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The future of research in France: population projections

*Henri Leridon **

The first quarter of 2004 found French public research laboratories in unprecedented turmoil, partly from the budget cuts made since 2002, and partly from 550 permanent civil service jobs being turned into fixed-term contract appointments. It is this latter minimal cost-saving measure around which the debate has crystallized. For the government, it reflected an aim to see greater diversification in the employment statuses of research personnel, so as to "add more flexibility" into the system. For researchers, it marked an abrupt worsening of the crisis in employment of young researchers: offering postdoctoral graduates the same pay as a tenured postholder, but without the job security was fated to reduce the appeal of public research. Also, the measure followed the scrapping of the 2001 "Schwartzenberg plan" for a substantial phased increase in the recruitment of researchers to counter the retirement outflow expected from 2006-2012, and a similar Jospin-Lang plan for higher education.

The demographic origins of the problem

Demography is therefore central to the discussions. It is an established fact that for the French population as a whole, the baby boom (the number of births rose from 661,000 in 1945 to 864,000 in 1946) will produce a sharp rise in the retirement rate around 2010-2011. There is of course no direct correlation between the age structure of an occupation and the overall French population structure: the past annual recruitment record is an important factor. The demographic shock from the baby boom will therefore vary with occupation and qualifications, and a report from the Office of the Planning Commissioner stressed that it would be particularly severely felt among civil service managers, teachers and researchers [1]. This article considers the characteristics of the research community based on the output of the Education Ministry, the Observatory on Science and Technology (OST) and the co-operative production system for inter-institutional indicators (DPCI) (1).

Table 1 - Total population engaged in research in France (2001-2002) (thousands)

	Researchers	Technical and administrative staff	All
Private sector	88	97	185
Public sector	171	85	256
Total (in 2001)	**259**	**182**	**441**
of which (in 2002):			
Higher education (a)	57	49	106
ATERs and teaching assistants (b)	12	-	12
EPST (permanent staff)	17	26	43
EPIC, Foundation Institutes	12	10	22
Non-tenured public sector researchers	6	-	6
Postdoctoral graduates	3	-	3
PhD students (bursary or grant-funded)	20	-	20
PhD students (not grant-funded)	44	-	44

(a) Faculty = professors and lecturers at universities (including teaching hospitals) and the *grandes écoles*.
(b) ATER = short-term teaching and research assistants (university). Some PhD students also hold ATER posts and so are counted twice.
Source: MEN-DEP B3 and DPCI/OST [4, 5].

** Epidemiology, Demography and Social Sciences Unit (Inserm-U 569, Ined, Paris XI)*

(1) The list of acronyms and their meaning is given on page 5.

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◆ 440,000 jobs all told

The research occupations include full-time researchers and related occupations (university faculty, PhD students, etc.) as well as technical and administrative staff, ranging from warehousemen to research engineers whose activities may very closely resemble those of researchers. All may be employed variously in the public or private sector.

Approximately 440,000 people are engaged in research in France, just over half of them in the public sector (table 1). Researchers and faculty account for nearly 60% of the total. 86,000 of them are in public service employment: 57,000 in higher education (universities and "*grandes écoles*" [higher institutes]), 17,000 in EPSTs (research organizations like Cnrs, Inserm, Inra and Ird which between them account for 95% of the total EPST staff complement), approximately 12,000 in EPIC (production-oriented and related research organizations, like the Cea, Cnes and Cirad) and foundations like the Pasteur Institutes in Paris and Lille.

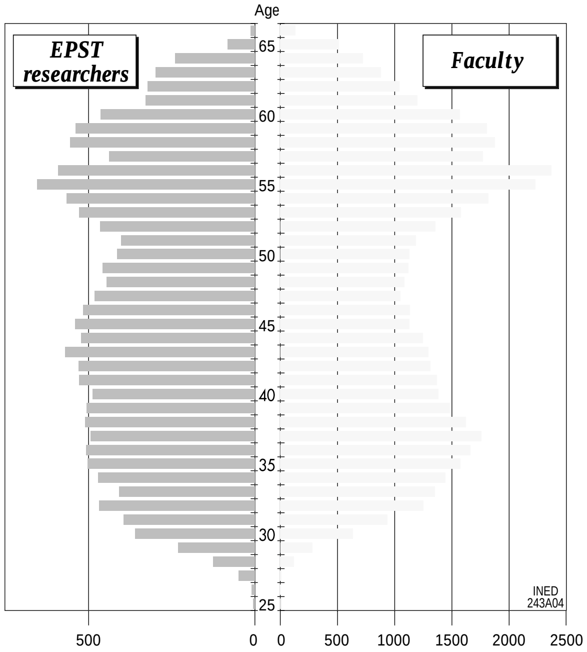
◆ Numbering university researchers

One immediate problem is the predominant share of universities, especially compared with that of EPSTs (a ratio of more than 3 to 1): is this to say that three-quarters of public research is done in universities? If so, the debate on the future of French research should focus mainly on higher education, and could almost dismiss EPSTs, which does not seem to be the consensus view. In fact, the precise share of research at universities is hard to judge. The Conference of University Vice-Chancellors recently advanced a series of estimates, one of which seems to have reasonable credibility [3]: it suggests that in total, universities contribute (through research funding, PhD student grants, staff pay) about as much as all EPSTs to public research; this calculation (like the OECD comparative data) puts the time spent by faculty on research at 50%, which—says the report—is surely a maximum.

At all events, universities must be seen as a case apart, because their primary obligation is to teaching. What is more, the sharp rise in the population of faculty in recent decades has mainly been a response to the huge growth in university enrolments, which doubled between 1970 and 1992, and have remained level since 1995.

Likewise, the EPICs and Foundation Institutes are not purely research organizations, and are generally engaged in more applied research than the EPSTs. But organizations like the CEA or the Pasteur Institutes also make an undeniable contribution to basic research. Their staff work either under ordinary contracts or special employment statuses. The focus here is on EPSTs and university teachers (excluding the "*grandes écoles*").

Figure 1 - Age distribution of researchers and faculty at 1-1-2003



Note: The scales for the two populations are different because they are not the same total size. There are nearly three times more faculty than EPST researchers.

Source: Co-operative scheme/OST.

◆ 45% leaving in ten years

The situation at year-end 2002 is clear from the age pyramids (figure 1). There are two very prominent peaks in higher education: one around age 37, and another even more pronounced at age 55-56. The smallest cohort (age 47) is almost two and a half times smaller than the age 56 cohort: retirement by the over-55s will therefore leave a big gap, raising management/supervision problems. The EPSTs show a more regular age distribution: this covers all nine EPSTs, but the Cnrs accounts for nearly 70% of the total. Here, there is no peak in the 35-40 age group, the constriction around age 50 is not significant, and the spike at age 55 is 60% above the minimum. As non-retirement outflows from these professions are fairly regularly distributed between ages 40 and 60, these pyramids display the effects of very irregular recruitment into higher education (with two big inflows in the 1970s and 1990s) and more regular inflow patterns in EPSTs (at least in the biggest organizations).

Retirement outflows in the years ahead will depend to some extent on the choices made by the 60+ age groups after the reforms decided in 2003. But because the maximum age remains unchanged (65, except in special circumstances), there is relative certainty about retirement exits over the next 20 years, given that retirements account for approximately three-quarters of all outflows, the other quarter comprising voluntary separations and deaths. Discounting the years 2003-2004

Table 2 - Faculty and EPST researchers: projected exits 2003-2022

	EPST researchers	Faculty
Average 1995-99	540	1,340
2003	725	2,661
2004	686	2,125
2005	673	2,102
2006	674	2,174
2007	713	2,310
2008	746	2,395
2009	744	2,413
2010	725	2,432
2011	743	2,426
2012	750	2,301
2013	714	2,097
2014	678	1,935
2015	649	1,827
2016	631	1,765
2017	638	1,750
2018	657	1,757
2019	668	1,780
2020	681	1,818
2021	694	1,873
2022	700	1,940

Source: Author's projections

(where there are strong elements of uncertainty related to changes in pension schemes), total annual exits are set to increase until 2010-2012, then decrease over the ten years after that (table 2). From an annual rate below 1,400 in higher education at the end of the 1990s, the number has already risen above 2,000 and will top 2,400 in 2009-2011, before slipping back below 1,800 at the end of the following decade. In all, outflows between 2005 and 2014 will cut the initial population of faculty by 46%. The trend will be a little less pronounced in EPSTs: annual exits of no more than 600 before 2000 will hover around 700 in the twenty years to come; 42% of the initial population will have left in ten years.

Seven scenarios, but few sound solutions

The large population outflows expected in the years ahead correspond to the major inflows of the 1970s. The aim at the time was to boost enrolments (and hence teaching staff) while simultaneously expanding public research: it is not a case of mismanagement, therefore, and no-one takes issue with the big impetus given to this sector. The question is, what to do about the situation it has created?

The first thing to look at is the "stationary population equivalent", i.e., the annual number of entries and exits which, in a stabilized regime, would maintain current population sizes. If all outflows were retirement exits only, careers would be spread over 30-plus years, and the replacement rate would be 3%, i.e., 1,500 recruitments to universities and 520 to EPSTs. In fact, there is some recruitment at relatively older ages, and significant outflows before age 60 (into the private sector, an EPST for faculty or university for the researchers, or on death): the annual attrition rate is about 1% for faculty and 1.5% for researchers in EPSTs (including deaths), and the difference between average exit and entry ages in 2002 was 23.6 years in both sectors, making the average retention time therefore close to this figure. As a result, the number of entries (and exits) in the benchmark stationary population would be about 2,100 for higher education and 720 for EPSTs.

In the 1990s, a particularly youthful age structure meant that annual outflows were well below these figures, averaging 1,340 and 540 respectively (table 2). This prompted the mistaken belief that the stationary population equivalent posited an entry and leaving rate around 3%, which was belied by future developments.

1 - One possibility is to see the coming "exit bulge" as an abnormality and straight away to cap the recruitment rate at 3%. This idea has been floated in various official documents. The advantage of constant recruitment is to regularize the age structure over the long-term; the big drawback with the level chosen is to reduce the total population size: the recruitment rate announced in 2003 for EPSTs would reduce the population of researchers by 12% in 10 years and by 19% in 20 years (table 3). More seriously, it would nearly halve the number of under-38s over the same period (–44%). The counter-argument may be that the jobs released could be redeployed (contracts, post-doctoral grants, etc.): but they would be temporary positions, and hence a population with a constant turnover rate (e.g., PhD students), which would involve a different projection assumption; this will be reconsidered in point 4. The consequences of the same decision for higher education would be less severe on total population size (16% in 10 years and 19% in 20 years), but more serious still for the under-38s (–50%).

2 - One way to achieve a more regular pyramid would be not to limit recruitment to young people (around age 30) but also to open up posts to older applicants. But would putting out a large number of senior research positions to (external) competitive examination attract a sufficient number of quality applicants? From where might these experienced researchers be drawn if not from universities, where the problems are the same, or the private sector, where researchers often have short careers as the best move on to other responsibilities? This leaves foreign recruitment, if any countries have a "surplus"... Arguably, such a solution can be no more than marginally effective.

Table 3 - Total population of faculty and EPST researchers in various recruitment scenarios: 2013 and 2023

	Faculty				EPST researchers			
	Reference stationary population	Exact counterbalancing of outflows	Constant rate inflows: 3% a year	Constant rate inflows: 4% a year	Reference stationary population	Exact counterbalancing of outflows	Constant rate inflows: 3% a year	Constant rate inflows: 4.1% a year
Total annual inflows	2,100	Variable*	1,500	2,000	720	Variable*	500	700
Population in 2003	–	49,450	49,450	49,450	–	17,030	17,030	17,030
Population in 2013	–	49,450	41,705	46,342	–	17,030	13,534	16,583
Population in 2023	–	49,450	40,014	48,340	–	17,030	11,596	16,812

* Annual inflows are equal to outflows in table 2.

3 - Keep the current population size stable by counterbalancing outflows with inflows. The drawback of this solution is to add a new major irregularity to the age structure, which can only shift over time as "boom years" will inevitably be followed by "bust years", with many fewer retirement exits (figure 2 and table 2).

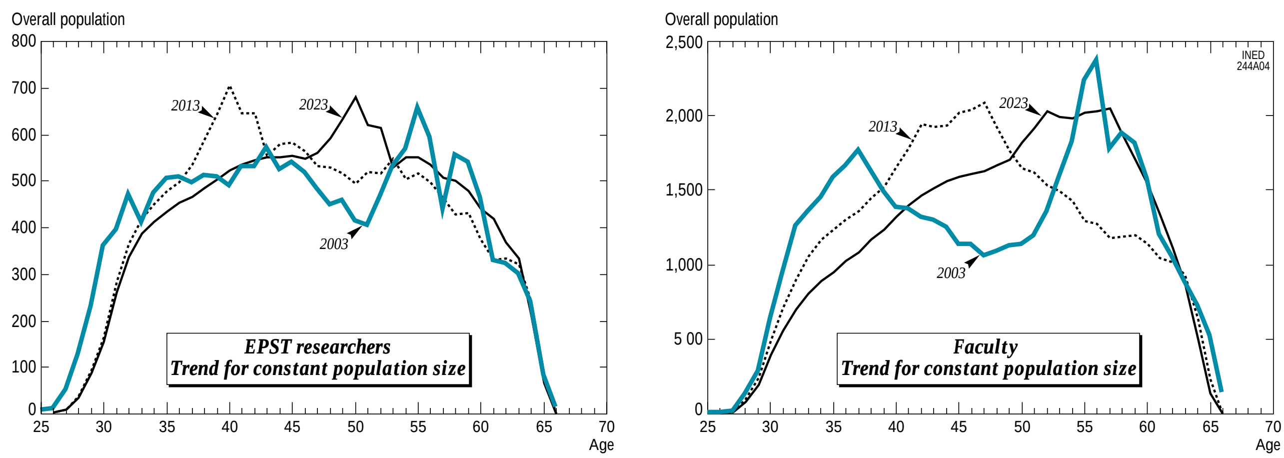
4 - A variant to this scenario would be to increase recruitment for some years, but in the form of fixed-term contracts, retaining only a proportion of these employees after 4 or 5 years: this is the idea behind the "pool of young researchers" from which the elite of permanent senior researchers would be drawn. But, maintaining the size of the experienced researcher population while increasing the inflow selection rate to it means increasing the total population of young researchers beyond the current figure. In other words, it is not enough to convert young researchers' permanent civil service posts into fixed-term contracts; these recruitments must be added to those resulting from the simple natural trend described in point 3. Also, issues arise about the future of non-tenured young researchers: the private sector places little value on PhD students and postdoctoral graduates, which leaves only education (higher or secondary).

5 - Try to smooth the process, by planning ahead during low exit years for a recovery in high exit years: this was the principle of the "Schwartzenberg Plan" to add 500 research posts in 2001-2004 and cut 100 in 2006-2009. But this was only a partial smoothing, and it was put in place just when an excess of retirement exits at the end of 1999 (as a result of targeted incentives) raised the recruitment rate, contributing to the sharp spike visible at age 40 in 2013 on figure 2. In any event, it is now too late to implement this solution.

6 - Having failed to forward-plan, limit total recruitment during the big exit years and hope to catch up later: but this will be difficult to do with a surge extending over 15-20 years, and will do nothing to stem the reduction in the overall population during the first 15-20 years with the drawbacks described in point 1.

7 - Accept a period of recruitment growth, but add some regularity to the age structure by keeping a constant rate of inflows. The advantage of this latter solution is to give leeway to diversify recruitment procedures without seriously affecting the stable core of the researcher population. As an example, this option is offered in table 3, based on a recruitment rate that keeps the population approximately stable over the long term,

Figure 2 - Projections with exact counterbalancing of outflows each year, 2003-2023



Source: Author's projections based on OST age structures in 2003.

i.e., 4% for higher education, and 4.1% for EPSTs. These are also the aims of the somewhat ambitious scenarios of the FutuRIS report [6]. The age structure effects, however, differ little from those of solution 3.

Do we need more researchers?

The above discussion assumes that the population of researchers will be kept more or less stable over the medium-term. As we have seen, there has been no growth in student numbers for some years and the size of cohorts likely to swell university enrolments is set to decline slowly over the coming decade. From this angle, maintaining the population of faculty in the medium term therefore seems a reasonable overall aim, but it overlooks the existence of specific needs in some fields, because faculty are not interchangeable [7].

The solution for EPSTs is governed by other determinants: is the current French research effort satisfactory (compared with other countries)? Should public research have the same, greater or lesser importance in the broader set-up? And should the status of researchers in the public sector (civil servants) change? This latter point is not addressed here, since the estimates relate to the public sector as a whole, all employment statuses combined. The research effort in France currently accounts for 2.2% of GDP, just under half of it in the public sector, and the (national and European) aim is to raise this to 3% in short order. This requires a substantial increase in the population of researchers. Some argue that the public researcher population is about its optimum size, and that most effort should come from private enterprise: but a doubling of their numbers within a matter of years seems a far-fetched proposition [2, 6], and an increased public effort will also have to be made.

A widely diverse community

A consideration of the situation of technical and administrative staff (*prima facie* similar to that of researchers), and a detailed examination of organizations and disciplines, whose problems are not the same, falls outside the scope of this article. The imbalance between the 55-60 and 45-54 age cohorts, for example, is particularly marked in some sectors, like physics and chemistry; conversely, there is no age 45-54 constriction in the social sciences, and the age profile in medicine is completely atypical (very few under-40s). The scenarios suggested above will therefore need to be adjusted by research discipline. Furthermore, the same discipline may have different aims in university and EPST research (see the work of the OST and [7]).

Also, a sound inflow to the teaching and research occupations requires sufficient numbers of PhD students, especially in the basic sciences. Approximately 10,000 dissertations are defended each year in France, a third of them supported by specific bursaries or grants. This number must not be allowed to decline at a time when the population of new researchers should be rising: sadly, that is what seems to be happening in certain disciplines, as is borne out by a recent report from the Academy of Sciences, the main features of which are given below.

* * *

It is virtually impossible to "regularize" a deeply gashed age structure for the simple reason that outflows tend to be replaced by very differently aged, but equally bunched, inflows. Sound management of scientific employment must therefore try to forward-plan for the coming shocks by conducting a long-term policy. But can the public sector really think in terms of fifteen to twenty years hence, when policy horizons are governed by five-year time-frames at best?

List of acronyms

DPCI: co-operative production system for inter-institutional indicators

MEN: Ministry of Education

OST: Observatory on science and technology

EPST: Public sector research agency
- **CNRS**: National Centre for Scientific Research
- **INED**: National Institute of Demographic Studies
- **INSERM**: National Institute for Health and Medical Research
- **INRA**: National Institute for Agronomic Research
- **IRD**: Institute for Development Research (formerly Orstom)

EPIC: Production-oriented and related research agency
- **CEA**: Atomic Energy Commission
- **CNES**: National Space Studies Centre
- **CIRAD**: Centre for International Co-operation on Agronomic Research for Development

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Special report

Are students shunning science?

Jean Dercourt and Ariane Azéma***

Students with science baccalaureates account for over 49% of those with general upper secondary school diplomas or over 46% if technology baccalaureates are included. These percentages are almost unchanged since 1985. Almost 35% (36% in 1996) of higher education enrolments, all courses of study combined, are in "science" subjects (1). Contrary to popular myth, therefore, French secondary school completers are not turning away from scientific studies in droves, instigated by a shortage of DEUG (first-cycle, two-year university diploma) places and widespread mistrust of science.

But disciplines are evolving in very different ways (table 1): from a sharp fall in the numbers taking physics to a huge rise in those studying engineering sciences, let alone the boom in computer studies, all against a background of little change in total university enrolments.

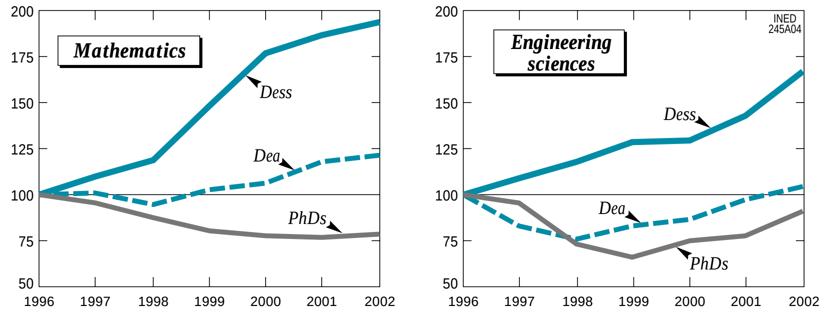
These contrasting pictures between disciplines affect traditional university courses equally with the so-called selective entry courses, whether university-level (university institutes of technology (IUT), colleges or academies) or otherwise (advanced technicians' courses (STS), preparatory classes for entry to the *grandes écoles* (CPGE), colleges). Furthermore, disregarding the traditional divisions between disciplines, some dating back to the time of Auguste Comte, with basic and applied sciences often in opposing camps, today's science students are divided into three fairly stable broad groups: 17% in "mathematics" (mathematics studies, STS and IUT in computer studies, some CPGE students, etc), 48% in "health" (life sciences, medicine, paramedical studies, some biotechnology courses, etc.) and 35% in "physics-chemistry" (physics, planetary and space sciences, engineering sciences, some STS electrical engineering courses, some CPGEs, etc).

Table 1 - Trend in university enrolments for science courses (all levels of higher education) 1996-2002 (Ile de France and Metropolitan France)

Discipline	Ile de France	France
Physics	−29%	−40%
Life sciences	−18%	−19%
Mathematics	−7%	−24%
Medecine-Pharmacy-Dentistry	−5%	−1%
Chemistry	+9%	−9%
Planetary and space sciences	+12%	+47%
Engineering sciences (other than computer studies)	+22%	+15%
Computer studies	+31%	+48%
All scientific disciplines	**- 5.9%**	**- 6.4%**

Source: BCP, Sise.

Figure 1 - Trend in university enrolments, postgraduate mathematics and engineering sciences (including computer studies): Ile de France, base 100 in 1996



More students opting for short-course qualifications

One argument advanced for this turning away from the basic sciences is that students were put off by long, difficult studies [3]. An analysis of the aims of secondary school completers in Ile de France, where applications for medicine have held steady, for example, suggests that it is not that simple [1]. The specific sociological trends in inflows from technological options and, for several years, the Science option ("série S"), particularly favour open-ended routes: courses that offer both final qualifications and opportunities for further study. Engineering and engineering sciences are cases in point, where there are multiple gateways, as evidenced in particular by post-IUT courses in universities or colleges. That contrasts with the compartmentalized nature of courses leading to education and research, where there are no real stepping stones or clarity as to ultimate opportunities.

Number of science PhDs likely to fall

With the likelihood of tensions on the graduate market in response to the needs created by retirement exits and changes specific to the production system, falling doctoral programme enrolments foreshadow a decline in the number of science PhDs, thereby depleting the research and educational system's own replacement pool. Figure 1 shows the trends in DESS (postgraduate vocational diploma), DEA (1st year doctoral thesis certificate) and doctoral programme enrolments for two representative disciplines—mathematics and engineering sciences—for Ile de France.

* * *

Expanding the pool of scientific talent does not necessarily involve increasing the numbers taking the Science option in upper secondary school. The main thing is to increase the appeal of higher scientific and technical education to foundation and first degree students. One possibility would be to use the "LMD" (bachelor's, master's, doctorate) reform to create a common pre-recruitment scheme for teachers and university faculty at the end of the first year of university, similar to the old preparatory institutes for secondary education scheme for secondary school teachers [2].

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* Academy of Sciences
** Rectorat of the Academy of Paris

(1) The Dercourt report's definition of "science/scientific" [2], and its base year, differ from that of the Ministry. See *Notes d'information*, DEP, and [4].

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