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1. Introduction

For almost thirty years the Spanish infrastructure for research and technological development was dominated by a single type of actor: Public Research Centres¹. University and business research were practically non-existent. All State efforts in R&D were channelled through PRCs, dependent upon specific Ministries, that acted under a modified principle of “delegation” [1] and were managed under a system of “bureaucratic hierarchical authority”, with politically appointed directors that freely allocated internally the resources received directly from government.

However in the eighties and in the nineties, Spanish Public Research Centres faced changes in their environment that simultaneously pressed them to make choices and offered them the instruments to adapt. The transformation of the environment in which PRCs operated was a consequence of both conscious political design aiming to reorganise the State action in support of research (the emergence of strategic R&D programmes) and of changes in the economic context of public research activity. The origins of these processes are traceable back to the period of transition to democratic rule and the economic crisis, although the main push forward of this transformation came from the reform of the Spanish research system launched in the eighties.

When the socialist government went into office, in December 1982, it made a consistent commitment to support and promote science and technology. Significant increases in public R&D funding helped to double the level of R&D expenditures over the GDP from 0,5% in 1982 to 1,0 % in 1990.

The socialist government also made a programme for reforms, in the science and technology policy domain, that affected the performing institutions (e.g. the Law of University Reform passed in 1983), the basic objectives and tools of public intervention (e.g. the approval of the National R&D Plan) and even the overall way of organising and co-ordinating public actions (e.g. setting up the Interministerial Commission for Science and Technology-CICYT). A basic building block and a symbolic milestone of this reforming strategies was the approval in 1986 of the Law for the Promotion and General Coordination of Scientific and Technical Research (Law 13/1986), popularly known as the *Law of Science*.

The Law of Science defined the basic rules, institutions and organisations of the Spanish science and technology policy domain and altered the administrative and finan-

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¹ We will use the abbreviation PRCs besides the fact that the collective label in Spanish is OPIs, or *Organismos Públicos de Investigación*.

cial regulations under which the Spanish PRCs operated. Public Research Centres were transformed into financial autonomous organisations, while maintaining their “administrative” dependence under their umbrella Ministries, that were allowed to obtain external non-budgetary funding, either through engaging in competition for European, national or regional R&D resources or through the establishment of contracts with enterprises. Then the Law made the PRCs more flexible to cope with the changes, by opening the door for diversification their sources of funding and by slightly changing from direct budgetary to non direct-budgetary appropriations. But these changes also contributed to enhance PRCs autonomy of decision *vis à vis* their ministries of affiliation and the independence of individual researchers from the authority of the PRCs directors.

All these transformations, together with the stagnation and later reduction in real terms of direct budget appropriations in the nineties, resulted in new pressures and incentives for PRCs to adapt. If we were to take the funding strategies of the PRCs as the behavioural variable to be explained, the question is to what extent did this new environment produce the “adaptive reaction” [2] of the PRCs. We also take into account the change in PRCs’ funding as an indicator of more deep and relevant transformations of the overall science and technology system.

How did these changes affect the funding strategies of Spanish PRCs? As we will show, the response of PRCs to this new environment varied considerably. One group of PRCs did in fact begin to diversify its sources of income, increasing the importance of non-budgetary sources over the total income of the organisation. Other PRCs, on the contrary, remained much the same, despite the new opportunities opened by the new regulations. Therefore, the variation goes from those Research Centres that obtained 40% of their funding outside direct ministerial budgetary appropriations to those that developed their activity almost completely within those financial limits.

What we try tentatively to explain in this paper is this variation in the degree of adaptation of the PRCs, measured by the proportion of external non direct ministerial budgetary appropriations in their total expenditures. We argue that the diverse dynamics of change of the various PRCs, in response to the new environment, could be explained mainly through the analysis of the institutional arrangements and organisational variables. We assume relevance of historical processes, that is “path dependency” [3,4] and “organisational inertia” [5]. In other words, the diversity of outcomes observed when PRCs are confronted with similar changes in their environment is attributable to the different institutional arrangements and trajectories of each organisation. Our task here is to find commonalities and differences.

According to our hypotheses, the degree of diversification in the PRCs’ funding strategies will be shaped by three set of variables: the strength of the relationship with the ministry of affiliation, the nature of the work undertaken by the research organisation and the nature of the individual incentive schemes within PRCs. All of them are, in turn, part of the institutional arrangements. How do these factors relate to one another and how do they influence the funding strategies of PRCs?

The relative strength or weakness of the link between the PRC with the ministry of affiliation matters all PRC directors are political appointees, the degree of delegation of the mission and the form of relationship between the principal (Ministry) and the agent (research performing organisation) [6, 7, 8, 9], is likely to play a role in the explanation of the differences. Whenever we find strong dependence we are likely to see some ministerial resistance, even if the PRCs gain flexibility within the new legal framework, this implied a loss of control on the part of the ministry. Also we observed important differences in the timing of incorporation of each PRC to the new rules and the differences in timing appear to account for some of the differences in outcomes.

The type of link with the ministry of affiliation is also related with our second hypothesis: The nature of the research mission also matters. Behind a single word (research) there are significantly different set of activities with diverse logic and requirements [10, 11] that could be described in a continuum between general knowledge producers and specific service providers. This specificity also provide diverse external funding opportunities to the PRCs and chances that research products of each organisation have in the market.

Lastly, the internal regulations of the research organisation usually condition the distribution of incentives within the organisation among its individual members. Researchers income and careers are basic determinants of their research performance [12, 13, 14]. If managers in PRCs were to be interested in raising external funding they have to try to build up systems of incentives to encourage their researchers to apply for competitive funding, that would complement their moral commitment, regardless of the formal authority the PRCs director has over its research officials.

The paper is organised as follows: the next section analyses the changes in the science and technology environment, as a consequence of the reforms and the evolution of the public direct budgetary appropriations. In section 3 we will describe some general features of the Spanish PRCs selected. Section 4 contains the core of the analysis and the development of the explanatory variables that could account for the present differences in the funding strategies of the PRCs. We finish with some brief conclusions and some prospects of some emerging dynamics.

2. The changing environment of Spanish PRCs

The Spanish R&D system was in the seventies very small from the point of view of resources, hierarchically ill-defined and uncoordinated, low-quality, and with little or no connection between basic research, applied research and technological innovation. There was a duality that came from the fact that the few existing resources and the few efforts made to coordinate and determine research priorities were concentrated on serving the purposes of economic development [15,16, 17]. In fact, there was a high level of discontent in the Spanish scientific community, because scientists considered that their interests in the production of knowledge were being put aside in favour of a bureaucratic approach for the definition of research priorities and the decisions over research funding [18].

During the dictatorship of Franco the PRCs were the only places in the country to develop research activities. There was almost no other “R&D actors”, since research in universities and private firms was negligible. In the first OECD review of Spanish science policy, this particular issue was stated clearly: “the great part of the scientific research is undertaken in Government Centers or Institutions (...) from the financial standpoint, 85 % of the total country’s research costs are channelled through (..) seven centres” [19]. In order to understand the transformation of the R&D system in Spain it is necessary to understand that the State had been a key player. .

Spanish PRCs, with the exception of the CSIC², were agencies established by their respective ministries in order to pursue their ministerial research interests and needs. PRCs had a mission to accomplish and were therefore economically dependent on the budget appropriations of their ministries of affiliation that, in turn, had the ultimate say over them. This fact was to a large extent at the origin of the heterogeneity and lack of

² CSIC is only a research performing organisation, named *Consejo Superior de Investigaciones Científicas*, Higher Council for Scientific Research.

co-ordination of the Spanish science policy during the pre-Constitutional period. The kind of internal arrangements that characterised Spanish PRCs were specific to their research domains and ministerial dependencies. Although they all had civil servant status, the requirements, professional careers, wages, and organisational structures, varied significantly from one PRC to another. Likewise, their research activities were carried out in isolation from one another, attending, almost uniquely, to the research interests and needs of their respective ministries.

The dynamic of change that has affected the environment of PRCs, is first the result of institutional and organisational reforms developed by the government in this policy domain and the process of redefining public intervention in relation to S&T, and second, due to the fate and fortune of the R&D public funding during that period.

2.1. Reshaping the institutions for S&T: The 1986 Law of Science.

When the socialist prepared their political program for the 1982 elections, the “situation of science and technology” was already a social problem [20] to be tackled with political action. Problems such as the low level of investments in R&D in comparison with other European countries; the lack of contact between the academic, CSIC and other PRCs research with the economy and societal needs; the huge technology trade deficit, and the lack of coordination of public intervention in the R&D system, were all part of the characterisation of the situation, that in fact was labelled as “the lack of a science and technology policy” [21].

The new political approach was based on a combination of the traditional “Bernalist” vision of the Spanish political left of “putting science to the service of society” and economy, plus the imitation of the emerging “EC R&D framework programme model”. Among the political initiatives derived from this new approach were the decisions to carry out a formal selection of national R&D priorities and a continuous call for coordination of public action in the R&D system. This political action culminated with the enactment of the “Law of Science” that institutionalised the new proposals through the creation of a policy system articulated under the pluri-annual “National R&D Plan” and the consolidation of the authority of the CICYT (Inter-ministerial Commission for Science and Technology).

One of the basic issues describing the situation of S&T in Spain has been the lack of coordination [22] both between different actors in the R&D system and within the public R&D sector. Attempts to increase the coordination of research activities and the public action have been an issue of reference for the initiatives of S&T policy makers. Through the creation of a new institutional structure some new principles were clearly set up and accepted: setting “national R&D priorities” or strategic R&D; actions in favour of connecting R&D academic actors with society such as: the “university-firms collaborative R&D programs”, “technology transfer initiatives”, or “technology transfer institutional infrastructures”; “competitive funding” that was assumed to be the norm for the future; and “peer review guaranteed by the State” [23] was introduced as a selection process for R&D projects.

Additionally the Law of Science included a second set of provisions referring to Public Research Centres which aim was to try to homogenise their different situations, to provide them of flexibility and to encourage them to align (and coordinate) their research activities with the national R&D priorities.

The 1986 Law of Science identified six “Public Research Bodies” (CSIC, CIEMAT, ITGME, INTA, IEO, INIA)³ under direct ministerial dependence, and they were defined as subject to some common principles of organisation and action. The Law changed some of the administrative and financial regulations under which the PRCs operated, and institutionalised a new common organisational field [24] for these Public Research Centres. The most important regulations affected the economic management conditions, the flexibility for hiring non civil servant researchers, and the possibilities of creating new individual economic incentives: a) These six PRCs (later on others joined the club) were transformed into autonomous state entities (“autonomous commercial bodies”) that were allowed to obtain external funding, either through engaging in competition for State resources or through the establishment of contracts with enterprises. b) Additionally they were endowed with special flexible mechanisms, outside of the regular ones in public administration, for hiring researchers to carry on funded R&D projects. c) The Law also approved the possibility (subject to further development and approval by the Ministry of Economic Affairs, Treasury and Finance) that some of the income, derived from contracts signed with public or private entities for the execution of the scientific work or technical advice, could be transferred to the individual researchers as a productivity bonus; an individual incentive system could be entered into these public research bodies regularly functioning under the rules of the “civil service”. d) Also the PRCs were assigned some relevant functions in relation to the definition of objectives and implementation of National, Sectorial or Regional R&D policies, but in practice they never were developed properly. These internal regulations increased the number of responses available to both management and researchers within the organisation when coping with their environment.

The question is in what sense were the access to non-budgetary competitive funding and the more flexible administrative conditions meant to provide research actors with incentives for engaging in a more responsive, accountable and autonomous behaviour? Firstly, by allowing the establishment of research contracts with enterprises the Law was encouraging greater responsiveness on the part of PRCs to the economic and technical demands of Spanish enterprises. Secondly, although PRCs were offered alternative funding sources, most of these alternatives were related, somehow or another, with the priority programmes defined by the National R&D Programme and, therefore, the research actors were still pushed into the research priorities of the State. Accountability would thus be enhanced because the more the number of competitive programmes that PRCs could apply for, the higher the level of competitiveness among the research organisations. This, in turn, was expected to provide them with incentives to make better quality research and in a more efficient way. Finally, by allowing PRCs access to external competitive funding, the Law was offering these organisations a set of alternatives that they did not have before. Spanish PRCs faced now different choices, concerning their sources of funding, and therefore were able to make explicit decisions about their research strategies.

The conditions for an increased level of autonomy of PRCs from their respective ministries had been settled. However, making use of such autonomy was something for the Research Centre to decide and to develop.

In summary, with reference to the changing environment, the emergent discourse was clear enough: although not arriving to a radical “market oriented reform”, an increased bureaucratic pressure to align the research agendas of the universities and PRCs with the economic and social needs of Spanish society was consolidated. The decision

³ See Table 3.

makers installed the “principle of competitive funding” as a basic way of financing research, and the promotion and incentives for “external funding”, either public, through the European, National, Sectorial or Regional R&D Plans, or private, through contracts with firms in joint R&D or the provision of scientific or technical services. With the expected increases in the public budgets of the different R&D programmes the government hoped to attract interest and to mobilise researchers in the pursuit of the national objectives. Some other political actions taken in those years, such as the reform of the University system, giving Universities an autonomous status, although funded with public money, also contributed to change the R&D environment. With the government increasing attention in university research and promotion of R&D within firms, the PRCs lost in those years their centrality in the Spanish R&D system.

2. 2. R&D budget stagnation during the 90s

The evolution of the amount of public funding available to research actors, in addition to their forms, was another determinant in the transformation of the R&D environment. When the socialists arrived to power, Spain dedicated about 0,5% of its GDP to R&D activities. The level of expenditure was very small compared with other European countries such as Germany (2,52%), France (2,06%), Great Britain (2,27%), or even Italy (0,90%) [25]. It was one of the priorities of the socialist government to increase the level of State expenditure on R&D to European standards, but besides the political commitment, public funding would depend on the evolution of the State budget over time.

In fact, the evolution of the R&D government appropriations had followed two very diverse patterns. Since 1983 to 1990 we can observe a significant increase of the Spanish R&D investment pushed by the public funding committed. In that period Spain represents a case of fast growing R&D expenditures, even if only considering the government performed R&D.

Table 1.-Total Government R&D Appropriations by country. (Million Ecus, 1990 PPS)

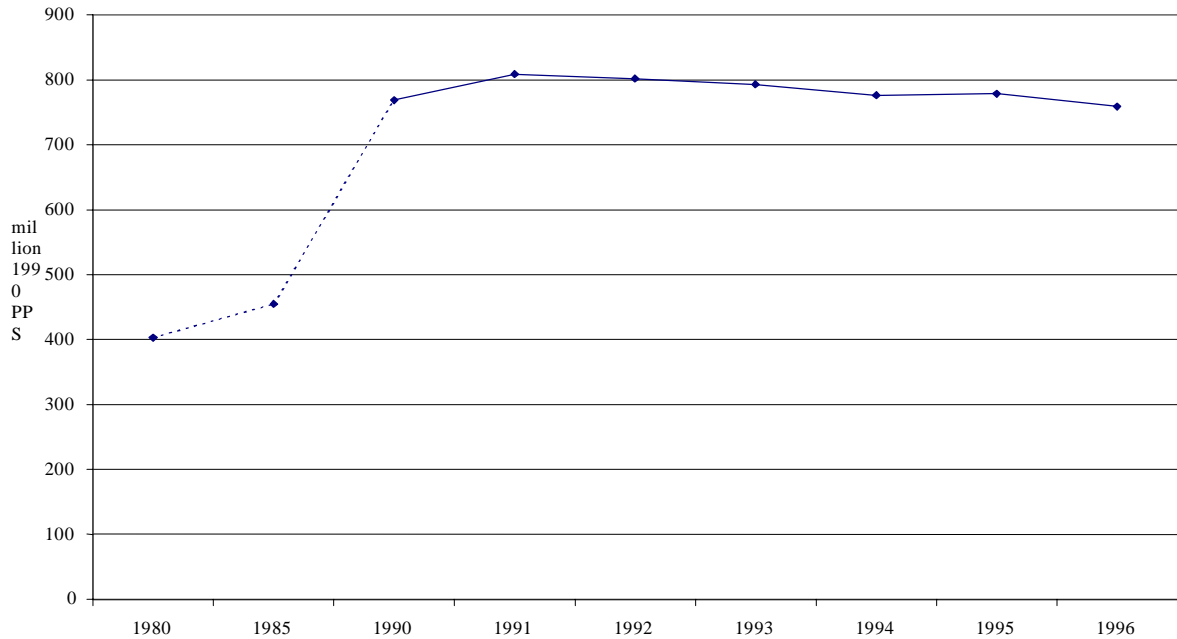
	1980	1985	1990	1991	1992	1993	1994	1995	1996
Belgium	726	798	922	947	934	978	976	1,007	1,073
Denmark	292	406	596	602	557	533	575	641	635
Germany	10,048	10,781	11,164	12,597	12,613	12,256	11,821	11,837	11,984
Spain	704	1,269	2,360	2,357	2,282	2,177	2,166	2,305	2,127
France	8,149	11,306	12,653	12,662	12,021	11,620	11,424	10,769	10,773
Ireland	119	114	108	117	128	138	131	179	196
Italy	2,765	4,867	6,340	6,552	7,013	5,988	5,540	5,624	
Austria	461	564	664	771	796	849	915	897	873
Portugal		164	291	361	396	504	407	467	467
Finland	306	434	615	673	702	719	715	731	708
Sweden	1,337	1,510	1,628	1,694	1,684	1,668	1,605	1,638	
UK	6,905	8,245	7,509	7,131	6,886	7,136	6,765	7,083	6,909
Total EU	33,723	44,399	48,609	50,131	49,740	48,560	47,149	47,447	45,400

Source: European Commission (1997) *Second European Report on S & T Indicators 1997*. Brussels: CEC. EUR 17639.

However the situation changed in the nineties, and it consolidated a period (that appears to have finished since 1997) of relatively stalemate, or decrease in real terms, of the public effort in support of R&D.

Figure 1 shows how even the R&D expenditure performed in the government sector, that is the PRCs, grew significantly in the years of the reform, mainly 1985-1990.

Figure 1. Total Government sector Expenditure on R&D (million Ecus 1990 PPS)



Source: European Commission (1997) *Second European Report on S & T Indicators 1997*. Brussels: CEC. EUR 17639.

Besides big increases of the public investments in R&D in the eighties, we can observe in Table 2 that the overall government sector, was growing during eighties weaker than other Spanish R&D sectors, that is the PRCs were losing ground. Public funding became much more significant for universities and private firms, because in 1980 the R&D government appropriations expended in PRCs represented the 57,2 %, while in the mid-eighties and nineties the figure decreased to 32-36 %.

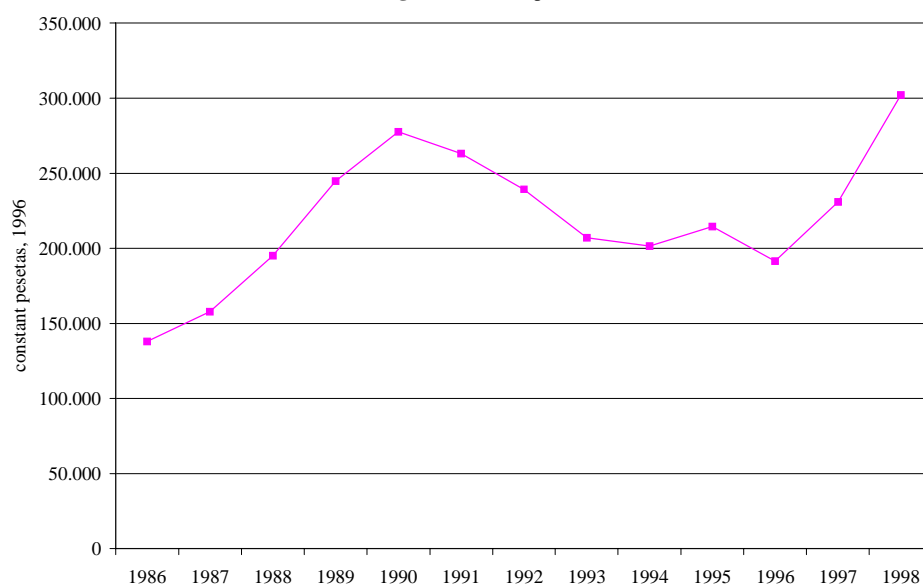
Table 2.- Percentage of total Government R&D Appropriations expend in Government R&D sector by country

	1980	1985	1990	1991	1992	1993	1994	1995
Belgium	14.5	14.9		16.6		15.8	9.9	9.7
Denmark	51.4	44.1	39.3	40.0	44.3	48.6		
Germany		31.4	35.3	35.2	35.1	37.1	37.5	37.3
Spain	57.2	35.9	32.6	34.3	35.1	36.4	35.8	33.8
France	38.0	39.7	42.2	39.7	39.2	41.0	40.5	43.7
Ireland		58.8	43.5	35.9	37.5	40.6	48.9	37.4
Italy	46.4	41.1	36.8	37.3	32.7	35.0	35.9	35.9
Austria		19.1				19.7		
Portugal			40.9		32.6			
Finland		45.9	43.6	43.2	42.9	43.1	42.8	40.2
Sweden		10.1		9.2		10.7		11.2
UK	44.7	35.2	31.7	35.2	36.6	35.8	39.4	37.2
Total EU	37.1	33.8	34.6	34.7	34.0	35.0	35.4	35.4

Source: : European Commission (1997) *Second European Report on S & T Indicators 1997*. Brussels: CEC. EUR 17639.

The stagnation of the research budget can also be considered as part of the environmental change to which Spanish PRCs have been responding in the last years. Figure 2 shows the ups and downs of the direct R&D budget government appropriations.

Figure 2. Spanish Budgetary appropriations for R&D ("Function 54 of the Annual Budget") (constant pesetas of 1996)



Source: Presupuestos Generales del Estado, various years.

However by the end of the eighties and early nineties, in addition to the National R&D Programmes, new forms of external funding have emerge and consolidated such as the funding from the international R&D Programmes, the EU R&D Framework Programmes, the funding from the regional Governments or funding from other specific

sectorial sources such the Health Research Fund (FIS), the Agriculture R&D Sectorial programmes, etc.

One would therefore expect that these reductions of direct R&D appropriations cuts would press the research organisation into the diversification of its research funding sources, regardless of the institutional trajectories of each organisation. What we found, on the contrary, is that the institutional trajectories explanation still holds under conditions of decrease of budget-appropriations.

3. The different responses of Spanish PRCs to the new opportunities

The persistence of a multiplicity of centres depending on the different Ministerial Departments was, to a large extent, at the origin of the Spanish PRCs' heterogeneity. This situation was identified by the policy entrepreneurs of the eighties as one of the main causes of lack of coordination in Spanish science policy. Historically there were significant differences in the structures and functioning between the different centres, due to the fact that at the time the Spanish Public Administration was far from being a single and coherent entity. However PRCs had in common a direct budget appropriation mechanism for funding their activities directly dependent on their respective ministries. The allocation of resources for research was made internally in the PRCs, following the "administrative authority criteria" of the directors, whom in most cases were an appointed General Director of the Ministry. Other external sources for funding or any kind of "competitive funding" at the time were negligible. In some cases, ministerial dependence was so strong for the PRCs that it was legally not permitted to accept external funding, either in the form of grants or contracts. The research staff was treated merely as public officials, who were expected to follow the instructions coming from above in the pursuit of their duties.

In this section we are going to present a brief description of the most important Spanish PRCs and of their different responses to their new environments. We will take as an indicator the extent to which the PRC has been obtaining non direct budgetary funding. In table 3 we present a list of the most relevant Spanish PRCs ([26, 27])

Table 3.- Some Spanish Public Research Centres (PRCs)

Acronym	Legal name 1999	English literal translation	Ministry of dependence 1999	Most relevant Areas of Scientific and Technical expertise	Similar organisations in France, Germany, U. K., Italy
CSIC	Consejo Superior de Investigaciones Científicas	Higher Council for Scientific Research	Ministry of Education and Culture	All kinds of basic and applied research	CNRS, MPG, CNR
CIEMAT	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas	Centre for Energy, Environmental and Technological Research	Ministry of Industry and Energy	Energy, nuclear, environment	CEA, KfK, UKAEA, ENEA
ITGME	Instituto Tecnológico Geominero de España	Spanish Institute for Geomining Technology	Ministry of Environment	Geology, Mining	BRGM, BfGR, BGS/NERC, SGI
INTA	Instituto nacional de Técnica Aeroespacial "Esteban Terradas"	"Esteban Terradas" National Institute for Aerospace Technology	Ministry of Defense	Aeronautic, space, electronic, communications,	CERT-ONERA, DLR, DERA, CIRA
CEHIPAR	Canal de Experiencias Hidrodinámicas del Pardo	"El Pardo" Hydrodynamic Model Basin	Ministry of Defense	Ship design	BEC, HSV GmbH, DRA, INSEAN
INIA	Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria	National Institute for Agriculture and Food Research and Technology	Ministry of Agriculture, Fishing and Food	animal health, forestry, agriculture food, fito & zooge-netic resources	INRA, FAL/IPK, BBSRC, ISC/ISZA
IEO	Instituto Español de Oceanografía	Spanish Institute for Oceanography	Ministry of Agriculture, Fishing and Food	Oceanography, fisheries, aquaculture, marine environment	IFREMER, BfF, DFR, --
ISCIH	Instituto de Salud "Carlos III"	"Carlos III" Health Institute	Ministry of Health and Consumer Affairs	Health and Biomedical Research	INSERM, GSF, MRC/NIMR, ISTISAN
CEDEX	Centro de Estudios y Experimentación de Obras Públicas	Centre for Public Works Studies and Experimentation	Ministry of Public Works	materials, public works hydrography environment	LCPCCh, BAST, TRLL, ISMES

The CSIC is the only Centre that can be characterised as an all-round research organisation, because it is the only one that covers all areas of research. The rest of them are, in fact, mission agencies, established by their respective ministries in order to provide scientific knowledge and qualified technical support required by those socio-economic sectors under ministerial responsibility. The institutional path of development of each Centre has conditioned the kind of intramural research carried out. The CSIC is not only the biggest Public Research Centre, in terms of budget and personnel, but also the one that concentrates its activity mostly in basic scientific research. The rest of PRCs, as agents created to serve the purposes of their respective ministries, concentrate most part of their activities on technical support and applied research.

The INIA was the result of a merge, in 1971, of the *Instituto de Investigaciones Agronómicas* (Institute of Agricultural Research), with a marked professional character linked to the professional development of the agriculture engineers, the *Instituto Fore-*

stal de Investigaciones (Institute of Research Forestry) connected to forest engineers, and the *Patronato de Biología Animal* (Board of Animal Biology) linked to the veterinary surgeons. As in many other countries the agricultural, animal and forestry research was linked to the agriculture extension services. Two significant features affect INIA. First the fact that in 1985 the INIA was seriously restructured because many of the research facilities (all outside Madrid) were transferred to the control of the Regional Governments. As a consequence the INIA budget fell to 50 %, and its personnel was reduced in more than 60%. The second important issue is that INIA and the Ministry of Agriculture, Fishing and Food manages a pluri-annual R&D programme, the “Sectorial Plan for Research in Agriculture and Food”, with approximately 1,500 millions pesetas that goes mainly to the INIA research institutes and associated Regional Agriculture Research Centres (ex-INIA).

Dependent on the same Ministry of Agriculture, Fishing and Food, is the Oceanographic Research Institute (IEO), that in fact had been integrated under this Ministry in the eighties. Despite the fact that it has most of its centres in the Spanish coast, the IEO had not been transferred to the Regional governments.

The INTA is a singular centre because it is dependent on the Ministry of Defence, despite the fact that its activities are much more associated to the ESA or NASA, with space and aeronautical research. The CIEMAT is the re-named Nuclear Energy Commission (*Junta de Energía Nuclear*), and concentrates its activities mainly in the area of energy and nuclear research and its impact in the environment. Historically, it also has had the surveillance and control of the nuclear facilities, but after the creation of the *Consejo de Seguridad Nuclear* (Nuclear Security Board), these activities lost ground at CIEMAT. For both INTA and CIEMAT their involvement in collaborative international research is very significant due to the singular technology areas in which they work that need large facilities and scale and develop in the frame of international collaboration.

The ISCIII has been mainly concentrated in knowledge provision and scientific advice to the Ministry of Health and Consumer Affairs. However, some other activities are holding within the Institute, such as the National Health School. Additionally, one specific feature of this centre is that, since 1996, its budget includes the Health Research Fund (FIS-*Fondo de Investigaciones Sanitarias*), with almost 5,000 millions pesetas for 1999, that finances most of the health and biomedical research in Spanish Hospitals through competitive procedures.

In the group of more technical assistance and service providers for the government, and less research oriented centres, we have the last three PRCs: ITGME, CEDEX and CEHIPAR. Even the definition of their mission, for example for CEDEX says that its main function is “technical assistance and services for Public Works and Urban Planning; and “research and development” represents less than 15% of the direct state budget appropriations for CEDEX. The ITGME is the Spanish Geological Survey. From this point of view these centres have the possibility to sell their services.

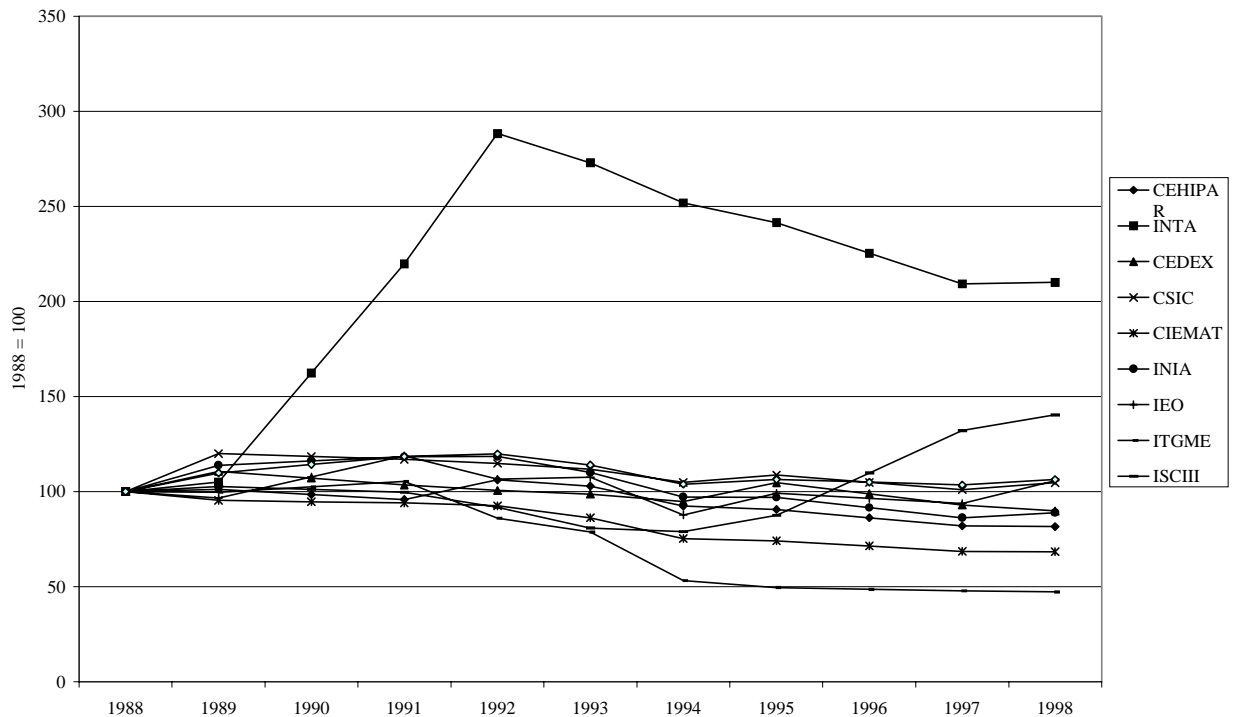
Our interest is how did all these changes affect the structures and behaviour of Spanish PRCs and to what extent the research strategies of the different PRCs have followed, due to similar environmental pressures, a process of homogenisation or differentiation. As we will argue, the homogeneous political design for PRCs appeared to produce heterogeneous effects on them.

Since 1986, it is possible to observe a significant level of variation in the adaptation of the PRCs to the new context. We measure the “adaptive reaction” of the PRCs with the weight of the external funding over the total R&D expenditures. This variation implies different levels of resource dependency on the part of PRCs in the development of their activities and this, in turn, has affected differently their research strategies and

their internal dynamics. It is this variation and its impact on the internal dynamics and research strategies of PRCs which is what we want to tentatively explain in this paper. We will argue that the degree of openness of PRCs to external sources of funding is the final outcome of a complex interaction between the internal dynamics of research organisations and the external environment in which they are embedded. When research organisations are subject to similar environmental changes, as was the case in Spain, the diversity of outcomes is attributable to the different institutional trajectories in which the decisions of individual actors within the organisation are embedded.

However, after a consolidation in 1988 and 1989 of these significant budget increases, a long period of stagnation in public R&D funding started. As the evolution of the State budget worsened, during the 90s, so did the public funding of PRCs through the budget appropriations of their respective Ministries. Since 1990 we have witnessed a process of stagnation, even decrease in real terms, of the direct budget appropriations for PRCs.

Figure 3. Direct Government Budget Appropriations for the Public Research Organisations in Real Terms, 1988-1998 (1988 = 100)



As we show in Figure 3, all the Public Centres suffered funding stagnation and decline after 1989, with some exception such as the INTA, the military and aerospace PRC, and later, the ISCHII, for health research, but in this case it is a statistical artefact because what appears is actually the integration of the FIS into the budget of the Carlos III Health Institute.

As a summary with respect to the socio-economic environmental changes, we should emphasise two different processes. On the one hand, an increased social pressure to align the research agendas of the universities and PRCs with the economic and social needs of Spanish society. On the other hand, after a rise of public funding in the eighties

–the highest rates in the EU- a stagnation or decline in real terms of the State expenditure in R & D activities.

Intuitively, one would expect that the bigger the public direct R&D allocation decrease as a consequence of a decrease in the budget appropriations, the bigger the incentive of the research organisation to move the attention towards non-budgetary sources of funding, if such possibility is available. However, as we will show below, this income decrease does not explain why some PRCs have diversified their sources of funding while others have not. We will see, in the following sections, to what extent this expectation has occurred. Nonetheless, the level of external competitive funding reached by the PRCs since 1986 varies significantly from one to another. At present, the CSIC is the most externally funded, with 38% of its income coming from self-financing. It is followed, as Table 4 shows, by the CIEMAT, with 31%. In the middle we find the ISCIII (10%), and the ITGME (6%), while in the other extreme we see CEDEX, ITGME or CEHIPAR.

Table 4. Relevance of the non-direct government budget appropriations in the total expenditure of the Spanish Public Research Centres (PRCs)

Acronym	Permanent staff 1998	Direct Government Budget Appropriations 1999 (Mill. Ptas)	Percentage of 'external' funding 1996 & 1997	Main Sources of external Funding (ordered by relevance in 1996 or 1997)
CSIC	6,862	39,709.7	38%	National R&D Plan (40%) Framework R&D Programme (28%) Firm's contracts (17%)
CIEMAT	1,146	7,877.3	31 %	EURATOM & R&D F Programs (34%) Firm's contracts (31%)
ITGME	329	3,485.5	6%	
INTA	1,203	14,525.1	25%	Firm's contracts (80%) EU Funds (15%)
CEHIPAR	125	766.3	Less 5 %	
INIA	530	5,521.4(*)	25%	Agriculture Sectorial R&D Programme (40%) National R&D Plan (40%) Services (10%)
IEO	398	4,469.1	25%	Framework R&D Programme (40%) Fishing Secretariat (40%) FIS (46%)
ISCIII	2,082	16,288.6(**)	10 %	National R&D Plan (21%) Framework R&D Programme (18%)
CEDEX	795	5,611.9	Less 5%	

(*) Includes the of Sectorial Programme for Agricultural R&D that amounts approximately to 1,500 Millions Ptas
(**) Includes the of Health Research Funding Programme (FIS-Fondo de Investigaciones Sanitarias) that amounts approximately to 5,000 Millions Ptas

This variation on the proportion of the external funding of the PRCs, the dependent variable, however, cannot be explained linearly by the level of budget decrease that we

have observed in the previous section. Some anomalies emerged in the adaptive response. The PRCs that have witnessed the biggest stagnation of their budget do not behave in a similar direction. For the five PRCs with the worse evolution of the public budget allocations and transfers, three of them, the ITGME, CEDEX, and CEHIPAR (see Table 4) present the lower trend to self-financing; while CIEMAT and INIA appear to react to the stagnation with big efforts of external funding. In the opposite direction, the better treated by the evolution of public R&D appropriations, INTA, is one of the most active in the search for external funding, while ISCIII has just a 10% of external funding. Both the CSIC and the IEO react to the stagnation with the increase of external funding.

Therefore, there must be some other explanation that accounts for this variation that is not based, exclusively, on the level of direct budget decrease. Thus we need to define much more the variables to account for the empirical diversity of the degrees of adaptation. In the following pages we propose an institutionally base explanation.

4. Explaining diversity in the PRCs' responses towards the diversification of funding sources

In this section we want to explore how similar pressures for adaptation from the changing environments gave way to different internal dynamics in each PRC, depending on factors related to their respective institutional arrangements and trajectories.

As we have seen in the previous sections, apparently the Spanish PRC have been affected by similar pressures for change: e.g. the effects of the consolidation of strategic S&T policy as a dominant way of public intervention in mid eighties, or the stagnation, freezing and even decreasing of the direct budgetary appropriations for the PRC. But also the opportunities were opened for the management of the PRCs, with the new institutional arrangements, that allowed the PRCs to obtain external funding. But why are their degrees of response of the PRCs, measured by the proportion of external funding over the total budget, significantly different?

Our main argument is that PRC adaptation is mediated by a set of institutional variables, some of them associated to long term historical trajectories of development, that is path dependent in some way. If we consider that the proportion of the external funding represents the *funding strategy* of the PRC, we can consider it the dependent variable in our argument. Some institutional variables appear to be the independent variables to explain the variation in the outcome.

First we have to consider the diverse degree of PRC political dependence from the Ministry, or put it in positive terms, the degree of autonomy of the PRC over its political controllers. The Ministerial authorities should approve, allow or encourage the autonomy of their own PRCs. The rationale for that movement for the ministerial policymakers could be very diverse: to abandon of the old idea of subordination of the PRCs to the needs of the Ministry, the acceptance of the new ideas of coordinated S&T policy that should follow national R&D priorities or simple attempts to contribute to the solution of the limitations for R&D activities imposed by budget restrictions. However the effects, once the movement had been made, are irreversible, because to increase the autonomy of their agents will mean to loose ground and authority over the selection of their activities and research tasks. Then our argument predicts that the higher the political dependence of the centres from its Ministry, the less incentives or pressures the PRC management will have to adapt to the new environmental pressures. Or the stated oppositely, as more PRC autonomy is perceived from its Ministry the pressures for adapta-

tion will be assimilated much rapidly. In our cases, the prediction would be that CSIC, that has the higher degree of political autonomy will show stronger move to the new funding strategy. In the opposite corner the ITGME, CEDEX o CEHIPAR, still very linked to their Ministries will have more difficulties to move into the direction of the new funding strategies.

Second, we have to consider some characteristics emerging from the interaction between the type of specific research or service providing activity of the public centres (the point in the continuum between generic knowledge producers and specific service providers to the Ministries) and the external resource raising opportunities (e.g. the existence of specific international R&D funding programmes or clearly defined external markets for selling services or knowledge). That is, we consider that the concrete and substantive activity of the PRCs creates some specificity that should influence their opportunities to adapt their funding strategies. In this case our argument predicts that the adaptation to the new funding strategies will be more intense in those PRCs that have at their disposal, because of their technological area, big specialised international R&D Programmes or clear markets for “selling” their services or competencies. The opportunities for external funding of our PRCs are significantly different, that vary from the existence of huge R&D programmes such as the nuclear research (EURATOM) or energy, immense contracts emerging from the ESA (Europeans Space Agency), or from military technological developments, to smaller programmes relating with marine and fishing research but very big financially in relation to the size of the PRC. Applying the argument to our cases we should expect more adaptation of the funding strategy in the case of CSIC, CIEMAT, INTA and IEO, than in the ISCIII, because in the area of clinical or biomedical research programmes in comparison are small. On the opposite extreme very little relevance of external sources appears to be the case for “public works testing” or “geological surveys” technologies.

The third important element in the explanation of the diversity of situations in terms of the funding strategies is what we could call the individual research incentives to search for the external funding. Since Merton studies, it is agreed that there is a scientific ethos that will push the researcher to do their best; additionally modern analysis of individual incentives and compensation systems, help us to relate the commitment of the individual scientist in raising external funding with some rewards and compensation systems, clearly associated to their differential performance in terms of raising external funding. In some cases, depending of the system, the incentives or rewards could be either associated to the professional career or to the increases in the pay. Then our argument is that the different impacts of the internal compensation systems of the PRCs set up by their managers will be a basic variable to explain the diverse commitment of the individual researcher on the strategy proposed by the PRC manager of increasing the availability of external funds. In addition the fact that having external funds increases the autonomy and the independence of the individual researcher *vis a vis* the direction of PRC. Our predictions say that if the PRC have either clear research careers or systems of pay associated to the performance in raising external funds the PRCs will be much more adapted to the new funding strategies. Our empirical observations confirm this variable as relevant because CSIC is the only PRC that has both a relatively consistent research career (in which the performance in the external funding is relevant) and a special productivity bonus associated to getting external funds from firms or European programmes, and the CSIC scores much higher in the proportion of external funding.

In the rest of the section we will focus on the specificity of our three main variables. We will first look at the degree of political autonomy of the PRC from their Ministries, and we will describe their reactions to the original proposal of the legislative changes

over PRCs included in the Law of Science, that somehow influenced the timing of application of the new institutional environment in other research centres. Then we will focus separately on the interaction between the type or specific activity developed by the PRC and the available opportunities for external research funding and how the managers tried to encourage researchers' responses to the new environmental conditions. Finally we will try to extract conclusions and to develop an explanation in what refers to the changing funding strategies.

4.1. Political dependence as an obstacle to non-budgetary funding.

The diverse degree political dependence on the Ministry of each PRC is important. The Ministerial authorities were to approve, allow or encourage the autonomy of their own PRCs. When promoting the legislative changes for S&T system and for PRCs the government was not free from discrepancies. In 1986, many ministries were involved in R&D activities and one of the objectives of the Law was precisely to create a common institutional structure under which this R&D activities would be co-ordinated. Inter-ministerial negotiations took place during 1983 and 1984 in order to arrive to a consensus on the contents of the Law. The main resistance to the reforms came from those ministries that saw the reforms as a loss of authority over their own agencies in benefit of the enhanced authority of the Ministry of Education and Science, that in practice was the co-ordinating actor.⁴

Ministerial resistance made it difficult for the political entrepreneurs within the Ministry of Education to advance a systematic approach for the functioning of the research centres that were administratively part of the different ministries. The contents of the Law finally presented to the Parliament for approval was the result of a complex process of internal negotiations between the different ministries within the Spanish executive. As a result, some of the ideas defended by the reformers had to be altered in the final text in order to reach a consensus over the Law.

Even though the new institutional arrangements of *autonomous commercial bodies* were a clear advance in terms of the management practices and flexibility, some of the Ministries rejected the idea. The will of the ministries to preserve the authority, hindered the reformers' attempt to foster, through legal mechanisms, more autonomous PRCs. The immediate consequence was that not all PRCs in 1986 were transformed from autonomous administrative bodies into autonomous commercial bodies, under the provisions of the Law of Science. Some of them would not become commercial bodies until very recently, this time lag) could be relevant to explain the adaptation responses and accounts for some of the different PRCs' responses to the new conditions.

In 1986, six PRCs were included under the new legal status established in the Law of Science: CSIC, CIEMAT, ITGME, INTA, INIA and IEO. During the following years more PRCs became commercial bodies: CEDEX (1989), ISCIII (1991), CEHIPAR (1999). According to our data, those organisations that first had access to the status of commercial bodies are also the ones with higher levels of non-budgetary funding. The only exception to this rule is ITGME, the "Geological Survey Centre", which was part of the first six, but appears to have with a low proportion of external funding in comparison with the overall budget.

⁴ From an agency theory perspective, the access of the research organisation to external sources of funding alters the agency relationship with its corresponding ministry. The existence of more than one principal enhances the discretionary power of the agency, especially if those principals are uncoordinated or do not share the same interests and objectives.

This is not to say that the expected evolution of those PRCs whose time of incorporation has been shorter will be towards increased levels of self-financing. Among the six organisations that first had access to external funding there are important differences in terms of non-budgetary funding (from the 38% level of CSIC to the 6% of ITGME) that also needs to be accounted for. But there is no doubt that timing of incorporation matters. Therefore, the reaction of the different ministries, as far as it determines the timing of incorporation of PRCs to the new legal framework, is a factor that helps us to explain the different responses of PRCs towards the diversification of their sources of funding.

4.2. Managerial approaches towards increasing the levels of external non-budgetary funding

Having the opportunity to finance or increase the research at PRCs with non-budgetary external funding sources does not necessarily imply that PRCs are interested in obtaining those external resources. They might or might not have incentives to look outside for funding resources when they have a guaranteed amount coming from direct budget appropriations.

Although we could think that the major incentive to look outside for funding resources would come from the level of budget restrictions the organisation has to face, the data do not support in a linear way this expectation, as we have already seen in the previous section. The level of budget restriction is an external pressure that forces the management of the research organisation into making a choice, but does not determine the final result. There are other pressures over the PRC directors (and researchers) that either mobilises their researchers or brings use of their authority to push them to search for funding.

Therefore, these other factors that account for the differences in the decisions adopted by management include how much income is worth getting externally. The organisational interest is shaped (in addition to the political autonomy of the Ministry) by the external opportunities available to finance specifically their research and technological domain of expertise or competence. In our opinion, the nature of the mission and the specificity of the scientific or technological area delegated on the organisation is what helps us to explain, to a considerable degree, the pressures of the research organisation in staying within the limits of the budget appropriations or, on the contrary, in competing for external resources.

Concerning the nature of their mission, PRCs could be located in a continuum from *service providers* to *knowledge producers*. Those PRCs whose mission, by way of their historic-institutional trajectory, is concentrated on providing their respective ministry with technical advice, expertise and services or which are overburdened with the requirements of their own ministry will be less willing to look for external resources. The management of these organisations does not see or find any advantages in competing for resources since the organisation's results will be judged not by the increase in the quality and quantity of its research activities but by the level of accomplishment of its mission. In consequence, the organisation's income is much more dependent on the good will of its ministerial superiors to transfer more ministerial resources to their agency or to fight politically to get more budget appropriations on behalf of their agency. Therefore, the research organisation will be better-off pressing internally to obtain an increase in its budget than competing for resources externally. External funding will most probably be a negligible part of the organisation's income.

On the opposite side, those PRCs developing a general mission, will feel better off if they increase their income externally. In these cases, PRCs dedicate a major part of their activities to research and can therefore be characterised as knowledge producers. As

such, they are willing to obtain as much funding as possible for their research activities since more funding implies more research and this, in turn, leads to better results in terms of knowledge production.

Also, getting more funding contributes to the cycle of reputation [28] for these organisations, which are seen as executing quality research and providing quality results. This cycle of reputation will reinforce their competitiveness in obtaining more external resources, but at the same time could be dangerous in such that it causes further reduction of the direct public budget appropriations due to standard practice of the Ministry of Economic Affairs, Treasury and Finance.

The differences in the nature of the research mission imply, on the other hand, distinct requirements in terms of the level of economic funding needed by each area of research. This will undoubtedly influence the decision of management and of individual researchers about to what extent it is in the interest of the organisation or in their interest to dedicate time and effort to compete externally for resources. Those research areas that need greater levels of investment and/or funding in order to be carried out will have more incentives to compete for external resources than those research areas that do not.

4.3. Individual research incentives

Analysis of individual incentives relates the commitment of the individual scientist with raising external funding with some rewards and compensation systems, and is clearly associated to their differential performance in terms of raising external funding. In some cases, depending of the system, the incentives or rewards could be either associated to the professional career or to increases in pay.

Let us assume that the researchers working inside the same organisation, in addition to the general *ethos* principles, act according to three different kinds of incentives: compensation schemes, contextual pressures or authority and career rewards. Compensation schemes are strictly referred to the income the researcher receives as a result of the position he/she occupies within the organisation. Contextual (or environmental) pressures are referred to all those factors that press research actors to make a choice among a limited number of options. The authority of PRCs directors could also be an element of pressure. We could think of internal funding restrictions as pressure that forces the researcher into making a choice: stay within the limits of those restrictions or look outside for non-budgetary funding. We think of career rewards as non-economic compensations, such as professional recognition (eg. change of status from junior researcher, to senior researcher, to research professor), greater autonomy of decision, recognition among peers, academic prestige and influence, self-satisfaction, or upwards mobility within positions of the research organisation.

This assumption seems plausible enough. All we are saying is that researchers want to do research (funded by external sources) because they obtain non-material rewards and sufficient economic incentives to decide that scientific research is worth doing in the first place. To do research, they want autonomy to decide what to work on, and economic funding to carry out research activities. The more the researcher is guided by economic incentives, such as compensation schemes, the more likely it is that he solves the trade-off in favour of acquiring more money, in spite of a loss of autonomy. In the opposite way, the more the researcher is guided by career rewards, the more likely it is that he solves the trade-off in favour of increasing his autonomy of decision and his career perspectives. In fact, one of the motivations of the researchers for searching external funding (or aligning over the priorities of the strategic R&D programmes) could also be to gain autonomy *vis à vis* the hierarchies of the PRCs, because financial autonomy means research and professional independence.

Research organisations might have incentives to look outside budget-appropriations for resources, but in order to do so, they need individual researchers to be willing to do it as well. Therefore, the management of the research organisation must think of a system of incentives for researchers that will result in an alignment of their individual interests to those of the organisation as a whole. The situation is not easy because in the public centres the position of researcher has the status of civil servant, to which all the regulations for the civil service compensations systems, appointments and career apply.

Researchers should find some clear economic or career advantages under the new funding conditions in order to have an incentive to compete for resources. If competing for resources, that is, if applying to non-budgetary sources of funding, means exclusively more money for the organisation, researchers will have little incentive to work hard in order to get those external funds. The extent to which this is so depends on the level of centralisation of decisions within the organisation. The competition for resources, as opposed to the previous situation of funding exclusively through budget appropriations, undoubtedly has an impact in the authority relations within the research organisation and, therefore, the attitude adopted by management will be of great relevance, in this respect. Since management is now more dependent on researchers commitment in order to get external funding, it will have clear incentives to provide those researchers engaged in non-budgetary competitive funding with enhanced autonomy and with economic and career rewards.

According to this, we can expect that those Centres most interested in getting external resources will tend to offer compensation schemes and/or career rewards to their researchers. These incentives will make it worth for researchers to compete for resources on the regional, national and European R&D programmes, and through contracts with enterprises. The final effect would therefore be an increase in the levels of external funding of those PRCs. However the ability to build up pay or incentives schemes for officials of the PRCs is very limited, because the compensation scheme is dependent upon the Government, mainly the Ministry of Economic Affairs, Treasury and Finance, and it follows a simple logic emerging from an attempt to homogenise situations in the public sector and administration; it always tries to avoid special situations, that may create the dynamics of “labour demands”. (The salaries of the researches, as in any other civil servant, have four basic components, and only one is subject to “discretionality”: Base salary, specific complement, labour post complement and productivity component. Additionally, researchers at universities and the CSIC benefit from a systems of rewarding its scientific performance build up on personal curricula evaluation at national level [29].

4.4.Changing funding strategies

Once we have suggested the main factors explaining the diversity of degrees of adaptive response of PRCs in their funding strategies –namely the political autonomy of PRCs *vis a vis* their Ministry of dependence, the nature of the research mission and its interaction with the availability of external funds, and the nature of the individual incentive schemes within the research organisation– we still have to test or contrast them empirically (see overview in Table 5). We have already seen that not all Centres increased equally their levels of non-budgetary funding in response to the environmental changes, despite a general tendency towards budget restrictions. Which PRCs have significantly altered their funding strategies and why?

We have already seen that those public research centres which have altered most significantly their funding strategies, and which, as a consequence, present a higher level of external funding are CSIC, CIEMAT and INTA.

Table 5.- Balance of situation for the PRCs

Acronym	Direct Government Budget Apprs. 1999 (Mill. Ptas)	Other funding sources, 1996 or 1997	Trends on Direct Government Budget Appropriations (1990-1998)	Became Autonomous Commercial Entities	Nature of the Mission (<i>knowledge producer or service provider</i>)	Individual Researcher Incentives
CSIC	39,709.7	38%	stay	1986	<i>k.p.</i>	direct ones
ISCIII	16,288.6	10%	stay/increase	1991	<i>both</i>	civil serv.
INTA	14,525.1	25%	increase/stay	1986	<i>k.p.</i>	civil serv.
CIEMAT	7,877.3	31%	decrease	1986	<i>k.p.</i>	civil serv. *
CEDEX	5,611.9	5%	decrease	1989	<i>s.p.</i>	civil serv.
INIA	5,521.4	25%	decrease	1986	<i>both</i>	civil serv. *
IEO	4,469.1	25%	stay	1986	<i>k.p.</i>	civil serv.
ITGME	3,485.5	6%	decrease	1986	<i>s.p.</i>	civil serv.
CEHIPAR	766.3	1%.	decrease	1999	<i>s.p.</i>	civil serv.

* means some evaluation to establish RPT (see note 5)

The CSIC is the organisation that receives the largest amount of external funding (38% of its income). This makes sense in terms of our explanation, since the CSIC can be characterised as a knowledge producer, and as an all-round agency whose mission is the general promotion of knowledge, regardless the area of research. At the same time, the CSIC is engaged mostly in basic research and, since it covers all areas, some of them require high levels of investment and funding while others present a good competitive market position for their research results. From this, we can deduce a great interest on the part of the CSIC to get external funding. This interest has led the CSIC to establish an internal system of incentives based on both compensation schemes and career rewards that, apparently, has had a positive effect over the level of external funding achieved since 1986. The CSIC is the only public research centre in Spain that allows each individual researcher to keep a fixed percentage (30%) of the funding received externally, from contracts with enterprises or research projects financed under EU R&D programmes. It is also the only one to offer the researchers a compensation scheme called “extraordinary productivity bonus”. This bonus is incorporated to the salary of those researchers that have been successful in the of evaluation of their research activities. It is offered every six years as an economic reward and is cumulative over time (26). Concerning career incentives, the CSIC is the only Research Centre in which there exists, together with a civil servant career, a research career quite similar to the university standards. Upward mobility is therefore possible in two different ways: either by ascending in the administrative hierarchy of positions, or by acquiring a superior research status. Another non-material incentive that has made attractive for the research-

ers of CSIC to compete for external resources is the enhanced autonomy of decision making. Those researchers who get external funding for their research projects and activities are free to decide what to work on. At the same time, getting external resources might create a cycle of reputation for the researcher that works as another non-material incentive to compete for resources.

The next group of centres that receive, comparatively, a significant amount of external funding, and that occupy a medium position in the continuum between those most externally funded and those less externally funded, are the CIEMAT (31% of its income), the INTA, the IEO and the INIA (all with 25%). They can also be considered knowledge producers. They depend on the Ministry of Industry and Energy, on the Ministry of Agriculture, and on the Ministry of Defence, respectively (see Table 3). But their explicit mission is not to provide services but to promote and carry out research and technological development in their respective areas: energy, agriculture, oceanography, and aerospace. Their main activities are concentrated on basic research and technological innovation.

The research areas in which they are involved require high levels of investment and funding. From these factors we can infer that the management of these PRCs are interested in obtaining external funding for their research activities. However, although the level of external funding is high (between 25% to 31%), none has developed the kind of compensation schemes based on productivity bonus, present in the CSIC, and the career perspectives for researchers depends exclusively on the improvement of their pay being appointed to a better labour position in terms of complements.

Except for the CSIC, the wage levels inside the rest of PRCs depend on the job position in the RPT catalogue⁵, and the appointments are part of the same system that works for all public administration. Comparing the level of wages between these PRCs we also observe significant differences. These differences depend of the success in the negotiations on the catalogues between the centres and the Ministry of the Economic Affairs, Treasury and Finance. There is no “research career”, since upwards mobility is achieved by ascension in the administrative hierarchy. However in some centres, like INIA or CIEMAT, mechanisms of evaluation of R&D productivity had been taken into account in the implementation of the rewards to research personnel using the RPT catalogue.

The *nature of their research areas* could also explain the higher level of external funding, at least in the cases of CIEMAT and INTA. Both are involved in highly internationalised scientific areas that require very important levels of investment on technically advanced infrastructures. They have strong incentives to get external funding by engaging in European and international programmes that can afford the levels of expenditure required. The nature of the research area, therefore, exerts pressure in a definite direction that is towards getting as much funding as possible.

INIA and ISCIII are centres that, in addition to knowledge production can be considered as service or knowledge providers to their Ministries. They both take advantage of a special situation. Both PRCs manage two independent funds, from which their researchers apply for funding: the Health Research Fund (FIS) and the Sectional Plan on

⁵ The compensation systems of the civil servants are based on the modern idea of wage differentials depending on the professional group of origin, the job, the performance and the seniority. Thus people from the same professional groups can have significant wage differentiation, depending on the job post or the performance. The way of implementing these principles all over the State is the so-called *Labour Position Catalogues* (RPT or *Relación de Puestos de Trabajo*). All the public bodies must have this RPT, which is used to differentiate and to incentive.

Agriculture and Food R&D⁶ These programmes imply an extra funding, and could also explain the low proportion of external funding of ISCIII. Since they manage extra amounts of funding of considerable weight for research activities, and since they are also involved in providing services to their respective ministries, these Centres could have a minor pressure to look outside for external funds.

The CEDEX, ITGME and CEHIPAR present the lowest levels of external funding. They are basically service providers. The research activities are just a small part of their work. Their main clients are the public administrations, especially their Ministries. Therefore, despite the new opportunities available for getting external resources, the management of these organisations does not have clear incentives to do so. Moreover, none of them have an available external market for their research products. In the three cases, no compensation schemes or career rewards have been established for their researchers besides the already mentioned civil servant career.

As a balance of the findings associated to the institutional variables we could simplify the argument as dummy variables (presence or absence) to determine the optimum situation in terms of adaptive response and the inertia situation of PRCs (see Table 6). The variables include 1.- Financial pressures; 2.- Political autonomy on the Ministry; 3.- General Knowledge producers (versus Service providers to their Ministries); 4.- External funding availability (Specific R&D programmes or markets); 5.- Internal individual incentive schemes. The optimum would be the presence in a positive way of all the variables (financial pressures, political autonomy, knowledge producers, available external funding and individual rewards incentives). The worse adaptive response would be in the absence of all the variables.

Table 6.- Summary of some variables affecting PRCs

	financial pressure	independence from ministry	knowledge producers	funding alternatives	system of incentives
CSIC	yes	yes	yes	yes	yes
INTA, CIEMAT, IEO	yes	yes	yes	yes	no
INIA,	yes	some	mix	yes	no
ISCIII	yes	some	mix	no	no
CEDEX, ITGME, CEHIPAR	yes	no	no	no	no

The most externally funded research centres, the CSIC, have positive presence of all the variables. The next group of PRCs, INTA, CIEMAT, IEO, have a slightly different situation because they also have high financial pressure, relative political autonomy, are mainly applied knowledge developers, and also have very significant external funding available. However although they having some of them hints of a research career, they do not have any direct reward mechanism or productivity bonus associated to the good individual performance in raising funds.

INIA would be in this group also, especially because the existence of alternative funding. However it also could be part of a group with the Carlos III Health Institute that lacks political autonomy because it is performing a mission for the Ministry, that also represents a mixture of applied knowledge production and services provision to the Ministry. External funding available for clinical research is very small and those for basic biomedical research are highly competitive, and there are no direct reward mecha-

⁶ *Fondo de Investigaciones Sanitarias and Programa Sectorial de Investigación y Desarrollo Agrario y Alimentario.*

nisms or productivity bonuses associated to good individual performance in raising external funds.

The fourth group, formed by the ITGME, CEDEX and CEHIPAR, have financial pressures, they have political dependence on their umbrella Ministry, they produce mostly services, provide technical testing and advise to the Ministry, and do not have significant external R&D funds available. In addition they do not have any direct reward mechanism or productivity bonus associated to good individual performance in raising funds.

5. Tentative Conclusions

5.1. Main findings

The aim of this paper was to shed light on the process of organisational adaptation of Spanish PRC's to the environmental changes that have affected them since the late 70s. The most important of these changes was the new financial and administrative regulations introduced by the 1986 Law of Science under which the Spanish PRCs had to operate in the future. These regulations increased the number of tools available both to the management and to the researchers within the organisation for deciding on their research strategies. Therefore, by enhancing the options available, incentives were set up for the Spanish PRCs to transform themselves into more autonomous and flexible organisations.

As we have seen, the response of PRCs to this new context has varied widely. Despite the possibilities opened for obtaining resources externally, the levels of external funding reached by each Centre vary from the 38% of the CSIC to almost nil in other cases. Likewise, although all PRCs had the opportunity to alter the internal incentive schemes for their researchers, only a few made the attempt to develop the principle and to negotiate with the Ministry of Economic Affairs.

Intuitively, one would have expected that as income decreased it would have improved the incentive of the research organisations to move towards external sources of funding. However, as we have shown, this has not been the case. The level of budget restriction has been a pressure that has forced PRCs to make choices, but has not determined the final result of those choices. We argue that the *nature of the mission* delegated on the PRC and, maybe, the type of *research areas* in which the organisation is involved are the factors that explain most of the variations. According to our main hypotheses:

- a) PRCs that focus on the production of knowledge and with a loose relationship to their respective ministry of affiliation will be more interested in obtaining external funding.
- b) PRCs whose areas of research demands more investment and funding will have more incentives to compete for external resources than those which do not. At the same time, those areas whose results have an outside market will do better in the competition for external funding. The same can be said about the nature of the services provided.
- c) As a consequence, as greater the interest of the organisation in obtaining external resources, the likelier the possibility for internal development of individual incentive schemes that align individual interests with those of the organisation.

- d) In the absence of individual incentive schemes, the interest of the organisation to obtain external funding might be impeded by the lack of interest of researchers to compete for external resources which will only benefit the organisation.

Data suggest, that there is a causal relationship between the nature of the mission and of the research area and the increase in the levels of external funding of PRCs. Also, the managerial interest in obtaining external funding seems to be closely related to the creation of new compensation schemes and/or career rewards for the researchers inside the organisation⁷. However, these are yet tentative explanations. The whole system is still evolving and has not come to a steady state; there is not enough of a time perspective to evaluate it definitely. Now at this point we interpret this hypotheses simply as guide towards further empirical testing and theoretical development.

5.2. Some possible effects of non-budgetary funding over the internal dynamics of PRCs

Despite the attempt of the PRCs most interested in obtaining external funding, to align the interests of the researchers with those of the organisation in order to compete externally for resources, the system of incentives established has produced certain unintended consequences. Individual incentives have successfully pushed researchers towards the competition for external funding, but new problems of internal co-ordination and conflict have emerged which, in turn, would affect its efficient functioning and the final results of its work.

The access to external sources of funding for individual researchers breaks the chain of authority relations within the research organisation. A process of decentralisation of decision power takes place, since researchers are now freer to decide where to apply in order to obtain financial resources and what to work on. Given the increased number of funding alternatives available and the individual incentive scheme developed internally, a considerable amount of researchers compete for external resources attending exclusively to their personal interests, and nobody can be certain as to which strategies other members of the organisation will pursue. As a consequence, the research organisation faces a problem of internal co-ordination in the definition and application of a clear and unitary research strategy. Managers have a better-financed organisation but have lost part of their power to decide over an efficient use of resources. As Miller has put it in *Managerial Dilemmas*: “Individuals in hierarchies inevitably find themselves in situations in which their own self-interest is clearly in conflict with organisational efficiency” [31]. This problem of co-ordination can be exacerbated by the fact that the different funding alternatives benefit some members of the research organisation against the others.

Therefore, the access to external sources of funding, although has been thought of as a solution to certain problems, can in turn open the way to new ones. The PRCs might have to face a collective action problem: how to involve all its researchers into a collective research strategy that would make the functioning of the organisation more efficient and effective.

This is undoubtedly something that requires further exploration, although it goes beyond the aim of this paper. On the one hand, to what extent the access to external sources of funding generates problems of internal co-ordination within the research organisations which, in turn, affect to their efficient functioning and to the final results of

⁷ The managers' incentives to promote change in the compensation schemes are something that demands further investigation.

their work. On the other, what are the possible solutions to these co-ordination and efficiency problems. Related to these, it might be useful to go back to Miller's words as a starting point for further enquiry:

“The solution to the co-ordination problem –achieving more efficient rather than less efficient solutions to repeated social dilemma games– involves personal characteristics and shared perceptions of the actors involved, the political skills of organisational leaders, and the constitutional resolution of the ultimate political problems of power sharing in organisations” [31: 233].

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