are prerequisites for a higher degree of efficiency and productivity. In particular, the proportion of competitive research funding needs to be increased over time beyond the 20% already envisaged for 2010.

5.4 Public Research Organisations

As with the Universities, the EPSTs are over-controlled from the centre and need greater autonomy at the level of research performance. Other countries tend to achieve this by separating the priority setting and research performance functions, which largely remain combined in the EPICs. For reasons both of quality and relevance of research, policymakers should consider reducing the proportion of block funding to the public research organisations, thereby exposing them to both competitive pressure and to social and economic needs expressed through R&D markets.

There are important issues of coordination between the public research organisations and the universities. In France, as in most countries, these are cohabiting more closely – certainly at the level of the CNRS and the Universities. They could probably benefit from a more coordinated approach to strategy and intellectual property rights at campus level.

In order to alleviate the transition from the present contracting regime to a more project-based regime, a feasibility study could be commissioned that explores the possibility of an independent funding council model, perhaps aligned with AERES.

5.5 Science – Industry Linkages

The policy mix contains a good number of instruments that address commercialisation of discoveries and support (especially smaller) firms' innovation capacity and activities. It needs further strengthening via instruments that promote active research collaboration between industry and the knowledge infrastructure.

The competitive part of funding for universities and large research organisations ought to be further increased, in order to stimulate universities and the large research organisations to become more interactive and entrepreneurial partners in the future knowledge-based society. In addition to scientific excellence, criteria for allocation of research funds should, at least in some instances, include relevance and interaction with industry and society – an increasingly important task for universities and research organisations in the knowledge-based economy. This is especially

important for the large research organisations. The planned assessments of research units and organisations by AERES will certainly be valuable in this respect.

A system for a peer review-based assessment of the performance of universities and research organisations in their third-stream activities, including utilisation and commercialisation of research results, should be implemented. Such an assessment system has been developed within CREST/OMC in Brussels.

Financial restrictions, which affect the balance between loans and grants at OSEO, should be removed, so that OSEO can take on more risk. Grants ought to be increased, especially to fund the first initial phase of commercialisation, which contains verification of commercial potential and technical performance and forms the basis for determining the choice of strategy for commercialisation. The need to recover the bulk of the money it invests through loans means that OSEO has incentives to follow the low-risk policies normally adopted by banks – something the private sector already does. More emphasis is probably needed on increasing firms' absorptive capacity, in parallel with efforts like those of OSEO that help companies use the innovative capacities they already possess.

The introduction of project-based funding via ANR is welcome, as a way to encourage science-industry cooperation, and we were happy to see the high level of support for the ANR among stakeholders. However, yet more needs to be done to build bridges between the knowledge infrastructure and large companies. For example, competence centre schemes exist in many countries, comprising long-term arrangements for active research cooperation between the knowledge infrastructure and industrial consortia and above all a stronger involvement in university research by leading researchers from industry and society. The selection of competence centres in these schemes is based on both scientific and relevance criteria. The model could be very useful in France, as a further mechanism for building science-industry linkages, and especially in engaging industry in longer-term research.

Finally, Competitive Clusters could usefully be extended to emerging, **research-based** clusters, where universities and research organisations would take a more leading role and where government support would be vital. This would further tend to integrate the work of the knowledge infrastructure with industrial needs and developments.

5.6 Human resources

From several perspectives, it is important that decisions about the employment and management of human resources are devolved from the central state to the knowledge infrastructure institutions themselves. Human resource issues block progress towards higher quality, increased relevance and effective research strategies across the knowledge infrastructure.

Given historical low levels of mobility among institutions – and especially between industry and the knowledge infrastructure – specific measures to encourage mobility are probably needed, at least for a transitional period.

Creating competence centres and other instruments that link industrial and knowledge infrastructural research will tend to increase the industrial usefulness of freshly graduated PhDs. Some countries, including the UK and Ireland, have taken steps to include course modules that develop industrially relevant knowledge and skills (for example, about intellectual property, commercialisation and project management) into PhDs. France might usefully follow this lead, in order to address the industrial complaints documented earlier.

5.7 Regions, EU and Internationalisation

If increasing the regions' role in managing the research and innovation system is a real policy objective, then the government should de-centralise more programmes, in order to deploy the potential of regions, while at the same time avoiding the 'fractalisation' of programmes (i.e. reproduction at lower scale of the same policies and programmes). Specialisation in specific roles will be needed. For example, basic research, including ANR and the research organisations, could be the responsibility of the central government, while the regions could play a stronger role in innovation promotion and innovation programmes. More generally, measures taken at regional, national and European levels need strong coordination.

France should also be more pro-active and aggressive in fostering the participation of the national research system in the EU Framework Programme. It should consider European funds as part of the domestic RTDI budget, and not simply as additional funds.

Finally, there is no denying that internationalisation of the French research and innovation system is a state priority. The Ministry of Foreign Affairs should be sensitive to this need by giving leadership to the Ministry of Research in matters of research, with necessary supervision. This would constitute a policy-mix approach, and avoid the current compartmentalisation of responsibilities.

5.8 Evaluation and policy learning

In order to learn from previous policies, it would be worthwhile putting in place procedures that link policy evaluation to policy design and formulation. AERES and Futuris could play useful roles in this activity, which should ideally be orchestrated at a national level. This is a further area in which the absence of a national policy arena makes itself felt, as this would provide a natural high-level focus for such policy learning.

6 Lessons for other countries

The peers took a number of lessons home to their own countries from France

- The commitment to science and innovation policy in France is exemplary Policymakers, high-level officials and stakeholders have clearly recognised the vital role science, technology and innovation play in underpinning future economic growth
- Similarly, French commitment to reform the national science and innovation system is strong. There clearly exists an excellent analytical capability to

analyse the science and innovation system and to pinpoint its problems. This is true not only for specialised organisations or programmes like Futuris but also for various other stakeholders. Other countries would gain if they maintained such a high level of analytical capability in this field

- Spin-offs from the knowledge infrastructure have been a success story since the beginning of the decade. This success story has been made possible by an excellent and coherent support infrastructure, involving a very broad policy mix, ranging from measures to raise awareness, tax incentives to OSEO support for newly founded firms to a network of regionally anchored incubators. This support infrastructure could provide inspiration for all the countries, in particular Spain
- Industry-led and regionally anchored Competitiveness Clusters link large firms, SME, universities and research institutes and underline and promote regional strengths. This is a model of interest to all countries concerned. The same is true for OSEO's measure linking small and large companies ('Pact PME')
- Establishing a coherent, transparent system of evaluation, organised by the newly founded organisation AERES, is seen with interest in Spain and Slovenia
- France has one of the highest level of S&E graduates in Europe. Most other European countries, including Spain, Slovenia, and Sweden, complain about a lack of interest and competence for mathematics and science already in school, which then translates into low levels of S&E graduates. The way France sustains interest in science and maths among pupils and students would be insightful for most European countries

There are also issues where an exchange of experience and collaboration would be welcome

- The subject of regionalisation and decentralisation in research and innovation policy is relevant in the UK and Spain as well
- Horizontal coordination of innovation policy between government departments and agencies is pertinent in the UK, Slovenia and Sweden as well
- Insufficient levels of business R&D are topical in the UK and Spain. It is an issue in Sweden as well, insofar as business R&D investments in large companies have been falling the last couple of years (although from a high level), and insofar as business R&D investments in small companies are far too low
- Strengthening linkages between the knowledge infrastructure and businesses is an issue in the UK, Spain, Slovenia and Sweden as well. In the UK, one major challenge in the governance system is that business-university engagement remains inconsistent across industries and regions. In Spain, the business community is failing to take advantage of the technology generated by public research centres
- The development of appropriate policies to address non-technological innovation and service innovations are an issue particularly in the UK, in Spain, in Sweden and in Slovenia

- In Spain, since 1995, fiscal incentives for R&D and innovation are considered one of the most important measures for promoting technological innovation in enterprises

ANNEX A

Programme of Policy Mix Review for France

Thursday 26 April 2007 – Friday 27 April 2007

Date/Time	Location	Focus	Participants
Wednesday 25th in the evening	Paris		Arrival in Paris of the Review team, consultant and European commission representative
Thursday April 26th 2007 8h30–9h30	Ministry for higher education and research - *Bâtiment Boncourt 21, rue Descartes 75005 Paris* **Salle B 109, 1st floor**	Team briefing	Review team and consultant
9h30-10h30 SESSION 1	Salle B 109	Science and innovation policies in France	Review team and Mr Gilles Bloch, Director general for research and innovation (DGRI)
10h30-11h TEA/COFFEE BREAK			
11h-12h SESSION 2	Salle B 109	Missions and Programmes of the National research agency (ANR)	Review team and Mrs Jacqueline Lecourtier, Director general of the ANR
12h-13h SESSION 3	Salle B 109	Competitiveness clusters, roadmaps for innovation, Agency for industrial innovation (AII), intellectual property and patents, etc.	Review team and Mrs Agnès Arcier, Deputy director general for competitiveness and innovation policies, Ministry of economy, finance and industry and Mr Jacques Magen, Head of the international department of the AII
13h-14h LUNCH	Lunch bag catering	Direction of strategy	Review team hosted by Mr Jacques Serris, Deputy director for strategy and Rémi Barré,

			Director of the foresight department, ministry for higher education and research
14h-15h **SESSION 4**	Salle B 109	Human resources	Mr Stéphane Demarquette, R&D human resources from l'Oréal and President of the executive committee of the Association *Bernard-Gregory* ; Mr Philippe Casella, Deputy director for humanities and social sciences, ministry for higher education and research ; Mrs Michèle Postel, Human resources department (National centre for scientific research – CNRS)
15h-16h **SESSION 5**	Salle B 109	Higher education policy in France : funding processes, research and higher education clusters (PRES), doctors training, etc.	Review team and Mr Eric Froment, General directorate for higher education (DGES) ; Mr Thierry Coulhon, Vice-President, Conference of university presidents ; Mr Gilbert Casamatta, President, Toulouse National institute for Technology (INPT) – PRES
16h-16h30 **TEA/COFFEE BREAK**			
16h-30-18h **SESSION 6**	Salle B 109	Industrial research and development (R&D) in France	Review team and Mrs Frédérique Sachwald, Head of industrial R&D unit, Innovation and regional action department (DGRI)
20h **DINNER**			Review team hosted by Gilles Bloch, Director general for research and innovation

Friday April 27th 2007 **9h-10h** **SESSION 7**	Salle B 109	Creation and development of innovative SME's, industrial innovation - OSEO-ANVAR	Review team, Mrs Catherine Larrieu, director of innovation and M. Thomas, Head of Incuballiance, an incubator/hatchery based in the south of Paris
10h-11h **SESSION 8**	Salle B 109	Evolution of the French Research and Innovation System and public/private parterships	Mr Denis Randet, Executive associate president of the National association for research and technology (ANRT) and Mr Laurent Buisson, Head of the service for innovation and regional policy (DGRI)
11h-11h30 **TEA/COFFEE BREAK**	Salle B 109		
11h30-12h30 **SESSION 9**	Salle B 109	Research institutions : the cases of the National institute for agricultural research (INRA) and of the National institute for research computer science and control *futurs* (INRIA) : strategies and contractualisation	Review team, Mr Guy Riba, Deputy director general of INRA
12h30-14h30 **WORKING LUNCH** **SESSION 10**	Salle bleue Bag catering	New tools for local cooperation : competitive clusters, Advanced networks for thematic research (RTRA) and research and higher education clusters (PRES)	Review team and Mr Alain Bravo, General director, Ecole supérieure d'électricité (to be confirmed) ; Maurice Robin, Associate general director for research, Ecole polytechnique ; Claude Puech, Director of INRIA *Futurs* ; Bertrand Demotes-Mainard, CEO Thales Research and Technology France ; David Adams, Vice-president for research, Paris-Sud university ; Laurent Buisson Head of the service for innovation and

			regional policy (DGRI)
14h30-15h30 **SESSION 11**	Salle B 109	European and international policy	Mrs Laure Reinhart, Director of strategy
15h30-16h TEA/COFFEE BREAK			
16h-17h	Salle B 109	Debriefing. Discussion of the Report	Review team and consultant

ANNEX B

CREST 3% OMC Third Cycle Policy Mix Peer Review

Background Report France

May 2007

Updated version after feedback mission

Erik Arnold
Technopolis Group

This report was prepared on behalf of the ERAWATCH ASBL as part of the IPTS support to the CREST 3% OMC Policy Mix Peer Reviews
(Specific Contract No. C150176.XII)

Contents

1 Introduction

1.1 The French system of research and education

1.1.1 Preliminaries

The French system has been described as a 'research and innovation system' to account for the specific place of research in the way it is organised. The shape of the French research and innovation system is the result of post-war developments, when technologies required for key industries were a top priority, state-run companies played a key role in technical research, there was strong economic growth, strong support for technical progress in public opinion, a strong career interest in the research sector and limited exchange with the outside world.

The 1982 Research Act *(Loi d'orientation et de programmation du 15 Juillet 1982)* formalised many current features of the state's part of the system, for example by defining the structure of the public research institutes. Recently, the French public research sector has been undergoing radical change. Since the 1999 Innovation and Research Act *(Loi sur l'Innovation et la Recherche)*, successive governments have enthusiastically reorganised the state's part of the innovation and research system (see Box 1) without there being a clearly stated overall vision or strategy. Three issues, on which there is general consensus among policy-makers, drove the reorganisations

- A need for more strategic direction of research
- The need for excellence
- A continuing drive towards regionalisation and decentralisation

Box 1: Recent Events in Research and Innovation Policy

1999 Innovation Act. Created a legal framework more favourable to cooperation between public and private research and to the creation of start-ups by researchers.

2003 Innovation Plan. Benchmarked French R&D expenditures vis-à-vis the largest industrialised countries, identified the main weaknesses of the French research system regarding R&D expenditures, and suggested appropriate research and innovation policies to overcome these weaknesses and increase R&D expenditures.

2005 Pact for Research. Action programme formulated by government to restore French competitiveness.

2006 Research Act. The legislative part of Pact for Research provides measures to enforce strategic orientation abilities, new tools to encourage cooperation between institutions of research and higher education, a renewal of evaluation procedures and innovation support structures.

1.1.2 Public Research Institutes

Public research institutes in France are divided into two categories: public institutes for science and technology *(Etablissements publics à caractère scientifique et*

technologique - EPST), and public institutes with a more industrial and commercial character (*Etablissements publics à caractère industriel et commercial - EPIC*) [10]. The main EPST is the Centre for Scientific Research *(Centre national de recherche scientifique – CNRS)*. With around 25,000 employees (around 11,000 of whom are researchers), CNRS is currently France's (and Europe's) biggest public research institute and represents nearly a quarter of the total civil R&D budget in France.

A French particularity relates to the status of researchers. The 1982 Research Act gave researchers in EPST a status equivalent to that of civil servants, i.e. they benefit from full-time, lifetime employment. Research at public research institutes is funded mainly through block grants. Project-based funding is (as yet) marginal. Each public research institute agrees objectives with the Ministry of Research and Higher Education via four-yearly performance contracts.

In the past, large public institutions like CNRS did basic research rather separately from the universities, but that isolation has diminished through the years, in part through voluntary cooperations with universities. Most EPST research is now performed in 'mixed research units' *(unités mixtes de recherche – UMR)* shared with higher education institutions, or in a minority of cases with industry. Currently, 80% of CNRS staff is located within universities, so that the role of the universities in research has been increasing.

An important corollary of the way French public research has been organised is that science - industry linkages have been poor. Industrial research is mainly carried out by big companies, which were in the past favoured in research and innovation policy over SMEs. Past policy often focused on customer-supplier relations and major innovation in infrastructural industries, rather that promoting links between industry and the knowledge infrastructure. In recent years, French innovation policy has become more 'bottom-up' and links between the different players in the research and innovation system have been strengthened, especially between public and private research.[11]

1.1.3 'Large programmes'

Public research organisations traditionally were strong pillars in the so-called 'large programmes' funded and run by the government. Coupled with the large public research organisations and state-owned firms in domains such as aerospace and aircraft, nuclear energy and ICT (and on occasion in co-operation with other European partners) these highly-centralised programmes used to absorb most of the French public research budget from the 1950s to the 1980s.

Indeed, some of the French innovation system's major strengths have been built upon tight relations between the state and suppliers to infrastructure industries: nuclear power; aerospace; vehicles; and telecommunications. As in other countries,

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10 EPIC are financed in part by contract research, services to industry, and royalties from IP. However, shares vary according to agency. The Agency for Environment and Energy Management *(Agence pour l'environment et la maîtrise de l'énergie)*, for instance, is fully funded by government, whereas the Atomic Energy Commission *(Commissariat à l'énergie atomique)* gets approximately 30% of its funds from industry

11 Philippe Mustar and Philippe Larédo, 'Innovation and research policy in France (1980-2000) or the disappearance of the Colbertist state', *Research Policy*, 31 (2002), pp55-72

changes in trade and competition rules and globalisation have undermined this traditional approach.

By the 1990s French innovation performance measured by traditional indicators such as patenting and markets shares was in decline. Against a background of liberalisation, privatisation and associated changes in markets that used to be state strongholds, the French government started to see its traditional technology policy, with its strong focus on large public research organisations and large industrial companies, as increasingly problematic. Indeed, one of the most influential changes taking place since the 1990s concerns the almost complete disappearance of the traditional 'large programmes'.

1.1.4 Higher Education Institutions

The most important research performers in terms of staff and funds are the universities and the schools of higher education ('*grandes écoles')*, many of which are engineering schools. There are more than 3000 research units in universities, of which roughly 1500 are mixed units financed by the university and by the public research organisations. In 2005, the budget allocation for universities in the Inter-ministerial mission for research and higher education (MIRES) was 3.15 bn€ (public expenditure for salaries: 2.77 bn€ plus public running costs: 376 m€).

In 2006, 54,000 researchers (about 27,000 FTEs, since university personnel have a fifty percent teaching obligation as '*enseignants chercheurs'* or 'teacher-researchers[12].) worked in higher education institutions. A further 27,000 researchers were employed by public research organisations (EPST and EPIC), many of whom in practice work in strong cooperation with higher education institutions.

At present, the universities and some *grandes écoles* can award doctorates granting approximately 10,000 doctoral degrees annually.

[12] Teacher-researchers are supposed to devote half of their time to research duties. Since 2003, the Ministry policy has been to create positions based on research priorities

Box 2: The French higher education system

A characteristic specific to France is the dual tertiary education system – in science, engineering and management - with universities on the one hand and *grandes écoles* on the other. *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 (education expenditures by student in the *grandes écoles* are five times higher than in the first two years of university[13]) and excellent career prospects. The outlook of 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 a habit of employing PhDs. They prefer to employ 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, where universities are the leading teaching institutions.

However, the *grandes écoles* and universities have been getting closer recently, as universities are being networked and encouraged to attain excellence and as the *grandes écoles* are planning to develop doctorates. Some schools have been integrated into or affiliated to universities, and there are also mixed research units between schools of engineering and universities. 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 as *grandes écoles*. The government aims to set all higher education institutions on the same level.

* Some *grandes écoles* are 'grander' than others: in fact, of the 200 hundred schools of higher education, only about a dozen business and engineering schools are leading *grandes écoles*

French higher education institutions have been set up in all parts of France, in order to equalise access to higher education. There are around a hundred universities and 200 schools of higher education, but in practice resources are rather concentrated. In 2001, one third of the resources went to nine higher education institutions and half of the resources to 18 institutions. There is also a strong geographical concentration as well, since the two most populous regions receive almost half of the resources: 29% for Ile-de-France and 16% for Rhône-Alpes.

The other end of the spectrum is fragmented, with a large number of small higher education institutions. Hence, in 2001, 66 institutions (24 of them universities) together received a mere 5% of the research budget. Policies have been developed to network universities within a geographical area, concentrating resources in an effort to attain scientific excellence via Research and Higher Education Clusters *(Pôles de recherche et d'enseignement supérieur – PRES))* and Thematic Advanced Research Networks *(Réseaux thématiques de recherche avancée - RTRA)*.

The universities conclude four-year performance contracts with the Ministry of Higher Education, which include funding on the basis of an ex-post evaluation. The objectives are established in dialogue with the university president, based on that evaluation.

The president of the university is supported by three councils: the Administrative Council *(Conseil d'Administration)*, the Scientific Council *(Conseil Scientifique),*

[13] Rémi Lallement and Sandrine Paillard, *The French innovation system in the knowledge-based economy*, Commissariat général du Plan, Paris, 2003

and the Council of Studies and University Life *(Conseil des Etudes et de la Vie Universitaire)*. The president is elected by the assembled members of the three councils, by an absolute majority. He or she must be a tenured teacher-researcher, active at the university and of French nationality. The president is elected for five years and cannot be re-elected. We were not able to find evidence that university governance has begun to include other social stakeholders in any great numbers.

The presence of mixed research units in universities means that these are subject to two modes of management and two different employment contracts within one organisational unit. They complicate the development of university strategy, as other actors – the public research organisations – are involved in resource allocation. This makes especially high demands on the quality and effectiveness of university leadership.

1.1.5 Regional and European Level

The diminishing importance of public research institutes, and hence the central state, is linked to the emergence of other public actors at the regional level and within the European Union. The French regions have indeed been more and more involved in research, science and technology since the first Decentralisation Act in 1982, when a new collective body - regions - were created. Regions are responsible for vocational education, professional and continuous learning, economic development, employment and regional transport. In practice, regions do not act alone on these issues but are supported by the central state, the European Union and other authorities (departments, cities or legally organised groups of cities).

The Regional Councils (Conseils régionaux) have become more important actors in regional research and innovation policy, in particular through their funding. In the period 2001-2003, regions spend more than €380m on research and technological development, representing on average 2.6% of their budget. However, in 2003, the regional budgets for R&D accounted for only 4.1% of total public R&D expenditures, indicating that research and innovation policy is still very much centrally organised.[14]

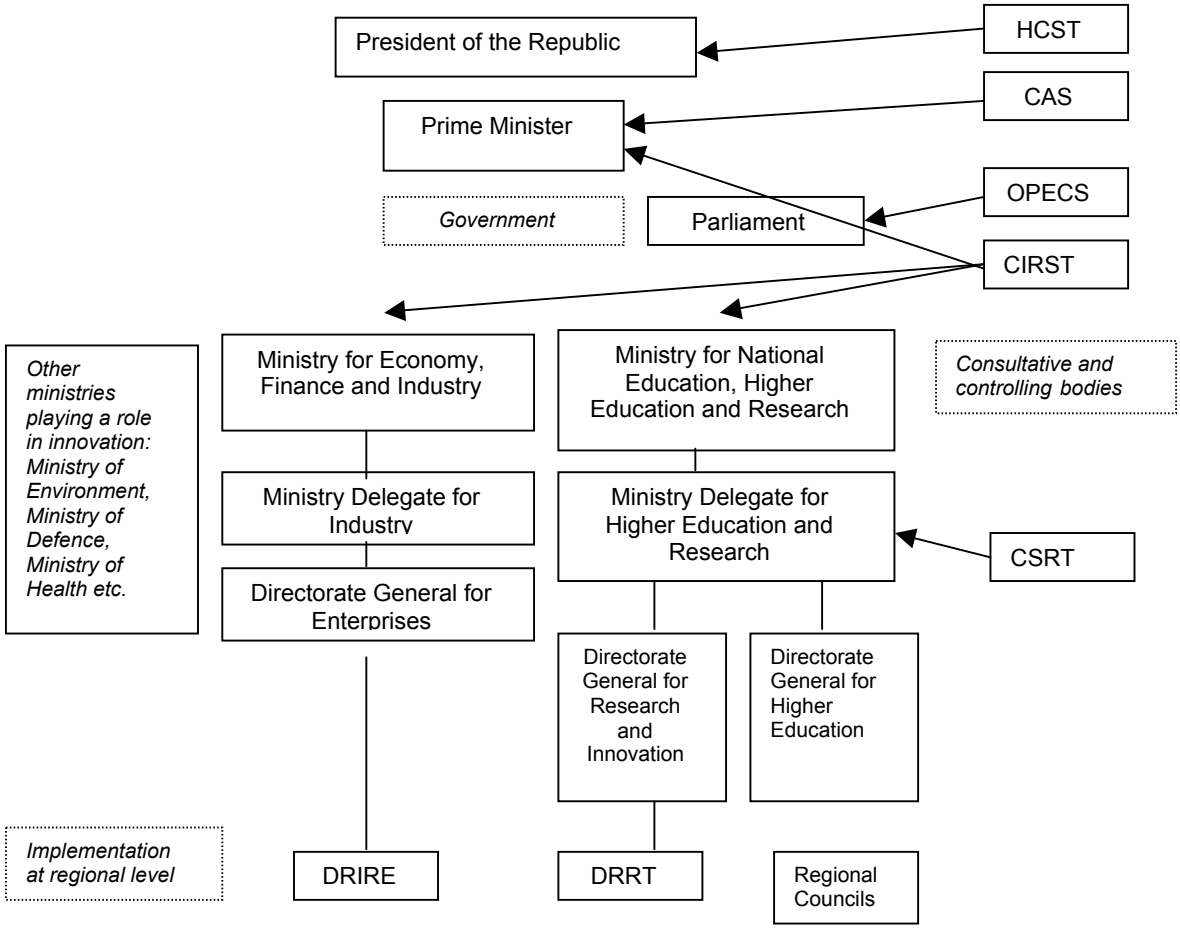
The availability of European funding has primarily been driven by successive R&D Framework Programmes launched since 1984.

1.1.6 Governance Structures in Research and Innovation Policy

Today, two ministries share responsibility for research and innovation policy in France: the Ministry Delegate for Higher Education and Research (which acts under the authority of the Ministry for National Education, Higher Education and Research) and the Ministry Delegate for Industry (which acts under the authority of the Ministry for Economy, Finance and Industry) (see Exhibit 1). Both ministries were reorganised in the last few months.

[14] Inspection générale de l'administration de l'éducation nationale et de la recherche, *Recherche et Territoires*, Rapport N°2005-103, Novembre 2005

Exhibit 1 Governance structure in science and innovation policy



CIRST: Inter-ministerial Committee for technical and scientific research/*Comité interministériel de la recherche scientifique et technologique*
CPCI: Permanent Commission of consultation with industry/*Commission Permanente de Concertation avec l'Industrie*
CSRT: High Council for Research and Technology/*Conseil supérieur de la recherche et de la technologie*
CSA: Centre for Strategic Analysis/*Centre d'analyse stratégique*
DGE: Directorate General for Enterprises
DRIRE: Regional Directorate for Industry, Research and Environment/ *Directions Régionales de l'Industrie, de la Recherche et de l'Environnement*
DRRT: Regional Research and Technology Delegations/*Délégation Régionale à la Recherche et à la Technologie*
HCST: High Council for Science and Technology/*Haut Conseil de la Science et de la Technologie*
OPECST: Parliamentary Office for Evaluation of Scientific and Technical Choices/*Office Parlementaire d'Evaluation des Choix Scientifiques et Technologiques*

Within the Education and Research Ministry, the Directorate General for Research and Innovation was created in May 2006. It is in charge of formulating and implementing policy with regard to research and scientific employment. The DRRT,

the Regional Research and Technology Delegations, represent the central state in matters of research and technology policy.

They inform regional partners of national policy programmes and measures, coordinate activities undertaken by public organisations in the region, develop and organise technology transfer activities, and try to bring together research and business in their region..

The Directorate General for Higher Education is in charge of formulating universities' policy orientations.

In the Industry Ministry, the Directorate General for Enterprises is in charge of the definition of measures promoting industrial competitiveness, the adaptation of the regulatory framework and the coordination of the Regional Directorates for Industry, Research and Environment (DRIRE), the regional representations of the ministry.

Inter-ministerial co-ordination between the Ministry Delegate of Higher Education and Research and the Ministry Delegate of Industry should in principle take place in the Inter-Ministerial Committee for Scientific and Technical Research *(Comité interministériel de la recherche scientifique et technologique - CIRST)* established in 1998 to define priorities in the field of research policy. CIRST meetings are prepared by the Ministry of Research and are chaired by the Prime Minister. The importance of CIRST varies depending upon the amount of priority given to it by different governments. Originally, CIRST promoted priorities like the need to put innovation at the heart of science and technology policy or the need to open up the research system to economic and international actors. However, its meetings have become less frequent and its importance in policymaking has diminished. The last meeting of CIRST took place on 1st June 1999.

In spite of (or perhaps because of) the weak functioning of the CIRST, the Research Act passed in April 2006 has reasserted CIRST's role in research policy design and monitoring. This is of importance, as in its evaluation report on research policies in 2003, the Court of Auditors concluded that the Ministry of Research did not have the real power to steer government research policy[15]. This was acknowledged by the Ministry of Research in its reply to the statement of the Court of Auditors. The report underlined that each ministry can decide to freeze budget lines without informing the Ministry of Research. Strengthening the CIRST, alongside the implementation of the LOLF, are regarded as major tools to provide the government with a single research policy and with monitoring procedures. Ideally, the CIRST would be the place where coordination between the Ministries is performed.

However, as in practice the CIRST is only rarely used, inter-ministerial co-ordination mostly takes place on an informal and problem-oriented basis, usually between the departmental staff of the two ministries.[16] At this lower, technical level, there is generally good inter-ministerial cooperation, which is facilitated by the

15 http://www.ccomptes.fr/Cour-des-comptes/publications/rapports/rp2003/chapitreV.pdf

16 At this level, there is a risk of incomplete co-ordination as each ministry is tempted to decide in its own field. At worst, some degree of competition can arise between the two ministries. At any rate, the disadvantage is that an overall view of the system is lacking. Indeed, much depends on the individuals in charge of the ministries concerned

relatively small number of people working in the field at the two ministries. It is easy for them to establish working groups and have representatives of the two ministries work on a specific (technical) topic. However, it is difficult to drive budget allocation or strategic direction from this level.

- At a general level, there is the Centre for Strategic Analysis (Centre d'analyse stratégique), which replaced the Commissariat Général du Plan in 2006. It is a consultative body working directly under the direction of the Prime Minister. Its objective is to assist the government in defining and implementing its economic, social, environmental and cultural policies. Its published works include long term strategies defined at the community level, and particularly in the framework of the Lisbon strategy. Some of these relate to research and innovation. There is also the Parliamentary Office for the Evaluation of Scientific and Technological Choices (Office Parlementaire d'Evaluation des Choix Scientifiques et Technologiques - OPECST), set up in 1983, is a parliamentary working group that produces high quality reports on sectoral aspects of innovation policy.

The Ministry of Research hosts a number of advisory bodies

- The High Council for Research and Technology *(Conseil supérieur de la recherche et de la technologie – CSRT*) set up in 1982. Its two colleges, composed of representatives of the scientific and technical communities and research partners, represent a forum where stakeholders can exchange views and be consulted. It does, however, not have any real weight in decision-making. One possible explanation is its dependence on the Ministry of Research, which prevents it from acquiring an overall view. The CSRT was upgraded in the 2006 Research Act in particular with new missions on relations between science and society
- The High Council for Science and Technology *(Haut conseil de la science et de la technologie - HCST)* was established in September 2006 in the context of the new Research Act in order to improve strategic orientation capabilities. Accordingly, its task is to provide the Government and the President of the Republic with recommendations on national research and innovation strategies. It reports directly to the President of the Republic. The President of the Republic appoints highly distinguished personalities to the Council for four years. It is not yet clear whether it can break the pattern of ineffectiveness among the advisory bodies

The National Committee of Scientific Research *(Comité national de recherche scientifique)* at the CNRS primarily has a distinct role from these other bodies, in that it is an assembly of national and international experts working as peers in evaluating research quality. However, the Committee also participates in the definition of research policy, through studies on performance and foresight

At the Ministry of Industry, special committees provide some support to policy making of a more technical nature

- The Managing Committee for Aid to Industry *(Comité de gestion des aides à l'industrie - CGAI)* gathers representatives of the Directorate General of Enterprise, the Directorate General of Research and Innovation, and of OSEO. It

mainly provides advice on initiatives covered by the Fund for Enterprise Competitiveness *(Fonds de Compétitivité des Entreprises - FCE)*, i.e. mostly research and innovation projects carried out in partnership.

- The Permanent Commission for Consultation with Industry (*Commission Permanente de Concertation avec l'Industrie* - CPCI), brings together representatives of the DGE and industry (MEDEF or GFI[17]) with representatives of the relevant ministries and other stakeholders (OSEO anvar; APCE etc). It is considered a more effective body than the CGAI. It is divided into sub-sections (taxation, innovation, etc.) and meets on an *ad hoc* basis depending on needs, usually about once a month. Once a year, the Prime Minister or the Minister of Industry also attends a general CPCI meeting

Moreover, there is the *Inspection générale*, a body of civil servants, generally of a high level, charged with a nationwide mission to inspect some specific services and provide government officials with advice regarding that service. In the area of research, innovation and higher education the following bodies are of particular relevance[18]

- General inspection of National Education (Inspection générale de l'education nationale)
- General Inspection of the Administration of National Education and Research (Inspection générale de l'administration de l'Éducation Nationale et de la recherche)
- General Inspection of Finance (Inspection générale des finances)
- Court of Auditors *(Cour des comptes)*

Finally, the Prime Minister can launch a consultation process by assigning an expert as chairperson of a consultative (ad hoc) body on a specific subject that may be related to research and innovation. The result of such a consultation process generally is a report published on the Internet and often well covered by the press. The reports are often considered important documents by R&D professionals and can feed into a public discussion of policy choices. The report drawn up by Jean-Louis Beffa (2005), which reawakened the idea of 'large programmes', is among the best known examples.

In general, consultations appear to be conducted 'internally'. Where external stakeholders are involved, they are often selected from a limited number of bodies (for example, Chambers of Commerce and Associations of Chambers of Commerce – CCI and APCCI, Regional Councils, etc.) or sectors (e.g. industrialists or groups of industrialists, specialists from the research sector or high senior officials). Stakeholder involvement is not very formalised.[19]

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17 The 'Mouvement des Entreprises de France' (MEDEF) is the biggest association of enterprises; the 'Groupement des Fédérations Industrielles' (GFI) gathers industrial associations within the MEDEF

18 Indeed, parts of this country backgroud report are based on reports drawn up by the *inspections générales* (see bibliography)

19 In general, coordination based on multiple personal contacts leads to implicit co-ordination in a context characterised by a lack of formalisation, little transparency and little corporate 'memory'

1.1.7 Change in Governance

The New Public Management has been comparatively late in coming to France, and was introduced in 2001 when the parliament radically reformed the 'financial constitution' by passing the Organic Act on Public Accounts *(Loi organique relative aux lois de finances - LOLF)*[20]. The Act replaces the traditional budgetary structures with a hierarchy of performance contracts. According to the LOLF, the budget has to present explicit objectives ('*missions*'[21], '*programmes*'[22] and '*actions*'[23]). The 2006 budget is the first budget to be defined according to the new rules. According to some authors, the LOLF symbolises nothing less than "the modernisation of the State"[24].

The LOLF entailed the Interministerial Mission of Research and Higher Education ('MIRES') in 2006. MIRES brings together 13 programmes related to seven Ministries with a total budget of about €20.5bn. The mission describes the objectives to be achieved each year by each of the 13 programmes and is supposed to improve monitoring, control and evaluation of the French research and innovation system.

Evaluation studies in other countries have shown that the main effect of introducing NPM lies mostly in a cultural change, insomuch as policy-makers start thinking about policy outcomes. So far, the effects of the LOLF on French public management have yet to be evaluated.

1.1.8 Use of strategic intelligence in policy formulation

The Ministry in charge of industry regularly launches studies of technological foresight for identifying what will be the most important technologies for French industry in five or ten years' time. The first study 'Key Technologies' was published in 1995; the second in 2000. The third study called 'Key Technologies 2010' was published in November 2006.[25]

The French foresight exercise FutuRIS, the first comprehensive foresight exercise of a systemic nature carried out in France, was launched in February 2003. In June 2005, it became the strategic foresight mission of the National Association of Technical Research (ANRT). Co-financed by government and RTD performing enterprises, FutuRIS provides a wide range of reviews on many different aspects of the research and innovation system. There is a consensus that FutuRIS had a certain influence on the 2006 Research Act.

1.1.9 Funding agencies

There were major novelties introduced in the French research and innovation system in 2005: two agencies in charge of financing innovation and research were established and public support to innovation in industry was reorganised

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20 http://www.finances.gouv.fr/lolf/index1.html and http://www.performance-publique.gouv.fr/

21 Main areas of national government policy

22 Each programme defines a strategy, objectives and indicators

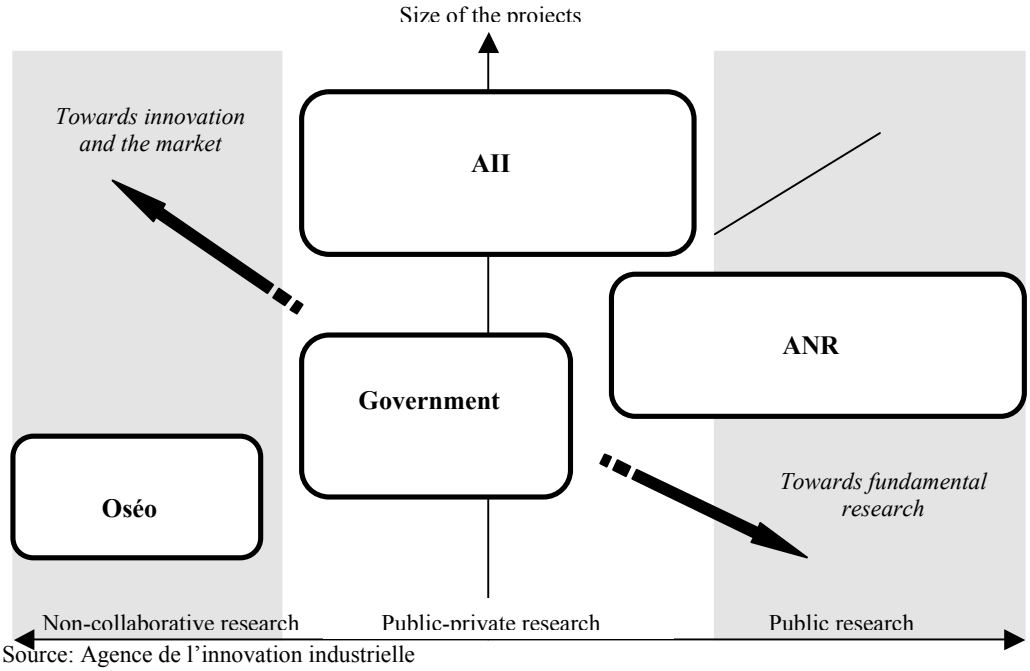
23 "Actions" describe the content of a programme and bring together credits that have the same end

24 FutuRIS, *La Recherche de l'Innovation en France*, sous la direction de Jacques Lesourne and Denis Randet, Paris: Editions Odile Jacob, 2006

25 http://www.industrie.gouv.fr/techno_cles_2010/html/sommaire.html#sommaire

- The National Agency for Research *(Agence nationale de recherche - ANR)* was created in 2005 to distribute research funds on the basis of grant proposals, thus enhancing competition in the research system. The ANR funds small and medium-sized projects according to research priorities identified by the government, supporting public as well as private research. Besides enhancing knowledge production, it also promotes partnerships between public and private actors. The ANR is supervised by the Ministry Delegate of Higher Education and Research, but the Ministry of Education, the Ministry of Health, the Ministry of Budget and the Ministry of Industry are represented in the executive board.
- The Agency for Industrial Innovation *(Agence de l'Innovation Industrielle - AII)* was set up in 2005 to promote the development of industrial activities in the high technology segment, following the recommendations of the Beffa report, which argued in favour of large-scale structural programmes. The AII's mandate is to identify and select so-called Mobilizing Programmes for Industrial Innovation ('*Programmes mobilisateurs pour l'innovation industrielle*' - PMII), contribute to their funding, evaluation and regular monitoring. These large-scale programmes for industrial innovation are based on multi-disciplinary research and development, and involve pre-competitive development activities.
- OSEO Anvar was established in 2005 to respond to the problem of the fragmentation and multiplicity of actors supporting innovation. The creation of the OSEO group, merging the National Agency for Innovation (ANVAR), the Bank for Development of SMEs *(Banque de développement des PME)* and the agency for SMEs *(agence des PME)*,it was intended explicitly to address the issue of complexity on the support system. OSEO Anvar provides SMEs with support for R&D and innovation projects. It has a strong presence at the regional level. Its main intervention instruments are subsidies, loans and expertise. The OSEO group is a holding company owned by the government. OSEO Anvar has the status of a private company with a mission of public interest and is controlled by the OSEO group
- CDC Enterprises is another significant actor in innovation and SME policy. It is a subsidiary of the *Caisse des Dépôts (CDC)*, which is a public funding institution. CDC Enterprises is in charge of providing capital for innovations to companies with high growth potential

Exhibit 2 Agencies Funding Research



Source: Agence de l'innovation industrielle

Exhibit 2 shows the clear division of labour among the funding agencies. ANR predominantly funds projects proposed by labs or public/private consortia and selects them through different calls for proposals according to scientific criteria. AII and OSEO Anvar support R&D and innovation projects proposed by companies and select them according to their economic potential. Accordingly, the former is supervised by the Ministry Delegate of Higher Education and Research, and the latter by the Ministry Delegate for Industry.

2 Science Base (R&D capacity)

2.1 Indicators and Challenges

In 2004, the French share in publications worldwide ranged from 3.7% in applied biology-ecology to 7.4 in mathematics (2004). In all disciplines except engineering, the shares decreased between 1999 and 2004, most so in chemistry (-19%). The same is true for the French shares of citations, which, except engineering and mathematics, all dropped by at least 10% (see Exhibit 3). These declines have to be viewed against the background of new very dynamic countries appearing on the international scientific stage[26] and a strong increase in international output and competitiveness.

According to Exhibit 3, the French disciplinary profile is more or less balanced, apart from a strong specialisation in mathematics (specialisation index of 1.6). Between 1999 and 2004, France reinforced its specialisation in physics, engineering and mathematics. As to the impact of French citations, the impact index is above-

[26] For instance, Brazil, China, South Korea, Singapore, Taiwan

average in four disciplines: applied biology-ecology (1.10), chemistry (1.07), engineering (1.05), mathematics (1.06). Moreover, the impact index has increased in half of the disciplines under examination, testifying to a gain in visibility.

Exhibit 3 French Scientific Publications

	Basic biology	Medical research	Applied biology-ecology	Chemistry	Physics	Space science	Engi-neering	Maths	All disci-plines
Share of scientific publications (in %)									
1999	5.6	5.3	4.5	5.6	5.8	5.7	4.3	7.9	5.4
2004	4.8	4.5	3.7	4.5	5.2	5.0	4.3	7.4	4.7
Development	*-14*	*-16*	*-16*	*-19*	*-10*	*-13*	*0*	*-6*	*-13*
Specialisation index									
1999	1.04	0.99	0.83	1.04	1.08	1.07	0.80	1.47	1.00
2004	1.03	0.96	0.80	0.97	1.13	1.07	0.92	1.60	1.00
Development	*-1*	*-3*	*-4*	*-6*	*+4*	*0*	*+16*	*+9*	
Share of citations (after 2 years) (in %)									
1999	5.0	4.4	5.0	5.5	5.8	5.5	4.6	8.5	4.9
2004	4.5	3.8	4.1	4.8	5.2	4.9	4.5	7.9	4.4
Development	-11	-14	-17	-12	-12	-11	-2	-8	-12
Impact index (after 2 years)									
1999	0.90	0.84	1.11	0.99	1.0	0.96	1.08	1.08	0.92
2004	0.93	0.85	1.10	1.07	0.98	0.98	1.05	1.06	0.94
Development	+4	+2	-1	+8	-2	+3	-3	-2	+2

Source: OST 2006.

As can be seen in Exhibit 4, ceteris paribus there is a strong positive relationship between the level of public expenditure on R&D relative to GDP and the number of scientific publications per million population across the EU countries, the US and Japan. In the French case, however, the high public investments in R&D do not translate into a large number of publications. France is off the trend line. This may be due to the large share of technological non-academic research funded by public money, especially in the EPIC. These expenditures do not translate in publications. However, this trend may also be due to organisational problems and a lack of long-term strategic planning that translates into a crisis in the profession of researcher. Public researchers benefit from the status codified by the research Act adopted in 1982, which, in principle, allows researchers to recruit their colleagues through cooption and enjoy a large degree of freedom to set their own research agenda and explore new pathways. In reality, however, the recruitment system is largely opaque and inflexible, and it stimulates proximity networks between established researchers rather than multidisciplinarity, scientific openness and new original pathways.[27]

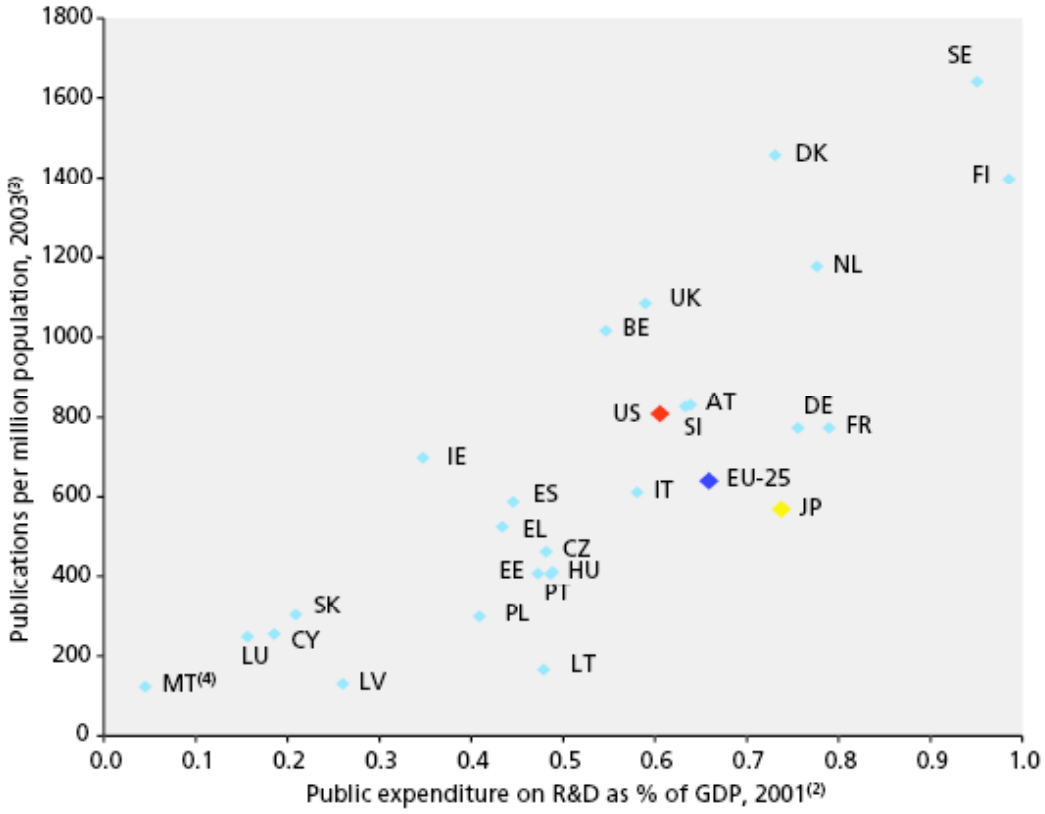
France is an important military power. Hence, the military share in total public research expenditures has been as high in the past. Since the end of the Cold War, however, its share has fallen dramatically (from 7.4 billion € in 1990 to 3.2 billion € in 2001 or from 30% of government R&D in 1995 to 23% of government R&D in 2004). According to the Commissariat Général du Plan[28], the withdrawal of the state since the end of the Cold War has contributed to the reduction of total R&D expenditure in relation to GDP, which sank from 2.38% in 1992 to 2.17% in 1999 and 2.16 in 2004 (see Exhibit 5).

[27] Rémi Lallement and Sandrine Paillard, *The French innovation system in the knowledge-based economy*, Commissariat général du Plan, Paris, 2003

[28] Rémi Lallement and Sandrine Paillard, *The French innovation system in the knowledge-based economy*, Commissariat général du Plan, Paris, 2003

Finally, France's attractiveness for foreign R&D investments has been diminishing in recent years[29]. Moreover, foreign R&D investments in France are mostly linked to production. A study by Ernst & Young[30] shows that companies do not move to France because of its R&D capacities but rather for the quality of its infrastructures, its geographic location, and the quality of life it offers.

Exhibit 4 Publications and Public Expenditure on R&D



Source: Key Figures 2005
Notes: In order to take into account the gap between R&D input and scientific output, a two-year lag between public expenditure on R&D and publications per million population has been applied.
2) MT: 2002; AT: 1998 3) AT: 2000 4) MT: Public expenditure on R&D does not include higher education expenditure on R&D

[29] Frédérique Sachwald, *Internationalisation de la R&D des enterprises et attractivité de la France*, FutuRIS-ANRT, December 2004

[30] Ernst &Young, *Baromètre attractivité du site France*, 2004

Exhibit 5 Indicative Indicators for the Science Base*

	France (year)	EU-15 (year)	European top performer (year)	Source
S&E graduates per thousand population aged 20-29	22.0 (2003)	13.6 (2004)	23.1 (Ireland) (2004)	EIS
S&E graduates as % of new degrees	29.4 (2003)	n/a	30.5 (Sweden) (2003)	3%AP
New PhDs in S&E fields of study per thousand population aged 25-34	0.71 (2000)	0.55 (2000)	1.37 (Sweden) (2001)	3%AP
GERD as % of GDP	2.16 (2004)	n/a	3.95 (Sweden) (2003)	OECD
Average annual real growth rates in R&D investment - 1997-2001	2.1	4.5	16.7 (Greece)	3%AP
Government-financed GERD as % of GDP	0.79 (2005)	0.66 (2004)	0.99 (Finland) (2005)	EIS
Percentage of GERD financed by government	39.0 (2003)	n/a	n/a	OECD
Percentage of GERD financed by abroad	8.4 (2003)	n/a	19.4 (UK) (2003)	OECD
Percentage of GERD financed by industry	50.8 (2003)	n/a	69.3 (Finland) (2004)	OECD
Percentage of GERD performed by industry	62.9 (2004)	n/a	74.1 (Sweden) (2003)	OECD
Defence budget R&D as % of total GBOARD (2004)	22.7	13.4 (EU-25)	31.8 (UK) [55.7 (USA)]	OECD
Researchers as % of the working population	0.77 (2003)	n/a	1.73 (Finland) (2004)	OECD
Women researchers as % of total researchers	27.8 (2003)	n/a	44.3 (Portugal) (2003)	OECD
Share of researchers in business enterprises (in %)	47.1 (2000)	49.7 (2000)	n/a	3%AP
Share of researchers in government labs (in %)	15.2 (2000)	13.4 (2000)	n/a	3%AP
Share of researchers in higher education establishments (in %)	35.8 (2000)	34.5 (2000)	n/a	3%AP
Higher Education R&D as % of GDP	0.41 (2004)	n/a	0.87 (Sweden) (2003)	OECD
Number of scientific publications per million of the population	773 (2003)	n/a	1642 (Sweden) (2003)	3%AP
Publication count - % share of world output	6.08 (2003)	n/a	8.49 (UK) (2003)	3%AP

Key: OECD = Organisation for Economic Cooperation and Development`
EIS = European Innovation Scoreboard
RTD = RTD Indicators Report
3%AP = 3% Action Plan
n/a = not available or not applicable
GBOARD = Government budget appropriations or Outlays for R&D

* There is some overlap with indicators relevant to other domains and between indicators from different sources.

2.2 Governance

2.2.1 Policy design

For the most part, research policy design and implementation fall within the remit of the Ministry for Higher Education and Research and the Ministry for Industry.

2.2.2 Policy Objectives

The indicators above suggest that the French research system's performance is not poor but that it is not excellent either: it is average. Indeed, since the end of the 1990s, the French have intensely discussed the decline of their system of research. The debate has been focussing on the system's current organisation, which dates back to the 1982 Research Act, and whether or not it is responsible for the average performance of the French system of innovation.[31]

Accordingly, the Government drew up a Pact for Research *(Pacte pour la recherche)*[32] in 2005. The pact is an action programme, aiming to restore French competitiveness. The Pact for Research was followed by the Research Act *(Loi de programme pour la recherche),* passed in April 2006[33]. The Research Act represents the legislative part of the Pact for Research.

In 2005, the Government prepared the Pact for Research (*Pacte pour la recherche*)[34], with six objectives, namely to

7 Strengthen organisations' ability to set strategies and define priorities
8 Build a research evaluation system that is unified, coherent and transparent
9 Use synergies and facilitate cooperation among (public) research actors
10 Offer attractive research careers
11 Increase the innovation-orientated linkages between public and private research actors
12 Strengthen the integration of the French research and innovation system into the European Research Area

The first three aims have been actively tackled. The same is true for the fifth objective, which will be discussed in the next chapter. The fourth and the sixth objective will be discussed in chapter 5.

2.3 Policy Instruments

- The most important recent policy developments are

- **Enhancing strategic capability**: A High Council for Science and Technology (HCST) was set up in 2006 to enhance strategic orientation of the research and innovation system and, more precisely, to advise the President of the Republic on science and technology issues.
- **Introducing systematic, coherent, transparent and independent evaluation**: In April 2007, the Agency for the Evaluation of Research and Higher Education *(Agence d'évaluation de la recherche et de l'enseignement supérieur - AERES)* was established. Its task consists of assessing research programmes and research

31 FutuRIS, *La Recherche de l'Innovation en France*, sous la direction de Jacques Lesourne and Denis Randet, Paris: Editions Odile Jacob, 2006
32 www.pactepourlarecherche.fr/pacte/index.htm
33 http://www.assemblee-nationale.fr/12/ta/ta0563.asp
34 www.pactepourlarecherche.fr/pacte/index.htm

units [35]. Formerly evaluation was assigned to different organisations, some dedicated to a single research organisation, other to one discipline or technological area, leading to a fragmented evaluation system. Thus, the creation of AERES responds to the need for a clearer and more effective system.[36]

- **Networking universities**: In order to concentrate public research resources, to increase research excellence and counteract fragmentation of university research activities, two new instruments have been designed, namely the Research and Higher Education Clusters *(Pôles de recherche et d'enseignement supérieur - PRES)* and the Thematic Advanced Research Networks *(Réseaux thématiques de recherche avancée - RTRA)*. Both instruments encourage public research actors to engage in joint projects. Participants in the clusters and networks will be given extra resources. The two instruments were introduced in May 2006.
  PRES is the principal instrument for grouping universities in a same district, department or region. It consists in forming large university sites, which manage research, education, and valorisation activities. In December 2006, there were nine established PRES projects, and a further five were in preparation. Most universities are therefore not yet involved in a PRES. The reform is generally welcomed both by the government and the heads of universities.[37]
  The RTRA consist of research units located closely to each other and gathering a critical mass of high-level researchers. Each RTRA works on one specific thematic field. Thirteen thematic advanced research networks were selected in early October 2006. Some RTRA will have links to competitiveness clusters by working on a related theme. Thus, the two instruments will complement each other, with the RTRA creating a scientific pole of excellence and the competitiveness cluster fostering partnerships with industry. For instance, the RTRA in Grenoble specialises in nanotechnology and will be connected to the competitiveness cluster Minalogic.
- **Changing the mechanisms of funding basic research**: Traditionally, in France, public research has been funded through contract mechanisms between the State and the research institutions, such as universities and public research organisations. The Government has recently introduced new instruments to fund research on the basis of projects. In 2005, the first beneficiary of the National Agency for Research was the CNRS (30%) followed by enterprises (18%). Currently, the competitive funds represent a small share of government R&D spending. In 2005, the credit for payments *(crédits de payment)* of the National Agency for Research corresponded to only 2.5% of GBOARD[38] (350 million €). However, this level is expected to increase in the future: In 2006, project-based research funding amounted to approximately 10% of total research funding. The government's objective is for 20% of total research funding to be project-based

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35 I.e. public research organisations, higher education institutions (HEI), scientific cooperation foundations (e.g. Thematic Advanced Research Networks), National Agency for Research, and HEI training programmes and formations

36 In general, French evaluation culture has changed considerably since the mid-1990s: formerly more or less reserved to the Court of Auditors *(Cour des Comptes)* and mainly concerned with the control of financial flows, the focus of evaluations has shifted, as a series of more strategic policy evaluations have been undertaken more recently

37 It is hoped that the establishment of PRES will have an influence on "signatures" of publications, as they will be attributed to a PRES rather than to one of the numerous universities or research units. Thus, the position of French higher education institutions in rankings such as the Shanghai ranking is expected to improve

38 Government Budget Appropriations or Outlays for R&D

by 2010. A part of the scientific community appears to be fighting a rearguard action to ensure that this does not occur through reductions in existing block grants.

2.3.1 Policy Effectiveness

Most policy measures are fairly recent, hence effectiveness is difficult to assess.

Exhibit 6 SWOT analysis of French Science Base

Strengths	Weaknesses
• One of the highest outputs of S&E graduates, second largest share of S&E graduates in EU-25. • Government-financed GERD as a percentage of GDP relatively high (0.85%) compared to top performer Finland (0.92%).	• Overall investments in R&D (GERD), only at average levels: 2.16% of GDP, GERD has more or less stagnated since 1995 → far from the 3% Lisbon target. • Compared to EU-25 (693) and top performer Sweden (1642) only average number of scientific publications per capita (773), a modest output given the relatively high (public) input. This suggests that the (public) research system might be able to increase its efficiency.
Opportunities	**Threats**
• Introducing more competitive elements into the research system, both in terms of research funding and in terms of employment of researchers, to improve efficiency of public research system • Introducing more public-private R&D partnerships, to tackle the growing science-intensity of engineering and to connect large as well as smaller forms into the knowledge infrastructure	• Status of researchers as civil servants makes introduction of project-based funding, i.e. competition, difficult, as opposition can be expected and has indeed already been mounted • Sclerosis leading to inability to define and deploy strategies within knowledge infrastructure institutions

3 Business R&D and Innovation (Technological and Innovative Performance)

3.1 Indicators and challenges

3.1.1 Business R&D and innovation

The French economy is characterised by a comparatively large primary sector that contributes 15% to GDP but employs only 3.8% of the labour force, implying that the primary sector is highly productive (see Exhibit 7). It is not surprising that, with a turnover of 124 billion in 2004 (21.9% of secondary sector), the food industry is the largest industry in the manufacturing sector. The tertiary sector contributes roughly 50% to GDP while employing 73% of the labour force. Tourism represents 6.5% of GDP.

Exhibit 7 Sectoral composition of French economy

	GDP per sector in 2005 (in %)	Active population per sector in 2005 (in %)
Agriculture	15	3.8
Industry	33	23
Services	52	73

Source: L'économie française. Dossier réalisé par l'UCCIFE (Union des Chambres de Commerce et d'Industrie Françaises à l'Etranger)

One of the characteristics of the French research system is the low proportion of R&D *financed* by industry. Ever since the early 1980s this share has been around 50%, whereas in Germany and the US it has consistently been above 60%. The lower French proportion appears to be the corollary of the significant proportion of business R&D funded by government (11.1%, see Exhibit 17 below) . The proportion of GERD *performed* by industry is 63% (Exhibit 8).

Exhibit 8 Proportion of GERD Performed by Business Enterprises, 2004 (selected countries ranked by GERD/GDP ratio)

Countries	GDP per Capita (2004, ppp)	GERD as percentage of GDP (2004)*	% of GERD performed by business enterprises (2004)*
Sweden	29,540	3.95	74.1
Japan	29,291	3.13	75.2
Korea	20,471	2.85	76.7
United States	39,678	2.68	70.1
Germany	28,104	2.49	70.4
Denmark	31,914	2.48	68.0
Singapore	28,860	2.25	60.8
France	**27,047**	**2.16**	**62.9**
Canada	31,263	1.99	54.0
UK	30,821	1.88	65.7
Netherlands	31,790	1.78	57.8
Norway	38,453	1.61	54.8
Ireland	38,827	1.20	64.5
New Zealand	23,932	1.14	42.5
Italy	27,480	1.11	47.3
Spain	24,992	1.07	54.4
South Africa	11.393	0.87	55.5
Portugal	19,629	0.79	33.2
Turkey	7,752	0.66	28.7
Greece	22,205	0.62	30.1
Poland	13.316	0.58	28.7
Argentina	13,302	0.44	29.0
Mexico	9,776	0.43	34.6

* Or nearest date for which data available.

Sources: GDP per capita 2004 (ppp $) – World Bank, *World Development Indicators*; IMF.
R&D – OECD, *Main Science and Technology Indicators 2006(1)*.

About 55.5% of France's researchers are employed in the private sector, of which the vast majority (90%) are employed in companies over 500 employees.

A total of around 5300 companies conduct R&D in France. About 4000 of these are in industry, which accounts for 80% of BERD, and 1300 in services, which represent 15%. The key industrial R&D-performing sectors are electronics, pharmaceuticals, ground transport systems, chemicals and aerospace.

Industrial R&D spending is rather concentrated, with the 13 largest alone accounting for half of BERD.[39] According to the 2005 EU Industrial R&D Investment Scoreboard, the five largest industrial R&D investors in R&D were (in 2004)

- Sanofi-Aventis (Pharmaceuticals) with €4.0 bn
- Peugeot (Automobiles & parts) with €2.1 bn
- Renault (Automobiles & parts) with €2.0 bn
- Alcatel (Telecommunications equipment), €1.6 bn
- Snecma (Aerospace & defence), €0.8 bn.

Community Innovation Survey data indicate that the proportion of companies performing innovation activities (41%) is just around EU average[40] (1998-2000) (see

[39] FutuRIS, 'Synthesis Report for a National Debate', Paris, March 2004

Exhibit 9). This rate rises to between 55% and 60% for companies in the French electronics, chemicals, and pharmaceutical sectors.

Germany has the highest proportion of enterprises with innovation activities (61%) and is in this respect a long way ahead of its main competitors[41].

Exhibit 9 Innovation indicators by size of firm (1998-2000/2000)

	Small	Medium	Large	Total
Firms with innovation activity (in %)	31	52	76	41
Innovation expenditure as % of turnover	4	2.7	3.5	3.4

Source: CIS3

As in other European countries, it is predominantly large enterprises[42] that are involved in innovation activities: 76% of French large firms reported the introduction of a new product or process (and/or had innovation activities that were incomplete or abandoned in the period studied) while only 31% of small and 52% of medium-sized firms did so. French small firms do not seem to be particularly 'innovation active' when compared to their counterparts in Germany (52%) or the Netherlands (39%) or the EU average 41%. Small firms spend a higher proportion of their turnover on innovation (4%) than medium or large firms. This pattern can be seen in other countries as well, most notably in the UK with small firms investing 7% of their turnover in innovation activities (EU average 4%).

Exhibit 10 Innovation indicators by sector (1998-2000/2000)

	Total industry (excluding construction)	Services (excluding public administration)	Total
Firms with innovation activity (in %)	46	34	41
Innovation expenditure as % of turnover	3.9	2.4	3.4

Source: CIS3

As Exhibit 10 indicates, French service sector firms seem to be not particularly 'innovation active' (34%) when compared to the German service sector (57%) and the EU average (46%). As in other European countries, French industrial companies spend a higher proportion of turnover on innovation than enterprises in services. However, the relatively low innovation expenditure of French industrial firms (3.9%) is striking, when compared to the UK (5.5%) or Germany (5.3%).

France lags in patent applications, both to the European Patents Office (EPO) and the USA (USPTO), with patent application rates per capita slightly under the EU-15 average (see Exhibit), only half of that of Germany (311.7 and 123.0 respectively) and a third of that of Switzerland (425.6 and 168.4 respectively). This rather average performance may be due to technological specialisation in sectors where patents are not prioritised as a way to protect innovations, notably the aeronautic and the

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40 EU-13 plus Norway: Italy, Spain, UK, Germany, France, Netherlands, Belgium, Sweden, Portugal, Denmark, Finland, Austria, Greece; Norway

41 Although this may in part be a reflection of the different sample structure used in Germany

42 Enterprise size: "small" = 10-49 employees; "medium" = 50-249; "large" = 250+

automotive industries, which prefer secrets or rely on the learning curve. Given that the propensity to patent increases with firm size, the low average size of French firms compared with countries such as Germany, Japan, or the US could also contribute to explaining the French performance.[43]

Exhibit 11 Indicative Indicators for Business R&D and Innovation*

Indicator	France	EU-15	Top performer	Source
Percentage of workforce in medium-high and high-tech manufacturing	6.34 (2005)	6.71 (2005)	10.43 (Germany) (2005)	EIS
Percentage of workforce in high-tech services	3.92 (2005)	3.49 (2005)	5.13 (Sweden) (2005)	EIS
Innovation expenditure (% of turnover)	2.23 (CSI4)	n/a	3.47 (Sweden) (CSI4)	EIS
EPO patents per million	153.7 (2003)	161.4 (2003)	425.6 (Switzerland) (2003)	EIS
USPTO patents per million	56.8 (2003)	60.2 (2003)	168.4 (Switzerland) (2003)	EIS
Number of triad patents per million population	36.5 (2003)	38.9 (2003)	108.9 (Switzerland) (2003)	EIS
Number of new community trademarks per million population	76.0 (2006)	115.7 (2006)	782.7 (Luxemburg) (2006)	EIS
Number of new community industrial designs per million population	88.1 (2006)	127.6 (2006)	377.6 (Luxemburg) (2006)	EIS
Percentage of SMEs innovating in-house	29.2 (CIS3)	n/a	46.5 (Iceland) (CIS3)	EIS
Percentage of SMEs involved in innovation co-operation	11.5 (CIS4)	n/a	20.00 (Sweden) (CIS4)	EIS
Percentage of SMEs using organisational change	35.9 (CIS4)	n/a	63.0 (Switzerland) (CIS3)	EIS
Early stage venture capital (seed and start-up) (in % of GDP)	0.023 (2005)	0.026 (2005)	0.068 (Denmark) (2005)	EIS
Value-added of high-tech and medium high-tech industries as % of total gross valued added	7.29 (2001)	8.44 (2001)	23.47 (Ireland) (2001)	3%AP
Value added of knowledge intensive services as % of total gross value added	32.07 (2001)	38.46 (2000)	61.32 (UK) (2001)	3%AP
Sales of 'new to market' products as % of turnover	6.2 (CIS4)	n/a	13.6 (Malta) (CIS4)	EIS
Sale of 'new to the firm but not to the market' products as % of turnover	5.6 (CIS4)	n/a	15.1 (Portugal) (CIS3)	EIS
Exports of high technology products as share of total exports	20.1 (2004)	17.7 (2004)	55.9 (Malta)* (2004)	EIS
Business expenditure on R&D (BERD) as a percentage of GDP	1.32 (2005)	1.24 (2004)	2.92 (Sweden) (2005)	EIS
Share of medium-high-tech and high-tech R&D	86.8 (2003)	89.2 (2003)	92.7 (Sweden) (2003)	EIS
Share of enterprises receiving public funding	6.6	n/a	39.7 (Luxemburg)	EIS

[43] However, Swiss firms have the highest patent rate worldwide even though 99% of Swiss firms are SMEs (i.e. employ less than 250 people). So the fact that French SMEs use IPRs comparatively rarely might point to a broader phenomenon, namely the low average propensity of French SMEs to innovate (see Exhibit 9)

for innovation	(CIS4)		(CIS4)**	
University R&D expenditures financed by business sector	2.9 (2002)	6.6 (2002)	n/a	EIS
Share of BERD in GERD (% of GERD financed by industry)	50.8 (2003)	53.7 (2003)	80.4 (Luxemburg) (2003)	OECD
Share of BERD financed by government	11.1 (2003)	n/a	n/a	OECD
Share of SMEs in publicly funded R&D executed by the business sector (%)	9.3 (2000)	n/a	75% (Switzerland) (2000)	3%AP
Share of BERD performed by SMEs	14.1 (2002)	n/a	n/a	3% AP

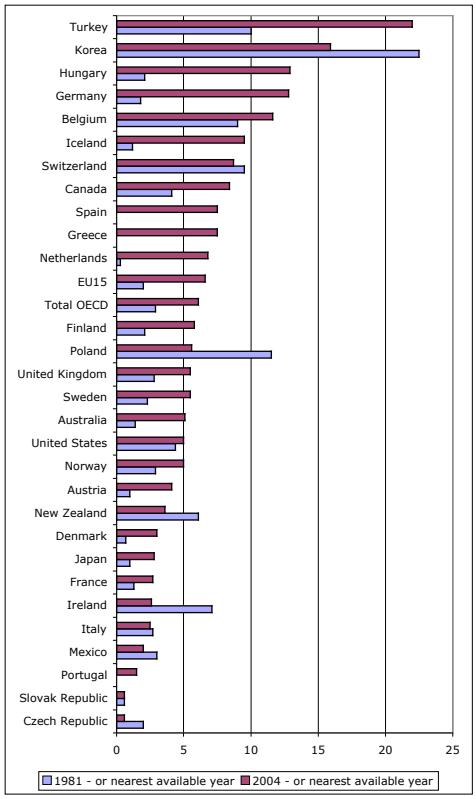
Key: OECD = Organisation for Economic Cooperation and Development
EIS = European Innovation Scoreboard
RTD = RTD Indicators Report
3%AP = 3% Action Plan
CIS3 = Third Community Innovation Survey 1998-2000
CIS4 = Fourth Community Innovation Survey 2002-2004
n/a = not available or not applicable

* There is some overlap with indicators relevant to other domains and between indicators from different sources.

3.1.2 Science – industry linkages

The willingness of industry to fund research in higher education institutions is one measure of the health of industry-university links.

Exhibit 12 Percent of HERD Financed by Industry, 1981 and 2004



Source: OECD, *Governance of Public Research: Towards Better Practices*, Paris: OECD, 2003; *Main Science and Technology Indicators*, 2006

Contracts with businesses fund 12% of academic research in Belgium, 6% in the UK and 5% in the US but only 3% in France (Exhibit). Moreover, the proportion of

higher education R&D that French industry funded increased only slightly from 1.8% in 1981 to 2.7% in 2004, whereas in other countries like the Netherlands the share rose much more substantially. Given the importance of public research organisations in the French system one might expect that they would have significant partnerships with industry. However, the private sector funds only 4% (2003) of research in the higher education and public research organisation sectors combined. Clearly, the business sector invests in research in comparative isolation from the academic environment.

Spin-offs from the knowledge infrastructure have tripled in number since 1999 but the growth of these firms is not very significant: less than one in ten attains a turnover of €1m or employs 20 people after four years. As with licence revenues, successful companies originate from only a few public research organisations, mainly the Atomic Energy Commission *(Commissariat à l'énergie atomique - CEA)* and the National Institute for Computer Science and Control *(Institut national de recherche en informatique et en automatique - INRIA).* A current evaluation study[44] concludes that the French position in terms of valorisation is "[…] average […] from an international perspective, except for the creation of businesses." At the same time, there has been an overall increase in the total number of new business as well as in the share of 'real' start-ups in the French economy (see Exhibit 11).

Exhibit 11 Number of business creations 1993-2005

							%
	1993	**1997**	**2000**	**2002**	**2003**	**2004**	**2005**
Ex nihilo creations	62.3	61.3	64.7	65.7	67.7	69.9	70.9
Take-overs	17.7	17.2	15.4	15.0	13.7	13.2	12.9
Relaunches	20.0	21.5	19.9	19.3	18.6	16.9	16.2
Total number	272,264	269,430	270,043	268,459	291,986	318,757	316,534

Source: INSEE (Institut National de la Statistique et des Études Économiques)

The French venture capital market is quite well developed. It ranks behind the UK but in front of Germany. Generally, there is enough money for expansion; the problem is seed money – a problem common to most countries. The government has set up a Seed Money Fund *(Fonds d'Amorçage) to compensate*, but this seems to have had limited success. There are a tenth as many business angels in France as in the UK (approximately 4000 in France compared to 40,000 in the UK), which might reflect cultural differences.

3.2 Governance

Innovation policy design and implementation (for the larger part) fall within the responsibility of the Ministry of Industry and Ministry of Higher Education and Research.

[44] Inspection générale des finances and Inspection générale de l'administration de l'éducation nationale et de la recherche, *Rapport sur la valorisation de la recherche*, N°2006-M-016-01, N°2006-82, Janvier 2007

3.3 Policy Objectives

One important policy objective in the area of business R&D and innovation is increasing private investment in R&D by large firms as well as SMEs. This objective responds to the low levels of private R&D investments in France, while being in line with the 3% target ('Barcelona target'), which was explicitly endorsed by the French government. The 2003 Innovation Plan was notably motivated by the need to increase public and private R&D expenditures (as well as partnerships between the two sectors). The government underlined that while R&D expenditures accounts for 2.2% of GDP, the private share of R&D spending is well below the target of 2% of GDP (1.2%). The volume of public R&D expenditure, in contrast, is in line with the Lisbon/Barcelona strategy. It is argued that because of the traditionally weak interaction between the public and the private sectors, the leverage effect of public R&D has been limited. Increases in public research investments do not entail sufficient private investments.

The other important aim, if not the most important, is the valorisation of research, in particular linking science and industry and promoting start-ups and spin-offs and their growth. This objective tries to counteract the traditionally weak science – industry linkages.

All measures address the fifth objective of the Research Pact: to intensify innovation dynamics and linkages between public and private research actors.

3.4 Policy Instruments

Policy instruments in the area of business R&D and innovation have two main thrusts. On the one hand, policy instruments aim at increasing private investments in R&D, as the share of GERD funded by French enterprises (50.8% in 2003) is comparatively low. On the other hand, policy instruments seek to increase the commercialisation of public sector research through measures such as strengthening linkages between private and public research and innovation actors, promoting business creation, in particular spin-offs from public research, and encouraging the mobility of researchers.

3.4.1 Increasing private investments in R&D

The main objective of policy interventions in this area is to encourage companies to devote more resources to research. Traditionally, French innovation policy has been directed towards large companies. However, some measures specifically address SMEs. Policy interventions in this area include (list not comprehensive)

- The most important instrument is the Corporate Tax Credit for Research Expenses *(Crédit d'impôt recherche - CIR)* In 2004, the scheme was changed thoroughly. The main modification is that the tax credit will no longer be calculated in incremental terms only but will also take into account the volume of research spending, i.e. a volume-based scheme (5% of R&D expenditures) was introduced and the incremental scheme was decreased (from 50% to 45%). In 2004, the budget for this measure was around 890 million €. In 2006, the incremental part was reduced (40%) while the volume-based part was increased (10%). The eligibility criteria for expenses were also extended. The CIR is capped (at 16 million € for 2006).

- The Young Innovative Company *(Jeune Entreprise Innovante - JEI)* scheme was introduced in 2004. The objective of the Young Innovative Company status is to help young innovative firms overcome the difficult first years of existence by granting them tax credits for R&D investments. JEI status is conferred on independent SMEs less than 8 years old, with R&D expenses amounting to at least 15% of their total expenditures. Companies that enjoy the JEI status become eligible for a series of tax rebates including exemptions from corporation tax, local tax and social charges associated with the employment of highly qualified personnel. In 2005, 1600 companies benefited from research tax cuts of 72 million €. OSEO ANVAR is the regional manager of the measure
- In order to promote the fastest growing SMEs, the Ministry of Industry launched the 'Gazelle Programme' in May 2006. It is one of five 'SME growth programmes' in France (Financing growth programme; Competitiveness programme; New markets for SMEs programme; External growth and transfer programme; Gazelles programme). The Gazelle Programme is to identify the 2,000 fastest growing SMEs (over 2 years). These will benefit from the investment fund 'France Gazelles', which is endowed with 2 billion €, as well as from tax credits and exemptions from social charges. The French economy lacks medium-sized enterprises, as these enterprises find it difficult to maintain a sustainable and strong growth rate over the long-term. The Gazelle Programme has to be seen in this context.

3.4.2 Commercialisation of research

The 1999 Innovation and Research Act *(Loi sur l'innovation et la recherche)* and the 2003 Innovation Plan *(Plan innovation)* have played an important role in encouraging interactions between public and private research.

Despite an increase in the number of patents granted to the public research organisations during the last ten years, their revenues from intellectual property have decreased in the last few years, fluctuating around 1% of R&D expenditure.[45] This implies that knowledge and technology transfers to the socio-economic sphere carried out by public research actors have stagnated.

There has been a rapid increase in the number of industrial liaison offices *(services de valorisation)* at higher education institutions and public research organisations in recent years. University liaison offices employ an average of 4.2 FTEs, although this figure ranges from 8.6 FTEs for science universities to less than 3 FTEs for half of the higher education institutions. A recent audit report argues that such a service is sub-critical if it has less than 3 people; that in the case of *unités mixtes*, competition arises between the liaison functions of the public research organisation and the university and that the public research organisations' liaison offices usually offer a better range of specialised services.[46]

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[45] Inspection générale des finances and Inspection générale de l'administration de l'éducation nationale et de la recherche, *Rapport sur la valorisation de la recherche*, N°2006-M-016-01, N°2006-82, Janvier 2007

[46] Inspection générale des finances and Inspection générale de l'administration de l'éducation nationale et de la recherche, *Rapport sur la valorisation de la recherche*, N°2006-M-016-01, N°2006-82, Janvier 2007

Policy interventions aiming at collaboration between public and private research actors include

- Research and Technological Innovation Networks *(Réseaux de recherche et d'innovation technologiques - RRIT)*: The launching of RRITs in the late 1990s was a turning point as they broke with the large programme tradition, instead aiming to intensify and diversify science-industry linkages and to encourage the participation of SMEs and young firms. The RRITs started out in the transport sector and in ICT, then the model was applied in other technological areas; there was no formal selection procedure in terms of technological fields chosen. One of the main differences from previous large programmes is the largely bottom-up approach when defining objectives and the larger autonomy enjoyed by the project partners. Projects in RRITs usually involve a mix of public laboratories, SMEs or start-up companies and industrial groups. Projects submitted within RRIT are now funded by the ANR. The RRITs are systematically evaluated ex-post, some are also subject to mid-term evaluations.
- Competitiveness Clusters *(Pôles de compétitivité)* were introduced in 2005, following a report from Christian Blanc, the former CEO of Air France. The logic of Competitiveness Clusters is to create regional poles of research excellence in accordance with regional strengths. Competitiveness Clusters pool public and private resources in specific research areas, involving the central state, local authorities, universities, research laboratories, training centres and enterprises. The French authorities launched a call for projects in December 2004. In reply to their call for projects, the authorities in the regions received 105 applications, of which they selected 67 cluster projects. They cover areas like aeronautics, ICT, life sciences, but also more traditional sectors such as wood or construction. The clusters are to receive 1,5 billion € for 2006-2008.
- The Carnot Award is awarded to a limited number of public research entities (laboratories, research units) for being particularly strongly involved in cooperation with social and economic partners, particularly with firms. It aims to enhance the visibility of the research units awarded (the so-called 'Carnot institutes') and to fund the development of longer-term knowledge assets by the organisation. The measure was inspired by best practices already in place in Europe. The Carnot award is granted by the Ministry Delegate for Higher Education and Research for a four-year period. In 2006, out of 67 applications, 20 research units were selected and obtained additional funding of up to 40 million € per year.
- Mutual Technology Licensing Offices, selected in 2005 through a call for proposals of ANR. 14 Mutual TLO have been selected in order to manage technology transfer by sharing the means of the different institutions present the same area : Lille, Nancy, Strasbourg, Dijon, Besançon, Lyon, Grenoble, Marseille-Nice, Toulouse, Bordeaux, Rennes, Clermont-Ferrand, Digitée-Labs-Saclay, Paris-Universitors.
- Mobilising Programmes for Industrial Innovation ('*Programmes mobilisateurs pour l'innovation industrielle*' - PMII) are industrial research programmes headed by a consortium leader, usually teamed up with other companies and research institutions to build a consortium. Its goal is to commercialize, within five to ten years, products and services that are clearly innovative and leap frog existing products. The cooperative aspects of the programme, i.e. the participation of other stakeholders (consortium, partners, subcontractors, public

research organisations, etc.) are managed by the industrial leader and spelled out in a contract. The AII will finance up to 50% of the research and development expenses incurred by consortium members, in the form of subsidies and/or reimbursable loans, within the framework of European regulations for R&D assistance.[47] The first PMIIs were launched on 25 April 2006. They differ from former 'large programmes' in that they are more geared towards cooperation.

Since 2000, many initiatives have been set up to promote the creation and the development of businesses, covering a wide range of instruments (list not comprehensive):

- National contest for promoting the creation of new technological businesses *(Concours national d'aide à la création d'entreprises de technologies innovantes)*. 200 projects have been selected (out of 1500) every year since 1999 and been granted subsidies of up to 450,000 € each. The contest is organised by the Ministry for Research, ANR et OSEO Anvar
- Entrepreneurship Houses (*Maisons de l'Entrepreneuriat*) are established at higher education institutions. Their mission is to open up universities to the business world, strengthen the links between universities and enterprises, raise students' awareness of entrepreneurship, identify and exchange good practices in promoting entrepreneurship within universities. The Entrepreneurship Houses must result from a collaborative initiative taken by several higher education institutions. This measure responds to the lack of entrepreneurship culture, perceived as traditionally weak in France.
- The creation of regional incubators has improved innovation support services by involving process consultants or associations in the development and creation of technology-based companies resulting from private-public cooperation within these structures. There are approximately 30 incubators spread all over the country
- Seed-capital funds *(Fonds de Capital d'Amorçage)* are private companies (mostly private venture capital funds) in which public research organisations and higher education institutions have an interest, so as to link investors, business and academia. In September 2005, there were 8 national seed-capital funds and 10 regional seed-capital funds representing €275.3m, mostly in the ICT and life sciences sector
- The Support for Innovation *(Aide à l'innovation)* is one of the main measure supporting innovative projects by SMEs in France. The scheme assists technology-based start-ups, newly created firms (less than three years old) or firms willing to develop an innovative project. Eligible firms should have less than 2000 employees and be independent. All the stages of the innovation process can be supported through this scheme: project definition and feasibility, project development and industrial launching of projects. It also supports technology transfer from public or private laboratories to industry and, in particular, to SMEs. The scheme takes the form of a grant covering no more than 50% of the costs of the project. If the project is successful, the grant is reimbursable

[47] Public laboratories participating in PMIIs will be financed by the AII according to their usual aid schemes

Mobility of researchers, especially to SMEs (list not comprehensive)

- The 1999 Innovation Act entitles staff in public research organisations and higher education institutions to participate in business projects while pursuing their research career. The Act also entitles public research organisations to pay the salary of the entrepreneur in the initial phase of the start-up.
- Support for the recruitment of PhD candidates by enterprises *(Conventions industrielles de formation par la recherche – CIFRE)*: The measure is part of several measures to support mobility of students and researchers. This scheme supports the recruitment of a PhD student by a private enterprise. The recruited student conducts their research in the enterprise in a topic relevant to the enterprise, under the supervision of a university or public research organisation. The scheme aims to increase the number of executives in key positions, who understand research issues and who have the capacity to liaise with research bodies (academics, institutes, universities or other public research performers). Since 1981 13,000 PhD students have completed their PhD in the CIFRE scheme
- Support for the recruitment of technicians on innovative projects *(Conventions de recherche pour les techniciens supérieurs - CORTECHS)*: CORTECHS is a scheme aiming to support young technicians' recruitment in SMEs for research purposes. This convention involves a technician, an SME, and a 'competence centre' (a school of engineering, high school, research lab etc.). The scheme also intends to reinforce linkages between research bodies - in charge of monitoring the research project and training the engineer - and the SME, since the technician attends a training course at the *'Centre de compétence'*, while being employed by the SME
- Support to recruitment for innovation (ARI) *(Aide au Recrutement pour l'Innovation)*: The scheme aims to support SMEs that wish to strengthen their R&D personnel and resources. It supports a SME when recruiting a researcher to conduct R&D activity. A subsidy is granted that covers up to 50% of the cost incurred by the company during the first year

3.4.3 Specific SME support structures

Traditionally, French innovation policy has been directed towards large companies. However, in recent times, specific measures have been taken to involve SMEs in research and innovation activities. Indeed, apart from the programmes specifically targeted to SMEs such as the JEI, there is a whole range of support structures targeted to SMEs. These mainly provide (technological) services to SMEs. Distributed all over the country and often involving regional actors, they are an important tool of regional innovation policy. The support structure comprises more than 200 organisations

- Regional innovation and technology transfer centres (Centres régionaux d'innovation et de transfert de technologie – CRITT);
- Technological resource centres (Centres de resources technologiques – CRT);
- Technological Platforms (Plates-formes technologiques – PFT);
- Technological Development Networks (Réseaux de développement technologique – RDT).

3.5 Policy Effectiveness

An OECD evaluation report[48] examining RRITs found that they followed best practices in many respects. For example, they are based on a sound economic rationale, fit well into the national and regional innovation systems and cover a large range of technological fields relevant to the French economy and French society. However, there are a certain number of points that merit reconsideration: for example, some networks lack 'critical mass' in terms of public funding or have few international links.

A qualitative evaluation of the Corporate Tax Credit for Research Expenses was carried out in 2005 and 2006[49]. Based on interviews with beneficiaries as well as non-beneficiaries, the evaluation report concluded that there are three types of effects

- Explicit impact: the company takes the level of tax credit explicitly into account, increasing its overall R&D expenditures by the amount of the tax credit from which it will benefit
- Implicit impact: the company does not explicitly take the value of the tax credit into account when it designs its R&D budget. However, it considers the tax credit to be a subsidy that reduces the costs of R&D and allows it to take more risks or fund more research;
- No impact on the level of expenses: The tax credit does not have any effect on a company's R&D budget in nominal terms, although in some cases companies selectively undertake projects that attract higher rates of credit

Given the fairly low innovation capacity of French SMEs it is certainly useful to gear measures to SMEs and to offer specific support structures to them. Mobility measures provide one way to encourage non-R&D performers and those with weak R&D resources to increase their R&D activities. There may be a gap in encouraging companies to do non-technological R&D and innovation activities that do not count as R&D. However, as will be seen in this and the next chapter, there is also a myriad of instruments, making orientation for SMEs somewhat difficult.

According to a current evaluation report drawn up by the *Inspection générale des finances* and the *Inspection générale de l'administration de l'éducation nationale et de la recherche*[50], the incubators and the seed funds set up have contributed to the creation of new businesses. However, policy measures in this field have become complex and may be ineffective in promoting fast transfers from public labs to the market and the inclusion of private actors. The proliferation of new facilities, their compartmentalisation, their location far away from the *Pôles de recherche* and an insufficiently selective choice of firms to support means that in many cases they attract other kinds of beneficiaries than those engaged in commercialising knowledge form the knowledge infrastructure. The study concluded that

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48 OECD, Les partenariats public-privé pour la recherché et l'innovation: une evaluation de l'expérience française, Paris, 2004

49 Philippe Larrue, Patrick Eparvier and Sophie Bussillet, 'Etude de l'impact du Crédit Impôt Recherche, Technopolis France SARL, Paris, Mai 2006

50 Inspection générale des finances and Inspection générale de l'administration de l'éducation nationale et de la recherche, 'Rapport sur la valorisation de la recherche', N°2006-M-016-01, N°2006-82, Janvier 2007

impediments to the commercialisation of research were mostly structural, with weak absorptive capacity in parts of industry, a lack of interesting results to be commercialised and weaknesses in the way the knowledge infrastructure tackle the task of commercialisation

- The low number of researchers in French enterprises limits the firms' absorptive capacity of inventions generated in France and elsewhere and constitutes one of the principal barriers in the development of linkages between public research and industry
- Empirical data suggests that the quality of scientific research influences the development of knowledge and technology transfer. Hence, some economists argue that it is the modest French scientific position that constitutes a barrier to valorisation and needs improving
- The way commercialisation of research is organised in France appears to be a barrier. Research funding is only marginally project-based, impeding the competitive concentration of resources necessary to achieve research excellence. The separation between universities, research organisations and *grandes écoles*, between teacher-researchers and researchers as well as the weak autonomy of universities impedes universities from trying to develop effective research and commercialisation policies

Exhibit 12 SWOT Analysis of French Business Enterprise R&D and innovation

Strengths	Weaknesses
• Strong R&D-performers among large industrial companies • Large increase in spin-offs from public research in the last few years and an increase in start-ups generally indicate that there entrepreneurship is beginning to take hold in France. • Well-developed venture capital market • Substantial government willingness to fund BERD	• Less interest in industry in funding R&D than in key competitor countries, undermining achievement of the Barcelona Goal • SMEs are not very 'innovation active'. Their capacity to innovate seems limited • Low propensity to innovate in services • Limited public-private research partnering • Low patenting level • Poor commercialisation structures and activities limit this source of innovation
Opportunities	**Threats**
• Refocus and exploit strength of public sector research through more public-private partnerships • Build competence centres to act as focusing devices for knowledge infrastructure R&D and knowledge communities that span industry, universities and public research	• Limited engagement between major industry and the knowledge infrastructure allows companies more easily to be footloose • Failure to shift to a more science-based mode of innovation can reduce competitiveness

organisations • Build larger and more inclusive innovation clusters around the existing strong industrial R&D performers • Use instruments that increase absorptive capacity, especially in SMEs	

4 Economic and Market Development (Absorptive Capacity)

4.1 Indicators and Challenges

4.1.1 General macroeconomic trends and indicators

During the second half of the 1990s, the French economy grew strongly, with figures mostly above the average of the EU-15 area (see Exhibit 13). The recovery was based on strong domestic demand boosted by tax cuts, an investment boom and a more relaxed fiscal policy at the end of the 1990s. It was accompanied by strong employment growth. The specificity of this period was indeed that the 'employment content' of growth was higher than in the past, in part due to important structural reforms that reduced labour costs. Since 2000, the French economy has grown more or less in line with EU-15.

Exhibit 13 GDP growth rate (annual % change)

	GDP growth rate (in %)	
	France	EU-15
1997	2.2	2.6
1998	3.5	2.9
1999	3.2	3.0
2000	4.0	3.9
2001	1.9	1.9
2002	1.0	1.1
2003	1.1	1.1
2004	2.3	2.3
2005	1.2	1.5
2006	2.2 (f)	2.7
2007	2.3 (f)	2.2 (f)

Source: Eurostat - Structural Indicators and Long-term Indicators http://epp.eurostat.cec.eu.int
(f) forecast

Between 2000 and 2005, France's GDP per head has fallen to the EU-15 average from a higher level (see Exhibit 14), implying that France has become relatively less wealthy. Indeed, GDP per capita is higher in Sweden, Finland, the United Kingdom, Belgium, the Netherlands, Austria, Denmark, Ireland, and Luxemburg.

In the long run, increasing labour productivity is the surest way to increase the standard of living of a population. Labour productivity is strongly influenced by innovation performance, as measured by total factor productivity. The French

economy starts from a healthy position, with labour productivity clearly above EU-15 average (see also Exhibit 14). Indeed, labour productivity per hour worked is one of the highest in the EU (fifth position after Luxembourg, Belgium, Ireland and Austria at 17.3% above the EU-15 average), meaning that French workers produce more than the average EU worker. However, France became relatively less productive between 2000 and 2005.

Total employment growth remains poor, rising by 0.4% between 2004 and 2005, while the EU-15 average rose by 0.8%. Unemployment remained above 9% between 2000 and 2005. Unemployment among young people, and especially among new entrants to the labour market is, high (17.3% among people aged 15-29 in 2005). Aspects of the labour code designed to protect employees, and some aspects of the system of social transfers have had some unintended but perverse effects leading to structurally high levels of unemployment and low labour force participation rates among groups such as the low skilled and those nearing retirement age. In particular, the high level of employment protection and a high minimum cost of labour raise the cost of employing many lower-skilled people above their productivity, despite reductions in social insurance contribution on low wages. This poor labour market performance contributes to a persistent budget deficit.[51]

Rising public debt threatens fiscal sustainability. According to the OECD, long-term fiscal sustainability requires better control of public expenditures, including social expenditures and those of regional and local governments. Moreover, the fiscal system should be reformed by reducing the number of organisations involved and simplifying the tax structure through eliminating those tax breaks that are insufficiently justified. This would permit reduction in some high tax rates, which currently create economic distortions.[52]

With a ratio of tax and social insurance contributions to GDP of around 44% over the last 20 years, France belongs to the group of OECD countries with relatively high tax levels. A number of other European countries (Austria, Finland, Norway, Belgium and Italy) also have tax levels at a similar order of magnitude (between 42 and 46% of GDP) and only Sweden and Denmark have significantly higher tax levels (around 50% of GDP). Personal income tax is highly progressive. The earned income threshold where income tax is payable is relatively high and the bottom marginal tax rate is relatively low (6.8% and including earmarked social taxes 14.6%), while the top marginal rate is relatively high (48.09% and including social taxes 55.9% for taxable earned income up from around 48,000 € in 2004).[53]

[51] OECD, 'Economic Surveys: France, Volume 2005/10, Paris, September 2005
[52] OECD, 'Economic Surveys: France, Volume 2005/10, Paris, September 2005
[53] OECD, 'Economic Surveys: France, Volume 2005/10, Paris, September 2005

Exhibit 14 Comparable indicators of economic performance

Indicator	France		EU-15 average	
	2000	2005*	2000	2005*
GDP per capita in PPS (EU-25=100)	113.3	108.2	109.6	108.2
Real GDP growth rate (% change previous year)	4.0	1.2	3.9	2.7
Labour productivity per hour worked (EU-15=100)	119.2	117.3 (f)	100	100
Total employment growth (annual % change)	2.7	0.4	2.2	0.8
Inflation rate (annual average % change)	1.8	1.9	2.1 (e)	2.2 (e)
Unit labour costs (growth rate)	-0.3	0.0	0.3	-0.4
Public balance (net borrowing/lending) as a % of GDP	-1.5	-2.9	0.5	-2.3
General government debt as a % of GDP	56.8	66.6	64.1	64.5
Unemployment rate (as % of active population)	9.1	9.6	7.6	7.9
Business investment as a percentage of GDP	16.4	16.4	18.2	17.4

Source: Eurostat - Structural Indicators and Long-term Indicators http://epp.eurostat.cec.eu.int
* or latest available year (2004); key: (f) forecast, (e) Euro area

International experience suggests that continuing substantial public ownership, the slowness of market opening in network industries, protection of some service sector professions and the absence of competition in parts of retailing in France reduce the potential for growth, innovation and employment. According to the OECD Economic Survey, the whole economy would benefit from stronger competition in network industries, reduction in restrictions on entry to many professions and a deep reform of controls on retailing.[54]

The link between general economic figures and R&D figures is complex. However, despite the deterioration in macro-economic indicators, the budget for research has acquired some political priority. Indeed, the budget for research was recently allocated an additional billion in 2005 (one quarter of which was allocated to the Corporate Tax Credit for Research Expenses scheme). For 2006 and for 2007, the same additional amount has been earmarked. Indeed, a €5 bn increase from €19 bn in 2004 to €24 bn in 2010 for research and higher education is planned.

4.1.2 Knowledge intensity of the French economy

Exports of high-tech products reflect a country's ability to commercialise the results of research and technological innovation in international markets. France has a share of 25.6% of high-technology products in total exports, clearly above the EU-15 average of 19.8%. Likewise, French world market share of exports in high-tech products appears strong, with the French share (7.43%) just below the Japanese (8.94%) and the German (8.10%). Similarly, the value added of high-tech and medium high-tech manufacturing as a percentage of total value added gives an indication of the overall importance of high-tech sectors in the economy. In 2001, 7.29% of French value added originated from high-tech and medium high-tech industries; while for the EU-15 the proportion was a little higher (8.4%). The weak French science-industry linkages appear not to be reflected in these indicators, which tends to suggest that the past focus on autonomous innovation in certain large industrial firms has been effective. A key question is whether this can remain the case in future.

[54] OECD, 'Economic Surveys: France, Volume 2005/10, Paris, September 2005

The value added created by knowledge intensive services is an important indicator of the overall knowledge intensity of an economy. Compared to top performer UK and to the EU-15 average, France scores low. However, employment in high-tech services is fairly high, with 3.92% of the workforce employed in this sector (EU-15 3.49%). Likewise, employment in knowledge intensive services (KIBS) and particularly growth rates in employment in knowledge intensive services are above EU-15 average (39.27% compared to 37.27% and 4.65% compared to 3.23% respectively). The figures are clearly indicate a structural change ('tertiarisation').

Exhibit 15 Composite indicator of investment in the knowledge-based economy: EU Member States

Source: DG Research/JRC Key Figures 2003-2004; data: Eurostat, DG Information Society
Notes : All 7 sub-indicators were included for the investment levels (horizontal axis), but the indicator on e-government could not be included in the comparison of the growth rates (no data available on e-government for 1995). LU is not included (no data for most of indicators). For more details about the calculations and methodology see website www.cordis.lu/indicators/publications.htm.

As to investment in the knowledge-based economy[55], France, together with the UK, Germany, Austria, Ireland, Belgium and the Netherlands, belongs to a second group occupying an average position in terms of both their investment level and growth in 2001 (see Exhibit 15). Turning to performance in the knowledge-based economy[56] (see Exhibit 16), France is below EU-15 average in terms of performance growth rate and slightly above EU-15 rate in terms of performance level.

55 This indicator is composed of: total R&D expenditure per capita, number of researchers per capita, new S&T PhDs per capita, total education spending per capita, life-long learning, e-government, gross fixed capital formation (excluding construction)

56 This indicator is composed of: GDP per hours worked, European and US patents per capita, scientific publications per capita, e-commerce, schooling success rate

Exhibit 16 Composite indicator of performance in the knowledge-based economy: EU Member States

Source: DG Research/JRC Key Figures 2003-2004; data: Eurostat, EPO, USPTO, ISI/CWTS, DG Information Society
Notes: All 5 sub-indicators were included. The data for the UK's schooling success rate are partial and not completely harmonised. To allow calculations, UK growth from 1999 to 2001 has therefore been taken as 0, which may lead to a marginal underestimation overall of the performance growth for UK and EU-15. LU not included. For more details about the calculations and methodology see website www.cordis.lu/indicators/publications.htm.

In general, depending on the indicators selected, France fares more or less well when looking at the knowledge intensity of its economy. It does particularly well in terms of indicators relating to high-tech performance, including employment in high-tech services. French high-tech industries are clearly competitive on international markets. Overall, the French economy is strongly knowledge-based.

Exhibit 17 Indicative Indicators for Economic and Market Development*

Indicator	France	EU-15	European top performer	Source
Sales of 'new to market' products as % of turnover	6.2 (CIS4)	n/a	13.6 (Malta) (CIS4)	EIS
Sale of 'new to the firm but not to the market' products as % of turnover	5.6 (CIS4)	n/a	15.1 (Portugal) (CIS3)	EIS
Share of high-tech venture capital investment (in %)	58 (2001)	32% (2001)	86 (Denmark) (2001)	RTD
Share of seed and start-up capital in total venture capital (in %)	44% (2001)	34% (2001)	66% (Finland) (2001)	RTD
Share of early stage (seed and start-up) venture capital as % of GDP (2001)	0.39 (2001)	0.43 (2001)	1.04 (Finland) (2001)	RTD
FDI inflows as a percentage of GDP (2000-2003)	3.4	n/a	16.4 (Ireland)	OECD
Internet access at home (% of households)	41 (2006)	54 (2006)	83 (Iceland) (2006)	Eurostat
Broadband penetration rate (per 100 population)	13.9 (2005)	12.0 (2005)	22.5 (Iceland) (2005)	EIS
ICT expenditures as % of GDP	6.0 (2005)	6.4 (2005)	9.9 (Bulgaria) (catching up)	EIS

			(2005)	
Labour productivity (GDP per hour worked, in current PPS)	39.6 (2002)	33.8 (2002)	47.5 (Norway) (2001)	3%AP
Labour productivity (GDP per hour worked) – annual real growth in percentage (1997-2002)	1.92	1.48	4.95 (Ireland) (catching up)	3%AP
Wold market share of exports in high-tech products (%)	7.43 (2001)	37.51 (2001)	8.10 (Germany) (2001)	3%AP
High-tech exports as a percentage of total exports	25.6 (2001)	19.8 (2001)	54.2 (Malta) (2001)	3%AP
High-tech manufacturing industries exports as a percentage of total manufacturing exports (2003)	22.5 (2003)	19.7 (2003)	59.7 (Malta) (2003)	3%AP
Percentage of workforce in high-tech services	3.92 (2005)	3.49 (2005)	5.13 (Sweden) (2005)	EIS
Value-added of high-tech and medium high-tech industries as % of total gross valued added	7.29 (2001)	8.44 (2001)	23.47 (Ireland) (2001)	3%AP
Value added of knowledge intensive services as % of total gross value added	32.07 (2001)	38.46 (2000)	61.32 (UK) (2001)	3%AP
Employment in knowledge intensive services as % of total employment	39.27 (2001)	37.27 (2001)	53.41 (NL) (2001)	3%AP
Annual growth rate (in %) in employment in knowledge intensive services (1996-2001)	4.65	3.23	6.25 (Austria)	3%AP

Key: OECD = Organisation for Economic Cooperation and Development
EIS = European Innovation Scoreboard
RTD = RTD Indicators Report
3%AP = 3% Action Plan (Key Figures 2003-2004 and Key Figures 2005)
CIS3 = Third Community Innovation Survey 1998-2000
CIS4 = Fourth Community Innovation Survey 2002-2004
n/a = not available or not applicable

*There is some overlap with indicators relevant to other domains and between indicators from different sources.

4.2 Governance

Industrial and innovation policy formulation and implementation (for the most part) fall within the responsibility of the Ministry of Industry.

4.3 Policy objectives

- The main policy objectives are

- Promoting growth and innovation
- Attracting business by increasing competitiveness
- Increasing small firms' competitiveness
- Fighting unemployment

All four objectives target known weaknesses in the French research and innovation system and the French economy in general.

4.4 Policy instruments

Economic and industrial policy is a vast area, ranging from foreign trade via competition to taxes and employment. Hence, we will limit ourselves to major policy projects, in particular those relating to innovation (list not comprehensive).

4.4.1 Economy

Economic policy focuses on supporting growth and innovation

- Access to financial markets: the Economic Modernisation and Confidence Act (*Loi pour la confiance et la modernisation de l'économie*) of July 26, 2005 is intended to facilitate access to the financial markets for businesses. For instance, it introduces the European limited company *(le régime de la Société Européenne)* to French law, in line with the European directive on public takeover bids
- Foreign trade: the government created an export tax credit in 2004, in order to encourage exports by small and medium-sized French firms
- New industrial policy: a shift to an innovation-based industrial policy (see section 3.4)
- Modernisation of public management via the 2001 Organic Finance Act *(Loi Organique des Lois de Finances - LOFL)* (see section 1.1.7)

4.4.2 Attracting business

Since 2002, the government has taken steps to increase the competitiveness of the French economy, thus attracting more businesses. The strategy rests on four pillars

- Promoting corporate investment in France: a cut in mandatory payroll taxes, simplified administrative and tax processes, enhanced monitoring and improved legal security aim to attract foreign businesses to France. In order to promote France as a location of choice for strategic sectors such as health, financial services
- Attracting and developing skills: the rules governing personal taxation, income tax and the procedures relative to entering France for employment have been made more flexible in order to make it easier for foreign executives to move to France. Tax deductions have been implemented to encourage pharmaceutical companies to hire young foreign researchers. In addition, France's cultural influence has been promoted through the 'preferred host' status given to non-governmental organisations and through tax credits granted to the film and other creative industries
- Synergy and growth clusters: competitiveness clusters have been set up as part of a strategy designed to make the French economy more attractive both for the businesses already operating and for foreign investors and researchers (see section 3.4.2)
- Infrastructures: the Act dated 21 June 2004 relative to confidence in the digital economy allows local governments to become high-speed Internet access providers. In addition, the government is pursuing the goal of covering the main areas of economic activity and all French municipalities with second-generation mobile telephony by 2007. Finally, a series of major infrastructure projects designed to improve the French transport grid will be completed by 2025, including eight high-speed rail lines, some of which will link up with neighbouring countries, five major rail lines for freight and nine motorway projects. The Agency for Transport Infrastructure Financing (AFITF) was set up in 2005 in order to facilitate the completion of these projects

4.4.3 SMEs

Another major government project is rendering small companies stronger, healthier and more competitive

- Revitalizing new business start-ups: apart from the various instruments described in section 3.4.2, there are many others, mainly aiming to increase security for the entrepreneur. For instance, entrepreneurs have the right to return to their previous job for a year after starting up a new business. Entrepreneurs receiving unemployment benefits may continue to receive benefits in addition to any income earned during their first eighteen months of business
- Development of SMEs: the SME Act dating from 2 August 2005 *(Loi en faveur des petites et moyennes enterprises)* sets forth a temporary waiver of mandatory payroll contributions and the option of paying in instalments. Investments in Alternext, the new European market dedicated to non-listed SMEs, will be rewarded with tax reductions
- Laying the foundations for business transfers: since 2003, any person who borrows money in order to purchase a business has been eligible for tax reductions. If the person purchasing the business is an employee of the business, s/he is fully exempt from all settlement taxes. The SME Act also provides a bonus for business owners who sell their companies rather than liquidating them
- A pro-employment policy: in 2005, the government created the 'first job' contract, an open-ended employment contract that includes a trial period of two years. Businesses with fewer than 20 employees are eligible to hire under the new contract, which also includes the use of special 'salary cheques' for micro-businesses. The cheques serve as both employment contract and pay slip for the employee.
- Modernizing business relations: the SME Act prohibits agreements proposed by major manufacturing corporations that aim to force SMEs producing similar products out of the market. The Act also includes a change to the margins that determine price dumping, which remains a criminal offence
- Promoting innovation: see section 3.4
- Exports: see section 4.4.1

4.4.4 Employment

Three priority actions have been developed

- The personal service development plan launched at the beginning of 2006 is designed to contribute to growth in demand for home-based services linked to daily life - family support, healthcare services, etc. Some 500,000 jobs are expected to be created by 2009. Various measures, including the very small business employment cheque and new hire contract, aim at simplifying the hiring process in small and very small businesses
- Valuing income from working: various incentives for returning to employment are offered, with bonuses and an increase in the minimum wage aimed at valuing income from working
- Various specific measures have been taken for groups most affected by unemployment

4.5 Policy effectiveness

Again, many of the instruments described above have been implemented only recently. Hence, even if there are evaluation studies, assessment of effects is difficult.

Many instruments rely on various forms of tax breaks. Clearly, they will not contribute to increasing transparency of the fiscal system. Given that the OECD deplores the complexity of the French fiscal system, advocating reform by reducing the number of organisations involved and simplifying the tax structure through eliminating those tax breaks that are insufficiently justified, the instruments are problematic from a fiscal policy point of view.

Exhibit 18 Swot Analysis

Strengths	Weaknesses
• High-tech exports: strong position on world markets • Stronger than average positions in KIBS	• High (structural) unemployment • Continuing labour market inflexibilities • Complex fiscal system with high effective tax rates
Opportunities	**Threats**
• Build on strong technology-based positions	• Declining productivity and GDP per head relative to EU-15 average (see Exhibit 14) • Increasing competition from economies with low, flat-rate taxation systems • Substantial increase in general government debt since 2000 • Failure to liberalise key infrastructural markets

5 Human Resources (Human and Social Capacity)

5.1 Indicators and challenges

5.1.1 Educational attainment of population

The level of educational achievement of the French population is above OECD and EU-15 averages at the lower secondary level, below average at the middle (upper secondary) level and around average with regard to higher education (see Exhibit 19).

Exhibit 19 Educational attainment of adult population (2004)

	Attained lower secondary level of education or below	Attained upper secondary level of education	Attained tertiary level of education
France	35	41	24
EU-19 average	29	45	23
OECD average	30	42	25

Source: OECD 2006

Education system reforms in the 1970s and 1980s increased the level of education of the labour force substantially, as can be seen in Exhibit 20: the share of adults with at least upper secondary education is below average in the age group 45 and older.

Exhibit 20 Percentage of the Population in Different Age Categories that has Attained at least Upper Secondary Education (2004)

	25-64	**25-34**	**34-44**	**45-54**	**55-64**
France	65	80	70	59	49
EU-19 average	67	78	71	63	52
OECD average	67	77	71	64	53

Source: OECD 2006

In spite of the reforms, the French educational system faces difficulties. The problem of failure at school is a serious issue. For the last ten years, 100,000 young people per year, mostly males, have left school without any qualifications.

5.1.2 Higher education

Exhibit 21 Population that has Attained Tertiary Education (2004)

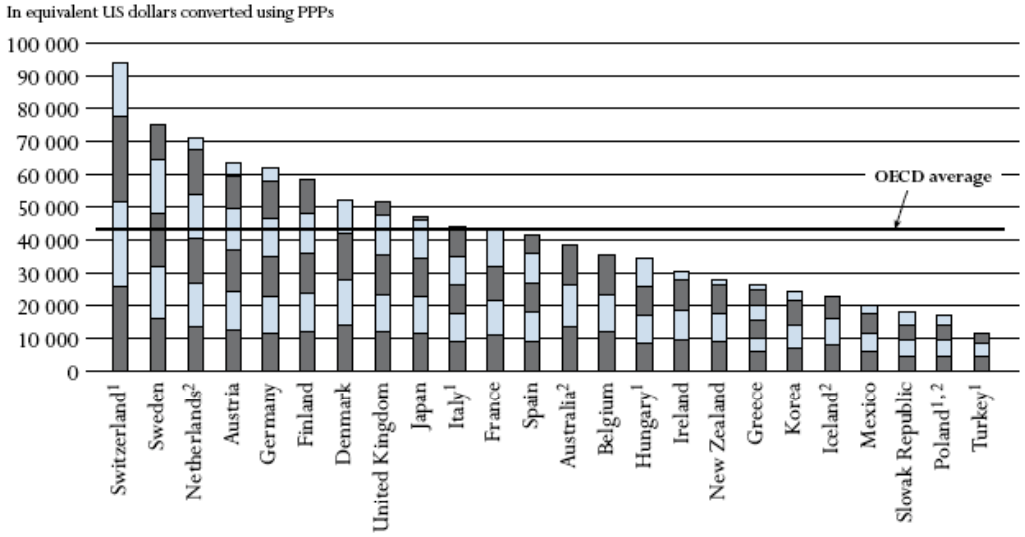
	25-64	**25-34**	**34-44**	**45-54**	**55-64**
France	24	38	24	18	14
EU-19 average	23	28	24	21	16
OECD average	25	31	27	23	18

Source: OECD 2006

Since the mid-1980s a significant increase in enrolments in upper secondary school has led to an increase in tertiary level graduates (see Exhibit 21). The downside of this development has been a strong demographic pressure on universities, for which financial resources remained relatively low. Indeed, France is one of the countries where education expenditures per tertiary student are average (Exhibit 22).This might contribute to the high rate of failure and withdrawal experienced during the first two years at university.[57] In the last few years, however, student numbers in universities have been more or less stable.

[57] Rémi Lallement and Sandrine Paillard, *The French innovation system in the knowledge-based economy*, Commissariat général du Plan, Paris, 2003

Exhibit 22 Cumulative Expenditure in Educational Institutions per Student over the Average Duration of Tertiary Studies (2003)



Note: Each segment of the bar represents the annual expenditure on educational institutions per student. The number of segments represents the number of years a student remains on average in tertiary education.
1. Public institutions only.
2. Tertiary-type A and advanced research programmes only.
Countries are ranked in descending order of the total expenditure on educational institutions per student over the average duration of tertiary studies.
Source: OECD, Table B1.3b. See Annex 3 for notes (*www.oecd.org/edu/eag2006*).
StatLink http://dx.doi.org/10.1787/717773424252

France has a very good rating with regard the number of Science and Engineering (S&E) graduates, which is 162% of the EU-15 average. In fact, it is the only indicator in the European Innovation Scoreboard 2006 where France ranks amongst the first three. The more general indicator, showing the share of the population with a tertiary education, is closer to the EU-15 average. At the same time, the share of expenditure on tertiary education (1.4% of GDP) is relatively low compared to the overall amount in all education levels (6.3% of GDP). Like in most European countries, public spending accounts for more than 90% of total expenditure in primary, secondary and postsecondary education. In tertiary education, the share is slightly lower (approximately 80%) (see also Exhibit 23). Finally, participation in life-long learning is rather weak**,** only reaching 80% of the EU average.

Exhibit 23 Expenditure on education in 2003 (in bracket figures for EU-19)

	Public	**Private**	**Total**
Expenditure on education as % of GDP			
- for all levels	5.8 (5.2)	0.5 (0.4)	6.3 (5.6)
- primary, secondary and post-secondary non-tertiary education	4.0 (3.6)	0.3 (0.2)	4.2 (3.7)
- tertiary level	1.1 (1.1)	0.2 (0.2)	1.4 (1.3)

Source: OECD 2006

5.1.3 Researchers

As to the mobility of researchers, 40% of all academics and researchers work in the universities and public research organisations where they obtained their PhD, or where they were already teaching. Once they are hired, academics and researchers generally show a rather low geographic or functional mobility.[58] Mobility of researchers and teacher-researchers to private companies remains low despite the measures taken: since 1997, only 0.2% of all researchers in public institutions have transferred to the private sector annually.

Research careers are felt by many to be unattractive. Owing to the massive increase in student numbers in recent decades, teacher-researchers have been forced to devote a growing proportion of their time to teaching and managing educational programmes and less time to research. However, recruitment and promotion of teacher-researchers are mainly based on research performance, which often leads to conflict with teaching responsibilities[59]. The professional integration difficulties faced by young PhDs (see Exhibit 24), the opacity of the recruitment system and the low wages further add to the low attractiveness of a research career.[60]

Exhibit 24 Professional situation of doctors in 2004, 3 years after their PhD

Disciplines	Unemployed in March 2004 (%)	Researchers and teacher-researchers in public sector (% of all employed doctors)	Researchers in private sector (% of all employed doctors)
Maths, physics	7	56	22
Engineering	6	43	32
Chemistry	14	43	30
Life and earth sciences	11	45	20
Law, economics, and management	11	50	18
Humanities and social sciences	17	49	5

Source: Centre d'études et de recherches sur les qualifications (Céreq), enquête 'génération 2001'

5.1.4 Vocational training

The French system of continuing vocational training was set up in 1970. The basis of the system is a requirement for firms to fund continuing vocational training for employees. Private companies with more than 10 employees have to spend at least 1.5% of their wages bill on continuing training (up from 0.9% in 1971).

The system has resulted in a significant increase in continuing vocational education. However, initial vocational training (apprenticeships) is still underdeveloped and has little social status, with most young people leaving the education system entering employment at the end of compulsory general education (including general education geared towards professional qualifications like the *lycée professionel* and

[58] Rémi Lallement and Sandrine Paillard, 'The French innovation system in the knowledge-based economy', Commissariat général du Plan, Paris, 2003

[59] FutuRIS, 'Synthesis Report for a National Debate', Paris, March 2004

[60] Rémi Lallement and Sandrine Paillard, 'The French innovation system in the knowledge-based economy', Commissariat général du Plan, Paris, 2003

the *lycée des métiers*). Consequently, the function of continuing training, which tends to be short in duration and specific to individual jobs, is to compensate to some extent for this lack of initial training.[61]

The training system has been modified in the last few years, introducing most notably an individualisation of continuing vocational training and an upgrading of the apprenticeship systems.

Exhibit 25 Indicative Indicators for Human Resources

Indicator	France (year)	EU-15 (year)	European top performer (year)	Source
Percentage of GDP spent on education	6.3 (2003)	5.6 (EU-19)	8.0 (Iceland)	OECD
Percentage of working population with tertiary level education	24.0 (2005)	24.9 (2005)	34.6 (Finland) (2005)	EIS
Percentage of working population in life-long learning	7.6 (2005)	12.1 (2005)	34.7 (Sweden) (2005)	EIS
Youth education attainment level (% of population aged 20-24 having at least completed upper secondary school)	82.8 (2005)	74.1 (2005)	96.3 (Norway) (2005)	EIS
Percentage of workforce in medium-high and high-tech manufacturing	6.34 (2005)	6.71 (2005)	10.43 (Germany) (2005)	EIS
Percentage of workforce in high-tech services	3.92 (2005)	3.49 (2005)	5.13 (Sweden) (2005)	EIS
Researchers as % of the working population	0.77 (2003)	0.59 (2003)	1.73 (Finland) (2004)	OECD
Percentage of GDP spent on tertiary education (public and private) (2003)	1.4 (2003)	1.3 (EU-19) (2003)	1.8 (F, DK, SE) (2003)	OECD
Researchers as % of the working population	0.77 (2003)	n/a	1.73 (Finland) (2004)	OECD
S&E graduates as % of the 20-29 age range	22.0 (2003)	13.6 (2004)	23.1 (Ireland) (2004)	EIS
S&E graduates as % of new degrees	29.4 (2003)	24.2 (2003)	29.9 (Ireland) (2003)	3%AP
Number of new S&T PhDs per thousand population aged 25-34 population (2001)	0.71 (2001)	0.55 (2001)	1.37 (Sweden) (2001)	3%AP
HRST breakdown				3%AP

Key: OECD = Organisation for Economic Cooperation and Development
EIS = European Innovation Scoreboard
RTD = RTD Indicators Report
3%AP = 3% Action Plan

* There is some overlap with indicators relevant to other domains and between indicators from different sources.

5.2 Governance

The main actor formulating and implementing policy regarding education and higher education is the Ministry of National Education, Higher Education and Research *(Ministère de l'éducation national, de l'enseignement supérieur et de la recherche),* in particular the Directorate General of Education *(Direction générale de*

[61] Philippe Méhaut, 'Reforming the training system in France', Industrial Relations Journal, 36:4, 2005, pp303-317

l'enseignement scolaire) and the Directorate General of Higher Education *(Direction générale de l'enseignement supérieur)*.

The Ministry of Employment, Social Cohesion and Housing *(Ministère de l'emploi, de la cohesion sociale et du logement)*, and more particularly the Delegation General of Employment and Professional Education *(Délélegation générale à l'emploi et al formation professionnelle)*, are in charge of professional training, including continuing professional training. However, as in many European countries, life-long vocational training is a system with many actors who share responsibility. It involves the central state, the regions, firms, employees and the more than 40,000 organisation delivering educational programmes.

5.3 Policy objectives

The issue of Human Resources is complex, and addresses the entire educational experience of people from their first school days through to adult learning. Consequently, there is a whole range of policies in place to build up human resources. As they have the most immediate relevance to innovation, we will limit ourselves to policy objectives and instruments relating to higher education and professional training.

5.3.1 Higher education

- The most important objectives are:

- Implementing the Licence-Master-Doctorate (LMD) system to facilitate the mobility of students and to enhance the international recognition of diplomas ('Bologna' process)
- Strengthening the link between research and education: at the Master's and doctoral levels, education and training has to be based on research. The importance of this objective is reflected in institutional terms: formerly, the *Direction de la recherche universitaire* was part of the *Direction de la recherche* but has been transferred to the *Direction de l'enseignement supérieur*
- Providing students with comprehensive information on higher education and facilitating their transition to the labour market. The former is supposed to reduce failure rate in universities
- Enhancing access to higher education for the most underprivileged and improving students' living and study conditions
- Improvement of doctoral training and increasing the number of PhDs employed by firms
- Making research careers more attractive

5.3.2 Vocational training, including life-long vocational training

- The most important objectives are:

- Development of initial vocational training (apprenticeship system).
- Strengthening continuing vocational training.

Given the high unemployment rate among young and low-skilled people as well as the qualitative changes in the labour market, an upgrading of the training system (initial and continuing) is vital.[62]

5.4 Policy instruments

5.4.1 Higher education

- LMD reform: in accordance with the Bologna process, France introduced the Licence-Master-Doctorate system. By leaving the initiative to the universities, France managed to reform the course system without problems and without a new law.[63] When renewing the contract with the Ministry of Research, the universities could choose between the old system or the new LMD system. Most universities opted for the LMD system, as there was a large and confusing number of different diplomas
- Enhancing access to higher education: since 2002 the government has spent considerable amounts of money on measures relating to housing, social security, health, and access to ICT in order to improve access to higher education for the most underprivileged
- Comprehensive information for students and students-to-be: Information to students from *lycées* and universities on universities, courses offered, failure rates, possible careers, student life etc. has been improved. The development and expansion of so-called orientation and career platforms *(plates-formes d'orientations et d'insertion professionelle*) at universities are strongly encouraged by the ministry of Research and Higher Education. An internet site has also been established.[64]
- Facilitating transition to the labour market: a national debate on university and employment was launched in 2006, supervised by a commission composed of 15 persons from the world of business and academia. All in all, more than 120 meetings in 29 academies took place and more than 20,000 people participated. The commission proposed a range of measures to improve the current situation, some of which were taken up. Moreover, apprenticeships in higher education, for instance in technical subjects, agriculture etc., are offered and internships are promoted
- Improvement of doctoral training and increasing the number of doctors employed by firms: PhD training takes place in doctoral schools. Doctoral schools are strengthened by gearing evaluation to scientific achievement, quality of supervision and career trajectories of PhD holders. Evaluation results will be taken into account when negotiating the contract between the ministry and the university. Moreover, universities are encouraged to unite to establish a doctoral school. Against the background of increasing employability of doctors and rendering them more attractive to firms, doctoral schools have set up specific courses in foreign languages, project management and communication skills as well as seminars ('*doctoriales*') where PhD students can meet people from

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[62] Indeed, countries with a strong apprenticeship system, i.e. the German-speaking countries, have comparatively low levels of unemployment among people aged 15-24

[63] This in marked contrast to, for example, Germany, where a heated debate about the Bologna Process has arisen

[64] http://www.etudiant.gouv.fr/

business. There are already programmes in place which allow PhD students to do their research in industry, most notably CIFRE (see section 3.4.2)

- Increasing the attractiveness of a research career: according to the Research Pact, research careers are to be made more attractive by upgrading the doctorate, by facilitating the entry of doctors into research careers and by diversifying the career options of researchers and teacher-researchers. This includes, for example, an increase in the value of PhD fellowships, so that PhD students will be paid better
- Mobility of researchers: in the context of increasing the attractiveness of a research career, the 2006 Research Act also increases the number of visiting researchers working in universities, with a special focus on post-docs and on temporary teaching and research fellows *(Bourse Descartes, Initiative PostDoc)*. There is also a programme that aims to attract foreign scientists and French scientists working abroad *(Chaires d'excellence senior et junior)*. Visits to France by foreign researchers and visits abroad by French researchers have been greatly facilitated. The scientific councils and national visit committees are now much more open to foreign expertise
- Strengthening the link between research and education: When the ministry authorises a new course, one of the most important criteria is the research potential in the field in which the course is situated. No master's degrees can be awarded in areas where university research units are weak

5.4.2 Vocational training

- Initial vocational training, i.e. the apprenticeship system, has been upgraded and modernised, with more flexible vocational training systems and stronger resources. Moreover, following a *mission de valorisation de l'apprentissage* launched in 2005, an 'Apprenticeship Agreement' *(Charte de l'apprentissage)* was set up, which has been signed by 1,300 firms so far. Radio and TV spots try to attract young people to this form of training. In 2006, 271,000 apprenticeship contracts were signed, 16,000 more than in 2005
- In 2001 and again in 2003 the social partners embarked upon new negotiations in a bid to redesign the system of continuing vocational training, leading to a new Act in May 2004 *(loi du 4 mai 2004 relative à la formation professionelle tout au long de la vie et au dialogue social)*. The agreement and subsequent legislation confirm and strengthen the basic characteristics of the system in various ways, in particular the employer training levy. The great novelties were an individualisation of training, most notably an 'individual right to training', a 'training passport' (which lists the knowledge and know-how acquired during initial and continuing training as well as experience obtained at work and the competences acquired by individuals in the course of that work) and a certificate validating knowledge and know-how gained from experience *(Validation des acquis de l'expérience, VAE)*
- Moreover, 'reskilling contracts' *(contrats de professionnalisation)* have been introduced for workers newly recruited from the unemployment register; these contracts replace the various forms of assistance available to unemployed individuals with low skill levels. In 2006, 140,876 reskilling contracts were signed, 50% more than in 2005 (92,500). The workers most at risk of losing their jobs because of technological change and/or skill obsolescence can take advantage of 'reskilling periods'. These may include on-the-job training, formal

training and evaluation of knowledge and know-how acquired through experience and could lead to a certificate or diploma. Workers aged 50 and over, those with more than 20 years' seniority and/or those regarded as a priority at industry level may claim their right to these 'reskilling periods'. These measures make sense, as, until recently, the French continuing training system worked to the detriment of the least-skilled and older workers.[65]

5.5 Policy effectiveness

All instruments are fairly new so that measuring effectiveness is next to impossible.

Exhibit 26 SWOT analysis

Strengths	Weaknesses
• High level of S&E graduates • High basic level of education of the population • High ranking in Europe for "Validation of Professional Experience"	• Above-average share of population with low educational attainment, especially among older age groups • Low levels of life-long learning • Limited researcher mobility • Unattractiveness of research careers
Opportunities	**Threats**
• Reinforcement of the apprenticeship system and vocational training	• High number of unemployed PhDs • Unattractiveness of PhDs to the private sector: firms prefer to recruit graduates from leading *grandes écoles* • Reduced innovativeness of industry

6 Overall Innovation System - Issues

The performance of the French innovation system is in many senses 'average' – for example, in innovation, research quality wealth per person – and the corresponding challenge is to raise performance to excellent levels. As often is the case, aspects of the average conceal a mixture of good and poor performance. For example, there is strong industrial R&D among the large companies but R&D and innovation performance among the small firms is weak. There is a strong supply of manpower with degrees in science and technology but comparatively a relatively weak system of vocational training. It appears likely that this mixture of strong and weak results are coming from the underestimation of the fact that the performance of complex systems is often driven as much by actors' mean performance as by the peak levels.

France has signed up to the Barcelona Goal, but it is perhaps worth considering whether the approach should be more nuanced, given the sectoral composition of the French economy (for example, the importance of the agrifood industry and tourism). It is probably more important that all parts of the economy have at least an adequate level of technological capability than that the country should hit some arbitrary quantitative target that has no basis in analysis at the level of France.

[65] Rémi Lallement and Sandrine Paillard, 'The French innovation system in the knowledge-based economy', Commissariat Général du Plan, Paris, 2003

The innovation system is more broadly characterised by a range of features that are increasingly recognised by policymakers as counter productive. The need for change is reflected in some institutional structures. One is the lack of clear separation between customers and contractors in relation to the public research organisations, which largely continue to programme their own research. This drives the need to fund via block grants rather than projects, in turn reducing competitive pressures on quality and relevance of research. It in turn impedes private-public partnerships in research, since these depend upon a degree of flexibility in contracting. A similar logic applies to the universities. Good practice in other countries is to balance university research funding through the block grants with 'binary' funding from research councils and other agencies that set priorities at the level of individual projects or Centres of Excellence. This binary funding is time-limited and subject to various tests of quality, and is generally understood to provide a guarantee of the quality and relevance of the research effort as a whole.

Another aspect of slow institutional change is the only partial separation of tasks between ministries and their agencies that leaves OSEO Anvar, for example, tackling innovation needs of companies on a one-to-one basis but the Industry Ministry with the responsibility for tackling innovation in clusters. A clearer and more consistent subsidiarity principle will allow more 'joined up' policies to be designed and to be implemented by agencies with the competence to tackle problems such as innovation in the round.

The capacities and capabilities of some parts of the innovation system need to be strengthened in order to bring it into balance. Low absorptive capacity among smaller firms and limited ability to define and implement strategy in universities are among the areas that should be tackled.

Most of these things are in various ways being tackled in the new policy implemented by the ministry in charge of higher education and research. There are important external drivers that demand increased flexibility ranging from globalisation to WTU and EU rules.

In that respect, the French national reform programme is a very positive change: the Research Policy Act of 18th April 2006 is based on three key pillars : significantly increasing the financial effort for R&D and education ; systematic assessment of each public funded action and institution ; increasing efficiency of partnership actions. It aims at increasing public research efficiency, improving public and private research interaction, strengthening project-based research and improving public-private linkages. This is a major commitment for the five coming years.

The Research Pact aims at increasing visibility and better connection to European instruments (ERA NET, ERC, etc). This means setting up research policy steering capacities (HCST) ; giving universities a leading role and better visibility and critical mass (PRES, RTRA) ; encouraging partnership-led and private research (Tax Incentive, Carnot label, ANR and AII, cluster policy) ; strengthening the appeal of science, increasing incentives to recruit young researchers and enhancing the attractiveness of scientific careers (CIFRE and Descartes Fellowship, etc.). The establishment of an independent agency for scientific and structural evaluation of

research and innovation (AERES) is an important tool for the renewal of French policy in that field.

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