ENCUENTRO ECONOMÍA PÚBLICA
ALMERIA, FEBRERO 2006

TITULO: INNOVATIÓN E I+D EN LA MODERNIZACIÓN Y EFICIENCIA DEL SECTOR PÚBLICO EUROPEO

AUTORES: ANDRÉS MAROTO SÁNCHEZ
LUIS RUBALCABA BERMEJO

Universidad de Alcalá y Servilab

RESUMEN:

El crecimiento económico en la UE ha decaído notablemente en el período posterior al Consejo Europeo de Lisboa (2000). Aunque durante estos años la productividad aparente del sector público, como tal, se ha comportado bien en la UE, la cuestión clave es si el actual tamaño, estructura y funcionamiento de las administraciones públicas europeas son los suficientemente eficientes para que se traduzca en impactos positivos sobre el conjunto de la economía. En términos de política económica, los resultados empíricos evidencian que el sistema de innovación europeo necesita ser drásticamente reformado si la UE quiere conseguir los objetivos propuestos en la agenda de Lisboa para el 2010. Una reforma estructural y un cambio institucional, así como poner énfasis en la competitividad basada en la ciencia y el conocimiento, es un prerrequisito para que pueda converger con EE.UU. y las economías emergentes asiáticas, y el sector público es un factor fundamental en este proceso. En este contexto, el objetivo de este trabajo es, por una parte, analizar la relación entre estructura, eficiencia e innovación del sector público en Europa; y, por la otra, explorar la influencia que la promoción de la innovación pública (I+D) podría generar en el sistema de innovación y funcionamiento general del sector público en los países europeos.

PALABRAS CLAVE: Sector Público, Innovación, I+D, Eficiencia, Europa

CODIGOS JEL: H1, H80, O4 (O47), O31, O32 y O38

INNOVATION AND R&D IN PUBLIC SECTOR

MODERNISATION AND PERFORMANCE

MAROTO SÁNCHEZ, ANDRÉS (*), RUBALCABA BERMEJO, LUIS (**)

ABSTRACT

Economic growth in the European Union slowed markedly in the aftermath of the Lisbon European Council of March 2000. Although in that period productivity of public administrations as such performed better in the EU, the question is if the current size, structure and functioning of European public sector is efficient enough to produce positive impacts throughout the whole economy. In terms of policy the empirical results stresses that the EU's innovation system needs to be drastically reformed if the EU is to make a decisive shift towards realising the broad features of which have been laid out in the Lisbon 2010 agenda. A structural reform and institutional change, and an emphasis on competitiveness that is based on science and on knowledge is a prerequisite for the Union to catch up with the United States and the dynamic Asian economies, and public sector has a key role in this process.

The aim of this paper is twofold: to summarise and discuss the links between public sector structure, performance and innovation in Europe, and to explore the influence that public innovation might exert on general innovation system and performance patterns in EU countries through some R&D indicators depending on the types of public sectors.

KEY WORDS: Public sector, performance, innovation, R&D, Europe

(*) University of Alcalá and Servilab. (**) University of Alcala, Servilab, and president of the European Network of Services Research. Plaza de la Victoria 2, 28802, Alcalá de Henares, Madrid. This paper is an outcome of the PUBLIN project (Public sector and innovation) under the V Framework Program of the EU Commission.

1. INTRODUCTION

Public sector research and innovation plays a key role in technological change and consequently in economic growth. In recent years, a number of trends have emerged, heightening interest in the economic effects of public sector innovation and, specially, R&D both in policy and academic circles. One of the key factors of the downturn of economic growth in the European Union in the aftermath of the Lisbon Council of 2000 is the structural nature of the EU's innovation systems and processes. If innovation is the process of generating and applying new ideas that raise living standards, create new growth industries, and improve the way institutions operate –then public sector will determine EU's success or failure in the innovation endeavour as much as the private sector.

Although in that period labour apparent productivity of public administrations as such performed better in the EU (European Commission, 2005), the question is if the current size, structure and functioning of European public sector is efficient enough to produce positive impacts throughout the whole economy. In terms of policy, the empirical results stresses that the EU's innovation system needs to be drastically reformed if the EU is to make a decisive shift towards realising the broad features of which have been laid out in the Lisbon 2010 agenda. A structural reform and institutional change, and an emphasis on competitiveness that is based on science and on knowledge is a prerequisite for the Union to catch up with the United States and the dynamic Asian economies, and public sector has a key role in this process.

A recent research of the U.S. Council on Competitiveness[1] explains the reasons why. Public sector sets the framework by which private entities innovate –as a regulator, an investor, a purchaser or a partner. Consider just a few public sector activities and their impact on putting new ideas into practice, such as research investment, education policy, intellectual property protection or infrastructure investment. Clearly, the capacity of the private sector to innovate relies heavily on public sector practices. Government also determines countries' innovation potential because the public sector accounts for a major portion of our society's activities[2]. Such an enormous swath of activity must be productive and efficient –it must be innovative- if EU countries are to prosper and compete in the global arena of 21st century.

Improving the performance of the public sector in terms of innovation is a goal that is high on the policy agenda in almost all European countries. Public policies play a key role in shaping competitiveness and growth in the economy. Due to the size of government activity, performance and efficiency in the public sector is an important determinant of aggregate economic performance at the national level. Secondly, the organisation and functioning of governments affects the private sector via three main channels through which government action can have an impact: taxation (that distorts relative prices in the economy and thus influence economic incentives such as the willingness to work, to invest or to engage in entrepreneurial activities), public spending on areas such as education, R&D or infrastructure; and regulations (that limit the choices which individuals and enterprises can make), and the state of efficiency and modernisation in the provision of public services (a high-performing administration will produce positive direct and indirect impacts in the economy as a whole).

Some of the public sector actions produce contradictory effects in the economy, causing debate among researchers and policy-makers. For example, cross-country studies investigating the role of public capital in explaining productivity growth differentials provide no clear

[1] Council on Competitiveness (2005): *Public Sector Innovation*, National Innovation Initiative Working Group Report, U.S. Council on Competitiveness

[2] In Sweden, which has the highest share of government employment in EU-15 in 2003, one out of three jobs is in the government sector. The Netherlands has the smallest share of government employment in 2003, one tenth of all jobs.

conclusions: while many of them find a positive impact, the effect is often not significant. For both education and R&D, the case for the public sector involvement is often based on the existence of externalities. There is econometric evidence suggesting the R&D performed by public sector could have stronger impacts on economic performance than business R&D (Griliches, 1992; Griffith, 2000). The extent to which public research can strengthen it depends also on the exploitation of the results in the business sector. Finally, some papers conclude that public R&D has to some extent taken the place of private research rather than adding to it (David et al., 2000); however, most available studies do not find such substitution effects.

Thus, in recent years, a number of trends have emerged, focusing on the economic effects of public research. Firstly, budget constraints are leading policymakers to re-evaluate public spending for R&D. Secondly, public academic research is being asked to contribute directly to industrial innovations and economic performance. In addition, a number of European countries have implemented or consider implementing policies to strengthen the linkages between universities and industry in order to enhance the contributions of university-based research to innovation and economic performance. These policies include encouraging the formation of science parks located nearby universities, spin-offs based on university research in science and technology, as well as policies which attempt to stimulate university patenting and licensing activities (OECD, 2002; Mowery and Sampat, 2002).

Furthermore, the public sector is not only a performer of R&D, but also an important source of R&D funding in the business sector. The gap in private research investment between the EU and the US[3] has alarming consequences for the long-term potential for innovation, growth and productivity performance. For this reason, the European Council in Barcelona 2000 decided to strive to increase gross expenditures on R&D to 3% of GDP in the EU by 2010 with industry contributing two-thirds of the total amount of R&D expenditures (European Commission, 2003). Public R&D and programmes for boosting innovation can be one of the most powerful instruments to overcome deficits and achieve competitive goals.

Public sector innovation, therefore, is directly related to economic prosperity and tightly linked to whether governments will meet their greatest national challenges in areas such as education or research and development. Following these ideas, the aim of this chapter is twofold: to analyse if R&D and innovation performance in EU countries differs according to the structure, organisation and typology of public administration; and secondly, to summarise and discuss the links between public sector performance, modernisation and innovation in Europe, exploring the influence that public innovation might exert on general innovation system and performance patterns in EU public sectors.

According to these objectives, four main research hypothesis raise (see figure 1):

Q1. Economic theories and empirical researches have shown that innovation and, concretely, R&D achieve better economic performance at aggregate level. Focusing on public sector, do this relationship persist? Are those countries with higher public R&D figures the ones with better public sector performance? Can R&D be categorized as a dimension of public sector performance?

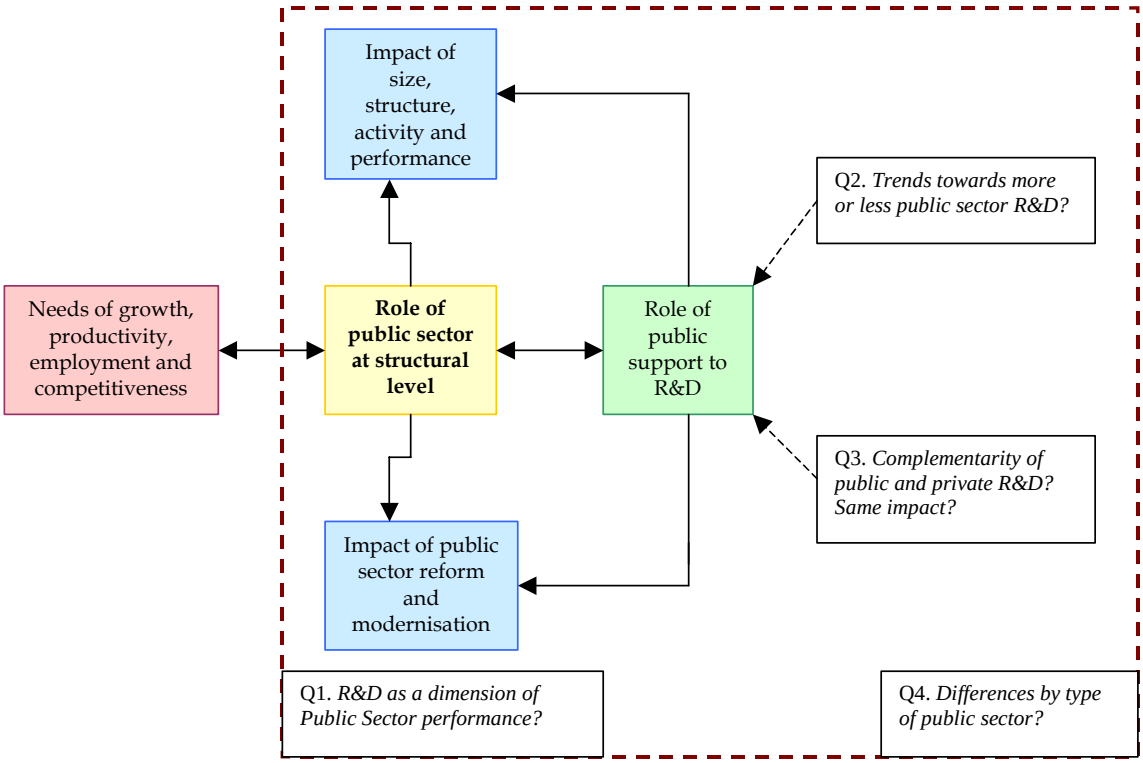
Q2. In recent years it can be observed a downward trend in public sector size. Has public R&D followed a similar path? Or, on the contrary, have trends towards more public R&D been observed in European countries?

Q3. Does public sector R&D complement or crowd out private sector R&D? Have both sides of the coin the same economic impact in public sector performance?

[3] Expenditures on business sector R&D as a percentage of GDP in the EU-15 (1,30% in 2002) lag significantly behind the US (1,86% in 2002) and Japan (2,26% in 2001) whereas there is virtually no gap in terms of public R&D expenditures (including the government and higher education sector ones)

Q4. Do R&D patterns in EU countries differ according to public sector typologies?. Different ways of structuring and administering public sectors across the EU should lead to different ways of performing innovation and R&D systems.

Figure 1. **Exploring key questions in the links between public sector and R&D**



The paper is divided into six sections. Section 2 presents a brief overview of the main aspects of the public sector, its size and structure, focusing into the classification or typology of states that can be observed in European countries. Section 3 analyses the performance of the public sector and the theoretical background about the economic impact of R&D, while fourth section describes briefly recent trends of the R&D in Europe, US and Japan, and analyses the links between R&D and public sector R&D. Section 5 contrast the final research hypothesis about the influence of diversity in EU public sector models. Finally, section 6 concludes with some final remarks.

2. STRUCTURE AND SIZE OF PUBLIC SECTOR IN EUROPE:

The modern public sector is a consequence of a long and even controversial process where different organisational models, sizes and profiles have been evolved. But, in any case, the State is actively present in social and economic life. Economic life constantly depends on the decisions of the governments, which can be illustrated in the condition of tax-payers citizens and capital owners are; the transferences from the government which almost everybody receive at any time; public parks, highways and other services or infrastructures provided; and, more recently, the public policies in charge of preserving natural resources and promoting sustainable development.

Due to all these points, public sector really has a great economic and social importance all over market economies, but even much more within the European Union, where different models, sizes, and organisational ways do exist. This fact becomes an economic achievement,

and shows the EU trying to get the right balance between high social protection levels and income redistribution processes, what sometimes involve a certain trade-off between economic growth and income distribution. More recently, some other debates are in the centre of discussion about the modern role of States; for example, the debate about complementarity/substitutions between public and private (crowding out effects included); the debate about the conflict between Welfare State and competitiveness or the debate on modernisation and innovation of public sector. Because of all these old and new debates, the present discussion about the size and structure of the public sector has a more direct effect on the European Union than on any other regions around the world.

The public sector in the economies of the advanced countries, and among them the European ones, fulfils nowadays one two-fold mission: it is creative and responsible of the institutional frame in which they operate the individuals and also an authority that take part actively in the economic processes correcting the results that would obtain the markets. Traditionally, it has been denominated "*arrangement policy*" to the first role, and "*process policy*" to the second one. In order to take care of both tasks, the public sector uses three generic instruments: regulations, public property, and state companies. In this analysis, the second instrument will be explored, leaving the other two for later studies, since it is the instrument that specifies the size and structures of the public sector in the European countries.

One of the main roles that the public sector takes at the present time is to develop all the activities that the Welfare State implies, which means the displacement of certain areas of the social conflict to the sphere of public action. In a strand of the literature, the performance of welfare states is linked to their institutions. A typology aims to explain the performance of national institutions for in the light of their key characteristics. One well-known typology of institutions for social protection found in welfare states was developed by Esping-Andersen (1990). Before that, between 1960-75 the three great models of European Keynesian Welfare State are based. Titmuss in 1974 had laid the way towards the consideration of three models differentiated of social protection in advanced Capitalist states. Esping-Andersen retakes this proposal and builds a very influential three-poled typology. In his approach, the defining characteristic of welfare states is the generosity and accessibility of government programs designed to protect the citizenry against loss of income and poverty. Each type is different in terms of the regulation of labour markets (primary protection) and the level and scope of income guarantees (secondary protection). He distinguished, in particular, a Nordic or socialist model (with Sweden like paradigm), a Continental or Christian Democrat model (Germany) and an Anglo-Saxon or liberal model (United Kingdom). Eastern countries emerge as a separate type of welfare state (SCP/CERP, 2004), while some authors, such as Castles (1995) or Rhodes (1997), describe an alternative model for Southern or Mediterranean countries.

Recent studies complement these typologies. Differences in administrative culture have a major impact both on fundamental choices concerning the structure of the public sector, and on the daily functioning of the government apparatus. Administrative culture forms part of a wider political and social culture. Hofstede's dimensions are probably the best-known categorisation of administrative cultures (Hofstede, 1980), although other attempts have been made (Mamadouh, 1999). It is clearly no simple matter to group countries on the basis of their administrative culture. Loughlin (1994) groups countries on the basis of broad philosophical and cultural traditions. He distinguishes an Anglo-Saxon (minimal state), a Germanic-organicist and a French Napoleonic state tradition. The Scandinavian type is a mix of the first two. Finally, Hooghe (2002) used four dimensions developed by Page (1995) –cohesion, autonomy from political control, caste-like character and non-permeability of external interest- to construct and index of 'Weberian bureaucratic tradition' (strong, medium, weak), indicating to what degree a national administrative culture corresponds to the Weberian model (strong cohesion, large degree of autonomy from political control, strong caste-like character of the bureaucracy and low permeability of external interests).

Table 1: **Typology of States in Europe**

		Scandinavian or Northern European	Mediterranean or Southern European	Continental or Western European	Anglosaxon	Eastern European
General characteristics	***Administrative culture***[1]	Public interest	No clear	Rule of law	Public interest	Transition
	Insipration[6]	Socialism	Mix	Christian-democratic	Liberal	Post-communist
	State tradition[2]	Mixture of Germanic and French	French Napoleonic	Germanic or organicist	Anglosaxon	Communist
	Type of administration[3]	medium	medium-weak	medium-weak*	strong	Strong/weak
Public Sector characteristics	***General characteristics***	High size, high quality and high confidence	Low size, low-medium quality and low-medium confidence	Mixed size, medium quality and medium-high confidence	Medium size, medium-high quality and average confidence	Low-medium size, low-medium quality and low-medium confidence
	Public Service sector characteristics[4]	Low private share, public orientation, less repressive, Beveridge type, uniform education and adversarial criminal law system	Low-medium private share, average repressive, Beveridge type, medium differentiated education	Medium private share, public orientation, less-average repressive, Bismarck type, differentiated education and inquisitorial law system	Medium-high private share, mixed repressive, Beveridge type, low-medium differentiated education	Medium-high private share, Bismarck type, low-medium differentiated education
	PS Performance[5]	Medium-high overall performance, medium-high in education, high in health care, low overall efficiency	Low overall performance, low in education, medium-high in health care, medium overall efficiency	Medium-high overall performance, medium-high in education, high in health care, low overall efficiency	Medium overall performance, high in education, medium-high in health care, high overall efficiency	Medium-low overall performance, low-medium in education, low-medium in health care, medium-low overall efficiency
Social protection characteristics	***Referring system***[6]	Redistribution (equality)	Household attendance	Security	Attendance	Transition towards Civil Society
	Secondary protection (income guarantees)[6]	High social expenditure level, impositive financing structure, universal cover and social right of citizens like criterion for access	Low social expenditure level, impositive (taxes) financing structure, universal cover and labour belonging like criterion for access	Average social expenditure level, contributive financing structure, selective cover and labour belonging like criterion for access	Low expenditure level, impositive (taxes) financing structure, selective cover and need like criterion for access	Medium social expenditure level, impositive financing structure, universal cover and social right of citizens like criterion for access
	Primary protection (labour market conditions)[6]	Average regulative density, very centralized and coordinated collective agreements structure, high cover rate of these agreements, very high union affiliation density	Highly regulated system. Intermediate systems for collective agreements and centralisation. Rigidity and black labour. Low union affiliation density	High regulative density, less centralized and by sector collective agreements structure, very high cover rate of these agreements, average union affiliation density	Low regulative density, decentralized and by company collective agreements structure, average-high cover rate of these agreements, high union affiliation density	Transition systems from fully regulated markets towards liberal markers Very centralized and coordinated collective agreements structure, high cover rate of these agreements, very high union affiliation density
Socio-economic characteristics	***Social***[4]	Medium ageing, high crime rate	High ageing, low crime rate	Medium ageing, medium crime rate	Low ageing, mixed crime rate	Low ageing, low crime rate
	Economic[4]	Average GDP per capita, average economic growth	Low GDP per capita, high economic growth	Average GDP per capita, low economic growth	High GDP per capita, average economic growth	Low GDP per capita, high economic growth

[1]Pollit and Bouckaert (2004); [2]Louhglin (1994); [3]Hooghe (2002); [4]SCP/CERP (2004); [5]Afonso et al. (2003);
[6]Subirats and Goma (2000)
*With the exception of France (strong).
Source: Own elaboration

Other studies have attempted to find a relationship between key demographic indicators and the institutions of welfare states. For example, Mellens (1999) tried to relate birth rate,

migration, family formation and the death rate to dominant socio-economic (level of income, educational attainment and health status of the population) and cultural treats of welfare states (gender equality, conservatism, individualism and post-modernism).

In summary, five groups of states can be distinguished in Europe according to all these characteristics (see table 1). These country-clusters are the Scandinavian or Northern European, the Mediterranean or Southern European, the Continental or Western European, the Anglosaxon, and the Eastern European. Countries differ in terms of system characteristics, resource use and performance of the public sector (this public performance will be analysed in detail in the next section). Nevertheless, it is possible to group European countries into these clusters that take account of each of those dimensions. These clusters are almost entirely consistent with generally accepted geographical/historical classifications of countries in Europe.

Though this suggests that our conclusions are plausible, there is a need to take a more self-critical view in some related aspects. Firstly, some authors ask to what extent is there really an Anglosaxon model. The United States and the United Kingdom are very different in many ways, and have different trends[4], so one could turn this around and suggest that the United Kingdom is far more like France, while United States is far more like Switzerland. Secondly, the current Germany system is now under radical changes, so its belonging to a narrow cluster can be discussed[5]. Finally, some authors (see, for example, Frenken, 2003) suggest that national boundaries are being broken down and a pan-European system is instead taking its place, not only in terms of convergence due to fiscal constraints imposed by the Euro stability pact. These critics could make the adopted typology here differ, but, in any case, it is the more extended one in the literature.

After the rapid expansion of the welfare state in the 1950s and 1960s, the public sector has been under considerable pressure in the past few decades. Declining public confidence in government institutions and growing demands on public finances have prompted governments to initiate measures to trim the public sector and make it more efficient and effective. Thus, after the great crisis in the 1980s, a "new" state was being built during the 1990s in the European Union. The objective of these new Managerial Public Administration theories is to build a state that responds to the needs of its citizens, a democratic state where bureaucrats respond to politicians and politicians to voters in an accountable way. For that reason, there are essential moves: political reform to increase the legitimacy of governments; fiscal adjustment, privatisation, deregulation to reduce the size of the state and improve its financial health; and administrative reform that, in addition to improving the financial situation of the state, will provide the means of good governance. Reform strategies adopted can be catalogued as a four-fold aim: maintain, modernise, marketise and minimise (Pollit and Bouckaert 2004) the public sector performance.

Recent reforms in the public sector have often been carried out as a response to pressures to limit public spending, to strengthen economic performance or to keep up with the innovations introduced in the private sector, such as the introduction of information technologies. Country-specific forces are usually at the root of public sector reforms (Knox, 2002). Table 2 summarises the three types of reforms handled to enhance efficiency in the public sector: management reforms, introduction of information technology; and privatisation and outsourcing processes.

[4] For example, the Bush administration has cut taxes for rich and is cutting budgets for basic medical services. By contrast, the last three Labour governments in United Kingdom have had policies of increasing taxes and spending much more on health and education. Further, in the United States health, education, and social systems are under much more control of the states and not the national (federal) level.

[5] For example, according to the opposition CDU leader, Angela Merkel, there is no such thing as the Rhineland model in Germany, but a changing German traditional system over time (Schweiger, 2004).

Table 2: **Recent reforms in the Public Sector**

Type of reform	Human resources management	Introduction of ICT	Privatisation and outsourcing
Mechanisms	Improvements in the incentive structure (wage differentiation, hiring and firing practices, promotion,…)	Introduction of ICT, changes in working methods and e-Government practices	Arms-length agencies, privatisation of service providers, and public-private partnerships
Critical factors	Reliable output and performance indicators	Quality of information, time savings, speed of response in interaction with citizens and businesses, and common standards across public agencies	ncreasingly efficiency, productivity, profitability and capital investment spending, risk sharing, management skills, and employment reductions
Examples	New Public Management and Total Quality Management	e-Europe 2005 Action Plan and US Government 2002 Programme	See Bennet et al. (2004), Claessens and Djankov (2002), Frydman et al. (1999), Gonenc et al. (2000), Nicoletti and Scarpetta (2003), Van der Nord (2002), and La Porta and Lopez-de-Silanes (1999).

Source: Based on European Commission (2005b)

This way of organising and structuring public activities in European countries determines a dimension or size of public sector, the second issue analysed in this section. The obvious difference in the economic performance of countries had led to the question why some countries are so much wealthier than others, and whether the size, the structure and the organisation of the public sector contribute to cross-country income and growth gaps (Handler et al., 2005). Since public production is difficult to measure with one single statistical indicator, the size and the composition of government activities are gauged using different indicators, which all cover the supply side public activities (see, for example, Beeton, 1987; Mahler, 1992; Gemmel, 1993; Karras, 1997; or Light, 1999). Consequently, any quantitative evaluation of the magnitude of the public sector must be observed with much precaution, and the empirical evidence showed in table 3 has to take refuge without forgetting that qualification.

Countries above 50% of GDP in public figures can be observed, such as the Nordic ones (Finland, Denmark and Sweden), France, Belgium and Austria. On the other side, countries such as Mediterranean countries (Spain, Portugal and Greece), have only around 40%-45%, and Ireland around 35%, near the levels of other countries such as Japan or the United States. Some countries, such as Belgium, the Netherlands, the United Kingdom and Ireland substantially decreased their public expenditure shares since the early 80s. Another characteristic is that public expenditure shares in the European countries seem to be counter cyclical and correlated with each other. Comparing the EU with Japan and the United States, the public sector size is much larger in the EU than in the United States or Japan, mainly caused by a larger extent of redistribution functions.

In terms of public employment, the EU public sector dimension remained roughly constant since 1980 and fluctuated around 17%. A slight downward trend can be observed since 1992 resulted from particular developments in a number of countries. In contrast to the stationary trend for the EU as a whole, the experience of individual countries is very heterogeneous in level and long-term development. While the Nordic countries and France have the largest numbers (more than 20% of total employment in 2002), public employment in Germany and the Netherlands is around 10%. The southern countries (except Italy) have increased public employment from very low levels in 1980, while the United Kingdom has decreased its share of public employment since then.

Table 3: **Size of the public sector in Europe, 2003**

	Public Expenditure (% of GDP)	**Tax ratio** (% of GDP)	**Public Employment** (% of total)
Austria	50,8	28,5	12,9
Belgium	51,0	31,5	18,3
Denmark	56,4	47,1	30,4
Finland	50,8	32,9	25,6
France	55,5	27,3	23,0
Germany	48,8	23,2	11,1
Greece	50,1	23,4	12,5
Ireland	34,4	25,3	12,0
Italy	49,3	30,1	16,0
Luxembourg	45,1	29,9	14,9
Netherlands	49,0	24,8	11,0
Portugal	47,6	25,5	17,9
Spain	39,6	23,5	15,0
Sweden	58,7	36,2	31,7
United Kingdom	43,3	29,3	18,8
EU-15	48,7	29,2	18,1
Slovakia	48,2	40,4	-
Slovenia	53,2	38,4	15,4
Estonia	49,8	39,0	21,4
Hungary	35,8	33,3	-
Latvia	34,1	38,4	-
Lithuania	48,1	33,6	12,4
Poland	39,2	32,3	-
Czech Republic	35,7	29,2	-
Cyprus	45,4	33,3	-
Malta	50,3	34,2	-
New Member States	44,0	35,2	16,4
EU-25	46,3	32,2	17,2
United States	35,7	28,9	14,6
Japan	38,2	27,3	8,7
Australia	37,9	30,1	17,5
Canada	41,7	35,1	15,7
Norway	48,9	43,3	5,7
Iceland	43,4	36,5	-
Switzerland	34,8	30,6	-

Source: OECD and Eurostat (2005)

The participation of taxes in the selected countries shows a wide range of variation: from over 50% of GDP (in Sweden and Denmark) to almost 35% (in Ireland and the Mediterranean European countries). This mirror the levels in expenditure ratios outlined in the previous lines. The average tax ratio in the EU steadily increased until the end of the 90s, when this indicator experienced a slight downward (in 2002 amounted to about 40%). In the United States this ratio remained broadly stable, while the behaviour of the taxation in the Japanese economy has been more variable. Regarding the new member states, most of the countries that have recently joined to the EU have faced in the last years the transition from strongly interventionist economies towards a typical market model of the western European countries (Utrilla de la Hoz, 2001). At the present time, almost all the new EU member states register levels of public expenditure and income related to the GDP similar to those of the EU, although they are relatively high in comparison with other countries of similar levels of output (European Commission, 2000).

One of the most important item of the dimension of the public sector is its effects on the economic growth of the advanced economies. The policy-making debate has turned at these days into focusing in the links between the size of public sectors and the performance of these economies. Clearly, economists of the Leviathan public choice school tend to support a view that sees a large public sector as detrimental to economic growth. In contrast, evidence of a correlation between GDP growth and the growth rate of government, and more weakly between

GDP growth and the size of government, have been associated with the argument that there is a strong positive externality between public and private sectors. In Europe, because of the creation of a single currency area and the disappearance of national monetary policies, the debate has focused on the role that national fiscal policies can play and the need for a fiscal federation. The permanent limits on budget deficits set by the Growth and Stability Pact have been criticised for not leaving enough room for fiscal policy to smooth output fluctuations (Eichengreen and Wyplosz, 1998).

3. BOOSTING PERFORMANCE AND MODERNISATION IN PUBLIC SECTOR: THE ROLE OF INNOVATION AND R&D.

The debate of the role of the public sector has shifted in recent years towards empirical assessments of the efficiency and usefulness of public sector activities. A growing academic literature has been investigating the stabilisation, allocation and distribution effects of public expenditure. It has also been assessing the role of rules and institutions, and the scope for privatising public sector activities (see e.g., Persson and Tabellini, 2001; Strauch and von Hagen, 2000; Rodrik, 2000; and Gwartney et al., 2002). Most studies conclude that public spending could be much smaller and more efficient than today. However, for this to happen, governments should adopt better institutions and should transfer many non-core activities to the private sector.

The measurement of public sector performance (defined as the outcome of public sector activities) and efficiency (defined as the outcome relative to the resources employed), however, is still very limited. Afonso et al. (2003) provides a proxy for measuring public sector performance and efficiency. Their paper compares the performance of the public sector and relates it to resource use. These authors use indicators relating to effectiveness and in a number of major policy areas: education, health care and infrastructure. In addition, they draw on indicators of the quality of public administration, based on survey data. Finally, the authors operationalize the conventional functions of government: distribution, stabilization and allocation (Musgrave and Musgrave, 1984). These indicators are aggregated by means of unweighted totalling of standardised component scores. Performance is then related to resource use on two levels: in each concrete policy area, and for the public sector as a whole.

Indicators suggest notable but not extremely large differences in the public sector performance across countries (with a few exceptions). Countries with the highest values for sub-indicators include Switzerland (administration and infrastructure), Japan (education), Iceland (health), Austria (distribution), Norway (economic stability) and Luxembourg (economic performance). Countries such as Luxembourg, Japan, Norway, Austria and the Netherlands report high total PSP indicators. The latter is true both a PSP indicator with equal weights for the sub-indicators and for different weighting, suggesting that the findings are relatively robust to moderate changes in weighting. Looking at country groups, small governments (industrialised countries with public spending below 40% of GDP in 2000) on balance report better economic performance than big governments (public spending above 50% of GDP) or medium sized governments (spending between 40 and 50% of GDP). Big governments feature more even income distribution whereas small ones perform better especially in the administrative, stability and economic performance domains. These results are consistent with those found in Tanzi and Schuknecht (2000). When comparing the main economic players of today, it is noteworthy that the US and particularly Japan report above-average performance in most sub-indices and for the total PSP measure. By contrast, the EU (weighted average) performs below average.

From 1990 to 2000 one can easily see that while some countries managed to deliver a relative improvement in public sector performance, some other countries showed a decrease in

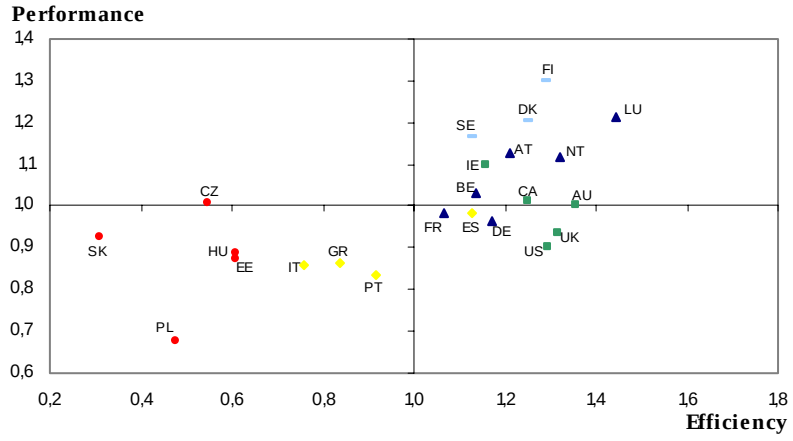
public sector performance. Examples of the first group of countries are Greece, Portugal, Spain and Ireland. However, only Ireland succeeded in placing itself above the average of the country sample. Some countries experienced reductions in public sector performance, especially Japan and Switzerland. This is also true for the EU and the euro zone as a whole. However, one should be aware that progress in public sector performance made by the different countries over time is measured relative to other countries and not relative to its own past performance.

Indicators of Public Sector Efficiency (PSE) are computed weighing performance by the amount of relevant public expenditure. One can find significant differences in public sector efficiency across countries. Netherlands, Australia, Finland and Luxembourg show the best values for overall efficiency. Looking at country groups, small governments post the highest efficiency amongst industrialised countries. Differences are considerable as small governments on average post a 40% higher scores than big ones.

In summary, it can be found that differences in efficiency are much more pronounced than in performance across countries, with small governments clearly outranking the others. This illustrates that the size of government may be too large in many industrialised countries, with declining marginal products being rather prevalent. But given the non-extreme differences in performance as outlined above, the incidence of negative marginal products of public spending may be more limited.

Other authors (SCP/CERP, 2004) have tried to improve on the work by Afonso et al. (2003) in some respects. The country-clusters resulted (figure 2[6])are very similar. Southern European countries present low general and educational performance, Eastern new EU member states show low general performance but high educational one, and the Northern European and Anglo-Saxon countries with high scores in both items (although the differences among countries in the educational performance are high; e.g. Luxembourg with a high macroeconomic score but fairly poor results for the effectiveness of its education system). It should be noted that, though there is considerable correlation between public sector performance in the different areas, it is by no means perfect. Countries that do well in several respects also produce poorer performances in other areas. Finland, for example, records high scores for many policy areas, but has a low score for other, such as crime. In the other side, Poland does badly in many areas, but does well on economic growth, income distribution and its school drop-out rate.

Figure 2: **Indicators of public sector efficiency and performance**[7]

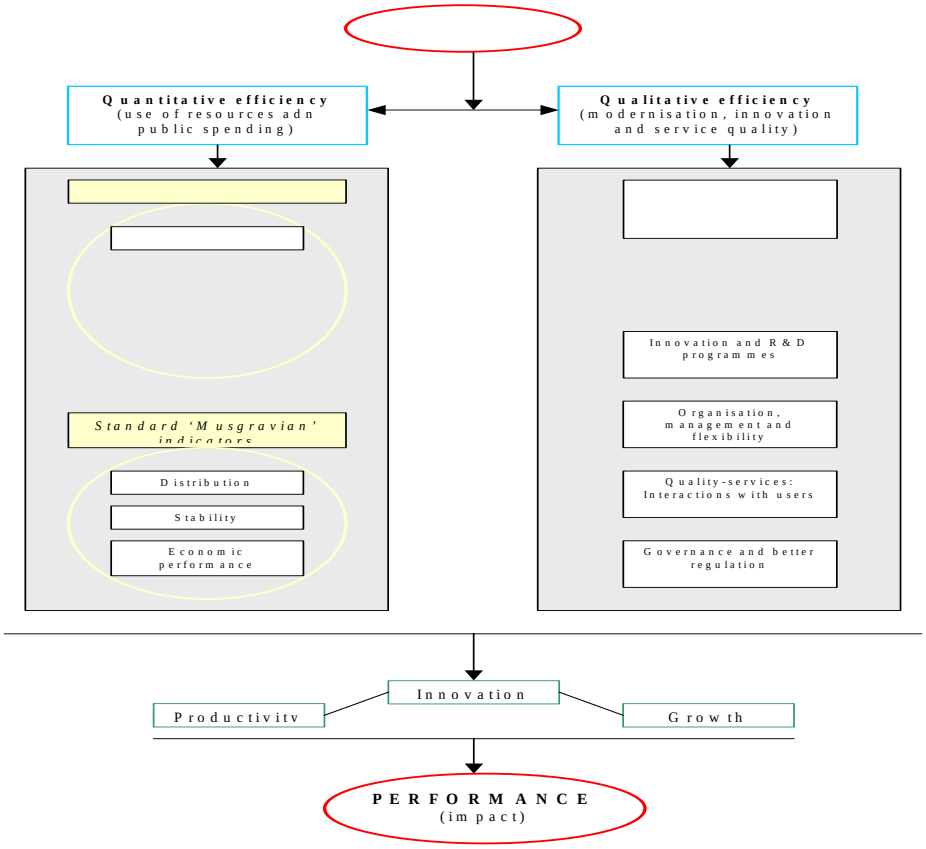


[6] Performance indicators used in this figure and in the following sections are an average of Afonso's and SCP ones; while efficiency indicators are an average of Afonso's and World Bank ones. All indexes are normalized and one-scaled.

[7] Colours are related to the typologies of public sector previously shown. Red marked countries correspond to Eastern ones, yellow to Mediterranean, dark blue to Continental, green to Anglosaxon, and sky blue to Nordic

The development of these two indicators of performance and efficiency of the public sector (PSP and PSE respectively) lead to the question about the interrelation between efficiency and performance, modernisation and impact, organisation and effectiveness. The uneven association between the two rankings (countries around the diagonal and countries with outlier behaviours) suggest that there might be certain links between the performance and efficiency that sometimes work better than others. Furthermore, the efficiency indicators should focus not only on the way in which public expenditure is done but on the quality of spending. An efficient public sector should spend well, within modern organisation systems, high-quality governance and efficient use and provision of services. Efficiency should contain certain qualitative aspects –although these aspects are difficult to measure- but relevant in the way businesses can perform its own activity and society perceive the quality of public services. The modernisation of public administration is not a good in itself, but for the consequences it produces in modern economies. In this sense, it is important to distinguish between the quantitative efficiency in the use of resources and the qualitative efficiency in the organisation and production of public services.

Figure 3: **Links between performance and efficiency in the public sector**



Within this framework, the links between performance and efficiency contain some key dimensions which are necessary to tackle upon (figure 3). In one side, the quantitative aspects of the efficient functioning of public sectors, which can be measured with opportunity indicators and traditional Musgravian ones (Afonso et al., 2003), explained before. But, in the other side, the complementary qualitative items. Among these aspects, it is important to point out some of them, like the interaction with private services; human capital, training and experience of labour force; organisation, management and flexibility of the public administrations; interaction with

the users; governance and better regulations within a correct institutional frame; and innovation and R&D public programmes. These two sets of variables will shape the performance of public sector, throughout the impact on the innovation system, productivity and economic growth of the economy.

Recent studies are encouraging the debate about the need for better governance (OECD, 2002, 2003b, 2004), better regulation and reduction of red tapes (European Commission, 2005; OECD, 2003a). There is also research approach the question of employment and human capital in public sector (e.g. OECD, 2001) and issues related to its management and organisation (the full research on New Public Management). However, a major lack of research is given in the issues related to the interrelations with private services and with final and intermediate users, that, together to the R&D programmes, are three keys sources of innovation generated in and from the public sector. Rubalcaba (2004) deeps inside the first of them, whereas the public R&D and innovation will be analysed in the following sections.

In this context, the role of public support to R&D, both private and public R&D, is not secondary. Public activity in the area of R&D can be discussed from two angles. First, it is possible to describe the actions of the public sector (for instance, to measure the degree of public intervention). This includes a discussion of direct R&D expenditures by the public sector as well as government instruments aimed at raising the economy-wide degree of R&D activity. Secondly, it is equally important to assess the impact or effects of public innovation. These impacts concern both the additional R&D activity induced in the private sector and the impact of public R&D efforts on outcomes such as patents, new products and economic performance. Other than R&D directly performed by the public sector there are two instruments commonly employed in order to achieve this social optimum: tax incentives and grants. Tax incentives reduce the cost of the R&D activity and therefore encourage companies to invest more in R&D. Grants usually match private R&D expenditures at a certain percentage with public money, by the selection of specific projects by the government. Since the aim of public intervention when using these instruments is the increase of private R&D expenditure, it is necessary to investigate whether the public money is really spent on additional R&D activities. It is not enough that the money is being spent, there also needs to be a return on this money. In other words, public funding should stimulate innovations that are valued by society. Economic policy analysis needs to go a step further. To foster economic growth it is not enough that resources be spent on innovative activities, it is also crucial that the innovative activities be successful (European Commission, 2005).

New studies investigate in detail the effects of research performed in the public sector. Bassanini and Scarpetta (2002) have reported cross-country regressions that suggest a negative return on public sector R&D. Subsequent research showed that the results of this study may be misleading because it fails to account for the time delay between public R&D and productivity outcomes. Guellec and van Pottelsberghe (2003a) explicitly examine the productivity effects of public sector R&D using panel data across sixteen OECD countries. They find that the long run impact of R&D seems to be higher when it is performed by the public sector than when it is performed by the private sector. Furthermore, the elasticity is higher for countries with a relatively large share of university-performed research compared to government laboratory research. The elasticity of public research is also higher where the business R&D intensity is relatively high, indicating that the spillover benefits of public research are complementary with corporate research activities.

Another strand investigates what proportion of firm's products could not have been developed without public research (Mansfield, 1991; Beise and Stahl, 1999). Overall, one can conclude that public research has a direct and significant impact on new products and processes and thus indirectly contributes to economic growth and productivity. Other authors address the spillover effect of academic research performed by universities and government research organisations (see, for example, Salter and Martin, 2001). The importance of universities in promoting technical change and innovation is widely recognized. Studies have found a

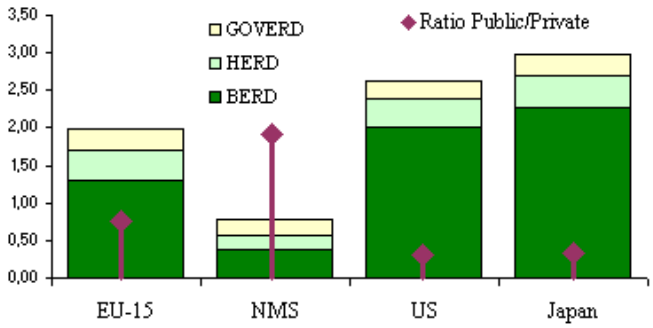
significant role for academic research in the innovation process (Acz et al., 1992; Jaffe, 1989, and Nelson, 1986). Another line of previous research of this type has utilised patent citations to identify positive knowledge spillovers.

Among the studies on the impact of public innovation intervention on private R&D expenditures and innovation output (Gonzalez et al., 2004; David et al., 2000; Guellec and van Pottelsberghe, 2003b), the majority of them finds that no complete crowding out takes place. Due to data restrictions, some analyses cannot differentiate between no complete crowding out and complementarity. But among the studies that are able to do so, many find indeed that public R&D and private R&D are in a complementary relationship. This is an important result in favour of government activities aiming to raise the economy-wide level of innovative activities. Summing up, innovative activities of private companies are a key contributor to wealth creation in economies, but the social benefits of innovation are larger than the private benefits. Therefore, innovation activity creates externalities which give rise to spill-over effects. Since externalities of innovation activities are positive, firms tend to under-invest in R&D (Nelson, 1959, Arrow, 1962). In addition, companies have some leeway to exclude competitors from research results (through patents or secrecy). However, in these cases research efforts may be wastefully duplicated. This market failure manifest in the under-provision of R&D provides a rationale for public intervention, whose aim is to raise R&D expenditure closer to the socially optimal level. So R&D seems to be a dimension playing a role in public sector performance.

4. R&D AND PUBLIC SECTOR R&D: EXPLORING TRENDS, COMPLEMENTARITIES, LINKS AND IMPACTS?

While the EU-15 (1,31%) lags significantly behind the US (2,00%) and Japan (2,26%) in terms of business sector R&D expenditure as a percentage of GDP in 2003, as it is shown in figure 4, there is no virtually gap in public sector expenditures on R&D (including the government and the higher education sector) which range between 0,68% of GDP in the EU-15 and 0,62% in the US. However, both public and private sector expenditures on R&D are lower in the new EU member states than in the EU-15 (at about 0,41% and 0,37% in 2000 respectively). In these economies, the lower ratio of public sector R&D expenditures to GDP is mainly due to the low ratio of R&D performed by the higher education sector to GDP. On the other hand, the ratio between public R&D and private R&D shows the opposite characterization. The new EU member states present the highest ratio (public R&D represents 1.92 times than the private sector one), followed by the EU-15 (0.76). While, Japan and the US, which invest much more in gross R&D than European countries, show lower ratios between public and private R&D (0.32 and 0.31 respectively). So, those countries with higher investments in gross R&D are those with lower ratios between public and private R&D.

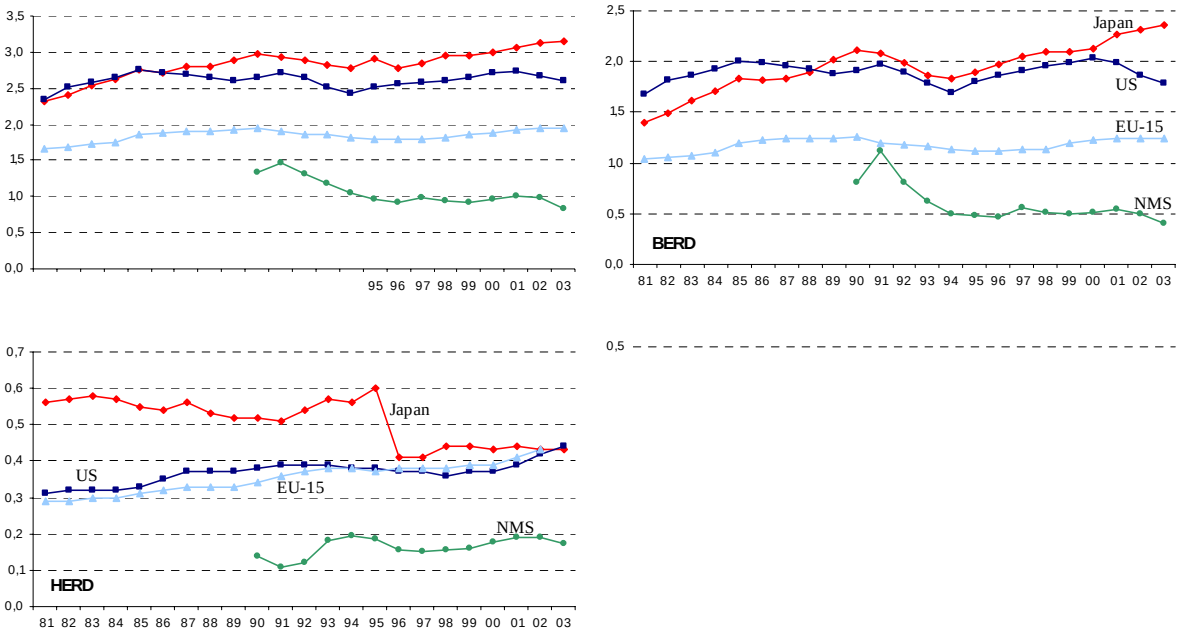
Figure 4: **R&D expenditures by performing sector, 2002***
(% of GDP)



Source: OECD (2005)

Analysing the trend of the investment in R&D of these economies (see figure 5), it can be observed that the R&D expenditure (as a % of GDP) in the EU-15 increased slightly over the 1980s and 1990s (reached 1,95% in 2003 compared to 1,67% in 1980). A more pronounced increasing can be observed in Japan (from 2,31% in 1980 to 3,15% in 2003). On the other hand, the US investment in R&D, after an increase at the beginning of 1980s, has fluctuated around 2,60-2,70% during this period, and the percentage for new EU member states has steadily decreased over the 1990s. Similar trends can be observed in the case of business sector R&D, although these are different in the one of public sector R&D. Concretely, in the EU-15 and US the R&D performed by the higher education increased steadily over the 1980s and 1990s with a slowdown in the mid-1990s (EU-15 reached 0,41% in 2003 compared to 0,30% in 1980, while the US reached 0,44% in 2003 compared to 0,31% in 1980). In the government sector can be observed a decline during these years (with the exception of Japan, which percentage increases from 0,26% in 1980 to 0,29% in 2003). In the EU-15, government sector R&D as a percentage of GDP dropped from 0,32% to 0,27% during the same period, with the majority of this fall occurring during the 1990s. This decline is largely due to drastic reductions in funding for government research organisations in countries such as France of UK (OECD, 2002). The US government sector R&D dropped from 0,29% to 0,24%, and the new member states from 0,40% in 1990 to 0,25% in 2003.

Figure 5: **R&D expenditures by performing sector, 1980-2003**



Source: OECD (2005)

Measured as a percentage of GDP (see table 4), public sector R&D spending is highest in Austria, Finland, Sweden, France and Netherlands. It is lowest in Portugal, Greece, Spain, Ireland, Luxembourg and in the new EU member states. Expenditures on R&D in the higher education sector are highest in Sweden, Finland, Austria and the Netherlands with a share in GDP of 0,50% or more. Public sector and private sector R&D expenditures are positively related across countries. Countries with a higher ratio of expenditures on R&D in the higher education sector to GDP tend to have a higher ratio of business sector R&D expenditures to GDP but the correlation coefficient between the government expenditures on R&D and business sector R&S is not statistically significant. Countries with a low initial level of public sector R&D (such as Portugal, Spain, Greece and Ireland) recorded the highest growth during the period 1995-2001. Some smaller EU countries (such as Finland or Denmark) also experienced

an increase in public sector R&D (European Commission, 2003). Ratio between public sector R&D and private sector R&D is highest in some new member states, such as Cyprus, Lithuania, Estonia, Poland or Latvia, Greece, Portugal and Austria. It is lowest in Luxembourg, Sweden, Belgium, Finland and Denmark.

Table 4: **R&D expenditures by performing sector in European countries, US and Japan, 2003**
(% of GDP)

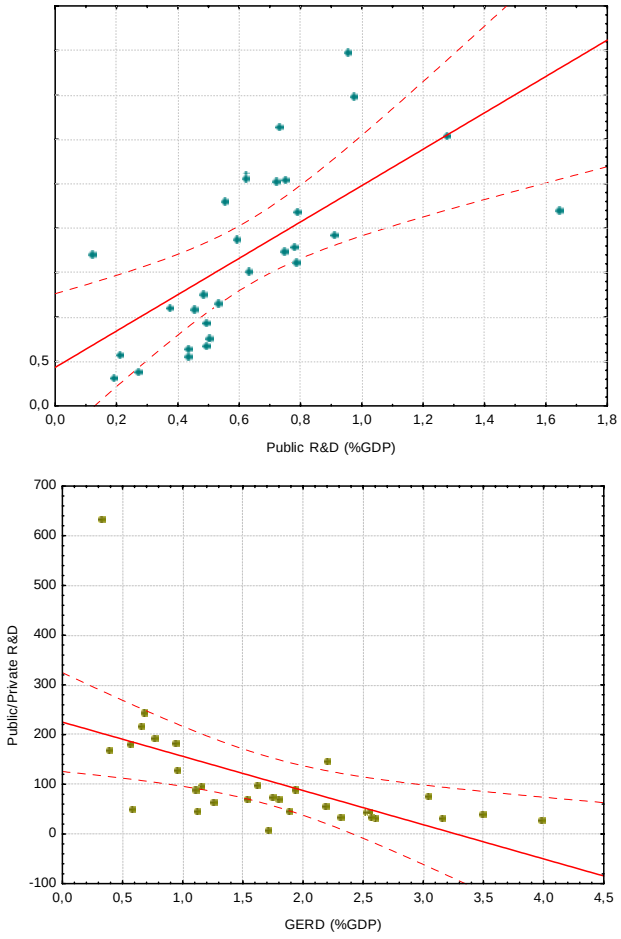
	Total	Public	Higher education sector	Government sector	Business sector	Ratio public/private
Austria	2,77	1,64	0,53	1,11	1,13	1,45
Belgium	2,15	0,55	0,42	0,13	1,60	0,34
Denmark	2,37	0,72	0,44	0,28	1,65	0,43
Finland	3,40	0,97	0,62	0,35	2,43	0,40
France	2,20	0,79	0,42	0,37	1,41	0,56
Germany	2,50	0,75	0,41	0,34	1,75	0,42
Greece	0,63	0,43	0,29	0,14	0,20	2,15
Ireland	1,17	0,37	0,26	0,11	0,80	0,46
Italy	1,09	0,53	0,33	0,20	0,56	0,94
Luxembourg	1,71	0,12	0,00	0,12	1,59	0,07
Netherlands	1,88	0,78	0,51	0,27	1,10	0,71
Portugal	0,76	0,49	0,31	0,18	0,27	1,81
Spain	0,95	0,45	0,30	0,15	0,50	0,90
Sweden	4,26	0,95	0,83	0,12	3,31	0,28
United Kingdom	1,87	0,59	0,41	0,18	1,28	0,46
UE-15	1,91	0,66	0,41	0,25	1,25	0,76
United States	2,62	0,62	0,40	0,22	2,00	0,31
Japan	2,99	0,73	0,44	0,29	2,26	0,32
Slovenia	1,54	0,63	0,25	0,38	0,91	0,69
Czech Republic	1,21	0,48	0,19	0,29	0,73	0,65
Hungary	0,87	0,49	0,24	0,25	0,38	1,29
Estonia	0,76	0,50	0,39	0,11	0,26	1,92
Lithuania	0,69	0,49	0,22	0,27	0,20	2,45
Poland	0,67	0,43	0,22	0,21	0,24	1,79
Slovakia	0,64	0,21	0,06	0,15	0,43	0,48
Latvia	0,43	0,27	0,18	0,09	0,16	1,68
Cyprus	0,22	0,19	0,07	0,12	0,03	6,33
New Member States	0,78	0,41	0,20	0,21	0,37	1,92

Source: Eurostat and OECD (2005)

Next issue to analyse is the complementarity between public and private sector R&D. When most of the literature focuses on the impact of publicly funded R&D that is performed by private firms, this section investigate the impact on private R&D of R&D performed by public sectors. It is need to study if those countries with higher investment in public R&D are those with higher gross investment in R&D. If this, the complementarity between both spheres of R&D would be reinforced. Countries with wider potential for innovation and R&D actually handle with both types of it. In order to get this, correlation analysis between these variables both in terms of percentage over GDP and of the ratio between public and private R&D will be used (see figure 6). Only in the case of complementary, public R&D spending can bring about positive effects on economic growth, because it does not crowd out private efforts.

It can be observed there is a positive correlation (with coefficient equal to 0.66) between public sector R&D and gross investment in R&D (both as % of GDP). It seems to reinforce the idea of complementarity between public and private R&D because those countries with higher gross R&D (and private sector R&D), are those with higher public R&D too. This follows the conclusions of some authors (see, for example, Robson, 1993, Diamond, 1999 or Guellec and van Pottelsberghe, 2000). They give evidence for complementary, while others (see, for example, Bassanini et al., 2001) indicate crowding out effects of public R&D on private R&D.It can be observed that leader countries in terms of innovation handle with both types of R&D, although in higher proportion in the case of private sector one[8]. Countries with higher investment in R&D are those focusing it in the private firms. This fact can be also contrasted if gross investment in R&D (as a percentage of GDP) and the ratio between public and private R&D are faced off. In this case, the correlation coefficient is negative (-0.57). Those countries with higher R&D are those with lower ratios between public and private R&D. It seems to be concluded a certain complementarity between both spheres of innovation. In any case, as only a slight majority of econometric research supports the notion of complementarity, the empirical question should be treated as unsolved or, at least, discussable[9].

Figure 6. **Relationship between public R&D and gross R&D**.



On the other hand, government support for business R&D (which includes direct R&D subsidies and fiscal incentives for R&D) is a small component of total business R&D expenditures. European Commission (2005) shows that rates of government funding of business

[8] Correlation between GERD and public sector R&D (as % of GERD) is negative, with a coefficient equal to –0.71.

[9] David, Hall and Toole (2000) survey around thirty empirical studies on this issue and come to a comparable conclusion.

R&D range from 8% in the EU-15 to 10% in the US. The majority of business R&D expenditures are financed by domestic business. Both in the EU-15 and in the US, the ratio of government funded business R&D to GDP has constantly decreased during the 1980s and 1990s, especially during the first half of the 1990s, and more pronounced in the US. It seems clear that the increases in the intensity of business sector R&D in some smaller member states are largely driven by domestic industry funding, followed by foreign sources. The contribution of financing from government seems to be negligible, thus the US also saw large increases in business R&D, despite significant reductions in government financing. In several other large EU member states, including Italy and the UK, both industry and government financed R&D declined as share of GDP.

Policies that directly target R&D include tax incentives for R&D. The relative generosity of R&D tax incentives differ significantly across the EU. According to the B-index, Spain and Portugal have the most generous fiscal incentives for R&D[10]. The least favourable tax environment can be found in Germany, Sweden, Finland and Belgium. Overall, there has been a significant increase in generosity of R&D tax incentives in Portugal, Spain, France, UK and Japan. In the new member states these kind of fiscal incentives receive a low priority, although, however, their overall corporate tax ratios are already very low compared to those in the EU-15 countries.

Table 5. **Relationships between R&D and innovation related variables and Public Sector performance and efficiency indicators**

Variables	Public Sector Performance		Public Sector Efficiency		GDP per capita	
	Correlation coef.	p-value	Correlation coef.	p-value	Correlation coef.	p-value
GERDpc	0.7392	*0.0000*	0.6953	*0.0003*	0.7494	*0.0000*
GERD (%GDP)	0.6765	*0.0004*	0.6693	*0.0000*	0.6289	*0.0001*
BERD (%GDP)	0.6774	*0.0004*	0.6475	*0.0000*	0.6349	*0.0001*
Public R&D (%GDP)	0.3622	0.0894	0.4432	0.0125	0.3010	0.0999
HERD (%GDP)	0.3458	0.1061	0.5811	*0.0006*	0.4002	0.0257
GOVERD (%GDP)	0.2239	0.2849	0.1427	0.4439	0.0916	0.6242
%GERD in Private sector	0.7118	*0.0001*	0.6107	*0.0003*	0.7025	*0.0000*
%GERD in Public sector	-0.6957	*0.0002*	-0.6269	*0.0002*	-0.7132	*0.0000*
%GERD in Higher Education	-0.6072	0.0027	-0.7484	*0.0000*	-0.7314	*0.0000*
%GERD in Government	-0.3360	0.1263	-0.0723	0.7041	-0.2297	0.2221
%GERD financed by Government	-0.4455	0.0377	-0.5885	0.0012	-0.4358	0.0231
Public/Private R&D	-0.6297	0.0013	-0.4144	0.0205	-0.4616	0.0089
Average patents	0.7040	*0.0002*	0.7011	*0.0000*	0.5637	*0.0010*
EPO patents	0.7165	*0.0001*	0.7086	*0.0000*	0.5610	*0.0010*

Marked in blue coefficients are significant at α=5%, and marked in red coefficients are significant at α=1%
Marked in red cursive coefficients are significant at Bonferroni alpha

The second part of Q3 hypothesis to be tested is which the impact of R&D and, concretely, public sector R&D have on public sector performance and efficiency. From this point of view, R&D can be seen as a key dimension of performance and efficiency within public

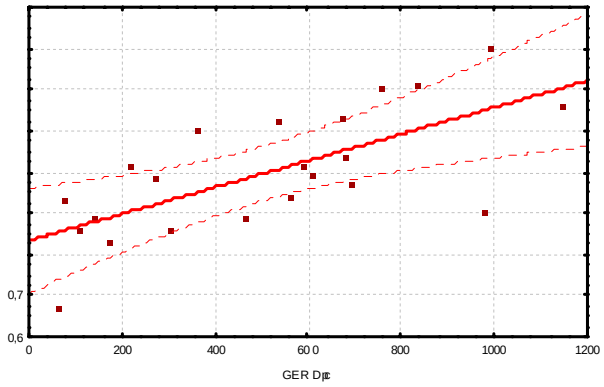
[10] The rate fo tax incentives for each Euro of R&D in 2001 in Spain was 0.44, and 0.34 in Portugal. On the other hand, countries such as Germany (-0.02), Belgium (-0.01), Finland (-0.01) and Sweden (-0.01) presented negative rates (European Commission, 2005b), calculated as 1 minus the B-Index.

administrations, in the same line that innovation and R&D plays a role in overall economic performance and development. Table 5 shows the relationships between the main R&D variables and public sector performance and efficiency (two first columns), and overall economic performance in the last column (measured by GDP per capita).

It can be observed that the links between public and private sector R&D with public sector performance numbers are similar. Those countries with higher income per capita and life conditions are those with better figures in both public and private R&D. This seems to induce the complementarity between both spheres again. Overall, the positive spillover effects seem to dominate the potentially negative impacts so that the net effect of public sector R&D on business sector R&D is positive[11]. University and government laboratory research has both direct and indirect impacts on the public sector performance and overall economy, although public sector R&D spending plays a deeper role due to its incidence over private companies, and not due to its direct activities. Another issue in the same vane is the high positive correlation between R&D investment performed in private sector (0.71). This association is so strong than all variables related to R&D investment performed in public sector show negative correlations with public sector and overall performance.

Ratios between public and private R&D and between public and gross R&D present negative relationships with public sector performance (as can be observed in figure 8) and, less clear, with public sector efficiency. This seems to show that private sector R&D could have been associated in a stronger way with performance and efficiency in public administrations, and with overall economic performance. While the role of public R&D would be key when promoting a more effective private R&D and a higher self-financed innovative activities in private companies. Figure 7 shows this relationship. Those countries with higher gross investment in R&D per capita are those with better public sector performance numbers. As gross and private R&D are very connected, as have been explained above, it seems to be clear that public sectors with better performance indicators are those with higher private sector R&D investments.

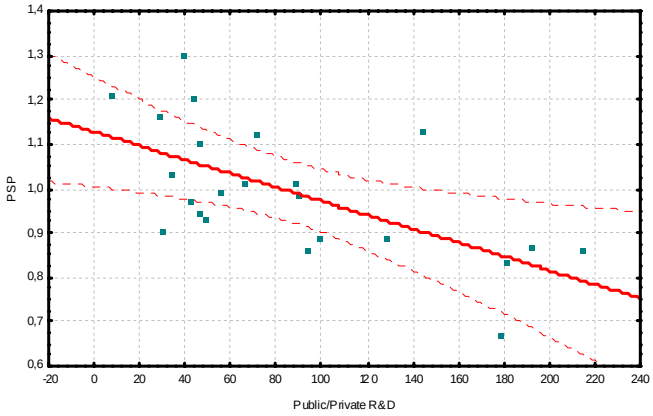
Figure 7. **Relationship between GERDpc and public sector performance**[12]



[11] The empirical literature evaluating the net effects of public R&D on private sector R&D is concerned with basically three sources of negative effects. First, the issue of "input additionality" address the extent to which public R&D assistance induces companies to spend more own additional resources on R&D than they would have spent without public R&D assistance. Second, indirect support through the promotion of R&D performed by higher education centres and government research organisations may substitute for R&D projects which otherwise would have been undertaken by the corporate world. Finally, public sector R&D can act as a substitute to the private earns exclusive property rights to the research results. On the other hand, despite these potential negative effects, the public sector can also act as a complement to the private sector by lowering the cost of research for the industry. University research has historically been an important source of external knowledge, equipment and methodologies for industrial researchers in the development of new products and production processes. Whether the positive stimulation and spillover effects dominate the negative effects discussed above is ultimately and empirical question.

[12] There are no significant differences between associations with public sector performance and efficiency, so results about first one can be translated to former.

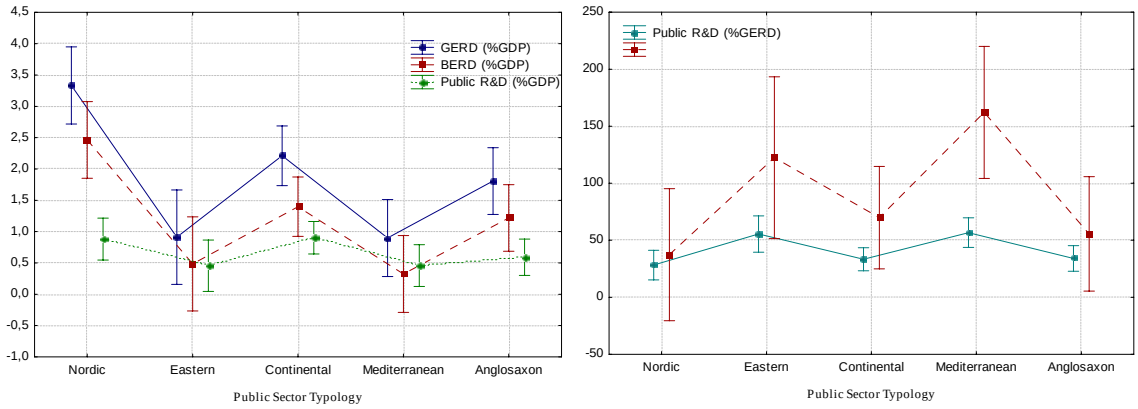
Figure 8. **Relationship between ratio public-private R&D and public sector performance**



5. THE INFLUENCE OF DIVERSITY IN EU PUBLIC SECTOR MODELS: WHAT IS REALLY DIFFERENT?

The final aim of this paper is to analyse the actual differences in R&D performance and systems across European countries according to the structure and model of public sector which characterized each one. Do R&D patterns in EU countries differ according to public sector typologies?. In order to answer this analysis of variance (ANOVA) of one factor methodology has been carried out. The five public sector clusters explained in the second section of this paper –Nordic, Eastern, Continental, Mediterranean and Anglosaxon- will be the factor or independent variable of the analysis, defining the comparable groups. Figure 10 and 11 show the main results (a detail summary table can be seen in the Annexe 1).

Figure 10. **R&D performance of different EU public sector models**

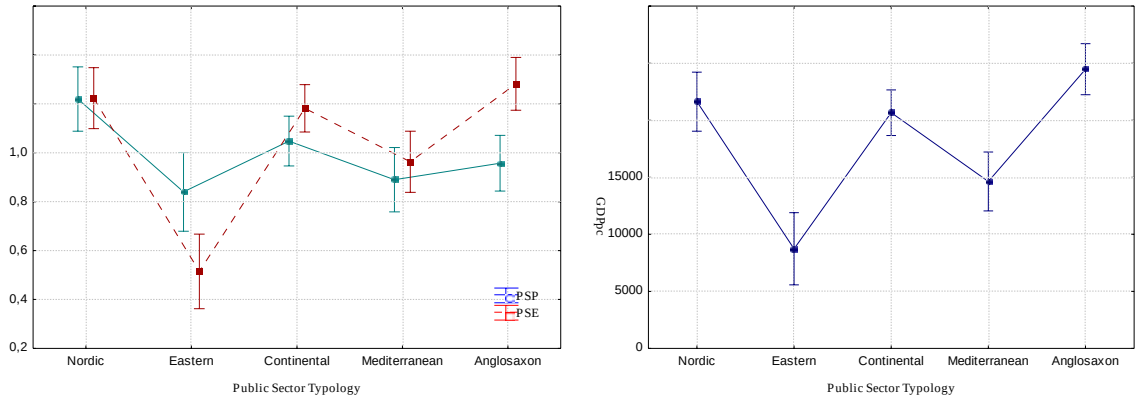


It seems to be clear that intensity of the R&D investment (as % of GDP) and business sector R&D expenditures (as % of GDP) actually differs among groups. Nordic or Scandinavian countries present the highest ratios of gross and private sector R&D, followed by Continental or Western and Anglosaxon ones. On the other hand, Eastern and Southern or Mediterranean group invest a lower proportion of their GDP in R&D activities. Nevertheless, this differences are smoothing when public sector R&D is analysed. Even, in the case of government R&D and

R&D financed by the government the differences are not significant, while the differences on the rest of variables related to R&D are (see table A1.1). This seems to assess the complementary function of public R&D. Those countries with higher gross R&D investment, focus this spending on private projects. The second graph of the figure 10 also shows this pattern. Eastern and Southern countries present higher ratios between public and private R&D. Public sector R&D in these countries represent a higher proportion of the total of R&D investment. Another key variable of R&D activities, R&D services (Nace. 73) doesn't differ significantly among groups.

Similar results conclude if public sector performance and efficiency indicators are analysed (first graph of figure 11). Again, Nordic, Continental and, specially, Anglosaxon countries behaves better than Eastern and Mediterranean ones. Differences observed in terms of R&D patterns, appear in terms of public performance too[13]. Those countries with more developed innovation systems are those with better numbers in terms of public sector efficiency and performance, as section 4 remarked previously. At first sight, differences observed would seem to respond to income and wealth differences, and not to public sector model differences. However, if second graph of figure 11 is observed, this doubt is refuted.

Figure 11. **Overall and public sector performance of different EU public sector models**



Although differences among groups in terms of GDP per capita follow the same path than previously analysed differences on R&D and public sector performance, the rank of each cluster differs. In terms of income per capita, Anglosaxon countries leads, followed by Nordic and Continental countries, and Southern or Mediterranean ones behaves clearly better than Eastern economies. This ranking slightly changes when focusing R&D patterns. Thus, Nordic countries, such as Sweden or Finland, achieve R&D numbers higher than expected, while Anglosaxon and, specially, Mediterranean countries worsen related to expected ranking according to economic position. To sum up, diversity of public sector models in EU countries plays a key role both in terms of R&D patterns and public sector performance and efficiency. Not only economic differences are significant, but differences on the way structuring and administering R&D activities among these five clustering groups are observed in European countries at this time.

6. FINAL REMARKS:

The aim of this paper was twofold: to summarise and discuss the links between public sector structure, performance and innovation in European countries; and to explore the influence

[13] Significant different variables among types or groups of countries can be observed in detail in table A1.2 in the Annexe 1.

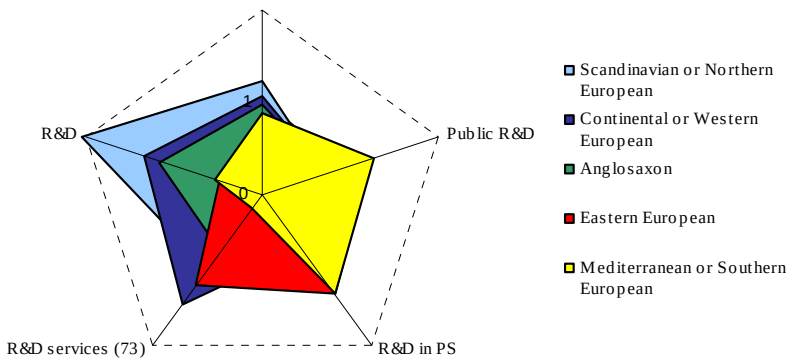
that public innovation might exert on public and general innovation system and performance patterns in EU countries through some R&D indicators depending on the models of administrating and structuring public activities. Since the gap in public research spending between the EU and the United States is quite small, government policies should be directed at stimulating private sector R&D spending, where differences between both economic areas are enlarged.

In latest years, and more deeply after budget constraints derived by stability pact in EU area, a downward trend in public sector size and dimension has been observed. But the question here is whether all public activities have followed this trend or not. Particularly, R&D spending plays a role here. Empirical data show that R&D gross expenditures in the EU-15 increased slightly over the 1980s and 1990s. This increasing is similar than one experimented in the United States, but far from the one in Japan. Similar trends can be observed in business sector R&D, although these differ in the case of public sector R&D spending. While in the higher education sector R&D expenditures increased steadily during this period, in the government organisations can be observed a decline (with the exception of the Japanese case).

On other hand, the debate of the role of the public sector has shifted in these years towards empirical assessments of the efficiency and usefulness of its activities. Economic theory and empirical researches have shown that innovation and, concretely, R&D achieve better economic performance at aggregate level. Focusing on public sector, the results on this paper show that this relationship persist. R&D behaves a key dimension within performance and efficiency of public administrations. Those countries with higher R&D are those with better performance of their public sector activities. Gross R&D and private sector R&D have a longer effect on the public sector performance, while public R&D has importance as supporting and stimulating innovation and research within private firms.

The results also support the importance of public sector R&D for creating spillover effects to the private R&D sector. Expenditures on R&D performed by universities and public research organisations are significantly positively related to business enterprise sector expenditures on R&D, indicating that public sector R&D and private sector R&D are complements. When public sector R&D is disaggregated into its two main components, both government and university R&D spending are significantly positively related to the R&D intensity in the business sector, with the impact of higher education R&D larger than that of the government one. Public sector has an important role to play in innovation by giving financial support and stimulating cooperation with private companies. It seems that the largest impact is achieved when collaboration and public funding are conducted simultaneously. The relevance of complementation in fostering R&D performance identified in this paper reflects the importance of the interconnections between public and private agents. European Commission suggests that it is precisely in this area that the EU tends to score low relative to the United States where public sector research organisations have developed a far more effective system of linkages with the world of innovation.

Figure 12: **Structure, performance and innovation in public sector in Europe and US**
(1-scaled variables)



Finally, figure 12 tries to conclude the empirical work of this paper. It shows the patterns of each model of public sector in EU countries about four key variables within the innovation system –gross R&D investment, Public R&D investment, R&D performed in public sector, and R&D services (Nace. 73)- and public performance indicators. The last research hypothesis of this paper asked for the influence of diversity of public sector models in the European countries. Different ways of structuring and administering public activities across the EU should lead to different ways to performing R&D systems. This can be observed in the following figure.

It seems to be clear that countries with higher R&D, such as Scandinavian and Continental countries, are those with better public performance show, while Mediterranean and Eastern countries present a worse performance in public administrations and lower general R&D figures. This pattern also can be observed if R&D services are analysed. Continental and Scandinavian countries are those with a more developed R&D services sector, although Eastern economies show a high relative development in these kind of tertiary activities. On the other hand, variables related to public sector R&D play the opposite role. Thus, Mediterranean and Eastern countries present the highest values in public R&D (as % of total R&D) and R&D performed within the public administrations, while those countries with higher general R&D spending, such as Scandinavian and Continental ones, present lower values in these two variables.

Public and private R&D deem to be considered as initially complementary but, once a certain level is obtained, countries with a high public sector performance develop much more private R&D than public R&D. This result suggest that a key dimension of the public sector performance should be the capacity of transmitting public R&D efforts in private investments: the capacity of spreading the public funding in economic system and innovation. Further research is needed to complement this type of results with innovation indicators: R&D are just inputs where the returns into innovative products, process or organisational changes do not necessarily to be the same in all countries.

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Annexe 1: ANOVA main results.

Table A1.1: **Summary table of ANOVA statistics**

Variables	Descriptive Statistics					ANOVA statistics	
	N	Mean	Std. Dev.	Minimum	Maximum	F	p
GERD (%GDP)	32	1,68	0,98	0,28	3,98	*0,87*	*0,0000*
GERDpc	27	547,24	313,19	64,50	1150,10	*1,08*	*0,0000*
GERD financed by Government (%GDP)	26	0,61	0,22	0,13	1,04	3,99	0,0145
BERD (%GERD)	31	55,01	18,66	17,40	92,60	*0,09*	*0,0000*
HERD (%GERD)	31	20,61	11,12	0,00	44,90	5,70	0,0019
GOVERD (%GERD)	31	20,35	15,88	1,30	61,70	*6,27*	*0,0000*
Public R&D (%GERD)	31	40,95	15,01	7,30	72,40	*8,49*	*0,0001*
%GERD in Private Sector	31	56,27	17,90	16,90	88,90	*7,83*	*0,0002*
%GERD in Higher education	30	18,38	12,12	1,30	49,80	*0,24*	*0,0000*
%GERD in Government	30	24,42	8,72	9,00	49,50	3,29	0,0268
%GERD in Public Sector	31	41,77	16,97	11,10	83,20	7,74	0,0003
R&D financed by Government (%GERD)	27	6,63	5,09	0,80	22,10	2,35	0,0857
BERD (%GDP)	31	1,08	0,79	0,03	3,31	*4,26*	*0,0000*
HERD (%GDP)	31	0,37	0,18	0,00	0,83	7,44	0,0003
GOVERD (%GDP)	31	0,25	0,19	0,03	1,11	0,87	0,4925
Public R&D (%GDP)	31	0,63	0,31	0,12	1,64	3,97	0,0120
Public/Private R&D	31	106,69	115,90	7,54	633,33	2,75	0,0493
GBOARD (%GDP)	25	0,68	0,25	0,25	1,18	3,04	0,0413
EPO patents	31	89,11	91,54	0,50	339,20	*6,00*	*0,0000*
Triadic patents	26	34,83	33,34	0,30	119,20	7,02	0,0009
Average patents	31	59,65	61,31	0,50	229,20	*5,12*	*0,0000*
GVA R&D Services (Nace. 73)	23	0,40	0,35	0,03	1,36	2,26	0,1025
Employment R&D Services (Nace. 73)	23	0,37	0,30	0,00	1,20	2,46	0,0824
PSP	23	0,99	0,14	0,67	1,30	8,85	0,0003
PSE	32	1,00	0,33	0,31	1,55	*4,08*	*0,0000*
GDP per capita	32	18299,52	6553,98	7665,44	34589,37	*2,27*	*0,0000*
PS expenditure (%GDP)	32	45,33	7,02	34,10	58,70	2,94	0,0386
PS revenue (%GDP)	32	31,95	5,88	23,20	47,10	*1,91*	*0,0000*
PS employment (%total)	23	16,63	6,38	5,70	31,70	1,55	0,2293

Marked in blue effects are significant at α=1%, and marked in red effects are significant at α=5%.
Marked in blue cursive effects are significant at Bonferroni probability (with α=1%)

Tabla A1.2. **Variables which difference PS models**[14]

	Northern or Scandinavian	Eastern	Western or Continental	Southern or Mediterranean
Eastern	GERD GERDpc HERD (%GDP) R&D in Education BERD (%GDP) EPO and avg. patents PSE PSP GDPpc PS employment	*******	*******	*******
Western or Continental	PS revenue PS employment	GERD GERDpc R&D in Education EPO and avg. patents PSE GDPpc	*******	*******
Southern or Mediterranean	GERD GERDpc HERD (%GDP) BERD (%GERD) R&D in Private R&D in PS R&D in Gov BERD (%GDP) EPO and avg. patents PSP GDPpc PS revenue PS employment	PSE	GERD GERDpc R&D in Private EPO and avg. patents GDPpc	*******
Anglosaxon	GERD EPO and avg. patents PS expenditure PS revenue PS employment	GERDpc PSE GDPpc PS expenditure	PS expenditure	R&D in Gov PSE GDPpc

[14] According to ANOVA results with Bonferroni test ad-hoc criteria.