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# **From research to patents within Spanish Public Research Organisations (PROs)**

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# **FROM RESEARCH TO PATENTS WITHIN SPANISH PUBLIC RESEARCH ORGANISATIONS<sup>1</sup>**

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## **Introduction**

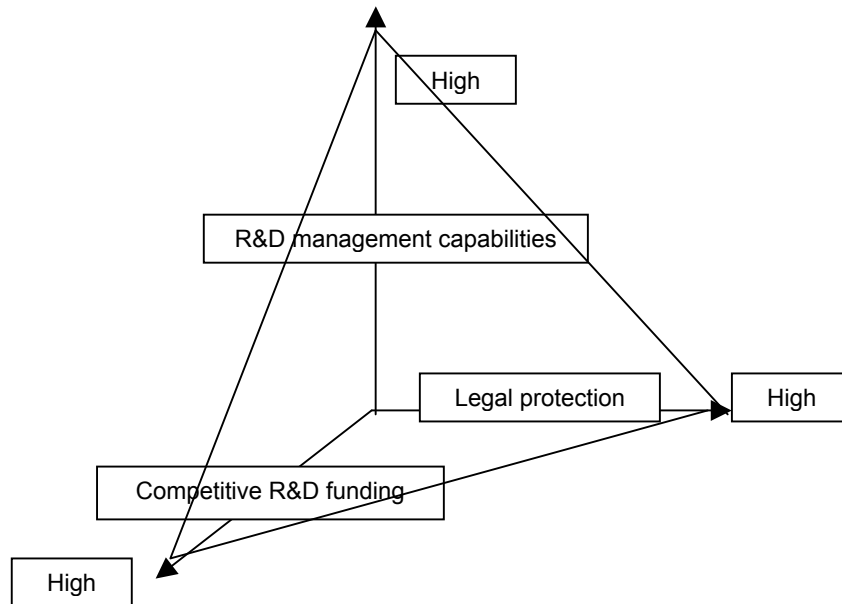
Current social and economic trends, dominated by market globalisation, technological innovation and the economics of information and knowledge, have renewed interest of both policy makers and social researchers in intellectual property rights (IPR) regimes (Maskus, 2000). In the specific field of scientific and technological research, IPR concerns are the protection of knowledge produced through international co-operation (EC, 2002a), the role of S&T policies (EC, 1999) and the management of IPR in the context of publicly funded research (EC, 2002b). The management of IPR in public research organisations (PROs) has been addressed mainly through legal protection and commercialisation of their scientific and technological research activities (OECD, 2002a; 2002b).

Discussion of IPR and knowledge management in public research organisations (PROs)<sup>2</sup> might be framed as part of a broader debate including: *i*) patterns of interaction and co-operation between academic research and business organisations; *ii*) alternative funding sources of R&D activities conducted by PROs; *iii*) the impact of strategic science and technology (S&T) policies; and *iv*) the legal framework for IPR protection. Figure 1 represents the three axes along which the management of IPRs within Spanish PROs evolved. (Figure 1)

This chapter argues that the increasing relevance of strategic use of IPR in PROs is the combined effect over the last 15 years of three processes. First, the growth of the public research system (Muñoz *et al.*, 1999). Second, the increasing relevance of “external funding”, either from public competitive sources such as the national R&D plan and the EU RTD framework programmes or business funding (Sanz-Menéndez and Cruz, 2003). Third, the emergence and consolidation in these institutions of technology transfer offices (TTOs) aimed at fostering technology transfer and creating economic value from scientific research. Consequently, IPR management in Spanish PROs is related to the increase in the relevance of contract-based research which lead to the growth of patent applications, licensing agreements and exploitation of IPR by these institutions. Thus, protection of research outcomes and effective management of IPR in PROs are likely to be strongly associated with an increase in targeted research, funded with a view to competitive advantage, and more specifically with a tightening of the

relationships between PROs and business firms. These trends cannot be isolated from the development of research management capabilities within PROs, commonly in their TTOs.

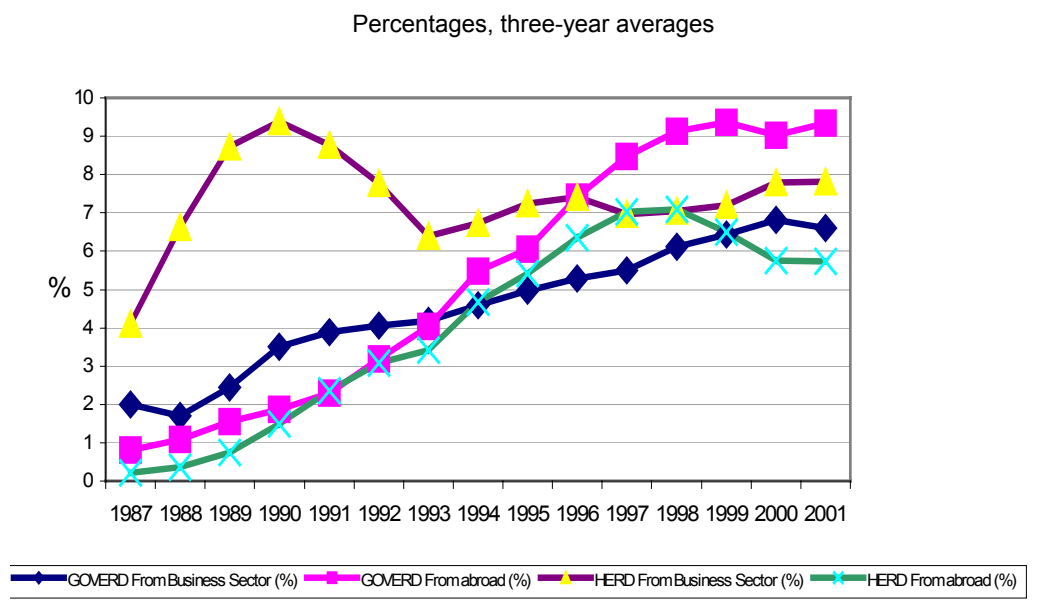
**Figure 1. The management of IPR within PROs**



This chapter examines the factors and explanatory variables that account for the performance and trends<sup>3</sup> in Spanish PROs' contract-based research with business, technology transfer and IPR management (Figure 2). It is an important issue, as the Spanish national system of innovation lags that of other European countries (EC, 2002c).

Public S&T policies have driven the acquisition of organisational and managerial capabilities by PROs and, more specifically, support the creation and consolidation of TTOs. TTOs were designed to promote ISRs, technology transfer and the management of contract-based research and to protect, license and exploit IPR in their home institutions. In the pursuit of such goals, Spanish TTOs have helped to extend R&D management from funding to commercialisation and are today prominent actors in the context of research and IPR.

**Figure 2. Government and higher education R&D expenditures financed by business and abroad**



Source: INE (Spanish Statistics), various years.

This chapter first focuses on the basic characteristics of Spanish S&T policies to provide a general framework for the analysis. Second, the creation and evolution of TTOs are presented in the context of Spanish public policy initiatives. Third, the management of research in PROs and the role played by TTOs in the evolution of contract-based research are discussed. Fourth, IPR is situated within the Spanish legal framework, along with PROs’ use of patenting to protect IPR resulting from in-house research. Fifth, PROs’ commercialisation, licensing and spin-off practices are examined as strategies to deal with IPR opportunities and barriers. Finally, some conclusions about present and future challenges are drawn, and some actions for increasing the organisational effectiveness of IPR management within PROs are noted.

### S&T in Spain: the policy context

Only in the early 1980s did the underdevelopment of the Spanish R&D system emerge as a critical policy issue. The Socialist Party (PSOE) designed a set of dramatic reforms affecting science and research organisations. First, the University Reform Act (LRU – *Ley de Reforma Universitaria*) of 1983 redefined the framework for the organisation and governance of higher education institutions (HEIs) and favoured the diffusion of a research culture by means of specific incentive mechanisms which have significantly contributed to expanded ISRs.<sup>4</sup>

The Science Law established the regulatory framework for Spanish PROs.<sup>5</sup> Together with the principles of Spanish S&T policy, based on competitive government funding, the law introduced a set of organisational reforms affecting PROs (Alonso *et al.*, 2001).

Since 1988, the implementation of S&T policy is mainly assured through the National R&D Plan, monitored by CICYT (Inter-ministerial Commission for S&T), on the basis of the national R&D programmes<sup>6</sup> and various ministry-based R&D programmes. While the national programmes correspond to the so-called strategic R&D, the latter aim at funding mission-oriented research or non-

targeted academic research.<sup>7</sup> Therefore, since the late 1980s, competitive public research funding has been directed towards “priority areas” and, fostering “free speculative research” (Sanz-Menéndez, 1995; Sanz-Menéndez and Muñoz, 1994).

Over the years, the effects of targeted public funding have been: *i*) an increased emphasis on research applications and the transfer of results; and *ii*) a strong awareness of IPR in PROs. This awareness is closely related to technology transfer and targeted research, since transfer implies co-ordination of R&D activities through contractual mechanisms and co-operation agreements between public and private organisations. Paradoxically, the national R&D programmes, throughout the period analysed, have been criticised for their academic bias (Sanz-Menéndez *et al.*, 1993). However, this bias may be the unintended outcome of weak institutional policy faced with increasing academic interests and lobbyist practices (Sanz-Menéndez, 1997).

Finally, the framing of the S&T problem, together with the rhetoric of S&T policy, led to an attempt to address simultaneously the country’s widely acknowledged endemic problems: *i*) significant scientific underdevelopment; and *ii*) a substantial technological gap.<sup>8</sup> Together with individual and organisational incentives to foster research within PROs, the promotion of ISRs has been based on a set of very simple principles. First, technology transfer and commercialisation of research was attached to specific units created within PROs that were also supported by public funds. Second, “research management capabilities” would evolve as research in PROs reached a threshold level.

#### **A public policy initiative: the creation of TTOs in PROs**

R&D management is not a simple task, and its complexity increases in organisations such as Universities and some PRCs, where R&D strategies are often shaped by the interests of individual researchers, and where a heterogeneous knowledge base, involving different S&T fields, coexists. R&D management becomes critical for the success or failure of PROs in a context of competitive public funding, targeted research and technology transfer and exploitation. It requires making and managing contractual relationships, seeking external funding opportunities, matching internal research capabilities and industry demands, as well as the necessary legal advice and the monitoring and control of IPR when both public and private actors are involved.

As a direct consequence of the S&T policies described above, public research laboratories and universities were confronted, at the end of the 1980s, with a new set of rules for their research activities, but they lacked in-house expertise and managerial capabilities to pursue the new S&T policy goals. With the exception of the National Research Centre (CSIC)<sup>9</sup> and a few universities such as the Polytechnic University of Catalonia (UPC), the management of ISRs involving contract research was mainly conducted by external entities, university-firm foundations (*Fundaciones Universidad-Empresa* – FUE), acting as intermediaries between university professors and business firms. Today, however, almost all Spanish HEIs and public research centres (PRCs) have a specialised in-house unit or TTO that manages relationships between the institution and economic actors. These units have recently expanded their activities from the early establishment of mechanisms to foster research and co-operation to strategic management of research activities, including IPR, and the support of university-based industries.

TTOs emerged under the first National R&D Plan (1988-91). The successful adoption of the new rules and the promotion of targeted research were strongly dependent on the development of an appropriate environment for industry and science co-operation. The links between PROs and business

firms required to achieve targeted research goals<sup>10</sup> led at the end of 1988, to the promotion of offices for the transfer of research results (OTRI) (CICYT, 1990; 1991).

The rationale for policy intervention was to “mobilise R&D potential from the business sector” and contribute to “the articulation of the science-technology-industry system”. ISRs were crucial to: *i*) ensure economic returns to research supported by public funds, based on the idea that technological progress occurs through co-operation between public institutions and business firms; and *ii*) encourage firms to apply research results of PROs.

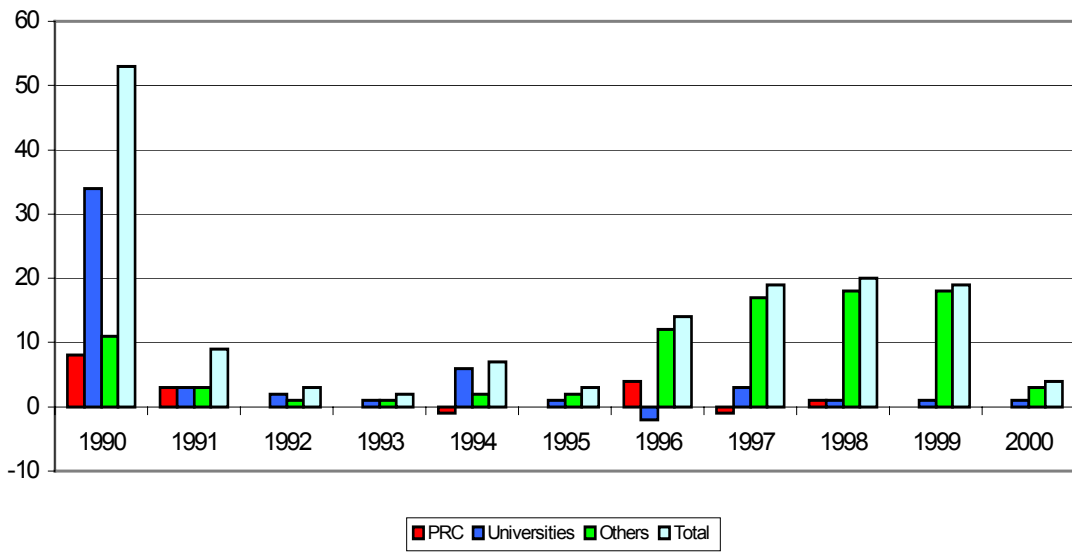
This rationale was translated into the creation of “interface units” to enhance and promote ISRs. Previous international experience, including the French ANVAR and the British Technology Group (BTG), and two Spanish in-house units (CSIC’s *Oficina de Valoración y Transferencia de Tecnología*, created in 1985; the *Centro de Transferencia de Tecnología* (CTT) of the Polytechnic University of Catalonia, created in 1987) served as organisational archetypes.<sup>11</sup> The functions to be developed by such units were, among others: *i*) the promotion of PROs’ research activities;<sup>12</sup> *ii*) the identification of transferable research results generated by research groups and their dissemination in the business environment; *iii*) the design of technology transfer mechanisms from PROs to business firms, including professional advice to help firms to adopt foreign leading-edge technologies; and *iv*) the provision of internal administrative and professional support to research groups for writing research contracts and managing research outcomes, including patenting and licensing agreements (CICYT, 1990).

This public policy initiative led to the allocation of a three-year grant to universities and PRCs to create these interface units or strengthen existing ones.<sup>13</sup> The total annual amount devoted to this was ESP 5.6 million for personnel and operating costs (about EUR 52 000 in 2002 prices). Ever since the first three-year programme, subsidies to TTOs have become institutionalised, although, on average, the need for public funds has decreased, as illustrated by the TTOs’ total expenditure budgets.<sup>14</sup> However, in the 1990s, government support to TTOs<sup>15</sup> was crucial to the development and survival of such units and to R&D management activities in PROs that lacked internal resources and capabilities. Moreover, average figures hide increasing heterogeneity within TTOs.<sup>16</sup>

The impact of government subsidies on the creation of TTOs in PROs has been unquestionable. Since the beginning of the programme, the number of TTOs has grown in universities, PRCs and new organisations such as private technological centres and industry associations. Before 1989, there were seven TTOs in PROs, five offices in universities (Ramon Lull, Barcelona, Navarra, Autónoma de Barcelona and Polytechnic University of Catalonia) and two in PRCs (CSIC and IRTA, the agricultural research centre). At the end of the First National R&D Plan (1988-1991), 32 of the 39 existing universities had a TTO unit. However, it took about eight years for these administrative units to be institutionalised in the Official Registry (Orden 02/16/1996, BOE 02/23/1996).

Figure 3 illustrates the growth of TTOs in the public research system. It reflects the year of creation/registration of the TTOs according to the nature of the home institution (university, public research centres and others, such as technological centres and industry associations). In 1994, all PRCs had their own TTO as did most public universities.

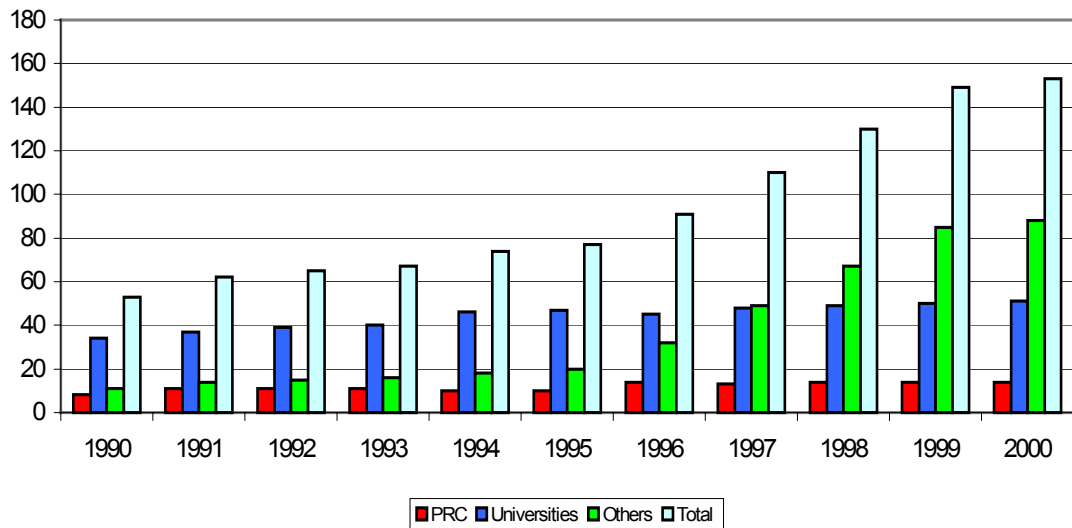
**Figure 3. TTOs by year of creation/registration and nature of institution**



Source: CICYT (1991-2002).

At present according to National Registry data, there are 164 TTOs. They are the interface units between business firms and PRCs and public and private universities and between these and a heterogeneous set of profit and non-profit organisations, namely FUE, science and technology parks and technological centres. In 2002, university TTOs represented 32% of the total units registered, PRCs 10% and TTOs at technological centres 43% (Figure 4).

**Figure 4. Evolution of the stock of TTOs by type of home institution, 1990-2000**



Source: CICYT (1991 to 2002).

In 1994, TTOs carried out their activities with very few experts; the average was two technicians and two administrative staff. Consequently, their activities mostly involved managing research in

PROs (two-thirds of their work load) (Fernández and Conesa, 1996). Although they have grown, Spanish TTOs still have an inward focus (SRI International, 2000).

The units are particularly active in the management of contracts under the EU R&D Framework Programme, competitive public funding and the search for external funding. Because PROs want external funding, TTOs have to engage in various forms of research management.

In spite of their common origin and the adoption of organisational archetypes, TTOs now differ according to the size and sources of their budgets, their activities and organisation.<sup>17</sup> For example, most university TTOs have become responsible for the management of European R&D Framework Programme research contracts, while only 50% manage competitive national research funding (Red OTRI Universidad, 2002).

Hence, Spanish TTOs have tried to create their own “identity” within their institutions.<sup>18</sup> Data for December 2001 (Red OTRI Universidad, 2002) indicates 435 employees (FTE) in 48 university TTOs, of which 195 technicians, 210 staff and support personnel and 30 grant holders. About a quarter of the TTOs had more than 20 employees. TTOs’ from universities, on average, have one technician for 165 university researchers, and each technician has about 85 research contracts a year and manages an average of EUR 2.5 million a year in research contracts.

The TTOs have gained external visibility over the last decade, but in many PROs, they still lack internal legitimacy. The research constituencies are reluctant to accept these units as legitimate actors in the S&T system. Therefore, their ability to influence the organisation of the knowledge structure has often been marginal, especially as others powers may dominate the university culture.

### **R&D management within PROs and the role of TTOs**

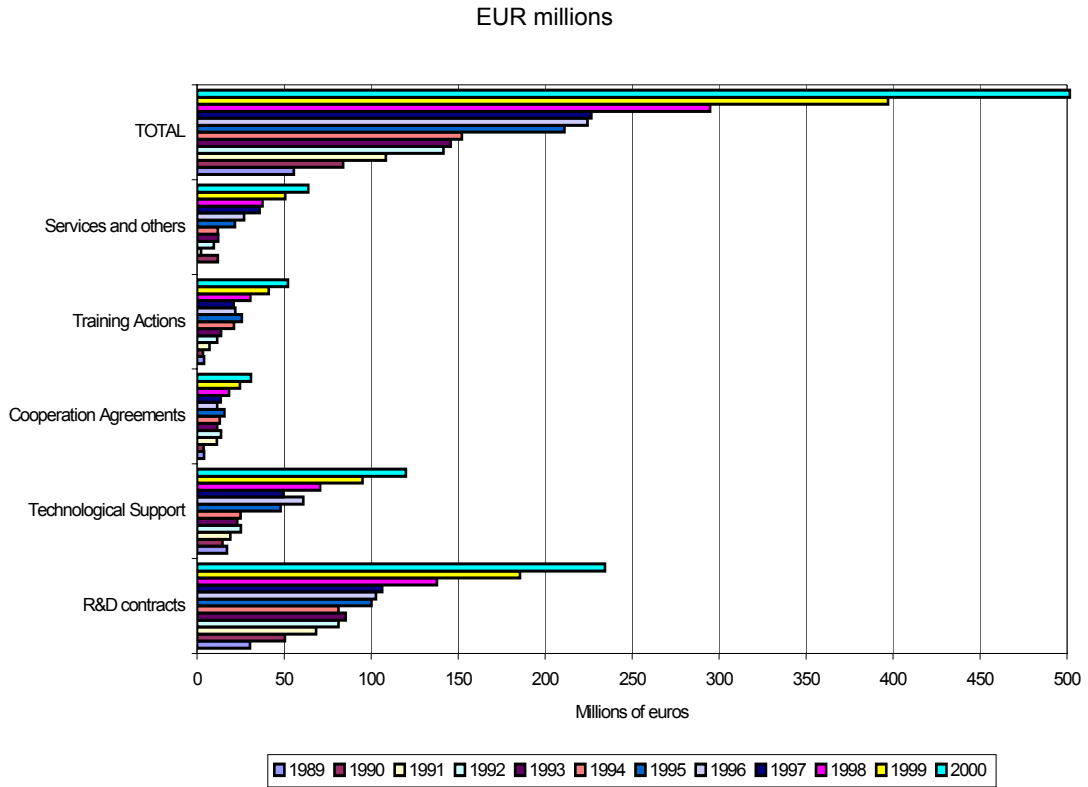
As noted above, external and competitive funding has been a key driver in the evolution of the Spanish public research system. Contract research increases with external sources of funding and is managed by the TTOs. In fact, about 60% of external research funding received by Spanish universities is contract research managed by TTOs. In 2000, contract-based activities of PROs represented more than EUR 500 million overall,<sup>19</sup> with about 70% for R&D or technological support contracts (Figure 5).

The rise in contract research also reflects the increase in the management efficiency of PROs and their TTOs, as the average amount of contract funding per TTO indicates. This figure has evolved from EUR 1.6 million in 1990 (EUR 2.4 million at 2000 prices) to EUR 3.3 million in 2000.

The development of contract-based research between business firms and universities has also been significant, as reported by the OTRI Network (*i.e.* university TTOs) and summarised in Figure 6. However, the distribution is uneven. For example, in 2001, CSIC, the biggest Spanish research institution, received EUR 35 million in R&D contracts with business firms, or about 25% of the institution’s total external funding.<sup>20</sup>

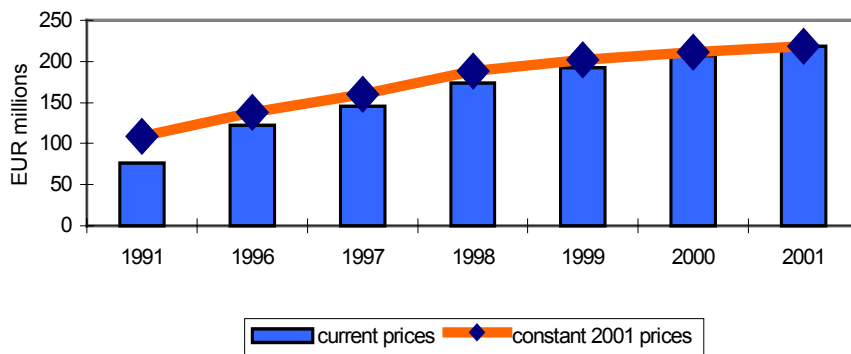


**Figure 5. Contract research funds managed by Spanish TTOs, 1990-2000**



Source: CICYT (1991-2002).

**Figure 6. R&D contracts managed by university TTOs**



Source: Red OTRI Universidades (2002).

More generally, about 25% of the TTOs received more than two-thirds of the total amount of contract research carried out by universities. The distribution is linearly correlated not with the size of the institutions but with the size and managerial efficiency of their TTOs. Contract-based research and external research funding are linked to the quality and culture of the university's research base and its managerial and administrative capabilities.

The spread of patenting, licensing and other mechanisms is the combined effect of contract-based research and the development of TTOs' dynamic managerial capabilities. This learning process is triggered by the rise in various types of ISRs, which involves acknowledging that IPR goes beyond traditional academic copyright to take account of business strategies and standard practices.

Thus, through their management of research contracts with both public and private actors, TTOs are crucial to the introduction and diffusion of a culture of IPR within PROs. This has been a process of learning by doing in which their IPR has become a very significant issue for business partners.<sup>21</sup> However, this learning is neither evenly distributed nor linear. On the one hand, the volume of contract-based research affects the dynamic capabilities of TTOs. On the other, the nature and characteristics of firms and their technological fields also affect TTOs' responses in terms of IPR management.

### The legal context and research management<sup>22</sup>

Although there have been significant developments in Spain's legal environment for IPR since the late 1980s, patent regulations have been relatively stable. Some elements of the legal context for IPR that affect research in PROs include: *i*) the new Patent Law of 1986; *ii*) the adaptation and adoption of new regulations imposed by the European Patent Office (EPO) which the Spanish Patent Office joined in 1986 as associate member and since 1989 as full member; *iii*) new regulations concerning semiconductors (1988) and software protection (1991); *iv*) the TRIPS Agreement (1994); *v*) the EU directives on biotechnological research; and *vi*) the commercialisation (1998) and protection of plant varieties (2000).

The basic regulatory framework for PRO patents is the Patent Law (1986). Articles 15-20 assign ownership to the employer (universities and PRCs) but grant the inventor the right to "fair compensation". Hence, PROs and HEIs have a significant degree of freedom in terms of managing IPR between the institution and its faculty members or between the former and its business counterpart if the invention is the result of contract research funded by the firm. In other words, IPR is subject to bilateral contractual mechanisms and shaped by the bargaining power of each participant.

**Table 1. IPR management of research outputs: an overall view**

Source of funding	IPR rights			Role of TTO in IPR management
	Economic rents	Residual control /ownership	Transfer decision	
Public R&D funding	Sharing by PRO and researchers	PRO (but if decision not to file, then researchers)	PRO	Yes
Public R&D funding in the context of joint collaborative projects	Sharing by PRO (researchers) and firm regulated by previous agreement	Firm	Firm	Bilateral contract provisions if applicable
Private research funding (contract R&D)	Joint sharing optional	Joint sharing optional but usually firm	Usually firm	Bilateral contract provisions

Source: Authors, based on the contribution to EC (2002b) by Martinez et Armesto.

Table 1 shows the basic characteristics of IPR management for research outputs of Spanish PROs. The information is organised according to the basic elements of IPR: *i*) the rights granted to the patent holder and the legal assignment of those rights to either individual or institutional actors; and

ii) the main source of the funding of the research. Ownership of the IPR for research outputs of PROs varies, depending on the source of R&D funding and bilateral agreements between the parties involved: individual researchers and PROs; or individual researchers, PROs and business firms. Ownership of patentable research supported by either “institutional funding” or “public R&D project funding” is granted to PROs, which is then the patent assignee. For “public S&T competitive funding” and for joint research projects, the usual case is “joint ownership” and is normally subject to negotiation by project participants; IPR protection is managed according to the provisions of the research contract.

The remainder of this section explains how the IPR process is managed in PROs, where decisions on IPR protection are made through “internal procedures”. Usually, individual researchers inform PROs about results that might be successfully exploited commercially. TTOs must analyse and advise, within a period of three months, under which legal forms the results might be protected. If the evaluation is positive,<sup>23</sup> the patent documents are drafted by TTO experts together with the inventors; advice from external experts is requested only in specific cases. The first filings normally follow procedures for patent rights granted in Spain.<sup>24</sup> The patent applications are normally extended under licence agreements and the licensee, who chooses the relevant countries, supports both examination and maintenance fees. However, IPR protection, extension and litigation involving Spanish PROs are subject to some restrictions. First, universities are exempted from paying fees for patent applications fees and utility models at national level, while other PROs cover the full cost. Second, international extension costs are usually not covered by PROs’ regular budgets. Third, for joint inventions (PRO/business) patent rights and IPR management are commonly allocated to the company.

The sharing of profits (fair compensation) is standard practice. In universities, shares are distributed according to the statutory regulations of each university. The participation of inventors (including students) in benefits derived from commercial exploitation of research results is also based on each university’s statutory regulations (and varies between a half and a third). In PRCs, profits are shared equally among the institution, inventors and the Board, which distributes its third according to variable criteria (RD 55/2002, 18 January). In both universities and PRCs, in cases of joint ownership, these provisions also apply.

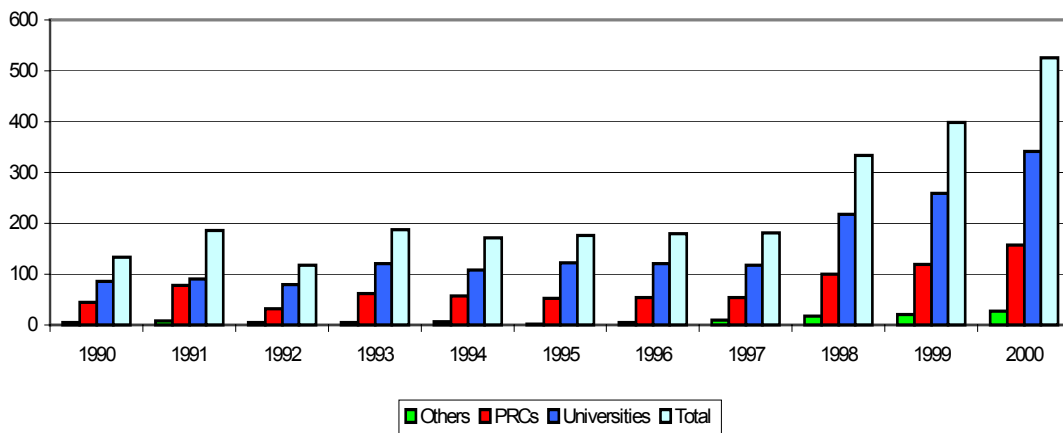
The licensing of PRO patents is managed through bilateral agreements between the institution and the licensee, except in the case of joint ownership where it is subject to previous contractual agreements. The common practice for joint inventions (PROs/business) resulting from contract research or a publicly funded joint research project is to allocate the patent rights and IPR management to the company.

## **The management of IPR in PROs**

### ***From research to patents***

The long-term evolution of IPR in PROs is reflected in the number of patents filed by their TTOs, and the trend is similar to that for research funding. However, IPR protection, measured by the total number of patents filed, has also increased as universities have become aware of its importance for research.<sup>25</sup> University-based patents represent more than two-thirds of the total number of patents filed by PROs (Figure 7). The new IPR management practices have emerged owing to the exemption of fees for universities filing national patents, the work of their TTOs and the learning and adoption of practices and values aimed at protecting and commercialising research outputs.

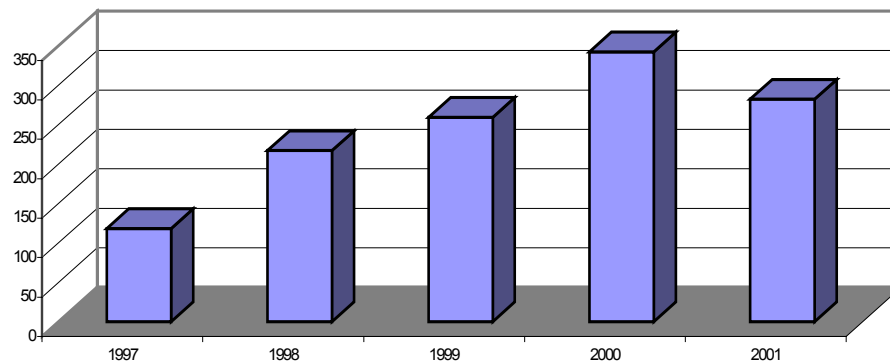
**Figure 7. Total number of patents filed by PROs**



Source: CICYT (1991-2002).

PROs, and especially universities, generally protect IPR at national level;<sup>26</sup> about 20% of patent applications are filed directly at international level, mostly via the EPO or the Patent Convention Treaty (PCT). Moreover, PRCs (*i.e.* CSIC) patent at international level more than universities. In 2000, CSIC filed 96 patent applications in Spain with extension to other countries in 2001 and had 528 patents, of which 367 registered in other countries. In contrast, TTOs in Spanish universities (Red OTRI Universidades, 2002) reported a total of 224 new applications for 2001, 40 of them extended internationally (Figure 8). In terms of the stock of university patents at the end of 2000, only 110 out of 1 045 were international.

**Figure 8. Total patents filed by university TTOs**



Source: Red OTRI Universidad (2002).

Differences between CSIC and universities in the evolution of patent applications and the relative strength of CSIC in technology transfer and IPR management are directly related to CSIC's earlier development of its TTO.

**Table 2. Distribution of the stock of patents technological classes and type of PROs, 1978-97**

Percentages

		1978-97		1978-87	1988-97
		Universities	PRCs	All PROs	
I	Electrical engineering	9.7	6.6	5.1	9.6
	1 Electrical machinery and apparatus, electrical energy	3.0	1.0	0.3	2.8
	2 Audio-visual technology	0.7	1.0	1.1	0.8
	3 Telecommunications	1.5	1.4	0.5	2.0
	4 Information technology	2.2	2.1	2.2	2.2
	5 Semiconductors	2.2	1.0	1.1	1.8
II	Instruments	28.6	12.7	12.7	23.3
	6 Optics	3.2	0.9	0.8	2.5
	7 Analysis, measurement, control technology	19.4	9.2	8.9	16.2
	8 Medical technology	5.2	0.5	1.1	3.3
	9 Nuclear engineering	0.7	2.1	1.9	1.3
III	Chemistry, pharmaceuticals	38.1	53.9	58.2	40.7
	10 Organic fine chemistry	13.2	28.1	38.5	11.8
	11 Macromolecular chemistry, polymers	2.2	3.7	5.4	1.7
	12 Pharmaceuticals, cosmetics	3.5	0.9	0.5	2.8
	13 Biotechnology	12.7	8.7	5.7	13.2
	14 Agriculture, food chemistry	2.0	6.5	3.2	5.5
	15 Chemical and petrol industry, basic materials chemistry	4.5	6.1	4.9	5.8
IV	Process engineering, special equipment	19.4	23.9	22.9	21.5
	16 Chemical engineering	3.5	4.7	4.3	4.1
	17 Surface technology, coating	2.7	1.7	1.6	2.5
	18 Materials, metallurgy	5.7	9.8	11.1	6.3
	19 Materials processing, textiles, paper	1.0	4.2	3.5	2.5
	20 Handling, printing	0.7	0.0	0.0	0.5
	21 Agricultural and food processing, machinery and apparatus	2.7	2.1	1.9	2.6
	22 Environmental technology	3.0	1.4	0.5	3.0
V	Mechanical engineering, machinery	4.2	2.8	1.1	4.8
	23 Machine tools	0.5	0.2	0.0	0.5
	24 Engines, pumps, turbines	0.2	0.2	0.0	0.3
	25 Thermal processes and apparatus	0.2	0.9	0.8	0.5
	26 Mechanical elements	0.2	0.0	0.0	0.2
	27 Transport	1.7	0.2	0.3	1.2
	28 Space technology, weapons	0.0	0.0	0.0	0.0
	29 Consumer goods and equipment	0.2	0.5	0.0	0.7
	30 Civil engineering, building, mining	1.0	0.9	0.0	1.5

Source: Authors, based on a sample of 975 patents in the OEPM, with first application by a university or PRC, using OST-FhG-ISI conversion table from IPC.

At universities, the distribution of IPR is very skewed; as for contract-based research, a few universities make most of the patent applications. Hence, 20% of public HEIs hold 80% of the stock of patents granted to Spanish universities. Again, IPR management in Spanish PROs follows an evolving but not linear trajectory from research management to contract research and IPR management. This

non-linearity is associated with both learning and the diffusion of best practices among research management communities, mainly TTOs.

This situation has to be analysed in the context of the scientific specialisation of Spanish PROs. Patterns of patent specialisation are quite different for universities and for PRCs. These differences are evident in a sample of 975 patent applications by PROs. Table 2 summarises these results, pointing out the technological competencies of Spanish PROs according to the fields in which they held patents.

The patents' applications filed by PRCs is dominated by chemical technologies owing to CSIC's strong research potential in organic and inorganic chemistry and its multiple applications in emerging areas. In contrast, applications filed by universities clusters around control and measurement technologies. Nevertheless, there is an increasing trend in PROs to patent research outputs in leading S&T areas such as biotechnology and related fields as shown by a comparison of patents filed from 1978 to 1987 and from 1986 to 1997.

It is worth emphasising that differences in the protection of research outputs by the means of available IPR instruments cannot be fully understood outside of the institutional and S&T policy framework in which research and technology management has evolved. Moreover, since technology transfer was institutionalised in PROs' TTOs, their functions and concerns have evolved from basic research management support to more complex activities ranging from publicly funded research projects to the management of contractual agreements with business actors and direct involvement in IPR management. In fact, through their TTOs, PROs are becoming active in the management of IPR by exploring the entrepreneurial possibilities of their research base.

### ***Licensing, commercialisation and direct exploitation of IPR by PROs***

In contrast with patent applications, PROs rarely commercialise their research output through licensing agreements. In 1994, the 56 licences managed by TTOs generated a revenue of ESP 30 million (approximately EUR 170 000) (Fernández and Conesa, 1996); six years later, university TTOs reported 114 technology licences under exploitation (stock) and EUR 1.2 million in revenue. In 2001, there were four new licences with net income of EUR 400 000.

As for patents, CSIC is the most active and prominent actor in the management of IPR through licensing agreements. In 2000, 74 of its national patents and more that 200 of its non-Spanish patents were licensed, with total revenue of over EUR 2 million, exclusively generated, however, by a very small number of the patents. For example, only two patents held by CSIC, one for sequencing technologies, exploited by a subsidiary of Pharmacia, and one on petroleum, exploited by a multinational, account for 30% of the royalty income. The same is true for universities; two patents, one for diabetes control and one for dietary supplements, generate most royalties at the University of Barcelona.

Factors inhibiting the use of licensing are: *i)* the small number of research patents with economic value on the global technological market; *ii)* the lack of leading-edge and innovative SMEs; and *iii)* the barriers to be overcome to be able to license out or, alternatively, to exploit their own research base. The insider view of such barriers is not only the lack of financial resources to engage in international licensing agreements but also economic and managerial inefficiencies for pursuing such licensing agreements, taking into account the limited number of patents that might be of commercial interest worldwide. PROs cannot support these activities in the absence of economies of scale. To avoid inefficiencies, they have sometimes been forced to sell the patent to a third party as a way to minimise the transaction costs associated with licensing. Another route, not yet used, is to delegate of

the exploitation of IPR from the Spanish patent holder to a third party, such as British Technology Group (BTG).

Owing to such barriers to the commercialisation of research through licensing, PROs and their TTOs have taken an active role in the promotion of research-based firms, often but not necessarily at university science parks. However, research-based firms have been a second-best alternative to a market for PRO research results. Moreover, public S&T policies at regional level are crucial for encouraging the creation of research-based firms. Regional governments provide subsidies and soft loans to innovators (academic research groups) as well as entrepreneurial advice for setting up market-oriented activities. Regional agencies such as CIDEM in Catalonia and SPRI in the Basque country have been especially successful. CIDEM gives direct subsidies to research groups (up to EUR 100 000), monitors the financial needs of the new research-based firm and aids in the search for venture capital. CDTI, the central government agency for industrial technology development, also has a programme called NEOTEC. However, the long-term success of these policy measures is limited by a narrow product range and the low potential for product diversification.

The adoption of alternative strategies to cope with licensing barriers is more difficult for PRCs than for universities. Universities enjoy greater managerial and financial autonomy, which allows them to participate in venture capital projects. Table 3 shows recent trends in the direct commercial exploitation of IPR by Spanish universities.

**Table 3. TTOs and university research-based firms**

	Stock of firms created to December 2000	Firms created in 2001
Total firms created	99	77
Of which spin-offs and start ups	15	36

Source: Red OTRI Universidades (2002).

In the field of IPR management and commercial exploitation of their knowledge base, universities have recently followed three different strategies. First, they have created joint research-based firms.<sup>27</sup> Second, they have used their own risk capital to support and participate in research-based firms. The pioneering initiative of the University of Santiago de Compostela (Galicia) illustrates this point. Its capital risk fund, UNIRISCO, promoted and controlled by the university and with capital of EUR 5 million, provides financial aid to 20 start-ups. Third, in PRCs with higher administrative barriers,<sup>28</sup> researchers may develop new research-based firms directly<sup>29</sup> and obtain a licensing agreement from their home institution. This alternative has been successfully adopted by the National Centre for Biotechnology-CSIC, where Bionostra commercialises genetics-based diagnostic tools that apply to a wide set of crops and genetically modified organisms (GMOs).

Universities' current activities to promote research-based firms are illustrated by the fact that by 2001, 20 had established programmes dealing with spin-offs, and four reported an active role in promoting venture and risk capital initiatives, such as the entrepreneurship programme IDEA from the Polytechnic University of Valencia or the risk capital fund, UNIRISCO at the University of Santiago de Compostela. As pointed out above, public universities have been involved in the development of science and technology parks over the past decade, and they play a leading role in at least 20. Science parks and research-based firms are often complementary, and many universities have developed related services, such as the innovation centre Las Cúpulas, University of Barcelona, or UNINOVA, the incubator for spin-offs created by the University of Santiago de Compostela.

The learning process and development of dynamic capabilities in the field of technology transfer described in this chapter have accelerated in the last five years. However, differences among TTOs are

increasingly relevant, as they are likely to increase as the focus shifts from IPR management through patents to strategic IPR management via licensing and commercial exploitation. Licensing activities and the creation of new research-based firms have emerged in the early 2000s. The strategic management of IPR for PROs requires more than a good legal environment and researcher incentives, it also requires strong and dynamic managerial capabilities in their TTOs. However, as the most recent experience shows, it is a long way from the development of organisational and managerial capabilities to the creation of the alternative resources and instruments needed to exploit, either through licences or directly, the output of research activities.

## **Conclusion**

It is argued here that IPR management, and knowledge management, in Spanish PROs is an outcome of S&T policy efforts of the late 1980s and early 1990s. These policy initiatives planted a seed that, in some PROs, has grown into organisational structures for technology transfer and IPR management. The trajectory of these units shows how they have enlarged their field of action from administrative tasks to technology transfer, to the promotion of ISRs and to IPR management. They have been crucial actors in the creation and consolidation in their home institutions of a research culture including technology transfer and IPR protection. Knowledge management capabilities and competencies have evolved, in many TTOs, from simple contract research activities to more complex functions linked to protection, commercialisation and exploitation of IPR.

First comes the culture of “protection”, which is similar to the culture of “publication of research results in papers”, and later the idea of commercialisation and strategic use of the PRO’s stock of knowledge. Advances in the functions of TTOs range from managing contract research to being involved in IPR-based spin-offs. Fewer than a dozen PROs, however, have fully developed their competencies in the area of strategic use of IPR. They play a very active role in protecting (and extending to other countries) the knowledge produced in-house and have started to license IPR to firms or to develop companies that exploit the stock of knowledge in the PROs.

The research management capabilities of PROs are increasingly heterogeneous in terms of protection of research through IPR. Some already organise their resources in terms of: *i)* the management of research in the area of public competitive funding area; and *ii)* business contract research. Additionally, they strongly encourage the provision of specialised services for patenting and protecting IPR. TTOs have generally found strong complementarities between contract research management and IPR management. However, they suffer from their small size in relation to their real needs for knowledge management and, therefore, from the lack of economies of scale in the pursuit of their goals.

PROs have unexploited technological capabilities but severe constraints on the licensing out of their patents. More efficient commercialisation of their IPR would require a concentration of resources and administrative capabilities in a collective organisation, or a network of organisations, acting as pool of resources and providing commercialisation services for the PROs.

Spanish PROs are more actively involved in spin-offs and start-ups than in commercialising IPR themselves. Public policy intervention in the form of subsidies to and accompaniment of new technology-based firms is helping to transform researchers into entrepreneurs, thereby dealing with the problems of exploiting IPR through the creation of a company.

The strategic management of IPR is not the simple result of the right incentives and legal framework, it requires organisational capabilities and the administrative competencies to protect and



exploit the research results. The study of the strategic use of IPR by PROs has drawn attention to the crucial role of organisational capability, usually in TTOs, to deal with contract research, technology transfer and the protection and commercialisation of knowledge outcomes obtained from publicly funded research. A conclusion is that IPR management in PROs has to be integrated with appropriate R&D and knowledge management.

The Spanish case study shows that there is room for government intervention aimed at addressing PROs' needs for commercialisation of R&D outcomes. Government intervention must solve the "collective action problem" by providing the basis for the creation of collective infrastructure: A single and centralised unit coordinating and assessing PROs and their TTOs for IPRs management.

## NOTES

1. Thanks to Pim den Hertog and Thomas Gering for their comments and suggestions on an early draft and to Rogelio Conde-Pumpido and Xavier Testar for their insights. The usual disclaimers apply.
2. PROs include universities, public research centres (PRCs) owned by government and non-profit institutions strongly dependent on public funding sources. This chapter focuses on the management of IPR within Spanish universities and PRCs.
3. These trends are the significant increase of R&D financed by industry and conducted by PRCs and universities; the movement towards the use of all forms of IPR; and the trend to license and commercialise the knowledge pool accumulated in PROs.
4. LRU (art. 11) granted university professors, all with civil servant status, the opportunity to conduct research together with the business sector on a contract basis. This translated into a direct economic incentive through a significant increase in personal income. The further application of this disposition allowed university researchers to increase their regular wage base by 350%. This provision of the law has been used effectively by engineering departments in polytechnic universities owing to the applied nature of their research activities and technological development consultancy work.
5. The Law for Promotion and General Co-ordination of Scientific and Technical Research (*Ley de Promoción y Coordinación General de la Investigación Científica y Técnica*) was passed in 1986 (*Ley 13/86*).
6. The national R&D programmes define some of Spain's research priorities, e.g. biotechnology, information and communication technologies, new materials, etc.
7. Some examples are "general promotion of knowledge (PGC)", aimed at funding academic non-targeted research and the "Health Research Fund" (FIS), exclusively focused on funding health and biomedical research based on health priorities.
8. Traditional indicators used to define Spanish S&T were the low level of resources – expenditures as percentage of national GDP – allocated to R&D and the deficit in the technological balance of payments.
9. The TTO of the National Research Centre (CSIC) was created in 1985.
10. Some policy initiatives promoting the relationship between PROs and business firms were already in place, including the so-called concerted projects (*Proyectos Concertados*) funded by CICYT, and technological development projects (*Proyectos de Desarrollo Tecnológico*) under the auspices of CDTI, the Spanish Agency for Industrial and Technology Development.
11. In addition, a central co-ordinating office (*Oficina de Transferencia de Tecnología*) was established within CICYT to provide support and co-ordinate the actions of individual interface units.
12. Promotion was strongly associated with the building of knowledge databases and research infrastructures available in the public research system, i.e. technological offer or R&D supply inventory.

13. These actions were complemented by other new policy instruments such as the Programme for Technology Transfer (PETRI) sponsored by the CICYT in which the public funding of technology and research projects is linked both to business funding and private-public partnerships.
14. Conesa (1997) reports that the average budget of a TTO in 1991 was ESP 22 million a year, which suggests that direct government subsidies represented about 25% of the total.
15. Government support in shaping technology transfer and ISRs in Spain continues with the implementation of a specific funding instrument, the Programme for Basic Action (PAB), devoted to the creation and consolidation of the new interface units. PAB supports personnel costs, current expenditures and IT infrastructure associated with the main functions of the TTOs. Public funding is granted for at least a three-year period, and in practice it is still the main source of funding for a large number of small interface units located in young universities (CICYT, 2002).
16. In 1994, with an average budget of ESP 27 million (approximately EUR 170 000), 30% of the operating TTOs were dependent on direct government subsidies.
17. Despite the diversity of PROs' IPR management services (in-house administrative unit *versus* a more "autonomous unit", possibly with independent legal status), one of the main tasks of most TTOs is to manage patent applications. There are exceptions; for example, one of the biggest research universities, the University of Barcelona, has an independent non-profit foundation (*Fundación Bosch i Gimpera*) as its TTO and the Patent Centre is an in-house unit.
18. A clear attempt in this direction was the creation, in 1997, of the network of university TTOs under the Conference of the Spanish Rectors (CRUE) which today includes the 54 HEI TTOs.
19. In 2000, the Ministry of Science and Technology provided slightly less than EUR 200 million of funding for competitive research projects (Sanz-Menéndez *et al.*, 2002).
20. The overall R&D expenditure budget of CSIC was over EUR 400 million, of which almost EUR 150 million was "external funding" obtained as competitive research grants or contract research.
21. According to data from 2000, R&D contracts between universities and firms usually allocate ownership to firms. Martín and Bravo (1999) report that 11.2% of the research contracts of the last 20 years have led to patents, in contrast with 6.6% between 1978 and 1989, and that 18% of research contracts were the source of new patent applications in the period 1990-97.
22. Thanks to Domingo Repra and Juan Martinez of CSIC's TTO for their valuable comments.
23. In case of a "negative evaluation", the PRO decides not to protect the output of research activities, and inventors can apply for a patent under present legal conditions (but the PRO will hold the right to a non-exclusive licence to use the invention and even 10% the benefits of exploitation).
24. The administrative procedures of the Spanish Patent Office (OEPM) are crucial for determining IPR strategies. In spite of the use of a simple set of rules based on "priority rights", there are significant delays as the OEPM's search report for the test of novelty takes on average 15-18 months after processing the application. This length of time is crucial in a context of rapid technological change and affects the appropriation of the economic rent by the patent holder.
25. Copyright for computer programmes and software is also important, with eight applications by Spanish universities in 2001 and a stock of 42 in December 2000. Universities also manage and apply for IPR for plant varieties, for which they have a stock of 12 and two new ones in 2001.

26. The request for protection usually starts with filing for a national patent, and only when there is clearly either a significant potential for exploitation or a world market do PROs start the process of IPR protection with a European, US or PCT (Patent Convention Treaty) application.
27. The implementation of this strategy is subject to strict controls and legal limitations that prevent universities from engaging in business activities. Often, the rigidities are overcome through the transfer (donation) of a symbolic share in new research-based firms from the research group to the institution signing the licensing agreement.
28. This is the case of PRCs that must have the permission of the Ministry of Public Finance for such entrepreneurial activities.
29. Up to 10% of the social capital of the new firm according to regulations for civil servants. Mobility from PRCs to research-based firm is fostered by the possibility of a four-year leave without resigning one's research position in the home institution.

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