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Bringing S&T Human Resources back in

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Human resources

Bringing science and technology human resources back in: the Spanish Ramón y Cajal programme

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This article analyses a government policy initiative that aimed to increase the number of researchers in the public research sector working in conditions equivalent to the tenure track, and to cope with the problems of employability, stabilisation and working conditions of PhDs. The paper describes the situation of science and technology (S&T) human resources in the context of Spanish research policy and explains the mechanisms by which policy-makers link problems and solutions in the context of a policy sequence, by analysing a case that deals with Spain's main problems in S&T human resources in the public sector.

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SINCE THE MID-50S, governments have systematically promoted the development of science and technology (S&T). Although one of the chief goals of the classic statement of modern science policy (Bush, 1945) was improving the production of human resources in S&T, the type of policies promoted by governments have focused more on general funding of research than on human resources.

However, since the beginning of the 80s, S&T public policies have been developed in the context of the international technological competition, where higher education and research were considered to be determinants of innovative capacities and of economic growth in the long term. At the beginning of the 90s, international studies focused their concern on the future shortages of skilled researchers, and these forecasts fostered a shift in the orientation of research policy in some countries. More recently (OECD, 2004) Ministers of the Organisation for Economic Co-operation and Development (OECD) countries have identified the S&T human resources as one of the two main pillars of the innovation policy.

S&T human resources policies, especially those developed by governments, are an unknown realm of research policy analysis; this probably has to do with the wide variety of developments and strategies in S&T human resources at national level that make it difficult to build up knowledge about the different models, and the different institutional arrangements affecting the supply and demand of scientific personnel. Concerning research training policies, some

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of these arrangements are distributive and regulatory initiatives centred on institutions, following decentralised schemes. These initiatives are likely to have their greatest impact on the increase of the supply of doctoral programmes in the context of the creation of scientific departments or graduate schools within universities and public research centres (PRCs).

Other initiatives have a more individualistic approach and consist basically in the funding of theses through the provision of subsidies, grants and fellowships to students based on criteria related to individual merits and research groups' performance. On the other hand, employment policies that affect the labour market for researchers are much more recent: Some are aimed at removing obstacles to international mobility (OECD, 2001), some consist of incentives for private firms to employ PhDs or are designed to facilitate the transfer of human capabilities from the public to the private sector, while others address the demand side of public-sector research through the increase of public-sector research jobs.

This paper is motivated by the important quantitative and qualitative changes in the research labour market in Spain over the last two decades. In the context of these transformations, this study analyses a government policy initiative aimed to increase the number of researchers in the public research sector. Beyond the official statement of this objective, great political importance was given to raising the number of PhDs employed in research in good and stable conditions and to cope with the problem of temporality and precariousness in this sector.

While public-sector research employment increased in quantitative terms in the second part of the 90s, it has also become strongly tied to project funding and hence to temporary jobs. Much of the national R&D funds spent for research projects in universities and PRCs was dedicated to employing researchers on a temporary basis. Therefore the promotion of research positions in PRCs through direct subsidies was a significant policy change. This paper explains how policy-makers link problems and solutions (Kingdon, 1984/1995) and presents a policy case that deals with today's main problems in S&T human resources in Spain, connecting the policy strategy with previous policies in the field in the context of a policy sequence (Weir, 1992).

In the next section, a general diagnosis and characterisation of the problems and challenges in S&T human resources in Spain are presented. After this, the general objectives and context for the Spanish human resources R&D policy, as defined in general S&T policy documents, are dealt with.

This is followed by a description of the objectives and principles of the Ramón y Cajal Programme, a relevant case of S&T human resources policy that attracted a lot of attention from professional journals such us *Nature* (2001a; 2001b) and *Science* (2003). The Programme was targeted to improve the "academic career prospects" and employment opportunities of PhDs in the public research sector, although the media only attracted attention to the issue of avoiding the 'brain drain' by bringing Spanish researchers back from abroad.[1]

The Programme's design and operating mechanisms are then described. The final section highlights the provisional results of the three calls (2001 to 2003), offering subsidies for public research institutions to contract 2,000 PhDs for five years from all scientific and technological fields.

Situation in S&T human resources

At the end of the 90s, it was generally agreed that the main problem of the Spanish S&T system was the low level of R&D investment. While European governments complained about the gap between the European Union (EU) and the USA, the gap between Spain and the EU average was also significant. While the Spanish gross domestic product (GDP) *per capita* was 85% of the EU average, in 2001, Spain had 0.96% of the GDP allocated to R&D, while the EU average was 1.98%;[2] in other words, 48.5% of the EU average. Additionally, there was insufficient expenditure on R&D executed (52.4% in Spain vs 64.5% in the EU average) and financed (47.2% in Spain vs 56.2% in the EU average) by Spanish industry, and very small business expenditure on R&D (BERD) in relation to industrial output.

While the issue of R&D expenditure was the main problem identified in policy documents and public debate, concerns also emerged regarding human resources in S&T and some problems were identified. First, insufficient human resources in R&D (in 2001

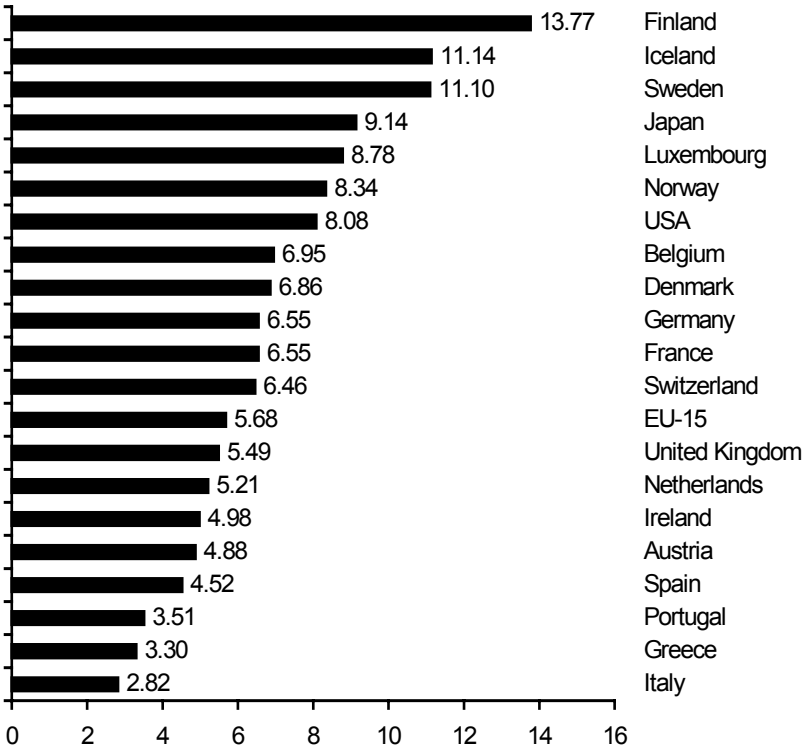

Figure 1. Researchers (FTE) per thousand labour force by country, 2001
Source: EC (2003a)

Spain had 80% of the average EU ratio of researchers per working population), especially in firms. Researchers in the business sector represented just 23.6% of the overall researchers in Spain versus 49.8% in the EU average. Second, in a context of growth in the number of PhD recipients, an emerging mismatch was perceived between the supply of PhDs and the demand for them, especially in some disciplines and S&T specialisations.

Third, a perception of the precarious state of the public research sector emerged, because some of the statistical increase in the number of researchers had been based on the growth of temporary jobs with low salary positions (fellowship[3] had become the regular labour relationship, even for experienced PhDs). The research labour market presented serious problems regarding 'academic career' opportunities and long-term employment prospects even for PhDs with high quality scientific records. Finally, while the total number of researchers in Spain represents approximately 8% of the EU total, the country had fewer researchers per 1,000 labour force than the EU average (see Figure 1), despite showing a significant increase in the last few years.

However, the quantitative improvement in S&T human resources witnessed in the last few years could also be the result of a small change in the methodology of Spanish S&T statistics.[4] In 2001, grant holders (*becarios*) represented approximately 25% of the total number of researchers, and females accounted for a greater proportion (see Figure 2). Figure 2 reflects the outcome of a gradual process of

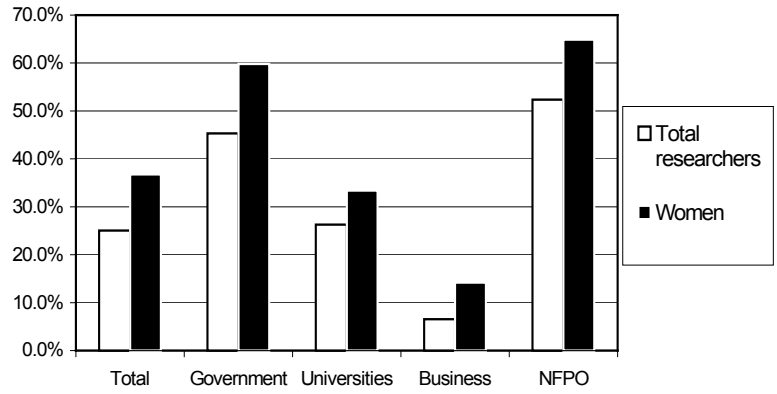

Figure 2. Grant holders (*becarios*) as % of the total number of researchers by sector and sex (2001)
Source: Spanish Statistics (INE, 2001)

There has been a gradual dualisation in the Spanish labour market for research: the gaps between those with a permanent position and those without have been widening in terms of salaries, social security benefits, employment stability and career prospects

dualisation in the Spanish labour market for research, whereby the gaps between those who have a permanent position and those who do not have been widening not only in terms of salaries, but also in terms of social security benefits, employment stability and career prospects.

The Spanish labour market for research is not only characterised by a very high proportion of temporary researchers and trainees, but also by the fact that the average expenditure per researcher, in purchasing power parity (PPP), in the public research sector (government laboratories and universities) is significantly lower in Spain than in other EU countries (see Figure 3). This is not the case in the business enterprise sector. Considering that the labour cost usually accounts for 60% of total expenditure, we could assume that there is also a problem associated with low wages in the Spanish research system, mainly in university and government sectors, in comparison with other countries.

From the OECD statistics on R&D activities, we could also build up some comparative data on the labour cost as a component of the gross expenditure on R&D (GERD). If we divide labour cost by the number of R&D personnel, we get an idea of wage levels in the different countries. For example, Spanish universities (HE) have approximately 30,000 PPP US$ per year of labour cost *per capita* R&D personnel, while the German universities have about 50,000 PPP US$ a year (see Figure 4). The labour cost in the business sector (BE) is much more similar in the different countries.

The wage gap between Spain and the EU average, especially in research, has become more evident after the publication of various reports on the issue (Pedró and Sala, 2002).

Career prospects

In so far as academic career prospects are concerned, the situation had worsened significantly in the past. Getting a tenure or a permanent research position at a public research institution was much more difficult at the end of the 90s than it used to be. One side effect was a delay in the average age at which researchers obtained their tenure. For example, at the CSIC, the most important public research institution in the country, in 1960, the average tenure age for a research scientist (CT) was 28, while today it is over 36.

Another very significant problem was the increasing delay in the age of getting professional promotion after good performance, for people who already have a tenure position. For example, when looking at promotion from CT or senior researcher (Inv) to the highest professional ranks (research professor, Prof) at the CSIC, we see that the average promotion age rose from 33 to 50 (Figure 5).

The explanation of this evolution is complex. On the demand side, part of today's problems of researchers' employability in the public sector are associated with the relative stagnation and/or low increase in the traditional academic positions available over the last ten years, along with the limited capacity of the Spanish private sector to absorb R&D human capital.[5] More importantly though, on the supply side, this evolution is associated with the very significant growth in the production of new graduates and PhDs.

A compounded effect of these two factors has been the multiplication of post-doctoral jobs as 'waiting positions' in the academic labour market,

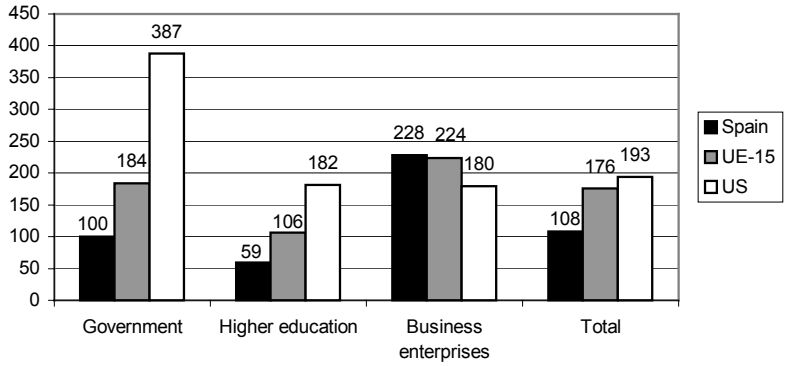

Figure 3. Expenditure in R&D per researcher (FTE) by sector, 1999 (in thousand PPP US$)
Source: OECD (2003b)

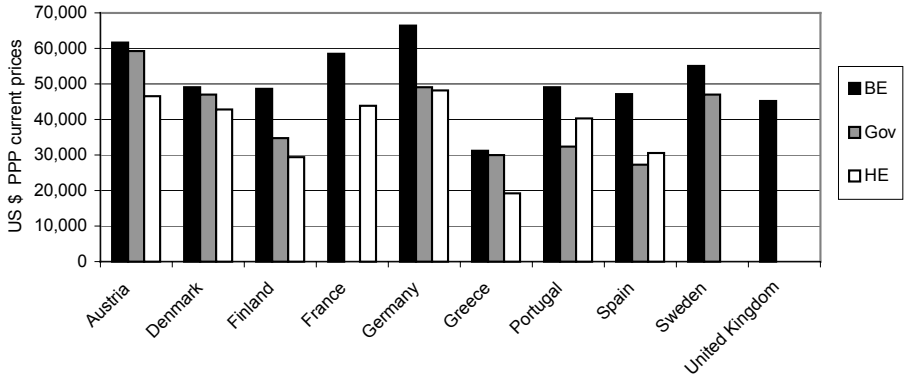

Figure 4. Labour cost *per capita* R&D personnel, 1999 or last year available (in PPP US$)
Source: OECD (2003c); EC Independent Expert Group (2003)

most of them with temporary grants. A recent study of a sample of Spanish PhDs currently employed in the private sector has shown that future employment preferences during the doctorate are more oriented to the public than to the private sector.[6] The choice to wait for some years in this type of post-doctoral position creates a segment in the research labour market, characterised in many cases by instability and low wages, but at the same time, absorbing mismatches between supply and demand.

The 80s and early 90s witnessed a significant increase in the students enrolled in graduate programmes in Spain and in the supply of PhDs. In 2000, Spain had more than 60,000 students enrolled in PhD programmes and around 6,000 getting their PhD degrees every year. If we consider that in 1982/83 Spanish universities produced less than 2,000 PhDs, the increase has been very significant (see Figure 6).

In Figure 6, we observe the sharp increase in the total number of annual doctorates awarded by Spanish universities along with a large increase in graduate students. This evolution is related to at least five factors. First, the expansion of tertiary education prompted an increase in the numbers of students participating in university education in the 80s and 90s. Second, because of the demographic structure, larger cohorts have been entering the Spanish labour market since the end of the 80s.

Third, some general economic conditions have had an impact on the number of doctorates. In the first half of the 90s in Spain, young graduates were given higher incentives to pursue a PhD in the context of a depressed labour market with limited employment opportunities. Besides, the general economic crisis of those years prompted a slow growth and a decrease in real terms of R&D public expenditure.

The next relevant factor has been the availability, since the mid-80s, of a significant number of four-year Government grants for funding doctoral studies. Over the last two decades, we have witnessed a diversification of the subsidies for PhD training at the regional and university levels, with increasing involvement of regional governments and universities in financing research training with their own financial resources. In fact, some of the current problems of 'employability' (or mismatch in the PhDs' labour

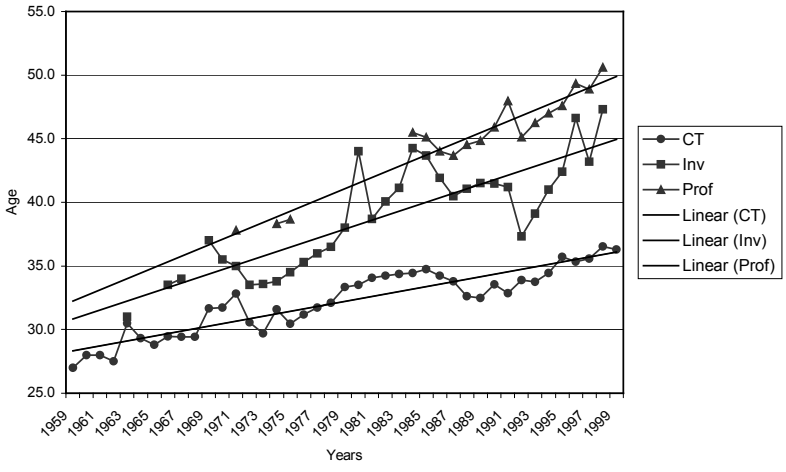

Figure 5. Evolution of tenure (CT) and promotion (Inv & Prof) ages at CSIC
Source: CSIC personnel databases

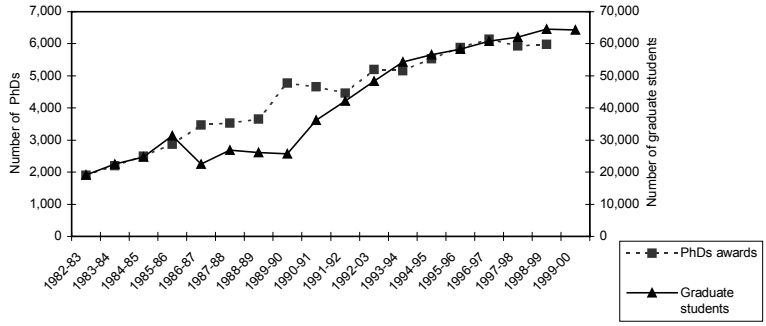

Figure 6. Evolution of the graduate students and PhDs awards Spain (1982–1999)
Source: Spanish Statistics (INE, various years)

market in some areas) relate to 'successful' research training policies in the mid- and late-80s, unconnected to demand-side policies.

Over the last 20 years, more than 20,000 individuals have had a grant related to their PhD studies. In the same period, almost 80,000 new PhDs have been awarded: 7,000 in engineering and technology and more than 45,000 in science and medicine. Central Government awarded a grant to 1 out of every 4 new PhDs to conduct their research activities full-time. This created good incentives to take up a research career, especially in times of bad general prospects in the 80s and early 90s for finding employment rapidly after graduation.

Possible mismatches by areas relate to the unequal distribution of the training grants by areas over the years. We should also observe that the distribution between disciplines and S&T areas has evolved. Today, of the 6,000 new PhDs per year, more than 3,000 are in experimental sciences and medicine and 700 in engineering (see Figure 7).

Finally, some institutional factors are relevant. In Spain, as in many other countries, the PhD degree is the only diploma that permits access to a stable or tenured academic job, with the status of civil servant. Some analyses have shown that professional trajectories in science are not flexible and that PhDs have to choose a career path when their level of information on employment and other prospects of returns are very low (Mangematin, 2000). Moreover, in Spain, the public and private research sectors are institutionally isolated, and it is difficult to obtain returns on the investment in a PhD outside academe. Therefore, the costs of mobility between sectors become too high, contributing to enlarging the number of post-doctoral waiting for positions.

There has also been an evolution in the composition of the supply of PhDs. While the evolution of annual PhD production has evolved positively in absolute terms, the situation is not so positive if we only consider S&T PhDs, especially when we look at the percentage of people from some population cohorts who obtain a PhD. Spain is still significantly below the EU average of annual production of new PhDs in S&T per thousand population aged 25–34 (see Figure 8).

Overview of problems in Spain

The balance of the problems that Spain faced in S&T human resources, that were part of the context, can be summarised as follows: fewer researchers than required by international standards; a significant level of researchers working and employed in poor conditions; a significant proportion of low salaries either for permanent or temporary researchers; deteriorating career prospects in terms of age of entrance and promotion; significant imbalances

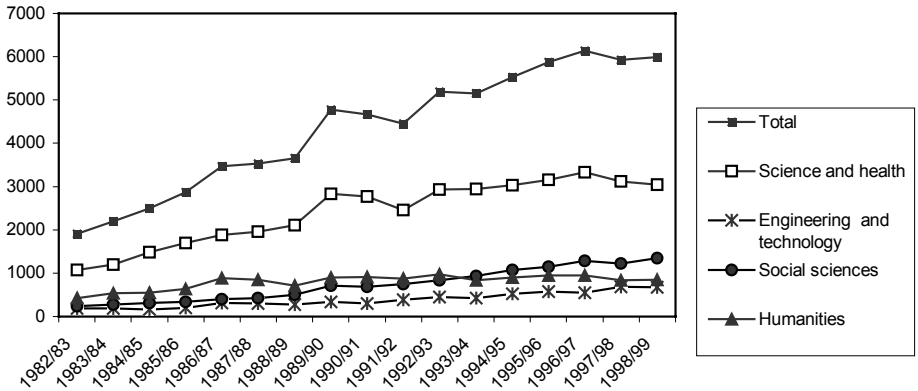

Figure 7. Evolution of the distribution of PhDs awards by discipline Spain, 1982–1999
Source: Spanish Statistics (INE, various years)

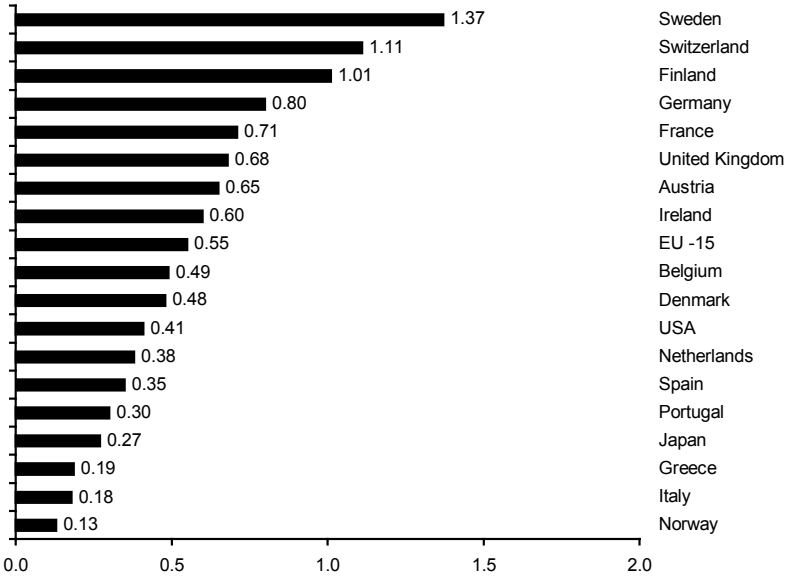

Figure 8. New PhDs in science and engineering fields per thousand population aged 25 to 34 years, 2001
Source: EC (2003a)

between the growing supply of PhDs and the real demand in a public sector under financial constraints; a slow growth of demand for researchers in the private sector;[7] and even apparent mismatches between supply and demand in some S&T areas.

The OECD identified three different types of problem related to S&T human resources (OECD, 2003a): low level of production of highly qualified scientists (scarce supply); strong mismatches between supply and demand because of bias by S&T areas; and low demand for PhDs or low employment opportunities, in the public and private sectors. The Spanish situation has some elements of all three, but fits much better in the last one.[8]

Role of human resources in S&T policies

S&T human resources policy in Spain has evolved significantly in the last few decades. It started with research training, in the 60s, as in many other countries, as a decentralised policy under the direct responsibility of the PRCs. PRCs were able to provide grants and fellowships to cover the expenses of the trainees either in a centre in Spain or abroad.

In the 70s, in the context of a financial collapse in the research system (Sanz-Menéndez, 1997) training new scientists and researchers through doctoral programmes became a political objective and research training emerged as a Government policy (Fernández Esquinas, 2002). A very large and centralised programme (Formación de Personal Investigador (FPI) to train research personnel) was consolidated in the 80s as a mechanism for giving grants to thousands of individuals, to pay them a salary or compensation, while they were preparing their PhDs. These grants were a monthly Government subsidy given to young people engaged in dissertation activities. It is worth mentioning that there was a policy tool precursor (re-incorporation contracts) that enabled young researchers working abroad to return to a research job in Spain.

The Ramon y Cajal programme is part of this policy sequence (Weir, 1992) that continued into the early 80s associated with what was called "research training policy". Over the years, however, the focus of policy has shifted. The specific policy tools and instruments have evolved; new instruments and a change of emphasis have appeared, building up and making the existing portfolio more complex.

Government policy has shifted from a simple training or mobility policy to one focused also on employability issues. Over the long run, there has been a swing from simple (individually based) strategies of training researchers (with more or less focus on some priority areas) to actions much more oriented to the objective of researchers' employability (either in private companies or in the public research sector) as a way of promoting the use and transfer of the R&D capabilities created (see Table 1).

Table 1. Some stages of the S&T human resources policy, based in the addition of new instruments to the focus

Year	Instrument
60s and 70s	Training strategies abroad defined by the PRCs
80s	Governmental research training programme (FPI) in Spain and abroad
Late 80s	Mobility schemes between public and private sectors
Early 90s	Re-incorporation of researchers (from abroad)
Mid 90s	PhDs employability schemes in firms (Acción IDE)
2000s	Employability of PhDs in the public sector (Ramon y Cajal Program)

Source: Own elaboration

In Spain, as in many southern European countries, training in research activities has followed a centralised model in which the government acts as 'guarantor', while in many other countries, with much wealthier institutions, the research centres and universities develop and implement the research training policy in a decentralised way. In the 90s, regional governments were very active in supporting S&T human resources as a way of creating a highly qualified labour force in their regions.

The actual policy mix that the Spanish Government, through the Ministry of Science and Technology, is managing, includes a combination of different tools and instruments that have been combined and prioritised in different degrees over the years. The Ramon y Cajal Programme was a new type of instrument, whose objectives were ambiguously set out in the National R&D and Innovation (R&D&I) Plan (2000–2003). The new Plan had defined very ambitious objectives, such as spending 1.29% of GDP on R&D, but no new significant budgetary amount was added to the traditional RTD (research, technology and development) budget, and most of the new ideas never got off the drawing board.

After a broad participatory process with research actors and users, the Plan was approved including a new policy instrument known as "five-year contracts (+5) for PhDs in public research institutions": 2,000 such contracts were forecast. This became the policy constraint within which the Ramon y Cajal Programme started to be designed.

Context and desing of the programme

After the 2000 elections, in April, the reshaping of the S&T policy domain in Government, and the creation of the Ministry of Science and Technology, transformed the environment in which the National R&D&I Plan was expected to operate.[9]

In 2000, no specific new measure was launched, and the 'new instrument' was only put on the agenda at the end of the year as a result of pressure from university representatives. The mass media also played a role by framing the issue of Spanish eminent researchers working abroad as a problem of a brain drain. In 1999, nearly 75% of European PhD recipients who had gone abroad preferred to stay in the USA after their PhD to establish their career: this was an increasing trend over the 90s (EC, 2003b).

It was widely accepted that the ability of some countries to keep the best 'brains' after their PhD was linked to giving them better employment and career opportunities afterwards. Thus the issue of 'bringing Spanish researchers back home' emerged as a relevant objective in the policy discourse. These two elements could explain why the Ramon y Cajal Programme (Sanz-Menéndez *et al*, 2002) was one of the few to be launched, even without new additional funding, while many others still remain on paper.

The Ministry set up an advisory working group with university representatives, with the objective of testing the proposal developed at the Ministry. However, in the process of reaching a consensus on the relevant aspects of the programme design, the group became a pressure instrument. Furthermore, a second level of policy action was needed, to inform other ministerial departments with competencies in boundary areas of the S&T policy domain in order to preclude possible vetoes to the proposal. A certain amount of serious opposition did come from the Ministry of Education and Culture, which has some regulatory powers on the universities and at the time was planning university reforms. Last but not least, some internal resistance at the Ministry of Science and Technology, due to the increase of workload in some internal services, was also overcome.

The debates inside the Ministry and with the university representatives triggered a growing perception that this costly new programme should address not only the problem of bringing Spanish researchers home, but also many other problems. Administrative and organisational resources were scarce and launching new initiatives is always costly; in the end, as in many other policy initiatives, the new policy instrument became 'the solution' for many of the public research system's different problems. Also relevant was the need to amend the Basic Labour Act (*Estatuto de los Trabajadores*) to permit temporary five-year contracts only in research.[10]

The Ramon y Cajal programme was designed to provide subsidies to PRCs and universities for contracting researchers for five years, but also the secondary objectives and the process mechanisms that would rule the initiative were relevant, and their set up was the outcome of an interactive process between political actors, S&T policy-makers, legal and accounting advisors and customers of the programme (Sanz-Menéndez, 2004).

It could be said that the main mechanisms of the Ramon y Cajal Programme, to help the matching of supply and demand, were defined in two ways. On the one hand, the provision of 2,000 temporary research positions (with five-year contracts) in PRCs and universities should increase the S&T capabilities in these research organisations and should influence

It was widely accepted some countries kept the best 'brains' after their PhD by giving them better employment and career opportunities afterwards: thus 'bringing Spanish researchers back home' became an objective in the policy discourse

their researchers' selection procedures. On the other hand, the offer of stable jobs to excellent researchers in Spain and from abroad, should increase their employability and improve their academic career opportunities.

Different driving objectives were present in the definition of the Ramon y Cajal Programme (see Table 2) that were reflected in the specification of the aims of the programme. In fact, as with many other important programmes, the initiative was designed to have an impact on many different aspects and issues of the system. Each of the objectives was associated with a perceived policy problem.

As regards the first, it is important to recall that, in the 90s, the growth of tenure-track positions in the PRCs and universities (the demand) had slowed down in relation to the supply of PhDs available for R&D activities. For example, the stock of university tenure jobs for PhDs increased by less than 10,000 between 1991 and 2002, with CSIC tenure scientists only increasing by a few hundred, just to compensate retirements. At the same time, the PhDs produced by the system exceeded 50,000. The policy instrument was meant to send a clear signal on the good 'future' prospects and opportunities, to avoid discouraging effects on research vocations.

Second, the growth in the number of researcher positions in Spain in recent years, had been mainly based on temporary post-doctoral fellowships, usually with low wages. Offering contracts with much better conditions (in wages and stability) was essential to keep good young researchers in research careers waiting and working for the tenure.

Third, in the 80s and 90s, hundreds of young researchers moved abroad, either temporarily or permanently. Some of them became recognised scientists. The debate on bringing them back to Spain had been in the newspapers and the media. The estimations are around 2,000 Spanish PhDs working in the USA alone.[11]

Fourth, after the changes in the university tenure-track regulations in the early 80s, there was some criticism regarding the selection committees' marked tendency to appoint not the best candidates but the ones with more local connections (*Nature*, 1998). Therefore the programme, by establishing a more centralised selection system of researchers to be contracted, was designed as a way to improve the information and reputation[12] in the labour market of researchers and then to try to reduce inbreeding in the selection process.

Another perceived problem of the system was the lack of a strategic approach, on the part of the universities and PRCs, in their processes of defining the profile of the offer of new tenure jobs. The reproduction and increase of tenure jobs had usually followed the distribution of existing resources in S&T areas, with very little selectivity, focus and orientation. Thus, another aim of the programme was to influence the selection of S&T priorities and personnel made by PRCs and universities. This was justified by the fact that, given the Spanish situation, competing in all research domains was not a sensible option for individual universities or research centres.

Additionally, the composition of the supply side of human resources of the Spanish S&T system was unbalanced. There was a commitment to prioritise new positions of researchers, but mainly and especially in the priority research areas defined by the R&D&I National Plan (2000–2003), such as biotechnology, nanotechnology, materials sciences and technologies, and engineering.

Traditional subsidies for S&T human resources were given to individuals through a grant, rather than to the organisations. The programme aimed to increase the PRCs' and universities' involvement in the research personnel policy. Therefore the institutions were given subsidies for hiring the researchers selected after the evaluation process; the public subsidy would be given to the PRC in a decreasing proportion of 10% every year until the completion of the five-year period. Thus, input additionality was built into the programme by requiring the organisation to co-finance the contracts gradually.

Finally, the issue of promoting the mobility of researchers was clearly an objective of the programme and providing five-year contracts would serve as a mechanism for exchanging people and for encouraging long-term mobility in some cases.

With an expected selection of 2,000 PhDs, and with the estimated level of subsidies, the overall cost forecast in Government subsidies to PRCs and universities for the Ramon y Cajal programme, between 2001 and 2007, was 315 million euro. For example, the first call in 2001, with 800 selected, represented 35 million euros (for the first year) and 115 (for the five-year period of reference). Payments to the PRCs were expected to be made on an annual basis.[13]

Overall, the programme was a grant-based direct policy measure aimed to affect both the demand and the supply side of the PhD labour market. Although finance is usually the motivation of this type of subsidy-based policy, and input or financial additionality

Table 2. Objectives of the Ramon y Cajal programme

To create (define) an entry point in a 'research career' (tenure track) for PhDs with a five-year contract
To stabilise and improve the working conditions of 'post-doc' researchers
To facilitate the return of Spanish researchers working abroad
To identify the best quality researchers and facilitate their employment in Spanish R&D institutions
To encourage R&D centres to define their strategic priorities
To support the demand of researchers on priority areas of the National R&D&I Plan
To establish co-responsibility of hosting institutions and the regional governments
To support mobility of researchers

Source: Presentations of the Ramon y Cajal Programme made by the Ministry of Science and Technology

was indeed built into the programme, it also appears to have been founded in the "behavioural additionality"[14] rationale. This is particularly so when using these subsidies to provide incentives for research organisations to prioritise strategically their research staff needs, and to avoid adverse selection within their internal market 'queues'.

How the Programme worked in practice

As a result of the definition of the Programme objectives and the interaction with the groups involved, a set of design principles was defined. Among them the most important were:

- The basic mechanism for allocation of resources should be the result of matching the researchers' demand of PRCs with the available supply of PhDs.
- The competitive evaluation of candidates at national level was key in the procedure for the selection.
- The evaluation was to be based mainly on scientific records ("scientific productivity"), but should also consider the "candidate's potential" and the "interests of the research proposal".
- The PhD applicant needed the *ex ante* acceptance of the PRCs to which he/she intended to go to participate in the process; that meant a "veto point" for institutions in relation to some individuals.

Up to the moment when the researcher is contracted by the research organisation and the latter gets the subsidy, the policy procedure is complex and, analytically, can be divided into various stages (see Table 3). This set of stages was designed as a way of intervening in a segment of the academic labour market that was showing evident failures associated with: the lack of financial investment to couple the real demand of research organisations; the amount and asymmetry of information available in the system about the needs of the organisations and the relative quality of PhDs; the lack of selectivity and strategic competitive approaches in the matching of supply and demand; and the negative incentives signals that the PhD labour market was sending to younger cohorts with respect to the attractiveness of scientific careers.

As has been explained, there was a clear distinction between the evaluation of the quality and competence of the candidates (which was left to the scientific community and followed peer-review rules) and the strategic decisions about the allocation of the number of contracts to the different R&D areas that was left in the domain of the policy-makers. The general criteria used for distribution of subsidies by S&T areas are: relative quality of researchers among different S&T fields; the thematic RTD priorities of the National R&D&I Plan; and the distribution of the aggregated demands of PRCs and universities by S&T areas.

Apart from setting up the financial framework conditions for the subsidy, the Ministry's annual call also included some regulatory terms for the labour relations between the PRCs and the PhD to be hired. In 2001, the minimum annual gross wages for contracted researchers under the Ramon y Cajal Programme was defined as 28,550€, an amount equivalent to the gross salary of a researcher who obtained the tenure without any incentives or extras. The amount of the subsidy to be paid to the organisation in the first year is 43,750 euros per researcher selected under the Programme. This amount included the gross salary plus the social security costs and a small amount for the start up of research activity.

Bringing the wages of these two types of researcher (Ramón y Cajal contracted and tenured) into line was a way of avoiding conflicts with researchers already in the system. Contracted researchers' wages could include any additional bonuses to be defined and paid by the PRCs and

Table 3. Stages in the management process of the Ramon y Cajal programme

- The first stage regards the demand side. After the call, PRCs submit their prospects on new researchers needs to the Ministry of Science and Technology (MCYT). The PRCs and universities define the maximum number of PhD researchers they can recruit upon a financial analysis (from the second year of the period the PRCs have to co-finance the contract with their own resources) and distribute them into S&T areas (24 in the evaluation procedure). After receiving these demands, the MCYT aggregates and publishes the information.
- The second stage concerns the supply side. PhD researchers, after checking the availability of jobs in the different PRCs, submit an application to the MCYT for their evaluation as candidates; applicants have to indicate their preferences for the different positions offered by PRCs or universities.
- Following this, the evaluation and selection procedure start. 24 Evaluation Committees assess the candidates' quality on the basis of defined criteria and, for each S&T area, they establish an ordered 'ranking' of the candidates. A selection committee receives the evaluations, and decides how many contracts to allocate to each S&T area in line with policy criteria; the order of candidates selected is respected in all the areas. The list of selected candidates in each area is published.
- After the evaluation and selection stages, the selected PhDs sign the final agreements with the PRC or university of their preference. Most of the PhDs join PRCs that have already pre-accepted them at the time of their application, but selected researchers are always entitled to change their mind and go to another PRC, provided they are accepted. The Ministry pays the annual amount of the subsidies to the institution hiring the PhDs selected.
- Finally, *ex-post* performance evaluation procedures are defined for monitoring and assessing the outputs of the research activity developed by the contracted researcher, either to renew the contract at mid term or for the final assessment.

Source: MCYT call for proposals

universities, but under the general regulations of public service. Under the programme, contracted PhDs were also allowed to allocate some of their time to teaching.

First results of the Programme

The National R&D&I Plan estimates for 2000–2003 were 2000 contracts for PhDs. The analysis of the results presented here is based on data from the three calls (2001, 2002 and 2003) of the completed Programme.

Table 4 shows the main figures for the three calls, which have already finished. Considering that there have been changes in the number of contracts approved every year, the figures present a stable trend, with an increasing number of PhD applicants, while the demands from the PRCs appears to be declining, as a result of the numbers already contracted in the previous calls. It is interesting that around 130–150 research centres presented applications every year and around 80 of them got subsidies for contracting researchers.

PhDs participating in the programme were largely attracted to full-time research jobs in research centres, where there are no teaching duties, meaning that they can consolidate their personal curricula, in which publications and demonstrated results are more important than teaching experience. In addition, the Ramon y Cajal researchers are allowed to run their own projects. Universities got 59% of the total Ramon y Cajal contracts while universities represent 78% of total researchers working in the public sector (universities and Government).

A total of 117 research centres got at least one contract, but concentration is high in the biggest research institutions: CSIC (522), the University of Barcelona (105), the Autonomous University of Madrid (90), the Complutense University of Madrid (76), the University of Valencia (75), the Autonomous University of Barcelona (65), the Polytechnic University of Catalonia (58). Total contracts were distributed as follows: universities (59.5%), public research centres (32.3%) and other public research institutes (8.2%) (see Table 5).

Table 4. Basic figures of the Ramon y Cajal programme, by annual call

	2001	2002	2003*
Contracts approved	800	500	700
Researchers finally contracted	774	480	706
Demands from research centres	2,064	2,059	1,898
Number of applicant research centres	151	155	131
Number of research centres getting at least 1 researcher	84	74	88
Researcher (PhDs) supply (applicants)	2,807	3,025	3,408
Demand from PRCs / contracts approved	2.6	4.1	2.7
Researchers supply / contracts approved	3.5	6.0	4.9

Note: * provisional data

PhDs participating in the programme were largely attracted to full-time research jobs in research centres, where there are no teaching duties, so they can consolidate their personal curricula, in which publications and demonstrated results are more important than teaching experience

It is interesting to recall that 36% of the PhDs contracted were women and that the average age of the PhDs was 35.3. In addition, some other features of the selected PhDs reveal the diversity of objectives in practice (Table 6).

The results reveal an increase in attractiveness for Spanish people to return from abroad. In the 2001 call, only 16% of the Spanish people contracted were living abroad, most of them in the USA (44), followed by the UK (13), France (13) and Germany (11). In the 2002 call, the number of selected Spanish people who were living abroad rose to 28%, most of them in the USA (47), followed by the UK (21), France (14), Germany (10) and The Netherlands (6). In 2003, 35% of the Spanish contracted were living abroad. Overall, 424 Spanish researchers living abroad have returned under the Ramon y Cajal Programme.

Looking at the nationalities of the PhDs selected, we see a significant increase in foreigners. A total of 334 foreigners, 16.9% of the total researchers contracted, have been hired by Spanish research institutions. In the 2001 call, the nationalities were: from other European Union countries (60), the USA (7), Russia (6), Morocco (5), Argentina (4) and so on. In the 2002 call, the distribution was: 80.2% (385) from Spain; 9.4% from other EU countries (45), and from other countries: Argentina (15), Russia (7), USA, Australia and China (3 each). In the 2003 call, we had from other EU countries (66), Argentina (11) Russia (7), from Venezuela (6) Bulgaria US (4 each). Even if most of the foreigners were European Union citizens, we can see the effect of some political and economic crisis with the presence of some of the nationalities.

The available data can be used to assess the extent to which the different objectives have been achieved

Table 5. Distribution of the contracts by type of research centres, by annual call

	2001 call		2002 call		2003 call[a]		Total	
	Number	%	Number	%	Number	%	Number	%
Universities	441	57.0	299	62.3	431	61.0	1171	59.5
Public research centres[b]	267	34.5	141	29.4	195	27.6	603	32.3
Other PRCs[c]	66	8.5	40	8.3	80	11.3	186	8.2
Total	774		480		706		1960	

Notes: [a] provisional data
[b] CSIC, CIEMAT, IAC, IGME, ISCIII, INIA, INTA, IEO.
[c] Hospitals, R&D regional centres, NFPO, and others
Source: Ministry of Science and Technology

(see Table 7). On account of the situation throughout the system, the first outcome in practice, of the implementation of the Ramon y Cajal Programme, especially in 2001, has been to improve the employment conditions and the academic career prospects, thus confirming that many people already in the system had poor employment conditions. Apparently, after many good young researchers in such poor conditions joined the system, in the second call, the Programme has earned a solid reputation abroad.

This has created opportunities for advancing in some of the other objectives, such as increasing the number of foreign researchers winning contracts, and in fact the numbers were not really expected. Although the policy idea was to boost the diversity, the Programme was not expected to attract many foreign researchers on account of the wage gap between Spain and other advanced countries. However, it seems clear that, in some countries, the research system conditions may be worse. In the last year, the Programme has contracted 47% of the researchers from abroad.

The distribution of PhDs by discipline has been the result of policy decisions made by the Ministry of Science and Technology, attempting to balance out the traditional distribution of human resources in S&T areas, which is dominated by social sciences and humanities. However, the most important factors in the allocation of contracts have been the existing supply of S&T human resources, the distribution of applications by areas and the demand of the PRCs and universities, which were indirectly shaped by the existing supply; the consideration of using the human capital accumulated in the last ten years has been relevant in the allocation (see Table 8).

These figures reflect the amazing predominance of molecular biology and biotechnology and, in general, life sciences, and a small aggregate number in engineering, mainly because of the lack of PhDs available.

The regional distribution of PhDs contracts (Table 9) has been quite similar to the distribution of S&T capabilities among the Spanish regions, and thus the Programme has helped to highlight the bigger chances of PRCs with a good reputation and large existing capabilities to attract excellent quality young researchers. This brings into the debate the need for other policy tools to spread excellence or to develop new capabilities in less developed regions. A small effect of reinforcing the concentration of the resources could be identified in Madrid and Catalonia, the most important regions in R&D in Spain.

Conclusions

It is too early to assess the mid- to long-term effects of the Ramon y Cajal Programme on the Spanish

Table 6. Basic characteristics of the PhDs selected under the Ramon y Cajal programme, by annual call

		2001	2002	2003*	Total
Number of contracted candidates		774	498	706	1978
Number of contracted foreign candidates		105	99	130	334
Number of contracted Spaniards living abroad		108	114	202	424
Average age of contracted candidates (years)		35.8	35.5	35.4	35.5
Sex distribution of contracted candidates (%)	Male	63%	66%	63%	64%
	Female	37%	34%	37%	36%

Note: * provisional data
Source: Ministry of Science and Technology

Table 7. Objectives of the Ramon y Cajal Programme (% of total contracted people)

	2001	2002	2003	Total
To return Spanish researchers	14.0	22.9	28.6	21.4
To attract foreign researchers	13.6	19.9	18.4	16.9
Improvement in employment conditions and career prospects	72.4	57.2	53.0	61.7

Source: Ministry of Science and Technology

S&T system, since further evaluations are required. However, it can be said to have contributed significantly to providing a short-term solution to the key problem in the Spanish system today — the employment opportunities, conditions and academic career prospects of PhDs.

We have discussed the multiplicity of objectives that the Programme has tried to address. The outcomes have been quantified by averaging the two calls examined: two out of every three PhDs contracted by PRCs can be classified under a group category for which the contract improved their working conditions, while the other third falls under the category of Spanish or foreign researchers brought into the Spanish S&T system from abroad.

One significant short-term effect of the Programme has been to create an information system on the quality of PhD researchers and institutions in Spain. The Ramon y Cajal Programme has become a tool for consolidating the reputation of the different research institutions and has demonstrated their capability to attract good researchers in the different fields.

The organisational impact of the Ramon y Cajal Programme has been to pressurise the PRCs to develop strategies for human resource recruitment by research fields, and to organise their priorities in terms of growth of competitive research capabilities.

Nevertheless, since the first call, the Programme has also shown that it can do little to allocate researchers, under the national R&D priorities, in areas where there is scant supply of PhDs, such as engineering and technological fields. The problem that these areas face is insufficient supply and production of PhDs rather than one of employability.

Therefore there is evidence of impact in terms of the way PhD labour markets and academic careers operate in Spain, but also in terms of the way in which PRCs manage their human resource strategies. Two additional relevant effects refer to distribution of the information as a way of improving quality and reputation, and the changing way in which the Spanish universities conceive full-time research, through this new type of full-time researcher without mandatory teaching duties.

However, as in many other public policy interventions, the 'solution' for today's problems might be a

Table 8. Distribution of the contracts by research areas, by annual call

	2001		2002		2003*		Total	
	Number	%	Number	%	Number	%	Number	%
Physic and space sciences	76	9.8	38	7.9	69	9.8	183	9.3
Earth sciences	42	5.4	18	3.8	35	5.0	95	4.8
Materials science and technology	39	5.0	30	6.3	45	6.4	114	5.8
Chemistry	74	9.6	36	7.5	66	9.3	176	9.0
Chemical technology	19	2.5	22	4.6	23	3.3	64	3.3
Plant and animal biology, ecology	56	7.2	33	6.9	43	6.1	132	6.7
Agriculture	42	5.4	31	6.5	44	6.2	117	6.0
Livestock and fishing	28	3.6	18	3.8	25	3.5	71	3.6
Food Science and technology	31	4.0	12	2.5	20	2.8	63	3.2
Molecular and cellular biology and genetics	139	18.0	56	11.7	109	15.4	304	15.5
Physiology and pharmacology	40	5.2	24	5.0	38	5.4	102	5.2
Medicine	50	6.5	32	6.7	36	5.1	118	6.0
Mechanical, ship and aeronautical engineering	8	1.0	9	1.9	8	1.1	25	1.3
Electrical and electronic engineering and robotics	12	1.6	9	1.9	8	1.1	29	1.5
Civil engineering and architecture	5	0.6	12	2.5	5	0.7	22	1.1
Mathematics	18	2.3	13	2.7	20	2.8	51	2.6
Computer sciences	11	1.4	24	5.0	18	2.5	53	2.7
Information and communication technologies	15	1.9	20	4.2	26	3.7	61	3.1
Economics	17	2.2	9	1.9	14	2.0	40	2.0
Law	3	0.4	3	0.6	4	0.6	10	0.5
Social sciences	5	0.6	6	1.3	6	0.8	17	0.9
Psychology and education sciences	7	0.9	4	0.8	4	0.6	15	0.8
Philology and philosophy	18	2.3	10	2.1	19	2.7	47	2.4
History and art	19	2.5	11	2.3	21	3.0	51	2.6
Total	774		480		706		1960	

Note: * provisional data
Source: Ministry of Science and Technology

Table 9. Distribution of contracts by regions and comparison with regional share of researchers (FTE) in universities and government, by annual call

	2001		2002		2003*		Total		% researchers in public sector (FTE) 2001
	Number	%	Number	%	Number	%	Number	%	
Andalusia	77	9.9	63	13.1	77	10.9	217	11.1	16.0
Aragon	28	3.6	9	1.9	21	3.0	58	3.0	2.7
Asturias	16	2.1	10	2.1	8	1.1	34	1.7	1.9
Balearic Islands	6	0.8	2	0.4	10	1.4	18	0.9	0.8
Canary Islands	8	1.0	5	1.0	7	1.0	20	1.0	3.5
Cantabria	11	1.4	4	0.8	12	1.7	27	1.4	0.7
Castilla –La Mancha	4	0.5	2	0.4	4	0.6	10	0.5	1.8
Castilla-Leon	35	4.5	20	4.2	26	3.7	81	4.1	6.0
Catalonia	199	25.7	147	30.6	177	25.1	523	26.7	15.9
Valencia	88	11.4	33	6.9	83	11.8	204	10.4	7.3
Extremadura	1	0.1	1	0.2	4	0.6	6	0.3	1.6
Galicia	21	2.7	14	2.9	26	3.7	61	3.1	5.8
La Rioja	0	0.0	0	0.0	3	0.4	3	0.2	0.5
Madrid	238	30.7	154	32.1	223	31.6	615	31.4	28.7
Murcia	16	2.1	8	1.7	11	1.6	35	1.8	2.0
Navarre	9	1.2	5	1.0	6	0.8	20	1.0	1.9
Basque Country	17	2.2	3	0.6	8	1.1	28	1.4	3.1
Total	774	100	480	100	706	100	1960		100.0

Note: * provisional data
Source: Ministry of Science and Technology and INE

'problem in the future'.[15] Over the next few years, the S&T system will require significant growth of the annual tenure employment or a change in the labour relations system if it is to offer PhDs stability.

The incorporation of 2,000 researchers into the S&T public sector through the Ramon y Cajal Programme will certainly require some future critical policy decisions. There is the notion that these contracts are meant to be equivalent to tenure-track positions within the research organisations in terms of stability and wages. Two different options seem possible. One could be based on the increase in the offer of traditional academic tenured positions in public-sector research. This would imply considerable public budgetary investment in the next few years.

In the absence of this, a dramatic change in the organisational cultures governing research institutions would be necessary, if all these PhDs and their research groups have to assume that the tenure is no longer the traditional academic post in mid-career. The consequences of this are difficult to ascertain, but a large part of the literature on the academic profession gives us reason to think that it might not be very positive for the future supply of academic researchers.

Notes

1. See editorial columns in *EL PAIS* newspaper, 23 March and 16 May 2001.
2. Data from Eurostat and OECD, last year available.
3. It must be made clear that to have a fellowship or a grant was very different from having a labour contract. Under the grant system, the researcher has no labour rights or social security or health benefits. In fact, a strong social movement (*Federación de Jóvenes Investigadores* (*FJI-Precarios*)) has emerged in the laboratories to fight for contracts as a way of having those rights. Similar movements have emerged all over Europe.
4. Since the year 2000, the R&D questionnaires for elaboration of the Spanish statistics of R&D include as researchers (following the *Frascati Manual* (OECD, 2002) recommendations) the "doctoral and post doctoral personnel" with fellowships (but not contracts), known in Spanish as *becarios*. This means that many young persons still under R&D training activities, preparing their PhDs at universities and PRCs, are being counted as researchers. This has been a hot topic in the political agenda of the last three years, and even became an issue in the 2004 electoral campaign.
5. In Cohen and Levinthal (1989), the capacity of a firm to absorb external knowledge is determined by its scientific and technological capabilities. A more recent paper (Mangematin and Nesta, 1999) has operationalised the concept through several dimensions at the level of the firm: R&D spending, number of researchers, number of laboratories, links to public institutions, publications and patents. In Spain in 2002, researchers in the firm sector represent 30.0% of total researchers; the business expenditure on R&D represented only 54.6% of the total, and the R&D financed by the business sector was 48.9% of the total. European patents granted by the European Patent Office to Spanish firms represented 66.6% of the patents granted to Spanish nationals (Sanz-Menéndez and Arias, 1998).
6. When recalling their preferences about future employment, at the time of doing their PhD, 55% of the sample stated that they would have preferred a job in the public sector (Sanz-Menéndez *et al*, 2004).
7. In Spain, most PhD students have very little information about research careers in industry and there are no institutionalised ways for firms to be involved in university doctoral programmes either financially or by providing on-the-job research training.
8. These trends associated with the fall of the share of tenured positions and the rise of temporary posts based on soft money are also apparent in other countries' S&T systems, such as Germany, Italy, the UK, France, the USA and Australia (OECD, 2003a).
9. After the March 2004 elections, the new Government redes-

igned the ministerial arrangements. The Ministry of Science and Technology no longer exists and its competencies were transferred to the Ministry of Education and Science and to the Ministry of Industry, Tourism and Commerce. The Ramon y Cajal programme is now under the responsibility of the Ministry of Education and Science.

10. Under Spanish General Labour Law, a temporary employee becomes a permanent employee after three consecutive years with temporary contracts with the same employer. The five-year period requested for the programme was considered as the standard first part of the tenure track.
11. *Science* (2003), with data from the Institute of International Education.
12. Here reputation is understood as an expectation of quality under conditions of imperfect information or uncertainty.
13. As mentioned, this initiative was envisaged in the National R&D&I Plan, but no specific new funding was approved to accomplish the objectives. The Ramon y Cajal Programme funding has come from the 'reallocation' of already existing budgets for other purposes. In fact in the budget for 2001, an amount of 8,000 million pesetas (approximately 48 M€) was approved as a mechanism for supporting European Social Fund actions, mainly aimed at employability in the private sector. A reallocation of this amount, and also funds from the National Fund for R&D, a general budget item mainly for competitive funding projects, have been used to cover the new expenditure.
14. For a definition of the different types of additionality, see Georghiou *et al* (2002) and Buisseret *et al* (1995).
15. It is likely that a very successful policy in year *n*, such as the 'research training' policy, could, even if it has created new capabilities, contribute to creating new 'policy problems' related to that policy in year *n*+5 or *n*+10.

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