Analysing territorial and sectorial dimensions of public-private partnerships in Science, Technology and Innovation policies

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The performance of innovation systems depends, largely, on its degree of public-private collaboration. Thus, innovation policies are often aimed to improve this collaboration through public-private partnerships. These are a multidimensional phenomenon whose success depends on factors related to each of its dimensions. This paper proposes the use of an analytical framework that reflects the multidimensional nature of public-private partnerships and allows a diagnosis of the degree of public-private collaboration in a specific system and a description of the factors that act as its barriers or drivers within that system. It is expected that this model could help policy makers to design appropriate public-private partnerships in each context. The Spanish innovation system is the reviewed case, given that the lack of collaboration is a structural problem within it since several decades ago, despite the implementation of policies aimed to solve it. Thus, if model works, key factors should be identified.

Keywords: Public-private partnerships; innovation policy; process tracing; innovation system; governance

Introduction

For a large part of the literature, public-private collaboration within innovation systems is an essential governance mechanism, and an increasingly prominent instrument to promote innovation, both in terms of strengthening internal capacity to innovate as well as absorbing knowledge from abroad (Weresa, 2017, p. 202). One of the most effective and most commonly used tools to structure this collaboration are public-private partnerships (PPP) (Rasmussen, 2016, p. 28). Since 2004, virtually all European Union (EU) countries have implemented innovation policies based in PPP formulas (Izsák, Markianidou, & Radošević, 2013, p. 52), but with very different impact on their innovation systems. The complexity and multi-dimensional nature of the PPP phenomenon (Hodge & Greve, 2013; Weihe, 2008) and the existence of several factors

influencing its success (Carbonara, Costantino, & Pellegrino, 2013; Carbonara & Pellegrino, 2018, 2019; Krumm, 2016), could explain this situation.

Literature analysing those factors have usually approached PPPs from a one-dimensional approach, focusing mainly on specific projects in certain sectors (e.g. Acerete, Gasca, Stafford, & Stapleton, 2015). Carbonara et al. (2013, p. 801), tried to solve this lack proposing a three-layer model for cross-country and cross-sector characterisation of PPPs. More recently, Carbonara and Pellegrino (2018, 2019) have proposed a model that focuses on four main PPP aspects: the arrangement structure, the industry structure, the contract structure, and the network structure. At the innovation policy field, Koschatzky and Stahlecker (2016, p. 12) defined an analytical framework for PPPs in research. However, Catalá-Pérez and De-Miguel-Molina (2018) have defined an analytical framework for PPPs in innovation, taking in account the aforementioned multi-dimensional nature (defining territorial, sectoral and organizational dimensions) and complexity (including levels and several variables in each dimension) of PPPs. This model is intended to analyse the situation of the public-private collaboration in a specific innovation system, to identify those key factors that are influencing on it and to review the different PPP formulas implemented in the system.

Give the importance of PPPs for innovation performance, this paper is aimed to test the analytical capacity of the commented model through its application to a specific case. In this way, it could be established as a valid framework for the design of innovation policies based on PPPs in a given context. The Spanish innovation system (SIS) is the reviewed case. Spain have been implementing innovation policies focused on improving public-private collaboration since decades ago (Giachi, 2018). Despite this, the SIS have been warned by national and international institutions on several

occasions about its poor performance in this area (European Council, 2019). Thus, the paper also covers a gap in the literature about the SIS. Few authors have focused their SIS reviews from such PPPs perspective, with the exception of some already outdated documents (Fundación Cotec, 2008; Sanz Menéndez, 2003), other few works focused on specific PPP experiences (e.g. Fernández-Esquinas & Ramos-Vielba, 2011; Mora-Valentin, Montoro-Sanchez, & Guerras-Martin, 2004) or a recent contribution about the emergence of Collaborative Research Centres (CRC) in Spain (Giachi, 2018).

Theoretical framework: the importance of PPPs for innovation

Scientific literature is confusing when defining PPPs, due to the different research approaches (Weihe, 2008) and their complexity as a multidimensional phenomenon (Hodge & Greve, 2013). Moreover, the innovation process is complex and includes different activities (OECD/Eurostat, 2018). Thus, the definition of PPPs in innovation is also difficult and it depends on the criteria followed to delimit their scope. In this sense, from a broad approach, PPPs in innovation are defined as formal mid or long-term relationships established between public and private agents within the framework set out by the competent authorities which aim to jointly finance, operate or manage innovation activities, in which risks and benefits are shared among the agents involved (Catalá-Pérez & De-Miguel-Molina, 2018). This definition reaches maximum meaning in a systemic scenario where the interactions between these agents are essential to explain the way in which knowledge is created and transferred within the innovation process and the governance model of the system.

In terms of governance, Kuhlman (2001) already foresaw three possible scenarios for the governance of innovation policy in Europe, starting from the recognition of a multi-actor and multi-level context. In this sense, the concept of governance networks (Sørensen & Torfing, 2009) applied to the field of innovation,

results in the so-called collaborative. For several authors, this is an effective formula to boost innovation from the public sector, based on interaction with actors of different nature (Hartley, Sørensen, & Torfing, 2013; Sørensen & Torfing, 2011, 2017). Then, the literature has recognised the existence of a policy mix dimension and a multi-level governance dimension (Magro & Wilson, 2013, p. 1649) which can be defined as the horizontal and vertical governance dimensions (Hassink & Marques, 2015, p. 129). In a deeper study of the horizontal dimension, Oughton et al. (2002, p. 98) stated the need for political initiatives based on collective learning and institutional innovation, rather than on purely financial aspects, and a governance model based on collaboration between the public and private sectors. For Muscio et al. (2015), the "machinery" of the governance of innovation systems requires the wholehearted promotion of partnerships in the management of innovation platforms. Grillo and Landabaso (2011, p. 548) emphasised the need to sustain regional development policies in instruments to promote innovation based on solid public-private collaboration. Chung (2016, p. 163) emphasised the need to align PPP strategies with each of the multilevel innovation systems.

About knowledge, the literature has proposed different innovation models linked to certain modes of knowledge creation in which knowledge arises from the collaboration between the different public and private agents in the system (Carayannis & Campbell, 2009; Etzkowitz & Leydesdorff, 1995; Gibbons et al., 1994). The Open Innovation strategy, according to Chesbrough (2003), is generated via experimentation and collaboration between companies, universities, government and end users. Thus, PPPs can occupy a prominent space. Cunningham and Gök (2016, p. 239) stated that collaboration with customers, suppliers, higher education institutions and even competitors contributes to greater productivity and, therefore, can be positively

associated with the innovative efficiency of companies. Companies themselves "call on public authorities to complement their own action through funding research projects and increasing public-private collaboration" (Potters & Grassano, 2018, p. 4). Institutions as the Organisation for Economic Co-operation and Development (OECD) (2014, p. 9) stated that PPPs play a particularly important role in reducing the uncertainty and complexity inherent to business innovation processes and can help to reduce the technical and financial risks associated with these processes. For Witters et al. (2012, p. 86), PPPs also enable the improvement of the skills and capabilities needed for human capital to promote innovative thinking, culture and creativity.

But also Rasmussen and Redi (2016, p. 141), besides considering PPPs the best formula for effective knowledge transfer and faster commercialisation of innovation, pointed the need to explore citizen participation through the public-private-people partnerships that facilitate open innovation driven by users themselves. In this sense, most recent debate about next generation innovation policies facing grand societal challenges (Fagerberg, 2018; Schot & Steinmueller, 2018), highlights the need of implementing cross-sectoral and directional mission-oriented (Mazzucato, 2018) and challenge-oriented policies (Boon & Edler, 2018), based in transformative PPPs that must allow collective action (Kuhlmann & Rip, 2018).

However, as innovation performance is affected by several internal and external factors (OECD/Eurostat, 2018), the greater or lesser success of PPPs in innovation could be similarly influenced. Part of the public polices literature has identified various contextual factors (e.g. political, ideological, financial, legal, cultural, etc.) influencing at the territorial dimension when comparing PPPs implementation in several countries (Akintoye, Beck, & Kumaraswamy, 2016; Krumm, 2016). Authors interested in PPPs in sectoral policies pointed different factors influencing each of these sectors (related to

policy governance, sector structure, legal framework, etc.) (e.g. Acerete et al., 2015 in health; or Chou, Ping Tserng, Lin, & Yeh, 2012 in infrastructures). And finally, PPPs' management literature agrees with the existence of organizational factors related to the PPPs' structure and functioning (Parrado Díez & Reynaers, 2017; Zou, Kumaraswamy, Chung, & Wong, 2014). Recent reviews about barriers and drivers for university-industry collaboration, one of the most analysed PPP formulas in an innovation system, have also identified factors in these three dimensions (Bjursell & Engström, 2019; Garcia, Araújo, Mascarini, Santos, & Costa, 2019; Rybnicek & Königsgruber, 2019). In this context, multi-dimensional analytical models as the one defined by Catalá-Pérez and De-Miguel -Molina (2018), maybe suitable frameworks for a comprehensive analysis of PPPs in innovation in an specific country (Table 1).

TABLE 1

Methodology

This paper is aimed to test the analytical capacity of the aforementioned model through its application to the specific case of the SIS, characterized by its low level of public-private collaboration (European Council, 2019). Consequently, it is also expected to identify the main factors that have caused and cause this situation. But some comments about the scope of this paper are necessaries. The proposed analytical framework includes general to highly specific variables (as can be seen at Table 1, they have been coded to give a clear explanation at the results section). All of them have descriptive capabilities. However, those that make up the territorial and sectoral dimension levels also play an explanatory role, while the variables in the organisational dimension also have prescriptive functions, which allow to identify PPPs really functioning as such (Catalá-Pérez & De-Miguel-Molina, 2018). Thus, given that from a public policy approach, territorial and sectoral factors themselves can explain the different levels of

PPP activity in different countries (Krumm, 2016, p. viii), we have applied the model for these dimensions of the SIS. Future research could deepen in the organizational analysis of specific PPPs or even conduct international comparative studies.

From a methodological point of view, a single case has been analysed by process tracing, a "research method for tracing causal mechanisms using detailed, within-case empirical analysis of how a causal process plays out in an actual case" (Beach, 2017). For some authors this is the best method to study causal mechanisms in political science (Beach & Pedersen, 2011, p. 2; George & Bennett, 2005, p. 224) or even in public administration studies (Charbonneau, Henderson, Ladouceur, & Pichet, 2017). Given that the main objective of this paper is to test whether that causal mechanism defined at the proposed analytical model is present in case, we are applying the theory-testing variant of the process tracing method (Beach & Pedersen, 2011, p. 29). In addition, as the research seeks to improve the understanding of a specific phenomenon, it adopts an exploratory approach and an empirical-descriptive orientation.

The meso and macro level analysis of a case, such as this, requires important documentation work. The information collecting, and processing techniques used are mainly of qualitative nature. But some minor quantitative analysis have been conducted basically when reviewing some indicators about innovation performance. In this sense we have followed the guidelines established by the OECD manuals on R&D and innovation activities (2018; 2015). The data presented have been obtained, basically, from the Spanish National Institute of Statistics, Eurostat, the OCDE statistical portal and the databases of the main international innovation indexes, such as the Global Innovation Index (GII), the European Innovation Scoreboard (EIS) or the Global Competitiveness Index (GCI). Regarding the qualitative part of the research, we have

conducted a content analysis and critical documentary review of scientific articles, working documents, policy reports, legislation and other official Spanish publications (strategies, national plans, annual work programmes, etc.).

Case study: a brief insight into the Spanish innovation system

In 1986, the first Spanish Law of Science established STI policies for Spain. However, it was not until the approval of the current Law of Science in 2011 when a national system of innovation specifically built and adapted to the circumstances of the country was defined. Since 1986, the SIS has grown remarkably, although not at the same rate as the Spanish economy (Mulet-Meliá, 2018, p. 6). Total expenditure on R&D in Spain has doubled, while GDP per capita has quadrupled.

The SIS has not grown as fast as the innovation systems of neighbouring European economies either, and especially those with which Spain should be compared in terms of wealth (Fundación Cotec 2018). According to the 2017 EIS, Spain has moderate innovation performance that stands at approximately 80 per cent of the EU average. As we can see in Figure 1, several countries with lower GDP per capita have similar (Malta, Cyprus, Portugal, Czech Republic, Estonia and even Lithuania) or even higher innovation performance (Slovenia) than Spain. Only Italy has higher GDP per capita than Spain and poorer innovation performance. It can also be seen that there is an important gap in innovation performance between Spain and countries with higher GDP per capita. The current trend of the SIS is not likely to reduce this distance (Figure 2).

FIGURE 1

FIGURE 2

During the recession, most of the European countries with highest innovation performances applied countercyclical policies, reinforcing their investment in science as a means to boost economic growth and social improvement, while in Spain the

government cut STI policies, bringing very negative effects to the SIS (De-Nó et al., 2018, p. 25; Modrego et al., 2018, p. 6). As shown in Figure 2, Spain has still not returned to the levels of investment in R&D of 2009, while the EU has exceeded them. Some authors talk about a lost decade for STI policies in Spain when referring to this period of time (Fundación Cotec 2018).

The analysis of the current situation suggests that the evolution of the SIS has hit ceilings that advise a thorough redefinition of its policies and of the system itself. The scientific community and an increasing number of national and international organisations that have analysed, monitored and evaluated STI policies have been claiming this for years (COSCE, 2017). The SIS has an inherent series of structural issues which, if not tackled, may compromise the long-term economic growth and development of Spain, as well as the welfare of society. These include a lack of collaboration between the public and private agents in the system, despite the awareness of the importance and necessity of this type of joint efforts in Spain (European Council, 2018).

Application of the analytical framework

A. Territorial dimension (country)

A.1. PPPs in their historical context and as a cultural set of assumptions

A.1.1. Political-ideological influences

For some authors (Bortolotti, Fantini, & Siniscalco, 2004), right-wing governments use PPPs more often and start processes earlier, while left-wing governments are more inclined to use in-house resources (Plantinga, de Ridder, & Corra, 2011). However, it seems that all governments resort to PPP instruments to a certain extent (Krumm, 2016)

and ideology simply has a greater influence in determining the specific type of instrument and government justification for using them (Gingrich, 2011).

At the beginning of the 1980s, privatisation became common place in Western economies. Spain participated in this trend, especially after it joined the European Economic Community. In 1985, a first phase of privatisations was started under the Spanish Socialist Party government, which lasted until 1996. That same year, with the arrival of the conservative *Partido Popular* government, a second phase of privatisations was initiated, coupled with the progressive liberalisation of certain sectors, generally driven by the EU, such as the energy sector, the telecommunications sector and the postal service. From the second half of the nineties onwards, the use of PPP mechanisms intensified, especially in certain sectors such as infrastructures and health. Spain was among the European countries that implemented this type of formulas intensively, with the second highest number of PPPs in the period from 1995 to 2011, only behind the United Kingdom (Švigelj & Hrovatin, 2013, p. 77). This trend has changed in recent years, especially at regional level, with the formation of new left-wing coalitions after the 2015 elections in a new political scenario for Spain which began to slow down and even reverse the use of PPPs (Catalá-Pérez & Del-Pino, 2018; Del-Pino & Catalá-Pérez, 2016).

A.1.2. Territorial design

The capacity of the state government to intervene, as well as the capacity of regional governments to design their own policies and resist State pressures, depends on the degree of decentralisation of powers in specific areas of public policy (López-Santana, 2015).

The Spanish Constitution of 1978 established a composite state model that led to the creation of the seventeen Autonomous Communities (AACC). This also meant the

beginning of a profound process of decentralisation, transforming the old centralised State into a new one that features different levels of government (local, regional, state and supra national) with a complex division of powers. The expansion of PPPs has occurred at the three levels of Spanish government (Del-Pino, 2015). In fact, from 1998 to 2006, the regions were the stratum of government that most applied this formula (Allard & Trabant, 2008). The recent experience with PPPs in the field of active labour market policies is a clear example of conflict of powers (Catalá-Pérez & Del-Pino, 2018).

A.1.3. Economic and financial factors

PPPs enable private investment to pay for the construction of infrastructures and the provision of public services. In this sense, an increase in the use of PPPs was expected as a result of the financial crisis. Yet literature is ambiguous in this sense, and in some cases, governments could have reduced the role of other levels of government or actors and even recentralised power in order to better control their accounts and the results of their policies (Braun & Trein, 2014). In the case of Spain, one of the criticisms received as a consequence of the application of PPPs was that it had been done without a strategic perspective, and was based solely on the budgetary objectives of increasing investments in infrastructure, on the one hand, and reducing public debt on the other (Allard & Trabant, 2008).

A.1.4. Administrative culture

The different PPP formulas are management instruments linked originally to the paradigm of New Public Management (Pollitt & Bouckaert, 2017). However, the degree of implementation of these reforms has varied considerably among European countries, based on their differing political and legal backgrounds (Ferlie & Steane, 2002, p. 1461).

In Spain, the last major reform project was carried out in 2012 by the CORA commission. This focused mainly on thinning the State apparatus and, in general, had little impact on organisational culture. In Spain "the modernizing processes have not really had the will to modify the administrative culture or they have not achieved it due, essentially, to the lack of political leadership and the scarce perseverance in the changes introduced" (Arenilla, 2017, p. 314).

A.1.5. Institutional framework of PPPs in general

Institutional framework refers to the legal framework for PPPs and the different bodies in charge of their promotion and institutionalisation (Pastor-Albaladejo & Medina-Mairal, 2016). When referring to the regulatory framework in Spain, the only direct regulatory reference governing PPPs disappeared with the approval of the new Public Procurement Law in 2017. The former specific public-private collaboration contract no longer exists, and the law only regulates concessions, which are only one of the possible PPP formulas.

In terms of the bodies responsible for the promotion and institutionalisation of PPPs, the Public Procurement Law also establishes an institutional framework, yet it should be borne in mind that this is a general framework for the whole scope of public procurement (Pastor-Albaladejo & Medina-Mairal, 2016). About PPPs, the National Evaluation Office, created by law in 2015 but not developed as such to date, aimed to analyse the financial sustainability of construction and public service concession contracts (typical PPPs) and to coordinate and monitor the efficiency and viability of PPP investment projects. After several legal reforms, nowadays it has lost its independence, official name and original PPP analysis functions.

B. Sectoral dimension (STI policies)

B.1. PPPs as a governance model

B.1.1. Sectoral legal framework

The Spanish Science Law defines the SIS as the set of public and private agents that develop financing, performance and coordination functions as well as the relationships, structures, measures and actions that are implemented to promote, develop and support STI policies (horizontal governance). In addition, the SIS is considered as a system of systems that brings together the mechanisms, plans and actions that can be defined and implemented both by regional and national government (vertical governance) in the public sphere.

According to the law, one of the challenges that the SIS must tackle is to ensure greater collaboration among its agents through a governance model based on public-private collaboration. In fact, one of its general objectives is to strengthen this collaboration. The fundamental instrument on which SIS governance pivots is the Spanish Strategy for STI, which is configured as the multi-year national reference framework to achieve the general objectives of the law. It is aligned with European policies and is developed by the Spanish State through its State Plans. The AACC, in turn, develop it through their own organisational and planning instruments. In fact, the European Commission conditioned access to structural funds to the definition of regional priorities, through the Research and Innovation Smart Specialisation Strategies (RIS3).

The Spanish Science Law is therefore the basic legal framework for STI policies in Spain. However, there are other regulations which have an impact in this field such as the Public Procurement Law; the Subsidy Law and the annual State budget laws; the University Law; the Patents Law; and the Entrepreneur Support Law.

B.1.2. Institutional framework: innovation system

B.1.2.1. Vertical governance: agents and distribution of power

One of the SIS problems highlighted by the European Council (2018) is the weak coordination between national and regional levels in terms of the design, application and evaluation of STI policies.

The Spanish Constitution establishes that the State has exclusive authority over the promotion and general coordination of scientific and technical research. Conversely, the Constitution gives the AACC powers to promote culture and research. The Constitutional Court has ruled that both the State and the AACC are competent in the promotion of scientific and technical research, and beyond the competence of the latter in matters of general coordination, both levels of government have full legislative and executive functions. The AACC have wholeheartedly embraced the role of promoting innovation, establishing their own mechanisms to support technological innovation, given that these are not subject to general State coordination (Díez-Bueso, 2013). This theoretical separation between scientific and technological activities and innovation does not exist in practice, which adds confusion to the distribution of power.

Finally, local governments lack specific powers, but are supported in general by Local Statutes (Gómez-Puente, 2007, p. 262). Thus, the role of local entities in the field of innovation is growing thanks to concepts such as smart cities and living labs, turning them into optimal fertilisation and hybridisation environments for research and innovation to drive urban development.

The Spanish Ministry of Science, which has suffered much instability in recent years, is in charge of the coordination of STI policies and their management at national level. Moreover, the STI Policy Council is the highest general coordinating body for the SIS. It is made up of important State and regional members. It works together with the

STI Advisory Council, which include the most representative business associations, trade unions and leading members of the scientific and technological community. Thus, this body is also linked to horizontal governance. These coordinating agents worked on drafting and approving the Spanish Strategy for the period 2013-2020 and are at present drawing up the new Spanish Strategy for 2021-2027.

On the other hand, the STI Public Policies Network also acts as a mechanism for multilevel coordination of public STI actions to generate synergies between regional, national and European bodies. This Network held its 7th Annual Meeting in March 2018, but evidence of its activities beyond 2015 is scarce.

B.1.2.2. Horizontal governance: agents, roles and level of involvement

Coordinating agents

Besides the competent ministry, planning functions at national level are carried out by the Executive Committee for STI Policy, the government body that plans and monitors the STI policy and coordinates the different ministerial departments involved in the implementation of this policy.

The STI Advisory Council is the (horizontal) participation body for the scientific and technological community and for economic and social agents, formally regulated by the 2015 law. The current minister affirmed that the Council should be empowered “as an organ of participation of the scientific community and of the economic and social agents” because until now it had not met ‘with the desirable frequency and its deliberations have not been made public’ (General Secretariat of the Congress, 2018, p. 4).

Likewise, the Ministry of Finance could be mentioned as a coordinating agent, as it is responsible for preparing the State Budget law (PGE) according to the proposals of the different ministries, as well as the different committees created for this purpose,

since these are the legal instruments that distribute the public funds for STI policies to the different financing agents involved in them.

Financing agents

Different Spanish governments have repeatedly been criticised by the scientific community for allocating scarce resources and not paying due attention to STI policies. This has led to a weak SIS, lacking the necessary financial and human resources and structures, instruments and management regulations and making it extremely difficult to perform research activities (Fundación Cotec 2018). Historically, the weight of the PG46 (the spending policy for STI policies) in the state budget has always been very limited and governments have never taken an active decision to promote this type of policy (Modrego et al., 2018, p. 7). The weight of the PG46 out of the total 2018 budget has only increased by 0.17 per cent compared to the year 2000. Since the beginning of the recession, the resources allocated in the PG46 have fallen by approximately 30 per cent (De-Nó et al., 2018, p. 8). In addition, the earmarked funds have not been spent. In recent years, only around 30 per cent of the funds allocated have been used, a figure which is well below the forecast (Modrego et al., 2018, p. 2). The lowest levels are found in financial assets, mainly used to finance innovation activities in companies through credit instruments (De-Nó et al., 2018, p. 21). In fact, public loans for business R&D have dropped by more than 20 per cent since 2011 (Fundación Cotec 2018 p. 102) when, for example, there was evidence that public support increased the chances of a firm cooperating with a public research organisation (Busom & Fernández-Ribas, 2008).

In this context, the degree of financial involvement of the Spanish private sector in the SIS is significantly below the European average and is way below the leading countries in investment and technological innovation. Figure 3 shows the internal R&D

expenditure funded by the EU countries' business sectors as a percentage of GDP in relation to their innovation performance, according to the 2017 EIS. The higher the funding participation of the business sector, the better the country's innovation performance. In Spain, this variable has remained stable over time, stagnating at around 46 per cent of total R&D expenditure over the last ten years. The lack of clear and decisive public support, with policies appropriate to the characteristics of the business sector is, as has been suggested, one of the main causes of this problem (Fundación Cotec 2018).

FIGURE 3

The behavioural pattern of financial flows between the public and private sectors demonstrates the limited structural collaboration between them. In 2017, the public sector financed 86 per cent of its own activities and the private sector financed 82 per cent of its own business activities. Figure 4 shows the percentages of private sector R&D expenditure funded by the public sector and vice versa. The private financing of public expenditure has not changed since 1997, although public financing of private expenditure grew considerably until the beginning of the economic recession in 2008.

FIGURE 4

Performance agents

The Spanish Unique Scientific and Technical Infrastructures, which are public facilities, resources, equipment and services, dedicated to premium quality, cutting-edge technological research and development, universities and Public Research Organisations (PROs) are responsible for most of the research activity. Yet the scenario becomes complex with the existence of other public, private and public-private organisations which, in turn, may be assigned to one or several public administrations or operate in different territorial areas (Giachi & Fernández-Esquinas, 2018). These organisations

include research centres focused on knowledge creation and the so-called interface structures. Technology Centres, Research Results Transfer Offices (OTRIs), Science and Technology Parks and Technological Platforms are the main interface structures mentioned above. In addition to considering them as performance agents, they are elements whose own existence and level of activity are already an interesting measure of the degree to which PPPs are a tool that is effectively applied in the SIS.

The number of Spanish companies that carry out innovation activities is reflected in the annual "Survey on innovation in companies" conducted among Spanish companies with 10 or more employees by the INE. This survey defines EIN companies as those with technological innovations that have been completed or are in progress or which have unsuccessfully tried to innovate during the three years prior to data collection. For the period 2014-16, there were 21,469 EIN companies in Spain. Table 2 includes the number of performance agents, resulting in a complex scenario, taking into account the overlap of these agents at different government levels.

TABLE 2

The main indicators used to analyse the role of performance agents are internal expenditure, the personnel working on STI activities, and the scientific and technological results obtained. However, from the point of view of PPPs, the analysis of the relations that take place between the different actors is particularly interesting in order to seek synergies and find points in common between them to develop innovation processes and manage policies (Boon & Edler, 2018, p. 443). The percentages reviewed above of public R&D expenditure financed by the private sector and vice versa could be used as one of them. In addition, the existence of interface structures and joint research structures and the review of certain indicators that aim to measure the number of R&D and innovation activities carried out and results obtained in cooperation (Mulet-Meliá,

2018) could also prove to be interesting information.

In the review of the performance agents, the existence of different interface structures is clear (technology centres, OTRIs, science and technology parks and technological platforms). OTRIs and technology platforms arose out of public programmes whose objectives were to facilitate results transfer and increase collaboration among SIS agents. Technology parks arose in Spain, following the American model, to attract high-tech companies and become poles of development. The science parks are a particular variant of this model, generally created in the environment of a university to take advantage of its scientific and technological capacity.

Based on the analysis of the complex network of performance agents, Giachi & Fernández-Esquinas (2018) identified and classified the Spanish CRC, defined as organisations or units within a larger organisation "that perform research and also have an explicit mission (and related activities) to promote, directly or indirectly, cross-sector collaboration, knowledge and technology transfer, and ultimately innovation" (Boardman & Gray, 2010, p. 450). The 216 Spanish CRCs are divided into three different categories: innovation and technology centres, cooperative research and excellence networks, and *ad hoc* R&D institutes (Giachi & Fernández-Esquinas, 2018, p. 162).

Despite the existence of this whole network of interface and CRC structures, the innovation performance of the business sector is not as good as expected. R&D expenditure in terms of GDP percentages in the Spanish private sector is significantly below the EU average (0.66 per cent compared to 1.36 per cent in 2017). Something similar happens when analysing the level of private expenditure on R&D as a percentage of total expenditure on R&D in Spain compared to the European average (55.13 per cent compared to 66.58 per cent in 2017).

In addition, according to the "Survey on innovation in companies", there has been a significant decrease in the number of EIN companies since 2004, both in absolute numbers (from 54,119 companies to 21,469) and in percentage terms (from 31.37 per cent to 14.82 per cent of survey population). Within the survey population of companies, those that collaborate with other actors (including both private and public actors) represent a very low percentage of the total, which has remained stable at around 4 per cent for years. In turn, the number drops further if we only include those that collaborate with universities (32.47 per cent of those that collaborate, i.e. 1953 companies) and research centres (3122 of collaborative companies, representing 51.91 per cent). These data do not differentiate between public or private universities and research centres, so the percentages will be lower if only public actors are taken into account.

Finally, following Mulet (2018), we analysed some of the indicators that are used to draw up the three international indexes commented at methodological section. These indexes are drawn up using wide groups of indicators focused on several innovation performance factors. Table 3 shows the Spanish position in each general ranking index and in those indicators related to public-private partnerships. In all cases except one (the number of public-private co-publications, within the EIS), the Spanish position in specific indicators has worsened compared to the general indexes.

TABLE 3

B.2. PPPs as a public policy

B.2.1. Evolution

From the perspective of the promotion of PPPs, Giachi (2017, p. 116) defined three stages in the evolution of Spanish STI policies, from the 1960s to the present, following

the sequential model established by Jacob et al. (2000, p. 256) regarding the development of collaborative relationships between the scientific and business sectors: 1st phase policies based on the linear model of knowledge transfer; 2nd phase policies favouring a model guided by the market or users; and 3rd phase policies that drive an interactive, integrated or networked model (Table 4).

TABLE 4

The role of regional governments in Spanish STI policies has varied considerably. Some regional measures to promote PPPs have not gone beyond political statements and others have led to policies resulting in the creation of different tools and specific organisations to promote the stability of collaborative research (Giachi, 2017, p. 122).

B.2.2. Strategy

According to the law, the measures established by government to strengthen the system should be directed at defining and implementing public-private collaborative management. The aforementioned Spanish Strategy is the tool to enhance all the capabilities of the SIS, facilitating collaboration among all its agents. It establishes four general objectives: promoting jobs and mobility of human resources; promoting excellence in public research institutions and developing highly competitive technological and business capabilities; promoting business leadership in STI activities to increase the competitiveness of industry; and promoting STI activities aimed at tackling global societal challenges. To achieve this, the Strategy explicitly states that government must adopt measures that encourage PPPs, acting directly to remove the obstacles that hinder them.

Regional government innovation strategies also promote collaboration between the agents in the respective systems, proposing measures related to PPPs at different

levels. The level of detail differs in each case, since the structure of the regional strategies does not follow a common pattern. However, it can be stated that they are generally aligned with the national Strategy in terms of PPPs.

B.2.3. Policies and instruments

The 2017-2020 State Plan is the current multi-year planning instrument for national level policies within the framework of the Spanish Strategy. It establishes the programmes and sub programmes that make up these policies, their priorities and objectives. There are four programmes that correspond to the four general objectives of the Strategy, which include encouraging collaboration between public and private agents through actions aimed at promoting PPPs as a mechanism to accelerate the circulation and cogeneration of knowledge; strengthening STI environments that contribute to the collaboration between agents, increasing synergies and promoting entrepreneurship in public research centres and universities; and the promotion of instruments for Public Procurement of Innovative Solutions.

Conversely, the Annual Action Programmes include the specific actions and instruments that are proposed each year within each sub programme in the State Plan. These enable the State Plan to be monitored, indicating the expected calendar of calls, the management units, the specific objectives and their main characteristics. The 2018 Annual Action Programme, summarised in Table 5, proposed different instruments based on PPPs at state level for each of the four programmes.

TABLE 5

Results summary and discussion

The information presented in this section is summarised in Table 6 and Table 7, which show the main ideas of the territorial and sectoral dimension analysis of the SIS.

TABLE 6

TABLE 7

Spain has regularly used PPPs in the last fifteen years in various sectors. This trend has been related to reformist currents in governments seeking optimisation and rationalisation, though in Spain it has been more a case of searching for alternative sources of funding in a context of austerity. The influence of Europe has also been important. More recently, the latest changes in national and regional governments have begun to slow and even reverse the trend towards PPPs in certain sectors. This short-term vision has led Spain to become one of the countries with the highest number of PPP-specific experiences yet with one of the least developed institutional frameworks.

Reducing the debate over the suitability of PPPs to a merely ideological issue or considering them solely as a source of alternative funding means ignoring the potential that they can have as a strategic element for public management and the creation of public value. In the field of STI policies, the need to strengthen the collaboration between public and private SIS agents to generate knowledge and to govern the system is evident. In fact, the improvement of the conditions for effective collaboration between public and private agents in the SIS is considered as one of the driving principles of the law itself. Yet the numerous laws add an excessive bureaucratic burden to the establishment of these relationships, and to the normal functioning of scientific activity in Spain (Larraga, 2017, p. 56).

On the other hand, the presence of STI policies on the political agenda has been marked by instability due mainly to two factors. First, there has been no clear political commitment to them. The activity of vertical and horizontal coordination bodies has been reduced to the mere fulfilment of the legal requirements for their establishment whilst drawing up the national Strategy. Secondly, STI policy budgets are not a State

priority. They fell dramatically in times of recession and are still at levels of more than ten years ago.

There is a proliferation of new semi-public R&D organisms looking for greater administrative flexibility and trying to obtain higher levels of mainly private financing (Giachi & Fernández-Esquinas, 2018, p. 159). While it is true that private financing is necessary, so is the effective involvement of companies in STI activities. Yet the role of the private sector is not as salient as expected in terms of financing and innovation performance. This situation must also be understood in the context of a multilevel government with shared and even overlapping powers that contribute to increasing the variability of the system (Lanahan & Feldman, 2015).

There are diverse groups of performance agents, with different types of interface structures and CRC. Many of them are assigned to regional and even local governments. By contrast, there is no strong national public programme focused on coordinating their activities. Thus, their existence is not reflected in more interaction between public and private agents. Initiatives such as the creation of the Cervera Network, which follows models such as the German Fraunhofer network, have barely taken off. Programmes based on the creation of large public-private consortiums have been based on former successful experiences (CENIT) but they are not achieving the same results. Other instruments have not even been implemented. In general, instruments are based in the public sector whose role is essentially to fund R&D projects and accredit research centres. Although these instruments are defined as 3rd phase policies, they are functioning as 2nd phase and even 1st phase policies.

This scenario reflects what certain authors call the seven plagues of Spanish scientific policy: excessive bureaucracy; political randomness; absence of institutions; budgetary instability; indifference of the economic powers; lack of strategy; and

individualism as a way of survival (Larraga, 2017, p. 59). The recovery of the Spanish Ministry of Science, the increase of the State R&D budget and the approval of urgent measures to eliminate bureaucratic obstacles are recent measures that seek to restructure the SIS. Yet they are very small steps given the long road ahead.

Conclusions

Koschatzky and Stahlecker (2016) stated that different contextual factors have influenced the path of PPPs in each country. We have mentioned them at the beginning of this paper. Although it would be advisable to carry out a comparative analysis based on the model proposed in this paper, the analysis of the case of Spain clearly reveals the existence of these influences in the territorial and sectoral dimensions of PPPs in innovation. For example, if PPPs had basically been created in Spain as an alternative financing instrument in certain social services or infrastructures, their application in the field of STI policies would have followed the same trend. Given that there is no institutional framework for PPPs at state level in the field of STI policies, the existence of specific coordination bodies does not imply the existence of that institutional framework at sectoral level either.

The model has also enabled us to review how the two dimensions of innovation system governance described in the literature are structured (Hassink & Marques, 2015; Magro & Wilson, 2013). In the Spanish case, this shows that the degree of coordination between the different levels of government is weak, and that the collaboration required between public and private agents is not enough to be the driving force that moves the system forward (Muscio et al., 2015), despite the existence of a strategy that promotes it and policies and instruments that seek to foster it. The likely issue is that the proposed instruments do not encourage interactive innovation models or modes of open knowledge generation that require the effective participation of all agents in the process

which, for the literature, are fundamental in promoting innovation (Cunningham & Gök, 2016; Rasmussen & Redi, 2016).

From an evolutionary approach, the instruments for promoting public-private collaboration should be based on increasing cognitive capacity and improving diversity and selectivity in a multi-level environment (Laranja, Uyarra, & Flanagan, 2008). The implementation of co-creation models based on open innovation platforms and the promotion of innovative public procurement formulas are valuable instruments in this regard. As Raunio et al. (2018) stated, the public sector must adopt a more dynamic role as a platform provider, co-creator and even as an innovative customer, transitioning from classic cluster policies to innovation platform policies. Kuhlman and Rip (2018, p. 451) talk about next-generation innovation policies whose "designs can build on 'creative corporatism', a concept in which governments (and/or related international alliances) will adopt the crucial role of facilitating broader, more diverse 'varieties of cooperation' in advanced capitalist economies". In addition, multilevel coordination must be real and involve not only regional governments but also local initiatives that are becoming increasingly important. In short, the vertical and the horizontal collaborations between agents need to evolve from being merely well-intentioned statements and specific contractual experiences to real, fully systematised and institutionalised practices.

Finally, the analytical capabilities of the model presented will ultimately be determined by the degree of certainty that establishes whether specific public intervention for the promotion of innovation can be considered as an example of PPPs. In most cases, it may be necessary to analyse the organisational dimension in greater depth through an empirical analysis to ascertain whether it actually behaves like the

PPPs defined in this paper. Yet this goes beyond the scope of this work and should be explored in future research.

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Tables

Table 1. Analytical framework of PPPs in innovation.

DIMENSIONS	LEVELS	VARIABLES
A.	**Territorial dimension (country)**	
	A.1.	**PPPs in their historical context and as a cultural set of assumptions**
		A.1.1. Political-ideological influences
		A.1.2. Territorial design
		A.1.3. Economic and financial factors
		A.1.4. Administrative culture
		A.1.5. Institutional framework for PPPs in general
B.	**Sectoral dimension (STI policies)**	
	B.1.	**PPPs as a governance model**
		B.1.1. Sectoral legal framework
		B.1.2. Institutional framework: innovation system
		B.1.2.1. Vertical governance: agents and distribution of power
		B.1.2.2. Horizontal governance: agents, roles and level of involvement
	B.2.	**PPPs as a public policy**
		B.2.1. Evolution
		B.2.2. Strategy
		B.2.3. Policies Instruments/tools
C.	**Organisational dimension**	
	C.1.	**PPPs as a management tool / PPPs as a project**
		C.1.1. Purpose of PPPs
		C.1.2. Temporary validity
		C.1.3. Complexity
		C.1.4. Shared responsibilities
		C.1.5. Formalisation

Source: adapted from Catalá-Pérez and De-Miguel-Molina (2018)

Table 2: SIS performance agents.

AGENT		NUMBER	
Universities		**Public** 50	**Private** 36
Public Research Organisations (PROs)		18	
Health research centres		95	
Unique Scientific and Technical Infrastructures		**Infrastructures** 29	**Facilities** 62
Research centres/institutes		**Dependent on a university** 512	**Non dependent on a university** 355
Non-profit institutions for science		40	
EIN companies (2014-2016)		21,469	
Interface structures	**Technology Centres**	140	
	Research Results Transfer Offices (OTRIs)	103	
	Technological and scientific parks	82	
	Technological platforms	36	

Sources: Own source adapted from the Register of Universities; R&D and Innovation Institutions Map (ICONO-Fecyt); ICTS Map; INE; and Ministry of Science, Innovation and Universities.

Table 1: Spanish performance in international indexes (2018-19)

INDEX	INDICATORS	SPANISH RANKING	% COUNTRIES ABOVE SPAIN
European Innovation Scoreboard 2019 (EU and non-EU countries)	**Summary Innovation Index**	**21/37**	**54.05**
	3.2-Linkages	23/37	59.46
	3.2.1-Innovative SMEs collaborating with others	28/37	72.97
	3.2.2-Public-private co-publications	20/37	51.35
	3.2.3-Private co-funding of public R&D expenditure	22/37	56.76
Global Innovation Index 2019	**General Index**	**28/126**	**21.43**
	5.2-Innovation linkages	67/126	52.38
	5.5.1-University/industry research collaboration	64/119	52.94
	5.2.2-State of cluster development	35/119	28.57
	5.2.3-GERD financed by abroad	47/100	46.00
	5.2.4-Joint venture/strategic alliance deals	73/113	63.72
	5.2.5-Patent families filed in at least two offices	30/115	25.22
Global Competitiveness Index 2018	**General Index**	**34/137**	**24.09**
	11.3-State of cluster development	36/137	25.55
	12.4-University - industry collaboration in R&D	67/137	48.18

Source: Own source adapted from EIS 2019, GII 2019 and GCI 2018 data.

Table 4: Evolution of Spanish STI policies

	CHARACTERISTICS	TYPES OF POLICIES	MAIN INITIATIVES
1st Stage (1970-1980)	- Science policies oriented to technical research promoted by state structures. - Limited business initiatives and few initiatives from public science.	Scarce 1st phase policies	
		Certain "vanguard" policies of the 2nd phase, limited in scope.	- Industrial Research Associations: provide specific industrial sectors with know-how from the public research sector. They were the germ of the current Technology Centres. - Joint projects: collaborative research led by companies together with a public research partner.
2nd Stage (1980-1990)	- Mainly state initiatives, with increasing prominence of regional governments, companies, universities and scientific researchers.	1st phase policies	- Promotion of the activities of universities and OPIs instead of R&D oriented to industry, to build an R&D system.
		Development of pre-existing 2nd phase policies (alliances and projects)	
		First policies of 3rd phase	- Promotion of the Research Results Transfer Offices (OTRIs) to facilitate cooperation between researchers and companies. - Promotion of the Technological and Science Parks as poles of industrial and scientific development. - Opening of OPIs to the private sector from the 90s.
3rd Stage (2000)	- Some of the regional governments especially active. - Higher involvement of companies and universities. - Higher presence of the non-profit private sector and OPIs.	1st phase policies are gradually abandoned	
		2nd phase policies already consolidated	
		Development of 3rd phase policies	- Promotion of centres of excellence and competence - CIBER action, destined to finance stable collaborative research structures and the constitution of consortiums. - CENIT Program (National Strategic Consortiums in Technical Research), for the promotion of PPPs and mobilisation of SMEs in high technology projects. The beneficiaries of CENIT were consortiums constituted by at least two large or medium companies, two SMEs and two research organisations (OPI or technology centres). - Promotion of Technological Platforms as public-private structures led by industry in a specific technological field.

Source. Adapted from Giachi (2017, p. 127)

Table 5: State STI policies and instruments based on PPPs

PROGRAMME TO PROMOTE TALENT AND EMPLOYABILITY		
Training Subprogramme	**TRAINING OF DOCTORS IN COMPANIES: "INDUSTRIAL DOCTORATES"**	Hiring research staff to develop their doctoral thesis in companies and be part of an industrial research project or experimental development.
Incorporation Subprogramme	**"TORRES QUEVEDO" GRANTS FOR THE RECRUITMENT OF DOCTORS IN COMPANIES**	Financing of the indefinite hiring of doctors in the private business sector to carry out R&D activities.
PROGRAMME TO GENERATE SCIENTIFIC AND TECHNOLOGICAL KNOWLEDGE AND STRENGTHEN THE SYSTEM		
Knowledge Generation Subprogramme	**ACTIVITIES OF DYNAMISATION OF RESEARCH NETWORKS**	Financing the creation and consolidation of research networks that generate synergies among SECTI agents.
Subprogramme to strengthen Institutions	**CALL FOR THE "CERVERA" NETWORK**	Promotion of collaboration between technological and business agents through their accreditation as "Cervera" Excellence Centres for those who excel for the quality of their scientific-technical research activities and for the impact of their collaborations with the manufacturing community.
BUSINESS LEADERSHIP PROGRAMME		
Subprogramme for Business R&D and innovation	**R&D PROJECTS and STRATEGIC R&D PROJECTS**	Financing of individual R&D projects, or company consortium projects with a duration of up to 96 months. They may include the participation, through subcontracting, of universities, PROs, etc.
	"CERVERA" TRANSFER PROJECTS and "CERVERA" TECHNICAL PROVISION FUND	Financing of business R&D projects with the participation of "Cervera" Centres.
	INNOVATIVE BUSINESS GROUPS (AEI, from Spanish acronym)	Financing of feasibility studies, various projects and expenses for structures to coordinate and manage incipient AEIs. The AEIs are, basically, clusters.
	PROMOTION OF INNOVATION BY DEMAND AND INNOVATIVE PUBLIC PROCUREMENT	Financing for the development of innovative products and services through the Innovative Public Procurement mechanism.
Subprogramme for the Promotion of Enabling Technologies	**R&D PROJECTS**	Similar to the R&D projects in the previous subprogramme but in the field of enabling technologies.
PROGRAMME OF R&D AND INNOVATION ORIENTED TO SOCIAL CHALLENGES.		
R&D actions oriented towards Social Challenges	**R&D AND INNOVATION PROJECTS: «CHALLENGE COLLABORATION»**	Co-financing, as PPPs, of projects into applied research, experimental development and innovation, always coordinated by a company.
	FUNDS FOR TECHNOLOGICAL PLATFORMS	Financing for the creation and consolidation of the state technology platforms network.
	PROJECTS "CIEN" (National Business Research Consortiums)	Promoting the creation of PPP consortiums, led by companies, with the aim of mobilising private investment and have a driving effect on the business community. Because of their ambition, duration and organisation, they have to tackle long-range problems associated with the challenges of society or cross-cutting, sectoral and strategic problems.

Source: Own source adapted from Spanish Ministry of Science, Innovation and Universities (2019).

Table 6: Territorial dimension analysis

DIM. LEV.	VARIABLES
A. Territorial dimension (country)	
A.1.PPPs in their historical context and as a cultural set of assumptions	
A.1.1. Political-ideological influences	
• Since Spain joined the EEC: privatisations and liberalisations (progressive and conservative governments).	
• Beginning in 1995 (conservative government): the use of PPPs intensified. Until 2011, Spain was the second European country with the most PPPs.	
• Since 2015: reversal of PPPs, especially at regional level (left-wing government coalitions).	
A.1.2. Territorial design	
• Highly decentralised state with local, regional and national governments. PPPs at all levels, especially at regional level.	
• Complex distribution of powers that causes conflicts in the implementation of certain PPPs.	
A.1.3. Economic and financial factors	
• PPPs without a strategic perspective, only with budgetary objectives to increase investments in infrastructure and reduce public debt.	
• No clear evidence that the crisis caused a greater use of PPPs	
A.1.4. Administrative culture	
• From 2000: certain changes in Spanish government in the direction of NPM, but the bureaucratic paradigm still predominates. No far-reaching reforms in the administrative structures.	
• The last major reform project in 2012, focused on thinning the State apparatus. Little impact on the organisational culture.	
A.1.5. Institutional framework for PPPs in general	
• Regulatory framework: no specific laws about PPPs.	
• Institutional framework: The Public Procurement Law (2017) extends to the whole scope of public procurement, not only for PPPs.	
• Failed experience: National Evaluation Office (NEO), created as a body in charge of ensuring the efficiency and viability of PPP investment projects, but never developed as such.	

Source: authors' own

Table 7: Sectoral dimension analysis

DIM.	LEV.	VARIABLES
B. Sectoral dimension (STI policies)		
	B.1. PPPs as a governance model	
		B.1.1. Sectoral legal framework
		• Basic legal framework: Law of Science, according to which, the governance model of the SSCTI must be based on public-private partnerships. • The key SSCTI governance instrument is the Spanish Strategy for STI. • In addition to the Law of Science, there is a wide repertoire of laws which have an impact on the field of STI policies.
		B.1.2. Institutional framework: innovation system
		B.1.2.1. Vertical governance: agents and distribution of power
		• Main state agents: o Ministry of Science, Innovation and Universities. Great instability in recent years. o STI Policy Council: highest general coordinating body, formed by representatives of the State and the AACC. Limited activity since its establishment. o STI Public Policies Network: mechanism for multilevel coordination between regional, national and European level. Very limited activity since 2015. • Distribution of power regarding Science and Technology policies: o State: general coordination. o State and AACC: full legislative and executive functions for the promotion of scientific and technical research. • Distribution of power regarding innovation policies: o Spanish Constitution does not reserve any exclusive competences in this matter for the State. o AACC have established their own mechanisms to support technological innovation. • Local governments: STI policies have general support in Local Statutes. The role of local government as poles of innovation is growing. • State, regional and local governments are conditioned by the general EU STI policies framework.
		B.1.2.2. Horizontal governance: agents, roles and level of involvement
		Coordination agents • Government bodies and entities linked to or reporting to government bodies, when they organise means and resources to carry out common actions in scientific and technical research or innovation. • Main state coordination agents: o Ministry of Science, Innovation and Universities. o Executive Committee for STI Policy: coordination between the ministerial departments involved in the implementation of STI policy. o STI Advisory Council: body in which the scientific community and economic and social agents participate (horizontal). Little prominence since its creation. **Financing agents** • Government bodies and entities linked to or reporting to government bodies and private entities, when they cover the expenses or costs of scientific and technical research or innovation activities carried out by other agents, or contribute with the resources necessary to carry out these activities. • Public sector as financing agent: o Limited allocated public budgets for STI policies. 2018 budget at the levels of the 2000 budget. o Very low percentages of budgets actually executed. • Private sector as financing agent: o Very low levels of private funding of STI activities. Well below the EU average.

- Spanish manufacturing industry: weak innovative orientation, very high percentage of SMEs, very few large companies as innovation drivers and little prominence of the high-tech sectors.

- Financial flows between the public and private sectors: limited structural collaboration between both segments.

Performance agents

- Performance agents are all the public and private entities that carry out or support scientific and technical research or innovation.
- Complex scenario of performance agents.
- Role of companies as performance agents must be prominent but in Spain:
  - R&D expenditure on GDP % in the private sector is significantly below the EU average.
  - Significant decrease in the number of innovative companies since 2004.
  - Very low percentage of innovative companies collaborating with public actors.
- Main indicators to analyse the role of performance agents from the point of view of PPPs
  - % of public R&D expenditure financed by the private sector and vice versa: very limited financial flows.
  - Existence of Interface Structures: technology centres (140), OTRIs (103), science and technology parks (82) and Technology Platforms (36).
  - Existence of joint research structures: 216 Collaborative Research Centres (CRC) catalogued.
  - Indicators measuring public-private linkages according to different indexes: poor Spanish performance.

B.2. PPP as public policy

B.2.1. Evolution

- Three main stages in the evolution of the Spanish STI policies based on PPPs
  - 1970-1980: Isolated initiatives based on alliances and collaborative research projects.
  - 1980-1990: Policies aimed at strengthening the public R&D system and the creation of interface structures.
  - 2000-2010: Promotion of centres of excellence, large consortiums and Technology Platforms.
- Since 2000, prominence of regional governments, taking on an ever greater role in the implementation of their own policies.

B.2.2. Strategy

- Law establishes that defining and implementing public-private partnerships is a must for the SSCTI.
- The Spanish Strategy proposes four general objectives, in which the collaboration between public and private agents is a key factor: government must adopt measures that encourage PPPs, acting directly to remove the obstacles that hinder them.
- Regional innovation strategies are generally aligned with the approaches of the EECTI.

B.2.3. Policies and instruments

- The 2017-2020 State Plan establishes the programmes and sub programmes that make up STI state policies.
- The Annual Action Programmes include the specific instruments included within each of the sub programmes. The last one published is from 2018.
- The main instruments are focused on:
  - Financing hiring of pre- and post-doctoral researchers in companies.
  - Promotion of research networks and excellence centres.
  - Financing R&D collaborative projects.
  - Promotion of public-private consortiums.

Source: authors' own.

Figures

Figure 1: EU countries GDP per capita and innovation performance according to EIS (2017). Source: Own source adapted from Eurostat and EIS data (including EU and non-EU countries)

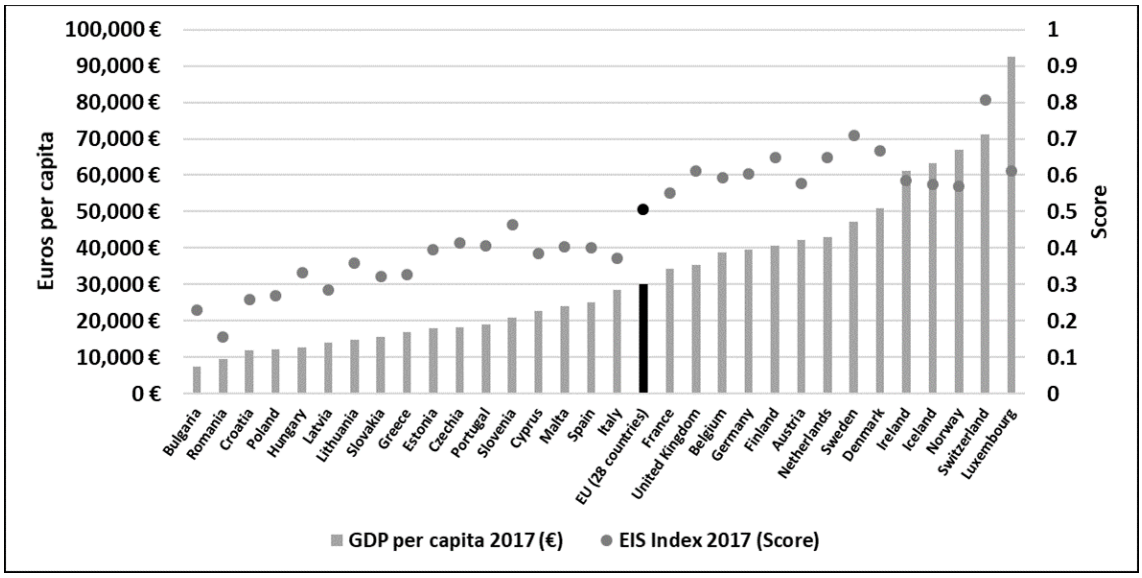

Figure 2: Evolution of R&D expenditure (GDP %) in Spain and EU-28 (2000-2017). Source: Own source adapted from INE and Eurostat data.

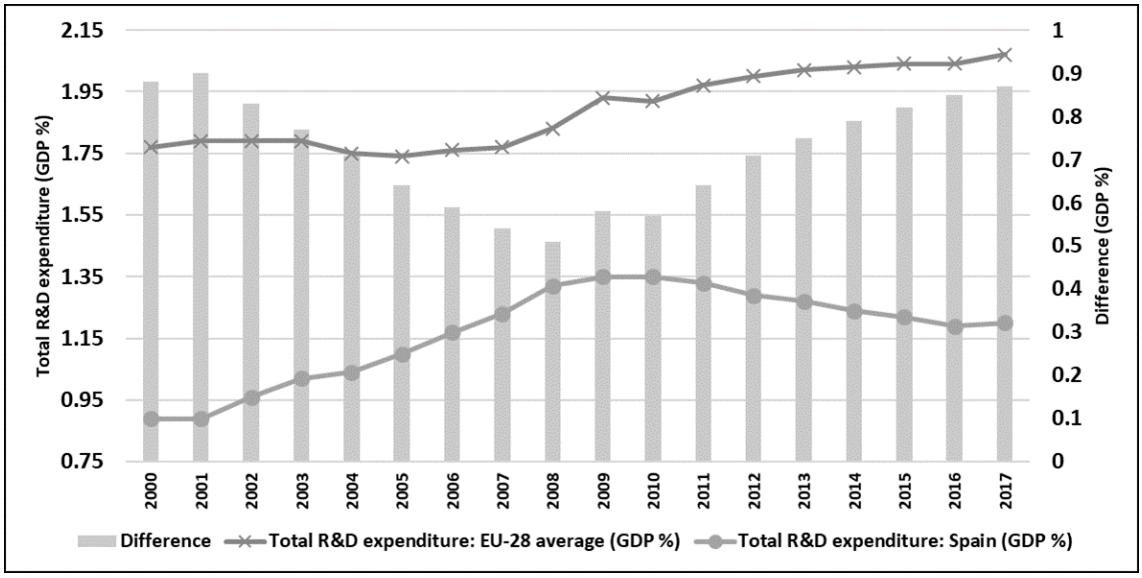

Figure 3: Relationship between internal R&D expenditure funded by the business sector and EU countries' innovation performance (2017). Source: Own source adapted from Eurostat and EIS data. Indicator was calculated with the most recent data available. Switzerland, Norway and Iceland are included in this analysis as they are included in the EIS.

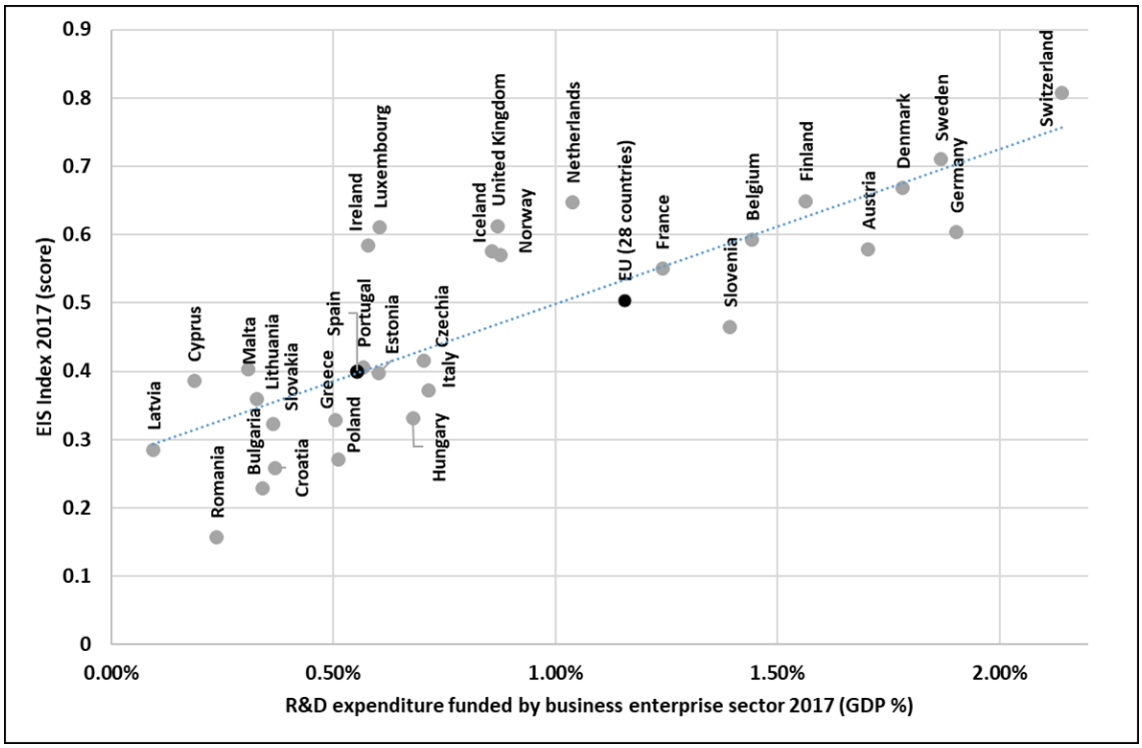

Figure 1: Effects of Public Sector funding of Private Sector R&D expenditure (1997-2017). Source: Own source adapted from INE data. Public sector includes Government and higher education; private sector includes business and private non-profits.