Chapter 4

Public research in France

This chapter presents the French public research system. By comparing international statistics, it analyses France's output in science, research organisations' primary sphere of activity: the number of articles published, recipients of international grants, etc. It goes on to examine the major public research organisations, such as the National Centre for Scientific Research, that are central to public research in France, as well as research at universities: its budgets, staff management and governance. These sectors have undergone successive reforms over the past decade. This chapter analyses them in detail, focusing in particular on the development of project funding and evaluation.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Introduction

Until recently, and even to a large extent today, the French public research system focused on large public research organisations (PROs), the largest of which is the National Centre for Scientific Research (CNRS). These PROs fulfil all the primary functions of a public research system: planning, funding, implementation and evaluation. This structure is unlike that of other countries in the world, where PROs are generally smaller and have more limited powers, where universities play a greater role in performing research and where resources – especially financial resources – are allocated by separate bodies.

Successive French governments since the late 1990s have sought to foster scientific excellence and to steer public research towards specific economic, social or environmental objectives. They believed that a more open organisational structure, in which politicians would have more control over planning and the various powers would be exercised by separate entities, would be more appropriate to these objectives. In this context, successive reforms over more than a decade have created new structures and mechanisms, generally reflecting a rationale closer to that of the international model. Consequently, the public research system has undergone a number of changes and reforms since 2005. The Law on the Freedoms and Responsibilities of Universities (LRU Law) in 2007, the creation of research and higher education clusters (PRES), the National Research Agency (ANR) in 2005 and the Evaluation Agency for Research and Higher Education (AERES) in 2007, and the "Investments for the Future" Programme (PIA) in 2009, which involved the establishment of the Idex (initiatives of excellence), are all changes that have shaped the French research landscape. These measures all have in common the quest for excellence and an increased focus on directing research towards socio-economic objectives. The chosen pathway is to concentrate research funding on teams or universities that fulfil the excellence criteria and are working on government-selected priority areas. At the same time, some PROs have themselves taken the path of reform, with the aim of promoting excellence internally and responding more systematically to the economic and social requirements of research with the framework of their existing structures and procedures. The new mechanisms and stakeholders complemented, rather than replaced, the old ones, even as some underwent significant changes: the system has therefore become less consistent while also becoming significantly more complex, leading to decreased transparency and increased operating costs.

The system now finds itself in a hybrid situation, which raises questions that will be discussed in this chapter: how does the quality of French science compare with that of other countries? How are the PROs positioning themselves in relation to the changes underway? To what extent are universities prepared to play the central role assigned to them under the new rationale? Do the new mechanisms concerning the competitive allocation of funding and evaluation meet expectations? How can the overall balance of the system be optimised in light of the various transformations underway?

This chapter will first describe how French science compares with that of other countries. It will then analyse the main stakeholders – the PROs and universities – as well as the resource allocation mechanisms (recurring or competitive) and the evaluation mechanisms.

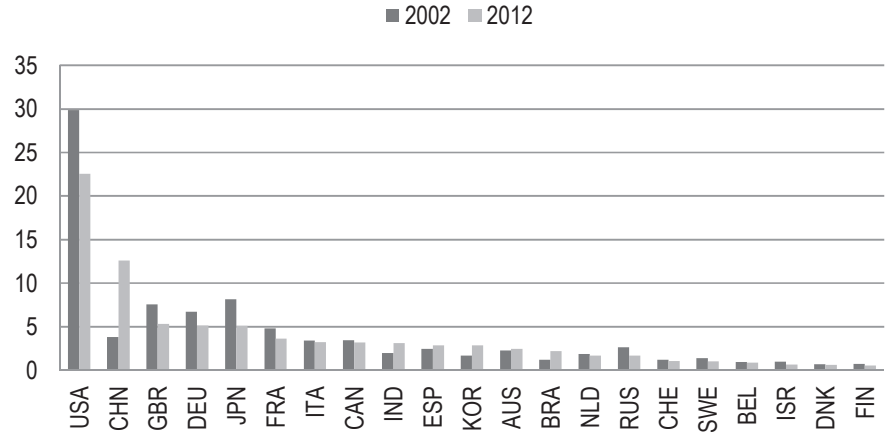
Scientific output and the cost of French public research

Scientific output of French research

It is surprisingly difficult to provide an overview of the scientific output of French research, and particularly to provide an analysis combining information on the system's performance with budgetary data. French scientific output has not recently been subjected to a detailed independent review (the 2013 report by the French Court of Auditors provides a very in-depth analysis of resources, but does not review output in the same detail). This contrasts with other aspects of the French research and innovation system (SFRI), which have been the subject of recent reports, such as the General Inspectorate of the Administration of National Education and Research (IGAENR) and Beylat-Tambourin reports on the commercialisation of public research and the Gallois and Beylat-Tambourin reports on industrial innovation. It would be helpful for the French Government to commission such a study, including a detailed analysis of performance indicators (publications, etc.) and budgetary data for the stakeholders concerned (organisations, universities). An annual publication produced by the Observatory of Science and Technology (OST) as part of the AERES and presented to the French Ministry of Higher Education and Research (MESR) would enable objective and official monitoring of the issue. Without such information, analysis can only be conducted on a relatively general level.

As measured in terms of publications, France has average scientific output in comparison with other countries of a similar size. In number and quality of publications, it is significantly outstripped by the United Kingdom and Germany, but is ahead of Italy and Spain. This intermediate position has not changed substantially over the past decade – an indicator of the low impact of the reforms undertaken so far.

Figure 4.1. Global share of scientific publications, 2002 and 2012

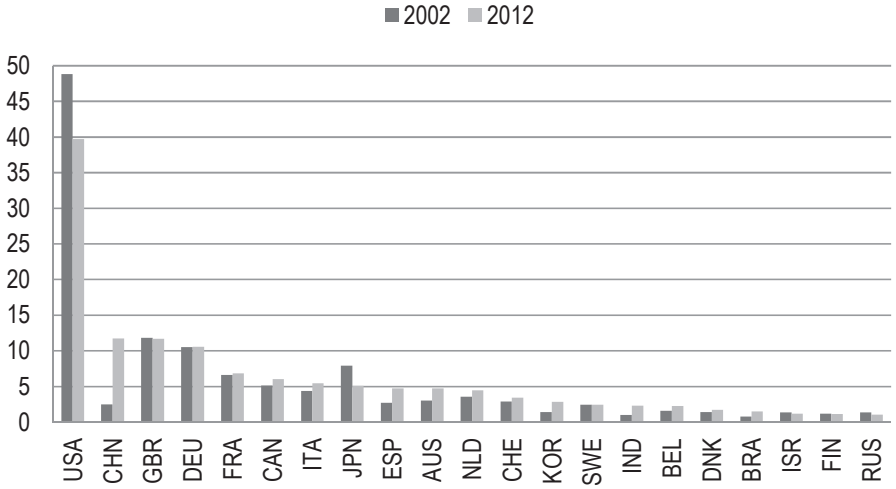


Source: OST, http://www.obs-ost.fr/fr/frindicateur/analyses_et_indicateurs_de_reference.

France's scientific output is average in relation to other countries of similar size in terms of publication numbers. Measured in terms of both the numbers and quality of publications, it is significantly outdistanced by the United Kingdom and Germany, but is ahead of Italy and Spain. This intermediary position has not changed substantially in the last decade, indicating that the reforms undertaken to date have had a limited effect on scientific output.

Between 2002 and 2012, France's global share of all scientific publications (Figure 4.1) fell from 4.8% to 3.6%, while Germany's share went from 6.7% to 5.1%, the United Kingdom's from 7.6% to 5.3% and Italy's from 3.4% to 3.2%. This reduced share among most countries is due to the rise of emerging countries and particularly China, whose share increased from 3.8% to 12.6%, while India's rose from 2.0% to 3.1% and Brazil's from 1.2% to 2.2%. Thus, France's quantitative decline, which concerns also other developed countries, largely reflects the arrival of new countries on the world's scientific stage.

Figure 4.2. Scientific publications: Countries' share in the 10% most frequently cited, 2002 and 2012



Source: OST, http://www.obs-ost.fr/fr/frindicateur/analyses_et_indicateurs_de_reference.

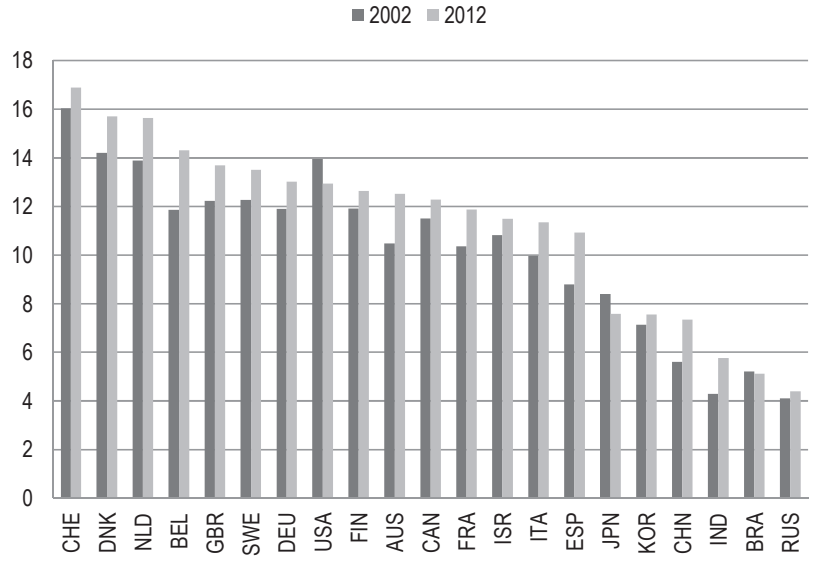
It is generally accepted that only a fraction of scientific publications are valuable enough to significantly affect the course of science or lead to applications. It is therefore a matter of identifying these publications to calculate them. The criterion most often used is citations – the number of citations received by an article purportedly reflecting its scientific value. Counting the share of the countries with the most frequently cited articles, we have identified the 10% most frequently cited (tests with the top 5% and top 1% produced similar results). France's share of the 10% most frequently cited publications relative to comparable countries is also average (Figure 4.2): it went from 6.6% to 6.9% between 2002 and 2012, while Germany's share went from 10.5% to 10.6%, the United Kingdom's fell from 10.8% to 11.7% and Italy's rose from 4.4% to 5.4%. These shares are higher than to these countries' shares in the total number of publications because of the relatively lower quality of publications from emerging countries such as China, which are therefore cited less often. The increase of China in the total publications explains directly the increase in the relative rate of citations of developed countries as it reduced the world average. The United States remains the world's leading scientific power, accounting for 39.7% of the most frequently cited publications in 2012 – compared, however, with 48.8% in 2002.

When comparing countries for this indicator, it is important to control for size: it is natural for a small country, such as Denmark, to produce fewer publications than a large country, such as China, quite apart from the quality of its scientific research. The rank often attributed to France as the 4th or 5th most important scientific power says more about

the size of the country than its actual research performance: evaluating France's performance requires studying indicators reflecting the individual quality, rather than the number, of its publications. The average quality of each country's publications is measured by the share of their publications which feature among the 10% most frequently cited publications (Figure 4.3). This amounts to comparing among countries the probability that a publication from the country will feature among the 10% most frequently cited. A country for which this indicator is high has a larger share of qualitative articles among its total publications, the world average being by definition equal to 10% (in fact, for statistical reasons it is slightly different). This can also be interpreted as reflecting greater selectivity in that country's scientific policy: funding is probably restricted to research that is deemed promising, evaluated *ex ante* as having great potential. Conversely, a country whose indicator is low can be seen as having a "broader" policy of financing a number of low-value research projects. In this context, this indicator reflects the relative selectivity of national scientific research funding models. In 2012, France's indicator was 11.9%; Germany's indicator was 13.0%, the United Kingdom's 13.3% and Italy's 11.4%. Some countries are way ahead, such as the Netherlands (15.7%) and Denmark (15.6%), while others are behind, such as Spain (10.94), Japan (7.6%), China (7.3), whereas the United States are at 12.9%. The increase in the indicator for most countries between 2002 and 2012 comes notably from the increase in China's share in total publications, which has reduced the world average of citations.

Overall, France therefore appears to hold an intermediate in terms of the quantity – and even more so the quality – of its scientific publications. French research appears both averagely productive and averagely selective.

Figure 4.3. Scientific publications: average quality indicator
(share of the country's publications which are among the 10% most cited in the world), 2002 and 2012



Source: OST, http://www.obs-ost.fr/fr/frindicateur/analyses_et_indicateurs_de_reference.

Beyond the national aggregate level, the position of individual stakeholders – in France's case, mainly PROs – can also be reviewed.[1] The performance of PROs in terms of publications was recently quantified as part of a broader review of major research organisations in Europe (Science Metrix, 2013). First, it appears that France has a high in-

stitutional concentration of publications, with the largest (the CNRS) and the fifth-largest (National Institute of Health and Medical Research [INSERM]) PROs in Europe. The CNRS produced nearly 189 000 publications between 2007 and 2011, compared with 62 000 by the Helmholtz (Germany), the next-largest organisation. In terms of the quality of the publications (as measured by the number of citations or the standing of the journals in which they are produced, adjusted for thematic structure; thus, the size of the institutions evaluated and their disciplinary focus do not affect their ranking), the CNRS falls behind most comparable large organisations in other countries, except for the Italian National Research Centre (Science Metrix 2013, Table V, p. 36), while INSERM fares rather well. In some areas, French PROs rank among the best, such as in mathematics (CNRS), physics and astronomy (Alternative Energies and Atomic Energy Commission [CEA]), and information and communication technologies (ICT [INRIA]). In other areas, French PROs rank better than average, such as biology (CNRS), cognitive sciences, health and clinical medicine (INSERM). By contrast, in many areas, such as humanities and social sciences (HSS) and clinical medicine, the CNRS ranks poorly or very poorly. The rather average overall ranking of the CNRS is the result of satisfactory rankings in some areas and much less satisfactory rankings in others; this presumably raises the question of the size and range of research fields at this organisation, especially since the areas where it produces lower quality are mainly the focus of other organisations (clinical medicine at INSERM and in hospitals, HSS at universities, etc.).

Researchers' level of excellence: European Research Council (ERC) grantees

ERC grantee figures by country, field and age group provide an insight into the importance of this "level of excellence" among researchers. ERC grants are awarded on a competitive basis at the European level in response to "open calls", i.e. calls stating minimal thematic content, thus allowing open proposals produced by the researchers themselves. There are three eligible research areas: physical sciences and engineering, life sciences and HSS. There are two types of ERC grant: "starting grants" for researchers under 35 and "advanced grants" for more experienced researchers. Grantees may be considered as undertaking projects recognised by their peers; they are "excellent" researchers. A country's share reflects its standing in the level of excellence of European researchers. Researchers can be affiliated with a country based on two distinct criteria: nationality (e.g. a French researcher is affiliated with France, regardless of the country where the research is undertaken) or the place where the research is undertaken (e.g. a foreign researcher who conducts research in France is affiliated with France). Indeed, a researcher who wins an ERC grant can then choose a host laboratory, and the relative research conditions in different countries will serve as an important criterion: a review f these choices indicates the relative attractiveness of the national research systems in terms of environment, salary, etc.

Over 2007-12, France had a total share of around 12% to 13%. This share was identical for "national" and "domestic" researchers, and for "starting grants" and "advanced grants" (Table 4.1). This share corresponds to that of French research in Europe and accurately reflects the "average" standing of French research, behind Northern Europe, the United Kingdom and Germany, and ahead of Southern Europe. The fact that national and domestic grantees have an identical share also reflects the "average" level of attractiveness of the French research system, which attracts as many excellent foreign researchers as it has national researchers who choose to work abroad. In proportion to the number of its researchers, France sends far fewer researchers abroad than Germany, but many more than the United Kingdom. Conversely, it hosts far fewer foreign researchers than the

United Kingdom, but as many as Germany. France also has a less pronounced specialisation than other countries (Table 4.2), with a relatively equal share of each of the three identified research areas; its share in the physical sciences is slightly higher than in the life sciences, unlike Germany and the United Kingdom.

Table 4.1. Country shares of ERC grantees, 2007-12, %

	Total		Starting		Advanced	
	National	Domestic	National	Domestic	National	Domestic
CHE	2.7	7.4	2.2	6.2	3.2	9.0
DEU	17.4	14.1	18.3	14.0	16.2	14.2
ESP	5.5	5.4	6.3	5.8	4.4	4.8
FRA	12.4	13.0	12.6	13.5	12.0	12.4
ITA	9.6	5.8	10.3	5.4	8.6	6.3
NLD	8.3	8.2	8.1	8.3	8.5	8.0
SWE	3.1	3.6	2.8	3.5	3.6	3.8
GBR	15.3	22.2	10.6	21.2	21.6	23.6
EU+A.C.	100	100	100	100	100	100

Source: European Commission; OECD calculations.

Table 4.2. Country shares of ERC grants by area, 2007-12, %

	HSS		Life sciences		Physical sciences and engineering	
	National	Domestic	National	Domestic	National	Domestic
CHE	1.0	2.4	3.2	8.9	3.0	8.3
DEU	14.4	9.5	18.7	15.8	17.6	14.6
ESP	4.3	5.4	6.3	5.4	5.3	5.4
FRA	10.6	10.5	11.9	12.5	13.5	14.5
ITA	12.0	8.8	7.6	4.2	10.2	5.9
NLD	10.7	11.4	7.9	7.2	7.5	7.6
SWE	2.4	2.1	3.9	4.5	2.7	3.6
GBR	19.7	32.5	14.8	20.1	13.9	19.7
EU+A.C.	100	100	100	100	100	100

Source: European Commission; OECD calculations.

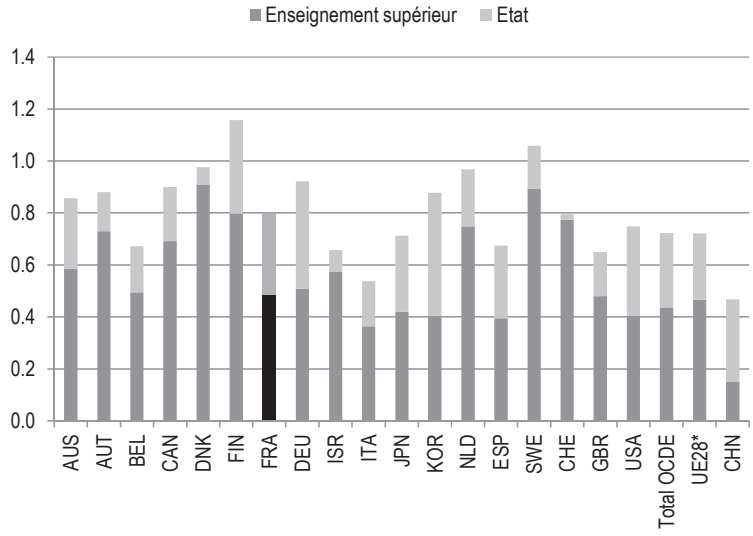
Public research resources

Funding

What resources are allocated to public research in France? How have they evolved over the past decade and how do they compare with those of other countries? According to the method described in the Frascati Manual for measuring R&D (OECD, 2001), public research is made up of PROs and universities. R&D conducted by the public sector accounted for 0.8% of France's GDP in 2010 (Figure 4.4). This figure stood at 0.9% in Germany, around 1% in Northern Europe, 0.7% on average in the OECD and the European Union, and 0.65% in the United Kingdom. This means France is just above the average and that the State plays a greater role in France than in many other countries. It

should be noted, however, that countries where public R&D has greater weight than in France are those where business R&D also plays a greater role, which is not the case in France.

Figure 4.4. Research & development (R&D) conducted by government and higher education sectors, 2010, as a % of gross domestic product (GDP)



Note: *OECD estimates.

Source: OECD, Main Science and Technology Indicators, www.oecd.org/sti/msti.htm, June 2014.

Public R&D as a percentage of GDP was almost constant between 2000 and 2010 in France, unlike in many other countries where it significantly increased over time, such as Germany (where it was 0.7% in 2000 and therefore grew 0.2% over the decade) and the United Kingdom (0.6% in 2000, an increase of 0.05% over the decade), while the OECD and EU averages grew by 0.1% over the decade. French public R&D fell between 2000 and 2010 relatively to other countries. The continued decline of defence contributed significantly to this drop: defence R&D expenditure accounted for 0.17% of GDP in 2000, compared with 0.08% in 2010, with a significant proportion conducted in public laboratories. Resources allocated to civil R&D have therefore grown over the same period, but probably to a lesser extent than in other countries.

The gradual ramping up of the PIA Programme after 2010 should help boost public research. The PIA allocates around EUR 9 billion (euros) to research between 2011 and 2020, including consumables and interest on non-consumables, of which over EUR 7 billion goes to public research (French Court of Auditors, 2013). This represents over EUR 700 million per year over the decade, i.e. around 5% of public research expenditure in 2010 – which could, providing the other components remain unchanged, reach 0.85% of GDP.

The review by the French Court of Auditors (2013) of French budgetary data (the MIRES, Interministerial Mission for Research and Higher Education, see below) provides a more in-depth view of developments in the various components. The resources of most organisations increased significantly between 2006 and 2011, but with three caveats:

- First, "subsidies for public service costs", a fixed annual funding paid by the State, increased slightly. "Own resources", particularly research contracts mainly undertaken by the ANR, are mainly responsible for this overall increase; they indicate policymakers' commitment to influencing more directly the thematic focus of public research, thereby promoting excellence.
- Second, in the case of organisations– particularly the CNRS – employing civil servants, pension costs have increased sharply, thereby reducing the resources available for funding the research itself.
- Third, funding channels became more complicated during the same period, with an increase in the number of stakeholders and programmes resulting in a fragmentation of contracts; it is likely that a greater share of resources (including some researchers' time) is used for management rather than research purposes.

Employment of researchers

In 2010, France numbered around 162 000 full-time equivalent (FTE) jobs in the public research sector. This figure includes researchers (research directors, research officers, professors, lecturers) and research engineers, who represent 50% of the workforce, as well as design engineers, assistant engineers and technicians (27%), other support staff (11%) and funded PhD students (12%). Human resources (HR) for public research are shared between universities (around 45% of the workforce) and PROs (50%); the remainder of the workforce is employed at non-profit organisations and other public administrative institutions and government departments. These staff numbers grew 11.6% between 2000 and 2010, with significant growth in the number of researchers (4.2%) between 2005 and 2010.

Public research has not been subject to the policy of not replacing every other departing civil servant enforced throughout the rest of the State civil service in France. Civil servant staff numbers have therefore remained more or less stable since the mid-2000s. This is also the case for staff employed by the CEA under private-law contracts. Conversely, the same period registered a marked increase in employment on a contract basis across all organisations: between 2006 and 2011, numbers increased from 1 064 to 1 869 at the CEA and from 5 750 to 7 550 at the CNRS. This development is directly related to the growth in short-term, contract-based funding (ANR, etc.) versus lump-sum awards (see the conclusion of this chapter).

Public research organisations (PROs)

Overview

The French public research system is structured around large PROs with recurring institutional funding by the State. The universities and competitive funding organisations that play such a large role in other countries have a more recent and lesser role in France. The main PROs (Table 4.3) are the CNRS for basic and applied research, the National Institute for Agricultural Research (INRA) for agriculture), INRIA for digital sciences and technology, INSERM for health, the CEA for energy and the French Space Agency (CNES) for space. Two types of PRO are recognised in law: scientific and technological public institutions (EPSTs), which conduct upstream research, and industrial and commercial public institutions (EPICs), which conduct finalised research. The following chapter focuses more on EPSTs than EPICs, which are discussed in the chapter on

knowledge transfer. These organisations each have their own heading in the budget – the MIRES – adopted by the French Parliament. They are linked to their supervising ministries via a multi-year contract that assigns them general objectives, which they take into account when allocating their resources internally among their priorities and among their research teams.

The CNRS is the largest PRO in terms of the number of researchers. Its task is to "identify, carry out and organise any research of relevance to the advancement of science and to national economic, social and cultural development". Approximately 70% of life and materials science publications with at least one author based in France emanate from research units of which the CNRS is a member or partner (CNRS website, 2014).

Table 4.3. Resources of major research organisations in 2012

Organisation	Research field	Total budget (EUR billions)	Staff numbers (FTE)
CNRS	Basic research; all disciplines (including human and social sciences)	3.310*	33 200
INRA	Agriculture	0.844*	10 100
INSERM	Health	0.598	7 900
INRIA	Digital science and technology	0.167	2 600
CEA	Nuclear, energy	2.681	13 000
CNES	Space	2.163*	2 400

* 2011 data.

Sources: 2011* and 2012 CNRS, INRA, INSERM, INRIA and CNES budget data, from www.assemblee-nationale.fr/13/pdf/budget/plf2012/a3807-tix.pdf (in French).
The budget data for the CEA relate only to the civil sector and are derived from the CEA 2012 financial report.

Budgets and employment

In total, PROs employ around 70 000 research staff, of which nearly half work at the CNRS and one-fifth at the CEA, the other organisations being smaller. Public research staff have a variety of statuses in France. At the EPSTs (CNRS, INSERM, INRA, INRIA etc.), most research staff have civil servant status; at the CEA and at the CNES, they are employed under private-law contracts. Civil servants (researchers, engineers, technicians and administrative staff) apply for these posts through a national competitive examination and become permanent employees after a probationary period. Career development is occurs through grade advancement according to length of service and is subject to review by a committee. PROs also employ a number of contract workers (non-civil servants): researchers, engineers and research technicians who meet more specific needs, as well as doctoral and postdoctoral students whose posts are by definition limited in time.

Governance

In the unanimous opinion of the senior officials interviewed during the preparation of this review, the PROs have considerable supervisory latitude in their strategic choices and internal allocation of resources. Hence, they are highly influential in setting actual research priorities in France. Financial resources in the CNRS are allocated according to set of mechanisms involving laboratory directors, elected staff representatives from all categories (via the National Council) and the organisation's government-appointed leaders

(IGAENR, 2012). Researchers are allocated to research units based on the "freedom of research" principle (researchers may freely choose the laboratory they will work in within the research organisation, provided the laboratory agrees) (IGAENR, 2012). On the other hand, an organisation such as the CEA is more centralised: due to the nature of its work, a "top-down" approach prevails.

These organisations bring together under a single authority different functions that in other countries are spread out among several institutions: the orientation (planning), funding, execution and evaluation of research in their respective fields. The most common model internationally is research steered by the ministry (or the ministries in their respective fields) under the supervision of the Parliament, mainly funded on a competitive basis by a specialist agency and implemented by university-based teams. Variants of this model are found in all leading global research countries in North America, Northern Europe, etc. This separation of functions can be explained by the State's desire to set the direction of research according to economic and social priorities, as well as by the potential conflicts of interest generated by the joint exercise of different prerogatives. If the research agenda is determined by those implementing it – the researchers – then purely scientific considerations can take precedence over extra-scientific considerations (such as economic and societal demands). In addition, existing disciplines are likely to persist at the expense of emerging domains, since they benefit from an established – and therefore influential – community of researchers. Funding must be separated from implementation for similar reasons, and also because competitive project funding calls for specific competences. Finally, the evaluation must of course be independent so as to be neutral and credible. Fulfilling all these functions under a single authority raises problems, which the reforms of the 2000s tried to address by creating specialist agencies for funding and evaluation, and publishing national strategies – the National Research and Innovation Strategy and then the PIA – setting the guidelines to be followed by the scientific community. The next section will show that these new stakeholders and mechanisms complemented the PROs without significantly changing their powers, and that the PROs themselves have implemented reforms aiming to internalise the objectives of excellence and relevance – as opposed to economic and social objectives – pursued by these policies. In that regard, the French research programme bears some similarities with the German programme (Box 4.1).

Box 4.1. PROs in Germany

Germany has four main PROs: The Max Planck Society (Max-Planck Gesellschaft), the Fraunhofer Society (Fraunhofer-Gesellschaft), the Helmholtz Association of German Research Centres (Helmholtz Gemeinschaft Deutscher Forschungszentren) and the Leibniz Association (Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz)[2].

	Institutes	Subject areas	Staff, including researchers	Budget in 2011	Share of contract funding
Max Planck	80 institutes	Life sciences, natural sciences, HSS	17 000 (5 200)	EUR 1.77 billion	20%
Fraunhofer	60 institutes	7 subject areas (ICT sciences, materials, photonics, etc.)	20 000	EUR 1.85 billion	66%
Helmholtz	18 centres	6 strategic programmes (energy, transport, health, etc.)	30 000 (9 700)	EUR 3 billion	30%
Leibniz	87 institutes	5 subject areas covering a wide spectrum	16 000 (7 100)	EUR 1.4 billion	33%, a majority of public contracts

Source: Data: Science Portal, French Embassy in Germany, 2013, www.science-allemagne.fr.

These organisations have autonomy in defining their scientific projects and allocating resources among their centres, institutes and laboratories. However, the degree to which decisions are "centralised" varies from one PRO to another: they are highly decentralised at Max Planck and Fraunhofer, but much less so at the others. Unlike in France, these PROs are not attached to universities as the joint units of the CNRS tend to be, but this does not prevent cross-collaboration. These organisations are multidisciplinary and have specific scientific orientations: basic research at the Max Planck institutes, more applied research focusing on technology transfer at the Fraunhofer societies, centred on major research tools at the Helmholtz societies and more rooted in the local/regional area at the Leibniz societies. Of the some 800[3] research units in Germany[4], nearly half are integrated into these four large PROs; the others are attached to one of the country's 392 higher education institutions. These research units are entirely funded through recurring funding from the Federal Government and by the 16 *Länder,* according to an established distribution grid. Universities, regional research organisations and academies are funded by the *Länder*, which also cover 50% of the financing of the Max Planck, 42% of the Deutsche Forschungsgemeinschaft (German Foundation for Research [DFG]) and 10% each of the Fraunhofer and Helmholtz. This distribution enables each *Land* to promote research activity in the fields it considers key, and the Federal Government to influence scientific activities through Germany's Federal Ministry of Education and Research (BMBF). Competitive funding is overseen by four large agencies: DFG, Projektträger[5], DAAD and foundations (e.g. the Alexander von Humboldt foundation).

The DFG is the main project funding agency in Germany, with a budget of almost EUR 2.5 million in 2011. It is involved in all scientific fields, with a greater focus on life sciences and medicine. It finances projects, coordinated research centres, priority programmes and graduate schools.

The project managers, in turn, implement BMBF research programmes, from managing the calls for projects to awarding funding. A large part of its budget funds university research projects.

Two other major stakeholders complete the governance of this system: the Gemeinsame Wissenschaftskonferenz (Joint Scientific Conference) and the Wissenschaftsrat (German Council of Science and Humanities), which advise on strategic policy.

Reforms

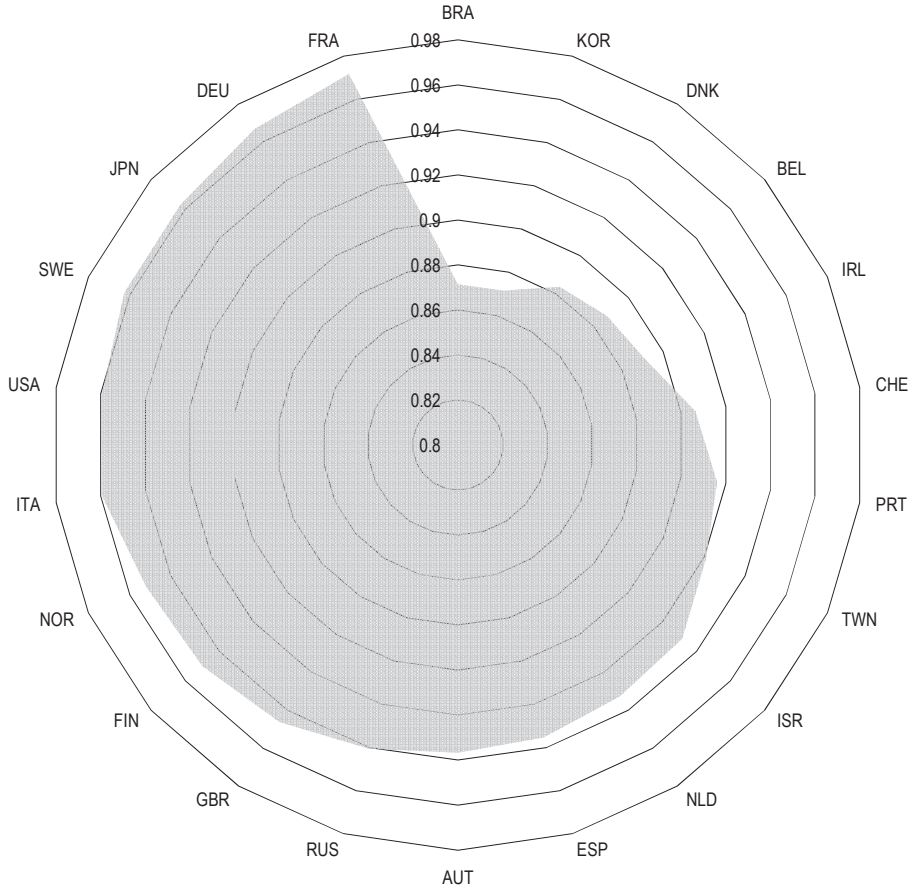
Successive French governments have stated their commitment to developing this French model into a system in which the State would steer the direction of research, and universities and project funding would play a greater role. A number of steps have been taken as a consequence, particularly in the past 15 years.

Justifications for the reforms

This change has multiple justifications:

- The organisation-based system makes directing research "from the outside" difficult, as the PROs have integrated control of the research – its thematic focus, funding, implementation and evaluation. They are therefore largely autonomous, leaving less room for influence by politicians; thus, a policy decision in 1998 to focus on research in biology was not reflected in the funding allocated to the organisations concerned (French Court of Auditors, 2007). On the other hand, an organisation ensuring a separation of functions could give the State greater influence with regard to the orientation of research and give stakeholders greater responsibility with regard to excellence.
- A governed organisation, which is more inflexible due to the internal (governed) resource management processes, does not meet the need for a high degree of adaptability in the changing thematic priorities of research. This is due to the influence of established disciplinary communities that wish to maintain their projects and because full-time researchers cannot easily be re-assigned to other work according to the research's evolving thematic focus. Figure 4.5 illustrates the high degree of thematic inflexibility of the French research system compared to that of other countries; it shows that of all the major research countries, France made the fewest changes to the thematic distribution of its publications between 2001 and 2011. While excessive flexibility is detrimental to the continuity of programmes and therefore to their success, excessive inflexibility means on the contrary that inertia becomes an important factor in resource allocation, at the expense of new demand and opportunities.
- The divide between teaching and research is detrimental both to high-level teaching (which draws on the most up-to-date research) and research (which needs to draw on the best students). Training at all levels must draw on research – and on the most advanced research in the case of doctoral training. Joint research units and other measures have certainly reduced barriers between universities and research organisations, but they have not abolished them completely, particularly with regard to staff management and careers (recruitment, progression, responsibilities, status). An additional step must be taken to integrate teaching and research more closely, particularly at the centres of excellence.
- The boundaries between the organisations do not reflect the disciplinary divisions of science. The CNRS is involved in all fields, rather than basic research only. INSERM, INRA, the CEA and the CNRS all deal with the life sciences. The very structure of the PROs has made co-ordinating their respective research agendas in similar or identical fields difficult, hindering the overall effectiveness of the system.

Figure 4.5. 2001-11 similarity index in specialisation (174 specialisms)



Note: The similarity index measures the degree of similarity between two vectors, representing here the thematic specialisation of a country's research in 2001 and 2011 respectively. The index has a value of 0 in the case of total dissimilarity and a value of 1 in the case of perfect similarity.

Source: OST data.

Reforms

Related policies have been implemented at several complementary levels for over 20 years: bringing together research organisations and universities, which could lead to partial integration; development of competitive project-based funding for research; creation of an independent evaluation system; reinforcement and autonomy of universities; and co-ordination between PROs through thematic "alliances". A series of reforms was introduced in 2005-2008, and these are currently being put into practice and evaluated in the French public research system.

Integration of PROs and universities

A policy has existed for over 20 years of bringing together large research organisations and universities, which at this stage has proven partial, complex and costly. The CNRS and other PROs created and then extended the joint research unit model, under dual PRO-university supervision (in some cases where other organisations are involved, supervision may be carried out by three or more authorities). These units accounted for 88%

of the 1 303 CNRS research units in 2000 and 95% of the 1 029 research units in 2012 (French Court of Auditors, 2013). The joint units have multiple sources of funding: organisations, universities, contracts and projects (ANR, EU programmes, etc.). They employ staff assigned by each of the supervising authorities. While they lessen the divide between universities and research organisations, they also face problems stemming from their multiple supervisory authorities. The incompatible accounting and management systems and procedures of the research organisations and universities, the potential strategic differences among supervisory authorities and the different staff statuses mean that managing joint units is complex, expensive and opaque (each authority is unaware of the other's contributions).

A policy of "delegated management" aims to enable one of the partners – a PRO or university – to secure in some cases sole management of the joint research unit. Although the agreement between organisations and universities has been in place for several years, it does not appear to have been followed very effectively (French Court of Auditors, 2013). Yet such an approach makes perfect sense for large research universities, since they have the required management capacities.

One obstacle to further integration of the PROs with universities is the difference in staff statuses at universities and research organisations (which are themselves diverse). This obstacle was identified long ago, and the solution appeared to be a focus on recruiting in universities, thus allowing a de facto gradual unification of statuses. It appears that this policy has not been followed over time, with a significant level of recruitment still taking place at the EPSTs.

Project funding and competitive funding

Public research can be funded using two main mechanisms: institutional funding and project funding. In the first, a given institution – e.g. a PRO – receives a certain budget, which it manages according to its priorities and a number of requirements specified by the supervisory authority. The budget amount may be fixed or linked to performance indicators (from the previous period). Institutional funding is sometimes competitive, at least initially (as for Idex in France and universities in the United Kingdom), but it is generally non-competitive (in the case of PROs in France). Alternatively, research can be funded on a project basis. In this case, each candidate project is evaluated by the authority in charge of funding, which will decide whether or not to fund it and will set the grant amount. This process is generally competitive: based on a call for tender published by the funding agency, various teams submit applications, only a few of which are selected. Most research countries have a joint system in which the research infrastructure (including the administrative infrastructure) and certain types of research are funded institutionally and part of the research is project-funded (Box 4.2).

Box 4.2. Project funding agencies in other countries

In the United Kingdom, seven Research Councils provide project funding. These seven councils, all members of Research Councils UK, cover all major scientific disciplines and granted EUR 3.1 billion in 2011-12. The allocation of grants by sub-field follows a four-year plan devised by each council and is based on the opinions of evaluation committees. Like France's ANR, calls for projects may be subject-specific or open and focus to varying degrees on commercialisation initiatives; 70% of recurring funding is allocated to the 20 highest-ranking institutions according to a periodic (every four years) evaluation of the research units.

In Italy, there is no research funding agency. The Ministry of Education, University and Research (Ministero dell'Istruzione, dell'Università e della Ricerca) funds projects directly.

In the Netherlands, one of the leading project funders is the Netherlands Organisation for Scientific Research (Nederlandse Organisatie voor Wetenschappelijk Onderzoek), which a budget of EUR 500 million. The funds are distributed to different programmes focusing on specific disciplines in the context of open or subject-specific calls for projects. The proportion of research funding dedicated to project funding was 27% in 2010.

In Germany, project funding is overseen by three main agencies: DFG, Projektträger and the foundations (e.g. Alexander von Humboldt). Nearly 44% of Federal Government funds allocated to R&D activities are allocated through calls for tender.

The Excellenzinitiative (excellence initiative): with a budget of EUR 1.9 billion for the period 2007-11, the excellence initiative was renewed for the period 2012-17 with an even larger budget of EUR 2.7 billion. The funding revolves around three areas: the graduate schools (Graduiertenschulen) to promote young scientists and researchers; the clusters of excellence (promoting cutting-edge research) and the universities of excellence (promoting high-level research within elite universities). Calls for projects cover various scientific fields (natural sciences, life sciences, engineering sciences, HSS). The objective is to increase the visibility of German research in the international scientific community through cutting-edge research.

The DFG and the German Council of Science and Humanities (CFS) oversaw the competition. Universities submitted proposals, which were subsequently evaluated by a panel of experts. Projects preliminarily selected by the Joint Commission (DFG and CFS) were finally submitted to a Grants Committee made up of the Joint Commission, federal authorities and the Ministry of Education and Research. This is a prominent example of co-operation between the Federal Government and the various Länder, which contribute 25% of the budget of the excellence initiative.

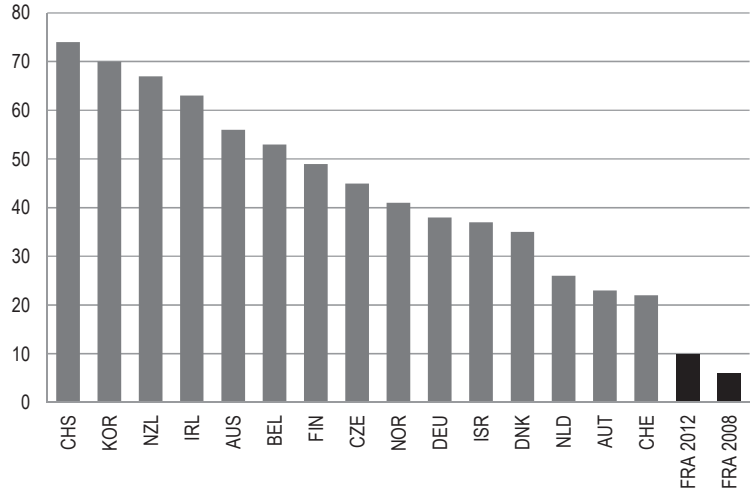
Following the 9 universities of excellence selected in the first round, a total of 11 qualified as universities of excellence in the second round (2012-17)[6]: Heidelberg, FU Berlin, LMU Munich, TU Munich, Constance, RWTH Aachen, Humbold Univ. Berlin, Bremen Cologne, Tübingen and TU Dresden.

	Budget	Higher education institutions	Clusters of excellence	Universities of excellence
2006-11	EUR 1.9 billion	39	37	9
2012-17	EUR 2.7 billion	45	43	11

Source: www.excellence-initiative.com/excellence-initiative; www.science-allemagne.fr/fr/donnees-comparatives/.

Project funding is less common in France than in other countries: 7% in 2008 and 12% in 2012 for higher education; 7% in 2008 and 10% in 2012 for the PROs (FutuRIS-National Technical Research Association [ANRT] estimate, 2013). This places France among the OECD countries with the lowest proportion of projects (Figure 4.6). These estimates are likely to be slightly below actual figures, since they do not take into account the fact that funded projects also receive institutional resources from the PROs, including the salaries of tenured researchers. However, the gap with other countries is such that it will not be filled even when taking this factor into account (the country that immediately precedes France in this ranking is Switzerland, with a 22% total share – 10 percentage points higher than France in 2012). The significant increase in France between 2008 and 2012 is due to the increased activity of the ANR, and particularly of the PIA.

Figure 4.6. Proportion of project funding in public expenditure on R&D, 2011, %



Sources: OECD and ANRT (for France).

The National Research Agency (ANR)

The ANR is the main player in the competitive project funding of French research. The Agency was set up in 2005 to manage the competitive resource allocation processes, which are believed to promote excellence (generated by competition) and flexibility in research areas (the re-allocation of funds is sufficient to spark new research). The ANR budget was gradually increased until 2009, after which it levelled off and began to drop. The ANR has since become an important source of funding for PROs and universities, complementing their budget allocations. Through calls for projects, the ANR steers the focus of research. This orientation has not always matched that chosen by the PROs, which has created friction. The solution to this problem adopted in 2010 was to increase the proportion of non-thematic programmes ("Programme Blanc" open to all research fields, postdoctoral fellowships, young researcher programme, Chairs of Excellence). These calls for projects select researchers based on their degree of excellence, without interfering with their research topics, and now comprise more than half of the ANR budgets dedicated to public research. In 2013, the decision was taken to involve alliances (and thus the PROs) more specifically in ANR planning. This entails reinstating the planning function itself within the PROs, which runs counter to the previous trend of separating powers.

In 2011, the ANR budget amounted to EUR 738.5 million, including EUR 557 million dedicated to calls for proposals and calls for tender. Nearly 1 300 out of 6 319 submissions have been financed since 2011; the average funding granted per project is EUR 350 000 for open calls for proposals and EUR 700 000 for partnership projects. The distribution of the ANR operating budget in 2012 is shown in Table 4.4.

Table 4.4. ANR operating budget in 2012, in EUR millions

Non-thematic programmes	266.3
Partnership research and commercialisation	18.8
Progress in knowledge of living organisms	56.5
Environmental emergency and ecotechnologies	107.2
Information, communication and nanotechnologies	71.9
HSS	12.0
Safety and dual research	21.3
Programming total	554.0
Partnerships and competitiveness	156.1
Total ANR commitment authorisations budget	710.1

Source: ANR and report of the French Court of Auditors (2013).

Decreased budget allocations since 2010, coupled with an increase in the number of submissions, lowered the success rate from 26% to 20% between 2005 and 2012. Although this rate seems lower than t abroad (40% for the DFG in Germany and 25% for the UK Research Councils, according to the French Court of Auditors [2013]), the success rate at the National Institutes of Health in the United States was 23% in 2010 and 19% in 2013; it was 22% at the National Science Foundation in 2011, which is not significantly higher than at the ANR, but the amounts allocated to each grantee are significantly higher. Moreover, average funding also declined somewhat over the period.

In addition to these funds allocated to the winners of the call for proposals, the ANR also makes a "*praecipium*" to the institutions hosting these projects. This praecipium amounts to approximately 11% of total funds allocated by the ANR, i.e. EUR 50 million in 2012. The beneficiaries are universities or the PRES research and higher education clusters (EUR 23.5 million), other higher education institutions (EUR 9.5 million), research organisations (EUR 14.4 million), hospitals (EUR 226 865), foundations (EUR 1.5 million) and other agencies and research units (EUR 1.2 million).

Since its inception, the ANR has demonstrated its ability to manage the sometimes complex processes of identifying research topics and selecting projects. As the agency in charge of implementing the PIA, it has had to manage numerous new procedures and has given a number of internationally recognised French research teams access to substantial resources. It is subject to criticism from several quarters, for several reasons:

- Many Blanc programme projects since 2009 have weakened the thematic steering of research by the ANR. This increase in the number of projects was a result of demand from the PROs, dissatisfied with interference by the interference the subject area chosen by the ANR and their own.

- The capacity of the ANR to establish thematic priorities for French public research has been called into question by some stakeholders; recent changes in the governance of the ANR (2013), which gave alliances (i.e. the PROs) an increased role in setting the Agency's priorities, seek to answer this. The aim is therefore to restore full control over planning to the PROs. In other countries, especially Nordic countries, high-level thematic orientation is initiated at the political level, rather than within the scientific community, thus avoiding the inevitable conflicts of interest that arise when planning and implementation fall under a single authority.
- Some ANR procedures are cumbersome, with declining success rates and appropriations (according to the AERES), particularly since a number of the appropriations are for collaborative projects, and the sum therefore has to be shared between different partners. The problem here is the ANR budget, which has been reduced over time.
- The ANR has been accused of failing to take into account all the administrative costs the research projects generate for the grantees ("praecipium"), forcing recipients and their institutional backers to bear part of the costs generated by the selected projects. This issue could be resolved by increasing the ANR budget, which could then incorporate a higher praecipium. On the other hand, organisations' basic funding also finances administrative services that could be put to contribution to manage this financing. A budget transfer from the PROs to the ANR (unlike the one carried out in 2013) would reduce the burden on the PROs of managing their administrative services, allowing them to devote more resources to managing funds received from the ANR, which would also include a higher praecipium thanks to the supplementary budget received by the Agency.

Overall, it appears that the first French experience of research project funding has worked well, beyond the inevitable teething problems. The ANR has, however, struggled to fit into a broader research landscape that has remained largely unchanged, with a decisive weighting towards the PROs, even though a project funding mechanism is more suited to a university-based research system. Thus, the overall balance of the system must be considered to allow a full assessment of the ANR.

Competitive funding in the PIA

The PIA was set up to promote the excellence and relevance (e.g. against clearly defined economic and social objectives) of research. To do this, it has created and uses specific mechanisms and new stakeholders, which complement established mechanisms and stakeholders and are driven by a rationale of competition and openness. The PIA allocates its funds mainly through open and competitive calls for tender, many of which are managed by the ANR. The aim of the PIA is to promote excellence in public research, through operations such as Equipex (equipment of excellence), Labex (laboratories of excellence) and Idex (initiatives of excellence), which together represent nearly EUR 3.5 billion over 10 years (this amount includes consumables, plus interest on non-consumables: French Court of Auditors estimate, 2013, pp. 194-195). Given the non-consumable aspect of some of the funds – only the interest of which is paid to beneficiaries – it is estimated (that the PIA allocates approximately EUR 1 billion to research and higher education every year (FutuRIS, 2013). The conjunction of the ANR and PIA explains the jump in project funding between 2008 and 2012t. These activities bear a strong resemblance to initiatives taken in most OECD countries over the past ten years to promote excellence in research (Box 4.3).

The ANR is the leading operator of these initiatives, which it manages from the selection to the contract stage, and subsequently from funding to follow-up. The eligibility of these projects has been evaluated by international jury panels consisting of academics and leading figures from the public and private spheres. These panels have then appointed external experts to provide informed and graded reports. The projects have been evaluated according to criteria on to team and infrastructure quality (including an evaluation by the AERES), the project's innovativeness and scientific ambition, its potential spin-offs and ripple effects, the match between the resources and the project, and finally the project's governance and structure. Some criteria are more specific to each programme: stakeholder structure, landscape simplification, consistency and ambition of the overall project, as well as governance and credibility of the implementation capacity for the Idex[7], the laboratory's involvement in high-level master's and PhD courses for the Labex[8], and the innovativeness of the project in relation to existing facilities for the Equipex[9].

Labex: with EUR 1.94 billion in funding, including EUR 1.8 billion in capital assets, this programme aims to "strengthen the international visibility and role of the best French laboratories, in all disciplines and throughout the country". The two successive rounds awarded the label to 100 grantees and 71 new Labex.

Equipex: with EUR 850 million in funding, including EUR 600 million in capital assets, this programme focuses on major scientific infrastructures and intermediate-size equipment (EUR 1 million to EU 20 million). The infrastructures include supercomputers, digital databases and experimental platforms. In 2011, 52 Equipex projects were selected[10], with capital grants ranging from EUR 1.28 million (for the REC-HADRON project in biology and health) to EUR 20 million (for the CILEX [Interdisciplinary Centre on Extreme Light] project in the field of energy).

Idex: with an initial funding of EUR 7.1 billion, subsequently reduced to EUR 6.35 billion in 2012, this programme aims to develop 5 to 10 multidisciplinary clusters of excellence in higher education and in world-class research in France. Idex submissions are evaluated by an international panel consisting of academics and leading economists. Following a four-year trial phase, a new evaluation by the international panel determines whether to renew the funding. Applications were examined in 2011 and 2012. The first round in 2011 produced three winning Idex (under the aegis of the universities of Strasbourg, Bordeaux and Paris Sciences-Lettres); the second round in 2012 selected five new projects (won by Sorbonne Universities, Sorbonne Paris Cité, Saclay, Aix-Marseille and Toulouse). The funding associated with these projects ranges from EUR 700 million to EUR 950 million.

Other PIA programmes include the Instituts Hospitalo-Universitaires (medical research and training institutes), the Plateau de Saclay and the commercialisation initiatives in line with the clusters of excellence strategy, along with the Idex and Labex.

Although most of this funding finances new operations, a small part has replaced existing funding, e.g. for demonstrations innovation incubators (French Court of Auditors, 2012).

Box 4.2. Promoting excellence in research: New financing methods

To response to growing scientific competition, many OECD countries have set up "research excellence initiatives" (REIs). These initiatives are based on competitive funding mechanisms and linked to results. REIs aim to promote research excellence with stable, long-term funding, allocated directly to the selected research units. In general, REIs combine elements of institutional funding and competitive funding; they fund the research infrastructure and the researchers' salaries and training. REIs now exist in more than two-thirds of OECD countries. Most of these initiatives have been implemented in the past ten years: Norway (Centres of Excellence, 2002) and Germany (*Exzellenzinitiative*, 2005) are two examples thereof. REIs are usually launched to foster interdisciplinary and collaborative research, attract talent from abroad, create high-level graduate schools, stimulate competition among research teams and increase the visibility of national research. In most of the countries covered by a recent OECD survey (OECD, 2014), REIs have achieved these objectives and have received positive feedback.

The results of the OECD survey on REIs can be summarised as follows:

- REIs provide long-term funding for ambitious, complex research projects. This is particularly important for high-risk interdisciplinary and co-operative research.
- Competition for the funding made available by REIs takes place through a transparent selection process. REIs generally use panels consisting of international experts to ensure the best quality of the selected projects.
- REIs allow for greater flexibility than other forms of funding, notably in terms of managing and recruiting personnel. Moreover, REIs are often able to offer attractive contractual terms to attract high-level researchers.
- REIs recognise the importance of (domestic and international) talent mobility. REIs therefore make it easier for research centres to recruit foreign scientists.
- Attracting and training the best students is a fundamental aspect of REIs. REIs fund doctoral and postdoctoral programmes in order to train and attract future generations of researchers.
- REIs concentrate research expenditure on a limited number of well-equipped laboratories. While on the one hand, the concentration of resources can create the critical mass necessary for high-level initiatives on a global scale, on the other hand, an excessive concentration of resources can be detrimental to the diversity of the system.
- REIs can affect the overall structure of the research system, through a virtuous circle of competition between research centres.
- REIs have the effect of enhancing the international reputation and visibility of domestic research institutions.
- The activities funded by REIs can promote the dissemination of knowledge and create positive externalities in the national research system as a whole.

This approach has been adopted in France for the "excellence initiatives" of the PIA (Idex, Labex, Equipex).

Source: OECD (2014), *Promoting Research Excellence: New Approaches to Funding,* OECD Publishing, doi : 10.1787/9789264207462-en.

Evaluation

Evaluation is an essential part of any public research system (Box 4.4). Although the innovation system is designed to sell products and is therefore ultimately sanctioned by the market, there is no such objective sanction for science. Ad hoc mechanisms therefore need to be put in place to govern the allocation of resources according to criteria of excellence and relevance, at the level of individuals, laboratories and organisations alike. *Ex ante* evaluation is carried out during the project or research group selection procedures that decide whether or not to fund them, depending on their potential. *Ex post* evaluation provides the information needed to judge stakeholders' past performance, which will eventually serve as a basis for decisions on current resource allocation.

PROs have internal systems for evaluating individual researchers and research units. But the increased use of joint research units and the reinforcement of universities have created a need for an evaluation system covering those new stakeholders. In addition, the self-evaluation that helps PROs manage their teams and researchers must be supplemented by an independent, and therefore external, evaluation.

Before the AERES was created in 2007, the 40 divisions of the CNRS evaluated the laboratories owned by and associated with the CNRS. This four-year evaluation is still in place in order to determine whether a research unit should be maintained or evaluate the creation of a new laboratory. "They [the sections] evaluate CNRS researchers every two years, and every year they review the promotion of these researchers within the research and research director bodies; they are made up of panels that evaluate eligibility for recruitment to each of these bodies before admissions panels appointed by the CNRS take the final recruitment decisions" (Fixari and Pallez, 2010).

The evaluation procedures of the PROs differ in their frequency, criteria and implications. In 2008, the CNRS compared the different internal evaluation practices of the French PROs. Thus, in the case of researchers, verbal or written recommendations or graded opinions were forwarded in full (with the exception of the French National Institute for Transport and Safety Research [INRETS]). These evaluations are sometimes passed on to superiors for follow-up (or, depending on the PRO, archiving) or to the panels responsible for recruitment and promotion. Evaluations of research groups follow similar procedures, with opinions forwarded to the persons in charge, possibly involving other technical departments within these organisations. A negative evaluation for the group may result in a reduction of its resources, or even its non-renewal or merger with another group, after a temporary status as an intermediate "evolving" team or unit (at the CNRS or INRA, for example) during which the group may attempt to address the shortcomings identified in the evaluation. The procedure often provides for a new – sometimes merely informative – passage in front of the evaluation authority (CNRS, [National Institute for Environmental and Agricultural Science and Technology Research, INRETS, INSERM, INRIA, Research for Development Institute, CEA) to see how its recommendations have been implemented.

The wide range of such practices and the inherent limitations of self-evaluation contributed to the need for a single agency in charge of evaluating research units and research organisations: AERES, created in 2006 to evaluate public research laboratories, graduate schools, universities and institutions. AERES has a modern approach to evaluation: independence, transparency, multilateral procedures, etc. Most stakeholders interviewed during this review believe it has largely fulfilled its role. A number of problems stemming from a lack of experience have been or could be resolved by adjusting its rules and procedures: team and university evaluations are considered too cumbersome and bureaucrat-

ic; evaluations of research organisations are sometimes not sufficiently incisive; publishing ratings in full might sometimes be seen as stigmatising. An important problem – although it does not relate to the AERES itself – is that these evaluations are sometimes ineffective, particularly where some PROs are concerned: although there are many reported cases of "C" or "B"-rated teams being restructured or closed, these teams' supervisory authorities have no obligation to take action, or even to perform simple reporting to the AERES. Universities, on the other hand, do appear to use the AERES reports effectively. From this perspective, the removal in 2012 of the overall rating obscured the Agency's evaluation of the units concerned and does not help decision makers – and especially universities – act on the findings of the evaluation.

Box 4.3. The evaluation of public research in other European countries

The evaluation systems for research activities in Germany, the United Kingdom and in Italy are quite different French systems. In the United Kingdom, the Research Excellence Framework (formerly the Research Assessment Exercise launched in 1986) is supervised by the Higher Education Funding Council, which allocates funding. Evaluation reports, conducted by committees, have evolved over time. They have evolved from quality rankings based on different scales to a "quality profile" reflecting indicators of scientific output. The results of these evaluations determine grading, and ultimately the allocation of funds. This method leads to restructuring research units with poor ratings.

In Italy, the National Agency for the Evaluation of Universities and Research Institutes (ANVUR) has been responsible since 2010 for evaluating both research and training. ANVUR resources, and HR in particular, are limited, with a total of 15 staff members and 45 experts. The ANVUR director is selected by the Bank of Italy.

Finally, the German model combines an *ex ante* competitive element, the *Exzellenzinitiative*, and an *ex post* evaluation, conducted by the Wissenschaftsrat.

Universities

In most countries, autonomous and responsible universities are the pillars of the higher education and academic research system. In the United Kingdom, higher education institutions are legally independent. They enjoy great freedom regarding the organisation of teaching and research activities. In Germany, they decide for themselves how they are organised, under the law of the *Land* to which they belong. The French system, on the other hand, is a dual one (universities and *grandes écoles* in higher education, universities and major research organisations in research) and highly centralised, which is not without implication for the governance of the research units distributed throughout the country. However, while centralisation is truly a distinctively French feature of the research systems, the duality between universities and large, non-university research institutions is less unique. It is actually quite close to Germany's model, for example.

The overall rise in universities' teaching and research capacity and the establishment of a select group of major research universities of global renown have been key objectives of French policy for the past decade or two. This is the reason for the various reforms implemented since. In a model where the key competences of a research system (planning, funding, implementation, evaluation) are separated, universities are responsible for implementing this goal, alongside PROs operating within a revised framework.

A first course of action was to group universities into larger units, either via merger or integration into federative structures – the PRES under the 2006 Law on Research, or "Communities" under the 2013 Law on Higher Education. There are several reasons for seeking an increase in the size of universities. The first is international visibility. For the past decade or so, universities have competed and cop-operated within global networks, and benchmarking tools have grown accordingly. Thus, rankings – such as the Shanghai ranking – which aim to reflect the quality of research carried out at universities, have a profound effect on their reputation, and therefore their access to HR (researchers, students). In this scenario – in which visibility becomes important – size, of course, matters: grouping institutions enhances their collective brand, and therefore the number of corresponding publications, researchers employed, etc. A second objective is to strengthen universities' influence in steering French research, since major universities are better equipped than smaller ones to enter into dialogue with PROs on an equal footing, or to replace them in managing research units. Grouping them together also aims to enable the creation of large and diverse research units, the idea being that size and multidisciplinarity promote quality (in the style of American campuses) for both research and teaching at doctoral level. Finally, the PRES emerge as a way of bringing universities and *grandes écoles* closer together, while respecting their differences (status, activities), which are still profound.

The second course of action is university autonomy. The 2007 LRU Law outlined certain conditions for autonomy that have gradually been fulfilled by all universities. Autonomy has multiple objectives: improving management efficiency; enabling management and objectives to be adapted to the specific conditions at each university; allowing each university, based on its specific strengths, to develop its own research and training strategy, thus leading to increased differentiation of the higher education system (particularly between research universities and universities that focus on teaching). A study by Aghion et al. (2008) on American and European universities shows a significant link between universities' degree of budgetary autonomy and the proportion of competitive funds (as opposed to recurring funds) in their budget on the one hand, and their research output (measured by their position in the Shanghai ranking) on the other hand.

Box 4.4. The PRES

The 26 PRES were formed in 2007 and were to allow universities, PROs and the *grandes écoles* to pool their activities and resources within a single entity: the PRES. The PRES could have different forms and statuses: scientific interest grouping, scientific co-operation foundation, public interest grouping, or even public institution of scientific co-operation (EPCS). The PRES selected the EPCS form. They were headed by a president and vice-presidents and had an administrative board (CA) that included the directors and president, as well as staff, student and founding member representatives.

The 2013 Law on Higher Education and Research abolished the PRES and replaced them with communities of universities and institutions (CUEs), without detailing the transitional arrangements[11]. These CUEs have the status of scientific, cultural and vocational public institution. Each founding institution can transfer part of its competences or assimilate some of its members into the CUE. The law allows for great flexibility in this regard (see the current discussions surrounding the future Poitou-Charentes-Limousin[12] or Bretagne-Pays de la Loire CUEs). These new groupings have similar objectives to the PRES (co-ordination of training, research and commercialisation activities), with a stronger regional co-ordination and a focus on student life. The structure of these institutional groupings is also evolving from a confederation to a more federal approach (e.g. with their own HR). Ultimately, the MESR will sign a single multi-year contract with the CUE (co-ordinating a joint project and those of partner institutions). Their governance is structured around a chairperson elected by the CA, an academic council and a members' council.

Three main types of autonomy have theoretically been acquired since the LRU Law was enacted:

- Administrative autonomy: the university is headed by its president, elected from the ranks of its professors-researchers, researchers, professors and lecturers; the university's training and research units are also headed by an elected director.
- Financial autonomy: the institution receives a block grant from the State to perform its work. It manages the funding allocated by the State, as well as its own resources; it has control over its HR as well as its immovable assets if it wishes.
- Educational and scientific autonomy: the university, in keeping with the national framework set by ministerial decree for each discipline, determines its own programmes, content, educational methods and materials and knowledge management methods.

However, university autonomy is still limited in its implementation.

Access to and management of resources: for the three key university resources – human, financial and immovable resources – universities are dependent on decisions over which they have only partial control.

- HR: some recruitment procedures, as well as the articles of association, careers, and promotion and remuneration levels are defined at the national level, in accordance with to the national public service grading.
- Financial resources: the ministerial budget allocation system (SYMPA) integrating performance indicators has been neutralised, and the current approach largely ignores performance. It also does not take sufficiently into account the differentiation of needs between research universities and other universities (the management costs associated with research are considerable); the joint research units are funded on the basis of decisions taken primarily within the organisations.
- For immovable resources: devolution is virtually impossible due to the poor state of the building stock (including building security) and the absence of a depreciation allowance, as well as problems with securing the necessary competences within universities.

Educational and scientific autonomy: the main qualifications are national (bachelor's degree, master's degree, PhD, university degree in technology...). Universities are subjected to prior accreditation in order to award these degrees. This accreditation is issued by the ministry on the basis of national criteria, including regarding their designation. Accreditation is valid for four years (currently five years) according to models evaluated by the ministry (but with no commitment as to specific or additional methods). In the case of research, most laboratories (particularly the most productive) are joint units for which scientific policy is decided in conjunction with the PROs. Thus, French research universities have narrower leeway compared with foreign universities, while their research policy is dependent on the choices made by the PROs according to their own priorities.

Governance of universities

At the "top", the president of the university runs the institution, chairs the councils and mandates expenditure and revenue. He is elected for a four-year term by absolute majority of the elected members of the administrative board. The external members serving on the board are appointed by the president himself. The statutory bodies of French universities

are the CA, the scientific council (CS) and the council for studies and student life (CEVU).[13]

The CA[14] consists of 20 to 30 members (8 professors-researchers representatives, half of whom are university professors; 3-5 student representatives; 2-3 library, administrative, technical, social and healthcare representatives and 7 or 8 external experts[15]). The university's CA determines the institution's strategy and approves the institutional contract, the agreements signed with the president of the university and the annual report. It also approves the budget and sets the allocation of HR. The CS[16] distribution is 60%-80% staff representatives, 10%-15% PhD student representatives and 10%-30% external scientific representatives. It proposes the institution's research strategies to the CA and is consulted regarding training programmes, research contracts and qualifications. Finally, the CEVU comprises 75%-80% professors-researchers, lecturer and student representatives, 10%-15% administrative staff representatives and 10%-15% external stakeholders.

Universities in other countries also have academic bodies equivalent to the CS and CEVU. These are the university board or conference in Germany, the academic board or senate in the United Kingdom and the university senate in Spain. The European equivalents of the decision making bodies (CAs in France) are the senate in Germany, the governing body or council in the United Kingdom and the governing council in Spain. Finally, the advisory and supervisory bodies have no equivalent in France: these are the governing board in Germany, the assemblies in the United Kingdom and the social council in Spain. Decision making powers and advisory and supervisory powers are sometimes grouped together in some countries (in Ireland and Sweden, these are the governing bodies). Depending on the country, the university president is nominated and appointed internally (France, Germany, Spain, United Kingdom, Ireland, Denmark) or appointed externally (e.g. Portugal, Belgium, Estonia, Latvia, Sweden, Czech Republic).[17]

University budgets

Each university receives allocated funding from the MESR. The overall budget for universities is distributed according to a key (the SYMPA model) that primarily takes into account each university's volume of activity, especially the number of students (60%), the number of professors-researchers who publish (20%) and performance in teaching performance (e.g. the number of graduates) and research (AERES evaluations). However, it appears that the model has not been used for several years, with the MESR using instead a "historical" system ensuring the stability of university resources. The financial position of some universities has deteriorated, in a scenario where staff costs are tending to grow mechanically (due to age and technical advances) and insufficient internal management capabilities have led universities to pursue a fiscally unsustainable HR policy.

Staff management

Since 2009, universities are responsible for payroll. Large disparities exist between the status of the professors-researchers, researchers, research technicians and engineers, and administrative staff who make up overall HR. Some are employed under private contracts (e.g. at the CNES and CEA, while others – the majority – are employed under statutory provisions (such as the civil service status, on the basis of legislation and regulations) or different types of public contracts.The funding sources for their salaries, as well as their status, also vary depending on the PRO. Similarly, the frequency and process of (local or national) recruitments and staff mobility vary widely among universities and PROs. This diversity has an impact on the management of HR in the public research and higher

education system, but also on the orientation of HR towards scientific fields. It particularly complicates HR management in research units, most of which are joint units answering to several supervisory bodies, and therefore have heterogeneous staff (in terms of status, recruitment, promotion mechanisms, career development, etc.).

The devolution of payroll management to universities in 2009 might arguably have been expected to produce better HR management by the institutions. However, it also introduced new challenges. In addition to the recruitment methods mentioned above, this reform has led to increased expenses, particularly pensions and retirement contributions, for the majority of operators in the research and higher education system. Furthermore, while the overall number of staff has not significantly changed since 2006, their composition has changed. Today, the trend is for universities and PROs to fund contracts – and therefore fixed-term contracts – with their own capital (Tables 4.5 and 4.6). This increased use of temporary employment reflects the need for greater job flexibility to remain competitive in a scientific arena that presents ever-changing opportunities, as seen for example in the ANR thematic calls for projects.

The duality of the French research and higher education system (Tables 4.5 and 4.6), which is also found within research units, raises the question of how the distribution of research time and teaching loads for some of these staff members, most of whom work for several entities.

Table 4.5. FTE staff at universities

FTEs remunerated by MIRES (P150)	FTEs remunerated by universities		
	Below threshold	Above threshold	Subsidised contracts
2008	125 170	13 434	5 253
2009	91 603	48 858	10 357
2010	37 513	101 882	12 591	707
2011	10 354	125 901	15 260	708

Source: Annual performance reports, French Court of Auditors, 2013.

Table 4.6. FTE staff in the main PROs

	Tenured staff		Contractual with state subsidy		Contractual with equity		Total	
	2006	2011	2006	2011	2006	2011	2006	2011
CNRS	25 485.6	24 964.8		2 611.0	5 764.9	5 635.4	31 250.5	33 211.2
INRA*	8 181.9	8 188.0	1 030.0	976.8	562.6	898.5	9 774.5	10 063.3
INSERM	5 016.5	4 896.0	591.6	711.1	948.8	2 301.0	6 556.9	7 908.2
INRIA	993.7	1 204.5	264.0	461.8	556.6	909.3	1 814.3	2 575.6

Note: * 2007 data for INRA.

Source: French Court of Auditors, based on EPST data.

Conclusion: What is the current status of the public research system in France?

The conclusion that can be drawn today is not substantially different from to that which could have been drawn in 2010. The current French public research system is composite, juxtaposing elements from two different ways of organising research: the traditional "governed" model, based on large autonomous structures with a high degree of control over their own fields of activity; and a new model, based on programming administered by the State, some competitive project funding, laboratories linked to universities and independent evaluation. A hybrid model normally allows for selecting the appropriate mechanisms according to the work assigned and the specific conditions of public research. Some types of research require specific resources, stability and planning that governed mechanisms can better provide. Conversely, other types are characterised by, for example, multiple *ex ante* alternative solutions that can be better explored through a competitive mechanism. The path followed by France over the past decade has been to extend the area covered by the competitive mechanisms over those covered by the governed model, in order to promote excellence and relevance (with regard to economic and social objectives). At the same time, PROs have made a number of changes in a bid to internalise excellence and relevance within their own organisations, while preserving their identity:

- They have emphaised transfer, including intellectual property and enterprise (see the next chapter).
- They have increased pressure for scientific excellence on researchers and teams: internal evaluations increasingly rigorous and effective, use of AERES evaluations, closure of underperforming units, etc.
- They have enchanced co-ordination between PROs, and with universities, through "alliances": these informal structures (with no articles of association or dedicated infrastructure) group together PROs and universities around major research fields (health and life sciences: Aviesan; energy: Ancre, etc.). Their task is to facilitate thematic and administrative co-ordination between stakeholders when preparing research programmes, managing certain programmes and procedures (e.g. recruitment), and so on.

However, these changes have so far not challenged the very foundations of the current public research system, i.e. the integration of the different roles (steering, funding, implementation and evaluation) within the PROs.

Thus, reform has progressed in France through two channels – the internal evaluation of existing organisations and mechanisms on the one hand, and the establishment of new organisations and mechanisms on the other. The first channel offers limited changes, while the second aims to effect more radical transformation.

In this context, the French research and innovation system now faces two questions: what is the appropriate balance between the two models under the current research and innovation conditions? And how can they co-exist in such a way as to maximise their complementarities and minimise systemic frictions?

In the current balance between the two models, incompatible mechanisms are operating simultaneously and leading to system inefficiencies. The creation of new entities and rules – which generally added to, rather than replaced, the existing entities and rules – has increased the system's complexity (leading to specific costs and inefficiencies) and created a feeling that resources are insufficient. Indeed, since resources have not increased as

fast as new entities have been created, they have to be shared among a larger number of stakeholders, each receiving a smaller share.

The case of HR clearly illustrates this point. The juxtaposition of the research organisation system with project funding has led to inconsistencies in resource allocation. In the second half of the 2000s, financial resources were increasingly allocated by the ANR, while HR (in this case, tenured researchers) still worked under large research organisations, such as the CNRS (where researchers decide in which laboratory they will work). Since those two processes were disconnected, the consistency of their results could not be guaranteed. This resulted in a shortage of staff in laboratories that had won ANR grants. Since these laboratories were unable to recruit permanent researchers (government employees whose overall recruitment volumes are controlled by the State), they had had to recruit staff on short-term contracts. At the same time, tenured researchers of the CNRS were tied to laboratories that had not received competitive funding, and whose insufficient resources prevented them from carrying out the planned research. There are several possible ways of resolving this inconsistency: one would be to revert to the previous system and reduce the share of project funding. This would amount to depriving the French research and innovation system of an essential tool to help it adapt to modern research conditions and the political authorities of a potentially powerful strategic steering mechanism. Another solution would be to establish mechanisms that promote the mobility of permanent researchers, perhaps by considering changes to the status itself required to promote such mobility (civil servant researchers fall under civil service regulations, albeit with some special clauses).

The composite nature of the French research system at this stage of its evolution creates further complexity, which itself makes the system both less efficient (a growing share of resources, e.g. researchers' time, is spent on management rather than output) and less transparent (and therefore less possible to steer). After a phase where new stakeholders and mechanisms were created, a thorough review should now take place in order to consolidate existing frameworks and make the system more consistent and transparent. Consideration should certainly be given to the reforms implemented by the PROs in this regard, which should facilitate better integration into the rafts of reforms already undertaken.

For example, the integration of the PROs with universities is already quite advanced where the joint research units are concerned. The internal management systems of the PROs have incorporated some parameters for managing university research (increasingly effective evaluation, role of competitive funding), and the switching of some units with partial PRO status to full university status could occur all the more easily as the single administrator system seems to be progressing. If such a direction were taken, major research universities would need to be allocated some of the management capacity (including staff) currently allocated to certain PROs.

The site policy, which aims to strengthen the integration of the different research stakeholders on a geographical basis – i.e. around universities – and which is promoted by the MESR and supported by the PROs, is also moving in this direction. It has the added advantage of being able to call on the regional authorities, which can provide useful resources for helping with the necessary adjustments.

The competences and experience built up by the PROs, particularly at the strategic and administrative levels, are considerable, and must of course be preserved in a model where the balance would be tipped towards project funding and universities. It could be partially reinvested in other organisations – the MESR, the ANR and major research universities – which would see their role enhanced under this new model.

Overall, it appears that additional structural changes would enable French public research to achieve a higher level of excellence and relevance, with reduced operating costs and increased transparency. The changes required are ultimately minor, as the components of this evolution– the alliances, the ANR, the AERES, university autonomy, the integration of some PROs within universities, the site policy and the PIA – are already in place. They now need to be leveraged strategically.

Notes

1. Scientific performance is always difficult to measure. The most common source is scientific publications. These have the advantage of reflecting the core activity of most researchers, the publication of articles in scientific journals. Publication data are traceable: researchers and their membership are well identified, and there is information reflecting the scientific value of the work (the prestige of the publishing journal, the number of citations received). Thus indicators publications are commonly used worldwide to assess individual researchers, research teams and universities. As such they are subject to intense monitoring by the agencies responsible for evaluation and by employers. However, they are not free of defects, many of which can be reduced by proper treatment of the data. For example the fact that the majority of major scientific journals are in English favours researchers in countries where this language is more prevalent; researchers often have to multiply poorly differentiated publications (of low marginal value) to increase their score; some scientific fields are less based on publication than others; etc. These faults are not present in the indicators used in this review, which is aligned with the best international standards in the field of bibliometrics as practiced in France by OST. In addition, the bias in favour of English could affect comparisons between France and the English-speaking countries, but it should not affect comparisons between third countries, France and Germany for example. It is, however, necessary to complete the analysis of bibliometric data with that of other sources. Indeed, the publication of articles is not the only activity of researchers: they also publish databases, research materials, blogs etc. and those working in the more applied areas are also involved in transfer activities and innovation.
2. For a complete overview of R&D in Germany, see: BMBF Federal Report on Research and Innovation 2012 or Research in Germany: The German Research Landscape 2011.
3. Data: Research in Germany (2011).
4. View distribution map: www.forschungslandkarte.de/en/institutional-research-priorities-of-universities/map-search.html.
5. Responsible for managing the research programmes of the regional and federal ministries.
6. See the distribution of funded projects per area: www.dfg.de/download/pdf/foerderung/programme/exin/entscheidung_exin_karte_120615.pdf.
7. For a complete list of the selection criteria for the Idex, see: www.agence-nationale-recherche.fr/investissementsdavenir/documents/ANR-AAP-IDEX-2010.pdf.
8. For a complete list of the selection criteria for the Labex, see: www.agence-nationale-recherche.fr/investissementsdavenir/documents/ANR-AAP-LABEX-2010.pdf.
9. For a complete list of the selection criteria for the Equipex, see: www.agence-nationale-recherche.fr/investissementsdavenir/documents/ANR-AAP-EQUIPEX-2010.pdf.
10. See the complete list of grantees: http://media.enseignementsup-recherche.gouv.fr/file/Investissements_d_avenir/94/9/Equipex-liste_des_52_projets_166949.pdf.

11. The presidents and CA of the PRES have one year to adopt the CUE articles of association (on an interim basis).

12. www.cese-poitou-charentes.fr/IMG/UserFiles/Image/Avis%20PRES%20L%20PC%20octobre%202013.pdf.

13. Composition of these bodies before the 2013 Law.

14. The 2013 Law on Higher Education and Research sets the number of members of the CA at 24 to 36, including 8 external parties appointed by university partners and elected members of the CA.

15. The openness of the CA, CS and CEVU to external stakeholders (business leaders, executives and representatives of regional authorities for the CA and other external stakeholders for the CS and CEVU) is also an example of how the research system has evolved.

16. The CS and the CEVU are becoming research and training committees that make up the academic council. See the breakdown of compositions and competences in the 2013 research law, Journal Officiel (Official Gazette).

17. See Eurydice (2008), Higher Education Governance in Europe, http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/091EN.pdf.

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