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Innovation policy and the concept of National System of Innovation in the Spanish context:

Are they ghost images or real entities?

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1. Introduction

Science and technology policy-making and the study of its effects on innovation are requiring a "more sophisticated understanding of the ways on which science and technology interact" (to quote, as an example, N. Rosenberg, *Science and Public Policy*, vol. 18, number 6, pages 335-346, 1991).

The exploration of these relations has been and continues to be at the core of the models that, along the period initiated after the Second World War, have been used to promote and analyse the science and technology activities and their outcomes. The "science model" left pace to the "science push-market pull – R&D model", inspired on linearity, a model that represented the technological change leading to innovation as closely dependent and based essentially on scientific results. More recently, after acknowledgement of the insufficiencies of the linear model, models have evolved considering that science and technology and innovation are part of a system, a "social" system, whose essential activity is learning and which is also "dynamic".

This orientation has corresponded with the idea that biology, and not physics, ought to inspire the economics of technology and innovation (application of the theory of Darwinian evolution, see for a review, J. Mokyr, *Bulletin of Economic Research,* vol. 43, number 2, pages 127-149, 1991). The microeconomics view has been at the onset of recognising the limitations of the dominant neoliberal theory based on the concept of a stable and unique equilibrium. An important lesson that has been learned from the use of evolutionary, biology based, models is that history – and culture – matters. As Mokyr has stated (see reference cited above) "... It is simply impossible to understand long-term economic growth without some kind of Schumpeterian theory of technological creativity and innovation. The neoclassical equilibrium paradigm seems singularly unsuited to that task".

1.1 National Systems of Innovation (NSI)

The concept of National Systems of Innovation has been gaining support as an explanatory variable of the size, role, and performance of innovation within the economy of each country or region. This concept counts on the interplay between a series of actors whose actions and interactions are influenced by a set of factors: the financial system, firms management, the legal frame, the regulations, the skills of human resources, their mobility, the social relations and the negotiations practices.

The idea of National Systems of Innovation relies in a view based on the complexity of

the socio-economic activities. Several schemes have been depicted to give an image of the concept. Fig.1 provides an example of the complexity of the elements that integrate the National Systems of Innovation and of their interactions. In spite of the comprehensive character of this scheme, there may be still some drawbacks in it. In any case, it serves to give ground to the idea that the National Systems of Innovation should present important differences depending on critical factors such as the organisation of the university research system, the characteristics of the public research centres and the nature and type of firms existing in each economic sector. I would like to stress the idea of divergence between NSI as more plausible than that of convergence.

1.2 Regional Systems of Innovation

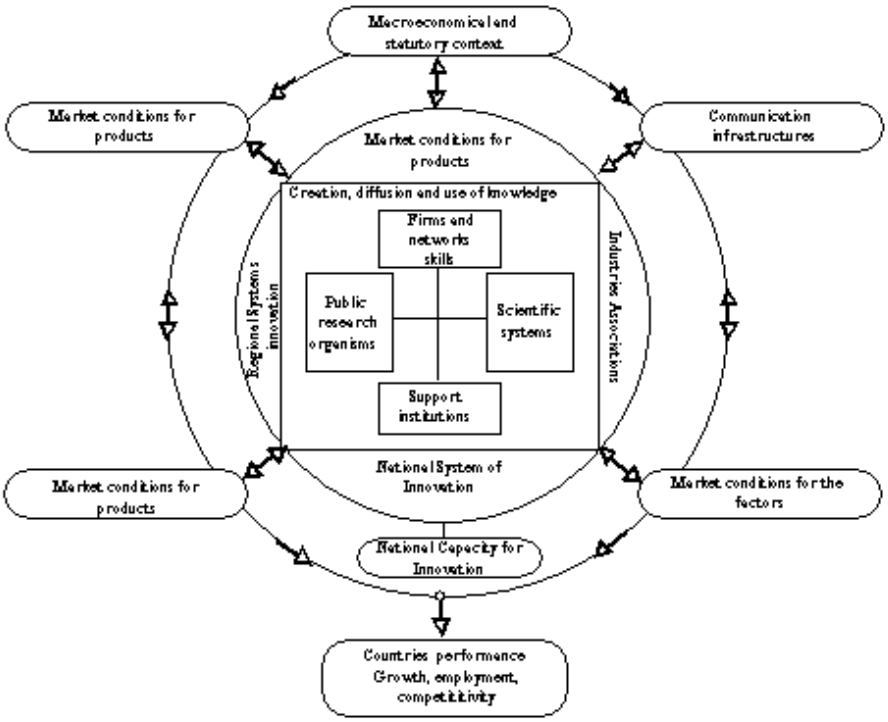
The scheme of fig. 1 introduces the concept of Regional Systems of Innovation placed at a similar level that of the National System of Innovation. The current literature (Cooke, 1998) considers this concept as new, although related concepts such as "regional innovation policies" "regional innovation potential", "innovation networks", together with "technopoles" and "high technology complexes" have been present since the early eighties and have been treated and developed along the last two decades (Cooke, 1998).

The outstanding elements that led to the building of the RIS concept are the changes in behaviour of the firms driven by the close link between competitiveness and innovativeness and the consequent rewamping of technology policies by the governments of Western countries.

Firms have reacted to this new situation by moving from the competition front to one where there is search for the optimal mix between competition and collaboration. Instrumental to this approach are the notions of "cluster" (Porter, 1990) and the recognition of the importance of culture to economic activity, coordination and development (Cooke 1998, Muñoz et al., 1996).

Among the main streams of economic theory, the neoclassical economics failed to explain innovation and technological change, while the evolutionary theory of economics allowed for rectification of the failure of the neoclassicals in relation to innovation studies. This theory has found a growing number of supporters and was compatible with systems approaches and allowed the analytical inclusion of previously heretical notions as "economy culture" and "economies of association", to quote Cooke (1998), a further step "was to integrate evolutionary economics and regional development theory in respect of innovation . Finally, regional innovation systems had been conceptualised in terms of a collective order based on microconstitutional regulation conditioned by trust, reliability, exchange and cooperative interaction" (Cooke, 1998).

Figure 1. ***Diagrammatic representation of the National System of Innovation and its relationships with different environments and factors.***



Source: OECI. Taken from 'La competitivité de l'industrie européenne, 1998

1.3 Indicators involved in the identification and characterisation of the National System of Innovation

According to the diagramm of Fig. 1 it is reasonable to sustain that the main outcome of the National System of Innovation is to create a National Capacity for Innovation which is able to influence the performance of the countries in terms of growth, employment and competitivity. Since the leading force for attaining competitivity is the market, there will be continuous influences on the national capacity of innovation from the market conditions for factors and products as well as from the global macroeconomic context.

This outcome must be reached through the outputs of the basic elements or actors that build up the National System of Innovation. These basic elements -public research organisms, scientific systems, firms and support institutions correspond to the classical elements of the R&D systems whose inputs and outputs have been and are being analysed through the conventional OECD indicators to which new indicators aimed to measure innovation performance have been recently added.

It is worth noting that the diagrammatic scheme of Fig. 1 places at the same (hierarchical) level two other institutional elements -the Regional Systems of Innovation and the Industries Associations- as well as internal market factors. This position suggests that these intermediate institutional and organisational factors play a crucial role in the shaping of a National System of Innovation or even according to a more daring proposition they may substitute for it.

The objective of the present paper is to analyse and assess the influence of the innovation process and its relationships with political initiatives in the economic development of Spain (growth, competitivity) through exploring the characteristics and indicators that shape the National Systems of Innovation [1]. Along this exercise, the existence or not of a Spanish Systems of Innovation should be lighted as well as the relevance of the regionalisation and internationalisation processes in the

development of national innovation capacities. This analysis is held in relation with the position of Spain with respect to Europe.

Summing-up, the present work has attempted to answer the following questions:

- **Have there been any explicit innovation policies in Spain?**
- **Did these policies contribute to the building of a National Innovation Capacity through the concept of Systems of Innovation?**
- **Are any relationships and links between the political actions and concepts related to innovation with the economic growth, productivity and competitivity of Spain and her regions?**

2. Innovation policy in Spain

The analysis of the innovation policy of Spain has to be placed into a complex context. On one side, the absence of a culture of innovation that has been influencing the development of business and firms and the subsequent back of explicit, well targeted innovation policies. On the other, the economic growth of Spain has been experiencing a positive trend along the second half of the twentieth century with two main peaks: one at the end of the fifties and beginning of the sixties under the impulse of the so-called "technocrats" who pursued the overcoming of the economic crisis that suffered Spain due to the autocratic policy of Franco's regime; the second followed the accession of the country to the European Community in 1985-1986. These periods of expansive economy coincided with efforts to propose and develop research and technology policies that were inspired by the science and technology agendas of the international organisations like UNESCO, OCDE or the European Commission. Those attempts to design and promote science and technology policies in Spain were inspired on models based on linearity and led to problems for attaining the goal of building a system of innovation.

As a matter of fact it has been repeatedly stated that the economic take off of Spain during the autarchy was apparently independent of the country efforts in R&D and innovation. However, different efforts were made later on to modernise Spain by incorporating in that process political segments of influence in relation with science and technology policies (Sanz-Menéndez, 1997, Muñoz, 1999, 2000, Muñoz et al. 1998, 1999).

While the centrist party UCD (Unión de Centro Democrático) was at governance, the most relevant events both around 1978, were the creation of the Ministry for Research and Universities and the establishment of the CDTI (Centro para el Desarrollo Tecnológico Industrial) supported by the World Bank and ascribed to the Ministry of Industry and Energy as an agency to foster technological development and innovation. These decisions gave support to the argument that the development of science and technology in Spain were still seen as separate entities and based on the linear model concept where the agencies to promote science base and innovation might act independently and be managed from different institutional arrangements.

The political agenda of the Spanish Socialist Party (PSOE) placed science and technology as one of the main issues at stake before the elections of 1979 and 1982. Its programmes included specific actions to drive the modernisation of the country with high priority give to education, research and technological development.

After winning the elections of October 1982, the efforts to develop an R&D system and

the will to link it with the industry remained as high priorities. Under the great political goal of improving the coordination between resources and political actors, the specific aims were the following:

- **To increase the public resources devoted to R&D activities, with the hope to drive also an increase in the research and innovation efforts of the private sector.**
- **To promote the competitiveness of the scientific community in the world context.**
- **To introduce the culture of research and innovation into the businesses and their managers.**
- **To foster the links between the science realm and the industries, in order to allow for a better use of the knowledge produced by universities and public research organisms.**
- **To favour dialogue and collaboration between the political actors of the State and the Regions. The Law for Scientific and Technological Development, known popularly as the "Law for Science", enacted in 1986 was the main political instrument for those goals that were implemented by the *National Plan for Research and Development* which was designed as the functional and operative instrument of the Law. Its first edition was launched in 1988 and lasted until 1991. Two other editions, corresponding to the 1992-1995 and 1996-1999 periods, have followed and ended allowing to assess their influence on the different elements that constitute a National System of Innovation.**

On the other hand, after the general elections of 1996, the conservative Partido Popular took the lead. The new government introduced some changes in the organisation of the science and technology management system. While keeping the spirit of the "Law for Science" and attempting to correct for one of the main limitations at institutional lever of the system such as it is the lack of coordination between the institutions responsible for the programmes, the science and technology political agenda was placed under the direct responsability of the Prime Minister. An Office for Science and Technology (OCYT from its name in Spanish, *Oficina de Ciencia y Tecnología*) was established and set under the authority of the Ministry of Presidency, chaired by a Vice-Prime Minister and in charge of the coordination of the Ministerial Cabinet. The main tasks of OCYT during the period 93-99 have been the management of the Third National Plan and the design and elaboration of the fourth National Plan which has shifted and enriched its scope towards the innovation process as it has been defined as a plan for research, development, and innovation (R+D+I).

Before the implementation of the fourth version of the National Plan, the first one incorporating innovation as a clear target, the elections of year 2000 won again by the Partido Popular led to a new reorganisation with the creation of the Ministry for Science and Technology.

It is too early to assess the performance of OCYT in its short trajectory and it is furthermore not too easy to analyse the outcomes of a system that in less than fifteen years has been experiencing such a complex transformation. That is why one has to look to a classical pattern of indicators in order to make an appraisal of the outputs and outcomes of the policies of the period from 88 to 96 and to confront them with the requirements and criteria that build up a National System of Innovation.

3. The Spanish R&D and Innovation Systems

3.1 General indicators and country characteristics of the Spanish R&D System in the European context

One of the first issues to consider in the assessment of R&D potential is to situate Spain in the European Union context with regard to some general dimensions and with respect to the characterisation of the science-technology system.

Country	Population (1995)	Surface (1,000xKm^2)	GDP 1995 (10^{9}x Euro)	1995 S & T system		
				Researchers (thousands)	Patents (thousands)	GERD (million US $)
France	58.1	552	1,173	151.2	96.2	27,052
Germany	81.7	357	1,850	231.2	109.6	38,498
Italy	57.3	301	834	75.5	67.9	11,224
UK	58.6	245	845	148	97	21,149
Spain	39.2	505	431	47.3	57.7	4,722
Remaining EU	77.2	1.277	1,309	168	424.7	24,825

Source: OECD (1998), Fundación COTEC (1999).

With all the limitations of the case, it is worth noting the good correlation between the figures for GDP and number of researchers, patents and GERD expenditure in France, Germany and United Kingdom and particularly in the rest of the EU where the number of patents is surprisingly high with respect to the number of researchers and R&D expenditure. In Spain the number of researchers is high for the level of expenditure - low spending research- and for the value of the GDP – low efficiency of research transformation into production. Whereas the number of patents is amazingly high and contrasts with current beliefs about the low productivity of Spanish R&D in this domain. However, the great number of these patents is solicited by non-residents (low self-sufficiency rate).

3.2 Evolution of the factors related to R&D and innovation activities. R&D resources and correlation with economic growth

The expenditure in R&D is considered as the first input indicator expressing the non-material investment for the future competitivity of countries and their industries. Spain has been lagging behind according to this indicator.

At the beginning of the eighties Spain was spending in R&D activities around 0.3 per cent of the GDP. The efforts undertaken during the eighties led to a strong expansion of the expenditure that followed until 1992. The crisis of 93 and 94 witnessed a decline though a new regain was observed from 95 onwards.

Table 1. ***Indexes of the evolution of the total R&D expenditure in Spain and comparison with the big four European countries.***

	Spain Indexes				Four Big EU countries	
Year	R & D expenses		GERD	GDP	Total R&D Expenditure	GDP
	Current PTA	Constant 1998 PTA				
1990	100	100	100	100	100	100
1991	115	100	100	110	125	110
1992	130	110	105	120	130	115

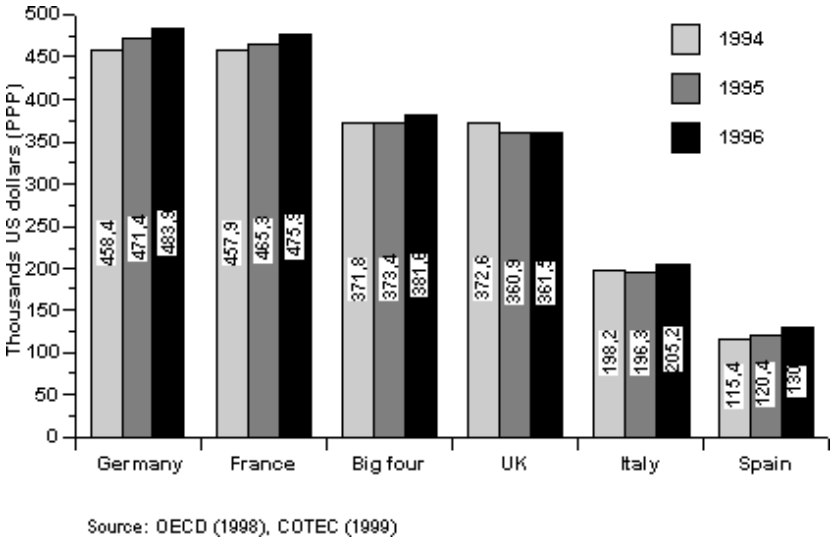
1993	125	105	105	125	130	120
1994	120	100	95	130	130	125
1995	125	105	100	140	130	130
1996	140	110	100	150	130	135

Source: ***OECD (1998), own elaboration***

The data recorded in table 1 show that the R&D expenses grew in the four big European countries faster or in parallel with the GDP, while according to Spain indexes , GDP grew faster than the expenditure in R&D.

The expenditure in R&D per inhabitant and year is recorded in Fig. 2.

Figure 2. ***R&D expenditure per inhabitant and year in Spain and the four big European countries.***



Source: OECD (1998), COTEC (1999)

This data in the case of Spain amounts to one third – one fourth of that of the big four countries, although the gap is slightly decreasing since 1995 and 1996. These two data are an indication of a slight trend to convergence with Europe of the Spanish expenditure in R& D.

In spite of this positive trend, Spain is failing to surpass the ceiling of the technological effort measured as percentage of the GDP. During the expansion period, it reached a peak at 0.91 per cent, declining to 0.8 per cent in the crisis year and remains stable since then at around 0.85 - 0.87 per cent.

The question remains open to see whether this is a structural or a functional threshold or both , an issue that requires further investigation.

3.2.1 Human resources

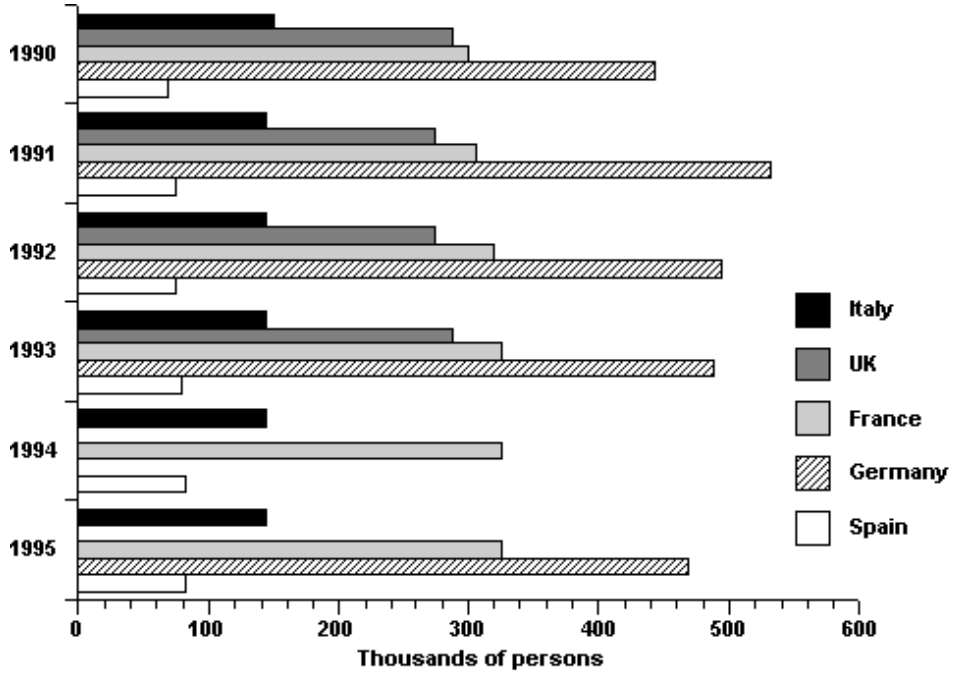
This indicator is the second input indicator that holds particular relevance for the National System of Innovation concept. For its effective integration, a complex set of actors have to intervene and cooperate: government, universities, public research centres and firms in the process that goes from the promotion initiatives to the employment passing through education and training of this highly skilled personnel.

The deficit in human resources devoted to R&D activities was identified as a critical one in any effort to update the Spanish System of Research. The R&D National Plans have so incorporated specific programmes (*Programas de Formación de Personal*

Investigador) **whose expenditures amounted to figures between 10 – 15 per cent of the resources of the National Plan (2,000 - 3,000 millions current PTA per year).**

The data gathered by the OECD for the four big countries in comparison with Spain show an increase in the number of employees during the period 1990-1995 for the whole of Europe with the higher rate found in Spain (80,000 persons – 47,000 researchers in 1995 representing a 14 per cent increase with respect to 1990). These facts seem to drive Spain to a convergent line (fig. 3) according to this parameter.

Figure 3. ***Evolution of R&D personnel in Spain and European countries (thousands of persons)***



Source: OECD (1998), COTEC (1999)

However, there are also some specifities in the case of Spain that point out to an opposite direction. Fig. 4 compares the percentage of researchers in the total amount of personnel employed in R&D in Spain and the big four European countries during 1995. The Spanish rate of qualified researchers is higher by a 20 per cent than that of the other countries what suggests a more academic-scientific and less organised system for Spain. It can be also argued that qualified personnel in Spain is performing in R&D activities at lower level than their skills. The average expenditure per researcher in Spain rounds up the 60-65 per cent of that spent by the average researcher in the main European countries and the trend does not seem to change (fig. 5), an additional argument in pointing out the lack of convergence in the performance of human resources.

Figure 4. ***Researchers percentage in the personnel employed in R&D (1995).***

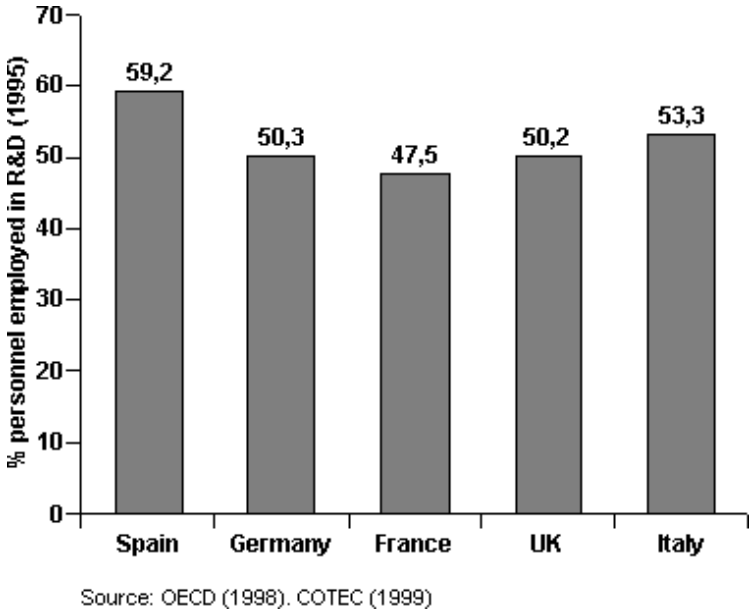
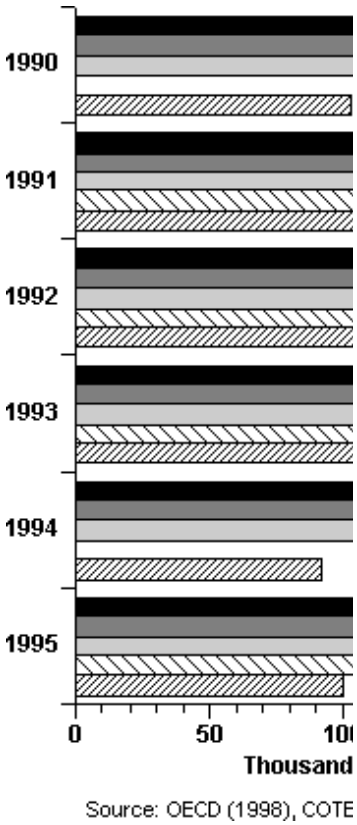


Figure 5. ***Evolution of average expenditure per researcher in different European countries***

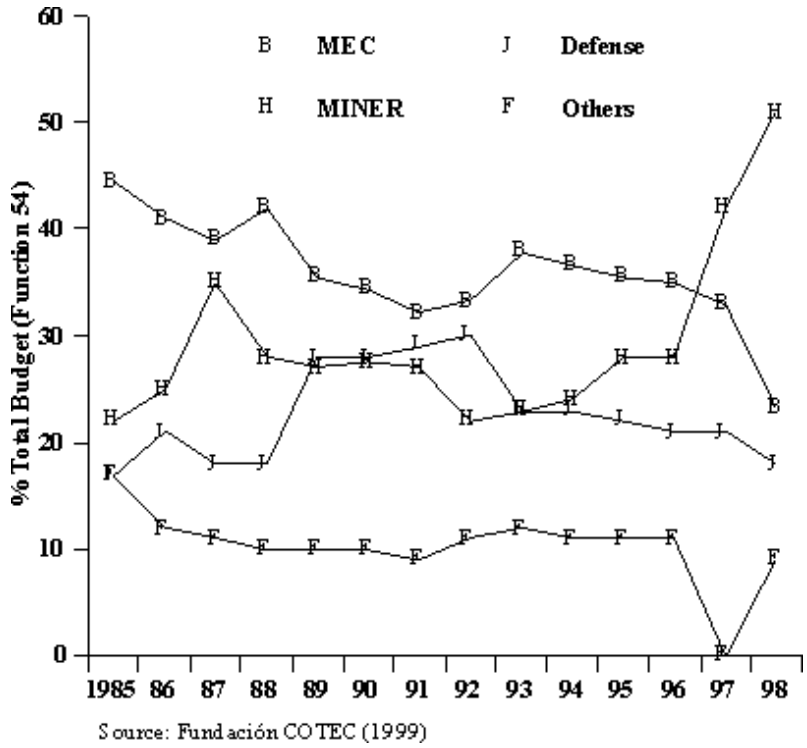


3.2.2 Public Sector Expenditure

The public expenditure can be easily followed through the national budget and includes the own resources to develop activities of the public research centres, the capital transfer to other actors (firms) and the internal expenses for programme managements as well as the funding of specific programmes and projects.

After the Law of Science, there is a specific budgetary chapter in Spain, referred as "Funcion 54" that collects mostly of the credits devoted to fund publicly R&D activities. One of the first aims of the establishment of function 54 was to foster internal coordination between the Ministries by increasing the level of the resources of the R&D National Plan in relation to those of the sectoral ministries. However, this goal has not been attained. Some ministries like the Ministry of Industry and Energy (MINER) has shown a continuous and significant increase since the early nineties while the budget of the Ministry of Education, Culture and Science (MEC)– responsible till 1998 of the National Plan– has been stagnant or declining (fig. 6).

Figure 6. ***Evolution of the budget of R&D activities in different ministries***



Source: Fundación COTEC (1999)

The expenditure of the public sector in Spain has followed a constant pace along the nineties with figures amounting to 0.55 – 0.50 per cent of GDP, except for a decline in this parameter observed from 1994 onwards (0.5 – 0.45 per cent). The tendency to decline has been stronger in the four big European countries taken as reference, in particular for Italy where the public expenditure has fallen in percentage of GDP to the level of Spain in 1995 and 1996.

3.3 Business sector – R&D, Technology, and Innovation

The business sector emerges as the main actor of the National System of Innovation concept. The measurement of the technological effort of the firms is a complex issue that requires to identify and estimate a set of parameters: expenses in R&D activities, the efforts in innovation activities, the balance in technology trades as well as the economic support provided to the firms by the public sector.

Unlike in the big four European countries, Spanish firms are spending in R&D less than 50 per cent of the total national expenses. The expenditure, including the support given by the public sector estimated to be about 10 per cent, has never reached a value higher than 0.5 per cent of GDP. This figure is clearly divergent from those of the business sector in Germany (between 2-1.5% GERD), France (1.5% GERD), United Kingdom (1.5-1.3% GERD) or even Italy (0.8-0.6% GERD) during the period 1990-1996.

Sectoral distribution of R&D effort in the business sector

The technological effort expressed as the rate between the expenses in R&D and the Gross Added Value at national level by cost of the factors has been declining in Spain from 1992 to 1996 (see Report 1999 of Fundación COTEC). In terms of big sectors only two, agriculture and manufacturing industries, have shown an increase.

Sectors with poor implication in R&D activities like building and services for sales, but very relevant to Spanish economy, showed a very important decline in R&D effort. On the other hand, the manufacturing industries are those investing largely in R&D (82.4 per cent of the total amount 327.9 milliards PTA(1997). The lion's share of the industry

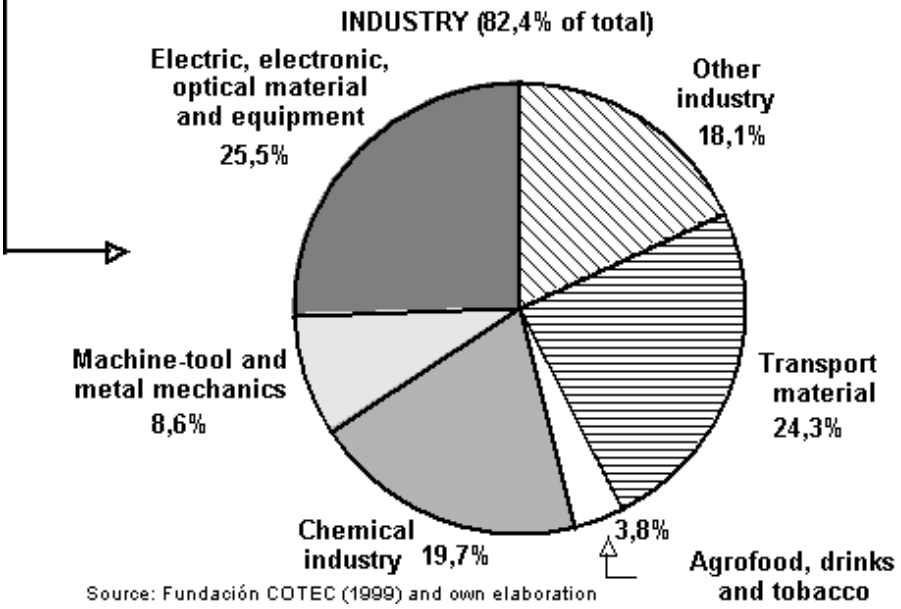
effort corresponds to three sectors of activity: chemistry (19.7% of the industry effort); electric, electronic and optical material (25.5%); and transport material (24.3%).

A summary of the situation is given in Table 2.

Table 2. ***Evolution between 1992 and 1996 of the sectoral technological effort in Spain.***

BIG SECTOR	R&D expenses/ GAV (%) 1992*	R&D expenses/ GAV (%) 1996*	Economic relevance
Agriculture	0,10	0,20	Medium
Energy and water	0,59	0,34	Medium-high
Manufacturing industries	1,70	1,91	Medium
Building	0,04	0,02	High
Services for sales	0,16	0,10	High
Total	1,00	0,93	

* The technological effort is calculated with respect to the Gross Added Value to the costs of factors and not with respect to the Gross Domestic Product



Source: Fundación COTEC (1999) and own elaboration

3.3.1 Innovation and R&D in the business sector

The survey on Technological Innovation that was established and performed by the *Instituto Nacional de Estadística* (INE) since 1994 following the Oslo Manual as well as the indications of Eurostat affords a new instrument to identify and characterise innovative firms in a broader sense than those performing traditional R&D activities and, at the same time, to compare and match both type of activities.

This analysis is interesting because the results of 1996 for innovation activities, unlike those of R&D activities, show a 28 per cent increase in the resources devoted to these activities as compared with 1994. The figures (794 thousands millions PTA 1996)

represented the 1.1 per cent of GDP (1 per cent in 1994). The ratio between innovation expenditure by firms in Spain and their percentage of GERD is 3 (1.2 vs 0.4) while in the European Union is near 2 (2.5 per cent in innovation, 1.2 per cent in R&D activities), a suggestion of the lower involvement of Spanish industries in research activities. Moreover, the percentage of firms characterised as innovative firms (respondents to the INE survey) was small (10.7 per cent of industries in 1994, and even decreasing to 9.6 per cent in 1996). However, as a positive data, the percentage of innovative firms able to develop R&D activities increased form 24.9% in 1994 to 32.9% in 1996.

The analysis by sector of economic activity does match well with previous analyses and data. Table 3 records the sectors with the highest percentages (>30 per cent), of innovative firms and of innovative firms performing R&D activities (> 50 per cent).

In addition to the five sectors recorded, it is worth to note that sectors like chemistry (excluding pharmacy); tobacco; ferrous and non-ferrous metals; machine-tool; ofimatic and informatics, as well as optical and watches instrument and equipment; with percentages of innovative firms lower than 30 per cent, show nonetheless very high percentages of the innovative firms performing R&D activities (between 60 and 90 per cent).

Table 3. ***Sectors of economic activity with high innovation and R&D performances***

	Percent of	
Sector	**Innovative firms**	**Those firms involved in R&D**
Pharmacy	54.12	78.78
Electronic components	34.39	76.12
TV. Communication	46.54	86.12
Aerospatial	38.07	69.9
Other transport material	32.82	73.6

Source: INE, own elaboration.

The technological balance presents a strong deficit with the covering rate moving around 10-15 per cent. This fact characterises the Spanish innovation system as highly dependent on foreign technology, a situation that is more acute when there are strong political and social pushes for technology. The deficit appears to be structural. The automobile sector is the one that shares the most important part of the technology purchasing (fluctuating around 45 per cent). The most innovative sectors such as pharmacology, electrical and electronic technology are accounting for 2-4 per cent of the technology transfer whereas intermediate sectors such as chemistry, computers, food, communications do rise to 4-6 per cent of the technology transfer payments.

The size of the firms appears as a critical variable to understand the strategies of technological innovation, R&D investments and technology transfer. The Spanish SMEs (less than 200 employees) are investing less with respect to sales than their larger counterparts. However, the active technological strategies do influence the sales of SMEs more positively than those of large firms. Both small and large business share the decrease in their R&D investment with respect to the volume of sales that has been noted during the last years.

3.3.2 The Spanish regional dimension in R&D, technology, and innovation

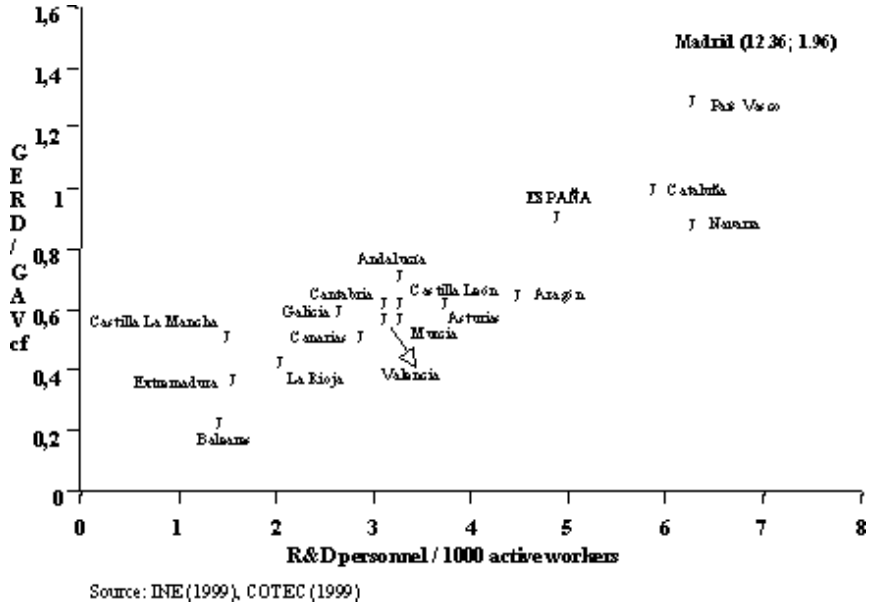
The introduction of the regional dimension into the analysis of technological and innovation issues in Spain reveals the existence of evident heterogeneities and

divergences between the regions.

The concentration of research capabilities and technological effort in Madrid remains as one of the main characteristics of the R&D and innovation systems in Spain. In 1996-1997, Madrid concentrated the 33 per cent of the national GERD, though the gap with Cataluña (21 per cent) was shortened.

The three regions that can be considered as the front runners and those possessing a pretty well equilibrated system of innovation according to the scheme of fig.1 are Madrid, Cataluña and País Vasco (9% of national GERD). All the three are non Objective 1 regions and account for 63 per cent of the R&D expenditure. The other three non Objective 1 regions – Baleares, La Rioja, Navarra – behaved quite differently with regard to R&D and innovation activities. Navarra remains close to the three front runners, both in economic support – expenditure with regard to GAV to the cost of factors and number of personnel involved per one thousand of active workers -, but La Rioja and particularly Baleares, the region with the great economic income per capita, are clearly lagging behind (fig.7).

Figure 7. ***Technological and research effort of the Spanish Regions. Correlation between economic effort and personnel (1995)***

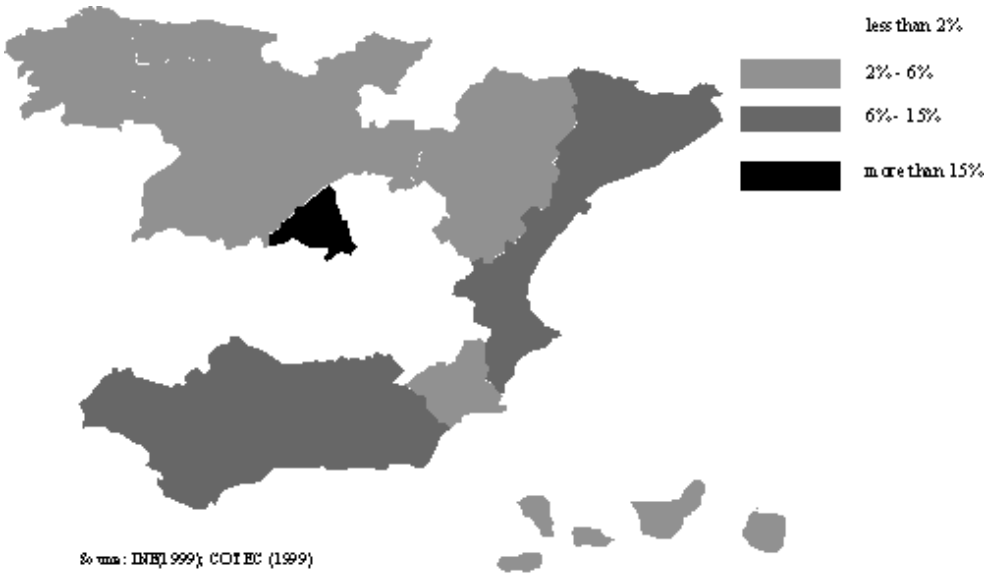


Source: INE (1999), COTEC (1999)

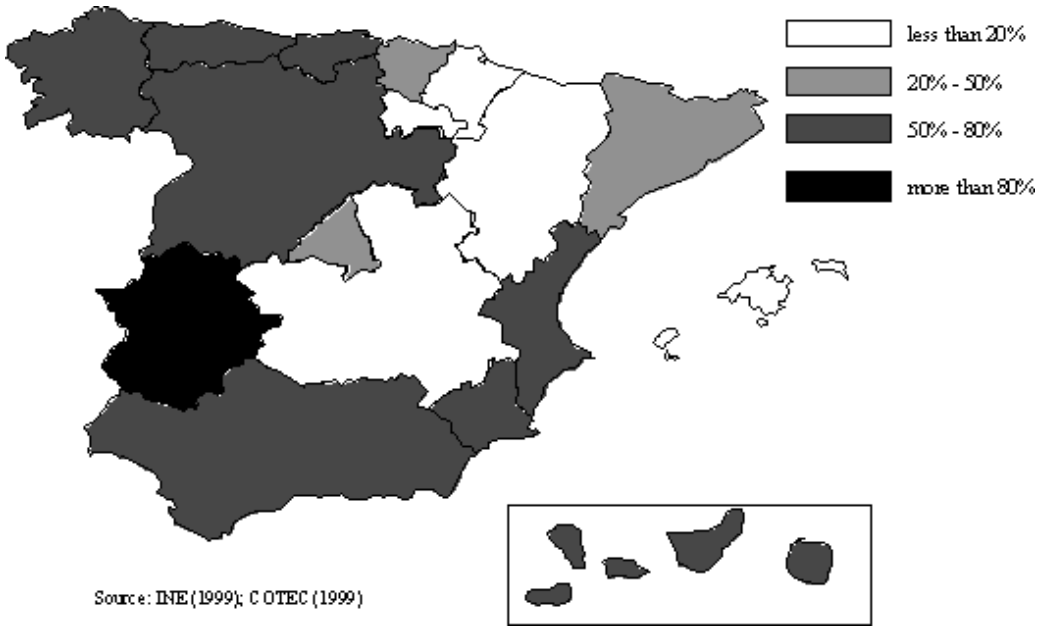
On the other hand, the 11 Objective 1 regions shared only the 32 per cent of the total GERD in 1996-1997, a situation that has not changed during the last decade with the operation of the R&D National Plans.

Figure 8.

a) ***Distribution of the weight of Public Research Organisms and universities in the Autonomous Regions in respect to the national total (%), 1997.***



b) ***Relative weight of Public Research Organisms and universities R&D expenditure in each Autonomous Region(% of each region, 1999).***



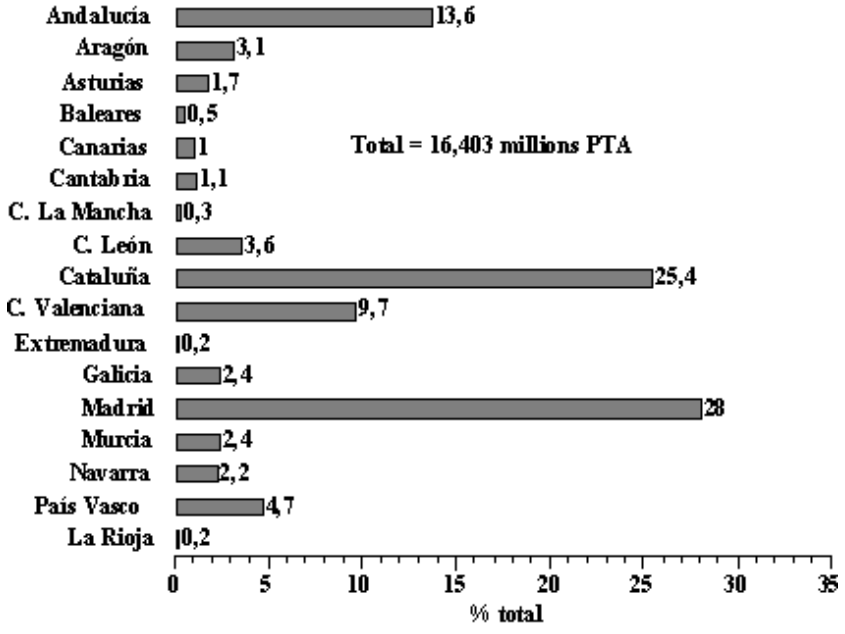
The relevance of the public sector (research organisms and centres and universities) marks another significant difference between the Spanish regions with regard to the research and technological effort. The R&D support in Objective 1 regions rests mainly on the important weight of the public sector (expenditure > 70% of the total), particularly due to the involvement of the universities whose efforts are accounting for around 54% of the R&D expenditure. The maps of Fig. 8 illustrate the different profiles shown by the Autonomous Regions of Spain in respect to the weight of the public sector research system both at national and regional level. The data serve to strengthen the disparities and paradoxical positions held by the regions. The public sector from Madrid does account for more than 15 per cent of the total at national level while it does represent less than 20 per cent at regional level. The public sector of Baleares and Extremadura contribute with less than 2 per cent to the total of Spain but represent more than 80 per cent of the regional effort. Demographic, organisational and economic variables should be taken into account to explain these facts. The share

of the funds allocated to the Autonomous Regions by the R&D National Plan (year 1997) and the whole Fourth Framework Programme is shown in comparative terms in fig. 9 (a and b, respectively).

The data do match in general with the strengths and profiles of the different regions in relation to research and technological potentialities: There are however some differences. The National Plan seems to be, within certain limits, redistributive in the allocation of funds: the gap between Madrid and the following regions is smaller than could be expected on a single background basis. The non-Objective 1 regions (7, including Aragón) received 64 per cent of the National Plan, while the eligible Objective 1 regions did receive 36 per cent, a slight increase with regard to the basal share of these regions in the national GERD. The situation is opposite in the case of the European Framework where Madrid is having the lion's share, followed by Cataluña to a great distance (20 percentage points in terms of funds) and larger than 30 percentage pints with Andalucía, País Vasco and Comunidad Valenciana. Specialisation, infrastructures and culture may be critical factors to explain these outcomes [2].

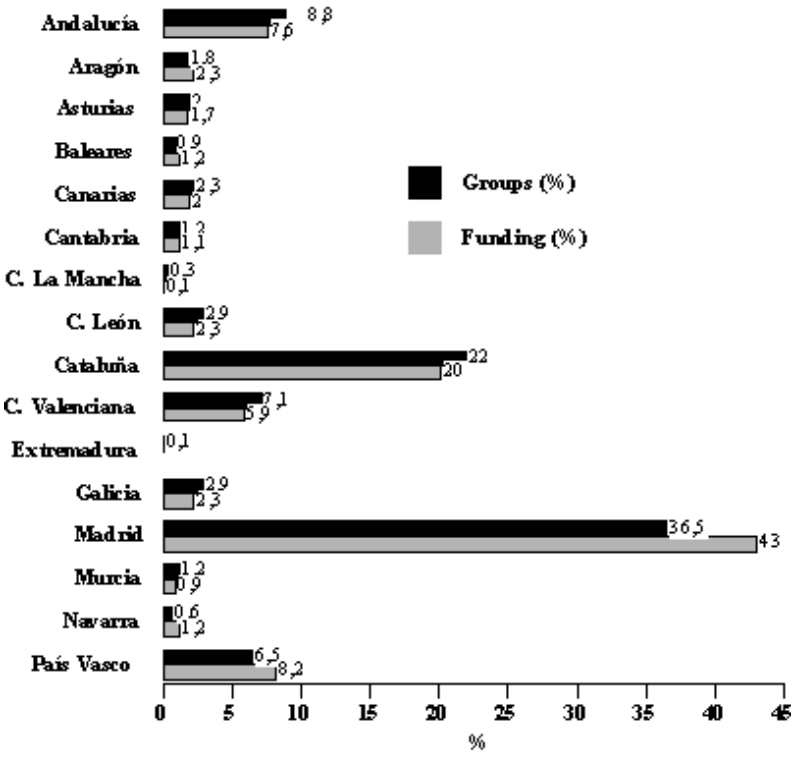
Figure 9.

a) ***Distribution of funds allocated by the R&D National Plan to the Autonomous Regions (year 1997)***



Source: CICYT (1999) Memoria de Actividades del Plan Nacional de I+D. CO TEC (1999)

b) Spanish participation in the IV Framework Programme by Regions (%)



Source: CICYT (1999) Memoria de Actividades del Plan Nacional de I+D 1997

3.4 Some evaluation approaches to innovation policies in Spain

The Instituto de Análisis Industrial y Financiero (IAIF) from the Universidad Complutense (Madrid) under the leadership of José Molero has been carrying out a series of exercises to evaluate the relevance and impact of innovation policies in Spain taking into account the national and regional dimensions as well as the influence of internationalisation processes. Most of these exercises have focused on the role and performance of CDTI because it emerges as the main institution in managing grants in aid to firms following their submittal of projects (see for instance, Molero *et al.*, 1995, Molero and Buesa, 1998, Heijs, 1999, Molero and Fonfría, 2000). Within the frame of the present report we can only comment on some general trends arising from those exercises.

a. **There is strong concentration of the technological activity in the three most industrialised regions: Madrid, Cataluña and País Vasco which together accounted for 77% of the firms promoting technological projects which were funded by CDTI in 1997. Such concentration is much higher than that of R&D resources as well as than to the contribution of these regions to the Gross Added Value (around 40 per cent in the same year).**
b. **The distance of Spain with respect to the leading countries is higher with respect to indicators that measure technological and innovative activity than with regard to R&D indicators. An important, and constant, characteristic of the Spanish research and development (plus innovation) system is the relative small presence of the firms in the spending of resources.**
c. **In spite of the upgrading tendency of the system to create technological inputs, the resort to foreign technology is a very significant structural feature of the Spanish system. Spain stands out among OECD countries in relation to the figures of importation technology but, unlike what happens in other countries,**

this fact is not compensated with a strong flow of technology exportation.

d. **The CDTI has contributed positively to the technological level of Spanish firms, though its actions (funding through loans) have had greater influence in the generic stimulus of R&D activities than in the technological orientation of the firms.**

e. **Firms seem to address their technological effort and innovation capacity by the exploitation of their "internal" skills and abilities rather than by co-operation strategies with other firms or even with public research centres.**

f. **Foreign multinationals have played a limited role in the building up of the Spanish innovation capacity as their market and innovation strategies were driven from the exterior. Until the mid-eighties there were no Spanish multinationals. Since then, a few ones have emerged related to classical sectors like banking, building, energy and fuel management or in the more innovative sector of telecommunications, although none of them has been outstanding in the field for the development of highly innovative potentials.**

4. Socio-economic outcomes

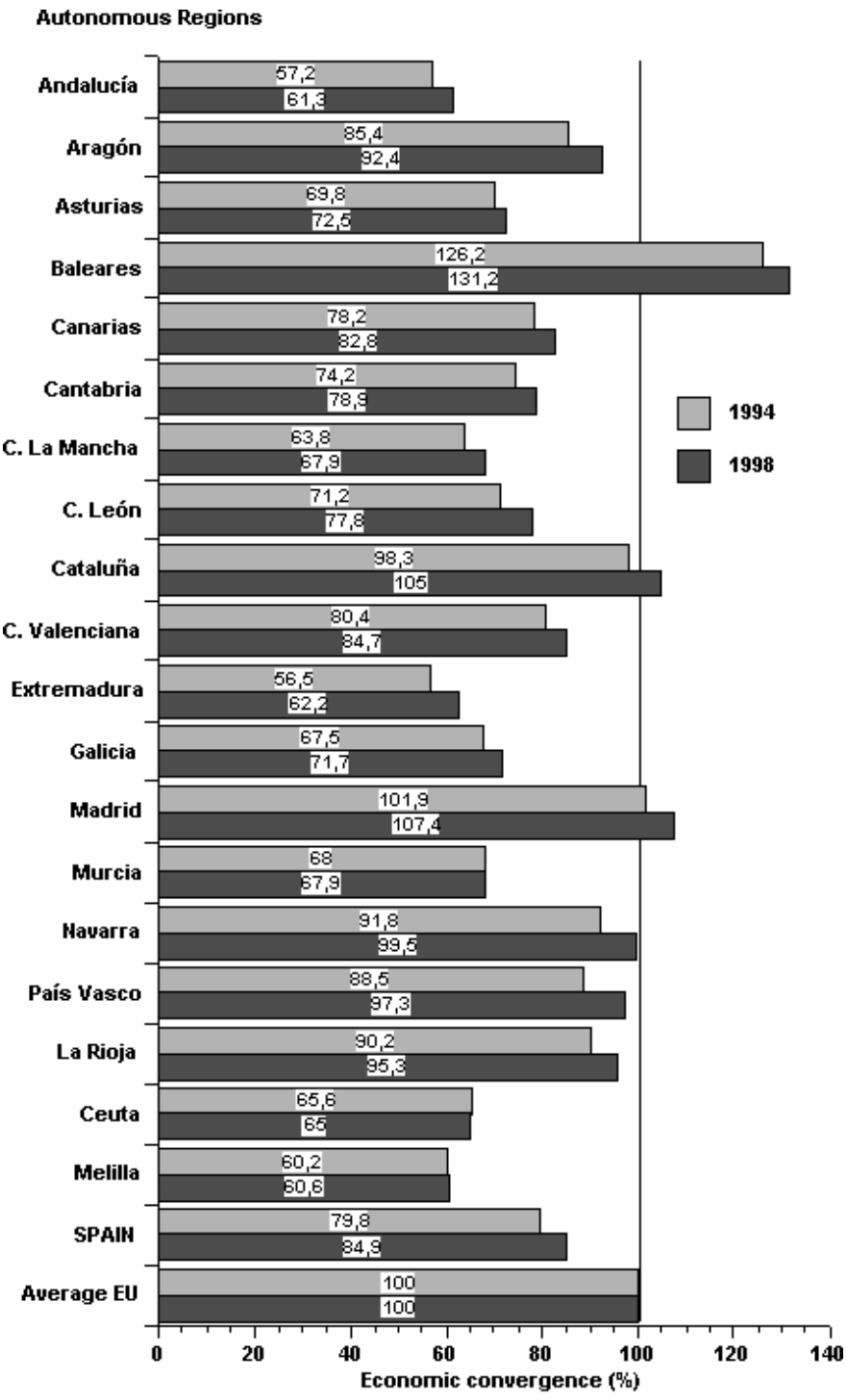
4.1 Incorporation of Spain into Europe: a crucial factor for convergence

At the onset of integration of Spain into the European Community, a high percentage of the Autonomous Regions of Spain were supported by the Structural Frame. Most of the regions were eligible as Objective 1 since their per capita GDP was lower than 75 per cent of Community average, others like the Basque Country or even parts of Madrid were objective 2. The only exceptions were Cataluña, Navarra, La Rioja and Baleares.

It is obvious that not all the structural funds have been addressed to innovation objectives and to foster research activities but it has to be recognised that a very important part of them have been driven to improve the infrastructure of transport, communications and technical and scientific laboratories, a crucial steps to build instruments that may foster the competivity of the productive sectors.

Along the process of convergence, the Spanish regions have experienced ups and downs with regard to the criteria of economic convergence. The 1998 situation as it is shown in fig. 10 represents important leaps ahead for most of the regions as compared to 1994.

Figure 10. ***Economic convergence of Autonomous Regions with the EU (per capita income).***



Source. Fundación de las Cajas de Ahorros Confederadas, 1999.

4.2 Socio-economic map of Spain and the Autonomous Regions

The CONVERGE project has clearly stated that the concept of "convergence" holds some ambiguities as it was used to refer the nominal criteria underlying the implementation of the single European currency. The interest of the CONVERGE project is to explore the "real convergence" and refers to the analysis of the regions in living standards, employment opportunities and social conditions.

The case of Spain appears as paradigmatic to illustrate the ambiguities of the concept of "nominal convergence" and to explore the data and eventually the causalities

underlying the issues related to value the "real convergence".

Characteristics of Spanish economy

Since its incorporation into the European Union in 1985-86, Spanish economy has followed a positive path, although it also accused the crisis of the early nineties, suffering of even less growth and more unemployment than the other Member States. However after this leap back, the economy of Spain has been growing at a higher rate than the average of the EU. In 1998, The Gross Domestic Product of Spain grew 4.60 per cent (4.67 per cent excluding the agrarian sector).

This pace of growth has been accompanied by a containment of the rate of inflation (remaining around 2-2.2 per cent) and by a significant decrease in the rate of unemployment, one of the most critical variables in the development of Spain during the last third of the century. Another important feature of the political and economic evolution of Spain along this period is the increasing relevance of the regionalisation. This was one important trend emerging from the democratic transition and has been constituting and still represents one of the major political issues at stake in Spain. The regionalisation is also extremely significant to light the lack of homogeneity existing in terms of macroeconomic indicators between the Spanish regions. This process adds value in assessing the relative significance of these macroeconomic indicators when they are not analysed in depth and with the sufficient level of breakdown. Disparities between regions with regard to growth, per capita GDP, distribution of employment by sectors are salient characteristics of the socio-economic map of Spain.

The aim of the present section is to provide some data which support the above assertion and to draw some conclusions that may frame the discussion on the innovation and technology influences on the real situation.

Table 4 records the whole GDP growth in the different regions of Spain or excluding the agrarian sector; this second indicator is helpful to identify the agrarian specialisation of some Spanish regions and to determine the relevance of this factor in the economic growth. The regions are classified in three groups: the first corresponding to those regions that grew over Spain average; the second to those regions growing around average and the third to those regions that show growth below average. These data are confronted with the ranking positions of the regions with respect to their technological effort (fig. 7) and per-capita income.

Table 4. ***GDP growth (1998) of Spanish Autonomous Regions both including and non-including agrarian sector as compared to Spain average (4.60 per cent; excluding agrarian sector 4.67) . Comparison with their ranks according to technological effort and per-capita income.***

Over average	GDP growth %		Ranking by technological effort	Ranking by per-capita income
	Total	Non-agrarian Sector		
Baleares	5.64	5.71	17	1
Canarias	4.83	5.01	12	7
País Vasco	5.38	5.38	2	6
Navarra	5.05	5.00	4	12
Castilla-León	4.93	4.60*	6	13
Extremadura	4.83	4.11*	16	16
Aragón	4.72	4.90	5	3

Castilla – La Mancha	4.71	4.50*	15	14
Cataluña	4.66	4.70	3	5
Average				
Andalucía	4.55	4.99	8	17
Madrid	4.51	4.52	1	4
Cantabría	4.51	4.63	11	8
Valenciana	4.36	4.55	10	9
Below average				
La Rioja	4.27	4.04	14	2
Murcia	3.93	3.94	9	15
Galicia	3.99	4.15	13	10
Melilla	3.93	3.94	-	-
Ceuta	3.83	3.85	-	-
Asturias	2.46	2.54	7	11

*** Denotes regions with overaverage growth essentially supported by the agrarian sector.**
Source: **FUNCAS (Fundación de las Cajas de Ahorro Confederadas).**

The distribution of employment by sectors in the whole of Spain as compared to that by the different regions points out to the same line of arguments; diversity and specialisation are the marked characteristics revealed by this indicator.

Results are illustrated in Table 5 and in Table 6 where only the results of the two extreme groups (over and below average) are shown.

Table 5. ***Distribution of employment by sectors in Spain***

Sector	**%**
Agriculture	7.9
Industry	20.6
Building	9.9
Services for sales	37.5
Services not for sales	24.2
Total	100.0

Table 6. ***Distribution of employment by sectors in the Autonomous Regions of Spain. Year 1998***

Sector	**Agriculture %**	**Industry %**	**Building %**	**Services for sale %**	**Services not for sale %**
Over	Galicia 20.0 Extremadura 16.6 Castilla-León 13.0	La Rioja 33.7 Navarra 30.4	Castilla-La Mancha 14.7 Extremadura 13.3	Baleares 53.1 Canarias 47.2 Madrid 44.2 Andalucía 35-40	Madrid 29.1 Extremadura

average	Castilla-La Mancha 12.4 Murcia 12.3 Andalucia 12.0 Cantabria 9.9	País Vasco 29.3 Cataluña 29.2	Baleares 12.2 Asturias 12.0 Cantabria 10.9	Com. Valenciana 35-40 Cataluña 35-40 País Vasco 35-40	27.7 Andalucía 27.3 Cantabria 27.0
Below average	Cataluña 3.3 País Vasco 2.6 Baleares 2.3 Madrid 1.1	Baleares 11.3 Extremadura 9.9 Canarias 9.0	Navarra 8.1 País Vasco 8.1 Madrid 8.0 Aragón 7.3	Navarra 29.2 La Rioja 27.2	Murcia 21.9 Com.Valenciana 21.3 Baleares 21.2 Cataluña 21.0 La Rioja 18.8

Source: Survey on Active Population (1998). INE.

4.3 Conclusions from the analysis of socio-economic characteristics

a. **There are strong differences in the growth rate between regions. Baleares runs far first, followed quite closely by País Vasco, their rates are around one point higher than the average of Spain. The difference between the better and the poorer regions in this parameter amounts to more than three percentage points.**

b. **The extremely good positions of regions like Extremadura, Castilla–León and Castilla–La Mancha are noteworthy. It is important to stress the fact that these regions rely strongly on the agrarian sector for their excellent performance. Productive growth of this sector in Extremadura and Castilla-León surpassed 8 per cent.**

c. **A series of regions (Navarra, Cataluña, Madrid and País Vasco) show a well balanced situation with respect to the growth dependence on sectors (differences between the first two columns of table 4 amount to less than 10 per cent).**

d. **Other regions (Aragón, Canarias and to some extent surprisingly Andalucía and Comunidad Valenciana) are stemming their growth from the non-agrarian sector. This is surprising in the case of Andalucía and Com. Valenciana that have been primarily agrarian communities. As a matter fact, the growth productivity from the agrarian sector in Comunidad Valenciana was the lowest of Spain along 1998 (less than 1 per cent). The last two regions are likely evolving towards balanced economies.**

e. Among the slow developing regions, the relative good position of Galicia in the data excluding the agrarian sector is worth mention, essentially because Galicia economy is still largely dependent on the agrarian sector. The situation is just opposite in the case of La Rioja, a community with strong agrofood sector.

f. The per capita income confirms the diversity among the Spanish regions as they can be grouped into three blocks corresponding to overaverage (ranks 1 to 6 in table 4), average (ranks 7 to 13) and below average (ranks 14 to 17 plus Ceuta and Melilla). The members of these groups show changed positions with respect to GDP growth as a new indication of the great heterogeneity existing in the socio-economic mapping of Spain.

g. With the exception of País Vasco, Cataluña, Navarra, Aragón and to some extent Madrid there is a mismatch between the socio-economic outcomes of the regions and their technological effort (potential innovation capacity). The most striking differences

between these two types of indicators are shown by Baleares, Canarias, Andalucía, Murcia, Asturias and La Rioja, though these differences run out in opposite directions, i.e. Baleares and La Rioja are the wealthiest regions of Spain with the lowest technological effort, whereas Asturias and Andalucía rank low in the socio-economic indicators with reasonable levels of technological effort.

h. The data on employment profiles of the regions point out in the same directions: high heterogeneity, lack of correspondence between the wealth of regions and the predominant employment rates in traditional innovative sectors, similar shares of employment rates between sectors in regions with marked differences in their wealth status.

5. Concluding remarks. Summary of the appraisal

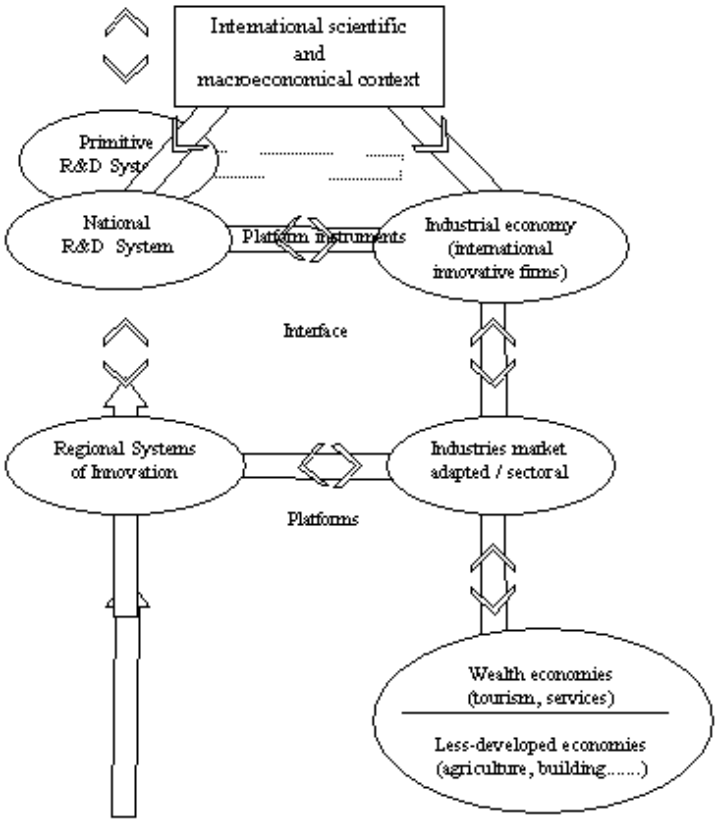
1. All the analyses, data and indicators, support the contention that the efforts carried out in Spain along the last half of the twentieth century have led to the building of a System of Research and Development with satisfactory scientific outputs. However its outcomes in relation to the building of innovation capacity in the productive sector have been rather limited. The public R&D system and the business system have followed separate paths [3].

   It is likely to conclude that Spain do possess a National R&D System but the country is still lacking a specifically built National System of Innovation shaped according to the main characteristics and specifities of the country.

2. However, there are patches of systems of innovation in some of the Spanish regions (Cataluña, País Vasco, perhaps Madrid), precisely the most industrialised ones though a better identifications of these systems is needed through particular, case by case, studies. The industries in theses regions reflect the ability for the adaptation and evolution to the needs for innovation of classical sectors like textile, machine-tool, mechanical engineering together with modern sectors like pharmacy, chemistry, optics and electronics.
3. **Economic criteria do not allow a grouping of the regions of Spain in terms of innovation capacities and assets. Non-Objective 1 regions are characterised very differently according to their research and technological efforts. Three of them (Madrid, Cataluña and País Vasco) are the leaders in these efforts whereas Baleares and La Rioja which are the leaders in economic wealth are the laggers in these effort. Navarra and Aragón occupy intermediate positions in terms of human and economic resources devoted to R&D and innovation activities.**
4. **Objective 1 regions share a predominant role of the public sector in their R&D efforts, although there are also marked differences between them. In general, it can be said that Spanish less-developed regions do possess incomplete, "primitive" systems of innovation.**
5. **There is a poor correlation between the degree of economic convergence with Europe and the level of research and technological efforts as illustrated by the cases of Baleares and La Rioja or by the positive economic performance during the last years of some Objective 1 regions (Castilla-León, Castilla-La Mancha, Extremadura…) grounding its positive trajectory essentially in the agricultural (agro-food) sector.**
6. **The percentage of innovative firms in Spain is lower than those of most European member countries. Moreover, the Spanish innovative firms are less active in R&D activities than their European counter parts. The trend seems to be changing to a slight increase in the number of innovative firms and essentially to a strong**

increase in the R&D vocation of those firms.

7. **The most innovative sectors in Spain are those behaving as such since long (agriculture and manufacturing industries are showing better performance than services, energy, building)**
8. **Among the innovative sectors, the industries belonging to areas of innovative tradition standing at least for twenty years are the most prone to perform R&D activities and programmes, i.e. pharmaceutical, electronic and optical material and equipment, transport material.**
9. **Spain is moving towards convergence with Europe in economic, and innovation and technology indicators, but the paths of convergence for these two parameters are moving quite differently and do not match according to geographical and temporal parameters.**
10. We would like to propose the analogy of an "ecosystem" to represent the situation in Spain with regard to R&D, innovation and economic outcomes.



The ecosystem model offers some explanatory advantage with respect to the classical concept of National System of Innovation (compare with fig.1). Unlike the circular, closed organisation proposed in that model, the ecosystem analogy takes into consideration the application of hierarchical principles (layers or subsystems) and also provides ground to explain situations where specialisation, diversification in relation to productivity do take place..

a. Thus, it allows to identify, understand and explain the role of main or leading elements and factors. By analogy with the role of energy supply in the natural ecosystems, the present model proposes such a leading role for the international context to which the different subsystems and elements attempt to adapt for their survival.
b. It serves to understand the existence and evolution of efficient subsystems, which can

evolve separately or be integrated into a more complex system.

c. It also permits to analyse how these new meso -or micro- systems are functioning either independently or integrated into a large system.

d. It provide means for understanding the emergence and subsequent evolution of new subsystems.

Notes

1- This analysis has been performed following a type of "meta-analytical" strategy based on secondary documents, derived either from the previous own work of the authors or from the analytical work of a series of Spanish authors and institutions. The bibliography has been thus arranged in four sections: the first one contains the works used for the meta-analytical work which are referred in the text; the other three sections refer to background documents.

2 The existence of a marked regional diversity in technological capabilities, as measured by the number and specialisation of patents registered in Europe, has been shown by Sanz Menéndez and Arias, 1998 (recorded in part **4** of the Bibliography section).

3 A very complex set of data and information on the innovation activities in all the regions of Spain can be found in the book Geografía de la Innovación (recorded in part 4 of the Bibliography section)

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