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EVALUATION IN A SYSTEMIC WORLD: THE ROLE OF REGIONAL SCIENCE AND TECHNOLOGY POLICY

PhD Thesis

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1 INNOVATION IN REGIONS, SCIENCE AND TECHNOLOGY POLICY AND EVALUATION: AN INTRODUCTION

This thesis provides an overview of the evolution of innovation theories, together with the evolution of Science and Technology (S&T) policies and their rationales. It focuses on the different theories that justify policy intervention in an innovation system and uses policy evaluation as an approach to analyse theories in practice, applied to a concrete case study. Taking into account that regions have become complex policy spaces in which different policies coexist and that regional systems have become central for innovation activities in firms, this research uses a regional case study focused on a specific S&T programme to analyse different policy impacts at firm level. In addition, interactions between different policies in a multi-level approach are analysed, constituting a systemic evaluation. Finally, the coexistence of different rationales in a certain policy and their interactions are explored. The thesis thus provides a complete overview of regional policy complexity in science and technology from both a theoretical and practical perspective, proposing a new approach for evaluating this complexity with a mixed methodology that takes the best from both qualitative and quantitative approaches.

1.1 Innovation in Regions: Innovation As a Key Feature in Regional and Firms' Competitiveness

The importance of innovation and technology in firms' competitiveness is not a new issue in economic literature. Innovation theories have constantly evolved: from the 1950s, in which science and technology were recognised as a key element for firms and for economic growth; to the present day, in which innovation and knowledge are key aspects of competitiveness (Porter, 1990, 1998, Maskell and Malmberg, 1999).

Firstly, there was an evolution of the consideration of science and technology as the only aspects involved in the innovation process to a broader conception of innovation; today innovation outputs are broadly defined to include, among others, organizational or even social innovations. Secondly, linear theories of innovation were substituted for interactive innovation models in which innovation outputs are a consequence of interactive processes that include feed-back loops in all the process stages within firms. Thirdly, innovation processes in firms became considered as part of a systemic and open process in which firms interact with other agents in the economy, and knowledge and innovation become part of a learning process that is only possible because of this interaction.

Thus a new paradigm has appeared in the last few years in which interaction and collaboration play an important role for innovation (Lundvall, 1992, Nelson 1993), and innovation and learning in turn are key and central aspects for regional competitiveness (Cooke and Morgan, 1998; Morgan 2007). This paradigm has territorially evolved from national to regional innovation systems (Cooke et al. 1997). The importance of regions in facilitating associational processes, mainly due to geographical proximity, could explain this evolution. Firms located in a given region are not isolated agents that innovate in order to improve their competitiveness, they rather form part of a system in which competitiveness is a result of firms' activities but is also dependent on other factors, for example institutional and contextual ones. For that reason, regional competitiveness will be enhanced by improving firms' competitiveness, which also depends on the context in which they are embedded.

This view implies a new approximation of innovation and competitiveness, adding complexity to the previous linear conceptions. Thus innovation depends on the components of the system and the relations established among these components. This interactive approach has been translated into policy, especially to regional policies that try to improve the innovation system. The policies are aimed at building the system and improving the relationships among the agents embedded in the system (both inter-firm relationships and firm-other agent relations).

1.2 Science, Technology and Innovation Policy: From an Isolated Policy to a Complex and Open Policy Space

Economic rationales for public policy have followed the same evolution as innovation theories: from a neoclassical to an evolutionary and systemic approach. Furthermore, innovation theories and policy learning are two co-evolving fields (Mytelka and Smith, 2002), and each one has taken from the other. In practice there is not a direct translation of policy-theories into policy-making practices, due to policy path-dependency (Flanagan et al., 2011). However we can distinguish two main theories - neoclassical and evolutionary-systemic (Laranja et al. 2008) and policy intervention is justified differently depending on the theory underlying it.

Following a neoclassical approach, Science, Technology and Innovation (STI) policy is justified due to the existence of market failures which are far from the market optimum (based on perfect competition). Evolutionary-systemic approaches, on the other hand, justify intervention due to the existence of systemic failures or problems (Edquist, 2008), without admitting a market optimum. Therefore, evolutionary-systemic approaches to STI policy have added complexity to policies, especially as there is not an optimum to reach. In addition, the recognition of innovation in a broader sense and the inclusion of evolutionary economics in which learning is a key issue in the innovation process have favoured the coexistence of traditional neoclassical policies with systemic policies that aim to enhance the system's performance. Moreover policies are clearly path-dependent, which means that new policies are defined over the previous ones and affected by them. This path-dependency leads to a partial substitution in practice of previous policies and rationales for new ones (Flanagan et al. 2011).

STI policy is also not in itself isolated. In the last few years an innovation policy-mix concept has arisen as an evolution from environmental and regulatory policies (Flanagan et al, 2011). This concept recognises not only the interaction of different rationales, as mentioned before, but also the interaction of different policy domains and instruments (OECD, 2010) aiming at achieving the same or complementary objectives as STI policy. Thus the innovation policy-mix constitutes an element of complexity in current policy-making processes.

Additionally to complexity in rationales and policy-mixes, regions constitute a complex policy space due to the interaction of policies administered at different levels. Multi-level governance of STI policy has become an important issue in the literature, increasing the importance and definition of regional policies as a consequence of the systemic view of innovation and the application of the regional innovation systems concept into policy-making. Therefore regions have become policy spaces in which policies at different administrative levels are being felt (Uyarra and Flanagan, 2009).

These two dimensions (policy-mix and multi-level governance), together with the broader conception of innovation, afford more complexity to the STI policy-making process - especially in regions - from definition through to policy evaluation. Policy evaluation is an important stage of the policy-making process due both to the need for analysing the real effects of the policy, which is related to accountability purposes, and the need for improving the understanding of policies themselves, thus linking evaluation to policy learning purposes.

Policy evaluation is related to the concept of additionality, which tries to capture the additional effect of policy. It means that policy intervention is only justified if it generates an additional effect that would not have occurred in the absence of the policy. In the literature different types of additionality can be identified: input, output and behavioural additionality (Georghiou, 1994; Bach & Matt, 2002; David et al. 2000; Heijs, 2001; Herrera & Heijs, 2003, 2007; Georghiou & Clarysse, 2006; Autio et al., 2008; Clarysse et al., 2009; among others). The first two additionalities (input and output) are associated with the neoclassical approach (Metcalfe and Georghiou, 1998), whereas behavioural additionality responds to an evolutionary-systemic approach (Georghiou, 2002, 2004). Nevertheless, behavioural additionality should be understood as a complementary effect of input and output additionality more than a substitutive effect (Clarysse et al. 2009).

Input and output additionality have traditionally been measured following quantitative approaches, whereas behavioural additionality is normally measured by qualitative approaches due to the fact that it is difficult to capture behavioural effects through quantitative analysis. Moreover, additionalities are commonly analysed in a separate way and do not take into consideration interactions among different policy additionalities. Indeed, STI policy evaluation has not evolved at the same speed as policy, and it is difficult to find empirical evidence of evaluations carried out following a systemic and multi-level perspective. Therefore regions or any other policy space might be defining STI policies without taking into account potential effects derived from interactions among rationales, domains and instruments from different administrative levels. This fact is important for the understanding of current STI policies and in order to improve the whole innovation system and optimise the resources assigned to it. Such concerns are heightened bearing in mind the current financial crisis, in which context it is not only important to assess the effectiveness of public resources, but also to understand interactions among policies that are produced and what effects these have. Assessing these effects will enable better design and implementation of such policies, thus maximising their impacts. Therefore, evaluation of STI policies constitutes an important tool for contributing to policy learning, taking into account policy complexity and budget restrictions.

1.3 Research problem and objectives

STI policies have evolved during the last few decades, as mentioned above, leading to a complex context in which different policies co-exist and interact. As consequence it is difficult to understand the different effects these policies are provoking both individually and systematically in a policy space. In addition, governance of these policies is not focussed on one specific actor or administrative level but on a set of them, which gives more complexity to effectively coordinate them. Moreover, policy path-dependency and policy-makers' own interpretations of theory-rationales makes understanding the role of each policy within innovation systems even more complex. Given all these arguments, the final aim of this thesis is *to contribute to the understanding of Science and Technology (and Innovation) Policy by analysing its rationales and impacts in a specific policy space: a region.* Specifically, this research will contribute to *regional policy learning* in STI policy by understanding:

- The foundations of regional STI policy, its rationales and instruments, and their interactions in the regional policy space;
- The evolution of the governance of STI policies from one isolated level of governance to a multi-governance level, leading to complex interactions among different policies in a certain territory;
- The additional role of STI policies in terms of innovation inputs, outputs and behaviour of firms in a certain territory;
- The interaction of different additionalities on firms in a certain territory and specifically the relation between collaboration and input, output and behavioural additionalities;
- Evaluation as a research approach useful for policy learning purposes and the role of quantitative and qualitative techniques in such a process.

In this thesis an evaluation approach is therefore a tool for policy understanding and learning more than a research subject itself. However, an overall analysis of evaluation, especially of regional and STI policies, is needed to overcome to these thesis objectives.

1.4 Contribution of this thesis

This thesis contributes to the theoretical and empirical understanding of regional STI policy through different aspects.

Firstly, it contributes to the understanding of theoretical rationales and their implications for regional STI policy. There is a clear consensus in the literature about the distinction between neoclassical and evolutionary rationales, although there is not an agreement about their complementarily or substitutive character. This thesis will contribute to the understanding of these rationales' co-existence in practice.

Secondly, as a result of the consideration of rationales as mutually-exclusive theories, additionalities or the additional effect of policy intervention on policy's beneficiaries have also been traditionally considered and studied in isolation, avoiding the possible interactions among them. The literature shows that neoclassical approaches to additionality (input and output) or evolutionary ones (behavioural additionality) are common, but only a few studies have focused on the interactions or interlinks among these different types of additionality.

Thirdly, this thesis considers the innovation policy system as a whole and evaluates the impacts of the different policies at different levels, instead of considering only the impacts of these policies separately. This constitutes a novel approach to policy evaluation and therefore a contribution.

Fourthly, this thesis explores a triangulation methodology for evaluating S&T policy. It proposes an approach that combines a quasi-experiment (quantitative technique) with semi-structured interviews (qualitative technique), therefore giving a holistic view of policy impacts. Specifically, the quantitative technique gives an explicative response to policies additionallities, whereas the qualitative technique complements the quantitative approach especially in terms of understanding firms' actual behaviour.

Finally, this thesis uses a specific case study for its analysis. This case study is focused on a concrete S&T policy from the regional innovation system of the Basque Country, Spain. It therefore contributes to policy learning in a specific region, a contribution that is bolstered due to the fact that there is not a systematic and holistic evaluation of STI programmes and policies in the Basque Country.

1.5 Thesis Structure

In order to meet the aforementioned objectives, this thesis is divided in several chapters that together provide a complete understanding of regional STI policy and its impacts on firms.

First of all, in chapter 2 the evolution of the main innovation theories provided by the literature is explained. This theoretical evolution is important in order to understand S&T policy evolution as they have evolved symbiotically. Therefore, in this chapter we set the main concepts and the basis for understanding the evolution of S&T policy.

Chapter 3 looks directly at the evolution of the foundations of S&T policy. Specifically, the evolution of policy rationales from neoclassical to evolutionary approaches is explored in this chapter. Moreover, an additional role of S&T policy is established, including the relations between this role and the stated rationales.

Once policy rationales have been understood it is important to further explore S&T policy. Chapter 4 endeavours to do this. First of all, the story and evolution of S&T policy is analysed with regard to its importance for understanding current policy path-dependency. In addition, chapter 4 explores the instruments for S&T policy and their evolution. It also discusses the new concept of policy-mix and its implications for policy making.

One of the main stages of the policy-making process is policy evaluation. Evaluation is understood in this research as an approach for policy learning. In chapter 5 we explore evaluation evolution and approaches in order to understand its role for policy learning and to set the basis for establishing an appropriate methodology for this research.

Methodological aspects of the research as well as the statements of research hypotheses in accordance with the research objectives are included in chapter 6. The methodological approach is focused on a regional case study of the Basque Country, and on a specific S&T programme from this region. Therefore in this chapter, apart from the methodological aspects, a brief description of the case is given in order to effectively design the research approach.

A further and detailed description of the case study is provided in chapter 7. Specifically, background is provided on the regional innovation system's components and their performance in order to establish the context for the research. In addition, an overview of STI policy trajectories in the region is established so as to understand the foundations of current policies.

Once the context of the case study has been introduced, analysis of the selected S&T programme and its results are provided in chapter 8. Results are shown according to the described methodology and the research design, and are aimed at responding to the stated research hypotheses and objectives. Firstly, the quantitative analysis is divided into three main sub-groups: descriptive, correlative and explicative analyses carried out through different statistic techniques. Secondly, results from the qualitative analyses carried out through interviews are presented. Finally, results from both the quantitative and qualitative approaches are combined to inform the thesis conclusions, which will be given in chapter 9.

Finally, the concluding chapter, apart from presenting the research findings, establishes future research lines as well as other remarks that should be considered in the context of this thesis.

2 THEORIES OF INNOVATION: FROM LINEAR MODEL TO NATIONAL AND REGIONAL INNOVATION SYSTEMS

2.1 Introduction

This chapter provides a review of the evolution of the major innovation theories and their implications for policy arenas, specifically for Science and Technology (S&T) Policy.

The main argument of this chapter is that the evolution of innovation theories cannot be separated from policy learning and they can both be considered as co-evolving fields (Mytelka and Smith, 2002). In addition, it is important to differentiate between theoretical and policy rationales, as theories are seldom adapted into policy (Laranja et al., 2008). However, a complex relationship between theory and policy thinking exists.

In this chapter, innovation theories will be presented; specifically, the evolution from linear to interactive innovation models. These theories have contributed to the evolution of rationales, which are economic theories that justify government intervention. They therefore represent an important input for policy design, implementation and evaluation (Laranja et al., 2008). This evolution or process of change in the policy field can be understood as policy learning (Mytelka and Smith, 2002).

The evolution of innovation theories has to be understood in a historical context, and always lead by some challenging economic situations and the need for stimulating economic growth and competitiveness. Following this assumption, linear models of innovation, in which innovation is considered as an engine of economic growth according to Schumpeter, were promoted and diffused for policy issues during the early 1980s as a response to the crisis of the 1970s. However, linear models of innovation were being developed since the beginning of the twentieth century and have been used for explaining innovation since the late 1940s (Godin, 2006). Moreover, aiming to improve competitiveness, in the 1980s Kline and Rosenberg (1986) introduced an interactive model of innovation, which includes feedback loops in the innovation process. Finally, Freeman (1987), Lundvall (1992) and Nelson (1993) introduced a new innovation paradigm, the (national) system of innovation approach, in which the interactions among actors are one of the main origins of innovation. Specifically, in the model of national system of innovation, the process of innovation is embedded in geographical environments (Mytelka and Smith, 2002). This model has also evolved towards regional innovation systems, in which the region is the main territorial unit in which innovations take place.

2.2 Science, Technology and Innovation Concepts

Firstly, it is important to shed light on the main concepts that will be stated in this thesis, in order to provide a better understanding of theories of innovation and their implications in policy.

According to Pavitt (1999) science can be defined as a process. The inputs to this process are scientists, engineers, etc, and the main output is knowledge, which in turn is an integral part of economic activity. This research looks for generalizations and produces reproducible knowledge that is easily codified. As Nelson (2004) states, scientific knowledge has to be an open source as it enables firms to use it and to change it into technological advancements. On the other hand, technology is understood as applied knowledge and basic research is therefore an input for technological processes. The results of such processes are mainly knowledge, which is both specific and concrete, although to a certain extent tacit. Nevertheless, as Nelson (2004) states, in some cases technological developments and advancements have allowed progress in science. He also argues that technological advancement is an evolutionary process, as firms have to compete to apply general scientific commons into practical developments. Finally, it is important to state that according to Pavitt (1999) there is not a clear agreement with regard to the characteristics of science's results. According to Pavitt, these results are public goods (codified, published, etc) but not necessarily free goods, which means that it is not costless to implement and develop them into technology.

The Oslo Manual points out that research and development (R&D) is an input to the innovation process. According to Jensen et al. (2007) it includes the activities carried out in the Science and Technology mode of innovation. That means that not every innovation is a consequence of R&D activities as some are a result of learning by practice or experience. More precisely, the Frascati Manual (2002, p.30) defines Research and Development as the *creative work undertaken on a systematic basis in order to increase the stock of knowledge of man, culture* *and society, and the use of this stock of knowledge to devise new applications.* R&D includes basic research, applied research and experimental development.

Innovation is considered a broader concept in comparison to R&D. The literature shows that there is normally a distinction between invention and innovation. Invention is the first occurrence of an idea of a new product or process, while innovation is the implementation of such idea into practice (Fagerberg, 2005). According to Schumpeter there are different types of innovation: new products, new sources of supply, new methods of production, and new ways to organize business. These types are also included in the Oslo Manual in its third edition (p.30), in which innovation is defined as: *the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.*

In this thesis we assume that innovation is both the process in which R&D inputs are introduced and the output of such a process. The output view includes new products and services, new processes and new organizational forms. However, as Science and Technology Policy is more focused on technological innovation, this will therefore be the emphasis of this thesis.

It is very difficult to understand Science and Technology Policy without understanding the role of science in relation to innovation in recent years and the different innovation theories that are detailed in the literature. Innovation theories provide frameworks for the policy making process in the science, technology and innovation policy arena, and thus it is important to analyse the different paradigms that exist in the literature.

2.3 Theories of Innovation: from the linear model to the system of innovation approach

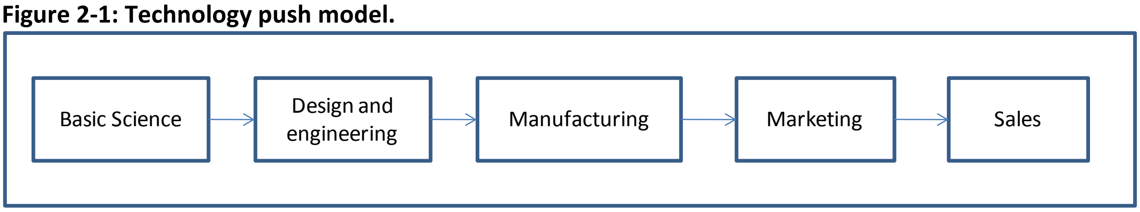
As Caraça et al. (2008) state, it was not until 1950 that economists started to recognize the role of science in supporting economic growth. Following a neoclassical perspective, science is considered a public good. In addition, the prevalent model of innovation (the so-called linear model) is linear and unidirectional, from science to economic development. This model was the dominant approach for innovation until the 1980s when the interactive model appeared as a consequence of the weaknesses revealed by the linear model of innovation. Moreover, in the 1990s a new innovation paradigm that was based in the interactive model of innovation was developed by economists: the (national) systems of innovation. Furthermore, Rothwell (1994) highlights that there are five generations of innovation process models, but we will focus on two main patterns, laid out by Edquist and Hommen (1999) and Caraça et al. (2008): linear and interactive or systemic models.

Linear models are those that show linear steps in the innovation process. According to Edquist and Hommen (1999) linear models are those that do not include feedback from the later stages of product development, marketing, etc. to the initial stage of research. They also do not include feedback between other stages. They are linear and unidirectional models of innovation.

Technology-push and market-pull models are considered linear models of innovation. The technology-push model shows linear steps from science to market innovation (figure 2-1). It was the prevalent model from 1950 to 1960. In this model the market was seen as a passive agent that receives every innovation. The main assumption of this model is that the more R&D the process contains, the more innovations will be produced (Rothwell, 1994).

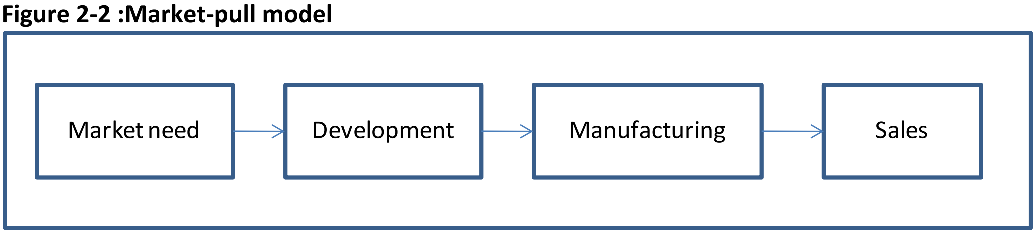
In the 1960s, market needs started to receive greater attention in the innovation process. As a consequence, a second linear model, the so-called market-pull model, provided an alternative explanation to the technology-push model (see figure 2-2). In this model the market is the origin of R&D ideas that will be developed and marketed.

Figure 2-1: Technology push model.



Source: Rothwell (1994)

Figure 2-2 :Market-pull model

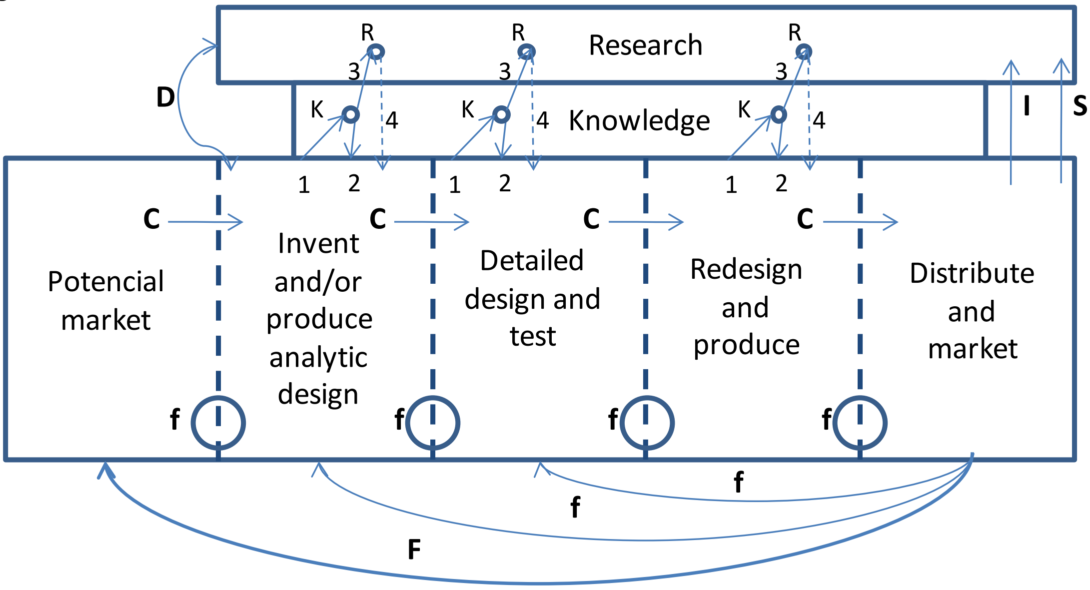


Source: Rothwell (1994)

The interactive models avoid the simplicity of the linear ones and adopt an interactive perspective to describe the innovation process. Some of the problems that arosed in the framework of the linear model of innovation were the origin of the interactive models. One of them is the need for feedbacks from one stage of the process to another, due to the fact that learning as a process of innovation is a consequence of trials and failures in some process stages. In addition, as Edquist and Hommen (1999) point out, basic research does not always lead to the design of innovations. Innovations may occur without any interaction of science or basic research. Moreover, as Fagerberg (2005) points out, firms innovate because they believe there is a commercial need and they start by combining existing knowledge. Only if this process does not work do they consider investing in research. That means that R&D is not the only source of innovation.

These problems were addressed by the designing of new models of innovation, which can be summarised within the interactive approach. One of them is the so-called chain linked model (see figure 2-3) by Kline and Rosenberg (1986). In this model technical development starts from the market and is then prototyped, designed, manufactured and produced. The main characteristic of this model is that in every step of the process there is a feedback loop with the market needs. There are also connections to the existing knowledge or creation of new knowledge through research. Thus, radical innovations can be distinguished in some cases. Furthermore, and according to Edquist and Hommen (1999), this approach is very useful to evaluate the role of demand side instruments in S&T policies such as public technology procurement, in which learning processes take place and market interaction is a central issue.

Figure 2-3: Chain linked model



Symbols on arrows: C: central chain of innovation; f: feedback loops; F: particular important feedback.
K-R: Links through knowledge to research and return paths. If problems solved at node K, link 3 to R not activated. Return from research (link 4) is problematic-therefore dashed line.
D: Direct link to and from research from problems in invention and design
I: Support of scientific research by instruments, machines, tools, and procedures of technology.
S: Support of research in sciences underlying product area to gain information directly and by monitoring outside work. The information obtained may apply anywhere along the chain

Source: Kline and Rosenberg (1986).

Finally, a new innovation paradigm was introduced in the 1990s. It was based on the assumption that firms do not innovate in isolation but depend of the interaction with their external environment: systems of innovation. This model goes beyond the interactive model and it is supported by the idea that innovation occurs due to the interaction of organizations and not as a result of an isolated one. Following Bergek et al. (2008), there are different types of innovation systems present in the recent literature: national innovation systems (Lundvall, 1992; Nelson, 1993), regional innovation systems (Cooke et al., 1997), sectoral systems of innovation (Breschi and Malerba, 1997) and technological systems (Carlsson et al., 2002). All of them are based on interlinks between the different actors that compose the system, being in a national, regional, sectoral or technological context. A System of Innovation, according to Edquist (2001), stresses the notion that firms do not innovate in isolation, but as a consequence of interaction between them and other organizations. Furthermore, the literature (Edquist, 2001; Teubal, 2002; Nelson 2007) suggests that innovation systems involve a collective means of innovation in which every innovator is embedded in a social and cultural context, including the institutions that support the system. Consequently, this theory makes infrastructures and institutions an important part of the system.

Edquist (2005) points out some characteristics of systems of innovation that can be considered strengths or advantages to the approach and reasons for its diffusion:

1. Innovation and learning processes are central processes of the approach, so technological change is not an exogenous variable.
2. It adopts a holistic and interdisciplinary perspective in the sense that includes views from different disciplines (social, economic, etc.) and a wide range of factors (organizational, economic, political, etc.).
3. It employs evolutionary perspectives, avoiding the notion of optimal equilibrium supported by neoclassical approaches.
4. It emphasizes interdependence and non-linearity. In opposition to linear models, systems of innovation consider innovation as a result of interaction among different organizations.
5. It encompasses all types of innovation (product, process and organisational innovations)
6. It emphasizes the role of institutions as determinants of innovation, although institution in this framework is a very fuzzy concept.

The main weakness of this approach lies in the lack of definitions or agreement on some important concepts among the scholars. Even the term 'system' is still very ambiguous.

According to Nelson (1993), a system can be defined as "a set of institutional actors that, together, plays the major role in influencing innovative performance" (p. 4). Nelson assumes that the system is not previously defined or consciously designed.

Carlsson et al. (2002) state that a system might be defined as a set of components working toward a common objective. Those components are inter-related, and include both market and non market links. Following on from this, Edquist (2005), who is one of the main authors in system's theory, also points out that a system is made up by components (institutions and organizations) and the relationships between those components.

In addition, Cooke (1998) added that a system has also to establish links and relationships with its external environment. This connection helps the system to increase its knowledge absorption capacity, in order to avoid lock in situations.

In summary, a system is composed of institutions (hard and soft institutions[1]) that interact among each other and their environment.

Fagerberg (2005) states that spatial systems (national or regional) have been very influential to S&T and Innovation Policy. Given this, this framework will be explained in detail in the next section.

2.4 National and Regional Innovation Systems

There are two main approaches to the national system of innovation which can be summarized in the work of two scholars: Lundvall and Nelson. Lundvall (1992) bases his approach on the interactive learning theory whereas Nelson's (1993) approach is supported by the evolutionary theory.

Lundvall and his colleagues from the Aalborg University stress the importance of interactive learning and user-producer interactions for innovation processes (Edquist and Hommen 1999). Moreover, in this framework innovation is conceptualized as learning, whose sources can be the organized market, the institutional framework or interactive learning (Mytelka and Smith, 2002). This approach also stresses the impact of institutions on the innovation processes. From this perspective, innovation is considered a learning process in which two modes of innovation can be identified according to Jensen et al. (2007): A Science, Technology and Innovation (STI) mode of innovation and learning; and a Doing, Using and Interacting (DUI) mode. The two models relate to different types of knowledge. The STI mode is more related to explicit and codified knowledge whereas the DUI model is closer to tacit knowledge, although in reality there is not such a dichotomy and both forms of knowledge appear mixed (Jensen et al., 2007). The STI mode refers to the way firms use the science to innovate and the DUI mode is related to the knowledge provided by experience and practice.

[1] According to Edquist (2001) and Smith (2000) hard institutions are defined as the formal institutional mechanism that may hinder innovation, including law, regulation, technical standards, etc. Soft institutions include norms and values, culture, entrepreneurial spirit, etc… those social values that determine somehow public policy.

National systems of innovation within Nelson's perspective are implicitly based on the evolutionary theory of technical change (Edquist and Hommen, 1999). Nelson and Winter (1982) provide an evolutionary view of technical change that can be summarized in the following points:

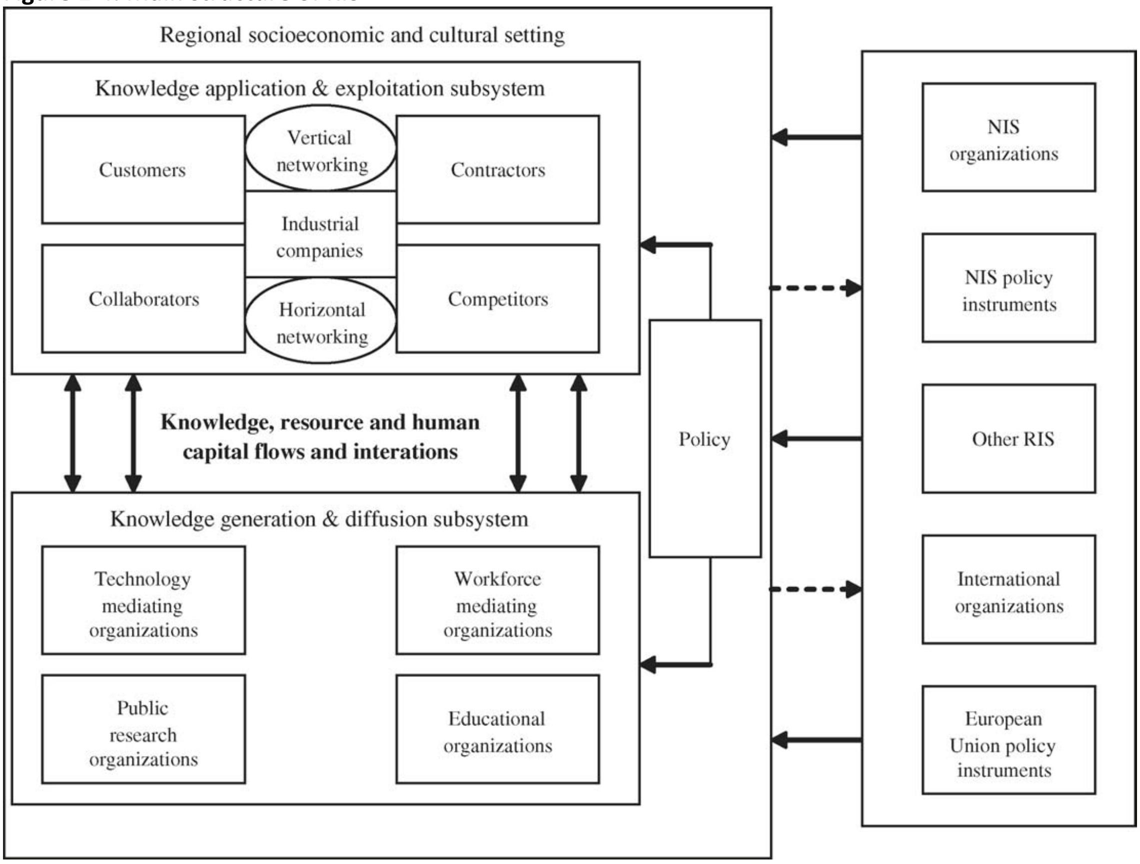
1. Technologies and certain organizational forms in innovation exist and reproduce themselves as they were species in biology.
2. Technical change introduces diversity to these organizations through novelty. In biology these changes are mutations whereas in the context of science and technology they are innovations.
3. There are mechanisms that select among the actors in the system as the natural selection in biology. Thus, diversity in the system is reduced and selection leads to the establishment of new technologies and organizational forms.

Nelson's view of national innovation systems differs from Lundvall's perspective on the concept of a national system, especially in relation to institutions. Nelson and Rosenberg (1993) limited the institutions in the system to those that support technical innovation. Lundvall (1992) adopts a broader definition of an innovation system, which includes all the economic and institutional actors that affect learning as the production system, market system, financial system, etc. Consequently, both theoretical bases of systems of innovation include an institutionalist perspective (Edquist and Hommen, 1999), although the Aalborg perspective is more explicit than Nelson's.

The innovation Systems' approach has been implemented specifically in the context of regions rather than in national contexts and has been widespread as a framework for policy design and implementation in a number of regions. Cooke (1992) was the first author that used the term Regional Innovation System (RIS) in the early 1990s. Despite its wide use in both literature and practice, the RIS concept still remains vague and fuzzy (Uyarra, 2008). According to Cooke (2004:3), RIS can be defined as "interacting knowledge generation and exploitation subsystems linked to global, national and other regional systems".

As next figure shows a RIS is composed of two main subsystems: 1) knowledge application and exploitation subsystem, which includes firms, their clients, collaborators, competitors and suppliers and 2) knowledge, resource and human capital flows and interactions, which is comprised of a set of organisations that provide knowledge and skills to technology organizations or research organisations. These two subsystems are ideally interlinked, facilitating flows of knowledge, resources and capital. In addition, regional policy-making has a role in this approach. It should connect the RIS with other levels, such as; National Innovation Systems, International organizations, and the European Union, as well as with other RIS. This will aid in avoiding RIS isolation or lock-in effects.

Figure 2-4: Main structure of RIS



Source: Tödling and Trippl (2005)

We can distinguish between a broad and a narrow definition of innovation within the concept of systems of innovation. Nelson and Rosenberg (1993) consider only technological innovations and their diffusion as part of the innovation system, whereas Cooke (1998) includes organisational and institutional innovations within the concept. Although the innovation concept is broader from Cooke's perspective, his approach to innovation systems is narrower compared to Lundvall's. As we mentioned before, Lundvall states that all the institutional and economic structures that affect innovation are included in the innovation system.

2.5 Conclusions and Implications for Public Policy

Innovation theories and models have influenced policy since their inception. Linear models of innovation have been the prevalent innovation theory in policy in recent years. Their origin was linked to three main policy priorities according to Godin (2006): the public support for university research (basic research), the importance of technology for industries (development) and the impact of research and development on society (diffusion). In addition, the simplicity of these models is another factor that explains the prevalence of this approach in the policy framework.

Although new interactive models have been developed and conceptualized, linear models have been the predominant framework for S&T policy. Interactive models, including the system approach, give complexity to the policy arenas, especially with regard to the needs for developing new measurement systems and indicators according to these models (Godin 2006, Mytelka and Smith, 2002).

However, interactive theories of innovation, and specifically systems of innovation, have influenced S&T policies in the last few years. Edquist and Hommen (1999) stress, from a systems of innovation approach, that compared to linear models of innovation, they *have a superior grasp of demand-side issues* (p. 75). This approach also includes the view of the interaction between users and producers as one of the sources of innovation. Both characteristics are very useful in policy arenas for understanding policy instruments from the demand side. In addition, Jensen et al. (2007) argue that nowadays there is a policy bias towards quantitative measures and indicators, and no data available for measuring the DUI mode of innovation. That could be justified by the complexity of measuring learning processes linked to the DUI mode.

Moreover, Godin (2009) suggests that the main implication derived from the national system approach is that this approach considers innovation embedded in a large society with institutions, rules, culture, etc. and not an autonomous activity.

Finally, the different contextualization of systems of innovation has considerably impacted the definition of S&T policies at different levels (national, regional, etc.). Consequently, this model has impacted the governance of S&T policies and resulted in the Regional Innovation System concept being widely used for regional policy-makers. Nevertheless, as Uyarra (2008) points out, an inappropriate translation of the concept has lead in many cases to an excessive focus on internal (regional) connectivity instead of also improving links with other systems. This focus caused regions act as “islands” in the policy-making panorama.

All these models have influenced policies at different levels, including the regional one. Furthermore, not only theories of innovation, but also economic theories or rationales have influenced S&T policies. Rationales for S&T policies will be analysed in detail in the following chapter.

3 ECONOMIC THEORIES UNDERPINNING SCIENCE AND TECHNOLOGY POLICY: S&T RATIONALES

3.1 Introduction

This chapter provides an overview of the main theories underlying Science and Technology Policy. These theories constitute what is denominated rationales. According to Laranja et al. (2008), rationales are theories that justify government intervention and therefore, they represent an important input for policy design, implementation and evaluation. There are two main rationales that have been employed for explaining Technology Policy (Bach and Matt 2002, Metcalfe 1994, 1997, Lipsey and Carlaw 1998, Nelson 2007): the Neoclassical approach and the Evolutionary model. They both provide justification for government intervention on S&T Policy due to different failures. Within a neoclassical perspective, technology policy is a consequence of market failures, whereas in an evolutionary approach, technology policy is responding to evolutionary and system failures.

Furthermore, the previous literature (Laranja et al. 2008, Heijs 2001, Hauknes and Nordgren 1999), states that there are different approaches that can be included under the framework of Neoclassical or Evolutionary Theories. Thus, the Endogenous Growth approach is an evolution of the Neoclassical Theory and it is also based on market failures, whereas the Systemic approach is based on the Evolutionary Theory. Each approach differs in various characteristics, but under the same theory, S&T policy will respond to the same objectives or failures. These will be explained in detail in the sections below.

3.2 Neoclassical Theory

Neoclassical Theory explains government intervention as a consequence of market failure. Taking into consideration that neoclassical theory is based on a perfect market assumption[2], only a market imperfection could justify a political action in order to re-establish the previous equilibrium.

[2] Perfect market implies that there are many buyers and sellers, low entry and exit barriers, perfect information, firms aiming to maximize profits and homogenous products.

Solow (1956) included technology as an exogenous factor in the production function models of economic growth. That means that technology was only considered as a given asset without questioning its origin.

After Solow, economic studies started considering technology as an endogenous factor with an important influence in economic growth. Arrow (1962), as the main exponent of this approach, stated that technology can be considered as a good produced by an agent (an innovator) in the market. The main difference regarding a standard market good is that technology is a result of an innovation process and it does not comply with the characteristics of traditional market goods. Technology is made up of knowledge, which can be codified and is thus amenable to diffusion and transfer. In this sense, technology is considered a knowledge output and for that reason it is related to three factors: *uncertainty and information asymmetries, lack of appropriability, and indivisibilities.* These factors are considered sources of market failures and they will be analysed in the paragraphs below.

Uncertainty and information asymmetries

Technology is an output of an innovation process. The results of the innovation process have, as a feature, their uncertainty. It is very difficult to predict the results of the innovation process as it frequently fails and does not produce an innovative output into the market. As consequence, a firm cannot easily estimate the economic returns of its investment in the innovation process. Arrow (1962) highlighted that once the information has been produced it can be used over and over and there is no need to produce it again (Dasgupta, 1987). Therefore, information can be considered as a fixed cost in production. Following Arrow (1962) and Meltcafe (1997), uncertainty produces information asymmetry in the market between firms and capital or financial suppliers. That means that not all the companies can assume the financial risk of innovating and large firms will be better positioned to deal with R&D investments. Information asymmetries are especially severe in early stages of the innovation process. Due to asymmetries a financial gap for R&D occurs (Czarnitzki and Toole, 2010) as financial suppliers do not assume uncertainty about investments returns as they do not have the same information as inventors (Trajtenberg, 2010). Furthermore, larger firms will take advantage of their size in terms of efficiency, technology capabilities, and financial guarantees to obtain better conditions in financing their innovation process. Therefore, two different firms will have different costs rates for the same project (Heijs, 2001).

Lack of Appropriability

A second factor that can be considered as a source of market failure is related to knowledge and technology appropriability, externalities and public goods. R&D, as an innovation process input, is mainly based on knowledge, which is considered in the traditional neoclassical framework as a public good. That means that there are fewer incentives for private companies to invest in such processes, taking into account that it will be difficult to appropriate their outputs (Edquist, 2001). Moreover, an innovation in the market produces externalities and spill- over effects of knowledge, the benefit of which lies on different agents: clients who have access to better products without any overprice and competitors that can take advantage of the newly generated knowledge to compete in the market. This leads the private return of innovation to be very low although the social rate of return for the economy as a whole is high in this case (Bach and Matt 2002). The public good feature of knowledge and R&D also limits the capability of innovators to cover their investment. In that respect it can justify the industrial property system in order to temporarily recover the innovation costs (Metcalfe, 1997).

Indivisibility

Indivisibility and the high costs to initiate the innovation process is also a source of market failure. Knowledge production is a highly costly process, but the average cost of producing knowledge falls progressively as it is spread (Metcalfe, 1997). This approach assumes that the greater investment in R&D a firm carries out the more technological advancements will obtain. That means that the resources invested are directly related to the scientific and technological results[3]. In this sense, it would be necessary to have a critical mass and size to obtain an initial technological development, even though at a certain point the technological advancement stops. At this time, the marginal profits obtained are less than the marginal R&D costs (Heijs, 2001). For that reason large firms will be in an advantageous position to carry out R&D

[3] Trajtenberg (2010) points out that this paradigm is being questioned these days. He highlights that there are too many resources for R&D and too little innovation and creativity so there seems that the direct relation between R&D investments and innovation is not so direct.

activities because of their critical mass and resources. Furthermore, the public good feature of technological knowledge is the origin of the market failure, as it is used, and not consumed, and is reusable by any individual, any number of times. Thus, it creates a situation of non rivalry (Meltcafe, 1997).

Another point of view that also considers technology as an endogenous factor is 'endogenous growth theory'. This is founded on the main assumptions of neoclassical economics, in particular those related to market equilibrium and perfect competition. The main difference is that endogenous growth theory considers that technology is built through a process based on learning and/or R&D investments, a process that is itself fundamental to economic growth. In this context, Romer (1994) pointed out that technology is an endogenous factor but a consequence of a learning-by-doing process.

Griliches (1979) showed us that R&D investments produce knowledge spill-overs among firms. Spill-overs, in some industries, are more prevalent in geographical areas where firms are located. This occurs because knowledge is easily transmitted and disseminated among firms in the same geographical space. Furthermore, Audretsch and Feldman (1996) argued that those industries in which knowledge spill-overs are important have a higher propensity of innovate. In addition, Jaffe (1986) proved that knowledge spill-overs also occurred from universities to firms because the former have fewer reasons to maintain their research secrets. Consequently, in such a situation, knowledge dissemination takes place more easily. This argumentation justifies not only firms’ role in spatial agglomeration, but also the knowledge externalities function.

Endogenous growth theory, therefore, justifies government intervention through public policies in order to promote private R&D investment and innovation (Laranja *et al.* 2008)

Other neoclassical failures

Although the aforementioned failures are the most important neoclassical failures, we can find other failures correspondent to this approach in the literature (Niosi, 2010; Dasgupta and Stoneman, 1987):

- Strategic trade: Governments may subsidize new firms in industries where economies of scale and experience are important, such as aircraft.
- Competition policy: Governments may subsidize new firms in a given industry in order to increase competition.
- National missions, such as defence or health may need governmental support to develop some technologies.
- Moral hazard and adverse selection in the production of knowledge: This refers to the difficulty to assess researchers' abilities and their efforts in order to be efficient in their tasks within a research unit.

Policy implications

In relation to the neoclassical approach, the State will intervene if the aforementioned market failures take place. Technology policy under this approach is designed in order to establish the market optimum equilibrium and it uses different tools to tackle different types of failures. Metcalfe (1997), Metcalfe and Georghiou (1998) and Lipsey and Carlaw (1998) point out that Technology Policies might be classified as resource-based policies. That means that there will be policies oriented to encourage firms to take advantage of their innovation possibilities and to exploit them more intensively. Therefore, there will be policies focused on a certain groups of firms, and they will be focused on supporting R&D through subsidies, tax allowances for R&D and patent protection. One important concept that relies on this approach, and that will later be explained in detail, is the additionality or incrementality function of public policy. That means that policy has to obtain results that would not have been obtained in the absence of policy. State intervention is only justified in this situation.

3.3 Evolutionary theory

Evolutionary Theory has emerged as opposition to Neoclassical Theory. Learning is a central idea of this approach and it is considered part of the process of creating new knowledge. Furthermore, innovation under this model is considered as a collective action that varies among sectors, firms and actors (Bach and Matt*,* 2002), (Laranja et al. 2008).

In Evolutionary Theory, innovation is a consequence of market competition and competition is a driver for innovation. Technology policy is therefore an essential element of competition policy (Meltcafe, 1997). Moreover, the main premises underlying evolutionary theory are: firstly, the processes that determinate the variety of innovations, and secondly, the processes that determine the innovations' selection under a competition framework. That implies a behavioural perspective of innovative firms. Technology policy in this framework is a mechanism to enable variety and selection (Meltcafe, 1994).

Metcalfe (1994) explains that innovation differs across firms depending on their cognitive and learning structures. For that reason differences within firms' behaviour constitute a variety in innovation performance. Selection, on the other hand, refers to the prevalence of firms with specific technologies in the economy depending on their behaviour. This results in a competitive advantage in the market in a concrete period due to innovative behaviour. The basic tension between variety creation and selection is one of the main reasons for governments to intervene under this framework.

Nelson and Winter (1982), in their seminal work, highlight the concept of bounded rationality. This has two implications: firstly, it means that a firm does not know all the existing technological possibilities and secondly, a firm does not have the ability to calculate all the results provoked by its decision-making processes (Smith, 2000). However, firms are learning agents, which have learning capabilities that affect their behaviour. Therefore, S&T policy in this framework is a tool for promoting learning capabilities in different actors.

In Evolutionary Theory there is not an optimum or equilibrium in which benefits are maximised. Technology is considered an endogenous part of the economy and institutions play an important role in the innovation process (Lipsey and Carlaw, 1998). According to Laranja et al. (2008) there is not a consensus about evolutionary failures but it is clear that although there is not an optimum there might be weak areas of performance that constitute failures or reasons for governments to intervene (Smith, 2000).

Evolutionary Theory is divided into two main approaches: the evolutionary-structuralist theory, in which cognitive capacities of all actors are the main focus, and the systemic approach, which gives more importance to institutions as the key element for promoting learning interactions.

The systemic approach assumes that government intervention in Science and Technology Policy can be justified by system failures and not only by market failures. In this context, the market is only an element of the system, which also includes institutions and networks (Hauknes and Nordgren, 1999).

Although there is not a common consensus about failures under the evolutionary perspective (Laranja et al. 2008) some authors have developed a typology of failures or problems[4] from an evolutionary approach (Carlsson and Jacobsson, 1997; Lundvall and Borras, 1997; Batt and Matt, 2002; Smith, 2000; Edquist, 2001; Laranja et al. 2008; Chaminade et al., 2009; Malerba, 2010; Niosi, 2010). Among them, two approaches can be highlighted, although they overlap in some aspects. Whereas Carlsson and Jacobsson (1997), Lundvall and Borras (1997), Bach and Matt (2002), Laranja et al. (2008), Malerba (2010) and Niosi (2010) established a classification of evolutionary failures, Smith (2000), Edquist (2001), Chaminade et al. (2009) and Malerba (2010) focused their attention on system failures, considering Systems approach as the alternative to Neoclassical Theory. A summary of all these approaches is shown in table 3-1:

[4] Edquist (2008) proposes the concept of "policy problems" instead of using the "systemic failures" concept. He argues that the term failure is a neoclassical concept, as (market) failure can only exist when a system is compared to an ideal one. Since it is not possible to define an ideal system in the evolutionary or systemic approach, the concept of failure is not appropriate.

Figure 3-1: Failures in the Evolutionary Theory

Author	*Approach*	*Taxonomy of failures*
Carlsson and Jacobsson (1997)	Evolutionary (General approach)	Network failures Institutional failures System failures
Lundvall and Borras (1997)	Evolutionary (General approach)	Exploitation-exploration dilemma Integration-flexibility dilemma Diversity-harmonising dilemma
Bach and Matt (2002)	Evolutionary (General approach)	Exploration-exploitation failures Selection failures System failures Knowledge processing failures
Laranja et al. (2008)	Evolutionary (General approach)	Learning failures Cognitive gaps Block-in, dysfunctions Lack of diversity
Malerba (2010)	Evolutionary (General approach)	Failure in the generation of high technological opportunity conditions Failure in the learning by firms and in accumulation of capabilities Evolutionary lock-ins and trade-offs
Niosi (2010)	Evolutionary (General approach)	Lack of variety and diversification Lack of technological infrastructure Lack of routines and learning in private and public institutions
Smith (2000)	Evolutionary (Systemic approach)	Failures in infrastructural provision and investment Transition failures Lock-in failures Institutional failures
Edquist (2001)	Evolutionary (Systemic approach)	Functions in the SI may be inappropriate or missing. Organisations may be inappropriate or missing. Institutions may be inappropriate or missing. Interactions or links between elements in the SI may be inappropriate or missing.
Laranja et al. (2008)	Evolutionary (Systemic approach)	System failure Institutional failures System dysfunctions
Chaminade et al. (2009)	Evolutionary (Systemic approach)	Problems related to the system components Problem related to the system's dynamism
Malerba (2010)	Evolutionary (Systemic approach)	A key element of the system is missing or has limited capabilities Connections among agents are not present Failures occurring in the change of existing innovation systems

Sources: Own elaboration.

This research focuses on a number of the aforementioned classifications. They are elaborated on below:

- *Network problems:* Technology is an asset based on knowledge and partly composed of tacit knowledge, which is inherent to human-personal-relationships. That means that technological development will depend somehow on personal relationships, which will form part of networks. Thus, networks play an important role in innovation systems as they contain the information and knowledge needed to innovate. In this regard, network problems appear when this exchange of knowledge and information fails. That might occur because firms are not well connected in the network, which will constitute a weak failure; or because firms take a wrong direction in technological development as a consequence of being strongly connected to a network (network- strong problem) (Carlsson and Jacobsson, 1997).
- *Institutional problems:* Institutions are an important part of the system. Institutional problems refer to the situation in which institutions are not fulfilling their role in the innovation system, that is to say, when institutions are not boosting or facilitating the innovation process. Taking into account the systemic approach, and following Edquist (2001), institutions are not organizations, but the legal, social, normative framework in which organizations operate. However, Smith (2001) distinguishes between *hard* and *soft* institutions, hard institutions being the legal and normative framework whereas soft institutions are referred to as the set of values, habits and culture embedded in the system. Policy making plays an important role by shaping the system's institutional framework. Additionally, Smith (2002) also includes organizations within the concept of institutions.
- *Transition or lock-in problems*: Carlsson and Jacobsson (1997) assume that technological or innovation systems located in a particular part of a nation or region will become a specialised system in a specific field. This situation might lead systems to become locked-in systems, systems with no external influence, which constitute a failure. Chaminade et al. (2009) point out that transition problems take place when systems are not able to change their technological paradigm due to the fact that firms and other system's agents have specialised in only one technological trajectory. They consider lock-in problems as a specific problem derived from transition ones. One of the main characteristics of innovation systems is that innovation is an endogenous output that leads to

path dependency or lock-in (Smith 2000; Edquist 2001). That means that systems of innovation can isolate themselves and, as a consequence, firms can become slow movers when it comes to changing into a new technological paradigm.

- *Learning problems:* Learning is a central issue in the evolutionary framework. Therefore, learning problems might take place within the system, in private and in public organizations. Thus, the key role of policy is to promote learning processes (Metcalfe, 1995; Laranja et al. 2008). With regard to firms, Nelson and Winter (1982) highlight that they create and use knowledge. Their specific knowledge capabilities are embedded in organizational routines[5] and these routines guide firms' behaviour. Consequently, firms learn and this learning affects their behaviour through routines. Learning problems might arise as a consequence of firms' bounded rationality, which causes them not to invest in R&D activities unless governments provoke this routine (Niosi, 2010; Malerba, 2010). In addition, inappropriate levels of advanced human capital and lack of diffusion of technical and market knowledge are other reasons for governments to intervene (Malerba, 2010).

Policy implications

Laranja et al. (2008) proposed, as one of the main rationales for this approach, the need to avoid lock-in situations. In a regional context, for example, it would be necessary not to become a locked-in system with no external relationships. Furthermore, Bach and Matt (2002) include, as a basic principle for policy makers, support of the cognitive capabilities of actors and the supply of requirements to use their learning capability. Consequently, policy options in response to these failures or problems are related to the support of infrastructures and institutions, as well as interactions between different actors. Nevertheless, within an evolutionary perspective, variety and selection processes should be guaranteed.

As Systems of Innovation implies a perspective in which innovation is a result of actors' interaction, public policy in this context has to focus on two different elements of the system.

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[5] Routines include problem solving abilities and decision rules with regards to the external and internal relationships in firms (firms and their environment and intra-firm relationships) (Bleda, 2010).

Firstly, it has a role regarding the agents comprising the system, such as organisations, institutions and scientific and technological infrastructure. Secondly, policy measures will have a significant role related to relations or interactions among the different elements of the system (Edquist, 2001).

The main differences between innovation systems dynamics and neoclassical approaches rely on the fact that innovation is not a linear process. This means that technology as an output of the process is not only a consequence of accumulating R&D resources but it is also related to experience and learning as interactive processes. This perspective lends itself to the design of different policy measures. Thus, in the neoclassical approach, policy measures are always related to putting more resources in the firm to generate innovations, through tax allowances or other incentives. Although the innovation systems approach contains some policy measures regarding resources (for example creating technological infrastructure), the policy emphasis is on interactive processes and networks.

Another important difference in the Systems of Innovation approach, according to Edquist (2001), is that in contrast to a neoclassical framework, there is not an optimal situation that has to be achieved. Therefore, there is not an ideal situation to compare to the current one in order to implement policy measures that will fill the gap. Edquist talks about two types of policy implications within this approach: general and specific policy implications. General policy implications are referring to failures related to the systems characteristics or features. As it is mentioned before, there might be policy measures regarding organizational and institutional failures, lock-in situations, network and infrastructure related failures, etc. Nevertheless, as ideal systems cannot be compared with current ones, it would be necessary to analyse some different systems (geographically or historically) in order to identify and tackle specific policy issues. Comparison and benchmarking between existing systems may generate problems that justify policy intervention. In this regard, Niosi (2002) includes a list of indicators used to measure efficiency and effectiveness of Systems of Innovation. He highlights that it is necessary to take into account the mission of the institutions in the systems' evaluation because they might differ and therefore the benchmarking will not be valid. In addition, it will be necessary to understand the causes of the problems. That is a very complex situation in socioeconomic science, which makes it more difficult to design effective public policies.

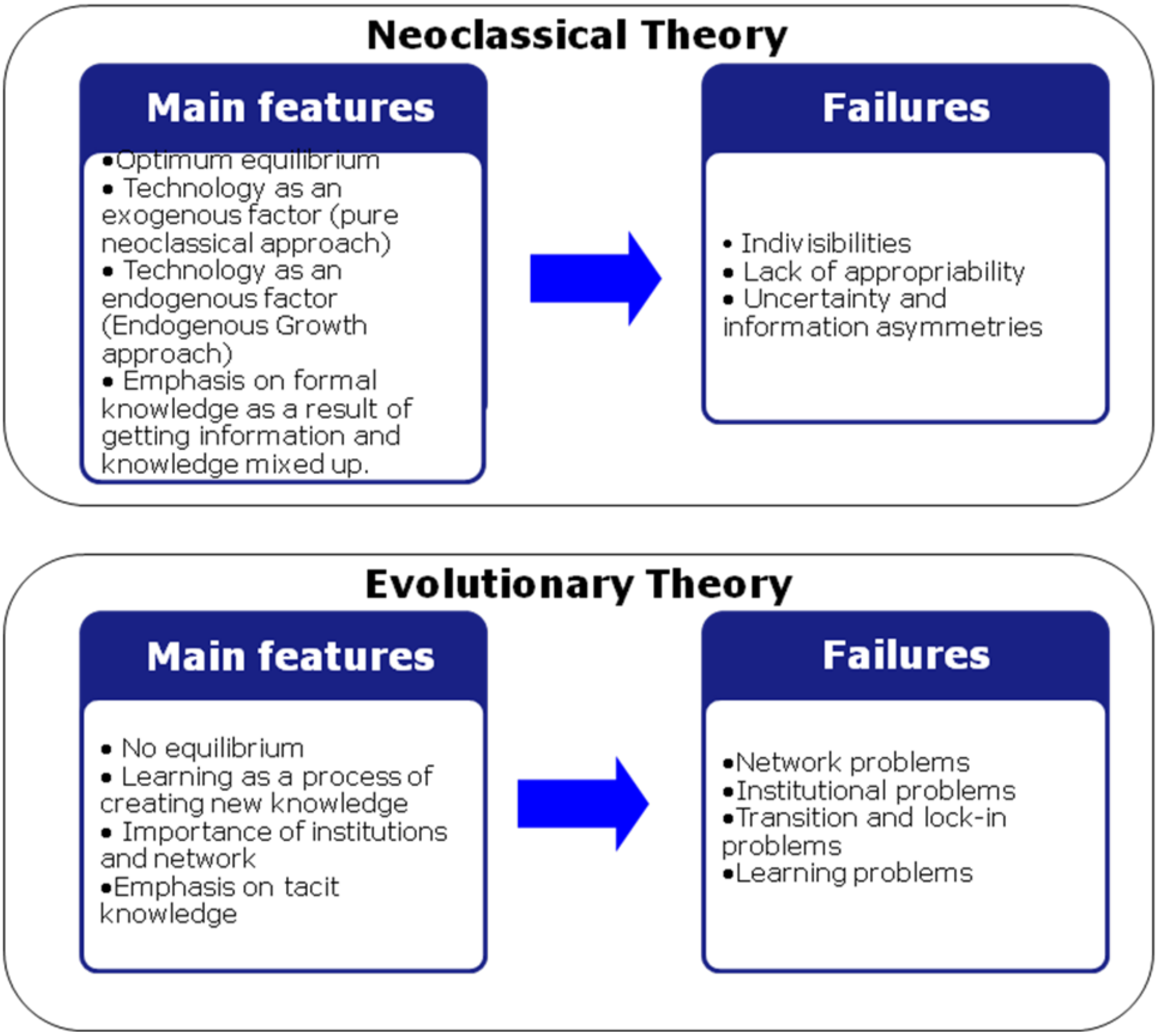
It is necessary to point out that one of the new features introduced by this pattern is the fact that R&D is not the only input for innovation process. Learning by actors' interaction is a new input for the process. For that reason, policy instruments under this approach are softer than in other perspectives and are directed to promoting learning and shaping institutions (Laranja et al., 2008). In addition to the failures mentioned, the evolutionary approach also recognises the existence of some market failures as government failures (Niosi, 2010), which are a consequence of the lack of learning in such an agent. Thus, policy learning processes contribute in order to avoid this problem.

Although the evolutionary approach differs from a neoclassical perspective, dynamic policy mixes could include some instruments responding to market failures and some instruments regarding evolutionary and systemic ones. Therefore, R&D subsidies supporting a specific sector or supporting new infrastructures such as technology centres might be responding not only to neoclassical failures of indivisibility, but also to a strategy of supporting knowledge creation and diffusion through an evolutionary perspective (Laranja et al., 2008).

3.4 Integrating perspectives

In summary, Science and Technology Policy arises as a response to failures or problems. According to neoclassical theory, S&T Policy is responding to market failures and it has, as its main objective, the re-establishment of market optimum equilibrium. Nevertheless, evolutionary theory, either in an institutional or a systemic approach, justifies Science and Technology Policy as a consequence of systemic failures (institutional, network, etc.). Thus, rationales are the main principles to define policies, and the aforementioned approaches are summarized in the following figure:

Figure 3-2: Rationales for Science and Technology Policy



Source: Own elaboration.

It is important to understand that in practice there is not a pure S&T policy based on evolutionary or neoclassical rationales since the measures implemented in the framework of one policy might be responding to different failures. According to Nauwelaers and Wintjes (2002), every policy aims at changing behaviour. Neoclassical policy can affect behaviour through subsidies or hard or soft infrastructure, while evolutionary approaches use subsidies to improve learning, and consequentially, to support changes in the innovative behaviour of firms. Nevertheless, focusing on behaviour is only significant if it produces a positive effect on the firm's innovative performance.

It is important to distinguish between two types of rationales. The first type is derived from theory and the second is related to what policy-makers use to justify the design and implementation of particular policies (Laranja et al. 2008 and Flanagan et al. (2011)).That is to say, theoretical rationales have to be differentiated from policy rationales, which are adapted by policy-makers (Laranja et al. 2008, Mytelka and Smith, 2002). Both of them constitute two different bodies of knowledge and for that reason it is important to first know and understand which kind of rationale is under a specific policy before evaluating it (theory or policy rationale). Additionally, Flanagan et al. (2011) also point out that new rationales do not substitute old ones but contribute to building a policy context. Public policies show path-dependency effects, which means that they are adopted within a pre-existing policy framework and past decisions affect new ones. That implies that in the policy-making context it is difficult to find pure neoclassic or evolutionary failures. Finally, it is important to point out that the mere existence of market or evolutionary failures or problems do not guarantee an optimal government intervention. The ability of governments to solve or mitigate failures and problems is a pre-condition for public policy intervention (Edquist, 2001; Edquist et al., 2009).

3.5 Additionality concepts and implications

Although rationales are defined as theories that justify government intervention, the concept of *additionality* is considered at the heart of that justification (Bach and Matt, 2002). Additionality, therefore, is the key element to justify government's intervention and consequently the measurable feature in policy evaluations (Georghiou, 1994; Bach and Matt, 2002; David et al. 2000; Heijs, 2001; Herrera and Heijs, 2003, 2007; Ebersberger, 2005; Georghiou and Clarysse, 2006; Autio et al., 2008; Clarysse et al., 2009).

Following the previous literature, the concept of additionality refers to the complementary role of policy. It means that a government intervention can only be justified if that intervention causes a complementary and positive effect, which would not have taken place without the policy. In Georghiou's words, additionality involves a comparison with the null hypothesis or what would have happened in absence of government intervention (counterfactual state). Thus, additionality is related to measuring the differences between two different situations.

The authors broadly recognised three types of additionality: input, output and behavioural additionality, although Bach and Matt (2002) also mentioned cognitive capacity as a fourth type of additionality.

In terms of input additionality, policy effects on the inputs of the innovation process are measured. According to Bach and Matt (2002), Georghiou (2002), David et al. (2000) input additionality means that the beneficiaries of a policy should add as many resources to the innovation process as what they are receiving, but in any case, they should be beneficiaries for a process that they would not carry on in absence of the policy. Thus, input additionality is a measure of the resources invested in order to obtain an output.

Output additionality is related to the results of the innovation process, which means that a complementary result is given by the government intervention. Therefore, output additionality is a measurement of the outputs obtained from the public intervention (Georghiou, 2002). These outputs must be related to the outputs from the innovation process, which are mainly patents, prototypes, new products and services, etc. Specifically, output additionality captures the effects of the policy intervention in the outputs of the innovation process. These effects would not have happened in the absence of the policy and consequently justify policy intervention. It is important at this point to differentiate between output and outcome additionality. The former is related to the outputs of the innovation process and the latter refers to the impact of these outputs in the business performance (increases in sales, etc.). Outcome additionality is therefore more difficult to measure, as it is difficult to really attribute the effects of the intervention on the business performance (Georghiou, 2002).

Behavioural additionality refers to the policy impacts on organizational behaviour and processes. That means, for example, changes in collaborative patterns among firms to innovate or promoting firms to take risks that they would not have taken otherwise, to continue with R&D activities after the subsidized project has finished and to internationalize R&D activities, etc… (Georghiou, 2002). All of them are related to the organizational learning achieved by the firm after public intervention (Clarysse et al. 2009). According to Bach and Matt (2002), behavioural additionality can overlap with output additionality in the sense that the changes in routines and processes within an organization or a firm can produce changes in the innovation outputs. In addition, Clarysse et al. (2009) and Autio et al. (2008) show that behavioural additionality is also related to input additionality in firms. These authors show that input additionality after a project has finished means that the organization continues investing more resources on R&D, which is a behavioural change. More precisely, Clarisse et al. (2009) state that behavioural additionality can be understood under the framework of organizational theory, and all the changes perceived in the company are results of some kind of learning (learning-by-doing, absorptive capacity or interorganizational learning). However, Clarysse et al. (2009) did not find empirical evidence of the relationship between output and behavioural additionality. Nevertheless, as both input and output additionalities imply some kind of organizational learning, they might be related to behavioural additionality. In summary, behavioural additionality can be considered as the effects produced in routines and processes within a firm as a consequence of government intervention.

Finally, and from an evolutionary perspective, Bach and Matt (2002) mentioned cognitive capacity additionality, which expresses the idea of a policy effect into the dimensions of the agent's cognitive capacity. This concept involves a policy impact on the agent or system's beneficiary, which the action targets. According to these authors, cognitive capacity additionality is a consequence of a system failure from an evolutionary perspective, while output additionality is responding to a market failure in a neoclassical perspective. The complexity of putting this concept into practice, however, has implied in practice that almost all the literature reduces additionality concepts to the first three: input, output and behavioural.

Although we have mentioned it before, it is important to analyse in more detail how additionality and rationales are related. Metcalfe and Georghiou (1998) point out that market failure has provided a general rationale for policy intervention, but it does not provide guidance on policy recommendations. Following Lipsey and Carlaw (1998) and Georghiou (2002) a neoclassical approach is linked to input and output additionality, as in this approach policy makers would insist on testing the development of technology that has been produced due to the intervention and in measuring the optimal use of government expenditure (cost-benefits of the intervention). Lipsey and Carlaw (1998) point out that from an evolutionary perspective it is very difficult to measure additionality as policy objectives and effects are not always clearly defined. In addition, Georghiou (2002, 2004) mentions that behavioural and cognitive additionality are closer to system failures and consequently can be included into the evolutionary approach. Nevertheless, and following contributions from Flanagan et al. (2011) that are empirically tested in Clarysse et al. (2009), both rationales (and both types of additionality) can co-exist in public policies, as there are not solely neoclassical or evolutionary policies. It is even more important to understand that their coexistence provides positive results on firms, as "neoclassical additionalities" produce a positive effect on "evolutionary additionalities". To sum up, it is important to understand the relations between different rationales to better contribute to policy learning.

Finally, and according to Georghiou (2002), it is important to highlight that the operational unit for testing additionality is the firm. Even in the measurement of behavioural additionality the firm is the most adequate unit to analyse it, except for the analysis of some system failures that can only be analysed at system level. These are failures are (following Smith's taxonomy) related to the infrastructure provision of the system and institutional failures, that is to say, those failures with no direct impact on firms.

Figure 3-3: Correspondence between theories and additionalities

Theory/Failures	Type of Additionality
Neoclassical Theory/market failures	Input additionality Output additionality
Evolutionary Theory/system failures	Behavioural additionality Cognitive additionality

Source: Own elaboration

3.6 Conclusions

In this chapter we have explored the economic theories that underlie S&T policy. We have specifically defined and analysed the reasons that justify policy intervention or rationales. We can distinguish between two main rationales that have been employed for explaining Technology Policy (Bach and Matt, 2002; Metcalfe 1994, 1997; Lipsey and Carlaw 1998; Nelson 2007): the Neoclassical approach and the Evolutionary model. Each one provides justification for government intervention on S&T Policy due to different failures. Within a neoclassical perspective, technology policy is a consequence of market failures whereas following an evolutionary approach, technology policy is responding to evolutionary and system failures or problems.

Although in theory there is a clear distinction about these two models, the evolutionary-systemic one has arisen in contraposition to neoclassical models. In practice there is not a clear division of such rationales in policy-making. Reasons for the coexistence may rely firstly on the path-dependency of policies and secondly on the interpretation policy makers make of theory rationales.

In addition to rationales, policy additionality is a key concept that this chapter has introduced. Policy additionality refers to the additional role of public policy. It means that a government intervention can only be justified if that intervention originates a complementary effect, which would not have taken place without the policy. In Georghiou's words, additionality involves a comparison with the null hypothesis or what would have happened in the absence of government intervention (counterfactual state). In the literature we can broadly identify three types of additionality for S&T policies: input, output and behavioural additionality. Input and output additionality correspond to the neoclassical approach whereas behavioural additionality responds to the evolutionary view. Following the assumption that neoclassical and evolutionary failures might coexist in a certain S&T policy, the three types of additionalities might be also found in a specific policy context.

4 SCIENCE AND TECHNOLOGY POLICY: EVOLUTION, TAXONOMY AND INSTRUMENTS

4.1 Introduction

Once the failures that justify government intervention in Science and Technology Policy have been explained, it is necessary to explore the main characteristics and evolution of Science and Technology Policy. After analysing S&T policy rationales it is clear that policy features will be influenced by the rationale that constitutes the policy basis. Thus, Science and Technology Policy defined by taking into consideration a neoclassical framework will differ from a policy based on an evolutionary approach. Moreover, as we mentioned in chapter 2, the evolution of innovation models and theories have contributed to policy learning. Thus, the evolution of S&T policy cannot be separated from the evolution of rationales and innovation theories.

In this chapter the evolution and history of Science and Technology Policy will be explained and a typology of policies following the different theories that are mentioned in the previous chapter will be included. This chapter will explain how S&T policies are becoming more complex and highlight the different models that are underlying this complexity.

4.2 History and Evolution of Science and Technology Policy

The evolution of S&T policy has to be seen as a mutually interactive process in which Innovation Models and S&T policy have been developed at the same time.

The evolution of Science and Technology Policy has as starting point the end of the Second World War and the beginning of the Cold War, as Lundvall and Borrás (2005), David et al. (2000) and Gassler et al. (2008) state. This policy was called *policy for science* (Gibbons et al., 1994), the main aim of which was the growth of science itself. During the Cold War investment in research and science were increasing, and due to the 'Space Race' between the United States of America and the USSR, most of the investments in research were focused in the field of aerospace. According to the aforementioned authors, S&T policy measures were directed at the allocation of resources to science and their efficient distribution, keeping in mind that the final objective of the policy was to contribute to societal welfare. Thus, S&T policy during this period was a resource-based policy and their objectives were engaged to regulate and promote an excellent infrastructure, including universities, research institutions and Research & Development laboratories[6]. One of the main criticisms to this policy is reflected by Lundvall and Borrás (2005) and it refers to infrastructure's freedom and government's autonomy, because in this policy framework research is state dependent, including budget. A second type of policy was developed in the 1970s which aimed to move away from science per se and towards achieving different technological objectives. This type of policy was called *science in policy* (Gibbons et al., 1994). According to Gassler et al. (2008) three factors were important to expand the importance of technology policy: firstly, the success of traditional mission policies established the possibility of public policies as mechanisms to foster technological developments. Secondly, the existence of research institutions established in the earlier stage and their interest to expand themselves and lastly, some countries perceived a technology gap relative to USA, so they stimulated some catching up policies, in order to reach their technological level.

As Gassler et al. (2008) point out, in the 1980s policies adopted a systemic approach related to the innovation system framework, which is also denominated in a broad manner as Innovation Policy. Previous policies were criticized for their focus on specific technology fields or industrial sectors. The main problem underlying the previous approaches was that there was no way to guarantee that policy makers would choose the right technology field or industrial sector. Thus, this wrong decision could cause the loss of public funds. Therefore, this new approach stresses the importance of generic aspects as key factors of the policy. This approach is seen as a consequence of the interactive process of innovation, which is the reason why research and development are not considered as important as in the previous policies. Within this model of innovation, knowledge and knowledge flows among the actors comprising the system are more important. Following Edquist (2001), innovation policy within a systemic framework, should not only be focused on the elements of the system, such as universities, research institutions etc, but it should also be focused on improving the relations between the elements of the system. In general terms, the main policy measures underlying innovation policy are focused, firstly, on institutions that support innovation and rules that stimulate interaction and

[6] According to Gassler *et al.* (2008), two different S&T policies can be distinguished during this period: mission-oriented technology policies, which were basically policies oriented to the development of key military technologies and mission-led policies, developed after the war, which were basically focused on aerospace and nuclear energy but also started to diversify through other technological fields, mainly civilian and industrial key technologies.

learning between the elements of the system. Consequently, some of the instruments included into Innovation Policy are more demand-related than in S&T policy. Nevertheless, as Lundvall and Borrás (2005) stated, innovation policy can also overlap with science and technology policy, if it is based on a neoclassical approach and a market failure rationale. In terms of systemic failure, innovation policy is specially based on improving institutions and organizations and their performance, including instruments to improve learning skills and social capital capabilities. Innovation policy focuses on all parts of the economy that impact on the innovation process, including those covered by S&T policy (universities, technological sectors etc.). This second type of innovation policy is therefore based on an evolutionary approach. At this stage, as Gibbons et al. (1994) state, policy’s aim is twofold: to maintain a high quality of scientific research and to keep a “creative tension” between science and industrial structure. Therefore, science and technology policy cannot be separated from innovation policy. Moreover, as Borrás (2009) explains, in the last few years a process of widening innovation policy has happened. As a consequence, this shows an extension of the scope of this policy area but it also encompasses science, research, technology and development approaches. Therefore, Science and Technology policies are currently integrated into the title of “Innovation Policy” (Uyarra, 2004).

4.3 Taxonomy of Science and Technology Policy

As the previous concepts of science, technology, innovation processes as well as the evolution of S&T policy have been clarified, it is important to discuss the different approaches to Science and Technology policy that authors have made over the last few years.

Following the previous literature, we attempt to classify Science and Technology policy according to four different criteria:

- The function of the policy or the failure it is trying to overcome
- The target audience of the policy
- The scope or object of the policy
- The scale of the policy

With regard to *failures*, two main groups of policy can be established: firstly, policies responding to market failures and following a neoclassical view and, secondly, policies that are defined to face up to system failures. Nevertheless, it is important to clarify that a policy that has been primarily defined to face up to market failures will also affect systems failures and vice versa. According to Lipsey and Carlaw (1998), many policies support technological development and innovation in firms while they are altering the facilitating structure to innovate. That is to say that, although policies can be classified under these two categories, there will be links between both of them. In this context, some classifications of technology policies can be highlighted. All of them differentiate between S&T policies focused on market failures and those focused on system failures and which measures will be directed to improve the elements and the relationships of the system. The first classification corresponds to Ergas.

According to Ergas (1987) two types of technology policy can be distinguished: mission and diffusion-oriented policies. Mission-oriented policies are characterised by supporting a small number of technologies in an early phase of their technological life cycle and large companies. According to Gassler et al. (2008), mission-oriented policies were first implemented during the Second World War and concentrated in key military technologies although the policy was later expanded towards industrial technologies. It is a policy characterised by high investments in R&D and science-based research. Its main rationale is linked to national sovereignty as it is a policy relevant for countries looking for international strategic leadership and main investments are made by governments although they are also based on market needs (i.e. nuclear energy or telecommunications) (Ergas, 1987).

On the other hand, diffusion oriented policies concentrate their efforts on supporting cooperation between scientific and technological infrastructure and promoting collaboration and relationships between different actors. They aim to provide a *broadly based capacity for adjusting to technological change throughout the industrial structure* (Ergas, 1987, p.66). In these policies small and medium sized firms are the policy's protagonists while the government plays a minor role. Therefore, these policies are considered as decentralized in opposition to the previous ones in which governments were the key actor. Although mission oriented policies can be interpreted as based on a neoclassical approach and diffusion oriented policies on an evolutionary rationale, in some cases, a policy focused on large firms and technologies can be a good way to improve cognitive capacities within a system, as Bach and Matt (2002) and Cantner and Pyka (2001) point out. These authors (Cantner and Pyka, 2001) add two types of policy to the ones developed by Ergas. They classify the policies around a matrix which axes are technology specificity and market distance. The two new types of policies are Basic I, responding to a narrow research concept, with low commercial orientation and Basic II/vision, that also has a low commercial orientation but a more specific target regarding technology. The main difference from Ergas' classification is that they prove that diffusion-oriented measures can also be applied in early phases of the technological life cycle, whereas, mission-oriented measures can be also concentrated in the mid stages.

In line with Ergas and also responding to different failures, Metcalfe (1995), Metcalfe (1997), Metcalfe and Georghiou (1998), established a policy dichotomy in the framework of Science and Technology policy from an evolutionary-structuralist point of view. Therefore, they distinguished between policies that promote the exploitation of firms' current knowledge and capabilities (responding to market failures) and those that improve the external supply of capabilities and knowledge of firms. They also have an objective to improve the connectivity between firms and the knowledge infrastructure (responding to system failures). As a consequence, the policy instruments will differ from one type to another. In the former, innovation grants, R&D subsidies, R&D tax credits and public procurement are the instruments employed. The latter is composed of a compendium of institutional and infrastructural measures in order to enhance firms' capability to learn and to interact with the actors within a system.

By also responding to different failures but with a stronger focus on the policy ***target***, we can distinguish between general policies, policies not particularly oriented to a specific group, or targeted policies. Lipsey and Carlaw (1998) established a classification following this perspective. They distinguish between *framework, focused and blanket* policies. Framework policies are general policies, which are accessible for everyone. They promote innovation and technology development through general instruments as patent protection or R&D subsidies and tax credits, and they do not focus on specific technologies or industries. On the other hand, focused policies are more specific and promote some technologies; they are only available for specific target groups. Finally, blanket policies are a mixure of the former policies. They are centred policies but differ from the focused policies and they are only available for a large number of firms. They are policies that intend to enhance technological capability in firms (Lipsey and Carlaw, 1998).

A more recent classification that combines the function of the policy with the target group was established by Remoe (2008). This classification demonstrates that three generations of innovation policies can be established according to the failures they are trying to mitigate and the policy's specificity on target groups. The first generation is related to the linear model of innovation and to efficiency, which means that policy objectives have to be focused on a specific sector. These kind of limited policies are basically technology and industrial policies. A broader view consists on specific innovation instruments in other policy areas. The second generation is based on an interactive innovation model and is related to the systems approach. In this case, innovation policy may be seen as integrated, which includes technology policy, education, cluster and other instruments. Lastly, a more horizontal view of innovation policy includes other policy areas and instruments, which constitute the third generation innovation policy. The third generation is related to what is called Policy Mix, which will be explained forthwith.

Coenen and Asheim (2005) and Nauwelaers and Wintjes (2002) also distinguish different policies depending on the function and the target level of support. They differentiate between policies that aim at introducing resources in a system (mission-oriented policies) and policies that aim at improving connectivity and learning among firms (diffusion-oriented policies). Their contribution relies on their differentiation of instruments depending on the policy's target level of support (firm or system). They classify instruments for innovation policy according to those items, which is illustrated in the following table:

Table 4-1: Classification of S&T regional instruments.

	Aim of innovation support	
Target level of support	*Assign lacking resources to firms: Support the accomplishment of innovation projects*	*Learning to innovate: Change firms behaviour*
Firm oriented	Financial support: traditional firms' R&D subsidies and loans, training subsidies, risk capital. Brokers Traditional technology centres	Mobility schemes Subsidy for hiring innovation managers in SMEs Proactive technology Centres Innovation management training and advice
(Regional) system oriented	User-oriented technology centres Subsidy for cooperative R&D projects Cooperative schemes HEI-industry	Upgrading of regional innovation systems Cluster policies Support for firm networking Schemes acting on the culture of innovation

Source: Coenen and Asheim (2005) and Nauwelaers and Wintjes (2002). Own elaboration.

In summary, there are policies directed to all the firms within a system (horizontal policies) or policies directed to one specific set of firms (firms in a sector or in a region). Additionally, other policy domains may be directed to reach Science and Technology objectives, which constitutes a broader vision of the policy arena.

Regarding *the scope* or the object of the policy, we can distinguish between demand side policies or supply oriented policies, depending on where the policy focus lies. We can also observe a distinction between Science and Technology and Innovation policies. The distinction lies where the scope of the policy has evolved from a strong focus on science, scientific infrastructures and technological development to a wider concept of innovation, including social innovations.

With regard to this, Edquist (2001) distinguishes between demand-side oriented and supply-side oriented policies. This classification is linked to the two theoretical models of innovation;

the linear and the interactive model. Supply side oriented policies are supported by a linear process of innovation while demand side oriented policies are wider policies, mostly supported by an interactive model of innovation. Demand-side policies are considered policies with a stronger focus on the use of instruments from the demand side, for example, public procurement.

Another interesting classification is the one established by Lundvall and Borrás (1997, 2005), Dodgson and Bessant (1996), who distinguished between Science policy, Technology policy and Innovation policy (see table 3). They state that Science policy primarily aims at promoting the development of science and training of scientists by allocating resources, whereas technology policy principally aims at developing technology in some specific fields or sectors. Innovation policy mostly focuses on promoting the interaction among actors within a system. This is a wider policy that has been implemented in recent years by the majority of policy-makers. It is a policy that includes the market vision of innovations (including technological ones) and aims at improving the commercial exploitation of inventions. It also includes organizational and social objectives and it does not focus all the resources in research and development, which is a characteristic of Science and Technology policies. Innovation policy can be interpreted as a demand-side policy, although Science and Technology policies also include instruments from the demand-side.

Table 4-2: Taxonomy of Science, Technology and Innovation Policy.

Policy	Main features	Recent trends
Science Policy	Scientific education Research in universities and government laboratories Basic research Focus on big issues, e.g, space, nuclear power	Selectivity (“foresight”) Internationalization
Technology Policy	Support for the creation of strategic or generic technologies, e.g. IT, biotechnology, and encouragement of new technology-based firms,	Targeted research efforts R&D collaboration IPR protection Regulation Environmental issues Favoured procurement
Innovation policy	Facilitating diffusion of technology Encouraging “transfer sciences SME focus	Systemic approach to innovation Network building Intermediary development Regionalization/descentralization Building firms capabilities as well as resources.

Source: Dodgson and Bessant (1996)

Lundvall and Borrás (2005) define Science policy goals as the production of scientific knowledge and its instruments are as follows: public research funds granted in competition, public research institutions (i.e. research centres, universities etc.), tax incentives for firms, higher education and intellectual property rights. Technology policy's objective is the advancement and commercialization of sectorial technical knowledge. As instruments for this policy they define public procurement, public aid to strategic sectors, bridging institutions (between the research world and industry), labour force training and improvement of technical skills, standardization, technology forecasting and benchmarking of industrial sectors. Finally, innovation policy is mainly focused on the overall innovative performance of the economy. For that reason, its instruments are: improving individual skills and learning abilities through the general education system and labour training, improving organizational performance and learning, improving access to information, environmental regulation, bioethical regulation, corporate law, competition regulation, consumer protection, improving social capital for regional development, intelligent benchmarking and intelligent, reflexive and democratic forecasting.

Finally, it is important to mention that the three policies co-exist under a systemic rationale and all of them are often included under the term of Innovation Policy.

Regarding the scale of the policy, we can clearly distinguish between national or regional S&T policies. In addition, and due to globalization processes, trans-national or supra-national S&T policies, for example European Policies, can also be identified.

As Fritsch and Stephan (2005) state, regionalization of innovation policies is due to different reasons: firstly, it occurs when innovation processes are concentrated in some regions; secondly, the same instruments cannot fit to all regions in order to achieve the same goal; thirdly, innovation policies can be an instrument for regional development and growth and finally, a variety of policies in regions promote learning of regional actors. Furthermore, the regionalization can be focused on certain elements of the policy, such as the policy objectives, instruments, decision competences or finance.

Innovation policies have been implemented in regions as a consequence of an experimental policy making process. According to Henderson and Morgan (2001), regions are the most suitable scale for implementing innovation policies, as building social capital and establishing interlinks among all the elements within a system can take advantage of the proximity. From a systemic perspective, regional experientialism tries to mitigate system failures by enhancing relationships that allow firms, among others, to improve their absorptive capabilities and to work jointly (firms and local agents) to develop common solutions to their problems. Henderson and Morgan (2001) go on to state that considering regions as laboratories for innovation policies should be complemented by national or supra-national policies, otherwise these regional policies may lack resources. Therefore, it is important not to take into account all the stages in the policy making process of regional policies in isolation, but as a part of a broader perspective, which also considers national or supra-national scales.

Following the same line of thought, Uyarra and Flanagan (2010) state that regional policies have to be formulated and coordinated with other policy domains. Depending on the level of coordination and centralization of the S&T policy, regions can be situated in one of these four situations (Perry and May, 2007). In the first one, regions are considered stages, that is to say that regions are a unit of policy, although they have not participated in the policy making process. Secondly, regions can have a role in the implementation of national policies. Thirdly, regions can be a partner of national bodies and participate in the policy formulation. Lastly, regions can be autonomous from the national government, having the necessary competences and resources to implement regional S&T policies.

Uyarra and Flanagan (2010) have elaborated on the categorisation proposed by Perry and May and see regions as “overlapping spaces in which policy impacts are being felt”. Thus, they consider regions as spaces for the mobilization of resources, spaces in which the effects of policies designed at other levels can be seen, spaces that are targets of national or supra national policies in order to promote their growth and development and finally, they consider regions as strategic platforms in which pilot policies designed at national level can be tested. This also constitutes a claim for the regional experimentalism explained before.

Furthermore, Laranja et al. (2008) review the different rationales that justify government intervention and what is the level of that intervention. Therefore, they conclude that neoclassical rationales, among others, support national S&T policies, while systemic and evolutionary failure support multi-level policies (trans-national, national and regional policies).

In the same vein, Koschatzky and Kroll (2007) suggest that Science and Technology policy is more appropriate for national governance, whereas Innovation policy might be the responsibility of regional governments, as it requires fewer budgets than the national ones. Nevertheless, the authors plead for a multi-level governance system. In a multi-level governance system, measures and instruments of Science, Technology and Innovation policy are divided in levels (national or regional) depending on characteristics, such as; budget and policy learning capabilities. Therefore, the creation of knowledge infrastructure and enhancing the strengths of knowledge infrastructures in a region should be financed and controlled at the national level, as they require a higher budget. Other measures of enhancing networks in a region or improving technology transfer are more adequate to be carried out by regional governments, because they require fewer budgets and less policy learning capabilities.

Finally, it is important to point out that coordination of S&T policies in a multi-level governance system requires adequate strategic intelligence and policy learning capabilities (Koschatzky and Kroll, 2007).

To sum up, the next table shows the different taxonomies of Science and Technology Policy:

Table 4-3: Taxonomy of S&T policy according to different criteria

Criteria of classification	Taxonomy	Main authors
Function of policy	1) Mission vs. diffusion oriented policies.	Ergas (1987) Cantner and Pyka (2001) Gassler et al. (2008)
	2) Policies that promote the exploitation of knowledge and capabilities vs. policies promoting external supply of knowledge and connectivity	Metcalfe (1995,1997) Metcalfe & Georghiou (1998)
Target audience of policy	1) Framework policies; focused policies; and blanket policies.	Lipsey and Carlaw (1998)
	2) Focused on a sector; integrated policies; horizontal policies.	Remoe (2008)
	3) Firm oriented vs. (regional) system oriented	Nauwelaers et al. (2003) Coenen et al. (2005)
Scope or object of the policy	1) Demand side vs. supply side policies.	Edquist (2001)
	2) Resource-based vs. mission oriented policies.	Gassler et al. (2008)
	3) Science Policy; Technology Policy; Innovation Policy.	Dodgson and Bessant (1996) Lundvall and Borrás (1997, 2005)
Scale of the policy	1) (Supra) National vs. Regional policies. Multi-level policies.	Henderson and Morgan (2001) Fritsch and Stephan (2005) Perry and May (2007) Koschatzky and Kroll (2007) Laranja et al. (2008) Uyarra and Flanagan (2010)

Source: Own elaboration

Consequently, there are different perspectives for classifying Science and Technology policies. It is normally difficult to establish a pure categorization of implemented policies as all of them combine elements from different perspectives. It is clear that S&T policy has to reach a function for a specific target in the framework of scope and scale. Therefore, the classifications mentioned only categorise S&T policy by placing emphasis on one characteristic, whereas an analysis of S&T policy has to include all of them.

4.4 Instruments for Science and Technology Policy

In order to promote and stimulate innovation processes, governments have developed different tools that have been included in Science and Technology Policies. Some of these tools have been added to the policy's portfolio at the same time that the perspective of the innovation models has changed. Following this evolution, in recent years a deepening of the innovation policy has occurred with regard to the use of new instruments and the improvement of the existing ones (Borrás, 2009). All these instruments (the new and the previous ones) can be part of the S&T policy options, as we explain in the following paragraphs.

Policy tools or government instruments can be defined as:

(T)he actual means and or devices governments have at their disposal for implementing policies, and among which they must select in formulating a policy. (Howlett and Ramesh, 2003).

Instruments for public policy have been generally classified into three main typologies (Bemelmans-.Videc, Rist et al. 2003, Borrás 2009): regulatory instruments, economic and financial instruments and soft instruments.

Regulatory instruments are referred to as law and binding regulations and are the main instruments for policy. In STI policy arena, examples of these instruments can be the regulation of intellectual property rights, regulation of universities and research centres, competition policy, etc.

Economic and financial instruments are the most commonly implemented in Science, Technology and Innovation Policy, as Borrás (2009) points out. These instruments are, for example; tax incentives for R&D in firms, support for technology transfer and support for venture and seed capital. Following the evolution of S&T policy, economic instruments have also evolved and diversified, including instruments that promote public-private interaction.

Soft instruments are those characterized by being voluntary and non coercitive measures. They are instruments that provide information, recommendations and offer contractual agreements: the most commonly used are the international or national standards, partnership agreements, public communications, etc. Borrás (2009) includes a variation of these, which are, the meta-instruments, defined as those providing intelligence to policy design. The most common instruments under this category are innovation indicators, policy benchmark and technology foresight.

Howlett (2005) also classifies policy tools into two types. The first is composed of the substantive instruments, which are those that affect the nature, types, quantities and distribution of goods and services. They are the “hard” instruments and traditional policy’s instruments. Examples of these types are loans, grants, regulation, etc. The second is procedural instruments, these include treaties and political agreements. They are “soft” instruments which look to affect the participation of the different actors in the governance process (Flanagan et al., 2011).

A more extended taxonomy is the one provided by Braun (1980), based on the OECD’s classification of 1978. Braun (1980) classifies instruments or tools for stimulating innovation into the following categories, he also gives some examples of the measures included in each category:

- Financial: Grants, loans, subsidies …
- Taxation: Tax allowances.
- Legal and regulatory: Patents, protection of designs, monopoly regulations…
- Educational: Technical education, universities…
- Procurement: Public procurement, R&D contracts, etc.
- Information: Information networks, public publications and database…
- Public enterprise: Innovation by publicly owned firms…
- Political: Planning regional policies.
- Scientific and technical: Research grants, research infrastructure…
- Commercial: Tariffs, currency regulations.

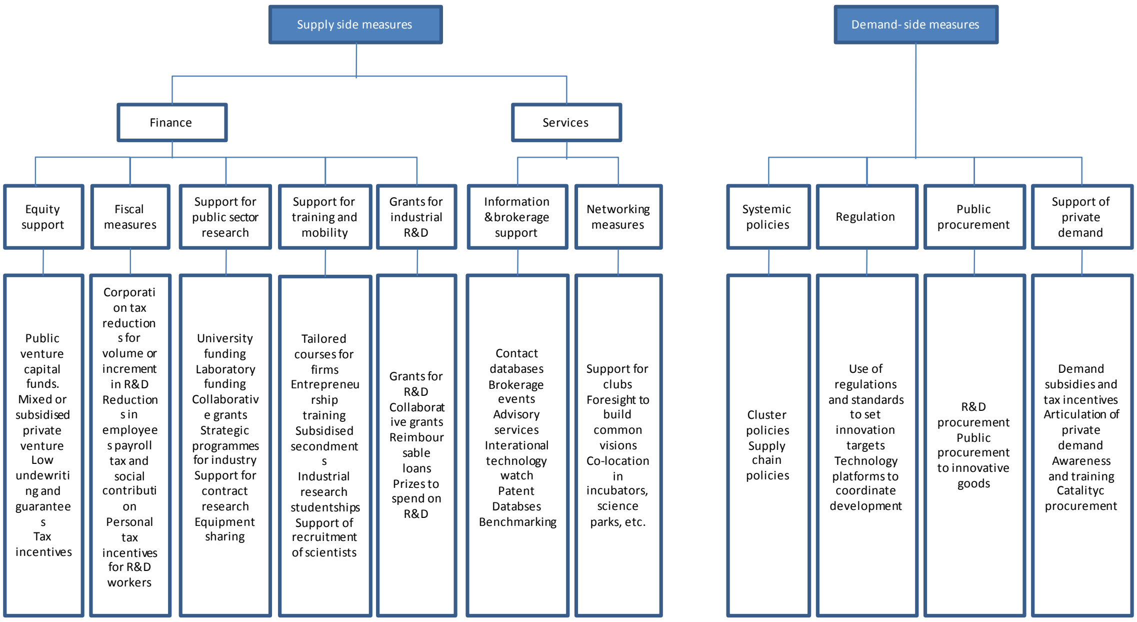
We can add some new instruments to this categorisation:

- Networking and coordination measures: Cluster policies, inter-firm networking activities, measures to improve university and industry links, institutional collaboration and coordination, etc.

Another classification is the one provided by Rothwell and Zegveld (1981, 1984), in which innovation policy tools or instruments can be divided into three categories: supply-side tools, demand-side tools and environmental tools. Supply-side tools are instruments that provide financial and technical support to firms, including scientific and technological infrastructure. Demand-side tools include instruments as public procurement. Finally, tax systems, patent regulation and other normatives are defined as environmental instruments.

Finally, Georghiou et al. (2003) and Edler and Georghiou (2007) give a taxonomy of innovation policy tools or instruments based on their contribution to achieve policy objectives. They distinguish between supply and demand instruments as the next figure shows.

Figure 4-1: Taxonomy of innovation tools.



Source: Georghiou et al. (2003), Edler and Georghiou (2007)

In summary, policy tools can be divided into hard or soft instruments. The former are the ones that affect the type or quantities of the good or service, they are normally economic measures that aim at assigning resources and instruments from the supply-side. The latter are measures that aim at improving capabilities and learning and are normally associated with demand-side measures, although they also include regulatory and economic measures.

Furthermore, as Nauwelaers and Wintjes (2003) assure, the same tool can respond to both a neoclassical perspective and an evolutionary approach. Thus, a subsidy for R&D in a neoclassical approach is an input to achieve better innovation performance. This also affects the innovative behaviour of firms by influencing their choices based on costs-benefits. Following an evolutionary approach, subsidies for R&D can provide a change in the learning process of innovation. Therefore, the instruments do not vary themselves, but the objective or the purpose of the instrument varies from one perspective to another. Moreover, within an evolutionary approach, some specific systemic instruments can be highlighted as cluster policies.

That is to say that new rationales or new policy perspectives do not invalidate previous instruments (Lundvall and Borrás, 2005 and Laranja et al. 2008). They add new instruments to the policy, increasing its complexity. Therefore, we cannot state that one instrument corresponds to one specific rationale, as it can be used to reach different policy's objectives.

4.5 Policy Mix for S&T Policy

In the framework of Innovation Systems, innovation policies are part of a complex set of actors, institutions, policies, etc. (Edler et al., 2008). Therefore, Innovation or S&T policy is not isolated in the system but interplays with other programs, policies and instruments, which is called Policy Mix.

Policy mix for Innovation Policies is a very fashionable term that has in recent years appeared in academic publications (Flanagan et al. 2011) as well as in other relevant publications from international organisations (Nauwelaers et al. 2009) and the OECD (2010). However, this term still remains under-conceptualised (Flanagan et al. 2011).

Policy mix focused on R&D concepts could be defined as:

The combination of policy instruments, which interact to influence the quantity and quality of R&D investments in public and private sectors. (Nauwelaers et al, 2009)

In this context, the policy mix or the combination of instruments that promote R&D investments should be considered in the evaluation of S&T policies as all of them are affecting R&D and innovation arenas. The main assumption of the policy mix is that this combination of instruments may have their origin in other policy domains, which add complexity to the policy making process. Nauwelaers et al. (2009) have designed a model in which all the policy domains that have an impact (direct or indirect) in R&D activities are reflected. This model includes taxonomy of instruments that impact on R&D, and can be summarized in the next table:

Table 4-4: Policy Mix for R&D

Policy Domain	Policy	Instruments
R&D Domain	R&D policy: Generic	Discretionary institutional funding for R&D projects Competitive R&D project grants Competitive project loans Support for R&D infrastructure Selective support for centres of excellence R&D friendly procurement, etc.
	R&D policy: Sectoral	Selective R&D support schemes for existing high-tech sectors, for new high-tech sectors, etc…
	R&D/Innovation Policies:Linkage policies	Collaborative R&D programmes Technology platforms Cluster policies Support for Science Parks, etc.
	R&D/Innovation Policies: IPR Policies	Reform of IPR regulations, etc.
	R&D specific finance policies	Risk capital for R&D measures Loan and equity guarantees for R&D investment Volume R&D tax measures, etc.
	R&D Specific Human Capital Policies: Specific Education Policies	Support for ST&I post-docs Support for ST&I post-grants
	R&D Specific Human Capital Policies: Specific Employment Policies	Subsidies for hiring R&D personnel R&D mobility schemes, etc.
Finance Domain	Financial and fiscal policies: Non R&D Specific	Risk capital measures supporting innovative companies Loan and equity guarantees supporting innovative behaviour Tax measures supporting technology diffusion and innovation, etc.
	Macroeconomic Policies	Sustainable growth oriented strategies Measures to ensure low interest rates Measures to ensure price stability, etc.
Human Capital Domain	Education Policies: Non R&D specific	Support for ST&I under-grads Efforts to make S&T more attractive to students Entrepreneurship schemes Support for life-long learning
	Employment Policies: Non R&D specific	Support for flexible labour markets, etc.
Innovation Domain	Innovation Policies: General	Technology diffusion schemes Awareness and demand stimulation schemes Non-R&D network schemes Innovation management support schemes, etc.
	Innovation Policies: Sectoral	Selective innovation support schemes for existing high-tech sectors, for new high-tech sectors, etc…
Other policies	Industry Policies, Trade Policies, Defence Policies, Consumer Protection Policies, Health and Safety Policies, Environment Policies, Regional Development Policies, Competition Policies, Other Policies**.**	

Source: Adapted from Nauwelaers et al. (2009)

In addition to this, as the OECD (2010) points out, several "mixes" could be included within the term policy mix. We can therefore find a mix of domains, (considered as policy sub-systems) mix of rationales (which support policy justification), mix of strategic tasks (referred to the broad direction of policy intent and includes timing and capabilities) and finally a mix of instruments. The OECD (2010) recognises that the policy mix concept could be interpreted in two ways: firstly, it refers to the interactions between the four dimensions (mixes) presented and secondly to the interactions within each dimension. These two interpretations are useful to understand policy impacts and therefore useful for policy learning.

Based on Nauwelaers et al. (2009) and the OECD (2010) we can define policy mix for S&T Policy as the combination of rationales, domains, categories, programmes and instruments interacting in a policy system and impacting in a set of actors as reflected in next table:

Table 4-5: Definition of Policy-Mix for S&T Policy

Policy rationales/goals	Rationales provide the justification for public intervention. They are strongly related to the causes that underlie policy definition and implementation and could be similar to broad policy goals.
Policy domains/areas	These are the different policy sub-systems that could impact on the innovation system and its performance. These could be broadly divided in subsystems with impact directly on the innovation performance of STI policies and other subsystems that could include sectoral policies as well as policies aiming to establish an adequate framework and conditions for STI.
Policy categories	Specific types of policies included in a domain with more specific goals and which include a set of programmes
Programmes	Set of activities that together are directed to achieve a specific goal targeting a specific actor or group of actors.
Instruments	The means or devices by which policies and programmes are implemented.
Target actors	Actors targeted by policy action.

Source: Own elaboration

In addition to this, there are other dimensions in which interactions may occur as illustrated in Flanagan et al (2011): policy space, governance space, geographical space and time. Although all these dimensions seem highly relevant for S&T Policy, geographical space could be the most interesting one. This dimension highlights the policy complexity that can be appreciated in some geographical units (i.e. regions) in which several mixes of S&T policies from different administrative levels (i.e. supra-national, national, regional, local) can co-exist and interact. Therefore, it will be important to understand what impact these interactions have in a certain geographical space.

Taking into account the complexity of policy mix itself, the evaluation of policy mixes constitutes a challenge (Edler et al., 2008; Nauwelaers et al., 2009; OECD, 2010 and Flanagan et al., 2011). It differs from the individual evaluation of programmes and it requires a meta-evaluation, a system evaluation or at least a coordinated evaluation of all the programmes that are included in the policy mix. Taking into consideration this reality, when an individual evaluation of a policy is being carried out, we cannot forget that there will be other policies and instruments that might affect the same objectives. The main problem here is that additive or additional effects provoked by the interactions will be difficult to detect as Flanagan et al. (2011) point out.

4.6 Conclusions

Science and Technology Policy has become more systemic and complex in concurrence with rationales. This evolution is viewed through the history of the policy itself, in which we can appreciate a broadening and deepening of S&T Policy towards STI Policy and towards systemic policies. S&T policies have not only evolved in concurrence with rationales or functions but also with scope and scale. This last phenomenon can be easily linked to the different de-territorialisation processes that have appeared in recent decades in which different administrative levels corresponding to different territorial units can be distinguished. Therefore, we find a situation in which different levels of S&T Policies can be distinguished (from supra-national to local ones) and these levels can have an impact in a certain territory (normally in a region).

In addition, instruments for S&T Policy have also evolved to becomes more systemic, although both kinds of instruments (hard or soft) could be applied in both types of policy, (neoclassical or evolutionary ones) therefore changing the aim of the instrument in each context.

In the last few years, combinations of instruments and policies that interact in a certain territory have been known as policy-mixes. Policy-mixes for innovation are therefore a new and key concept to take into account in the S&T Policy field as they represent the complex reality in which the policy-making process is undertaken. Therefore, in order to design and implement an S&T evaluation is necessary to take into account this new reality of interactions and the different levels of governance that might co-exist in a certain territory.

5 EVALUATION OF SCIENCE AND TECHNOLOGY POLICY.

This chapter provides an overview of evaluation as a process that should be included within the policy-cycle. Firstly, we will describe the importance of evaluation and its links to the policy-making process. Secondly, we will give an overview of the history, purposes, types and dimensions of evaluation in S&T policy. In addition, we will describe the current challenges of evaluation in S&T policy, which are the main arguments of the thesis. Finally, we will summarise some of the most common methods for evaluating S&T policy and their strengths and weaknesses. The aforementioned steps contribute to better understand the evaluation in the context of S&T policy.

5.1 The Evaluation Framework: the Importance of the Evaluation in the Framework of Policy Life Cycle.

Evaluation can be defined as the *process that seeks to determine as systematically and objectively as possible the relevance, efficiency and effect of an activity in terms of its objectives, including the analysis of the implementation and administrative management of such activities* (Papaconstantinou and Polt, 1997). Valovirta (2002) elaborates further by stating that evaluation is based on *collecting and analysing evidence, and drawing conclusions and recommendations from this evidence.*

The aforementioned definitions of evaluation highlight two main aspects: first, evaluation is a process and not just a static stage of the policy-cycle, as it is described below, and second, evaluation has different phases, from collecting data to drawing conclusions and recommendations in order to improve the effectiveness of policies.

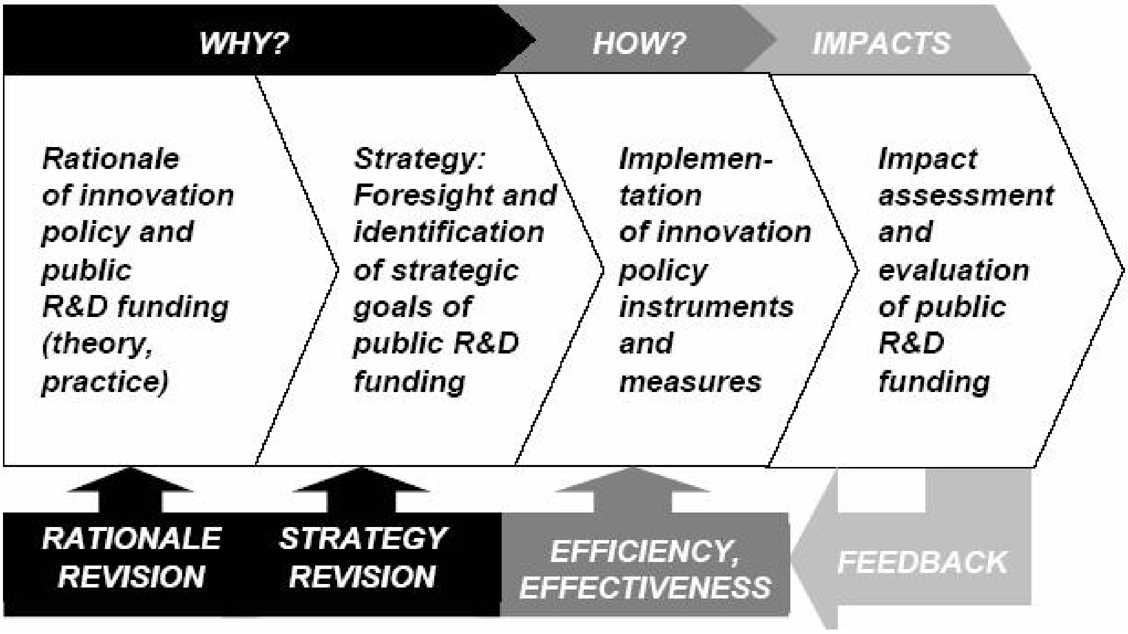
Evaluation cannot be understood without understanding the whole policy-cycle. It is also accepted that policy’s rationales and objectives will condition the evaluation process. In relation to this, Storey (2004) states that evaluation cannot take place adequately if policy’s objectives are not clearly defined. According to Hogwood (1987) and Raines (2002) a policy life cycle can be divided into four phases:

1. An initial analysis of the needs
2. The design and development of policy responses to the needs.
3. The implementation of programmes and measures
4. The evaluation of the performance of programmes and measures after a period.

This cycle, as Raines (2002) and OECD (2004) explain, is not a linear but an interactive process. That means that evaluation needs not to be considered a stage at the end of the line, but a stage that promote discussion in the policy life cycle and consequently a review of the objectives and targets of the policy.

Loikkanen et al. (2006) try to show, in a more systemic model, the stages in innovation and R&D policy making, stressing the interlinks among all the stages, including the evaluation phase. They also stress four stages in the innovation policy making process. First, innovation policy making, as we mentioned before, is based on rationales, which means that they justify why the policy is needed. In the second stage, the phase of establishing strategic goals and targets of policy stresses the importance of the use of tools for strategic planning such as foresight. This phase of the policy corresponds with the design of policy responses to the needs and it also highlights the importance of justifying the necessity of policy. Subsequently, the implementation stage begins. The implementation of policy instruments and measures attempts to answer the question of how and how effectively innovation and R&D policy is executed. Finally, the last phase of the policy making process concentrates its efforts in evaluating the additional impacts of the policy. As mentioned in the previous chapters, we will focus the evaluation on the additional effects of the policy. As the next figure shows, this stage produces feedback from the previous ones, stressing the view of policy making as an interactive and not entirely linear process, although linearity still remains:

Figure 5-1: Policy-cycle's stages



Source: Loikkanen et al. (2006)

This approach is one of the *stages models*, which has been widely criticised by political scientists for still remaining linear. As John (1998) states these stages models have emerged as a consequence of complex and chaotic policy processes. They try to simplify reality within public policy. Therefore, the main idea of these models is that public policy is a sequential or lineal process in which the process' inputs turn into outputs. These models give top down character to policy making instead of bottom up. In an attempt to introduce some complexity in the model, policy theorists have introduced feedback loops in all the stages. This introduction still relies on linearity (John, 1998). In accordance with John (1998) these models can be used as a learning tool to apply some order in the complexity of the policy making process. The evolutionary framework needs to be applied to policy making for building a more realistic model. However, it is remarkable that it is a useful model if we consider the complexity of each stage and try to break down the policy process and see where the evaluation fits in.

Moreover, it is important to stress that evaluation has become a critical part of the policy making process in the last decade, as Raines (2002) and others state. Among the reasons underlying this increasing importance of evaluation the following can be highlighted: Firstly, policy makers need to know the economic effectiveness of the policies that have been implemented. Secondly, the limited budgets of the government force policy makers to better allocate their resources in the most effective policies. Finally, evaluation gives transparency to the policy making process and makes it more valuable (Bachtler 2001, Raines 2002, Papaconstantinou and Polt, 1997). As a consequence, evaluation in a R&D framework has become an important issue in the S&T policy making process. New technology developments, as well as the importance of technology and innovation diffusion and the importance of measuring organisational changes (i.e. innovative behaviour) have led to the development of new methodologies and concepts around the evaluation of S&T and innovation policies (Papaconstantinou and Polt, 1997).

5.2 Origin of evaluation and evolution

Evaluation has changed over time. Different models and theories of evaluation have appeared in the last fifty years. In this section we will explore the origin and evolution of evaluation and the primary evaluation theories.

The origin of evaluation as a systematic activity based on data can be dated to the early twentieth century in the United States, at the same time that social sciences developed (Rossi and Freeman, 1989). Education and public health programmes were the main policy areas in which evaluation were systematically implemented during that period. According to Lee (2000), evaluation at this time did not follow any theoretical approach.

The first evaluation theory developed is by Ralph W. Tyler in 1949, who established a theory including methods and standards to use in the evaluation process (Haarich, 2006).

Later, during the 1950s and 60s public programmes on a large-scale were implemented in areas of urban development and construction. Rural development and health, among others produced a large amount of funds dedicated to those purposes in many countries (including the less developed ones). Evaluation became a common activity in order to obtain an indication of the outputs that had resulted from the public intervention. As a consequence, during the 1970s academic articles and books were published with regard to evaluation theories and models (Rossi and Freeman, 1989).

In addition, in those years evaluation was systematized as an instrument to analyze the effectiveness of public policy, first in the United States and then in Europe (Haarich, 2006). According to Derlien (1990), institutionalization of evaluation was implemented in two waves. United States, United Kingdom, Sweden, Germany and Canada were the first countries to institutionalized evaluation practices in the 1960s and 70s. Therefore, they belong to the first wave of evaluations, which main objectives were the programmes administration and management. Secondly, in the 1980s, Denmark, Netherlands, Norway, France and Finland institutionalized evaluation, making up part of the second wave. Some authors (Boyle et al., 1999) have recognized a third wave of evaluation institutionalization. Switzerland and Ireland in Europe, Korea and Indonesia in Asia, Zimbabwe in Africa or Colombia in Central America are examples. Their evaluation processes have been supported by the World Bank.

As Haarich (2006) points out, in Europe evaluation has also been introduced as a consequence of the Structural Funds. Those countries are primarily in Southern and Eastern Europe (Greece, Spain, Italy, etc.), in which there was not previously an evaluation culture.

This evolution can be also followed by the evolution of the different evaluation theories. Guba and Lincoln (1989) established four generations of evaluation. The first generation aimed at measuring the effects of the programmes or actions, the role of the evaluator is technical and he knows all the different types of instruments that can be used in evaluations. The second generation is characterized by descriptive evaluations, in which the evaluator is a describer, although he also maintains technical knowledge. These two generations can be associated with classical evaluations. Tyler (1949) developed theories, based on experimental and quasi-experimental design, that can be included under this framework.

The third generation of evaluation is comprised of evaluations that aim at reaching judgements and in which the evaluators assume the role of judge. In this framework some different theories can be included as the decision-oriented models, such as; CIIP (Stuffleberan et al. 1971) and effects-oriented models (goal-free evaluation from Scriven, 1973).

In addition, Guba and Lincoln (1989) developed a fourth generation of evaluation based on a constructivist paradigm. In this generation, the stakeholders adopt a principal role in the evaluation. This generation can be considered part of a set of evaluation approaches that have been developed in recent years, such as; empowerment evaluation, participatory evaluation, responsive evaluation, etc. These evaluations normally use qualitative approaches.

Finally, we can add a fifth generation of evaluation in which we can include the realistic evaluation model developed by Pawson and Tilley (1995). In this model experimental methods are also employed but not in order to analyse the effects of an intervention in the recipients but to analyse in which circumstances or context the effects are produced. This theory takes into consideration the particular context or circumstances of the intervention in order to better evaluate them.

These last three generations of theories (third, fourth and fifth generation) have had little impact on Science and Technology evaluation practice for several reasons. First of all, these theories were developed for the evaluation of educational and social programmes and the S&T academic field is relatively small in comparison. Additionally, S&T evaluation involves a closed and homogenous community with less diversity of interests than in other fields. Finally, S&T evaluation approaches favour traditional methods (first and second generations) and consequently, the diversity of methodology has been reduced.

5.3 Evaluation of Science and Technology Policy

Shapira and Kuhlmann (2003) state that evaluation of Science and Technology Policy is a field at an early stage of development in the policy making arena. Evaluation methods applied to S&T Policy have followed the same evolution as the Policy itself, although not the same speed and consequently they have not reached the same stage of development.

The beginnings of policy evaluation can be traced back to shortly after the Second World War. In this period, evaluations were focused on analysing the quality of scientific research with peer reviews and citation counts as the main evaluation methods. Subsequently, when government focused on programmes to support industrial innovation through collaborative research, evaluation moved to the analysis of the socio-economic effects (direct or indirect) of programmes. In order to analyse these impacts in-depth surveys and quantitative methods, including cost-benefit methods were increasingly employed. With the growing number of policies incorporating a systemic perspective, which includes both the hard and soft sides of innovation (the former is directed to increase the inputs and outputs of the innovation process while the latter aims at creating networks and improving learning processes), evaluation methods and techniques comprise a large portfolio of tools and instruments, including quantitative and qualitative approaches (Turok 1991, Papaconstantinou and Polt 1997, Kuhlmann 2003, Williams 1999).

In the S&T evaluation space or area, it is important to understand different elements that characterize an evaluation in order to better design and implement it. These are a) evaluation purposes or functions, b) evaluation time frame, c) evaluation stages, d) evaluation levels and e) required data for evaluation. All these elements will be explained in the following paragraphs.

Evaluations can have different purposes. Thus, evaluation's main role is the justification of programmes, including the analysis of the effects and impacts on the firms, as well as providing information that guides the allocation of public resources among the different programmes. A complementary objective is to increase the quality and responsiveness of the programmes (Papaconstantinou and Polt 1997).

In this framework, the previous literature (Díez-Lopez and Izquierdo-Ramírez, 2005, Batterbury 2006, Kulhmann et al., 1999) distinguishes among these different evaluation purposes:

1- Accountability and legitimacy: It is directed to analysing the programme's impacts and the effectiveness of the programme in terms of cost-benefit. Evaluations regarding this objective analyse if the programme has achieved its goals and targets.
2- Improving planning and efficiency: It is directed to assure that the programme's resources are efficiently assigned and used.
3- Implementation: It aims at improving the programme's implementation and the efficacy of its implementation mechanisms.
4- Learning and knowledge production: It focuses on the analysis of the causes of the produced effects and impacts and it looks into other programmes evaluation in other to extract lessons and learn from them.

5- Institutional strengthening and empowerment: It aims at improving the capability of the programme's participants (recipients, agencies, governments, etc) of acting over the environment.

Moreover, according to Tavistock Institute et al. (2003) and Batterbury (2006), the ultimate goal and purpose of evaluation is improving learning as *it considers why a programme had the observed effects, what lessons can be learned for other programmes and policies, and whether and why there are unintended effects.* (Batterbury, 2006: 183)

Attending to the criterion of the function or the purpose of the evaluation, we can distinguish between summative and formative evaluation (Scriven ,1991, Raines, 2002, Kuhlmann, 2003, Tavistock Institute et al. 2003):

- Summative evaluations are those which aim at measuring the programme's performance. That is to say, summative evaluations are concerned with the measure of the effects of the policy in both, the recipients of the programme and the wider economy. Summative evaluation is mainly focused on the effects of the programme and consequently evaluation results will be directed to implement a more effective scheme.
- Formative evaluations are those in which the information obtained from the evaluation is used as a learning procedure for the policy makers, in order to incorporate those findings into the implementation of policies. This type of evaluation is an on-going evaluation and collects data during the entire programme's life cycle. Formative evaluation makes use of a more qualitative approach, including the use of case studies. This evaluation is focused on the analysis of how policy change inputs into outputs and its conclusions are used to improve the administration of policy.

Although summative evaluations are normally implemented after the intervention (ex-post evaluations) and formative are carried out during the programme's life-cycle, they are not exclusive functions and evaluations are normally balanced between summative and formative (Diez, 2002, Tavistock Institute et al. 2003).

Moreover, Tavistock Institute *et al.* (2003) and Diez-Lopez and Izquierdo-Ramirez (2005), propose a typology of evaluations in terms of the purpose they try to achieve and the methodological framework applied, although they state that each type can be responding to more than one purpose. Thus, they highlight five types of evaluations:

- Type I: Economic: It aims to analyse efficiency in resources allocation both in terms of planning and use.
- Type II: Management and performance. It is focused on the verification of standards and targets.
- Type III: Formative: It is focused on the generation of conclusions in order to improve the programme during its implementation.
- Type IV: Causal/experimental: It is focused on the analysis of the programmes' impacts and identifying causal mechanism on what operates, how and when.
- Type V: Participative: It aims at developing networks and communities from a bottom-up perspective with participative approaches.

Therefore, we can establish the following correspondences between purposes and types of evaluation, although one methodology might be employed for more than one purpose:

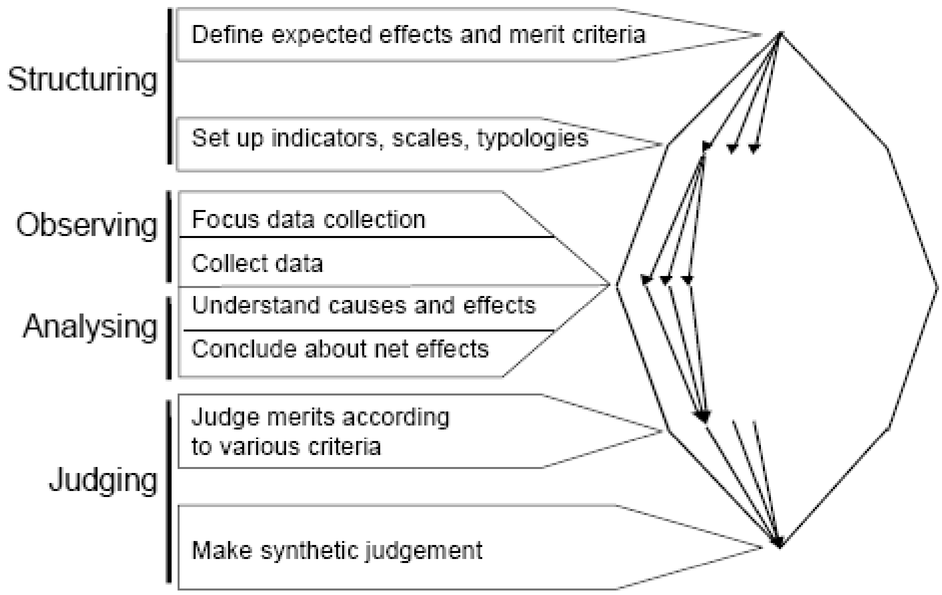
Table 5-1: Correspondences between evaluation purposes and methodologies.

Evaluation purposes	Types of evaluation and methodological approach
Improving planning and efficiency	Type I: Economic: Efficiency analysis in terms of the resources planned and used and the results obtained.
Accountability and legitimacy	Type II: Management and performance: Analysis of the effectiveness by the verification of targets and standards.
Implementation	Type III: Formative: Produce useful recommendations to improve the programme during its implementation
Learning and knowledge production	Type IV: Causal/experimental: Analyse the programme's impacts, their causes and links in order to understand how the programme is functioning
Institutional strengthening and empowerment	Type V: Participative: Develop networks from a bottom up approach with participative methods.

Adapted from Díez-López and Izquierdo-Ramírez (2005).

In addition to evaluation purposes, it is important to further define, within an evaluation framework, the key stages through which to carry it out in order to implement an effective evaluation system. In this regard and according to Williams (1999) four stages can be highlighted. Furthermore, he distinguishes eight steps that can be summarized in the following figure:

Figure 5-2: Stages and steps of an evaluation.



Source: Williams (1999) from Scriven (1980)

The first stage defines the evaluation questions and methodology, including indicators that will be employed during the evaluation. Afterwards, it is important to define the field of observation and to collect the data associated to that field. Moreover, when data is collected it is necessary to analyse it in order to formulate a judgement.

Along the same line, Polt and Rojo (2002) specify different stages for *ex-ante* and *ex-post* evaluations. In the former, the stages are a) identifying the rationales for the policy intervention, b) introducing modelling approach, including the assumption on which the projections will be made, c) analysing in each scenario what would happen with and without the programme, d) calculation of the costs and benefits of every situation and scenario and providing an indication on the basis of the calculation. In the latter (ex-post evaluation) the phases are: a) providing a clear specification of policy objectives, b) defining data collection for the evaluation, c) designing the evaluation approach, d) analysing what would have happened in absence of the policy, e) compiling good practices and failures and d) providing conclusions and recommendations.

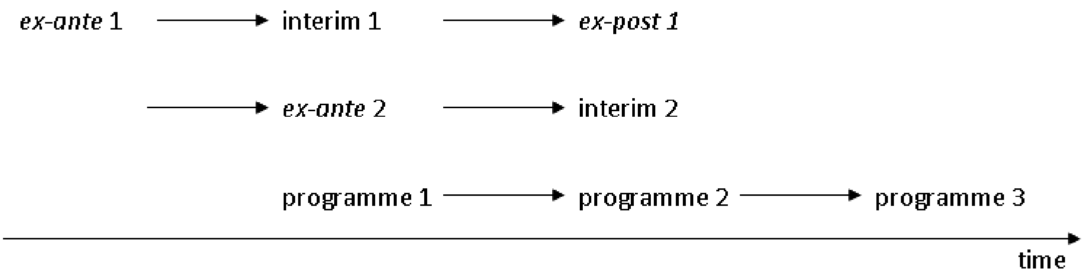
Summarizing evaluation stages, evaluation is a process that includes a) revision of policy rationales, b) design phase (including definition of the scope, methodology and data), c) collecting data stage, d) analysis of data collected and e) conclusions and recommendations.

Different types of evaluation according to their time-frame can also be distinguished. Three types of evaluation can be distinguished with regards to different time-frames (Gibbons and Georghiou, 1987 and Papaconstantinou and Polt 1997): ex-ante, ex-post and interim.

- *Ex-ante* evaluation is carried out in the policy design phase. Nevertheless, as Gibbons and Georghiou (1987) state, this is an evaluation that cannot be carried out in the cases in which the budget and priorities of the programme are already decided.
- *Interim* evaluation: It is an on-going or monitoring evaluation, running during the policy implementation phase. For that reason it is a very useful evaluation, as it interacts with programming and thus, it can be an important decision making tool.
- *Ex-post* evaluation: It is the evaluation that is carried out after the programme has been implemented. It aims at analysing the main results and effects that can be attributed to the programme's intervention.

According to Gibbons and Georghiou (1987), ex-post evaluation would have to be connected by a feedback loop with the following ex-ante evaluations, in order to take advantage of the results of the evaluations in the next programme's design. As the following figure demonstrates, ex- ante evaluations can only incorporate the results of interim evaluations, as programmes run systematically and the next programme's design is carried out at the same time as the interim evaluation of the first programme. Therefore, there is a time gap between ex-ante and ex-post evaluations and consequently, they are understood as separate activities with no connections.

Figure 5-3: Chronology of evaluation



Source: Gibbons and Georghiou (1987)

In addition, it is important to highlight that evaluation can be applied at different policy levels, which are defined by Polt et al. (2002: 17) from the widest level to the most specific one:

- *Policy: a set of activities, which may differ in type and may have different beneficiaries, directed towards common general objectives or goals.*
- *Programme: a set of organised but often varied activities bundled together –for example, projects, measures and processes– to achieve a common objective.*
- *Project: a single intervention with a fixed time schedule and dedicated budget.*
- *Thematic: is centred on a common objective pursued by several programmes.*[7]

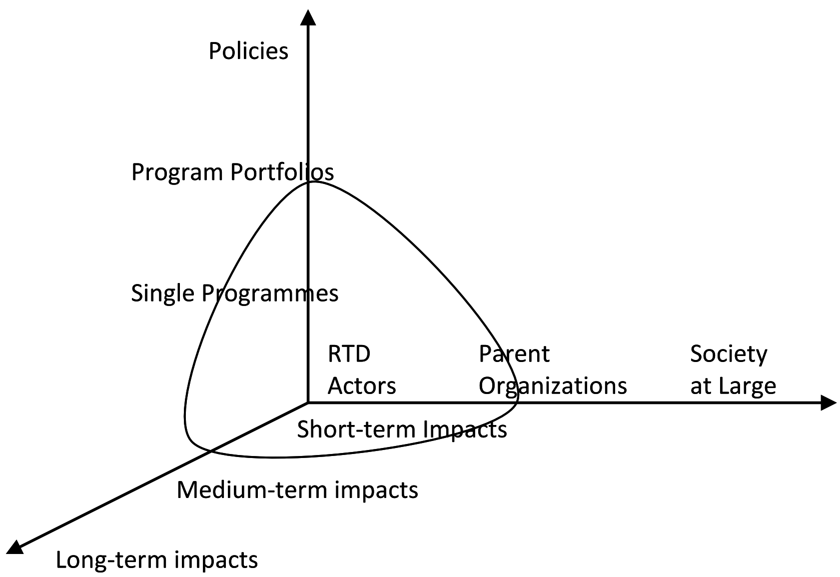
Finally, and with regard to the data required for evaluation we can distinguish between inputs, outputs, outcomes and impacts. Inputs are defined as those resources provided by the intervention. Inputs change within the intervention into outputs, which are the goods and services etc, that have been produced in the beneficiary as a direct result of the intervention (i.e. new products or services, patents, prototypes, etc.). Outcomes or results are the changes produced in the beneficiary as a consequence of policy outputs (i.e. increase in sales, increase in productivity, etc.) and they constitute the first impacts of the intervention. Finally, impacts refer to the effect of the intervention in both the beneficiary and the wider economy, which are basically long-term and socioeconomic. (Raines 2002, Polt et al., 2002)

In this regard, and taking into account two of the aforementioned elements (levels and data) we can define R&D evaluation as the space defined by the intersection of three dimensions, according to Guy (2003): a) focus of an evaluation that refers to the level of intervention

[7] As an example of the different levels we can consider European Research Policy as an example of the first level (policy). The VII Framework Programme is an example of a programme within this Policy and all the individual projects that are funded under that programme can be grouped by thematic. An example of thematic is “Nanoscience, nanotechnologies, materials and new production technologies” (NMP).

analysed (single programs, program portfolios or policies), b) impact dimension, referring to impacts on the actors involved in the intervention (firms, universities, society) and to different types of impact (societal, economic, etc.) and to one or more sectors. Finally, the third dimension is the time frame of the impacts, which can be short, medium or long-term. This evaluation space is shown in the following figure:

Figure 5-4: Three-dimensional evaluation space



Source: Guy (2003)

5.4 The Role of the Evaluator

Apart from the above-mentioned elements that characterise evaluation processes, another important element that has to be considered in evaluating is the role of the evaluator. In section 5.2 we state that alongside the evolution of evaluation theory the evaluator's role has changed. Moreover, the evaluator is a critical actor in the evaluation process. According to Haarich (2006) evaluators can be internal or external to the institution owner of the intervention. The decision of carrying out an internal or external evaluation normally depends on the evaluation purpose itself. When the evaluation's purpose is to improve internal processes and management, evaluators are normally internal. These internal evaluators can belong to a centralized unit specialized in evaluation practices or to decentralized units, normally from the department in which the intervention is being managed. On the contrary, when the evaluation's purpose is to improve policy learning or knowledge in general evaluators tend to be external.

Sonnichsen (1999) exposes the main advantages and disadvantages of each type of evaluator. This table illustrates these characteristics:

Table 5-2: Type of evaluator.

Type of evaluators	Advantages	Disadvantages
Internal evaluators	Familiarity with the organization. Facilitates program improvement. Credibility. Develops institutional memory. Monitor and follow up recommendations.	Lack of independence. Perceived organizational bias. Ethical dilemmas. Burden of additional tasks. Possible lack of power.
External evaluators	Superior skills. New perspectives. Independence and objectivity. Readily available skills. Facilitates program accountability.	Lack knowledge of organization. Limited access to information and people. Expensive. Lack of follow up.
Centralized units	Develops degree of independence. Develops institutional memory. Develops superior skills. Facilitates program accountability. Enables strategic planning of evaluations.	May appear threatening. Can be perceived as tool of agency. Remoteness from front line.
Decentralized units	Greater program knowledge. Less resistance from managers. Facilitates participatory evaluations. Facilitates program improvement.	May lack independence. May lack methodological skills. Possible lack of power.

Source: Sonnichsen 1999: 64

Independently from the type of evaluator, it is commonly accepted that there is a set of minimal competences that an evaluator has to control. Scriven (1996) summarized these into ten competences, as the next table shows:

Table 5-3: Necessary competences for evaluators.

Necessary competences for Evaluators, including understanding and abilities:
1. Basic qualitative and quantitative methodologies
2. Validity theory, generalizability theory, meta-analysis
3. Legal constraints on data control and access
4. Personnel evaluation
5. Ethical analysis
6. Needs assessment
7. Cost analysis
8. Internal synthesis models and skills
9. Conceptual geography
10. Evaluation-specific report design, construction, and presentation

Source: Scriven (1996: 160)

In conclusion, a consideration of the evaluations purpose must be undertaken in order to decide between the types of evaluator. However, it is clear that all of them have to develop a minimum set of competencies, which include both technical and personnel skills, including personal values and communication skills.

5.5 Challenges of Evaluation of S&T Policy

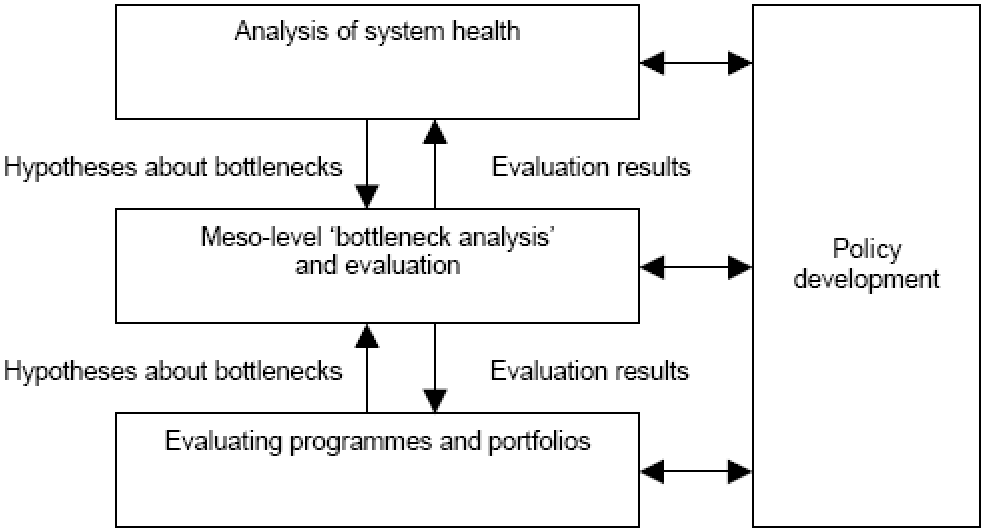
Evaluation of Science and Technology Policy has to evolve at the same rate as the policies. They have become more complex, as we highlighted in the previous section, which leads to a multidimensional evaluation framework. Nevertheless, there is a lag between the current stage of evaluation and policy theory (Molas-Gallard and Davies, 2006) as they have not evolved at the same speed. According to these authors, the existing gap is a consequence of the complexity of theories that have been applied to the policy arena. This complexity can be extracted from the previous paragraphs, but we will explain those features and trends that constitute challenges for policy evaluation in more detail.

First of all, the purposes of evaluation have changed. Thus, the need to demonstrate accountability has changed into the need to improve the understanding of policies (Kuhlmann, 2003), which constitutes a change into policy learning. Within the same context, evaluations have evolved from an objective assessment of the effects of intervention (summative evaluation) to an evaluation in which recommendations are provided and all relevant stakeholders are involved in a participatory process (formative evaluation) (Kuhlmann, 2003, Diez 2002, Guy, 2003, Molas-Gallard and Davies 2006). This is also a consequence of the evolution from the linear model of innovation to the systemic model, which affects the design of S&T policy (Molas-Gallard and Davies 2006), and therefore moving from neoclassical to evolutionary rationales, as was demonstrated in chapter 3.

In this evolutionary or systemic view, according to Molas-Gallard and Davies (2006), policy initiatives are not designed and implemented in isolation but are part of a policy portfolio, which includes different measures centered around the performance on the system at different levels. For that reason, S&T policy evaluation has to adopt a multilevel and systemic approach, in order to cope with this policy reality (Molas-Gallard and Davies, 2006). Guy (2003) also proposes portfolio evaluations in order to adapt evaluation process to this systemic context. Moreover, following Fahrenkrog et al. (2002), in this scenario, evaluation methodologies would need to converge with other policy support tools as foresight or technology assessment, in order to enhance policy-making process. Thus, evaluation would be a source of strategic intelligence (Kuhlmann, 2003).

Nevertheless, although new approaches to evaluation rely on the formative role of this process and not on the accountability purpose, policy makers are still demanding evaluations based on impacts assessment of policy, which are mainly supported by a linear view of the innovation process (Molas-Gallard and Davies, 2006). According to Arnold (2004), traditional evaluations can coexist with systems evaluations. Moreover, accountability and learning are important in evaluations at programme level. Arnold (2004) proposes three levels of evaluation in a system world, as next figure shows. The first level regards the evaluations at programme level, following the traditional approach, but considering them a bottom-up element of evaluation. In addition, there is an overall view of health of innovation systems as a top-down evaluation, an evaluation of sub-system at meso-level explores the role of institutions, actors, etc. The main difference in this approach regarding the traditional evaluation of programmes is that within the systemic approach the scope of evaluations is wider. In this type of evaluation evaluators have to consider many contextual factors that might affect the achievement of programme's objectives (Arnold, 2004).

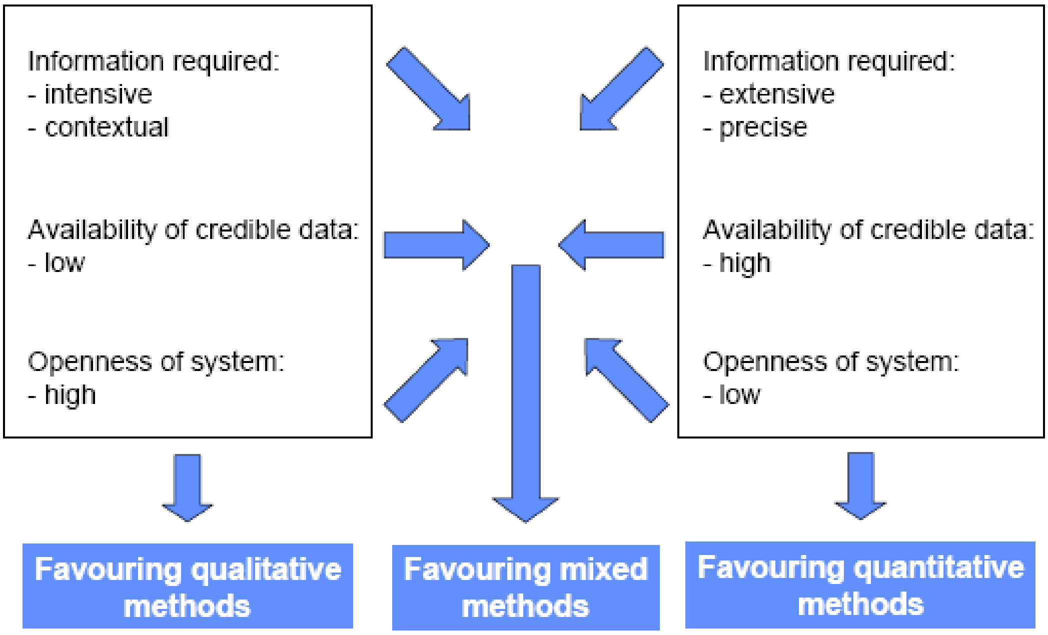
Figure 5-5: Evaluation within a systemic perspective.



Source: Arnold (2004)

Furthermore, and due to the need of moving from a summative evaluation to a formative one, there are some tensions between employing quantitative and qualitative tools in the process. Some authors (Turok 1991, Papaconstantinou and Polt, 1997, Williams, 1999, Diez, 2002) plead for a combination, or mix of, quantitative and qualitative approach and tools, in order to tackle the challenges shown above. Papaconstantinou and Polt (1997) point out that a mixed-approach gives the evaluation's results credibility. Williams (1999) states that a mixed-method approach is the appropriate route for evaluation as qualitative methods compensate weaknesses of quantitative methods and vice versa. This approach is presented in the following figure:

Figure 5-6: Evaluation approaches.



Source: Williams (1999) from Chen (1998)

As Diez (2002) remarks, the combination of techniques, which is called triangulation, will become *a powerful tool for evaluation in the future.*

Finally, regarding regions, Diez (2002) highlights the evaluation challenges posed by new forms of regional policies. Some of these challenges can be attributed to the systemic view of regions as regional systems of innovation. For that reason, some of these challenges would be included in those referred to above. The next table shows evaluation challenges proposed by Diez (2002):

Table 5-4: Evaluation challenges

Characteristics of regional policy	Challenges	Evaluation proposals
Intangible objectives	There are numerous difficulties in quantifying effects and identifying measuring indicators	Qualitative information is the most useful tool for the observation of intangible effects
The complexity of cause-effect relationship	There is no linear causal relationship between resources, activities, results, effects and regional impact	An approach is required that can help to clarify the mechanism that explains changes
Systemic nature	Complex interactions are produced in multiple areas and at different levels of effects: companies, institutions, regional community.	Case studies as a method of observation and analysis
Embeddedness	The cultural and political context and the socioeconomic conditions are an intrinsic part of the policy	Social, cultural and political elements must be wholly integrated in the evaluation. Evaluation is a socio-political process
Dynamism and flexibility	The implementation process is as important as the changes produced. The integration of possible changes in conditions (context) and in the need of users.	A summative and formative exercise. Evaluation design must be and active-reactive-adaptative process
The region as "animateur"	Helping regional governments to design better policies and recognizing the existence of a pluralist society.	The participation of the stakeholders must guide the evaluating design. Evaluation must be a collective learning process

Source: Diez (2002)

As we mentioned, some of these challenges can also be attributed to other systems as national or sectoral systems of innovation. These refer to the complexity of the cause-effect relationship, systemic nature and dynamism and flexibility. The feature of intangible objectives also depends on the scope of the policy (i.e. innovation policies versus science and technology policies). Therefore, we can say that embeddedness and the region as "animateur" are specific characteristics of regional policies that constitute challenges for evaluation.

Moreover, Georghiou (1998) describes some tensions regarding evaluation. These include the necessity of evaluating during the whole programme's life and not only in a specific moment, the need to evaluate a portfolio of projects and not a single project, and the need to evaluate institutions and their industries linkages in order to incorporate a system perspective. Additionally, as different policies can produce effects on a certain domain (policy mixes), it is necessary to detect the indirect or direct effects of these other policies in the one that is being evaluated (Flanagan et al. 2010).

Therefore, following an evolutionary perspective and taking into account that current policies (including regional ones) are becoming more complex, evaluation of Science and Technology policy has to evolve in order to tackle these challenges. This evolution includes the use of different and combined methods that will be explained in the next section.

5.6 Methods for evaluation

In order to provide a complete vision of the different existing methods to evaluate Science and Technology Policy, we will give an integral overview of most of them. This vision includes the strengths and weaknesses of the method, which will help us to decide between them in order to select the most appropriate method for each evaluation case.

The next table summarizes the existing evaluation methodologies as well as their associated outputs, outcomes and impacts. According to Zabala Iturriagagoitia and Jimenez Saez (2006), in regional S&T evaluation of policies there is still a lack of coherence as most of methods do not incorporate the systemic view and they are linear methods designed to compare outputs, outcomes and impacts with the inputs provided by the policy.

Table 5-5: Evaluation methods.

Method	***Data application level***	***Output***	***Outcome***	***Impact***
Innovation Surveys	• Firm • Industry • Economy-wide	• New products and processes • Increase in sales • Increase in value added • Patents counts • IPRs	• Creation of new jobs • Innovation capacity building	• Enhanced competitiveness • Institutional and organisational efficiency • Faster diffusion of innovation • Employment
Micro methods	• Plant • Firm • Industry • Economy-wide	• Output and value added (collect baseline info for before-after comparisons)	• Sectoral productivity • Industry Sectoral spillovers • Additionality • Leverage effects	• Firms' competitiveness
Control group approaches	• Firm • Industry	• Output and value added (on supported and non-supported firms)	• Additionality • Rate of return to R&D	• Firms' industrial competitiveness
Macro Methods	• Firm • Industry • Economy-wide	• Output and value added	• Change in R&D capital • Human capital • Social capital • International R&D spillovers	• Regional/Country productivity • Employment • Good governance • Economic and social cohesion
Productivity Studies	• Plant • Firm • Industry • Regional • Economy-wide	• Output and value added	• Knowledge • Geographical and international R&D spillovers	• Regional/Country productivity • Employment • Economic and social cohesion
Cost Benefit Analysis	• Firm • Industry	• Value added • Benefit cost ratio • Consumer surplus	• Health improvements • Consumer protection • Environmental sustainability	• Quality of life • Standard of living
Expert panels/Peer review	• Firm • Industry • Economy-wide	• Publication counts • Technological output	• Scientific and technological capabilities	• R&D performance
Field/Case studies	• Firm • Industry	• Detailed inputs and outputs	• Firms' RTD capabilities	• Industrial competitiveness

Method	***Data application level***	***Output***	***Outcome***	***Impact***
			• On-the-job training • Educational schemes	• Quality of life • Organisational efficiency
Network analysis	• Firm • Industry • Regional	• Cooperation linkages	• Cooperation in clusters • Social embeddedness	• Efficiency of institutional relationships • Technological paradigm shifts
Foresight/Technology assessment	Institution Regional Economy-wide	• Identification of generic technologies • Date of implementation	• Technological capacities	• Technological paradigms shifts
Benchmarking	• Firm • Industry • Economy-wide	• Efficiency of technology policy	• Technological capabilities	• Industry competitiveness • Good governance

Source: Adapted from Polt and Rojo (2002) and Tavistock institute et al. (2003)

Each method has its own strengths and weaknesses and they are chosen depending on the type of evaluation that will be implemented (ex-ante, ex-post or monitoring). In the following paragraphs we will explain some general characteristics of each method.

- *Innovation surveys:* Is a method applied in monitoring and ex-post evaluations as it is based on a survey of innovating firms. It is mainly a data collection of innovations in firms. It is a method use to evaluate a) the characteristics of firms participating in a programme, b) differences among countries and c) impacts on innovation inputs and outputs, if they are combined with econometric techniques. Innovations surveys have, as their main advantage, that they are not normally designed for evaluation purposes and, for that reason they include a range of firms apart from the programme's recipients. Moreover, they address innovative and non-innovative firms and they can give a complete vision of government's interventions on firms. They also provide a wide range of indicators and they can be combined with other techniques. However, they are highly time consuming and some specific information that is needed for the evaluations is difficult to obtain. It is also complicated to establish the linkages between the programme's intervention and the outcomes produced. As consequence it is not the best method to overcome data availability. (Licht and Sirilli, 2002)

- *Micro methods:* These methods try to quantify the effects of the intervention on the recipients (in the case of S&T policy on firms). They try to estimate the differences in the state of the recipients after the intervention compared to their counterfactual state, which means their situation had they not received any subsidy. As this latter state is not observable, they try to estimate it with several methods (matching approaches, selection approaches, etc). Their main advantage is that the analysis is based on the explicit formulation of causal relationships between the objectives of programme and the factors influencing these objectives. They also provide an estimation of the impacts of the programme on the recipients, although knowledge spillovers to non-recipients cannot be estimated with these methods. The main limitation of micro methods is the need for quality data that sometimes is not available for evaluators. These methods are mainly used for monitoring and ex-post evaluations (Arvanitis and Keilbach, 2002). Control group approaches could be considered as a specific micro method but this will be explained separately.
- *Control group approaches:* These are methods used to evaluate effects and impacts of the programme intervention on the participants. It requires constructing groups of actors (the beneficiaries and those who did not receive the subsidy compose the control group) in order to compare performance between the two groups. They use quantitative techniques to compare these two situations. The main advantage of this method is that it can estimate the additionality of the programme, although this technique requires technical skills and data quality and availability in order to be implemented. It is a method useful for ex-post evaluations. (Kinsella, 2002).
- *Macro methods:* They are used to assess policy effects on economic performance at macro level. Furthermore, they are used in ex-ante, monitoring and ex-post evaluations. These are mainly models that assess the impact of policy in some macroeconomic variables, such as: employment, GDP, etc. Their main advantages are that these methods provide an indication of the spillovers produced by programmes and they can estimate long term impacts. They can also be used for ex-ante evaluations as they simulate future scenarios for policy. Nevertheless, it is difficult to estimate the socio economic effects of policy, as other factors can also affect macroeconomic variables. (Capron and Cincera, 2002)
- *Productivity studies:* They are used to measure productivity produced by any given set of inputs. It is a measurement used in ex-post evaluations as well as in monitoring

evaluations. Its main advantage is that it evaluates one of the expected effects of R&D programmes; productivity. Nevertheless, it is a method limited by the difficulties of measuring it, when taking into consideration the firm's outputs, because they have to be value-measured and summarized into one variable. These methods are also based on econometric techniques. (Eaton, 2002).

- *Cost Benefit Analysis:* Is a method employed specifically for ex-ante evaluations but also used for monitoring and ex-post evaluations. It is a quantitative technique that tries to estimate the costs and benefits of an intervention, primarily of investment projects. It is a good approach to evaluate the efficiency of an intervention but it requires a high technical capacity. Moreover, this method has as major disadvantage; not all benefits can be easily quantified in monetary terms. For this reason, results from evaluations have to be carefully interpreted. (Polt and Woitech, 2002).
- *Expert panels/Peer review:* These are methods based on groups of experts that combine the most relevant knowledge, expertise and experience for evaluation. It is a qualitative method used for all types of evaluations (ex-ante, monitoring and ex-post). These are very flexible and inexpensive methods for evaluation but they depend on the availability of experts. The independence of experts is also other important feature to be considered when using these techniques. (Rigby, 2002).
- *Field/Case Studies:* These are qualitative techniques that involve a direct observation of the events, trying to study social interactions of actors in their natural environment. Consequently, they are appropriate when the evaluation seeks to assess socio economic effects in recipients in their natural context. They are useful in an exploratory stage of evaluation and less useful to obtain results regarding causal relationships. Moreover, their results cannot be generalized. (Stern, 2002)
- *Network analysis*: Is a qualitative or semi quantitative technique used to analyse the cooperation linkages among different actors. This technique is employed to analyse within a network a) the characteristics of relationships and b) the characteristics of networks. Its main advantage is that it provides a view of linkages that it is not provided by other techniques and it is very useful for policy purposes. Nevertheless, as it is a method based on a survey, therefore it is time consuming. It is a technique employed in ex-post evaluations (Buhrer, 2002).
- *Foresight/Technology assessment:* These are two valid methods for ex-ante and monitoring evaluations. "Technology foresight is the systematic attempt to look into

the longer-term future of science, technology, the economy and society, with the aim of identifying the areas of strategic research and the emerging of generic technologies likely to yield the greatest economic and social benefits" (Martin 1995, 140). “Technology assessment, in very general terms, can be described as the anticipation of impacts and feedback in order to reduce the human and social costs of learning how to handle technology in society by trial and error. Behind this definition, a broad array of national traditions in technology assessment is hidden” (Schot and Rip 1997; Loveridge 1996). Their main advantages are that both techniques are focused on strategic intelligence and they open new spaces for discussion within policy-making. However, they are not valid methods for detecting innovation breakthroughs. (Kuhlmann, 2002).

- *Benchmarking:* This is a method based on comparisons between the performance of firms, organisations, institutions, countries, etc. against each other. In general, benchmarking is used to learn from the best practice but as pointed out by Navarro et al. (2011), in the systemic and evolutionary context there is not an optimum. Consequentially, benchmarking should be used to establish comparisons between comparable systems, and therefore learning from good practices instead of learning from best practices (Navarro et al., 2011). It is a technique normally used in ex-post and monitoring evaluations. It allows systematic evaluation of institutions and systems but it has to be used avoiding the narrow perspective of comparing just quantitative indicators. Nevertheless, systems complexity is one of the major challenges that benchmarking techniques have to tackle. (Polt, 2002).

Next table shows a summary of the strengths and weaknesses of each method.

Table 5-6: Scope and limits of evaluation methods.

Method	***Type/Use***	***Strengths***	***Limitations***
Innovation Surveys	Semi-quantitative Quantitative *Monitoring* *Ex-post*	Detect innovation trends and insights on the soft side of innovation. Findings from interviewed sample can be generalised to the population. Permits to identify size and distribution of impacts. Provides groups comparisons and changes over time.	High cost and time consuming Processing and analysis of data requires large human resources Some types of information are difficult to obtain Long time series generally not Available Difficult to reach a representative sample.
Micro methods	Quantitative qualitative categorical data *Monitoring* *Ex-post*	Results based on explicit formulation of theory based causal relationships R&D Additionality Control for different effects: firm size, expenditures, innovation capacity	Quality of data Persuade participant and non participant entities to disclose information Only private rate of return to R&D
Macro Methods	Quantitative modelling methodology *Ex-ante (simulation)* *Monitoring* *Ex-post*	Social Rate of return to R&D Capture R&D Spillovers Estimate long term policy intervention impact Scenario simulations for policy supported geographical areas	Average returns Robustness of results Time lags for observation of the effects
Productivity Studies	Quantitative modelling methodology *Monitoring* *Ex-post*	Estimation of effect of R&D on productivity Estimate the rate of return to R&D	Quality of data Deflation of series Required assumptions for measurement of stock variables
Control group approaches	Quantitative *Ex-post*	Capture the impact of policy intervention on the programme participant entity	Requires high technical capacity High Implementation Cost Data Demanding
Cost Benefit Analysis	Quantitative (with qualitative elements) *Ex-ante (especially)* *Monitoring* *Ex-post*	Provides an estimate of socio-economic effect of intervention. Good approach to assess the efficiency of an intervention. Addresses by making them explicit all the economic assumptions of the impact of the intervention.	Requires high technical capacity. Some degree of judgement and subjectivity depends on largely on assumptions made. Not easily comparable across cases. Careful interpretation of results when benefits are not easily quantifiable in monetary terms.
Expert panels/ Peer review	Qualitative Semi-quantitative *Ex-ante* *Monitoring* *Ex-post*	Evaluation of scientific merits Flexibility Wide scope of application Fairness	Peers independence Economic benefits not captured
Field/Case studies	Qualitative Semi-quantitative *Monitoring*	Observation of the socio-economic impacts of intervention under naturalistic conditions.	Results not generalized.

	Ex-post	Good as exploratory and descriptive means of investigation. Good for understanding how contexts affect and shape impacts.	
Network analysis	Qualitative Semi-quantitative *Ex-post*	Comprehensive empirical material. Compilation for policy purposes. Co-operation linkages.	Time involved in collecting the survey information. Persuasion requirements.
Foresight/ Technology assessment	Qualitative Semi-quantitative *Ex-ante* *Monitoring*	Consensus building to reduce uncertainty under different scenarios. Combination on public domain and private domain data. Articulation and road mapping of development of new technologies.	Impossibility to detect major RTD Breakthroughs
Benchmarking	Semi-quantitative *Ex-post* *Monitoring*	Comparison method across different sectors. Support to systemic evaluation of institutions and systems.	Data detail requirements Non transferable

Source: Polt and Rojo (2002)

As we can appreciate, there are different approaches and methods for evaluation. All of them have strengths and weaknesses. For that reason it is important to adopt a framework including a triangulation of different approaches, together with both quantitative and qualitative methods.

Finally, it is also important to highlight that methods employed for the evaluation of Science and Technology Policy will differ from the ones used to evaluate softer policies such as Innovation Policies. In the former, the use of econometric techniques, including cost-benefit analysis are more amenable than in the latter, in which the use of cases studies or user-surveys is more extended, as the information needed to be captured is qualitative. (Papaconstantinou and Polt, 1997). The diversity of methods for evaluation in theory is also seen in practice, as the variety of different evaluation studies show. An overview of these studies is provided in the next section.

5.7 Review of Previous Evaluation Studies

We will divide the previous studies into three areas: studies related to input additionality, studies regarding output additionality and studies aiming at measuring behavioural additionality, although there are studies that cover some of these aspects.

In the next table we summarize a selection of studies regarding input, output or behavioural additionality, including the technique and the variables used and the main results:

Table 5-7: Studies regarding additionality

Type of research	Type of additionality	Authors	Scope of the study	Techniques used	Results
Quantitative	Input additionality	Levin/Reiss 1984 Scott, 1984 Antonelli, 1989	Relation between private R&D expenditure and public R&D expenditure (subsidies)	Macroeconomic models	Not concluding findings. They found a linear correlation between private expenditure and subsidies but some of them show crowding-out effects.
Quantitative	Output	Herrera and Heijs (2003)	Effect of the public funding on R&D intensity	Matching methods: *propensity score matching* (Control groups)	There is not a crodwing-out effect
Quantitative	Input/Output	Schibany et al. (2004)	Impact of the funding on: 1) Private R&D expenditures 2) Firms' productivity growth	Panel regressions	1) Not crodwing-out effect-subsidies generate private R&D expenditure 2) There is statistical evidence of an increase of firms' productivity per worker.
Quantitative	Input/Output Relation between input and output	Ebersberger (2005)	Effect of the public funding on: 1) Innovation input (Private R&D funding) 2) Innovation outputs (patents	Matching methods: *propensity score matching* (Control groups) Differences in differences Heckman selection models	1) There is not a crodwing-out effect: subsidies lead to a higher private R&D expenditure 2) There is a positive effect on the patent activity of subsidized firms 3) There is a positive correlation between private R&D expenditure and innovation outputs
Quantitative	Input	Streicher (2007)	Effect of the public funding on the private R&D expenditure	Regression panels	There is not a crodwing-out effect: subsidies lead to a higher R&D

Type of research	Type of additionality	Authors	Scope of the study	Techniques used	Results
					expenditure. Firms that carry out systematic R&D activities take advantages from this situation in a higher proportion.
Quantitative	Output	Aerts et al. ,2008	Effect of the public funding on R&D intensity	1) Matching methods: *propensity score matching* (Control groups) 2)Differences in differences	Funded firms show, on average, higher R&D intensity.
Qualitative	Input	Molero/Buesa 1995,1996	Substitution of private expenditure by public expenditure. Existence of alternative financing sources Possibility of carrying out innovation projects without public funding Importance of the funding quantity	Case Studies	Different conclusions depending on the employed indicators.
Qualitative	Output	Ernst &Young (1999)	Impact analysis of the Structural Funds on EU's SMEs and regions.	Bottom-up research: Field research in some regions and firms. Phone survey with a control group.	It shows estimations about the net employment generated as a consequence of Structural Funds.
Quantitative	Output	Czarnitzki et al. (2007)	Impact of R&D funding on firms' patenting activity	Matching methods: *propensity score matching*	It shows positive influence of public R&D funding on patenting activity in firms
Quantitative	Behaviour	Fernandez-Ribas and Shapira (2009)	Analysis of the effects of national and regional funding on international collaborations	Matching methods: *propensity score matching*	It shows positive (but small) influence of domestic-level programmes on the probability that a firm develops

Type of research	Type of additionality	Authors	Scope of the study	Techniques used	Results
					innovation with foreign partners.
Qualitative-quantitative	Behavioural additionality	OECD (2006)	Measuring behavioural additionality in different cases studies	Case studies, surveys, econometric technqieues	Positive behavioural additionality effects, especially in terms of collaboration.
Quantitative	Behavioural additionality	Busom and Fernandez-Ribas (2008)	Analysis of the effects of R&D funding on fostering collaboration	Matching methods: *propensity score matching*	Public support significantly increases the chances that a firm will cooperate in partnerships
Quantitative	Behavioural additionality	Aschhoff et al. (2006)	Analysis of the effects of R&D funding on fostering collaboration	Matching methods: *propensity score matching*	Positive effect of public support on firms' collaborative partnerships.
Quantitative	Behavioural additionality and relationship between behavioural and input additionality	Clarysse et al. (2009)	Analysis of the effects of R&D funding on various behavioural additionality aspects (related to learning processes in firms) and analysis of relationships between behavioural and input additionality	Matching methods: *propensity score matching*	Positive behavioural additionality and positive correlation between input and behavioural additionality.

From the previous table we can appreciate that most of the research has focused on input additionality, and more specifically on the effect of public funding on private R&D expenditure. Following a neoclassical perspective, public R&D resources should impact on a higher R&D private expenditure, as innovation is a linear process. From the same point of view, more resources would lead firms to higher innovation outputs. These outputs have been traditionally measured by patents or R&D intensity.

Some of the conclusions that can be extracted from the previous tables are that:

- Quantitative studies prevail over qualitative studies in input and output additionality research.
- Most of the existing evaluation studies of R&D policy are focused on input and output additionality (especially on input additionality).
- Most of the studies do not analyse the relationship between different types of additionality.
- Most of existing studies are only based on one type of approach - either quantitative or qualitative - and they do not triangulate methods from both approaches.
- None of the analysed studies have considered the interaction of other programmes at other administrative levels leading to a one-level evaluation instead of a multi-level one.

5.8 Conclusions

Although evaluation of S&T Policy has evolved over the last few decades it has not followed the same evolution speed as policies and a gap still remains in this context. Policies have become more complex and it is therefore more difficult to evaluate them. This is one of the reasons why evaluation role has evolved towards policy learning purposes following evolutionary approaches. Policy evaluation has become a tool for policy understanding and learning, which is useful in a complex context. However, there is still a huge interest among policy-makers for measuring policy effectiveness attending to traditional and more neoclassical purposes. Therefore, a mix of purposes remains in current evaluations (from accountability to learning purposes), creating some tensions between methodological approaches corresponding to each purpose. Moreover, new intangible assets, included in these new evolutionary frameworks, (i.e. learning, collaborations, etc.) make it difficult to measure policy effects through traditional and quantitative methods. It is therefore important to find out the combination or triangulation of methods that are most effective for each evaluation. In this chapter we have reviewed the existing evaluation methods and their weaknesses and strengths in order to give an overview of the different possibilities for evaluation. In addition, we have provided an outline of the most employed methods in practice, highlighting the existing lack of triangulation in evaluation studies. Finally, it is important to stress the necessity of designing each evaluation according to the intervention, the context and other characteristics.

All these issues could be considered as evaluation challenges that are becoming more important at a regional level. Regions are spaces in which different policies with different characteristics and rationales and from different domains and levels co-exist in a complex context. Evaluation has to evolve towards this scenario by capturing different policy effects with a policy learning purpose in order to better design and implement S&T policies in a given context.

Taking into account these evaluation challenges, we propose a methodology for this research in the following chapter.

6 TOWARDS A NEW APPROACH FOR THE EVALUATION OF SCIENCE AND TECHNOLOGY POLICY

Taking into consideration all the current challenges for evaluating Science and Technology Policy and the different methods and techniques available for undertaking evaluation, this chapter will explain the methodology that will be applied through this research in order to achieve the mentioned research objectives.

Firstly, the research hypotheses will be explained and justified according the previously analysed literature. Secondly, as these hypotheses will be contrasted through a case study, this methodology will be explained, and the chosen case will be justified and contextualized.

Moreover the proposed methodology will be explained, together with the reasons for its selection. This explanation will also include the techniques selected to test the research hypotheses, the reasons for selecting the case study and the programme to evaluate it. Finally, the research design will be presented, which includes an explanation about the data set and the variables included in this research.

6.1 Research Hypotheses

The research hypotheses are related to the need to justify governments' intervention through public policies. That means that the rationales explained in chapter 3 are important because they are used to justify government intervention. Furthermore, additionality is a concept to be focused on in order to analyse the role of public policies and their effects on firms' performance. Because we can distinguish three main types of additionality, we can therefore formulate three set of hypotheses:

1. Hypotheses related to input additionality.
2. Hypotheses related to output additionality.
3. Hypotheses related to behavioural additionality.

In addition, as we mentioned before, different additionalities may be related between them. Therefore, another set of hypotheses can be formulated:

4. Hypotheses with regards to the relations between different additionalities.

Finally, we can also establish an hypothesis referring to the interaction of different policies at different levels that impact on firms located in a certain territory:

5. Hypothesis with regards to multi-level policy interactions

As we mentioned before, *input additionality* measures the effect of the policy on the inputs of the innovation process. Therefore, public funding of R&D will have a consequence on the R&D expenditure of firms (David *et al*. 2000). Following the previous literature (Georghiou 1994, Bach and Matt 2002, among others), which defines additionality as the complementary effect of governments' intervention, input additionality means that the beneficiaries of a policy should invest in the innovation process additional resources to the ones that they would had invested in absence of policy. That means that input additionality is a measure of the resources invested in order to obtain an output. The input additionality concept relies on the linear innovation model and assumes that the more resources a firm invests in R&D the more technological advancement will obtain. Due to market failures of uncertainty, appropriability and indivisibility, firms do not take advantage of all the innovation possibilities. For that reason, governments intervene in order to reach the market optimum, following the neoclassical approach. The research question that summarises this hypothesis is: Does public R&D funding (in the form of R&D subsidies) raise private R&D funding? In order to measure the complementarity of public intervention into private innovation processes, private R&D expenditure is the main variable to be used, together with another important input of innovation process: R&D personnel. For this research, the hypotheses can be stated as follows:

H.1: Firms that have received some regional R&D subsidy will have increased their inputs to the innovation process in a greater amount than those firms with similar characteristics, which have not received any regional R&D subsidy. More specifically:

H.1.1. Firms that have received some regional R&D subsidy will have increased their R&D private expenditures more than those firms with similar characteristics that have not received any regional R&D subsidy.

H.1.2. Firms that have received some regional R&D subsidy will have increased persons dedicated to R&D activities more than those firms with similar characteristics that have not received any regional R&D subsidy.

Output additionality is also based on a linear process of innovation and it tries to measure the effect of government intervention in terms of outputs of the innovation process. These effects would not have happened in absence of the policy, in order to give a justification to policy intervention. As Bach and Matt (2002) state, this is also a view influenced by the neoclassical approach. Regarding output additionality, the literature (Bach and Matt, 2002) distinguishes the following scientific and technological outputs: products, processes, patents, services, articles or papers, standards and norms, increased sales revenues, etc. In the same context as input additionality, the question to answer in this case is: Would the firms have obtained the same outputs in absence of the policy? As Bach and Matt (2002) state, it is important to assess the outputs' impact - for example the sales produced by new products - in order to correctly assess the policy's impact. Traditionally, patents have been the output used to measure the impact of S&T Policy, although other variables have also been studied. As Science and Technology Policy concentrates on technical developments and outputs, we have kept patents as an important variable for the evaluation model. The hypotheses underlying this concept can be stated as follows:

H.2: Firms that have received some regional R&D subsidy will have higher innovation outputs than those firms with similar characteristics which have not received any regional R&D subsidy.

> **H.2.1.:** Firms that have received some regional R&D subsidy will have registered more patents than those firms with similar characteristics firms that have not received any regional R&D subsidy.
>
> **H.2.2.:** Firms that have received some regional R&D subsidy will achieve a higher productivity per worker than those firms with similar characteristics firms that have not received any regional R&D subsidy.
>
> **H.2.3.:** Firms that have received some regional R&D subsidy will achieve a higher R&D intensity than those firms with similar characteristics that have not received any regional R&D subsidy.

Behavioural additionality is a concept that goes beyond input and output additionality and measures the changes in the agents' behaviour produced by the policy action. Bach and Matt (2002) distinguish between two types of behavioural additionality, depending on the period. The first type refers to the changes produced when the intervention is carried out (for example a project that would not be carried out in collaboration). The second refers to the changes produced at the end of the intervention (that means that the agent has modified its routines, etc.. after the intervention has finalised). As the authors mention, in terms of evaluation, the second approach is the most important. In addition Clarysse et al., 2009 relate behavioural additionality to the organizational theory of the firm. Therefore, the behavioural effects of a public intervention can be attributed to learning processes that take place within firms.

Behavioural additionality tries to answer the following question: Does the policy change the firms' behaviour? Behaviour can be measured in terms of collaboration. This means that firms that did not collaborate before the policy support have started to collaborate afterwards. In Luukkannen's words (2000), we can talk about collaboration failures in the case of subsidies that aim to enhance collaborative behaviour among firms.

Behavioural additionality presents differences with respects to input and output additionality. According to Georghiou (2004) and Larosse (2004), behavioural additionality is based on an interactive model of innovation and responds to an evolutionary rationale instead of a neoclassical approach. Therefore, Georghiou (2004) argues that behavioural additionality tries to respond to the following questions: Does the support help to overcome a lock-in situation; does the support help to build or coordinate networks in the system? And finally, does the policy incentivise the firms to acquire new skills or capabilities? This is to simply state that behavioural additionality tries to measure the effect of four evolutionary problems: transition or lock-in, network, institutional and learning problems.

The hypotheses related to behavioural additionality can therefore be stated as follows:

H.3: Firms that have received some R&D subsidy will have higher behavioural additionality than those firms with similar characteristics which have not received any R&D subsidy.

> **H.3.1.**Firms that have received some regional R&D subsidy and did not invest in R&D before receiving the subsidy will have a higher probability to start developing systematically R&D activities than those firms with similar characteristics which have not received any regional R&D subsidy.
>
> **H.3.2.** Firms that have received some regional R&D subsidy will have a higher probability to participate in international R&D projects due to the experience and learning acquired in regional ones, than those firms with similar characteristics which have not received any regional R&D subsidy.

H.3.3. Firms that have received regional R&D subsidies will acquire more capabilities and need higher human resources specialization than those firms with similar characteristics which have not received any regional R&D subsidy.

Following Georghiou (2002), behavioural additionality substitutes input and output additionality, the former being a translation of additionalities within an evolutionary perspective. Nevertheless, Autio et al. (2008) and Clarysse et al. (2009) have demonstrated that there is a positive correlation between input and behavioural additionality. This means that both types of additionality coexist within the same public intervention. This is possible due to the fact that, in practice, there are not purely neoclassical or evolutionary policy rationales, as Flanagan et al (2011) point out. In addition, and if we assume that changes in behaviour are consequence of organizational learning processes, input and output additionalities are part of such processes and, consequentially, are related to behavioural additionality. We can therefore state hypotheses that relate these concepts, taking into account that we consider collaboration patterns a measure of behavioural additionality.

The hypotheses can be stated as follow:

H.4.1: Firms that collaborate with other firms or agents in regional R&D projects will have increased their inputs of the innovation process in a greater amount than those which have not collaborated in such R&D projects (those participating in individual projects). That is to say that input and behavioural additionalities are positively correlated.

H.4.2: Firms that collaborate with other firms or agents in regional R&D projects will have higher output additionality than those which have not collaborated in such R&D projects (those participating in individual projects). This is to say that output and behavioural additionalities are positively correlated.

H.4.3: Firms that collaborate with other firms or agents in regional R&D projects will have higher behavioural additionality than those which have not interacted in such R&D projects (those participating in individual projects). This is to say that collaboration is correlated to other behavioural additionalities' measures.

Finally, the complexity of S&T policies has been increased in the last decades. This complexity can be perceived by the diversity of policies from different domains aiming at foster innovation with a mix of rationales and instruments (Nauwelaers et al., 2009; Flanagan et al., 2011; OECD, 2010) that interact in a certain territory. In addition, this mix of policies could have been designed and implemented at different administrative levels (from supra-national to regional or local) leading to the fact that one territory (i.e. region) could be considered as an overlapping space in which different policies are being impacted (Uyarra and Flanagan, 2010). Interactions among different policies, therefore, could lead to different results, as opposed to one policy analysed in isolation. Assuming that the systemic effect of policy-mixes at different levels should be higher than the additional effect of an isolated policy, we can state the following hypotheses:

H.5.: Multi-level policy-mix impacts on a territory will be lead to higher additionality effects than impacts from isolated policies for the same amount of resources.

> **H.5.1.:** Multi-level policy-mix interventions will achieve higher input additionality effects than isolated interventions for the same amount of resources.
>
> **H.5.2.:** Multi-level policy-mix interventions will achieve higher output additionality effects than isolated interventions for the same amount of resources.
>
> **H.5.3.:** Multi-level policy-mix interventions will achieve higher behavioural additionality effects than isolated interventions for the same amount of resources.
>
> **H.5.4.:** Multi-level policy-mix interventions will achieve higher collaboration effects than isolated interventions for the same amount of resources. These effects will lead to higher input, output and behavioural additionalities when considering the whole system of policies impacting in the beneficiaries from a certain territory for the same amount of resources.

These hypotheses will be further contrasted in a case study following the methodological approach presented in the next sections.

6.2 Mixed Methodology for Policy Evaluation

As we mentioned in chapter 5, there are different methods for policy evaluation. All of them have advantages and disadvantages, for, when taken in isolation, a single method is inadequate for evaluating R&D policy. Given this, we argue that a good option for evaluation research is to triangulate methods, mixing quantitative and qualitative methods. For this purpose, we have selected a case study of regional R&D policy on which we will contrast the mentioned hypotheses through a cuasi-experiment method. It is necessary, therefore, to know the main characteristics of each method, in order to better design a mixed research methodology.

According to Yin (1994) a way of integrating quantitative methods with qualitative ones (concretely with case studies) is when a single evaluation may consist of several studies. *Each substudy may have its own research design and may use different methods, but the aggregating of these substudies into a singular evaluation framework will best occur when the singular framework is considered a case study framework* (Yin, 1994:287). In this research, the evaluation of a single programme from different perspectives will be done mainly through , quasi-experiment designs. Nevertheless, these experiments will be embedded in a case study framework, which is the regional S&T policy framework.

The case study methodology is appropriate in contemporary research, when the researcher wants to obtain a holistic view of reality. Additionally, the rationale for the method of case study is to answer "how" and "why" questions, in the same manner as experiments methods. (Yin, 2009). Both methods therefore, are appropriate to policy research and policy evaluation, as they aim at understanding reality and their mechanisms, including causal links in the latter.

Case studies provide "a richly detailed portrait of a particular social phenomenon" (Hakim, 2000:59). They can be exploratory, when the research field is quite new; they can be selective, and focus on particular aspects to refine knowledge, or they can be explanatory, in order to achieve experimental isolation of selected social factors (Yin, 2009, Haakim, 2000). According to Yin (2009) case studies are used to "contribute our knowledge of individual, group, organizational, social, political and related phenomena" (Yin 2000:4). Following a systemic perspective, case studies methodology is the best method to understand complexity and the different relations established within the system. However, some limitations of this method should be highlighted. First of all, a lack of rigor is seen in the case studies method, compared to other methods as experiments, as the rigor depends on the researcher. Case studies for research are sometimes confused with case studies for teaching, where some elements are altered for pedagogical purposes. Secondly, case studies provide little generalization. As Yin (2009) points out, however, it provides little statistical generalization, but not analytical generalization, that is to say, provide an input to generalize theories. In addition, a limitation for these methods is that it is time consuming, although with new ICT technologies researchers can now tackle the case study in less time. Finally, cases studies are often criticised for not providing causal relationships explanation (Yin, 2009). These limitations can, however, be overcome with the use of experiments within case studies. As Yin (2009: 16) states, case studies must be seen as an “adjunct to experiments rather than as alternatives to them”. Finally, it is also important to take into account the fact that there are some differences between single or multiple case studies. The rationales for designing a single case study are described by Yin (2009). Among these rationales, we can highlight that it is convenient to apply a single case study when a) the selected case is critical in contrasting one established-theory, b) it represents a unique case, c) it is representative or typical, d) it is a revelatory case, or e) it is a longitudinal case. Additionally, Yin (2009) points out that within a single case study, more than one unit of analysis can be analysed, evolving to an embedded case study design. In our research, the case study will be a regional R&D programme and the units will be the firms funded by this programme. This embedded case study has as its main advantage, distinct from its holistic ones, the fact that it can include concrete measurements, keeping the research far from abstract. It is nonetheless important to know how to return from unit analysis to the larger unit of analysis, keeping in mind the general context of the research design (Yin, 2009).

Experiments also constitute a methodology which aims to answer “why” and “how” questions as case studies. Experiments are not a very common method in social research, although they are extended particularly in policy evaluation. The main purpose of experiments is to analyse casual links between two factors or variables.

In social sciences, pure experiments cannot be implemented, as it is not feasible to apply treatment into one group of individuals in order to compare them with a control group who have not received the treatment. This is why, in social sciences, we try to take advantages from experiments through the design of quasi-experiments. The main advantage of these methods is that they eliminate selection bias as they introduce randomization to the sample. This means that, if the basis of experiments is the comparison of two groups (a group that receives treatment and a group that does not receive treatment-control group), randomization determines that all the units, in both the treatment and the control group, will be exactly the same. Therefore, it is possible to realize ‘before’ and ‘after’ comparisons between the two groups (Hakim, 2000). Five types of quasi-experiments can be identified (Bechhofer and Paterson, 2000):

a) Where there are two groups - the treatment and the control group - and they are both measured before and after the experiment. Because option a) is often not easy to carry out, matching methods can be used to identify units from the control group similar to the ones in the treated group with regards to certain characteristics.

b) There is only one group and both pre-test and post-test are implemented in the group. The main disadvantage of this technique, distinguishing it from the one above, is that it is difficult to find out what would have happened otherwise.
c) There are two groups but there is not a pre-test. One of them receives the treatment and the other not.
d) There is only a group and the measurement occurs afterwards, which does not allow making any comparison.
e) There are also natural quasi-experiments, which naturally occur without the researcher intervention.

The most important value of these quasi-experiments is that they provide a way to vividly demonstrate valid comparisons between two situations. In addition, as Hakim (2000:130) highlights “the procedures for quasi-experimental designs include using combination of different research designs” as, for example, case studies, supporting the thesis, therefore, of method triangulation.

Finally, it is important to point out the approach to policy research that will be adopted within this study, as evaluation is considered a particular form of policy research (Hakim, 2000). Theoretical and policy research present different characteristics, as next table shows:

Table 6-1: Differences between theoretical and policy research

	Theoretical Research	**Policy research**
Aims	Theoretical research aims at producing knowledge for understanding. It is interested in causal explanations and it is based on theoretical constructs.	Policy research aims to produce knowledge for action, and concretely concerned with social action.
Target audience	Mainly academics.	Multi-disciplinary audience, including all relevant groups of policy makers, public pressure groups, etc.

Source: Based on Hakim (2000) and Uyarra (2004)

Although this research is based mainly on theoretical constructs, the selected case study has a component of policy research, as it is the desire of the researcher to generate knowledge, not only for understanding, but also for acting. In this sense, policy research involves a review of how policy is working, which can in some cases, be extended to formal evaluation studies. This thesis, therefore, will assume theoretical research basis, but overlapping within the case study with policy research purposes.

6.3 Justification of the Case of Basque Region

The case study we have selected to contrast with the stated hypotheses is the Basque Region in Spain. More concretely, we will base our analyses on the main R&D programme of the region (the INTEK programme), which will be further described in Chapter 7. The main purpose of this section is to give theoretical-based reasons for the selection of the Basque Region as case study and the INTEK programme as experiment design embedded in the case study.

The Basque Region is a region located in the North cost of Spain, in the South of Europe and close to Southwest France. It is a small-related region, with an area of 7,235 km^2 and 2,099,200 inhabitants, which represents around 5.1% of total Spanish population. The Basque Region is an Autonomous Community composed of three “historical territories” which enjoy important competences, including tax collection. In fact, there is no region in the EU that enjoys more political autonomy than the Basque Region does(Cooke and Morgan, 1998). This is one of the reasons that motivated the choice of the Basque Region for the case study, as it provides a valid framework for analysing a regional policy, which is part of a complex policy setting that overlaps sub-regional, regional, national and international policy arenas. This complexity can also be seen in the interrelation with various industrial policies, as the cluster policy initiative supported by the Basque Government in the early 90’s reflects.

Additionally, following Cooke et al. (2000), the Basque Region is one of the few European regions considered real Regional Innovation Systems. According to Tödtling and Kaufmann (1999) there are some elements of innovation systems that can be identified in the Basque Region. As the systemic view of innovation and S&T policy is a central issue for this research, the Basque Region constitutes a pivotal case to further study S&T policy and evaluation from this perspective.

The Basque Region has evolved from a crisis situation in the 80's to become a high position within the Spanish regions, both in macroeconomic rates (GDP per capita) as well as in industrial performance, including the ratios related to R&D expenditure[8]. It has evolved from a reconverting region in the 90's to a medium-high innovating region in the last decade according to RIS (2009). It is interesting therefore to analyse the role of R&D public policies on the regional innovative performance.

According to Orkestra (2009), the Basque Region, when compared with the rest of OECD countries or other Spanish regions, is the most publicly funded single region in R&D activities. In this funding framework, it is also peculiar that regional and local R&D funding provides more funding than national or international funding programmes do. Although regional R&D programmes provide 11.7% of private R&D funding (compared to 12.8% of national funding), there is not a systematic evaluation of programmes' additionality that supports policy-makers decisions. This lack of evaluation culture is one of the innovation system's gaps, and one which this research's contribution aims to cover.

Finally, the Basque Region is an industrial region which has evolved from traditional sectors (mainly metal-mechanics), to medium-high technology sectors (i.e aerospace). As Bilbao-Osorio (2009) points out, this specialization has transformed the Basque industrial sector. It is interesting to analyse the relationship between public policies and changes in firms' technological trajectories.

6.4 Research Design

This section introduces an overview of the research design applied in this thesis, which includes an overview of the research scope, database and variables used. It also includes a detailed description of the techniques employed from both the quantitative and the qualitative approaches, although a greater detailed description of the quantitative technique is provided.

6.4.1 Research scope

This research offers a holistic scope as it includes, through different statistical and qualitative techniques, descriptive, correlation and causality analyses.

[8] The R&D expenditure has evolved from 0.1 % of GDP in the early 80's to 1.6% in 2006 (being 1.2% the Spanish average in 2006) (Bilbao-Osorio, 2009). More than 50% firms that have R&D activities have started these activities between 2000 and 2006 (Navarro, 2009).

The descriptive analysis is first provided to give a general overview of 1) the performance of Basque Innovation System and 2) firms' characteristics in both subsidized firms and innovative firms that have not received any subsidy from the Intek programme (a treated and control group). A descriptive analysis around Basque system and its performance is provided in chapter 7. A descriptive analysis regarding the firms participating in the Intek programme during the analysed period (2001-2004), and those that have not participated (although they carry out R&D activities) is reflected in chapter 8, section 1.

In addition to the descriptive analyses, a correlation analysis is provided in order to have an overview significant enough for next stages. It is also provided to look for evidence concerning the relationship between receiving subsidies from the Intek programme, and the set of input, output and behavioural variables applied in this research. This correlation analysis is carried out by multivariate linear regressions and is shown in chapter 8, section 2. The main disadvantage of this technique relates to the impossibility of obtaining casual conclusions. This is why the matching approach is the main quantitative technique used in this research.

The matching protocol applied in this research constitutes the casual scope of the research, as it is a quasi-experimental approach that gives an overview of causal relationships between firms that have received Intek subsidy in the analysed period (2001-2004) and the inputs, outputs and behaviour impacts , compared to the ones that have not received any subsidy. In addition, this causal relationship is complemented by semi-structured interviews with some firms that have been beneficiaries of the programme. Interviews provide a comprehensive added-value to results obtained from the matching technique, offering a holistic perspective of the programme's impact on firms.

6.4.2 Research method: Matching approach

Following the previous empirical studies, we apply to this research a propensity score matching method (Rosenbaum and Rubin, 1983). The main advantages for using this matching approach, instead of other quantitative methods, are the following:

- First of all, the matching procedure avoids selection bias by establishing a control group with similar characteristics of the treatment group (quasi-experimental design).
- Secondly, no particular form of equation has to be established.

- Finally, all non matched observations (discarded observations) are not included in estimating the treatment impact.

This method has also limitations. The most important is the fact that some of the characteristics of both the treatment and the control group are unobservable and therefore cannot be included in the model. This limitation is important when considering innovation policy, in which managerial capabilities of the firm's managers have an influence on innovative behaviour. Nevertheless, given the abovementioned advantages and the use in many empirical studies regarding additionality (Ebersberger, 2005; Aerts and Schmidt 2008; Herrera and Heijs, 2003 and 2007; Aschhoff et al. 2006; Fernandez-Ribas and Shapira, 2009; among others) we will apply this method.

Propensity score matching is a non parametric method that imitates natural experiments in order to apply it to social sciences. The basic idea of these quasi-experiments is to randomly match units from two groups (the treatment and the control group) with similar characteristics in order to compare them and therefore identify the effects of the policy in the treated group. The matching protocol can be summarized as follows: (Rosenbaum and Rubin, 1983; Dehejia and Wahba, 2002; Herrera and Heijs 2003 and 2007; Hujer and Radic 2005; Ebersberger 2005; Schibany et al. 2004, among others).

The first step in the matching approach is to select a control group with similar characteristics to the treated group, which is comprised of firms that have received subsidy within the studied programme. Propensity Score Matching (PSM) is used for calculating the probability of being treated within the units in the control group, according to a set of characteristics. It is useful therefore, for identifying non-participants with the same probability of participating than the treated group (participants in the programme). The method's second step compares the average rates in both groups in order to identify the effects of the policy intervention. The following paragraphs explain this in detail:

Through the PSM we can identify the causal effect (τ) of the binary treatment (T), comparing the result of the treated units (Y_1) with the units in the control group (Y_0). The causal effect (τ) can be defined as follows:

$$E(\tau) = E(Y_{1i} \mid T_i = 1) - E(Y_{0i} \mid T_i = 1)$$

As one unit (i) cannot be observed in both treated and not treated situations in the same period (being and not being subsidized), the situation of not being treated is analysed through the mentioned control group. The PSM method calculates the *Average Effect of Treatment on the Treated* (ATT) and reduces the comparison bias between the treated and the control group through the matching of units in both groups with similar characteristics. This method finds similar firms in the control group, which allows defining a counterfactual situation (in absence of subsidies) for the participating firms. The first step of this method is to calculate the probability of being subsidized as matching criteria (*Propensity Score*). The criteria used for calculating the propensity score is composed of a set of individual firm's characteristics. Therefore, *propensity score* can be defined as the probability of being subsidized according to a set of individual characteristics (X):

$$p(X) \equiv P\{D = 1 | X\} = E\{D | X\}$$

where(X) is the vector of individual characteristics and D= {0, 1} is the participating situation of the firm, being 0 when the firm has not being subsidized and 1 when the firm has received a subsidy.

Given that the PS is a continuous variable, the probability of finding two firms with the same characteristics is near zero. Therefore, in the literature we can find some estimators to effectively match firms in the two groups. The most used one is the NNM (*Nearest Neighbour Matching*), which matches each treated unit with the most similar unit in the control group according to their propensity score:

$$\tau^{NNM} = \frac{1}{N^T}\sum_{i \in T} Y_i^T - \frac{1}{N^T}\sum_{j \in T} w_j Y_J^C$$

where T is the treated group, C is the control group, Y_i^T and Y_J^C, the dependent variables in both groups, N_i^T shows the number of control units matched with treated units $i \in T$, and the weightings are defined by $w_{ij} = \frac{1}{N_i^C}$ if $j \in C_{(i)}$ and $w_{ij} = 0$ on the contrary.

Once the matching is carried out, we calculate the *Average Effect of Treatment on the Treated* (ATT) through the difference between the average of the dependent variable in the treated group and the average of this variable in the control group. Summarizing, the average effect of an intervention or programme is calculated by the average of the differences in both groups[9].

6.4.3 Research method: Semi-structured interviews

In addition to the matching approach, semi-structured interviews were implemented through the empirical research, in order to complete the conclusions reached through the quantitative approach. This combination of techniques (the quantitative and qualitative) constitutes a method triangulation and gives an added value therefore to the methodological approach, established for the understanding of policy impacts.

Interviews are one of the possible sources for collecting evidence case studies (Yin 2009). Interviews conducted during the research were focused interviews, carried out during a short period of time and, although remaining open, were carried out according to a guide of questions (see Annex 1). This kind of interview is useful for confirming or corroborating facts or information obtained from other sources (Yin 2009). It is for this reason that interviews conducted during this research were undertaken in order to confirm the results obtained by quantitative analysis. In addition, interviews are a good source of behavioral issues that cannot be obtained through other sources of information. Behavioural aspects of the firms were analysed in this research, and interviews were a good way of obtaining information therefore about precisely these issues. Interviews do, however, also have their disadvantages. These relate to interviewer's bias in questioning and also response bias (Yin, 2009). Nevertheless, these disadvantages are a minor issue in comparison to the contribution of interviews to quantitative analysis.

6.4.4 Sources and variables

Data for the empirical analysis of the Intek programme were obtained from three sources. Data was obtained firstly from the Basque Development Agency (SPRI), which is the agency that manages innovation programmes from the Department of Industry, Trade and Tourism. The agency provided data concerning the firms that have received an Intek subsidy during 2001-2004, the amount received and the type of project in which they have participated (collaborative or individual projects). Secondly, data from the Basque Statistic Agency (EUSTAT) constituted the main source of information for monitoring and evaluating impacts on

[9] Dehejia and Wahba (2002) give a detailed description of this method.

firms. This database was comprised mainly of all the variables included in the statistics about Scientific Research and Technological Development carried out by EUSTAT every year (see annex 7 for knowing more about the questionnaire). More specifically, the database comprised all the variables included the questionnaire from 2001 to 2009. Finally, a third data set comprised the patents registered in the Spanish Patent Office from 2001 to 2007. These three data sets were combined into a unique database in order to implement the quantitative approach. This data set has been useful not only to identify the treated and the control group for carrying out the analysis, but to also measure different impacts and additionalities of the programme on firms.

First of all, the treated and control group was established with the basis of firms that have received any Intek subsidy from 2001 to 2004 and with firms that have not received any subsidy from this programme but still carry out R&D activities and projects. In order to compare both groups (the treated and the control group) we will match the firms according to some external characteristics that have been used in similar studies (Almus and Czarnitzki, 2003, Aschhoff et al. 2006, Aschhoff 2009, Busom and Fernández-Ribas, 2008, Czarnitzki et al., 2007, Fernández-Ribas and Shapira, 2009, Herrera and Heijs, 2007, among others).

Table 6-2: Control variables employed in the research

Control Variables	Type of variable	Unit of measure
Firm Size	Continuous	Number of persons employed on average in each firm in the Basque Country between 2001-2004
Technology and Knowledge Intensive Groups	Dummy	Clasification of firms' activities according OECD and Eurostat
Multinational Ownership	Dummy	Multinational firms are those with at least 50% of foreign ownership
Systematic R&D	Dummy	Systematic or occasional R&D activities
Other funding	Continuous	Sum of other external funding received by firm during 2001-2004 apart from the regional one.

- Firm size: Although there is not a common agreement in the literature (Malerba et al., 1995, Acs and Audretsch, 1998), we expect that biggest firms have a higher probability to develop R&D activities than SMEs. For research, average employment in the firm during the analysed period (2001-2004) has been used to determine company size.
- Technology and Knowledge Intensive Groups: Literature shows that innovative behaviour differs across industries (Pavitt, 1984, Acs and Audretsch, 1998, Malerba and Orsenigo, 1995, Breschi and Malerba 1997, and Asheim 2007). The classification of industries used is the one defined by Eurostat and OECD, which define industries into seven technology groups. The seven groups are: high technology manufacturing, high-medium technology manufacturing, medium-low technology manufacturing, low technology manufacturing, high technology and knowledge intensive services and other knowledge intensive services, less knowledge intensive services.
- Multinational ownership: We distinguish between national firms and firms with foreign capital (at least with more than 50%). As Love et al. (1996) stated, much of the literature suggests that, taking into account its size and industry, it is expected that there is a negative relation between foreign ownership and innovation behaviour in a firm,. This occurs as a consequence of the concentration of strategic activities, skills and know-how, including R&D, in the parent companies. However, both the literature (Narula and Zanfei, 2005; Carlsson, 2006) and some current indicators referred to R&D internationalisation (share of world trade represented by R&D intensive sectors, internationalisation of patenting …) suggest that the R&D internationalisation is growing. For that reason, we expect that firms with foreign ownership will carry out more R&D activities than national firms.
- Systematic R&D[10]: As routines previously embedded in firms constrain or influence future behaviour of firms due to the concept of path-dependency (Teece and Pisano, 1997), we have included the previous innovative behaviour of the firm (systematic or occasional) as a control variable. The systematization of R&D activities configure a response of an organizational learning in R&D, and also a consequence of some acquired resources that the firm has reached through the previous participation in R&D funded projects (Malik et al., 2005). Firms with systematic R&D activities therefore, are supposed to have acquired some learning and develop some competences not acquired through occasional R&D activities.

[10] We consider systematic R&D activities according to the R&D statistic from EUSTAT when firms employ at least one person in full-time equivalent employment and intend to continue doing it.

- Other external funding received: In order to control effects produced by other R&D subsidies, firms that received this variable will be introduced in the analysis. We added the total amount of subsidies from other R&D programmes received during the period 2001-2004 excluding the regional ones[11]. Taking into account this new control variable, and that one of the main regional R&D programmes is the Intek programme, we can assume that this model measures the impact of the programme (isolating it from other programmes' effects). Additionally, we could compare the effects by introducing this variable as a control. This way, we will able, taking into account the same amount of resources received by each firm, to quantify the effects due to the overall funding system.

In addition to these variables, used for controlling firms' characteristics and therefore useful for the matching protocol in order to find out similar firms to compare them, we have, according to the previous literature and data availability, defined the variables more suitable for measuring additionality,. A programme's additionality is measured in the subsequent period of funding reception due to the expected delay in programme's results. This lag of time regarding results can be accounted for by the fact that the innovation process, and their results, might take years. Among these results we can distinguish more tangible results, as those measured by input and output additionality and as the results from learning processes, which can be defined as firms' capabilities. Because capabilities are based on "soft" or intangible assets they take years to be built (Teece and Pisano, 1997). Behavioural additionality therefore, could only be measured after R&D activities have been finalised. It is also important to highlight that behaviour additionality measures the most durable effects on firms (Davenport et al. 1998) as they stay over time.

[11] We consider the total R&D subsidies received during the period 2001-2004 by the Spanish Government, EU direct R&D subsidies, and local subsidies (provincial council and other local institutions).

Specifically, variables for measuring input additionality are the following:

Table 6-3: Variables for measuring input additionality

Variables for measuring input additionality	Type of variable	Unit of measure	Previous studies
Total internal R&D expenditure	Continuous	€ invested in the firm during 2005-2009 (sum)	Aschhoff (2009), Clarysse et al. (2009), Licht & Stadler (2003), Streicher et al. (2004), Aerts and Schmidt (2008), Ebersberger (2005)
R&D employees in the Basque Country (FTE12)	Continuous	Average of employees in the firm during 2005-2009	
Number of PhDs in the whole firm	Continuous	Average of employees in the firm during 2005-2009	

When measuring input additionality effects we could distinguish between two main types of variables. The first of these are those variables related to R&D spending in firms (total intramural R&D expenditure) in order to measure the additional R&D effort in subsidized firms. Secondly, we have considered R&D personnel indicators (R&D workers in the Basque Country in full-time equivalent, number of PhDs in the whole firm) for also measuring input additionality. In both cases we have considered the variables for the period after receiving Intek funds (2005-2009). Previous studies have considered these variables for measuring input additionality, for example the ones carried out by Aschhoff (2009), Almus & Czanitzki (2003), Czarnitzki et al. (2007), Aerts and Schmidt (2008), Almus and Czarnitzki (2002), Herrera and Heijs (2003), Herrera and Heijs, (2007), Czarnitzki et al. (2007), among others.

For measuring output additionality we have defined the following set of variables:

[12] FTE: Full-time equivalent.

Table 6-4: Variables for measuring output additionality

Variables for measuring output additionality	Type of variable	Unit of measure	Previous studies
R&D intensity	Continuous	Total R&D expenditure/ firms sales for the period 2005-2009	Aschhoff (2009), Almus & Czanitzki (2003), Czarnitzki et al. (2007), Aerts and Schmidt (2008), Almus and Czarnitzki (2002), Herrera and Heijs (2003), Herrera and Heijs, (2007), Czarnitzki et al. (2007)
Productivity	Continuous	Firm's sales/number of employees in the firm for the period 2005-2009	Cioni and Conforti (2007), Schibany et al. (2004)
Patents (num)	Continuous	Number of patents registered by the firm in the period 2005-2009	Czarnitzki and Hussinger 2004, Ebersberger 2005 and Czarnitzki and Licht 2006
Patents (probability of patent)	Continuous	Log of patents registered during the period 2005-2009	Czarnitzki and Hussinger 2004, Ebersberger 2005 and Czarnitzki and Licht 2006

With regards to output additionality we have considered the most analysed results regarding economic and innovation outputs of the innovation process. Taking this into consideration, the variables defined are the following:

- R&D intensity: R&D intensity is defined as the rate between R&D private expenditure and firm's sales and it measures the R&D effort the firm is carrying out. It is a measure of firm's R&D activity. It could be considered as an input because it is measured by using R&D expenditure, but it could also be considered as an intermediate output obtained as a result of an intervention. We have followed this assumption and considered it a variable for measuring output additionality, as in most previous studies.
- Productivity: Productivity is defined as apparent productivity, which is calculated through the rate between firm's sales and number of employees. Productivity is considered as an output on the innovation process. Indeed, it is more related to economic impacts of the innovation process (outcome) than of innovation outputs *per se*. Productivity as a firm's innovation performance and as a consequence of a funding programme has been studied for several authors as the following list reflects (Cioni and Conforti, 2007; Schibany et al., 2004).
- Patents and probability to patent: Patents are considered an important output of firms' innovative process, although it is not the only possible output of such a process. As has been previously mentioned, new products and processes and new organizational forms

could be considered innovation outputs without their being patented. Nevertheless, due to data availability, the only innovation output that has been included in this analysis is that reffering to patents. Several studies (Czarnitzki and Hussinger 2004, Ebersberger 2005 and Czarnitzki and Licht 2006, among others) have found a positive impact of the programmes on the patenting behaviour of firms.

Other innovation outputs could have been included as new products, processes or services derived from innovation processes in firms, although they were not available for the analysed group of firms.

In terms of behavioural additionality, we have considered the following variables:

Table 6-5: Variables for measuring behavioural additionality

Variables for measuring behavioural additionality	Type of variable	Unit of measure	Previous studies
R&D systematization	Dummy	Change from occasional to systematic R&D activities in the firm during 2005-2009	Clarysse et al (2009)
Participation in European funded projects	Continuous	Total amount of € received from European R&D funds during 2005-2009	Fernández-Ribas and Shapira (2009)
Specialization of R&D resources	Continuous	Number of PhDs/total employment in the firm during 2005-2009	

- Systematization of R&D activities: This variable measures the change from occasional R&D activities in firms to systematic ones in the period 2005-2009. The systematization of R&D activities configure a response of an organizational learning in R&D and also a consequence of some acquired resources that the firm has reached through the previous participation in R&D funded projects (Malik et al., 2005). In addition, systematic R&D activities could be a consequence of a learning process in which firm's capabilities are built (Teece and Pisano, 1997).
- Internationalisation of R&D activities: For measuring behavioural additionality in terms of participation of R&D international projects, we use the amount of European funds received by firms in the period 2005-2009. We will analyse the participation of those previously subsidized firms by a regional programme in international projects in

comparison to those that have not been subsidized. Previous analyses about this issue can be found in Fernández-Ribas and Shapira (2009), among others.

- Specialization of R&D resources: Following the assumption of learning processes in firms acquired through participation in regional R&D projects, these will lead not only to a systematization of R&D activities as mentioned before, but also to a higher specialization of R&D resources. For that reason, the PhD's share in the firm's overall personnel is analysed in this research.

In addition to these three set of variables, other variables regarding collaboration in R&D activities have been considered in this research. Specifically we have included the following variables:

Table 6-6: Variables for measuring collaboration

Variables for measuring collaboration	Type of variable	Unit of measure	Previous studies
Collaboration in the Intek programme	Dummy	Participation in any collaborative project during 2001-2004	Previous studies that have analysed effects on R&D collaboration in R&D activities among their different forms (firms-firms, firms-science, firms-technology centres, regional-foreign partnerships) through quantitative or qualitative approaches and have included these variables among their studies are the following: Busom and Fernández-Ribas (2008), Czarnitzki et al. (2007), Aschhoff et al. (2006), Olazaran et al. (2009), Fernández-Ribas & Shapira (2009), Autio et al. (2008).
Total external expenditure	Continuous	Total amount of euros spent in external R&D activities during 2005-2009	
External expenditure in technological centres	Continuous	Total amount of euros spent in external R&D activities in Technology Centres during 2005-2009	
External expenditure in other firms	Continuous	Total amount of euros spent in external R&D activities in other firms during 2005-2009	
External expenditure in Public Administrations	Continuous	Total amount of euros spent in external R&D activities in Public Administrations during 2005-2009	
External expenditure in private institutions	Continuous	Total amount of euros spent in external R&D activities during 2005-2009	
External expenditure in foreign firms	Continuous	Total amount of euros spent in external R&D activities in foreign firms during 2005-2009	
External expenditure in universities	Continuous	Total amount of euros spent in external R&D activities in universities during 2005-2009	

Collaboration could be understood as a measure of behavioural additionality *per se.* Here, we have analysed collaboration patterns in two ways. First of all, collaborative behaviour in the

Intek Programme has been used as a criterion for comparing two groups of firms: those that have demonstrated a collaborative behaviour in the mentioned programme during 2001-2004, and those that have only participated in the programme through individual schemes. Given the assumption that regional programmes support learning in firms and changes in behaviour (Malik et al. 2005, Fernández-Ribas and Shapira 2009, Clarysse et al. 2009), collaborative firms during 2001-2004 should have developed a pattern more collaborative in 2005-2009 compared to those firms that only participated through an individual scheme. Some variables explaining collaborative behaviour during the period 2005-2009 have therefore been considered. Due to data availability, this collaborative behaviour has only been measured through formal R&D arrangements, which constitutes firms' external subcontracting or expenditure to other firms' or types of agents. Specifically, these expenditures are those included in total external expenditure, external expenditure in technology centres, external expenditure in other firms, external expenditure in public administrations, external expenditure in private institutions, external expenditure in foreign firms and external expenditure in universities.

In addition to this analysis, we have considered collaborative and non-collaborative firms during 2001-2004 as means of measuring relationships between collaboration as a proxy of behavioural additionality and the indicators defined above to measure *input, output and behavioural additionality.* Consequently, in addition to understanding different relations among rationales, we will also be able to understand the effects of collaborative behaviour on firms' results.

Finally, we have undertaken interviews as a complementary source of information and these were carried out according to a guide of questions (see Annex 1). Interviews carried out in this research have been selected according to the distribution of subsidized firms and their characteristics. Therefore the following firms and people have been interviewed:

Table 6-7: List of interviewees

Firm	Person interviewed	Size	Technology and knowledge intensive groups	Main activity
Fundiciones del Estanda	Luis Ángel Erausquin (R&D Manager)	151-250 employees	Medium-Low manufacturing	Foundry
Luma Industrias	Enrique del Valle (Financial Manager)	11-50 employees	Medium-high manufacturing	Lockers for motos and bikes
Ikusi	Tomás Villameriel (Technology and Development Department)	More than 500 employees	High-manufacturing	Electronic systems
CAF	Germán Gimenez (R&D manager) and Joanes Murua (Economic R&D manager)	More than 500 employees	Medium-high manufacturing	Equipment and components for railway systems
Instant Sport	Josema Odriozola (Engineering Responsible)	Less than 10 employees	High-intensive services	Engineering
Kendu	Eusebio Agirre (Technical Manager)	Between 10 and 50 employees	Medium-low technology	Cutting tools
Burdinola	Iñaki Aldamiz (R&D Department) and Leire Laka (Financial Department)	Between 50 and 249 employees	Low-technology manufacturing	Laboratory furniture

Results from all these analyses including the interviews' analysis are shown in chapter 7.

7 STI POLICY TRAJECTORY IN THE BASQUE COUNTRY

7.1 Introduction

In order to better understand the reasons why the Basque Country is the selected region to be studied and analysed as a regional innovation system in which Science and Technology Policies have played an important role in its development, this chapter provides an analysis of the Basque regional trajectory linked to its policies. Thus, a brief description of the region's main socioeconomic characteristics and their evolution is provided in this chapter. Provided too are the main characteristics of the Regional Innovation System's (RIS) performance to the present day.

In addition, an analysis of the main actors and agents of the Basque RIS will be provided, with a special emphasis placed on those operating in the period analysed in this thesis (2001-2004). These agents play a significant role in the Basque Innovation System and they determine the System's singularity in comparison with other regions. These agents have also an important role in the Intek programme, which is the programme analysed in this research.

Basque trajectory and its constitution as a Regional Innovation System are a consequence of the evolution of Public Science and Technology Policies. Mentioned earlier, the Basque Country has had Science and Technology competences since the 80's and even its three provinces are responsible for some specific policy instruments, such as taxes and tax-reductions. This political system is embedded in a national and supra-national policy system that makes policy coordination and governance a really complex task. However, Basque autonomy in STI policies has lead to a particular system underlying the regional innovation performance and firms' competitiveness.

The main programme that has specifically supported firms' R&D in the Basque Region is the Intek programme. At present, this programme co-exists with a number of other programmes more specifically directed to product developments or to organizational innovation in firms. In the analysed period (2001-2004) the Intek programme grouped other R&D supports as the ones referred to product development or start-ups development. However, despite it being a programme that has been running for a long time (even with variations), it has not been properly evaluated and its interactions with other programmes have not been considered in a systemic conception. This chapter will provide an overall view of this programme and its role in the Basque STI policy before the following chapter provides a detailed analysis of its impacts.

7.2 Basque Country: A Regional Innovation System

The Basque Country is a region located in the North coast of Spain and is divided in three provinces that enjoy administrative competences, including tax collection. During the 70's Basque economy, which was mainly based on traditional industries as iron and steel, began to decline and, in the first half of the 80's, the economy was stagnant. Thereafter, the Basque region experienced a deep socio-economic transformation based on industrial reconversion and economic modernization. In the 90's, the Basque region began to recover and forged a new industrial base comprising primarily of small and medium-sized firms in medium, medium-high technology industries as aerospace, machine-tools, electronic household appliances, electronics and energy (Bilbao-Osorio, 2009). Since the 90's, economic growth in the Basque Country has been significant and has caused the Basque region to become one of the most prosperous regions in Europe. According to OECD (2011) the Basque Country average GDP annual growth was 3.41% in the period 1997-2007, which exceeds the GDP growth of, for example, Madrid and Cataluña, Spain's other advanced regions.

Sources of regional growth have been identified as a result of business investments (Bilbao-Osorio, 2009). However these investments are not a result of a high productivity growth, when neither considering labour productivity per worker nor total factor productivity[13]. According to Erauskin (2010) and OECD (2011), total factor productivity declined in the Basque region in the period 1995-2004 while the sources of growth can be mainly attributed to capital investments and labour. The regional growth in that period was, therefore, directly a consequence of a resources mobilization and an increase of the productive capacity, as opposed to higher efficiency in productive activities. Nevertheless, the total factor productivity decline seems to have reversed in the period 2004-2007 as we will show in the section 7.2.4.

Levels of economic growth in the Basque Country are nevertheless not aligned with innovation performance, which constitutes the so-called "Basque Competitive Paradox" (Orkestra, 2009). In the following sections we analyse in more detail these and other features, which characterize the Basque innovation performance. We will firstly give a picture of Basque Innovation performance. Secondly, we will analyse the manner in which the Basque region is

[13] Total factor productivity is considered the economic growth due to different sources than capital or labour. It is normally assumed that it is the growth originated by technical progress.

considered in regional typologies analyses. Finally, Basque innovation performance and its evolution will be explored in detail from both input and output perspectives. These analyses will combine to compose an overall picture about the Basque Regional Innovation System.

7.2.1 Basque Innovation Performance at a Glance

One of the most widely used assessments of innovation in European regions is the Regional Innovation Scoreboard. This scoreboard classifies regions around three main items: enablers, firm achievement and outputs. The Basque Country scores in the 2009 Scorecard as “medium-high” for enablers, “medium-high” for firm achievement and “high” for outputs.

In addition, the European Innovation Scoreboard, promoted by the European Commission, provides a general overview of innovation performance in the EU countries. The Basque Institute of Statistics provides a calculation of this index for the Basque region so we can compare it with other European Countries or with the EU average. This index, as Navarro (2010) mentions, includes apart from input and output indicators, other reflecting innovative capacities,

As the next table shows, the Basque Country position is, in general, above European Union 27 average. Upon deeper analysis, differences between different indicators and their relative positions arise. With regards to innovation enablers, the Basque relative position is higher than EU average. With respect to firms’ activities, although their general position is higher in the Basque Country, firms’ investments are lower than the European average. Finally, the Basque position in terms of outputs illustrates what was mentioned as “Basque Competitive Paradox” or “the hour glass” as mentioned by Parrilli (2010). This last metaphor highlights the main characteristics of the Basque innovation “black box”, in which knowledge inputs are not reflected in innovation outputs as is the case, for example, with patents, but it does not prevent a high economic output.

Table 7-1: European Innovation Scoreboard 2009

	Countries	**EIS 2009**	**Relative position EU27**	ENABLERS			FIRM ACTIVITIES				OUTPUTS		
				Index	Human Resources	Finance and Support	Index	Firm Investments	Linkages and entrepreneurship	Throughputs	Index	Innovators	Economic effects
1	Sweden	0.64	132.90	0.75	0.72	0.79	0.62	0.74	0.62	0.54	0.51	0.47	0.52
2	Finland	0.62	130.10	0.70	0.74	0.65	0.62	0.88	0.63	0.49	0.54	0.43	0.58
3	Germany	0.60	124.68	0.46	0.40	0.52	0.56	0.58	0.58	0.54	0.77	0.76	0.78
4	United Kingdom	0.58	120.26	0.72	0.65	0.80	0.52	0.65	0.64	0.36	0.48	0.27	0.55
5	Denmark	0.57	120.04	0.65	0.64	0.66	0.59	0.53	0.58	0.67	0.48	0.43	0.51
6	Austria	0.54	112.01	0.45	0.42	0.49	0.58	0.64	0.61	0.51	0.58	0.62	0.55
7	Luxemburgo	0.52	109.65	0.52	0.43	0.60	0.50	0.40	0.35	0.66	0.55	0.60	0.53
8	Belgium	0.52	107.88	0.51	0.50	0.52	0.49	0.45	0.68	0.39	0.55	0.55	0.54
9	Ireland	0.51	107.57	0.59	0.63	0.54	0.39	0.27	0.50	0.39	0.58	0.54	0.60
	Basque Country	**0.51**	**106.35**	**0.56**	**0.56**	**0.55**	**0.44**	**0.38**	**0.56**	**0.38**	**0.54**	**0.34**	**0.64**
10	France	0.50	104.83	0.56	0.55	0.56	0.40	0.42	0.43	0.37	0.56	0.58	0.56
11	The Netherlands	0.49	102.67	0.57	0.51	0.65	0.48	0.39	0.53	0.50	0.43	0.36	0.46
12	Estonia	0.48	100.59	0.54	0.50	0.61	0.43	0.61	0.55	0.18	0.49	0.55	0.46
13	Cyprus	0.48	100.08	0.48	0.40	0.61	0.43	0.47	0.64	0.27	0.52	0.71	0.43
	EU-27	**0.48**	**100.00**	**0.49**	**0.44**	**0.56**	**0.42**	**0.47**	**0.41**	**0.40**	**0.53**	**0.44**	**0.58**
14	Slovenia	0.47	97.38	0.52	0.52	0.53	0.36	0.40	0.42	0.29	0.54	0.61	0.52
15	Czec Republic	0.42	86.77	0.36	0.37	0.35	0.34	0.47	0.37	0.20	0.56	0.45	0.62
16	Portugal	0.40	83.88	0.45	0.36	0.56	0.31	0.29	0.38	0.25	0.47	0.65	0.38
17	**Spain**	**0.38**	**78.78**	**0.45**	**0.31**	**0.64**	**0.25**	**0.16**	**0.26**	**0.31**	**0.47**	**0.30**	**0.57**
18	Greece	0.37	77.29	0.32	0.30	0.34	0.22	0.10	0.44	0.14	0.59	0.70	0.54
19	Italy	0.36	75.92	0.35	0.29	0.43	0.30	0.28	0.25	0.36	0.45	0.36	0.50
20	Malta	0.34	71.77	0.26	0.14	0.47	0.29	0.27	0.13	0.37	0.47	0.17	0.61
21	Slovakia	0.33	69.23	0.31	0.35	0.26	0.25	0.40	0.24	0.14	0.46	0.17	0.60
22	Hungary	0.33	68.47	0.31	0.30	0.33	0.28	0.31	0.32	0.22	0.40	0.12	0.54
23	Poland	0.32	66.33	0.39	0.47	0.28	0.22	0.33	0.18	0.17	0.36	0.25	0.41
24	Lithuania	0.31	65.49	0.50	0.55	0.41	0.21	0.17	0.36	0.11	0.27	0.19	0.31
25	Romania	0.29	61.44	0.27	0.30	0.23	0.19	0.27	0.26	0.06	0.44	0.34	0.49
26	Latvia	0.26	54.48	0.43	0.44	0.42	0.18	0.23	0.19	0.15	0.18	0.02	0.24
27	Bulgaria	0.23	48.38	0.34	0.33	0.35	0.13	0.21	0.06	0.12	0.25	0.17	0.29

Source: EUSTAT

Finally, Navarro et al. (2011) provide an overview of the Basque Country position with regards to innovation input, output and economic output comparing to its regions of reference[14] (defined in their study) and to the average of European regions. In the table 7.2 we can appreciate that the Basque Country's position with regards to innovation inputs is higher than the average of the reference regions and the average of all European Regions. In terms of innovation and economic outputs however, the Basque position is lower than the average of reference regions but higher than the European average. This analysis supports the idea of the emphasis on inputs in the Basque Country, although there is not a direct translation of these inputs into innovation and economic outputs, compared to the regions of reference. Consequentially, when we compare the Basque Country with its regions of reference, the paradox is not as strong as in the previous analyses. All these analyses are based on composed indexes. Individual ones will be analysed in detail in this chapter.

[14] Navarro et al. (2011) identify in their study the 29 regions of reference for the Basque Country, according to a series of geo-demographic variables, industrial structure and patents. These regions are the most close to the Basque Country and, for that reason, they are the most adequate for comparisons and benchmarking exercises.

Table 7-2: The Basque Country comparing to its regions of reference

NUTS Code	NUTS name	Level of innovationn input ranking	Level of innovation input index	Level of innovation output ranking	Level of innovation output index	Level of economic output ranking	Level of economic output index
AT12	Niederösterreich	109	45	105	47	51	58
AT22	Steiermark	30	62	45	59	55	56
AT31	Oberösterreich	91	50	83	53	38	63
AT32	Salzburg	75	52	97	50	25	68
AT34	Vorarlberg	119	45	95	50	29	67
DE1	Baden-Württemberg	23	65	1	79	34	65
DE9	Niedersachsen	44	58	27	63	67	54
DEA	Nordrehein-Westfalen	48	57	21	66	58	55
DEB	Rheinland-Pfalz	53	57	18	67	57	55
DEC	Saarland	83	51	31	62	66	54
DED	Sachsen	26	63	36	61	99	49
DEE	Sachsen-Anhalt	88	51	62	57	100	48
DEF	Schleswig-Holstein	80	51	48	59	62	55
DEG	Thüringen	50	57	53	58	97	49
ES21	Basque Country	56	56	85	53	76	52
ES22	C. F. de Navarra	54	56	74	55	82	51
ES51	Cataluña	78	52	80	53	102	48
FR22	Picardie	130	43	93	51	105	48
FR41	Lorraine	95	48	64	56	104	48
FR71	Rhône-Alpes	46	58	24	65	54	56
ITC1	Piemonte	127	43	63	56	83	51
ITC3	Liguria	98	47	92	51	92	50
ITC4	Lombardia	126	43	57	57	49	59
ITD2	P. A. Trento	110	45	91	52	53	56
ITD3	Veneto	159	36	86	53	68	54
ITD4	Friuli-Venezia Giulia	111	45	70	55	87	51
ITD5	Emilia-Romagna	104	46	41	60	50	58
ITE2	Umbria	138	42	100	49	112	45
SE12	Östra Mellansverige	9	70	4	74	46	61
UKG	West Midlands	61	55	51	58	61	55
Average of 30 reference regions		81	52	60	58	69	55
Average of all 206 NUTS		104	47	104	46	104	45

Source: Navarro et al. (2011)

7.2.2 Which type of region is the Basque Country?

There are several analyses that characterise the Basque Country according to an innovation regional typology. Three typologies can be highlighted:

1. RIS typology
2. Typologies elaborated by Navarro et al. (2009) and Navarro and Gibaja (2009)
3. OECD's typology

In the *RIS typology,* with data referred to 2004 and 2006, the Basque Country is considered, in comparison with all other European regions, a medium-high innovator. Other Spanish regions that are included in this class are Navarre, Catalonia and Madrid.

Navarro and Gibaja (2009) built a typology for the Spanish regions. According to this typology, the Basque Country is located in the group of industrial regions that are economically and technologically advanced. In this analysis, the Basque strengths are also positioned on the input and economic outputs sides, with the innovation outputs being its main weakness.

In addition, Navarro et al. (2009) also built a typology for European regions. According to this typology, the Basque Country is positioned in the group of regions with intermediate technological and economical capabilities. In this group, regions are characterized by a similar economic output than EU average but with lower levels of technological inputs and outputs. Other regions in this group include Lorraine, Friuli-Venezia, Giulia, Wallonia and Catalonia. The Basque Country is on the verge of being included in the following group with higher levels of economical ouput. This supports previous analyses in which the Basque Country holds a better position in economic than in innovation outputs.

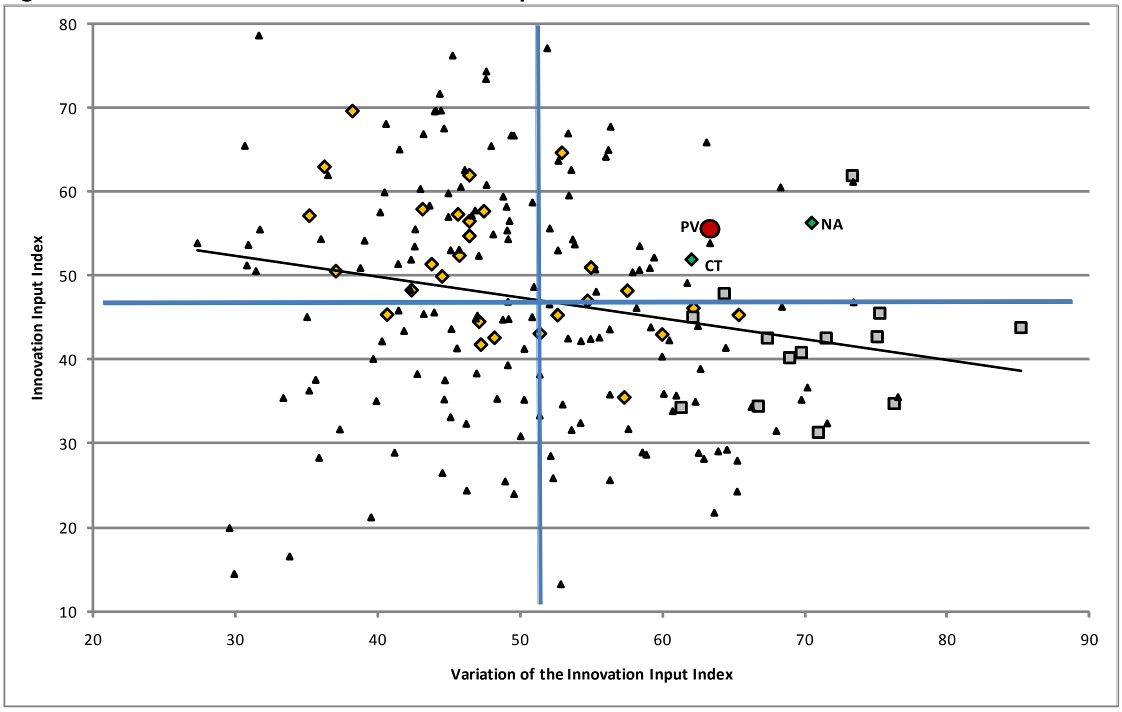
Finally, the OECD (2011) categorises the Basque Country in a group of "medium technology and technological sophistication". Regions in this group are characterized by a highly educated workforce and industrial activity. These include both creative and industrial manufacturing activities. The OECD (2011) includes in this group, among others, global regions such as Ontario and Quebec in Canada, Rhône-Alpes and Alsace from France and other Spanish regions (Madrid, Catalonia and Navarre)

In summary, the Basque Country is presented according to the different typologies as an industrial region with intermediate-high innovation performance, especially in terms of economic outputs and is comparatively close to other Spanish regions such as Catalonia, Madrid and Navarre.

7.2.3 Innovation Inputs in the Basque Country

Innovation inputs are analysed by Navarro et al. (2011) through a composed index for all the European, Spanish and the reference regions identified for the Basque Country. The following figure shows the level of the index (vertical axe) and its variation in the last five years (horizontal axe). We can thus appreciate the different situations within the regions of reference. The Basque Country (PV) has a higher level of innovation input than the Spanish regions and the average of European regions, but still reflects a lever of innovation lower than the regions of reference. In addition, the Basque Country (PV) and the other Spanish reference regions (Catalonia-CT- and Navarre-NA) have growth in their innovation inputs in the last five years, but this growth has been lower than the rest of the Spanish regions. This index is comprised of the most traditionally employed input indicators[15], but these are not available for all the EU regions for a long-time series. For that reason, in the analysis and evolution of individual indicators, the Basque Country will be compared to Spanish, other EU countries and European averages.

Figure 7-1: Level and variation of Innovation Input Index



Source: Navarro et al. (2011)

Note: rhombus are referred to the regions of reference, square to Spanish regions (except the ones included in the regions of reference) and the triangles are the rest of the European regions.

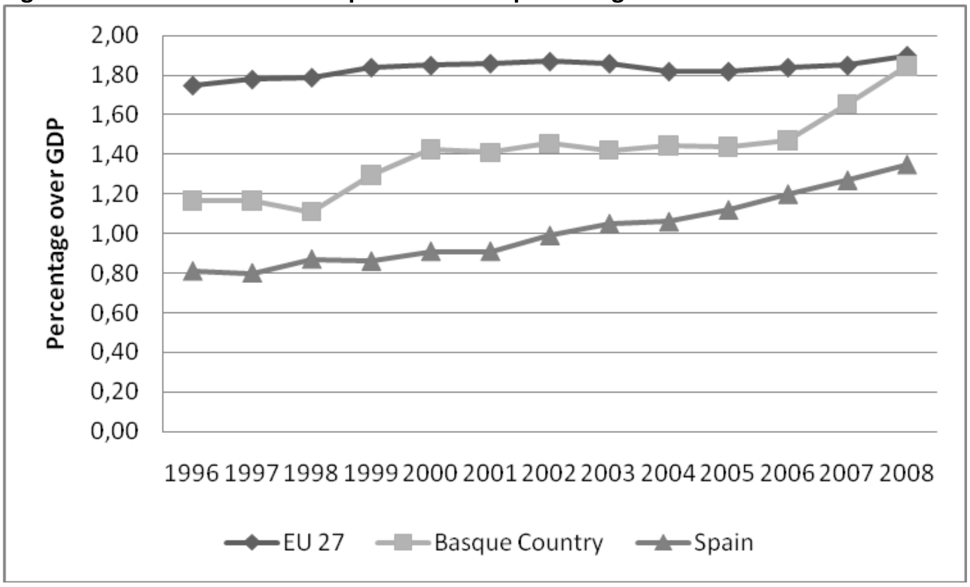
In terms of *input indicators* the most used are R&D expenditure and R&D personnel. These indicators can be calculated for the economy as a whole or for the business sector only. In the case of the economy as a whole, the main variables used for measuring R&D inputs are R&D expenditure as a percentage of GDP and R&D personnel, which can be calculated in full-time equivalent (FTE).

[15] These input indicators are the following:

- Level of human resources: human resources in science and technology (% of population), population aged 25-64 that has attained upper secondary and tertiary educational level (% of population aged 25-64), students in tertiary education (% of population aged 20-24) and population aged 25-64 taking part in long-life learning (% of active population).
- Variation in human resources: percentage change in human resources in science and technology, population aged 25-64 that has attained upper secondary and tertiary educational level and population aged 25-64 taking part in long-life learning.
- Level of R&D: business R&D expenditure (% of GDP), public R&D expenditure (% of GDP), business R&D personnel (% of employment) and public R&D personnel (% of employment)
- Level of connectivity: families with broadband Access (%), patent co-invention (% of patents) and new foreign firm (per million inhabitants).
- Variation in connectivity: percentage change in patent co-invention.

Evolution of R&D expenditure in the Basque region has followed a positive trend in the last decade. In 2008, the R&D expenditure as a percentage of GDP was almost the same than EU and United Kingdom averages and during the past years it was always above Spanish average although still far from some reference countries as Germany or Finland.

Figure 7-2: Evolution of R&D expenditure as a percentage of GDP



Source: EUSTAT (Basque Country), INE (Spain) and Eurostat (EU 27). Own elaboration

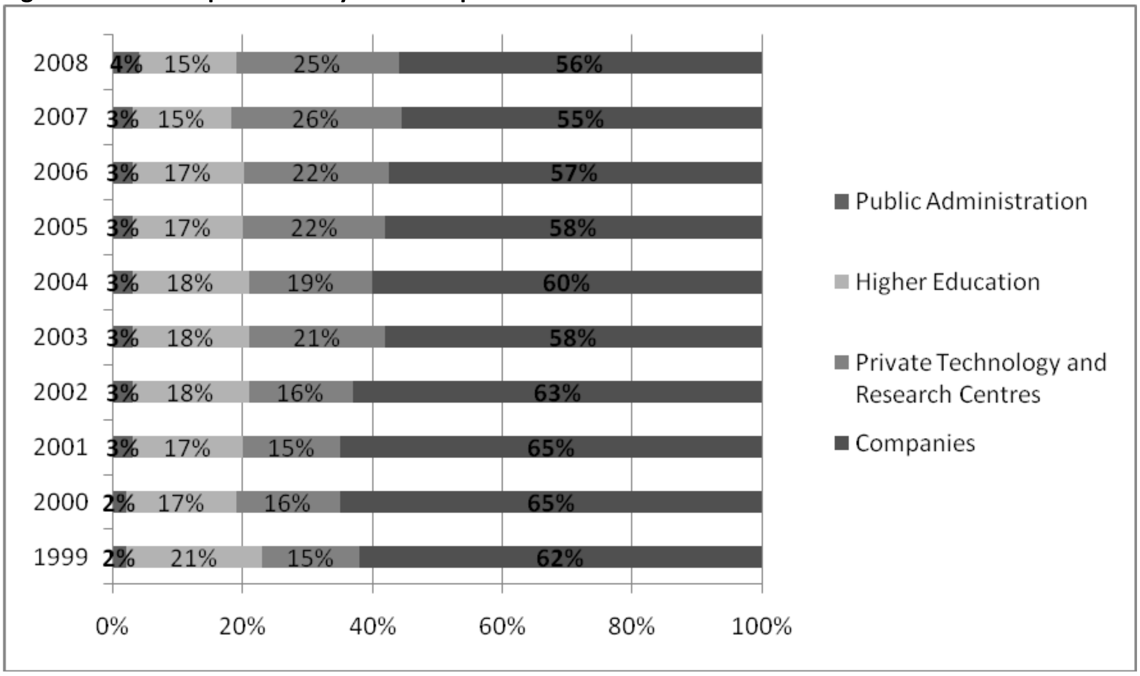
Table 7-3: Evolution of R&D expenditure as a percentage of GDP

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
EU 27	**1.75**	**1.78**	**1.79**	**1.84**	**1.85**	**1.86**	**1.87**	**1.86**	**1.82**	**1.82**	**1.84**	**1.85**	**1.90**
Basque Country	**1.16**	**1.16**	**1.11**	**1.29**	**1.43**	**1.41**	**1.45**	**1.42**	**1.44**	**1.44**	**1.47**	**1.65**	**1.85**
Spain	**0.81**	**0.80**	**0.87**	**0.86**	**0.91**	**0.91**	**0.99**	**1.05**	**1.06**	**1.12**	**1.20**	**1.27**	**1.35**
Germany	2.19	2.24	2.27	2.40	2.45	2.46	2.49	2.52	2.49	2.48	2.54	2.53	2.63
Finland	2.52	2.70	2.86	3.16	3.34	3.30	3.36	3.43	3.45	3.48	3.45	3.47	3.72
France	2.27	2.19	2.14	2.16	2.15	2.20	2.23	2.17	2.15	2.10	2.10	2.04	2.02
United Kingdom	1.83	1.77	1.76	1.82	1.81	1.79	1.79	1.75	1.69	1.73	1.76	1.82	1.88

Source: EUSTAT (Basque Country), INE (Spain) and Eurostat (EU 27).

More than a half of the R&D expenditure is carried out by firms in the Basque region although this proportion has been reduced in the last years in favour of private technology centres, which constitute one of the main actors in the Basque System. It is also remarkable that the proportion of R&D expenditure executed by higher education institutions is low, compared to the one performed by technology centres. This is one sign of the Basque system's bias towards technological development instead of scientific activities.

Figure 7-3: R&D expenditure by sector of performance



Source: EUSTAT from OECD (forthcoming)

With regard to R&D personnel in the Basque economy, figures show a positive evolution of this indicator for the Basque Country between 1996 and 2008 raising above European Union average. The same situation can be highlighted for the researchers' indicator. In both cases, 2008 values are higher than the analysed countries, and are even higher than Germany's. In summation, the Basque position in terms of R&D inputs (R&D expenditure and R&D personnel) have evolved positively during the last years, reaching a good European relative position.

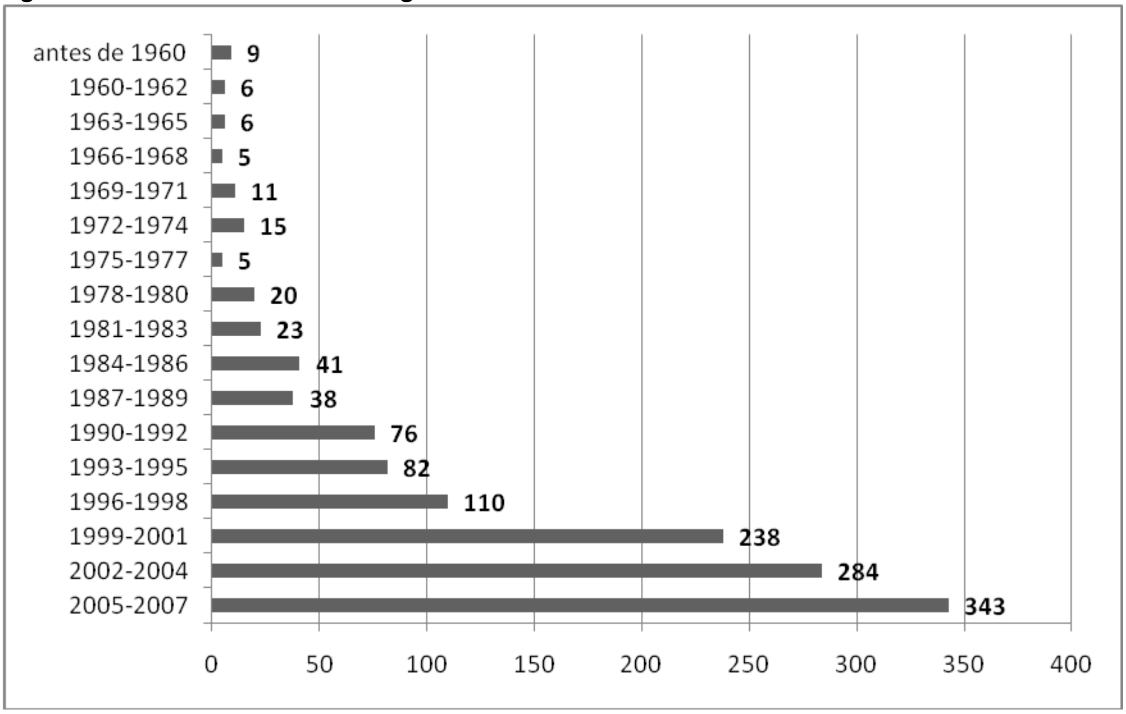
Table 7-4: Evolution of R&D personnel in the Basque Country

	1995	2008	1995	2008	Variation 1995-2008	
	R&D personnel (FTE)/Total employment (‰)	R&D personnel (FTE)/Total employment (‰)	Researchers (FTE)/Total employment (‰)	Researchers (FTE)/Total employment (‰)	R&D personnel (FTE)/Total employment (%)	Researchers (FTE)/Total employment (‰)
Germany	12.8	13.3	6.5	7.7	5	12
Spain	6.4	10.6	3.8	6.5	42	27
France	1.45	n.a.	6.9	n.a.	n.a.	n.a.
Italy	7.1	10.1	3.8	4.1	30	3
Portugal	3.4	9.4	2.5	7.8	60	53
United Kingdom	10.6	12.2	5.6	8.9	16	33
USA	n.a.	n.a.	8.3	n.a.	n.a.	n.a.
Japan	14.7	n.a.	10.4	n.a.	n.a.	n.a.
UE-15	10.5	12.4	5.6	7.5	19	19
Basque Country (data from 1996)	8.6	15	5.1	9.4	64	43

Source: EUSTAT and Eurostat

Regarding firms or the business sector, we can also provide an overall view of the firms that carry out R&D activities in the Basque Country, which is distinct from those indicators used for the economy as a whole,. As the next figure shows, the increase of firms initiating R&D activities in the Basque region has been exponential in the last years, although they count for a very minor part of the whole Basque business panorama[16].

Figure 7-4: Number of firms initiating R&D activities



Source: Eustat (2007). Estadística sobre Actividades de Investigaciones Científica y Desarrollo Tecnológico (I+D)

The evolution of R&D expenditure in these firms has also been positive in the last years. By the year 2007, Basque firms invested about 1.52% of Basque GDP in R&D activities, which is a level of expenditure higher than the EU average and other countries as Spain, but still lower than levels reached in Finland, Japan, United States or Germany, for instance.

[16] By the year 2008 firms carrying out R&D activities in the Basque Country were about 0.82% over total number of firms, according to EUSTAT data.

Table 7-5: Business R&D intramural expenditures as a percentage of GDP

	2001	2002	2003	2004	2005	2006	2007
Finlandia	2.36	2.35	2.43	2.42	2.46	2.48	2.51
Japan	2.30	2.36	2.40	2.38	2.54	2.63	2.68
United States	1.96	1.82	1.80	1.76	1.79	1.85	1.91
Germany	1.72	1.72	1.76	1.74	1.72	1.77	1.77
Denmark	1.64	1.73	1.78	1.69	1.68	1.66	1.78
Belgium	1.51	1.37	1.31	1.28	1.25	1.29	1.32
France	1.39	1.41	1.36	1.36	1.3	1.32	1.29
EU27	1.21	1.20	1.19	1.16	1.15	1.18	1.19
United Kingdom	1.17	1.16	1.11	1.05	1.06	1.08	1.15
Basque Country	1.02	0.97	1.06	1.19	1.15	1.24	1.52
Norway	0.95	0.95	0.98	0.87	0.82	0.82	0.88
Italy	0.53	0.54	0.52	0.52	0.55	0.55	0.61
Spain	0.48	0.54	0.57	0.58	0.60	0.67	0.71
Portugal	0.26	0.25	0.24	0.28	0.31	0.47	0.62
Greece	0.19	0.18	0.18	0.17	0.18	0.17	0.16

Source: Eurostat

The share of R&D expenditure in medium-high and medium-low technology industries is higher in the Basque Country, due principally by the industrial regional composition. Evolution of these shares over the years has been similar for all the technology and knowledge intensive groups.

Table 7-6: R&D intramural expenditure distribution in firms by technology and knowledge intensive groups (percentage of total expenditure)

	High-Technology Manufacturing	Medium-High Technology Manufacturing	Medium-Low Technology Manufacturing	Low Technology Manufacturing
1993	16.1%	59.0%	21.5%	3.4%
1994	15.4%	58.3%	23.0%	3.3%
1995	28.3%	48.8%	20.4%	2.5%
1996	27.9%	50.0%	20.3%	1.8%
1997	17.8%	50.7%	29.1%	2.4%
1998	18.2%	51.7%	28.3%	1.8%
1999	24.3%	48.5%	25.0%	2.2%
2000	29.2%	43.9%	24.5%	2.3%
2001	27.1%	46.8%	23.2%	2.7%
2002	30.5%	46.8%	18.9%	3.8%
2003	18.9%	51.9%	25.7%	3.4%
2004	17.2%	55.8%	24.0%	2.9%
2005	17.3%	55.9%	24.0%	2.8%
2006	18.0%	54.0%	25.4%	2.6%
2007	24.0%	48.7%	22.8%	4.5%
2008	18.8%	48.3%	29.4%	3.4%

Source: EUSTAT

Additionally, services industries perform better than industries due to the fact that in this service group (specifically in knowledge intensive services), all the research firms, including the aforementioned Technology Centres are included, as they are not part of the higher educational sector. This is partly the reason why figures in this statistic seem to favor the services sector. The increase, however, in R&D expenditure of medium high-technology firms during the analysed period, is remarkable,

Table 7-7: R&D intramural expenditure distribution in firms by technology manufacturing and services groups

	2001 (thousands of euros)	2001 (percentage)	2006 (thousands of euros)	2006 (percentage)
High Technology Manufacturing	93,605	19.13%	32,333	4.94%
Medium-High Technology Manufacturing	111,699	22.83%	136,942	20.94%
Medium-Low Technology Manufacturing	64,416	13.17%	76,383	11.68%
Low technology Manufacturing	7,617	1.56%	4,676	0.72%
Total Manufacturing	**277,336**	**56.69%**	**250,334**	**38.28%**
Knowledge-Intensive services	174,716	35.72%	316,185	48.35%
Other knowledge-intensive services	32,532	6.65%	66,059	10.10%
Less knowledge-intensive services	4,601	0.94%	21,373	3.27%
Total Trade and services	**211,850**	**43.31%**	**403,617**	**61.72%**
Total R&D expenditure	**489,186**	**100.00%**	**653,951**	**100.00%**

Source: EUSTAT

In terms of size, the share of R&D expenditure is higher in small and medium firms, which is coherent with total firms' distribution by size in the Basque Country[17]. However, it is remarkable among this group the increasing share of expenditure carried out by small firms as a replacement for medium firms.

[17] In 2009 99.8% of Basque firms were SMES.

Table 7-8: R&D intramural expenditure distribution by size (percentage of total expenditure)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Less than 20 employees	4.6%	3.8%	5.6%	5.4%	5.3%	6.2%	8.3%	8.8%	10.9%	11.6%	13.7%	12.1%
20-49 employees	8.8%	8.1%	7.9%	8.9%	9.8%	9.0%	13.5%	16.0%	16.3%	19.4%	18.6%	17.9%
50-99 employees	11.7%	12.6%	15.8%	12.7%	9.9%	11.2%	10.4%	12.0%	11.6%	12.6%	13.5%	12.9%
100-249 employees	33.4%	32.2%	29.4%	29.9%	34.9%	29.7%	27.6%	26.2%	27.7%	26.2%	26.2%	29.7%
250-499 employees	24.2%	24.5%	26.4%	20.9%	18.2%	22.7%	19.1%	18.3%	15.6%	13.3%	12.8%	9.6%
500-999 employees	6.4%	4.6%	4.2%	12.5%	12.1%	12.3%	11.7%	11.5%	10.3%	10.2%	9.7%	6.5%
>=1000 employees	10.9%	14.3%	10.5%	9.6%	9.7%	8.8%	9.4%	7.1%	7.5%	6.7%	6.0%	11.4%

Source: EUSTAT

Regarding R&D personnel, it is remarkable that the share of this indicator in firms in the Basque region is higher than in other type of agents integrating the Basque Science and Technology Network as, for instance, Universities, Technology Centres or firms R&D units. However, this share, related to the total personnel, is higher in those organizations included in the Basque Network, excepting universities. On the contrary, Universities present the higher share of researchers in relation to total R&D personnel, which indicates the scientific specialization of these organisations.

Table 7-9: R&D personnel by type of employer (2007)

	Total	University	RVCTI* (minus Universities)	Firms (minus those in the RVCTI)
R&D personnel total	22595	6394	5698	10503
R&D personnel in FTE	14435	2957	4791	6687
Share by actor	100%	20.5%	33.2%	46.3%
Share of R&D personnel in FTE/all R&D personnel	63.9%	46.2%	84.1%	63.7%
Researchers in FTE	9220	2587	3144	3489
Share by actor	100%	28.1%	34.1%	37.8%
Share of researchers in FTE/R&D personnel in FTE	63.9%	87.5%	65.6%	52.2%
Share of total R&D spending share by actor	100%	15.2%	38.3%	46.4%
R&D spending per researcher FTE (€)	118250	64152	132941	145124

*RVCTI: Basque Innovation Network of Science, Technology and Innovation
Source: OECD (2011) from EUSTAT data.

A more detailed analysis of R&D personnel and researchers in Basque firms shows a significant increase between 2001 and 2006 in the share of researchers over R&D personnel, and in the number of employees in both high and low technology industries, which supports an increase in these industries' specialization. On the other hand, the share of researchers in services has not experienced great changes between 2001 and 2006 both in terms of the number of employees and FTE.

Table 7-10: R&D personnel and researchers in firms in the Basque Country by technology and knowledge intensive group

	R&D personnel		Researchers		Researchers/R&D personnel (%)	
	2001	**2006**	**2001**	**2006**	**2001**	**2006**
Total num. employees	**10,033**	**12,230**	**4,137**	**6,345**	**41.2%**	**51.9%**
High Technology Manufacturing	1,307	620	534	384	40.7%	61.9%
Medium-High Technology Manufacturing	2,580	2,501	712	1,005	27.6%	40.2%
Medium-Low Technology Manufacturing	1,750	1,772	433	666	24.7%	37.6%
Low technology Manufacturing	283	178	96	111	33.9%	62.7%
Total Manufacturing	**5,920**	**5,071**	**1,775**	**2,166**	**29.9%**	**42.7%**
Knowledge-Intensive services	3,139	5,191	1,884	3,171	60.0%	61.1%
Other knowledge-intensive services	790	1,531	397	816	50.2%	53.3%
Less knowledge-intensive services	184	437	81	192	44.0%	43.9%
Total Trade and services	**4,113**	**7,159**	**2,362**	**4,179**	**57.4%**	**58.2%**
Total FTE	**7,878**	**9,156**	**3,469**	**5,005**	**44.0%**	**54.7%**
High Technology Manufacturing	1,169	563	505	365	43.2%	64.8%
Medium-High Technology Manufacturing	1,989	1,816	569	788	28.6%	43.4%
Medium-Low Technology Manufacturing	1,038	1,061	288	445	27.7%	41.9%
Low technology Manufacturing	139	83	54	56	38.8%	67.5%
Total Manufacturing	**4,335**	**3,523**	**1,416**	**1,653**	**32.7%**	**46.9%**
Knowledge-Intensive services	2,927	4,409	1,746	2,732	59.6%	61.9%
Other knowledge-intensive services	491	956	255	495	51.9%	51.8%

	R&D personnel		Researchers		Researchers/R&D personnel (%)	
	2001	2006	2001	2006	2001	2006
Less knowledge-intensive services	125	269	52	125	41.6%	46.5%
Total Trade and services	**3,543**	**5,633**	**2,053**	**3,352**	**57.9%**	**59.5%**

Source: Eustat

Regarding size distribution, the share of researchers over R&D personnel has increased in all firms' size, although the largest increase has taken place in firms with 50-99 employees and in largest firms. In addition, the share of researchers over R&D personnel in FTE has increased in all the firms' sizes, most especially in medium firms (250-499) and the largest firms. In conclusion therefore, although the share of researchers in small firms has risen in the last years, medium firms have intensified researchers' full time equivalent dedication over R&D personnel.

Table 7-11: R&D personnel and researchers in firms in the Basque Country by size

	R&D personnel		Researchers		Researchers/R&D personnel (%)	
	2001	2008	2001	2008	2001	2008
Number of employees	10192	16765	4203	8980	41.2%	53.6%
< 20 employees	1022	2466	539	1409	52.7%	57.1%
20-49 employees	1185	3330	539	1761	45.5%	52.9%
50-99 employees	1397	2628	539	1384	38.6%	52.7%
100-249 employees	3256	4526	1609	2648	49.4%	58.5%
250-499 employees	1583	1484	485	752	30.6%	50.7%
500-999 employees	788	1212	336	573	42.6%	47.3%
>= 1.000 employees	961	1119	157	453	16.3%	40.5%
FTE	7972.4	11791.5	3517.5	6672.2	44.1%	56.6%
20-49 employees	582.8	1509.9	324.3	913.6	55.6%	60.5%
50-99 employees	1038.3	1789.7	440.6	971.3	42.4%	54.3%
100-249 employees	2785.7	3678.9	1476.5	2254.1	53.0%	61.3%
250-499 employees	1317.5	1080.1	420.4	583.1	31.9%	53.9%
500-999 employees	644.2	764.7	311.7	346	48.4%	45.2%
>= 1.000 employees	767.2	907.8	136.6	380.4	17.8%	41.9%

Source: EUSTAT

As next table shows, there have not been dramatic changes in terms of R&D personnel and researchers' qualification in firms during the period 2001 and 2006. The only remarkable data could be the raise of PhDs with firms' R&D personnel.

Table 7-12: Qualification in R&D personnel in firms

	2001 (number)	2001 (percentage)	2005 (number)	2005 (percentage)	2006 (number)	2006 (percentage)
R&D personnel with a PhD	452	4.4%	673	5.7%	786	6.0%
R&D personnel with a degree	4,470	43.8%	6,117	49.6%	6,547	50.1%
Total R&D personnel	**10,197**	**100.0%**	**12,327**	**100.0%**	**13,076**	**100.0%**
Researchers with a PhD	436	10.4%	653	10.2%	719	10.6%
Researchers with a degree	3,108	73.8%	4,489	69.9%	4,802	70.8%
Total Researchers	**4,209**	**100.0%**	**6,415**	**100.0%**	**6,779**	**100.0%**

Source: EUSTAT

In terms of the specialization in R&D personnel and researchers, we can highlight it increases with size and in higher technology and knowledge intensive firms. However, this evolution has not followed the same trend for all the industries. Indeed, industrial firms have reduced their personnel specialization between 2000 and 2006 in both R&D personnel and researchers while services have increased this share. One of the reasons behind this increase can be found in the inclusion of Technology Centres in the service group.

Table 7-13: R&D personnel qualification distributed by size and technology group

		2000						2006					
		R&D personnel with a PhD	R&D personnel with a degree	Total R&D personnel	Researchers with a PhD	Researchers with a degree	Total Researchers	R&D personnel with a PhD	R&D personnel with a degree	Total R&D personnel	Researchers with a PhD	Researchers with a degree	Total Researchers
High and medium-high technology industries	Less than 10 employees	0.09%	0.89%	2.07%	0.22%	1.63%	2.60%	0.34%	1.61%	3.52%	0.43%	2.60%	4.02%
	Between 10 and 49 employees	0.15%	4.08%	10.56%	0.30%	7.95%	11.29%	0.34%	7.41%	18.28%	0.68%	11.62%	17.49%
	Between 50 and 243 employees	1.06%	10.12%	29.70%	2.38%	16.79%	27.12%	0.79%	18.51%	41.04%	1.73%	31.15%	39.12%
	250 employees or more	2.16%	20.26%	57.68%	5.20%	40.42%	58.99%	0.45%	13.58%	37.15%	0.93%	20.46%	39.37%
	Total	3.46%	35.34%	100.00%	8.10%	66.79%	100.00%	1.92%	41.10%	100.00%	3.77%	65.82%	100.00%
Medium-low and low technology industries	Less than 10 employees	0.21%	0.10%	1.28%	0.69%	0.35%	1.56%	0.19%	1.28%	2.80%	0.48%	2.41%	4.95%
	Between 10 and 49 employees	0.56%	7.94%	19.63%	1.91%	22.36%	32.24%	0.43%	7.50%	25.00%	1.09%	15.68%	27.99%
	Between 50 and 243 employees	0.87%	8.35%	25.53%	2.43%	17.16%	27.90%	0.81%	13.43%	36.39%	1.57%	20.99%	34.74%
	250 employees or more	0.82%	13.94%	53.56%	2.77%	28.94%	38.30%	0.14%	12.00%	35.82%	0.36%	21.83%	32.33%
	Total	2.46%	30.34%	100.00%	7.80%	68.80%	100.00%	1.57%	34.20%	100.00%	3.50%	60.92%	100.00%
Total industries	Less than 10 employees	0.13%	0.60%	1.78%	0.36%	1.25%	2.29%	0.28%	1.48%	3.25%	0.45%	2.53%	4.33%
	Between 10 and 49 employees	0.30%	5.50%	13.88%	0.78%	12.27%	17.58%	0.37%	7.44%	20.78%	0.82%	13.00%	21.05%
	Between 50 and 243 employees	0.99%	9.47%	28.17%	2.39%	16.90%	27.35%	0.80%	16.61%	39.31%	1.68%	27.71%	37.64%
	250 employees or more	1.67%	17.95%	56.17%	4.47%	36.97%	52.78%	0.34%	12.99%	36.66%	0.74%	20.92%	36.98%
	Total	3.09%	33.51%	100.00%	8.01%	67.39%	100.00%	1.79%	38.53%	100.00%	3.68%	64.16%	100.00%
Knowledge intensive servicies	Less than 10 employees	0.15%	1.23%	2.12%	0.23%	1.35%	2.11%	0.88%	2.41%	4.75%	1.30%	3.01%	4.80%
	Between 10 and 49 employees	0.64%	2.66%	5.37%	0.83%	2.86%	4.29%	3.34%	19.24%	35.00%	4.96%	22.52%	33.17%
	Between 50 and 243 employees	8.37%	51.06%	92.52%	12.71%	72.33%	93.61%	8.17%	35.37%	60.25%	11.91%	46.34%	62.03%
	250 employees or more	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
	Total	9.16%	54.95%	100.00%	13.76%	76.54%	100.00%	12.39%	57.02%	100.00%	18.17%	71.87%	100.00%

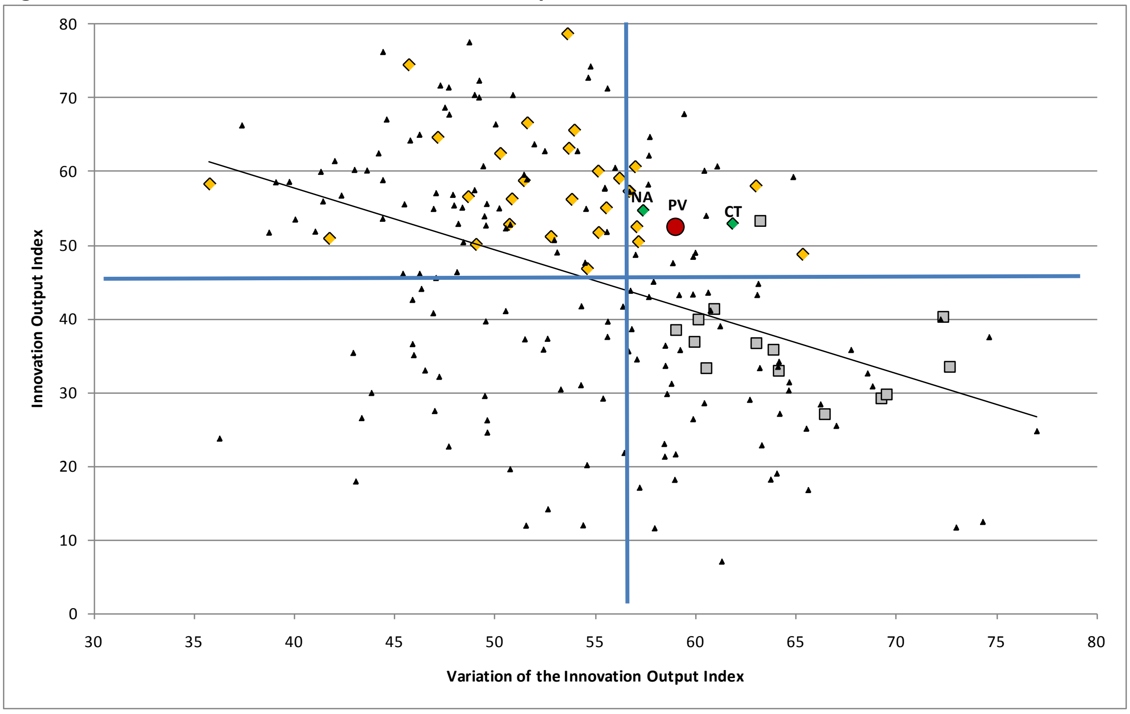
		2000						2006					
		R&D personnel with a PhD	R&D personnel with a degree	**Total R&D personnel**	Researchers with a PhD	Researchers with a degree	**Total Researchers**	R&D personnel with a PhD	R&D personnel with a degree	**Total R&D personnel**	Researchers with a PhD	Researchers with a degree	**Total Researchers**
Other knowledge intensive services	Less than 10 employees	0.51%	8.03%	**11.18%**	1.07%	11.37%	**14.38%**	0.80%	8.54%	**14.45%**	1.59%	11.66%	**16.58%**
	Between 10 and 49 employees	1.73%	33.33%	**46.95%**	3.22%	36.05%	**44.85%**	3.28%	26.58%	**42.72%**	4.01%	31.26%	**41.26%**
	Between 50 and 243 employees	0.71%	16.57%	**23.07%**	1.50%	22.10%	**25.75%**	2.06%	19.37%	**27.42%**	3.94%	27.48%	**33.69%**
	250 employees or more	0.00%	11.69%	**18.80%**	0.00%	14.81%	**15.02%**	0.00%	10.76%	**15.41%**	0.00%	8.33%	**8.48%**
	Total	**2.95%**	**69.61%**	**100.00%**	**5.79%**	**84.33%**	**100.00%**	**6.14%**	**65.26%**	**100.00%**	**9.54%**	**78.73%**	**100.00%**
Less intensive services	Less than 10 employees	0.83%	12.40%	**29.75%**	1.82%	18.18%	**29.09%**	0.46%	8.47%	**14.42%**	1.04%	16.15%	**21.88%**
	Between 10 and 49 employees	0.83%	28.93%	**52.89%**	1.82%	41.82%	**52.73%**	0.69%	16.70%	**37.76%**	1.56%	26.04%	**36.46%**
	Between 50 and 243 employees	0.83%	7.44%	**17.36%**	1.82%	9.09%	**18.18%**	0.46%	8.70%	**29.06%**	1.04%	14.06%	**21.35%**
	250 employees or more	0.00%	0.00%	**0.00%**	0.00%	0.00%	**0.00%**	0.69%	11.67%	**18.76%**	1.04%	18.23%	**20.31%**
	Total	**2.48%**	**48.76%**	**100.00%**	**5.45%**	**69.09%**	**100.00%**	**2.29%**	**45.54%**	**100.00%**	**4.69%**	**74.48%**	**100.00%**
Total trade and services	Less than 10 employees	0.29%	3.79%	**6.03%**	0.49%	4.38%	**6.00%**	0.78%	4.92%	**8.67%**	1.32%	6.20%	**9.07%**
	Between 10 and 49 employees	0.99%	13.30%	**20.25%**	1.46%	12.37%	**15.94%**	3.00%	20.88%	**36.37%**	4.26%	24.34%	**34.24%**
	Between 50 and 243 employees	5.68%	38.55%	**67.83%**	9.56%	57.81%	**74.28%**	5.08%	26.25%	**43.54%**	8.30%	36.61%	**48.15%**
	250 employees or more	0.00%	3.67%	**5.90%**	0.00%	3.73%	**3.78%**	0.45%	7.12%	**11.41%**	0.74%	7.71%	**8.54%**
	Total	**6.95%**	**59.31%**	**100.00%**	**11.51%**	**78.28%**	**100.00%**	**9.32%**	**59.17%**	**100.00%**	**14.62%**	**74.85%**	**100.00%**

Source: EUSTAT

7.2.4 Innovation Outputs in the Basque Country

Innovation outputs are also analysed by Navarro et al. (2011) through an index composed for all the European regions and for the reference regions identified for the Basque Country. The following figure shows this index[18] and its variation. We can thus appreciate the different situations within the regions of reference. The Basque level of innovation outputs is higher than the average of the European regions and the Spanish regions, but is lower than the regions of reference. The Basque Country (PV) and the other Spanish reference regions (Catalonia-CT- and Navarre-NA) however, have experienced growth in their innovation output more than that of the EU average, which indicates a convergence process in the last years. This index is composed of the most important output indicators, but these are not available for all the EU regions for a long-time series. For that reasons, in the analysis and evolution of individual indicators, the Basque Country will be compared to Spanish, other EU countries and European averages.

Figure 7-5: Level and variation of Innovation Output Index



Source: Navarro et al. (2011)

Note: rhombus are referred to the regions of reference, square to Spanish regions (except the ones included in the regions of reference) and the triangles are the rest of the European regions.

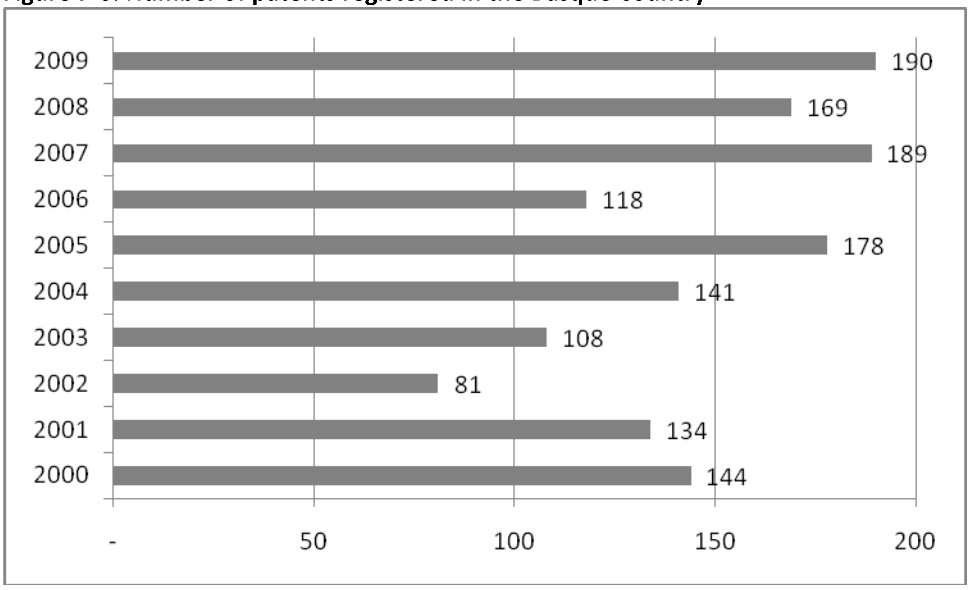
[18] The innovation output index is composed for the following simple indicators:

- Level of economic performance: GDP per capita, employment rate and productivity.
- Variation in economic performance: annual percentage change of employment, productivity, real GDP and real GDP per capita.
- Level of innovation output: EPO patents (per million inhabitants), scientific publications (per million inhabitants), employment in high and medium-high technology manufacturing sectors (%) and employment in knowledge intensive services (%).
- Variation of the innovation output: percentage change of EPO patents, publications, employment in high and medium-high technology manufacturing sectors and employment in knowledge intensive sectors.

With specific regard to innovation outputs, patents have traditionally been the main output indicator for measuring innovation, although they do not include other innovation outputs as new products on processes that are not patented. In addition, Navarro et al. (2011) state that these are intermediate innovation outputs instead of final innovation outputs.

The following figure shows the evolution of patents registered in the Basque Country, which has been very irregular during the last ten years.

Figure 7-6: Number of patents registered in the Basque Country



Source: EUSTAT

Concerning applications to the European Patent Office, the Basque Country's relative position is higher than the position reached by Spain, although it differs considerably from other European Countries, such as those situated in Scandinavia or Central Europe. These figures show relatively low levels of innovation outputs for the Basque Country.

Table 7-14: Patent applications to the European Patent Office (EPO) by priority year per million of inhabitants

	2000	2001	2002	2003	2004	2005	2006	2007
Belgium	126.712	117.033	125.234	127.849	142.202	135.973	136.363	88.016
Bulgaria	0.907	1.961	1.854	2.734	2.407	3.069	3.515	0.844
Czech Republic	6.478	6.986	8.608	11.163	11.022	10.412	14.653	9.453
Denmark	177.129	168.787	174.169	192.438	191.804	202.064	193.908	113.898
Germany (including former GDR from 1991)	267.752	264.341	260.712	263.169	276.165	283.636	283.49	186.351
Estonia	4.067	6.825	4.187	7.913	6.425	2.968	7.615	7.933
Ireland	53.566	63.168	56.912	55.31	63.969	63.283	64.212	34.905
Greece	5.124	6.474	6.795	7.873	6.059	9.902	9.321	5.294
Spain	19.952	21.285	22.9	22.476	28.59	30.98	30.232	19.011
Basque Country	37.256	39.009	37.426	36.773	51.434	61.357	62.62	41.606
France	120.418	118.864	119.221	126.673	133.487	130.741	130.871	79.684
Italy	70.073	69.394	73.142	75.293	79.441	82.314	83.567	56.074
Cyprus	10.427	22.622	9.326	11.005	8.215	21.41	9.564	11.455
Latvia	3.334	2.043	2.656	3.624	4.234	4.947	5.099	3.945
Lithuania	1.335	0.903	0.765	4.095	4.002	2.607	2.841	2.009
Luxembourg	183.602	163.964	138.048	195.561	245.516	205.906	220.024	116.026
Hungary	11.803	9.69	11.809	12.592	15.43	13.382	16.02	8.04
Malta	11.836	13.924	10.136	14.045	11.254	27.939	18.889	7.356
Netherlands	216.889	242.34	213.784	212.434	221.139	208.063	220.58	100.319
Austria	147.27	149.748	157.45	164.638	175.405	180.675	204.365	129.731
Poland	1.134	1.503	2.124	2.995	3.148	3.197	3.61	3.544
Portugal	4.118	3.973	3.992	6.074	5.583	10.953	10.097	7.847
Romania	0.279	0.474	0.52	0.747	1.048	1.324	0.888	0.931
Slovenia	25.466	25.124	38.179	37.914	57.543	53.354	48.174	37.441
Slovakia	2.08	2.261	4.512	5.852	3.831	5.701	7.341	4.057
Finland	274.619	266.524	241.858	241.243	263.925	247.011	248.789	111.371
Sweden	258.174	236.096	224.553	221.041	246.157	260.251	280.119	145.771
United Kingdom	102.021	94.472	92.878	91.458	90.832	88.485	89.804	41.563

Source: Eurostat

Finally, TFP (Total Factor Productivity) can be considered an innovation output as it reflects the contribution of technical progress to productivity growth. Specifically, it reflects the effects of technological and organizational changes due to knowledge 'spillovers' and investments in intangibles. Although TFP analyses carried out by Erauskin (2010) and OECD (2011) pointed out a decline of this factor during 1995-2004, latest analyses provided by IVIE show that the share of economic growth attributable to TFP for the period 1995-2007 was 0.65%, higher than the Spanish, UE-15 and Japanese shares and similar to German share. However, these shares did undergo declines in 2008 to -0.82%, and were indicative of the economic crisis.

Table 7-15: Growth accounting. GVA (percentage)

	Basque Country		*Spain*		*Germany*	*EU-15*	*USA*	*Japan*
	1995-2007	**2008**	**1995-2007**	**2008**	**1995-2007**	**1995-2007**	**1995-2007**	**1995-2006**
GVA	4.26	0.07	3.69	0.09	1.39	2.45	3.52	1.10
Labour contribution	2.49	-0.31	2.90	-0.50	-0.23	0.73	0.84	-0.26
Capital Contribution	1.13	1.20	1.28	1.20	0.95	1.13	1.49	0.89
TFP	0.65	-0.82	-0.49	-0.62	0.68	0.60	1.19	0.46

Source: IVIE

7.2.5 Strengths and Weaknesses of the Basque Innovation System Performance

Finally, it is important to point out that R&D inputs and outputs in the Basque Country are partially subsidized by public government at different administrative levels. The following tables show a brief description of this funding evolution. Concerning business funding, national, regional and local funding have replaced own resources' funding during the last years, which seems to support the idea of funding 'crowding-out' effects, but also suggests the increased importance of innovation in public policies. Detailed analysis of funding distribution by actors shows a larger increase of public funding in firms and other actors from the Basque Science, Technology and Innovation Network (RVCTI) in replacement of universities. Also noteworthy, in overall terms, is the public funding increase in the last decade.

Table 7-16: R&D business expenditure funding

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
Own resources	61.76%	67.59%	62.61%	63.87%	63.17%	58.89%	56.22%	54.25%	52.58%
National Funding	4.91%	4.65%	4.59%	7.01%	5.20%	5.87%	10.56%	12.76%	13.00%
Regional Funding	9.13%	7.11%	8.40%	9.41%	10.73%	12.92%	12.38%	11.66%	13.01%
Local Funding	1.33%	1.54%	1.87%	2.20%	2.04%	2.29%	2.17%	3.47%	5.17%
Other firms funding	18.48%	10.30%	12.88%	13.21%	14.00%	15.78%	15.05%	14.17%	12.42%
Non-profit private institutions	0.51%	0.08%	0.14%	0.10%	0.06%	0.27%	0.19%	0.22%	0.32%
Foreign institutions	3.88%	8.73%	9.52%	4.20%	4.79%	4.00%	3.43%	3.47%	3.50%

Source: EUSTAT

Table 7-17: R&D expenditure funding by type of actor

		Total	Universities	RVCTI (except universities)	Firms (except RVCTI)
2000	National Funding (thousands €)	162703	75919	38914	47870
	Foreign institutions (thousands €)	18.999	0	11596	7402
	National Funding (% distribution by actor)	100%	46.70%	23.90%	29.40%
	Foreign Institutions (% distribution by actor)	100%	0	61%	39%
	National Funding (% over R&D expenditure)	27.40%	74.90%	25.50%	14.10%
	Foreign Institutions (% over R&D expenditure)	3.20%	0%	7.60%	2.20%
2007	National Funding (thousands €)	409532	129130	170542	109859
	Foreign institutions (thousands €)	35156	3112	22500	9544
	National Funding (% distribution by actor)	100%	31.50%	41.60%	26.80%
	Foreign Institutions (% distribution by actor)	100%	8.90%	64%	27.10%
	National Funding (% over R&D expenditure)	37.60%	77.80%	40.80%	21.70%
	Foreign Institutions (% over R&D expenditure)	3.20%	1.90%	5.40%	1.90%

Source: EUSTAT as presented by Navarro (2010)

In conclusion, we can thus highlight some strengths and weaknesses of the Basque Innovation System.

Firstly, R&D inputs have positively evolved during the previous years both in terms of R&D expenditure and personnel. Nevertheless, the share of R&D expenditure in higher educational sector is still very low in comparison to other sectors. This reveals a system weakness as the science side of the system is not as strong in R&D investments as is the technology side. In terms of R&D personnel and researchers, although the number and share has also followed a positive evolution, little to non-existent increase of personnel's qualification can be perceived in the Basque economy. Furthermore, it is imperative to point out that size and technology group disaggregation shows the same distribution that can be found in the Basque industrial structure.

With regard to outputs, a possible systemic inefficiency arises as the level and evolution of traditional innovation outputs as patents do not correspond with inputs levels. The same happens with regards the PTF until 2004, although this tendency started to change between then and 2008. However, the Basque Country has achieved relatively high levels of economic outputs, which are measured both in terms of GDP, and other indicators as exports or employment.

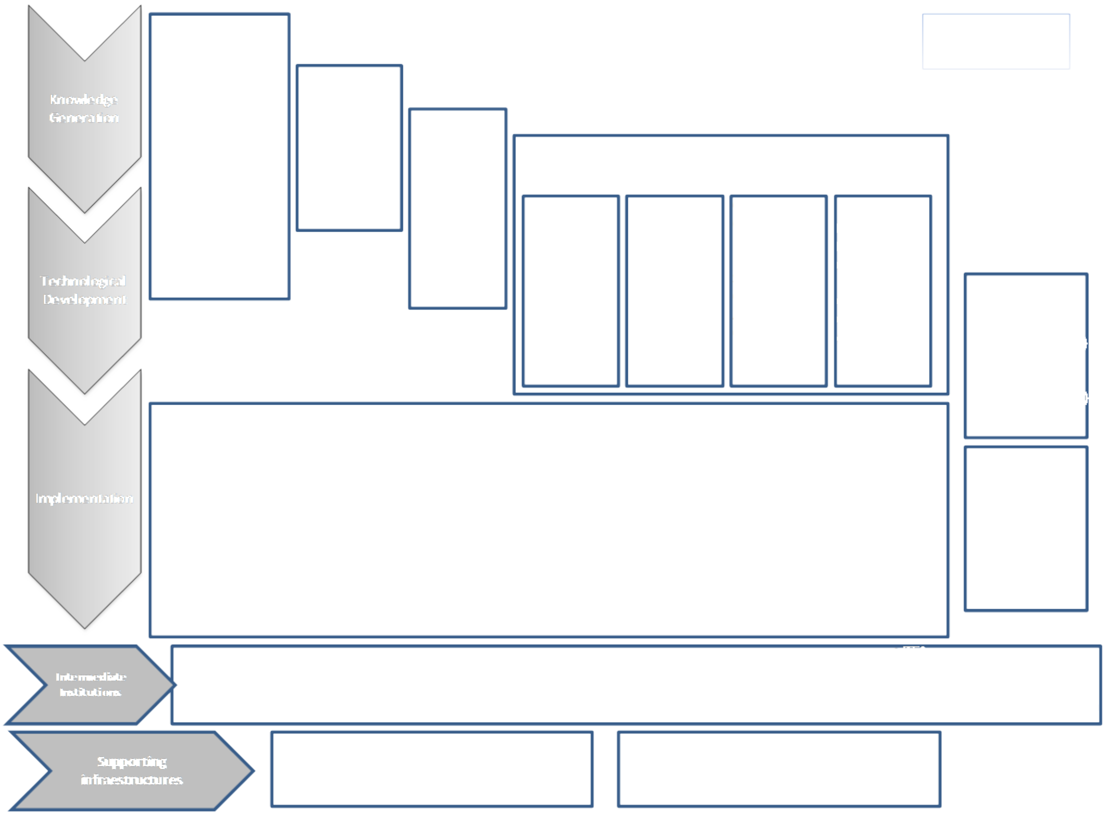
Moreover, in terms of R&D funding, the data shows a positive trend in public funding in replacement of private funding, which is a direct consequence of the increasing importance of innovation in public policies. This trend will be analysed in the following section. This increase in public funding should have a positive impact on both innovation and economic outputs of the system; in all circumstances, however, it should not become a substitute for private expenditure, which will provoke a crowding -out effect.

In conclusion, therefore, the main weaknesses of the system underscores the need for an evaluation of public R&D funding as the relationship between R&D inputs and innovation outputs reflect a partially inefficient system.

7.3 Main agents and actors in the Basque Regional Innovation System

One of the main specificities of the Basque Regional Innovation System relies on the configuration of its actors, both in their number and characteristics. The following figure shows an overall view of the actors currently active in the Basque Innovation System. This figure illustrates the variety and complexity of the regional actors in the innovation system. As the OECD (2011) states, the Basque region is characterised by strong institutions supporting applied research, public-private collaboration and low public research. This assumption is also supported by the analysis carried out in the previous section.

Figure 7-7: Science and Technology Actors in the Basque Country



Source: Own elaboration based on Innobasque

Some of the actors belonging to the Basque System compose the Basque Network of Science, Technology and Innovation (RVCTI) (before it was the Basque Network of Science and Technology-RVCT). The network is composed of three subsystems: i) scientific and university subsystem, which includes universities and excellence research centres ii) technological, development and innovation subsystem (technology centres, firm R&D units, which are R&D units constituted as legal bodies themselves, etc.) and iii) support to innovation subsystem (technological parks, intermediaries, etc.) (OECD, 2011).

The scientific and university subsystem is mainly composed of universities (two private and one public), basic excellence research centres and cooperative research centres (see Table 7-18). Excellence Research Centres were created over the last decade by the Department of Education, Universities and Research, and were based on the existing critical mass for improving the scientific and research foundations of the innovation system. On the other hand, cooperative research centres have been also fostered over the last decade by the Department of Industry in order to support strategic sectors that either already exist in the region or are sectors or technologies that the government seeks to promote.

Table 7-18: List of Basic Excellence Research Centres and Cooperative Research Centres in the Basque Country

Name and area or sector	Year created	
Basic Excellence Research Centres		
BCAM Basque Center for Applied Mathematics	2008	Created by the Department of Education, Universities and Research
BC3 Basque Center for Climate Change	2008	
BCBL Basque Center on Cognition, Brain and Language	2008	
DIPC Donostia International Physics Center	2000	
UB Biophysics Unit UPV/EHU-CSIC	2000	
MPC Material Physics Center, UPV/EHU-CSIC	2000	
Cooperative Research Centres		Created by the Department of Industry and SPRI
CIC-marGUNE-Manufacturing	2002	
CIC tourGUNE-Tourism	2006	
CIC bioGUNE-Biosciences	2002	
CIC biomaGUNE-Biosciences, biomaterials	2002	
CIC nanoGUNE-Nano-sciences	2006	
CIC microGUNE- Microsciences	2004	
CIC energiGUNE- Alternative energy	2007	

Source: OECD (forthcoming)

The second subsystem, the technological development and innovation subsystem, is the cornerstone of the Basque Innovation System. Specifically, Technology Centres are a key actor in the system and at present, some of them have merged under different legal forms towards two main networks, Tecnalia and IK4[19]. Their research activity is applied and directed to contribute to technological needs of Basque firms. In addition to this, firms that dedicate one unit to R&D activities can adopt a particular legal form in order to belong to the Basque Network and benefit from some subsidy and tax advantages. Distribution of public funding along the Network has considerably changed in the last years as the next table shows. Technology centres, for instance, received almost 60% of regional public funding in 2000, whereas in 2007 this funding proportion was 36% (see table 7-19). It is also remarkable that all actors have increased their dependence on public funding, especially excellence research centres and sectorial public centres, which corresponds to their public nature. This applies similarly to firms that have doubled their funding share due to public resources. This situation underscores the need to evaluate the effectiveness of public funding in firms, and also the effectiveness of interlinks among firms and the rest of system's agents.

[19] Tecnalia has merged into one big corporation composed of Inasmet, Labein, Robotiker, ESI, Fatronik, Cidemco, Leia and Euve, which maintains an alliance with Azti and Neiker, while IK4 is a strategic alliance in which the individual centres still maintain their legal forms. IK4 is composed of CEIT, CIDETEC, GAIKER, IDEKO, IKERLAN, TEKNIKER and VICOMTECH.

Table 7-19: Funding sources by type of actor

		Distribution by type of funded actor (%)						Distribution by type of funding source in each actor (%)					
		Excellence Research Centres	Technology Centres	Sectorial, public centres (including Health R&D)	Firms R&D Units	Other R&D services	Total	Excellence Research Centres	Technology Centres	Sectorial, public centres (including Health R&D)	Firms R&D Units	Other R&D services	Total
2000	Public funding	0%	62%	28%	5%	4%	100%	0%	30%	63%	9%	5%	25%
	by national authorities	0%	66%	25%	4%	5%	100%	0%	8%	13%	2%	1%	6%
	by regional authorities	0%	59%	32%	6%	3%	100%	0%	19%	48%	7%	3%	17%
	by provincial and local authorities	0%	82%	10%	1%	8%	100%	0%	3%	2%	0%	1%	2%
	Own resources	0%	23%	3%	29%	45%	100%	0%	16%	10%	75%	85%	39%
	Other firms	0%	81%	8%	5%	6%	100%	0%	42%	19%	8%	8%	27%
	Foreign funding	0%	67%	12%	15%	5%	100%	0%	10%	8%	8%	2%	8%
2007	Public funding	25%	33%	18%	10%	13%	100%	89%	36%	67%	18%	32%	41%
	by national authorities	37%	33%	13%	13%	5%	100%	54%	15%	19%	10%	5%	17%
	by regional authorities	16%	36%	25%	8%	15%	100%	28%	19%	45%	7%	17%	20%
	by provincial and local authorities	21%	20%	7%	9%	42%	100%	7%	2%	3%	1%	10%	4%
	Own resources	1%	14%	4%	53%	29%	100%	3%	11%	9%	67%	49%	29%
	Other firms	3%	64%	9%	12%	12%	100%	7%	42%	19%	13%	17%	25%
	Foreign funding	3%	71%	10%	8%	7%	100%	1%	10%	5%	2%	2%	5%

Source: Eustat as presented by Navarro (2010)

In addition, we can mention a few other institutions, such as the technology parks or Innobasque (the Basque Innovation Agency) that play an important role in supporting the Science, Technology and Innovation Network.

Finally, although they are not part of the Basque STI Network, it is important to mention the existence of 12 cluster associations (plus 10 pre-clusters) created over the last two decades. These cluster associations promote networking among firms within the Basque Country and therefore contribute to enhance the Innovation System (see the following table).

Table 7-20: List of Cluster Assotiations in the Basque Country

Cluster Association	Year of Creation	Created and supported by
Home appliances	1992	Basque Government (BG)-Department of Industry
Machines tools	1992	BG-Department of Industry
Automotive	1993	BG-Department of Industry
Environment	1995	BG-Department of Industry
Port of Bilbao	1995	BG-Department of Industry
Telecommunications	1996	BG-Department of Industry
Energy	1996	BG-Department of Industry
Shipping	1997	BG-Department of Industry
Aerospace	1997	BG-Department of Industry
Paper	1998	BG-Department of Industry
Sociolinguistics	2004	BG-Department of Industry
Audiovisuals	2004	BG-Department of Industry
Transport and Logistics	2005	BG-Department of Transport- Pre-Cluster*(Industry)
Food	2008	BG-Department of Agriculture- Pre-Cluster*(Industry)
Arts Graphics	2009	Pre-Cluster*-BG-Department of Industry
Foundry	2009	Pre-Cluster*-BG-Department of Industry
Forging	2009	Pre-Cluster*-BG-Department of Industry
Biosciences	2009	Pre-Cluster*-BG-Department of Industry
Habitat	2009	Pre-Cluster*-BG-Department of Industry
Construction	2010	Pre-Cluster*-BG-Department of Industry
Hand tools	2010	Pre-Cluster*-BG-Department of Industry
Steel production	2010	Pre-Cluster*-BG-Department of Industry

* Pre-clusters are based on existing sectorial associations.
Source: Own elaboration based on information provided by the Basque Government

In conclusion, there are a variety of institutions and organization related to innovation and R&D activities in the Basque Country that are both beneficiaries of public funding, but also responsible for part of the Basque innovation performance. A detailed evaluation of their specific role and impact within the system should provide important information for policy-making purposes.

7.4 Basque STI policy

Most of the innovation performance and the regional system configuration can be understood when analysing the evolution and the role policies have played in the Basque Region. In this section, origin and evolution of Basque S&T Policy is described, as well as their implications in terms of policy complexity, which determines policy evaluation and learning.

7.4.1 Origin and evolution of Basque STI Policy

During the 70's Basque Innovation System was not well-structured, which led to the definition and implementation of Basque Technologies Policies in the subsequent years (Bilbao-Osorio, 2009). The first steps established during the 80's were aimed at building a research infrastructure through technology policy. According to Valdaliso (2011, forthcoming) technology policy in the 80's was focused on developing a R&D infrastructure in the Basque Country. During these years the most important advances were directed to promote R&D activities and adoption of new technology in firms, but much greater efforts were directed to promote the creation of Technology Centres, which were designed to strengthen the technological development in firms. Fundamentally, technology policy was supply-based and its main objectives were directed towards creating applied-research infrastructure. In the subsequent decade, public support to technology infrastructures continued with the creation of more technology centres and technology parks, which constitute infrastructures for supporting the system. It is also noteworthy that in this decade aggregation of firms in clusters and cluster associations were created in order to promote cooperation in strategic projects among firms, and between firms and other actors within the system, as technology centres. Furthermore, by the end of this decade some public funding programmes were created by the regional government to promote R&D activities in firms, such as the INTEK programme, which was first launched in 1997. This decade therefore, was characterised by reinforcement of research infrastructure (supply-based policy) but also by a more demand-based policy with a higher presence of firms and coordination mechanisms (Bilbao-Osorio, 2009; Valdaliso, 2011, forthcoming).

The creation of Basque Technology Centres was the main result of this first phase. They are, as mentioned before, the cornerstone of the Basque Innovation System. These actors however, suffer from some weaknesses, as Navarro (2010) and Olazaran et al (2005) state. This particular stage is also characterised by a technology bias, in which policies are industry-oriented and for that reason, defined and promoted by the Department of Industry. This bias provoked the attempt in the mid 90's of promoting the scientific side and integrating both technology and science policies, although science policy has always seen as a separate policy. As Olazaran et al. (2005) point out, science policy in the Basque Country has been largely separate from technology policy and has focused on the general promotion of the university and its resources. This isolation can be seen in the fact that Science Policy is managed by the

Education Department while Technology Policy is managed by the Industry Department. It also supports the academic bias of the Science Policy as highlighted by Olazarán et al. (2005) and Sanz-Menendez and Cruz-Castro (2005).

The real interaction of both policies started with the Science, Technology and Innovation Plan (2001-2004) although this objective was already included in the previous regional plan (Science and Technology Plan 1997-2000) (Olazarán et al. 2005; Bilbao-Osorio 2009). Since the late 90's or early 00's therefore priorities were established, which aimed at enhancing scientific system, integrating it with technology research infrastructure and stimulating innovation in firms. At this time, some weaknesses in the scientific system had arisen, although by this time too, some university groups were considered excellence groups. Among these "undesirable effects" we can single out the excessive public economic dependence of these groups, due to the huge amount of public funds received. This public funding lead to a higher entry barrier for new research groups as they were not able to access to the same amount of public funding.

A positive sign of the search for integration was the creation in 1997 of SARETEK, the Basque Science and Technology Network, which comprised technology centres, firms R&D units, essay laboratories, universities and other public research institutions. In addition, the Basque Council of Technology turned up in the Basque Council of Science and Technology, in order to better reflect the searched for integration (Valdaliso, 2011 forthcoming). The STI Plan 1997-2000 did not reach these objectives however, and this had several effects on the system's integration (OECD, 2011). Firstly, the Plan's resources were stable during through all years, although there was a decline in the share of funding for Science and Technology Infrastructure. Moreover, although the financial support for R&D and innovation projects increased over the period, cooperation projects declined, which highlights a weakness in the system (OECD, 2011).

The real integration started with the Science, Technology and Innovation Plan (2001-2004) which was aimed at improving the links between industry and science through institutional arrangements. This plan (together, at least partially, with the previous one) established the foundation for more systemic and horizontal policies within the Basque Innovation System (Valdaliso 2011, forthcoming). The main measures designed and implemented within the plan include the following (OECD, 2011):

- Creation of Cooperative Research Centres (CICs): The creation of these centres has been promoted by the Industry Department in those strategic areas for diversification in the Basque Country (biomaterials, alternative energy...). The main aim of these centres is to develop basic and applied research in those sectors and technologies. They are basically funded by public grants, which are both non-competitive and competitive, although they are institutionally independent. They are organised through associational forms in which various stakeholders, including firms, form a part.

- Creation of Basic Excellence Research Centres (BERCs): These centres were promoted by the Education Department and aim to develop fundamental research activities. They are usually associated with university research groups. They are also autonomous in their activity, although their funding is mainly institutional.
- RTD support programmes to Basque STI Network: Two main types of programmes can be distinguished: Those aiming at promoting the development of S&T capacity (i.e. SAIOTEK) and those aiming to promote the development of new strategic R&D projects (i.e. ETORTEK).
- Firms support: This plan also includes support for R&D and innovation activities in firms and cooperation between firms and actors belonging to the Basque Network (RVCTI) as such Technology Centres. This cooperation was promoted by some specific R&D programmes as the INTEK programme. The creation of new technology-based firms was also promoted by the NET's programme.
- Emphasis on human resources: This plan also includes incentives to support the development of qualified human resources for S&T and promoting their mobility.

As pointed out by Navarro (2010), the creation of CICs and BERCs has been an attempt to correct the systemic unbalance between science and technology in the system. These are, however, only partial measures as the Industry Department still maintains its leadership within Science & Technology Policy in the Basque Country. In addition, the OECD (2011) aims for a better coordination between the new established centres (CICs and BERCs) and previously existing ones (Technology Centres) in order to maximise research efforts. This would include coordination between the two regional departments from Basque Government (Education and Industry). Navarro (2010) highlights the restrictive vision with which this plan and, in general S&T policy in the Basque Country, was designed and implemented by pointing out that it is mainly focused on R&D programmes and organisations instead of building a system based on science joining with the existing technology and innovation activities.

Furthermore, the following plan PCTI (2010) was established following the basis established by previous plans and policies. It was launched in 2007 and it was one of the core strategies from the Second Basque Transformation, aimed at giving a central role to STI policies (OECD, 2011). In addition, it reflects a holistic view and seeks to reinforce cooperation among different agents in the innovation system. This enhancement is not only focused on the technological side but also in the science and innovation, involving other organizations that play an important role in innovation networking in the system, for example the Local Development Agencies, and seeks on improving this by the creation of Innobasque, the Basque Innovation Agency.

We can establish three stages in the Basque Science and Technology Policy according to its characteristics. Between 1980 and 1996, S&T Policy was mainly a supply policy aiming at establishing the basis from the Basque Science and Technology Network. Between 1997 and 2005, the policy was focused on the supply reinforcement, including science reinforcement as well as an orientation to industrial and social needs. Finally, from 2006 onwards this policy has focused on results, where it combines a demand pull side with a supply push one.

It is important to point out that the Basque Region is currently defining a new Science, Technology and Innovation Plan (PCTI 2015), which will be launched in 2011 and will follow the previous line of PCTI 2010.

7.4.2 Basque Innovation Policy Mix

Innovation Policy Mix in the Basque Region is fragmented in various Departments as has been explained in the previous section. Moreover, the classifications established by Nauwelaers et al. (2009) and the OECD (2010) provide a framework for analysing STI policy mix that can be combined with the overview the OECD (2011) draws of the Basque mix. This combination can give us an idea of the main policies and instruments implemented in the Basque Country and their overlapping spaces. Building on these three approaches, we provide a view of the Basque STI policy mix of the present by identifying policy goals, policy domains, programmes and instruments in order to clarify the Basque policy framework for science, technology and innovation policies (see Table 4-5 in chapter 4 for a detailed definition of each term). There is not a straight division line between policy goals and policies however, as one policy can be implemented to give a response of more than one goal. In addition to this, one programme might be responding to different goals provoking different impacts.

The Basque STI Policy mix is mainly composed of Technological and Innovation Policies managed by the Industry, Trade and Tourism Department and Science Policies, which are managed by the Education, Universities and Research Department. An overview of these policies is drawn in the following table:

Table 7-21: Basque STI Policy Mix

Policy rationales/ goals	Policy domains	Policy categories	Programmes	Target actors	Instruments	Department
Develop and support STI infrastructures	Technology and Innovation domain	Support for R&D infrastructures and organisations	SAIOTEK (2002)	RVCTI	Grants to strengthen R&D infrastructures' capacity	Industry Department
			EMAITEK (2008)	Techn. Centres		
			CICs (2008)	CICs		
		IPR policies	Support to patent application (2008)	RVCTI except UPV	Grants	Education Department
	Science domain	Support for Science infrastructures and organisations	Scientific equipment (2008)	RVCTI except UPV and Firm's R&D units	Grants to strengthen scientific infrastructures and foster their excellence	Education Department
			International Physics Centre (2000)	International Physics Centre		
			BERCs (2008)	BERCs		
			Competitive research grants for special actions (2008)	RVCTI		
			Basic and applied projects (2007)	RVCTI		
			Grants to University Research groups (2007)	Research Groups from universities		
Support investment in S&T and innovation	Technology and Innovation domain	Generic R&D and Innovation Policies	GAITEK (2005)*	Firms	R&D grants	Industry Department
			INNOTEK (2005)*	Firms		
			NET's (2005)*	Firms and RVCTI		
			ETORGAI (2008)	Firms and RVCTI		
			ALDATU (2008)	SMEs		

Policy rationales/ goals	Policy domains	Policy categories	Programmes	Target actors	Instruments	Department
			HEDATU (2005)	Firms and RVCTI		
		R&D specific finance policies	Tax incentives to R&D	Firms	Tax incentives	Provincial Councils**
	Environmental, Agriculture, Fishing and Food Domain	R&D policies in environmental, agriculture, fishing and food sectors	IKERKETA (2003)	Firms and sectoral associations	Grants	Department of Environment, Territorial planning, Agriculture and Fishing
	Health Domain	R&D policy in health research	Health research projects (2010)	Public and private research centres	Grants	Department of Health and Consumption
Enhance competencies in firms	Technology and Innovation domain	R&D Specific Human capital policies	IKERTU (2005)	Individual researchers and SMEs	Grants for researchers or SMEs	Industry Department
Strengthen linkages within innovation systems	Technology and Innovation domain	Linkage policies	INNOTEK, GAITEK &NETs (INTEK-1997)	Firms (and RVCTI)	Collaborative R&D programmes (grants)	Industry Department
			ETORTEK 2002	RVCTI		
			ETORGAI (2008)	Firms and RVCTI		
			CLUSTER (1997)	Clusters	Cluster policy (grants)	
	Science domain	Linkage policies	University/enterprise cooperative projects (2007)	Universities except UPV	Grants for collaboration	Education Department
Provide an appropriate framework conditions for STI	Other policies	Fiscal and finance policies non R&D specific, Educational policies, Industrial Policy, Regional Development Policies, Employment Policies, etc.				

* These programmes were launched in 2005. In previous years they were included in the framework of the INTEK programme

**As it will be explained in next section fiscal policy in the Basque Country belongs to the provincial government and not to the regional one.

Own elaboration based on Nauwelaers et al. (2009), OECD (2010, 2011).

The above table reflects Basque Innovation complexity in terms of its mix of regional policies that interact in the Basque region. A first review of existing policies and programmes give us an idea of the system's characteristics and bias and of the main beneficiaries of such policies.

In terms of governance of policies and programmes, we can grasp the supremacy of the Department of Industry over the Department of Education and others as Health and Consumption Department and Environment, Territorial planning, Agriculture and Fishing . This also implies that some of the system's actors are favoured in terms of amount and diversity of programmes and types of instruments to apply to Technology Centres, CICs and the firms located in the Basque region. This is consistent with the industrial bias of Basque policies trajectory during the last three decades. Secondly, the implementation of different programmes in different stages also shows the evolution of policies from supply-based to more demand-based (i.e. from a focus on creating S&T infrastructures to support R&D and innovation) and from more linear policies to strengthen links among actors within the Basque Innovation System. It also reflects that most of the science-oriented programmes were launched recently with the objective to reinforce science, but also to close off these scientific actors to firms. In addition, the bias for promoting R&D investments instead of a more organisational innovation is also perceived within the set of programmes. Moreover, little importance has been given to industrial property policies in opposition to promoting R&D investments. It is also crucial to point out that there is a mix of direct and indirect instruments for supporting R&D and innovation in firms. There are a range of direct measures, such as grants or direct subsidies for firms (either individually or in cooperation with other system's agents) and also indirect measures from fiscal policies as the R&D tax reductions, which make Basque policy for supporting R&D and innovation investments quite generous in comparison to other regions or countries (OECD, 2011). Lastly, in terms of policy rationales and goals, we could make a distinction between two types of policies. Firstly, those aimed at improving the regional innovation system and responding to system and evolutionary failures, such as those directed at developing R&D infrastructures, improving the linkages among the system and enhancing learning capabilities in firms. Secondly, those aimed at respond to more neoclassical failures, such as fiscal policies. Taking into account the policy mix as a set of policies and instruments, the rationales interaction should nevertheless be analysed and understood in a systemic context in which isolated rationales have no sense.

In addition to these regional policies promoted by the Basque Government, the Basque Innovation actors (technology and research centres, universities, firms, associations, etc...) have access to other policy mixes at other governance levels. Firms located in the Basque region, for example, can apply to national, European or even local programmes which can provoke different effects, ranging from the crowded-out effect due to overlaps in the policies to other additional effects as a result of a systemic combination of programmes. These two possibilities will be further explored through the empirical part of this research. This context gives us an idea of the complexity of STI policies and the importance of their coordination, not only between regional departments, the industry and the education ones for example, but also between different levels, which underscores the importance of the multi-level governance of the innovation policy system. The following section explains this in detail.

7.4.3 Multi-level Governance of STI Policy with Impact in the Basque Country

Almost all the policies which are components of the Basque Policy Mix, detailed in the above section, are managed by regional departments (apart from the fiscal policy). The Basque Innovation System however, is favoured by a wide range of other STI policies from different administrative levels. This set of policies and its impact on the region should be considered when defining, implementing or evaluating a certain policy moving towards a multi-level governance of STI policies. In addition, this vision could motivate the emphasis of Regional Policies within a Regional Innovation System to considering a range of policies that impact in a region and consequently the region could be defined as a regional space (Uyarra and Flanagan, 2009).

Policy governance is a key issue in the Basque case, as the region holds a great autonomy with respect to Spanish government and also high governance capacities, as the RIM report (2011) highlights. These capacities have been developed through the implementation, among others, of regional innovation strategies. As the Spanish Constitution reflects, the Basque Region and its three provinces hold a special status in terms of fiscal policy . Although the region does not count for total autonomy, its fiscal control is higher than in the rest of Spanish regions and also is greater than in most OECD's Countries (OECD, 2011). The Basque region, moreover, holds a special status in terms of STI policy, which makes the Basque Government autonomous in STI policy-making. Although this situation defines a special context for regional STI policies, this does not imply that national policies do not impact in the region. We can define four policy-levels that impact specifically on the Basque Innovation System. These are policies from the European level, from the Spanish government, from the Regional Government and from the local administrative level.

Spanish STI policies have therefore impacted on the Basque Innovation System, although they have not been an *a priori* focus on developing the Basque Innovation System. Indeed, Spanish STI policy has traditionally been focused on the development of Spanish public research system that is operationalized by universities and the CSIC centres. In the last years, Spanish STI policy has increased its STI budget in order to reduce the science and technology gap with respect to other OECD's countries (2011). Spanish STI policies have also evolved towards technological and innovation policies which include in their objectives the fostering of Spanish participation in European programmes as the Framework Programme. They also include several programmes (many of them managed by the Spanish Centre for Technological and Industrial Development CDTI) to promote technological developments within consortiums of firms and other research entities, thus enhancing linkages within the Spanish Innovation System. Although Basque Policy provides a wide range of support for STI it is remarkable that the Basque region has been successful in competing for national funds in technological innovation. In fact, the share of national funds reached by Basque organisations is higher that Basque share of Spanish GDP (OECD, 2011).

Coordination mechanisms between regional and national level are established through formal bodies as well as governance tools as bilateral contracts. Among formal bodies, the General Council for Science and Technology can be singled out and it counts with representatives for every region in Spain. Large infrastructures projects are normally arranged by bilateral contracts, as the Spanish Government aims at promoting territorial balance and cohesion with regards to large STI infrastructures (OECD, 2011). As Jaureguizar (2008) states, the Autonomous Communities in Spain are not a homogenous set of regions, meaning the central government has to adapt to every regional context and develop bilateral relationships among them on three levels: regional policies, national policies and European policies. However, although Jauregizar (2008) supports the idea of a shared decision-making process between regions and national governments, the reality is such that we could define this coordination as a top-down coordination, in which only national funds are taken into consideration, at the expense of a more systemic coordination in which all the policies that impact on the region should be taken into account. Moreover, it is remarkable that large investments, such as the ones necessary to large STI infrastructures are coordinated by the Spanish government. This follows the line of thought established by Koschatzky and Kroll (2007) in which multi-level governance of STI policies should be determined by the level of funds needed to implement certain policies, leaving the most funding-demanding ones to the national administrative level.

European Policy is currently one of the most important administrative levels in setting up STI priorities and policies, as well as in funding a wide range of projects (from research ones to technology and innovation ones). European Policy has also promoted the definition and implementation of Regional Innovation Strategies (RIS) through European Regions.

The Basque Country has benefited from European supporting programmes such as the Structural Funds as the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund, in order to promote firms' competitiveness through STI as well as a knowledge society. As the RIM report highlights (2011), these funds have contributed to the development of governance capacities in the region. The region has, furthermore, taken advantages from INTERREG programmes, including those that favour cross-border analysis jointly with France and has participated in the RIS strategies. The greatest contribution from European supporting programmes to Basque STI however, takes the form of the Framework Programme. In its various stages (VII Framework Programme 2007-2013 is currently running) this programme has supported several research projects built up in European consortia. Basque Technology Centres have been very effective in obtaining research funds from the European Framework Programme. Furthermore, Tecnalia (one of the two large corporations of the Basque Country that involves 8 Technology Centres) is the most effective actor in the Programme within Spain (according to Tecnalia's information). Firms' participation seems to be limited, however, to the most innovative ones and to the ones involved in previous projects with Technology Centres.

There is not a formal coordination mechanism between European and Basque Policies, although Innobasque, the Basque Innovation Agency (and Eurobulegoa before) promotes STI internationalization through the regional agents and encourages the participation in the Framework Programme.

In addition to the regional, national and the European level, STI policies with impact in the Basque region could also be implemented at sub-national or local level. The three Basque provinces use their own resources to foster STI through their actors, although they do not have STI competences per se (OECD, 2011). They can precipitate overlaps between provincial and regional policy-making, especially because coordination mechanisms are not well functioning. In addition, Local Development Agencies, which are another important coordination actor at Basque local level, are fostering grassroots innovation initiatives as the actors oriented to define and implement networks of firms for innovation. Although their role has been very important during the last years, a better coordination at regional level will be necessary in order to avoid overlaps (OECD, 2011).

Apart from the coordination among these three levels, coordination within the Basque System is necessary in order to articulate an effective STI Policy. In this context, there should be a coordination mechanism which integrates policies and programmes defined by both the Industry and the Education Department as well as by other departments as Health Department and Environmental, Territorial Planning, Agriculture and Fishing Department. The Basque Council for Science Technology and Innovation is a coordination mechanism set up in previous years (during the implementation of the last STI plan 2007-2009) aimed at providing the basis for coordination between Industry and Education Departments. It also serves as an instrument for multi-level governance and coordination as the three provincial councils are also represented in this Council. As pointed by the OECD (2011), unfortunately this Council has not fulfilled its expectative and effective coordination is still a necessary strategic task within the Basque region.

In conclusion, it is important to establish coordination mechanisms for effective multi-level governance in the Basque Region. At the same time, a systemic evaluation will be required in order to identify possible overlaps within STI policies at different levels and to consequently maximize the implementation and effects of public funding.

7.5 The Intek Programme: Characteristics and evolution of the programme

The Intek Programme was first launched in 1997[20] and it is the corner of the stone of Basque Policies aiming at promoting R&D investment in firms. Initially, it was the only programme that supported R&D and technological development in the Basque firms and, although has evolved since its early years, the main aim of the programme has remained consistent. The programme has also been divided into three programmes (as stated in section 6.4.2).

The Intek programme was launched by the Department of Industry, Trade and Tourism and managed by SPRI (the Regional Development Agency managing all the public funding programmes from the Industry Department). The programme's primary objective was to "increase the competitiveness of Basque firms through the support of R&D and innovation activities that are established through supply and demand collaboration" (SPRI).

[20] First regulation of the programme was defined by the Regional Decree 185/1997

The Intek programme supports projects through annual subsidies or grants selected on the grounds of a competitive process. Two types of projects can be distinguished: cooperation or individual projects. Cooperation projects are defined as those projects carried out by a consortium of at least two firms or firms associations and at least one member of the Basque Network of Science, Technology and Innovation (RVCTI). Individual projects are those carried out by one firm, but they can also include subcontracting funds for one member of the Basque Network (RVCTI). Therefore, although the only direct type of beneficiary of the programme is firms, agents from the Basque Network are the indirect beneficiaries of the programme. In economical terms, moreover, subsidies for firms are at maximum of 50% over the total project's budget in the cooperation projects. In the individual projects this amount can be reached if a subcontracting partner from the Basque Network (RVCTI) is included. , "Complementary Actions", are supporting measures and are additional to the projects directed to enhance R&D projects or to facilitate collaboration between firms and other agents from the Innovation System. Thus, although this programme is directed to firms located in the Basque Country and has as its main objective the fostering of R&D&I investments in firms, it also has as its complementary objective the strengthening of linkages between firms and members of the Basque Network.

The Intek programme was the main programme supporting firms' R&D during the Science and Technology Plan (1997-2000) and Science, Technology and Innovation Plan (2001-2004). Main figures from those years in terms of budget are summarized in the following table:

Table 7-22: Evolution of the Intek's budget

Type of project	**1997**		**2000**		**2001**		**2004**	
	Euros	**%**	**Euros**	**%**	**Euros**	**%**	**Euros**	**%**
Cooperation	8.447.303	49,1%	9.363.294	51,5%	13.708.700	69,1%	19.516.360	66%
Individual	8.773.971	50,9%	8.817.322	48,5%	6.137.130	30,9%	9.842.300	34%
Total	17.221.275	100,0%	18.180.616	100%	9.845.830	100%	29.358.660	100%

Source: SPRI

According to the figures above, the budget directed to the Intek programme increased from 1997 to 2004, especially the budget dedicated to cooperation projects. Consequently, it seems that the cooperative objective have been covered during that period. We will analyse this in detail through the empirical analysis.

Through the Intek programme, several types of projects were funded, including those related to product development and the creation of new firms. Afterwards, in 2005, in order to give more attention to the different programmes designed, the Intek programme evolved into the Intek Berri programme which distinguishes three types of funding initiatives. First, projects directed to new product development are funded by GAITEK programme, secondly there is a initiative to fund new firms called NETs, and finally, R&D&I projects are funded by the INNOTEK programme. The diversification of these programmes has been completed in the last few years with the launch of some other new programmes, such as ALDATU. The Intek, or Innotek, programme nevertheless remains a very important programme for financing R&D and innovation in Basque firms.

7.6 Conclusions

This chapter has provided a description of the Basque Innovation System and its evolution, as well as the role of STI policies in developing the Basque Innovation System.

The Basque Innovation System's performance is characterized by a "paradox" in which economic growth is not aligned with innovation outputs. The Basque Innovation Systems is characterised therefore by high levels of inputs (R&D expenditure and R&D personnel) and comparatively low levels of innovation outputs (i.e. patents). It is also a system characterized by a technology bias which can be seen through the large number of technology-based actors located in the region and their important role in the system. This bias is now less intensive, given the promotion of science-based institutions, although it remains still high. Institutional organizations therefore, have played an important role in the development of Basque Innovation System and have impacted in firms located in this system.

In terms of the Basque STI policy trajectory some facts can reiterated. Technology policy has been the corner of the stone of STI policies in the Basque Country. Technology Policy has focused on developing R&D infrastructures such as Technology Centres and little attention was paid to develop the scientific side of the system until very recently. Furthermore, a lack of coordination between technology policy and science policy can be seen throughout the whole period. With reference to complexity policy, the Basque region presents a regional innovation policy mix from two regional departments that combined with innovation policies administered at other levels (European, national, local) to provide a wide range of policies affecting the region. This complexity should be taken into account in all the stages within the policy-cycle, from policy definition to evaluation. Coordination mechanisms should, moreover, be established and improved in order to take advantages of all the policies interacting and impacting on the Basque Innovation System.

One of the actors within the system is the firm. Firms in the Basque region could benefit from a number of different policies and programmes at different levels, although one of the most important programmes in terms of resources and wide scope has been the Intek Programme. This programme subsidizes technological innovation in Basque firms at the same time as promoting collaboration among firms and other agents within the regional innovation system. Due to the fact that this has been the main programme directed to firms during the last decade in the Basque Country and one which has not been previously evaluated in terms of its impacts on firms, the following chapters bring together evaluation this programme and its consequences for the better understanding of regional STI policies.

8 MEASURING THE ADDITIONALITY OF A REGIONAL PROGRAMME

This chapter presents the main results from the empirical analysis. Our analysis followed the proposed research design in order to contrast the aforementioned hypotheses. Firstly, we will give the descriptive results, and secondly we will estimate the results from a regression analysis. Finally, we will show the results obtained from the two models run following a matching protocol.

8.1 DESCRIPTIVE RESULTS

Before conducting an explicative analysis of the programme and its impacts on firms, an exploratory analysis has been conducted and its results are shown in this section. The exploratory analysis aims to provide a general view of the population of firms, the variables employed and its distribution.

The following tables show the distribution of firms according to their size and participation in the Intek programme between 2001 and 2004. Therefore, we can appreciate the size distribution of the subsidized firms and of those firms with R&D activities that have not participated in the Intek programme. Data shows that the most subsidized firms are small and medium (SMEs), with less than 151 employees. The number of micro-SMEs receiving funds is remarkable. In terms of non-subsidized firms with R&D activities a similar distribution is noted. This distribution reflects the distribution by size of firms' population in the Basque Country, according to the figures presented in chapter 7. The non-subsidized but innovative[21] firms' distribution by size is very similar to that obtained for subsidized firms. Therefore, it is a variable suitable to be incorporated as a control variable in subsequent econometric analyses.

[21] In this thesis we use the term innovative in a restricted way and referring to firms with R&D activities.

Table 8-1: Distribution of subsidized firms by size

Firms subsidized in 2001-2004		
Size	**Number of firms**	**% firms**
Less or 10 employees	139	19.07%
Between 11 and 50 employees	271	37.17%
Between 51 and 150 employees	178	24.42%
Between 151 and 250 employees	55	7.54%
More than 250 employees	86	11.80%
Total	**729**	**100.00%**

Source: Own elaboration: Data from SPRI and EUSTAT.

Table 8-2: Distribution of firms with R&D activities by size

Firms with R&D activities in 2001-2004		
Size	**Number of firms**	**% firms**
Less or 10 employees	233	18.52%
Between 11 and 50 employees	515	40.94%
Between 51 and 150 employees	290	23.05%
Between 151 and 250 employees	100	7.95%
More than 250 employees	120	9.54%
Total	**1258**	**100.00%**

Source: Own elaboration: Data from EUSTAT.

In addition, the following tables show the distribution of firms in technology groups[22] for those firms that have been subsidized by the Intek programme between 2001 and 2004 and for those that have not been subsidized but that are carrying out R&D activities, which will compose the control group in the following analyses.

We can note that the most subsidized firms belong to medium-high and medium-low technology groups with regards to manufacturing and knowledge intensive services. This distribution is similar for the group of firms that have carried out R&D activities during this period but have not been subsidized by the Intek programme. Therefore, there seems to be a correlation between medium-technology and knowledge-intensive services with the probability of carrying out R&D activities. The similarities between both groups of firms are remarkable, which allows us to use this variable as a control variable in subsequent analyses.

[22] In Annex 2 a list of the industries and their corresponding technology group is shown, according to the classification provided by Eurostat and OECD.

Table 8-3: Distribution of subsidized firms in technology groups

Firms subsidized in 2001-2004			
Technology Groups	**Labels**	**Number of firms**	**% firms**
Other industries	010	28	3.84%
High Technology	020	39	5.35%
Medium-High Technology	040	187	25.65%
Medium-Low Technology	060	171	23.46%
Low Technology	080	48	6.58%
Knowledge-Intensive Services	100	197	27.02%
Other Knowledge-Intensive Services	120	19	2.61%
Less Knowledge-Intensive Services	140	40	5.49%
Total		**729**	**100.00%**

Source: Own elaboration: Data from SPRI and EUSTAT.

Table 8-4: Distribution of firms with R&D activities in technology groups

Firms with R&D activities in 2001-2004			
Technology Groups	**Labels**	**Number of firms**	**% firms**
Other industries	010	50	3.97%
High Technology	020	61	4.85%
Medium-High Technology	040	308	24.48%
Medium-Low Technology	060	296	23.53%
Low Technology	080	111	8.82%
Knowledge-Intensive Services	100	318	25.28%
Other Knowledge-Intensive Services	120	29	2.31%
Less Knowledge-Intensive Services	140	85	6.76%
Total		**1258**	**100.00%**

Source: Own elaboration: Data from EUSTAT.

If we focus our analyses on subsidized firms and subsidies received by firms during the analysed period we can note that most SMEs have received between 10.000 and 150.000 Euros. On the other hand, more than half of the big firms subsidized have received more than 250.000 Euros. Therefore, it seems that subsidies received are correlated with firms' size.

Table 8-5: Distribution of subsidies by size

Firms Subsidized in 2001-2004 (number and percentage)					
Subsidy received/ Firm Size	**<=10 employees**	**10-50 employees**	**51-150 employees**	**151-250 employees**	**>250 employees**
<10.000	28 (3.84%)	30 (4.12%)	9 (1.23%)	2 (0.27%)	7 (0.96%)
10.000-50.000	61 (8.70%)	116 (15.91%)	68 (9.33%)	15 (2.06%)	12 (1.65%)
50.000-150.000	42 (6.56%)	73 (10.01%)	68 (9.33%)	23 (3.16%)	21(2.88%)
>150.000	8 (1.34%)	52 (7.13%)	33 (4.53%)	15 (2.06%)	46 (6.31%)
Total	**139 (19.07%)**	**271 (37.17%)**	**178 (24.42%)**	**55 (7.54%)**	**86 (11.80%)**

Source: Own elaboration: Data from SPRI and EUSTAT.

With regard to subsidies received by firms during the analysed period and their belonging to a certain technology group, we can also see a correlation between technology groups and the level of subsidy received. Firms in medium-technology and knowledge-intensive groups have received more subsidies in the analysed period than those belonging to other groups (low-technology or less knowledge-intensive).

Table 8-6: Distribution of subsidized firms by technology group

Firms Subsidized in 2001-2004 (number and percentage)								
Subsidy received/ Technology Group	**Other industries**	**High Technology**	**Medium-High Technology**	**Medium-Low Technology**	**Low Technology**	**Knowledge-Intensive Services**	**Other Knowledge-Intensive Services**	**Less Knowledge-Intensive Services**
<10.000	5 (0.69%)	2 (0.27%)	11 (1.51%)	20 (2.74%)	5 (0.69%)	23 (3.16%)	7 (0.96%)	4 (0.55%)
10.000-50.000	11 (1.51%)	11 (1.51%)	65 (8.92%)	63 (8.64%)	28 (3.84%)	69 (9.47%)	4 (0.55%)	20 (2.74%)
50.000-150.000	11 (1.51%)	11 (1.51%)	62 (8.50%)	60 (8.23%)	9 (1.23%)	57 (7.82%)	7 (0.96%)	10 (1.37%)
>150.000	1 (0.14%)	15 (2.06%)	49 (6.72%)	28 (3.84%)	6 (0.82%)	48 (6.58%)	1 (0.14%)	6 (0.82%)
Total	**28 (3.84%)**	**39 (5.35%)**	**187 (25.65%)**	**171 (23.46%)**	**48 (6.58%)**	**197 (27.02%)**	**19 (2.61%)**	**40 (5.49%)**

Source: Own elaboration: Data from EUSTAT.

In addition, the next tables show the distribution of firms in these two groups by both size and technology group. Comparing both groups we can see some similarities in the distribution of firms. Thus, firms below 50 employees in both groups are more likely to belong to knowledge-intensive services whereas firms with over 50 employees are more likely to belong to medium-high or medium-low technology groups.

Table 8-7: Distribution of subsidized firms by size and technology group

Firms subsidized in 2001-2004 (number and percentage)								
Firm size/ Technology Group	Other industries	High Technology	Medium-High Technology	Medium-Low Technology	Low Technology	Knowledge-Intensive Services	Other Knowledge-Intensive Services	Less Knowledge-Intensive Services
<=10 employees	3 (0.41%)	8 (1.10%)	13 (1.78%)	11 (1.51%)	4 (0.55%)	75 (10.29%)	10 (1.37%)	15 (2.06%)
10-50 employees	12 (1.65%)	14 (1.92%)	54 (7.41%)	59 (8.09%)	20 (2.74%)	88 (12.07%)	5 (0.69%)	19 (2.61%)
50-150 employees	8 (1.10%)	9 (1.23%)	66 (9.05%)	51 (7.00%)	17 (2.33%)	22 (3.02%)	2 (0.27%)	3 (0.41%)
150-250 employees	1 (0.14%)	3 (0.41%)	25 (3.43%)	17 (2.33%)	3 (0.41%)	6 (0.82%)	0 (0.00%)	0
>250 employees	4 (0.55%)	5 (0.69%)	29 (3.98%)	33 (4.53%)	4 (0.55%)	6 (0.82%)	2 (0.27%)	3 (0.41%)
Total	**28 (3.84%)**	**39 (5.35%)**	**187 (25.65%)**	**171 (23.46%)**	**48 (6.58%)**	**197 (27.02%)**	**19 (2.61%)**	**40 (5.49%)**

Source: Own elaboration: Data from SPRI and EUSTAT.

Table 8-8: Distribution of firms with R&D activities by size and technology group

Firms with R&D Activities in 2001-2004 (number and percentage)								
Firm size/ Technology Group	Other industries	High Technology	Medium-High Technology	Medium-Low Technology	Low Technology	Knowledge-Intensive Services	Other Knowledge-Intensive Services	Less Knowledge-Intensive Services
<=10 employees	6 (0.48%)	10 (0.79%)	24 (1.91%)	17 (1.35%)	10 (0.79%)	125 (9.94%)	12 (0.95%)	29 (2.31%)
10-50 employees	22 (1.75%)	29 (2.31%)	106 (8.43%)	114 (9.06%)	49 (3.90%)	145 (11.53%)	9 (0.72%)	41 (3.26%)
50-150 employees	13 (1.03%)	11 (0.87%)	103 (8.19%)	87 (6.92%)	35 (2.78%)	26 (2.07%)	5 (0.40%)	10 (0.79%)
150-250 employees	2 (0.16%)	5 (0.40%)	38 (3.02%)	33 (2.62%)	10 (0.79%)	12 (0.95%)	0 (0%)	0 (0%)
>250 employees	7 (0.56%)	6 (0.48%)	37 (2.94%)	45 (3.58%)	7 (0.56%)	10 (0.79%)	3 (0.24%)	5 (0.40%)
Total	**50 (3.97%)**	**61 (4.85%)**	**308 (24.48%)**	**296 (23.53%)**	**111 (8.82%)**	**318 (25.28%)**	**29 (2.31%)**	**85 (6.76%)**

Source: Own elaboration: Data from EUSTAT.

In addition to the descriptive figures of the firms included in both groups (subsidized and non-subsidized but innovative firms) we provide more details about other variables that will be relevant to the subsequent analyses carried out in this research. In the next table we see the distribution of multinational firms and firms with systematic R&D activities among the subsidized and non-subsidized firms by size. We also offer some data about the number of firms that have participated in the programme with individual or collaborative projects according to their size.

With regard to multinational firms (firms with international private capital), we note that both subsidized and non-subsidized firms show similar distribution by size. The medium-sized firms (between 51 and 150 employees) and the largest firms (with more than 250 employees) are those with more international capital participation. Regarding the systematization of R&D activities, there are also similarities between subsidized and non-subsidized firms; in particular, the small firms in both groups carry out R&D activities systematically. However, the subsidized micro-firms notably carry out R&D activities more systematically than the non-subsidized ones. We will also employ these two variables (multinational firms and systematization of R&D activities) as control variables. Finally, most subsidized firms (near 70%) have participated in the Intek programme with an individual project as opposed to a collaborative one.

Table 8-9: Distribution of firms by other variables and size

Firms subsidized in 2001-2004					Innovative firms but not subsidized by the Intek Programme in 2001-2004 (control group)		
Firm size/Variables	Number of multinational (% over total firms)	Number of firms with systematic R&D activities (% over total firms)	Number of subsidized firms following a collaborative scheme (%over total subsidized firms)	Number of subsidized firms following an individual (%over total subsidized firms)	Firm size/ Variables	Number of multinational (% over total firms)	Number of firms with systematic R&D activities (% over total firms)
<=10 employees	4 (0,55%)	88 (12.07%)	105 (20.71%)	34 (15.32%)	**<=10 employees**	3 (0.41%)	56 (7.68%)
11-50 employees	13 (1.78%)	180 (24.69%)	186 (36.69%)	85 (38.29%)	**10-50 employees**	10 (1.37%)	160 (21.95%)
51-150 employees	28 (3.84%)	130 (17.83%)	108 (21.30%)	70 (31.53%)	**50-150 employees**	22 (3.02%)	80 (10.97%)
151-250 employees	10 (1.37%)	45 (6.17%)	37 (7.30%)	18 (8.11%)	**150-250 employees**	9 (1.23%)	34 (4.66%)
>250 employees	16 (2.19%)	77 (10.56%)	71 (14%)	15 (6.76%)	**>250 employees**	13 (1.78%)	27 (3.70%)
Total	**71 (9.74%)**	**520 (71.33%)**	**507 (69.55%)**	**222 (30.45%)**	**Total**	**57 (7.82%)**	**357 (48.97%)**

Source: Own elaboration: Data from SPRI and EUSTAT.

Finally, it is important to point out that all the different output variables employed in the subsequent econometric analyses have been transformed into logarithms due to their distributions' shape. Specifically, an analysis of their skewness and kurtosis coefficient is shown in annex 3, jointly with some figures that provide an initial approach to the output variables. In addition, in annex 4 the correlation matrix of all the employed variables can be found. With all these descriptive data analyses we can offer an initial understanding of firms that have participated in the Intek programme between 2001 and 2004 and firms that have carried out R&D activities but have not received subsidies from the Intek programme. However, due to the high dispersion of the employed variables, we cannot identify any reliable conclusions from this analysis. Therefore, in the next section we show the results from an econometric analysis carried out with regressions in order to point out some correlation and explicative results.

8.2 RESULTS FROM THE ECONOMETRIC REGRESSIONS

After the descriptive analysis of the overall population of firms that will be included in the research and before showing the results from the matching procedure, we have analysed data with econometric regressions in order to survey relationships between variables. We have split the analysis following the same structure as the defined hypotheses. Therefore, we have econometric regressions for analysing relations between being subsidized and variables related to input, output and behavioural additionality and between being subsidized and collaboration. In the next sections we show the results from these regressions.

8.2.1 Results from Regressions with regards to Input Additionality

With regards to input additionality we have run three regression models in order to analyse the relationship between different variables and how they relate to input additionality:

1) **TOT_R&D_EXP**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βR&D_SIST+ βSUBS+ βEXT_FUND
2) **R&D_EMPL**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βR&D_SIST+ βSUBS+ βEXT_FUND
3) **PHDs**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βR&D_SIST+ βSUBS+ βEXT_FUND

Relationships between subsidies and R&D expenditure would support the hypotheses defined around a positive effect of subsidies on firms' R&D input. In addition, a positive effect of subsidies on firms' R&D employees (including PhDs) would be an indicator of the programme's input additionality. Furthermore, these models will provide inputs on the analysis of external funding influence on firms. This 'external funding' is defined as the R&D funding that firms receive from other administrative levels that are separate from the regional government and excluding the European level. That is to say, local and/or national subsidies.

Table 8-10: Regression models and input additionality

	Total private R&D Expenditure (log)	R&D employees in the Basque Country (FTE) (log)	Number of PhDs in the firm (log)
(Intercept)	1.033124***	-0.1167068**	-0.0473058*
	(0.094633)	(0.0359401)	(0.0193683)
GROUP_TEC010	0.008053	0.046601	0.0012737
	(0.130682)	(0.0496308)	(0.0267463)
GROUP_TEC020	0.067701	0.0006298	0.0264744
	(0.123472)	(0.0468929)	(0.0252708)
GROUP_TEC040	0.041294	-0.0324021	0.0111953
	(0.091099)	(0.034598)	(0.018645)
GROUP_TEC060	0.022427	-0.0303052	-0.0111372
	(0.091412)	(0.0347168)	(0.018709)
GROUP_TEC080	0.064561	-0.0629365	0.0036391
	(0.105854)	(0.0402018)	(0.0216649)
GROUP_TEC100	-0.014521	0.0147367	0.0268629
	(0.089666)	(0.0340539)	(0.0183518)
GROUP_TEC120	-0.15464	-0.0285801	0.0483587
	(0.156672)	(0.0595018)	(0.0320658)
R&D SIST.	-0.064662	-0.0002014	0.0015117
	(0.046512)	(0.0176644)	(0.0095195)
MULTINATIONAL	0.110106	0.0217967	0.004298
	(0.070475)	(0.0267654)	(0.014424)
EMPLOYMENT	-0.039813	0.045872**	0.0215309**
	(0.038498)	(0.0146209)	(0.0078793)
SUBSIDIES	-0.022145*	0.0025223	-0.0006289
(INTEK PROGRAMME)	(0.009381)	(0.0035627)	(0.0019199)
EXTERNAL FUNDING	1.032434***	0.3781575***	0.0336926***
	(0.020138)	(0.0076482)	(0.0041216)
Adjusted R squared	0.7232	0.7295	0.08394

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Source: Own elaboration: Data from SPRI and EUSTAT.

The above table shows the results from the regressions related to the programme's input additionality. The adjusted R squared show some significant models, related to firms' total R&D expenditure, R&D employees (in full-time equivalent (FTE)) and less significant for firms' PhD numbers. Taking this into consideration, we can extract some conclusions from the analyses carried out. Although firms' size, subsidies and external funding are the only significant variables for explaining the three dependent variables, we explain the results obtained in detail.

First of all, in terms of firms' R&D systematization, although none of the coefficients are significant, we note a positive correlation only for the number of PhDs in firms. These results support the idea of the need for a minimum personnel structure in firms for systematic R&D activities. However, the results show a negative correlation between R&D systematization and the other variables, especially the ones related to expenditures. These findings seem to support a crowding-out effect of programmes in terms of non-supporting R&D activities in a long-term period. This effect will be analysed in detail in the next section, when matching techniques are applied.

In addition, we can highlight a positive but non-significant relationship between international ownership (more than 50%) and all the input variables, which could support the multinational effect on firms' resources for R&D.

In terms of size (measure by number of workers) we found a positive and significant correlation with R&D employees in FTE in the Basque Country (significance level 0.001) and PhDs in the firm (significance level 0.001). Consequently, R&D human resources are positively correlated with firms' size. There is a negative (and non-significant) correlation with R&D total expenditures, which leads us to think that a larger expenditure among small and medium firms (as opposed to large ones) may be due to the relatively small average size of Basque firms.

With regard to subsidies received by the Intek programme, although we expect a positive and significant correlation with all the input variables, we only found a positive (but non-significant) correlation with R&D employees in FTE. On the contrary, we found that subsidies received by the Intek programme were negatively correlated with total private R&D expenditure (significant at 0.01 level). This suggests a crowding-out effect of the programme or a negative input additionality. In addition, we found a negative but non-significant correlation between subsidies and the number of PhDs in firms, which also might imply a crowding-out effect.

Finally, we found a positive and significant correlation (0 level of significance) for the relationship between external funding and all the input variables. These results suggest an input additionality in firms due to the rest of programmes apart from the regional ones, maybe due to the average subsidy's size. We will analyse these results in detail in the section related to matching procedure.

To sum up, the results suggest a crowding-out effect of the Intek Programme on firms' inputs. This is contrary to the thinking of an input additionality effect. Nevertheless, this effect seems to take place due to other external funding, such as, national programmes.

8.2.2 Results from Regressions with regards to Output Additionality

In this section we will highlight and analyse the results obtained from four regression models in which we analysed the relationship between Intek subsidies and output additionality and also between other subsidies and output additionality. The study centred around firms in the Basque Country that had carried out R&D activities between 2001 and 2004. The variables used for measuring output additionality are R&D intensity, productivity and patents (number and probability) in the subsequent period of analysis (2005-onwards):

1) **R&D_INT**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βEXT_FUND
2) **PRODUCT**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βEXT_FUND
3) **PAT_NUM**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βEXT_FUND
4) **PAT_PROB**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βEXT_FUND

Table 8-11: Regression models and output additionality

	R&D Intensity	Productivity (log)	Patents(num)	Patent (prob)
(Intercept)	0.1359649*** (0.0396733)	1.07766*** (0.150028)	-0.17387* (0.07556)	-0.047676. (0.026538)
GROUP_TEC010	0.0024858 (0.0547861)	-0.491939* (0.207178)	-0.11583 (0.10434)	-0.035427 (0.036647)
GROUP_TEC020	-0.0223869 (0.0517638)	-0.217208 (0.195749)	0.03008 (0.09859)	0.030098 (0.034625)
GROUP_TEC040	0.0019205 (0.0381918)	0.037135 (0.144425)	-0.06696 (0.07274)	-0.044558. (0.025547)
GROUP_TEC060	0.0009025 (0.0383229)	0.006523 (0.144921)	-0.06213 (0.07299)	-0.033119 (0.025634)
GROUP_TEC080	-0.0188266 (0.0443776)	-0.011527* (0.167818)	-0.117 (0.08452)	-0.054467. (0.029684)
GROUP_TEC100	0.1012411** (0.0375912)	-0.29951 (0.142154)	-0.09062 (0.0716)	-0.044178. (0.025145)
GROUP_TEC120	0.0845641 (0.0656824)	-0.02128 (0.248383)	-0.1483 (0.1251)	-0.072711. (0.043935)
R&D SIST.	0.0457456*	0.319861***	0.05014	0.027954*

	R&D Intensity	Productivity (log)	Patents(num)	Patent (prob)
	(0.0194993)	(0.073738)	(0.03714)	(0.013043)
MULTINATIONAL	-0.0085644	-0.129033	-0.07556	-0.022545
	(0.0295456)	(0.111729)	(0.05627)	(0.019763)
EMPLOYMENT	-0.100554***	0.190867**	0.13664***	0.0479***
	(0.0161396)	(0.061033)	(0.03074)	(0.010796)
SUBSIDIES	-0.0043625	0.022569	0.01819*	0.007389**
(INTEK PROGRAMME)	(0.0039327)	(0.014872)	(0.00749)	(0.002631)
EXTERNAL FUNDING	0.0710392***	0.326077***	0.04838**	0.016349**
	(0.0084426)	(0.031926)	(0.01608)	(0.005647)
Adjusted R squared	0.1315	0.1615	0.04812	0.05819

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Source: Own elaboration: Data from SPRI and EUSTAT.

The regression models illustrated in the previous table give an initial view of the correlation between subsidies and output variables although adjusted R squared are not extremely high for all the models. We will explain in detail all the results in the following paraghaps, even if they are not significant.

In particular, we found a positive and significant correlation between R&D systematization and R&D intensity (at 0.01 level of significance), productivity (at 0 level of significance) and probability of patent (at 0.01 level of significance) and a positive but non-significant relation between R&D systematization and number of patents registered by firms in the subsequent period. These results suggest a positive effect of systematization of R&D activities on innovation and economic outputs.

Furthermore, regression models reveal a negative but non-significant correlation between multinational companies, innovation and economic outputs, which could reflect the effect of delocalization of R&D activities to headquarters located outside the Basque Country.

In terms of size, we found a positive and significant correlation between innovative firms’ size and productivity (at 0.001 level of significance), number of patents (at 0 level of significance) and probability to patent (at 0 level of significant). However, we found a negative correlation between size and R&D intensity (significant at 0 level), which suggest a low R&D intensity in the largest firms. Nevertheless, in general it seems to be a positive relation between firm size, innovation and economic outputs.

With regard to subsidies received by the Intek programme in the period 2001-2004, their effect on firms' output in the subsequent period seems to be positive in terms of productivity (but not significant), patents (significant at 0.01 level) and probability of patent (at 0.001 level of significance), and negative (but non-significant) in terms of R&D intensity. The positive effects suggest an output additionality of the Intek programme. The negative effect on R&D intensity could be explained by the crowding-out effect on total R&D expenditures as this is the ratio between these expenditures and firms' sales.

Finally, regarding the other R&D funding programmes firms have received during the same period, we found a positive correlation with all the output variables. These correlations are significant for all the variables at different levels, but again, they suggest R&D subsidies that do not come from the Intek progremme have a positive effect on firms.

Therefore, R&D programmes seem to create output additionality in firms. The particular programme we are analysing also creates this additionality (except for R&D intensity) although in a lower level than the rest of programmes as a whole.

8.2.3 Results from Regressions with regards to Behavioural Additionality

In addition to the models explained above, we ran three regression models to evaluate the relevance of R&D funding and Intek programme on firms' behaviour.

1) **CHANGE_R&D_SIST**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βEXT_FUND
2) **EU_FUNDS**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βEXT_FUND
3) **PHD_EMPLOY**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βEXT_FUND

These analyses will provide an initial assessment of the programme's behavioural additionality, which has been measured, for this case, in terms of change in the systematization of R&D activities; participation in EU funded projects and the ratio between PhDs and total employment, all of them in the after-funded-period.

Table 8-12: Regression models and behavioural additionality

	Change in systematization of R&D activities	Participation in EU funded projects (log)	PhDs/total employment
(Intercept)	0.271583***	-0.205177**	0.285619***
	(0.055374)	(0.063921)	0.06548
GROUP_TEC010	0.118892	0.056942	-0.089196
	(0.076467)	(0.08827)	0.090424
GROUP_TEC020	0.08139	-0.177887*	-0.174623*
	(0.072249)	(0.0834)	0.085435
GROUP_TEC040	0.045191	-0.072953	0.018011
	(0.053306)	(0.061533)	0.063035
GROUP_TEC060	0.028654	-0.074661	0.003375
	(0.053489)	(0.061745)	0.063251
GROUP_TEC080	-0.006197	-0.057141	0.063912
	(0.06194)	(0.0715)	(0.073245)
GROUP_TEC100	0.086725.	0.052858	-0.049807
	(0.052468)	(0.060566)	(0.062044)
GROUP_TEC120	0.099229	0.155155	-0.023012
	(0.091676)	(0.105826)	(0.108408)
R&D SIST.	-0.022535	0.016752	-0.042722
	(0.027216)	(0.031417)	(0.032183)
MULTINATIONAL	0.028355	-0.029956	0.001282
	(0.041238)	(0.047603)	(0.048765)
EMPLOYMENT	0.017047	0.104237***	-0.171035***
	(0.022527)	(0.026004)	(0.026638)
SUBSIDIES	-0.010623.	-0.000151	-0.013367*
(INTEK PROGRAMME)	(0.005489)	(0.006336)	(0.006491)
EXTERNAL FUNDING	-0.056874***	-0.000151***	-0.088517***
	(0.011784)	(0.006336)	(0.013934)
Adjusted R squared	0.02674	0.1873	0.1135

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Source: Own elaboration: Data from SPRI and EUSTAT.

In the table above we show the results obtained from the three regression models. They reveal a low adjusted R squared. Although these are not high levels, these models give us some early conclusions about firms' behaviour. In particular, we found that size and external funding are negative correlated with the three dependent variables. However, we will explain in detail all the obtained results.

First of all, these results reveal a positive and non-significant correlation between R&D systematization and participation in R&D projects. They demonstrate a negative and non-significant correlation between R&D systematization and change in systematization of R&D activities (which was expected) and specialization of R&D personnel.

With regard to firms with international ownership, there is a positive and non-significant relation with change in systematization of R&D activities and R&D specialization but a negative (and non-significant correlation) between these firms and their participation in UE R&D funded projects. This last result seems to be contradictory as multinational firms are, *a priori*, best positioned to participate in EU projects. However, they are also best positioned to collaborate among different firms' subsidiaries.

As expected, there is a positive correlation between firm size and change in systematization of R&D activities (non-significant) and participation in EU funded projects (significant at 0 level) but a negative correlation between size and R&D personnel specialization. This last result suggests a higher specialization in smaller firms.

A first analysis of the correlation between subsidies received from the Intek programme and firms' behaviour reveal a crowding-out effect in terms of behavioural additionality. There is a negative correlation between subsidies from the Intek programme and change in systematization of R&D activities (significant at 0.05 level), participation in EU funded projects (non-significant) and R&D personnel specialization (significant at 0.01 level). Although these results will be further analysed employing a matching procedure, a possible explanation for this negative effect of the programme would be the lack of a larger time period in which to analyse these behavioural effects or even to carry out a change in learning processes in firms reflected in behaviour.

The external funding results are very similar to the ones just explained. That is to say, we found a negative (and significant at 0 level for all the explained variables) correlation between external R&D funding (from national and local programmes) and change in systematization of R&D activities, participation in EU funded projects and specialization of R&D personnel (ratio between PhDs in the firms and total employment).

These results reveal a crowding-out effect in terms of behavioural additionality. These could be due to several reasons that will be further explained later, but as a first analysis, they might concern the inadequacy of instruments or the characteristics of expected behaviours that might need a longer period of time to be developed through learning processes in firms.

8.2.4 Results from Regressions with regards to Collaboration

In the previous sections we provided an initial assessment of input, output and behavioural additionality of the Intek programme through regression models. In this section, we would like to complete the analysis by adding to the equation a dependent variable that explains the collaborative attitude of firms within the Intek programme. These regressions have been run for all the innovative firms' population (those that carried out R&D activities). In addition, we have also analysed the different collaboration patterns found in firms. For that purpose we have built seven regression models in which the dependent variable corresponds to different collaboration modes (only contractual and transactional) through external expenditures in R&D in firms.

1) **TOT_EXT_EXP**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
2) **TECH_CENTRES**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
3) **OTHER_FIRMS**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
4) **PUBLIC_ADM**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
5) **PRIV_INST**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
6) **FOREIGN_FIRMS**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
7) **UNIV**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND

Table 8-13: Regression models and collaboration

	Total external expenditure (log)	External expenditure in technological centres (log)	External expenditure in other firms (log)	External expenditure in Public Administrations (log)	External expenditure in private institutions (log)	External expenditure in foreign firms (log)	External expenditure in universities (log)
(Intercept)	-0.63052	-0.88434*	-0.44531	0.010145	-0.154807	-0.71631**	-0.360763
	(0.39631)	(0.34987)	(0.37628)	(0.095587)	(0.158764)	(0.24105)	(0.226703)
GROUP_TEC010	0.03182	0.06111	-0.07873	0.2715***	0.139931	0.31785*	0.299239*
	(0.266)	(0.23483)	(0.25255)	(0.064155)	(0.106559)	(0.16179)	(0.152158)
GROUP_TEC020	0.14523	0.04727	0.20297	0.019688	0.034949	-0.07118	0.07928
	(0.2436)	(0.21505)	(0.23129)	(0.058754)	(0.097587)	(0.14816)	(0.139347)
GROUP_TEC040	-0.11221	0.0165	-0.31719.	0.031539	-0.088845	0.11689	-0.003796
	(0.19047)	(0.16815)	(0.18084)	(0.045939)	(0.076302)	(0.11585)	(0.108954)
GROUP_TEC060	-0.18683	-0.04344	-0.32095.	-0.025929	-0.149456.	0.01903	-0.053709
	(0.1912)	(0.1688)	(0.18154)	(0.046116)	(0.076596)	(0.11629)	(0.109373)
GROUP_TEC080	-0.24467	-0.06034	-0.47752*	-0.02404	-0.11119	-0.08357	-0.0445
	(0.23068)	(0.20364)	(0.21902)	(0.055637)	(0.092409)	(0.1403)	(0.131954)
GROUP_TEC100	-0.28343	-0.24677	-0.26742	-0.006832	-0.06411	-0.04228	0.001802
	(0.18641)	(0.16457)	(0.17699)	(0.044961)	(0.074678)	(0.11338)	(0.106635)
GROUP_TEC120	-0.14188	-0.02408	-0.3948	-0.018358	-0.122827	-0.02461	-0.131267
	(0.29839)	(0.26343)	(0.28331)	(0.07197)	(0.119538)	(0.18149)	(0.170691)
R&D SIST.	0.11242	0.02711	0.15217.	0.016389	-0.026754	0.0521	-0.029137
	(0.0933)	(0.08237)	(0.08859)	(0.022503)	(0.037377)	(0.05675)	(0.053371)
MULTINATIONAL	-0.1522	-0.1211	-0.16754	-0.004787	0.004418	0.09179	-0.152821.
	(0.13696)	(0.12091)	(0.13004)	(0.033034)	(0.054868)	(0.0833)	(0.078347)
EMPLOYMENT	0.30907***	0.06711	0.44709***	0.029256	0.075103*	0.16027***	0.094983*
	(0.07447)	(0.06574)	(0.07071)	(0.017962)	(0.029834)	(0.0453)	(0.0426)
SUBSIDIES (INTEK PROGRAMME)	0.17944*	0.20235	0.05303	-0.020151	0.035008	0.08824	0.056605
	(0.08875)	(0.07835)	(0.08427)	(0.021406)	(0.035555)	(0.05398)	(0.05077)
COLLABORATION IN R&D PROJECTS (INTEK PROGRAMME)	0.17643.	0.39663***	0.0229	0.020838	-0.024253	0.01386	0.01718
	(0.09355)	(0.08259)	(0.08882)	(0.022564)	(0.037477)	(0.0569)	(0.053514)
EXTERNAL FUNDING	0.4286***	0.36730***	0.25144***	0.030836**	0.056057***	0.10954***	0.16115***
	(0.03941)	(0.03479)	(0.03742)	(0.009505)	(0.015786)	(0.02397)	(0.022542)
Adjusted R squared	0.2985	0.27	0.208	0.05947	0.05591	0.1226	0.1317

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Source: Own elaboration: Data from SPRI and EUSTAT.

The table above shows the results from the analysis of external expenditures in R&D and the variables we considered as a proxy for collaboration in R&D activities. As is reflected in the table, the adjusted Rs squared obtained from the models are not very high but are sufficient for providing an early assessment of these external expenditures that will be completed in the following sections. In particular, size and external funding seems to be the most explicative variables for all the equations. However, we explain the results in detail in the following paragraphs.

We found a positive correlation between firms' R&D systematization and total external expenditure, external expenditure in technological centres, expenditure in other firms (significant at 0.05 level), external expenditure in public administration and external expenditure in foreign firms. On the contrary, there is a negative and non-significant correlation between R&D systematization and external expenditure in non-profit and private institutions and also external expenditure in universities, which seems to be related to more isolated collaborations.

With regards to firms with foreign ownership and their external expenditure in R&D, we found a positive correlation (but non-significant) in external expenditure in private non-profit institutions and foreign firms and a negative correlation for the rest of the explicative variables (only significant in the case of external expenditures in universities). This suggests that firms with foreign ownership already have the required competences in-house and do not consider it necessary to subcontract R&D activities except to their subsidiaries.

Firms size and its relation with external expenditure was also analysed through these models. We found a positive correlation between firm size and external expenditure in all types of organisation. This relation is highly significant (at 0 level) for total external expenditure, external expenditure in other firms and in foreign firms; less significant (at 0.01 level) for external expenditure in non-profit and private institutions and for external expenditure in universities; and non-significant for the rest of external expenditures (in technological centres and public administrations). These results suggest that the largest firms have more resources to invest in external organisations (subcontracting R&D activities).

With regard to subsidies and external expenditures the correlation is positive for most of the dependent variables (except for the expenditure in public administrations) and significant only in the case of total expenditure. These results suggest that in some cases subsidized projects involve external expenditure that remains constant over time.

In terms of collaboration projects in the Intek programme and the external expenditure carried out in the subsequent years we found positive correlation in almost all the models. We found a positive and significant correlation between collaboration in R&D projects within the Intek programme and external expenditure in technological centres and also with regards to total external expenditure. There is also a positive but non-significant correlation in external expenditure in other firms, foreign firms, universities and public administration. Finally, results show a negative and non-significant correlation between collaboration in Intek projects and external expenditure in private and non-profit firms. Thus, it seems that the collaboration in the Intek programme is encouraging collaboration through external expenditures in the subsequent years, especially in technological centres.

Finally, concerning external R&D funding from national and local programmes and external expenditure, we found a positive and significant (at different levels) correlation among them. That is to say that external funding is promoting long-term contractual relationships in R&D in all types of organisations (especially in technological centres).

In summary, collaborative projects seem to be one source of enhancing contractual collaboration among different organisations, especially between firms and technological centres. However, we also note an effect of other established programmes (national/local) in these kinds of contractual-links.

8.2.4.1 Results from Regressions with regards to Collaboration and Input Additionality

This section analyses the relationship between collaboration in the Intek R&D projects and the variables used for analysing input additionality. We ran the same models as in section 8.2.1, but added the collaborative R&D project variables. With this addition we improved two out of three models, as their adjusted R-squared are higher. The unimproved model is that which refers to the number of PhDs in-firm.

1) **TOT_R&D_EXP** = α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
2) **R&D_EMPL**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
3) **PHDs**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND

As correlation among previously included dependent-variables and explicative variables do not vary excessively from the previous analysis, we only highlight the results from the collaboration-side. These are those referring to the correlation between collaboration in R&D projects within the Intek programme and the input variables. In this context, we noted that collaboration in Intek's R&D projects are positively correlated with total private R&D expenditure (significant at 0.05 level) and negatively correlated with R&D employees in FTE and the number of PhDs in the firms.

As mentioned in section 6.2.1., it seems there is a crowding-out effect in terms of Intek subsidies and total private R&D expenditure but this effect might be larger in individual projects than collaborative ones. Collaborative projects seem to be positively correlated with the total private R&D expenditures. Therefore, it seems that collaborative projects lead to larger input additionality than individual ones, but this will be analysed in detail within the matching protocol.

Table 8-14: Regression models and collaboration: input additionality

	Total private R&D Expenditure (log)	R&D employees in the Basque Country (FTE) (log)	Number of PhDs in the firm (log)
(Intercept)	1.459877***	-0.227248*	-0.124736.
	(0.236585)	(0.104144)	(0.064316)
GROUP_TEC010	-0.195969	0.0901	-0.015147
	(0.15879)	(0.069899)	(0.043167)
GROUP_TEC020	-0.013011	0.001895	0.023463
	(0.14542)	(0.064013)	(0.039533)
GROUP_TEC040	0.015105	0.023615	0.009166
	(0.113703)	(0.050051)	(0.03091)
GROUP_TEC060	0.003179	-0.001195	-0.014609
	(0.114141)	(0.050244)	(0.031029)
GROUP_TEC080	-0.116797	-0.081033	0.00434
	(0.137705)	(0.060617)	(0.037435)
GROUP_TEC100	-0.12298	0.046803	0.037787
	(0.111283)	(0.048986)	(0.030252)
GROUP_TEC120	-0.223175	0.022806	0.031026
	(0.178131)	(0.078413)	(0.048425)
R&D SIST.	-0.032788	-0.008627	-0.007721
	(0.055697)	(0.024518)	(0.015141)
FOREIGN OWNERSHIP	-0.029344	0.036249	-0.011603
	(0.081761)	(0.035991)	(0.022227)
EMPLOYMENT	-0.056591	0.040377*	0.021737.
	(0.044457)	(0.01957)	(0.012086)
SUBSIDIES (INTEK PROGRAMME)	-0.113161*	0.020365	0.019593
	(0.052983)	(0.023323)	(0.014403)
COLLABORATION IN R&D PROJECTS (INTEK PROGRAMME)	0.099997.	-0.012104	-0.01286
	(0.055847)	(0.024584)	(0.015182)
EXTERNAL FUNDING	1.047583***	0.388751***	0.031727***
	(0.023524)	(0.010355)	(0.006395)
Adjusted R squared	0.7861	0.7471	0.07376

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Source: Own elaboration: Data from SPRI and EUSTAT.

8.2.4.2 Results from Regressions with regards to Collaboration and Output Additionality

In this section we include collaboration in Intek's R&D projects as an explicative variable into the regression models run in the section 8.2.2. As the next table shows, the only improved model (with a higher adjusted R squared) from the previous ones relates to productivity. However, these models reveal some early assessments about the role of collaborative projects and output additionality.

1) **R&D_INT**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
2) **PRODUCT**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
3) **PAT_NUM**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
4) **PAT_PROB**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND

According to these models, collaborative projects within the Intek programme are positively correlated (non-significant) with R&D intensity and patents (number and probability) but negatively correlated with productivity (non-significant). Therefore, it seems that collaborative projects could have a higher relation with R&D intensity and patents than with productivity. As the results are non-significant we cannot conclude anything. We will further analyse this relationship in the section related to matching analysis. Finally, we have to remark that in the model related to R&D intensity, subsidies correlation changed in relation to the one showed in section 8.2.2., from a negative and non-significant coefficient to a positive but still non-significant one.

Table 8-15: Regression models and collaboration: output additionality

	R&D Intensity	Productivity (log)	Patents(num) (log)	Patent (prob)
(Intercept)	0.114995 (0.132817)	1.08933** (0.3962)	-0.53669. (0.27399)	-0.1156694 (0.0908036)
GROUP_TEC010	-0.002028 (0.089144)	-0.26794 (0.26592)	-0.11742 (0.1839)	0.0003859 (0.0609452)
GROUP_TEC020	-0.048819 (0.081638)	-0.17408 (0.24353)	0.0618 (0.16841)	0.0673022 (0.0558138)
GROUP_TEC040	0.026483 (0.063832)	-0.20235 (0.19042)	-0.07686 (0.13168)	-0.0284501 (0.0436402)

	R&D Intensity	Productivity (log)	Patents(num) (log)	Patent (prob)
GROUP_TEC060	-0.003281 (0.064078)	-0.15153 (0.19115)	-0.06461 (0.13219)	-0.0168653 (0.0438083)
GROUP_TEC080	-0.043387 (0.077307)	-0.04949 (0.23061)	-0.15963 (0.15948)	-0.0570024 (0.0528526)
GROUP_TEC100	0.084752 (0.062474)	-0.35892. (0.18636)	-0.09541 (0.12888)	-0.0217645 (0.0427114)
GROUP_TEC120	0.03689 (0.100002)	-0.09799 (0.29831)	-0.10543 (0.2063)	-0.0433433 (0.0683684)
R&D SIST.	0.039874 (0.031268)	0.30145** (0.09327)	0.08349 (0.0645)	0.0445901* (0.0213771)
MULTINATIONAL	-0.007708 (0.0459)	0.09894 (0.13692)	-0.07319 (0.09469)	-0.0203267 (0.0313809)
EMPLOYMENT	-0.142095*** (0.024958)	0.23118** (0.07445)	0.16975** (0.05149)	0.0602539*** (0.017063)
SUBSIDIES (INTEK PROGRAMME)	0.012544 (0.029744)	0.02136 (0.08873)	0.07601 (0.06136)	0.0098709 (0.0203353)
COLLABORATION IN R&D PROJECTS (INTEK PROGRAMME)	0.039717 (0.031352)	-0.02184 (0.09353)	0.01112 (0.06468)	0.0008229 (0.0214346)
EXTERNAL FUNDING	0.06221*** (0.013206)	0.35647*** (0.0394)	0.05097. (0.02724)	0.0197754* (0.0090289)
Adjusted R squared	0.1024	0.2056	0.04589	0.05678

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Source: Own elaboration: Data from SPRI and EUSTAT.

8.2.4.3 Results from Regressions with regards to Collaboration and Behavioural Additionality

In this section we will provide an overview of the relationship between collaborative R&D projects and the three dependent variables related to behavioural additionality analysed in section 8.2.3. By adding this variable none of the three models improved. Nevertheless, we will analyse these relationship as an initial assessment of collaboration.

1) **CHANGE_R&D_SIST**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
2) **EU_FUNDS**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK+ βEXT_FUND
3) **PHD_EMPLOY**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βSUBS+ βINTEK +βEXT_FUND

Therefore, collaboration in Intek's R&D projects is positively correlated with participation in EU funded projects (significant at 0.01 level) and with the ratio between PhDs and firms employees (non-significant). Conversely, we found a negative relationship between collaborative projects and change in systematization of R&D activities (non-significant). As consequence, it seems that firms that have collaborated in the Intek programme are more likely to participate in EU funded projects than those that have not previously collaborated.

It is also interesting that in the improved model (the one explaining participation in EU funded projects), the subsidies relationship has become positive and significant and external funding has also become positively significant with respect to the dependent variable.

All these relationships will be further analysed in the following section, in which a matching procedure is applied.

Table 8-16: Regression models and collaboration: behavioural additionality

	Change in systematization of R&D activities	Participation in UE funded projects (log)	PhDs/total employment
(Intercept)	0.25669. (0.1503)	-0.812201*** (0.211537)	0.805192*** (0.219145)
GROUP_TEC010	0.15454 (0.10088)	0.145526 (0.141978)	-0.231865 (0.147085)
GROUP_TEC020	0.03254 (0.09239)	-0.23884. (0.130024)	-0.306615* (0.134701)
GROUP_TEC040	0.04438 (0.07224)	-0.077324 (0.101665)	0.045752 (0.105321)
GROUP_TEC060	0.05603 (0.07251)	-0.072854 (0.102056)	-0.006697 (0.105727)
GROUP_TEC080	0.07447 (0.08748)	-0.085785 (0.123126)	0.071604 (0.127554)
GROUP_TEC100	0.08384 (0.0707)	0.068825 (0.099501)	-0.051795 (0.103079)
GROUP_TEC120	0.19575. (0.11317)	-0.04317 (0.159272)	-0.08029 (0.165)
R&D SIST.	-0.08275* (0.03538)	0.003728 (0.0498)	-0.016922 (0.051591)
MULTINATIONAL	-0.03275 (0.05194)	0.014074 (0.073105)	-0.00686 (0.075734)
EMPLOYMENT	-0.01332 (0.02824)	0.080594* (0.03975)	-0.186285*** (0.04118)

	Change in systematization of R&D activities	Participation in UE funded projects (log)	PhDs/total employment
SUBSIDIES (INTEK PROGRAMME)	0.01391	0.119722*	-0.122024*
	(0.03366)	(0.047373)	(0.049077)
COLLABORATION IN R&D PROJECTS (INTEK PROGRAMME)	-0.0575	0.104555*	0.021089
	(0.03548)	(0.049934)	(0.05173)
EXTERNAL FUNDING	-0.03882**	0.184473***	-0.087131***
	(0.01495)	(0.021034)	(0.02179)
Adjusted R squared	0.02291	0.2048	0.1292

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Source: Own elaboration: Data from SPRI and EUSTAT.

8.3 RESULTS FROM THE MATCHING PROTOCOL

In this section we show the results obtained from the two models run employing the matching technique. Thus, we have contrasted the hypotheses twice: the first time taking into account the isolated impact of the Intek programme and the second considering the impact of the whole funding system on the subsidized firms. These two models present some differences in results, as we will see in the next sections.

First of all, we show the main results from the matching. Although in annex 5 and annex 6 we provide the matching results in their entirety, here we illustrate the main figures obtained from the matching procedure. In doing this we can distinguish between two pairs of matching procedures. The first pair concerns the matching between firms which received Intek subsidies between 2001 and 2004 and those which did not, but carried out R&D activities. We ran the matching procedure controlling the amount received from the rest of the funding programmes in order to match firms with similar external funds and therefore avoiding subsidy's size effects.

Matching model:

TREATED (participation in Intek)= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βMULTIN+ βEMPLOY+ βR&D_SIST+ βEXT_FUND

We matched 529 firms, as this is the total amount of control firms from our population. Therefore, we have 200 firms unmatched (see table 8-17).

Table 8-17: Matched data for all the firms

	Control	Treated
All	529	729
Matched	529	529
Unmatched	0	200
Discarded	0	0

Source: Own elaboration: Data from SPRI.

Additionally, the second pair of matching is composed of firms which received Intek subsidy, but in this case, we consider the treated group as the one that received a subsidy in collaboration and the control group as the one that participated in isolation. Therefore, in table 8-18, we see that we could match 222 firms, as we did not have enough firms for the control group. We also ran the model controlling for other external funding.

Matching model:

TREATED (collaboration in Intek)= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βMULTIN+ βEMPLOY+ βR&D_SIST+ βEXT_FUND

Table 8-18: Matched data for all the collaborative firms

	Control	Treated
All	222	507
Matched	222	222
Unmatched	0	285
Discarded	0	0

Source: Own elaboration: Data from SPRI.

The matching samples shown in table 8-17 are used to evaluate input, output and behavioural additionality according to the aforementioned hypotheses. The samples in table 8-18 are used to evaluate the effect of such subsidies on firms that have collaborated within the Intek programme, compared with those that received an individual subsidy.

8.3.1 Results with regards to Input Additionality

In the next table we show the results obtained from the input additionality side. We observe the differences in results from the two models (controlling for the rest of programmes, which means analysing the Intek's effect on firms, and not controlling for these programmes, that is to say observing the effect of the whole funding system on firms).

Controlling for the rest of the programmes: Intek's effects

1) **TOT_R&D_EXP**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βEXT_FUND
2) **R&D_EMPL**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βEXT_FUND
3) **PHDs**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βEXT_FUND

Without controlling the rest of the programmes: System effects

4) **TOT_R&D_EXP**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY
5) **R&D_EMPL**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY
6) **PHDs**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY

In table 8-19 we can distinguish between two different results. First of all, we show the expected coefficients from the regressions run considering the different dependent variables and the matched sample. In all the cases we expect a positive correlation between the control variables and the dependent variables. Secondly, we show the difference in averages for each dependent variable between the treated and the control group. We expected a positive difference in all the variables, as we consider a positive effect of the Intek programme on firms. In the first set of results (those referring to the impact of the Intek programme on firms, isolating the effects from other R&D funding programmes) we found a positive expected value, significant in all the cases except for the number of PhDs in firms. Therefore, we expect that this value is higher in the firms funded by the Intek programme. That is to say that we expect a positive difference in the average between the treated and control group. We found that this difference is higher in the treated group than in the control group, especially for R&D employees in the Basque Country (FTE). Nevertheless, for the total private R&D expenditure the effect is higher in the control than in the treated group (although is not significant), which means that the programme is causing a crowding-out effect. This implies that firms would have invested the same amount of R&D expenditures without the Intek's funding. Thus, the programme could not be creating a complementary effect or an input additionality in terms of expenditure.

However, if we do not control the rest of funding that firms are receiving, we find out that firms funded by the Intek programme show an additional impact on R&D's inputs than those not being funded (all the variables significant at 95% level of confidence). These results show us that the Intek programme on its own does not provide enough of an impetus for firms to develop input additionality. Nevertheless, taking into account the whole funding system,- all the subsidies firms have received from national or local R&D programmes - there is not a crowding-out effect and therefore, treated firms had a positive impact on these funding programmes with the same amount of resources received than the firms included in the control group. The difference in averages is also remarkable. This is especially so when taking into account the whole funding system, which is higher than the same difference obtained from the Intek's impact in isolation.

Table 8-19: Input additionality

	Controlling for other R&D programmes (national & local)			Without controlling for other R&D programmes		
Variable(log)	**Expected coefficient sign**	**Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)**	**Differences in averages (firms subsidized by Intek- control firms) Mean (SD. in parentheses) (*significant at 95%)**	**Expected coefficient sign**	**Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)**	**Differences in averages (firms subsidized by Intek- control firms) Mean (SD. in parentheses) (*significant at 95%)**
Total R&D expenditure	+	+ 2.9087(*) (1.0350)	-0.03290 (0.06281)	+	+1.7288 (*) (0.3669)	0.73215 (*) (0.07422)
R&D employees in the Basque Country (FTE[23])	+	+0.63063 (0.3625)	0.0382706 (*) (0.0198618)	+	+ 0.235450(*) (0.142805)	0.3270 (*) (0.2818)
Number of PhDs in the whole firm	+	+ 0.06199 (0.04394)	-0.006315 (0.008215)	+	+0.02914 (0.02984)	0.024913 (*) (0.006307)

Source: Own elaboration. Data from Eustat

8.3.2 Results with regards to Output Additionality

In the case of output additionality we have also implemented the matching protocol twice, once for the Intek programme in isolation and second for the effects from national and local R&D funding programmes on firms. The variables chosen for measuring output additionality, as we mentioned before, are R&D intensity, productivity, number of patents and probability of patent.

[23] FTE: Full-time equivalent.

Controlling for the rest of the programmes: Intek's effects
1) R&D_INT= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βEXT_FUND
2) PRODUCT= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βEXT_FUND
3) PAT_NUM= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βEXT_FUND
4) PAT_PROB= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βEXT_FUND

Without controlling the rest of the programmes: System effects
5) R&D_INT= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY
6) PRODUCT= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY
7) PAT_NUM= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY
8) PAT_PROB= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY

Table 8-20: Output additionality

	Controlling for other R+D programmes (national & local)			Without controlling for other R&D programmes		
Variable	**Expected coefficient sign**	**Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)**	**Differences in averages (firms subsidized by Intek-control firms) Mean (SD. in parentheses) (*significant at 95%)**	**Expected coefficient sign**	**Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)**	**Differences in averages (firms subsidized by Intek-control firms) Mean (SD. in parentheses) (*significant at 95%)**
R&D intensity	+	+ 0.20326 (0.13079)	-0.07085(*) (0.01616)	+	+ 0.10687 (0.10195)	0.01288 (0.01317)
Productivity (log)	+	+ 2.0645 (*) (0.5403)	0.18070(*) (0.09763)	+	+1.8083(*) (0.3835)	0.38977 (*) (0.06988)
Patents (num)	+	+0.03315 (0.04978)	0.15022 (*) (0.01774)	+	+ 0.02910 (0.04392)	0.16183(*) (0.01293)
Patentes (probability of patent)	+	+0.01970 (0.02960)	0.057807 (*) (0.009587)	+	+0.01679 (0.02623)	0.064494(*) (0.007204)

Source: Own elaboration. Data from Eustat

In the table above we show the expected values of the dependent variables in both cases: controlling and not controlling for other funding programmes. All the coefficients are positive, but only significant for the variable *productivity.*

Regarding the isolated effect on the Intek programme on firms' R&D outputs, we find out a positive and significant effect on productivity and patents (number and probability of patent), which means an output additionality for the programme. Nevertheless, we cannot determine an additional effect on R&D intensity. On the contrary, in terms of R&D intensity, the Intek programme shows a negative and significant effect on subsidized firms.

The systemic effect of all the funding programmes on firms is similar when considering only the Intek programme. All the subsidized firms have obtained, on average, more R&D outputs than those not subsidized by the Intek programme for the same amount of subsidies received. We can also highlight that, considering all the funding together (the mix of funding), the effect on firms is higher when considering the regional programme in isolation for the same amount of resources received in both the treated and control groups. However, the main difference we can point out here is a positive but not significant effect of all the funding programmes on firms' R&D intensity. Therefore, we can conclude that the Intek programme has, on average, a positive effect on firms' outputs (or output additionality).

8.3.3 Results with regards to Behavioural Additionality

In terms of firms' behaviour, we measured the following variables in two models (taking into account other funding programmes and not): systematization of R&D activities, firms' participation in international R&D funding programmes (specifically the European Framework Programme), and human resources specialization in R&D measured by the proportion of PhDs over the firms' total employment.

Controlling for the rest of the programmes: Intek's effects

1) **CHANGE_R&D_SIST**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βEXT_FUND
2) **EU_FUNDS**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βEXT_FUND
3) **PHD_EMPLOY**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βEXT_FUND

Without controlling for the rest of the programmes: System effects

4) **CHANGE_R&D_SIST**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY
5) **EU_FUNDS**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY
6) **PHD_EMPLOY**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY

The results are shown in the next table:

Table 8-21: Behavioural additionality

	Controlling for other R+D programmes (national & local)			Without controlling for other R&D programmes		
Variable	Expected coefficient sign	Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)	Differences in averages (firms subsidized by Intek-control firms) Mean (SD. in parentheses) (*significant at 95%)	Expected coefficient sign	Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)	Differences in averages (firms subsidized by Intek-control firms) Mean (SD. in parentheses) (*significant at 95%)
R&D systematization	+	+ 0.217078 (0.112531)	-0.04127 (0.03443)	+	+ 0.32557 (0.09402)	-0.13087(*) (0.02579)
UE(log€)	+	+ 0.2342 (0.1815)	0.01766 (0.02538)	+	+ 0.10522 (0.15460)	0.12508 (*) (0.01978)
PhDs/total employment	+	+ 0.009044 (0.015052)	0.012230 (*) (0.002006)	+	+ 0.006391 (0.016156)	0.012120(*) (0.001552)

Source: Own elaboration. Data from Eustat

In the table above we highlight the effects on firms' behaviour in two situations: controlling for other R&D programmes, where we can observe the effects of the Intek programme, and without controlling. Coefficients resulting from the regressions run with all the firms' population and variables are positive as expected in both situations, but none of them are significant.

However, when we analyse the effect of the Intek programme on firms (controlling for other national and international R&D programmes) we see a negative effect on R&D systematization (but not significant) and a positive effect on firms' participation in European R&D programmes and R&D human resources specialization in PhD's (in this last case the effect is significant). If we do not control other R&D programmes firms have participated in, which means analyzing the whole subsidy system effect, we find a negative and significant effect on firms' R&D systematization and a positive and significant effect on firms participation in EU programmes (Seventh Framework Programme) and the percentage of PhDs in those firms. This data shows that the Intek programme jointly with other subsidies received by firms promoted a change in behaviour concerning the specialization of human resources and the participation of firms in European programmes but had a negative effect on R&D systematization on the firms subsidized by the Intek programme. The fact that the Intek programme in isolation (controlling for other subsidies) has a higher effect on human resources specialization (1.22% vs. 1.21%) is quite remarkable. It is also remarkable that the negative effect on R&D systematization is higher in firms that have received other subsidies (national and international) than in firms only subsidized by the Intek programme.

To sum up, we can appreciate the changes in behaviour as a consequence of the Intek (and other) programmes that can be considered an additional effect on firms, (behavioural additionality) but we can also appreciate a negative effect on subsidized firms, such as, what was observed concerning the systematization of firm's R&D activities. Therefore, R&D subsidies can cause a paradoxical effect on firms, fostering firms not to develop systematic but occasional R&D activities. This could be linked to a firm's behaviour related to carrying out R&D activities only with external resources or to the fact that some changes in behaviour take a longer time to be assumed by firms as they involve other changes in strategic processes.

8.3.4 Results with regards to Collaborative Firms

In this section we show the results from the second set of matched data, in which we compare firms that have received Intek subsidy in collaboration with other firms and knowledge-based agents with those that have carried out a R&D project subsidized by the Intek programme individually. These results will allow us to understand the relationship between collaboration (as a measure of innovation by interaction following an evolutionary approach) and input, output and behavioural additionality. Firstly, we will analyse the differences in collaboration patterns as a result of the Intek programme.

8.3.4.1 Results with regards to Collaboration Patterns

In this section we show the results obtained from the analysis of the collaboration patterns of firms that have been subsidized by the Intek programme. We analyse the collaboration patterns through the external expenditures in R&D that subsidized firms have realized after the funding period. Thus, we assume that firms that have participated in the Intek programme between 2001 and 2004 in collaboration have invested more resources in external R&D in the subsequent period than those not involved previously in collaborative Intek projects. The results are shown in table 8-22.

Controlling for the rest of the programmes: Intek's effects

1) **TOT_EXT_EXP**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
2) **TECH_CENTRES**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
3) **OTHER_FIRMS**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
4) **PUBLIC_ADM**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
5) **PRIV_INST**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
6) **FOREIGN_FIRMS**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
7) **UNIV**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND

Without controlling for the rest of the programmes: System effects

8) **TOT_EXT_EXP**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK
9) **TECH_CENTRES**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK
10) **OTHER_FIRMS**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK
11) **PUBLIC_ADM**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK

12) **PRIV_INST**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK

13) **FOREIGN_FIRMS**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK

14) **UNIV**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK

We first analyse the results of the Intek programme in isolation, that is to say controlling for the rest of R&D programmes. We observe, for the matched sample, positive relations between collaborative firms and external expenditures in all the cases. However, these results are not significant. On the other hand, the results from the differences in averages between the firms that have participated in collaboration in the Intek programme and the firms that have participated individually are in some cases positive and significant. These are related to the external expenditures invested in technological centres and public administrations. Therefore, the Intek programme had a positive impact in these collaborations. The negative (although not significant) impact on the firms' external expenditures in universities is also noteworthy.

In the next table we can observe the results of comparing the collaborative and the non-collaborative firms without controlling the rest of the programmes. The matched sample demonstrates the expected positive impact, except for the expenditures realized in public administrations and for the total expenditures. Moreover, the results concerning university expenditures are significant. The firms that have participated in the Intek programme in collaborative projects have, on average, more total external expenditures in the subsequent period than the firms that participated in isolation. These results are also positive and significant in the case of external expenditures in technological centres and in public administrations, showing similar results as the ones obtained from the single evaluation of the Intek programme. Therefore, it seems that the rest of R&D programmes stimulate collaboration through external expenditures in a higher proportion than the Intek programme, but there are not huge differences in boosting cooperation between firms and technological centres and firms and public administrations in both cases.

Table 8-22: Collaboration patterns

	Controlling for other R+D programmes (national & local)			Without controlling for other R&D programmes		
Variable	**Expected coefficient sign**	**Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)**	**Differences in averages (firms subsidized by collaborative Intek projects- control firms) Mean (SD. in parentheses) (*significant at 95%)**	**Expected coefficient sign**	**Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)**	**Differences in averages (firms subsidized by collaborative Intek projects- control firms) Mean (SD. in parentheses) (*significant at 95%)**
Total external expenditure	+	1.29615 (0.76705)	0.21358 (0.15617)	+	1.1148(*) (0.6567)	0.39491(*) (0.14892)
External expenditure in technological centres	+	0.6464 (0.5372)	0.4568(*) (0.1169)	+	+0.5131 (0.4324)	0.5901 (*) (0.1176)
External expenditure in other firms	+	0.7875 (0.5711)	0.01501 (0.13238)	+	+0.6804 (0.5120)	0.1221 (0.1346)
External expenditure in Public Administrations	+	0.01126 (0.07956)	0.056314(*) (0.028991)	+	-0.0007882 (0.0733312)	0.06836(*) (0.02755)
External expenditure in private institutions	+	0.1200 (0.1867)	0.02066 (0.05751)	+	+0.07877 (0.15928)	0.06188 (0.05493)
External expenditure in foreign firms	+	0.09632 (0.28396)	0.06013 (0.08339)	+	+0.05809 (0.26700)	0.09836 (0.07631)
External expenditure in universities	+	0.3477 (0.3313)	-0.01265 (0.07489)	+	+0.2812(*) (0.2699)	0.05383 (0.07474)

Source: Own elaboration. Data from EUSTAT.

8.3.4.1 Results with regards to Collaboration and Input Additionality

We also analysed the relationship between collaborative projects and R&D inputs in order to find differences between individual and collaborative projects. We analysed these differences in two situations: controlling for other programmes (showing the isolated effect of the Intek programme) or without controlling for other R&D programmes.

Controlling for the rest of the programmes: Intek's effects

1) **TOT_R&D_EXP** = α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
2) **R&D_EMPL**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
3) **PHDs**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND

Without controlling for the rest of the programmes: System effects

4) **TOT_R&D_EXP** = α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK
5) **R&D_EMPL**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK
6) **PHDs**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK

In the former, although we expected a positive and significant mean for all the variables in the matched sample (subsidized firms) we only found significant coefficients for "total private R&D expenditure". With regards to the effect of the programme on collaborative firms (differences in means) we found different results for the studied variables (although we have to notice that none of the results are significant). Therefore, we found a positive effect of the Intek programme on total private R&D expenditure in collaborative firms. However, the effect is negative on R&D employees in the Basque Country in FTE and number of PhDs in the whole firm. Therefore, it seems that there are no significant effects of collaborative Intek projects on firms' R&D inputs.

In the second analysis all the coefficients from the matched sample for all the variables are also positive but none of them significant. Nevertheless, in this case we found more positive effects of the collaborative projects on the studied variables (highlighted in the next table). We only found negative differences in averages between individually and collaborative funded firms in terms of number of PhDs in the whole firm. However we did not find any significant results in this case so we cannot conclude that collaborative projects within a perspective that takes into account the whole funding scenario for firms are leading to more R&D inputs in firms.

Table 8-23: Collaboration and Input additionality

	Controlling for other R+D programmes (national & local)			Without controlling for other R&D programmes		
Variable	**Expected coefficient sign**	**Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)**	**Differences in averages (firms subsidized by collaborative Intek projects- control firms) Mean (SD. in parentheses) (*significant at 95%)**	**Expected coefficient sign**	**Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)**	**Differences in averages (firms subsidized by collaborative Intek projects- control firms) Mean (SD. in parentheses) (*significant at 95%)**
Total R&D expenditure	+	+ 2.6135788(*) (1.3729163)	0.03029 (0.09158)	+	+2.0158 (0.9482)	0.34444 (0.18365)
R&D employees in the Basque Country (FTE[24])	+	+ 0.6456 (0.4442)	-0.009584 (0.038343)	+	+0.4512 (0.2838)	0.08376 (0.06673)
Number of PhDs in the whole firm	+	+0.08702 (0.09255)	-0.02632 (0.02301)	+	+ 0.07107 (0.09030)	-0.01768 (0.02353)

Source: Own elaboration. Data from EUSTAT.

8.3.4.2 Results with regards to Collaboration and Output Additionality

We have also analysed the impact of collaborative projects on firms with regard to the outputs of the innovation process.

Controlling for the rest of the programmes: Intek's effects

1) **R&D_INT**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
2) **PRODUCT**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
3) **PAT_NUM**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
4) **PAT_PROB**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND

Without controlling for the rest of the programmes: System effects

5) **R&D_INT**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK
6) **PRODUCT**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK

[24] FTE: Full-time equivalent.

7) **PAT_NUM**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK

8) **PAT_PROB**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK

As in the rest of the analyses carried out we have analysed the programme's impact on collaborative firms in two different cases. In the first case, (controlling for other R&D programmes) we found a positive and significant coefficient for the variable productivity and positive but non-significant for the rest of variables. In terms of differences in averages (impact of the Intek programme on collaborative firms), we found a positive effect for all the variables (R&D intensity, productivity and patents-number and probability to patent). However, none of these variables is significant.

In the second situation, when we do not control for other R&D programmes, we also found a positive and significant coefficient for firms' productivity in the matched sample and a positive mean for the rest of the variables. Regarding the impact of the programme without controlling for the rest of R&D programmes: in the collaborative firms we found (as in the previous analysis) a positive and non-significant effect in all the variables (R&D intensity, productivity and patents). Notably, these effects are higher when other programmes have also funded collaborative firms.

Table 8-24: Collaboration and output additionality

	Controlling for other R+D programmes (national & local)			**Without controlling for other R&D programmes**		
Variable	**Expected coefficient sign**	**Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)**	**Differences in averages (firms subsidized by collaborative Intek projects- control firms) Mean (SD. in parentheses) (*significant at 95%)**	**Expected coefficient sign**	**Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)**	**Differences in averages (firms subsidized by collaborative Intek projects- control firms) Mean (SD. in parentheses) (*significant at 95%)**
R&D intensity	+	+ 0.1257 (0.1386)	0.047739 (0.028338)	+	+ 0.1153 (0.1281)	0.052973 (0.029321)
Productivity (log)	+	+ 1.9810 (*) (0.8843)	0.1507 (0.1494)	+	+1.7711(*) (0.7021)	0.25348 (0.16148)
Patents (num)	+	+ 0.08432 (0.28174)	0.04181 (0.09125)	+	+0.05109 (0.26250)	0.07954 (0.08584)
Patents (prob to patent)	+	+0.04795 (0.13152)	0.01061 (0.03214)	+	+ 0.03859 (0.12307)	0.01997 (0.03187)

Source: Own elaboration. Data from EUSTAT.

8.3.4.3 Results with regards to Collaboration and Behavioural Additionality

As a final analysis regarding collaboration and differences in firms, we analysed the programmes effect on firms' behaviour.

Controlling for the rest of the programmes: Intek's effects

1) **CHANGE_R&D_SIST**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
2) **EU_FUNDS**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK+ βEXT_FUND
3) **PHD_EMPLOY**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK +βEXT_FUND

Without controlling for the rest of the programmes: Intek's effects

4) **CHANGE_R&D_SIST**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK
5) **EU_FUNDS**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK
6) **PHD_EMPLOY**= α+ βGROUP_TEC010+ βGROUP_TEC020+ βGROUP_TEC040+ βGROUP_TEC080+ βGROUP_TEC100+ βGROUP_TEC120+ βR&D_SIST+ βMULTIN+ βEMPLOY+ βINTEK

In the first analysis, in which we isolated the programme's effects from other R&D funding, we obtained positive but not significant means for all the variables in the whole matched sample. With regards to differences in averages, we found a positive and significant effect of the collaborative funding on fostering firms' participation in European Programmes (specifically in the Framework Programme). We also found a positive (but non-significant) effect on the specialization of firms' human resources through PhDs, but with regards to R&D systematization, the analysis shows a negative (and non-significant) effect.

The same result, but in this case significant, can be observed in the second analysis, That is to say, collaborative projects have a negative influence on R&D systematization in firms. In terms of participation of firms in European projects we also find a positive and significant effect on collaborative firms, but this effect is lower than in the previous analysis, when we had control over other programmes. This leads us to think about a more positive effect of the Intek programme on firms' R&D internationalization than other national and local programmes. Finally, the analysis also illustrates a positive but non-significant effect of collaboration on human resources specialization, but in concordance to the previous results, this effect is lower when we consider other programmes influence.

In conclusion, the results show a higher impact on collaborative firms' behaviour of the Intek programme in isolation. Therefore, we can conclude that the programme has promoted behavioural additionality in collaborative firms, especially in terms of participation in European funding programmes.

Table 8-25: Collaboration and behavioural additionality

	Controlling for other R+D programmes (national & local)			Without controlling for other R&D programmes		
Variable	**Expected coefficient sign**	**Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)**	**Differences in averages (firms subsidized by collaborative Intek projects- control firms) Mean (SD. in parentheses) (*significant at 95%)**	**Expected coefficient sign**	**Expected mean from the matched sample (SD. in parentheses) (* significant at 95%)**	**Differences in averages (firms subsidized by collaborative Intek projects- control firms) Mean (SD. in parentheses) (*significant at 95%)**
R&D systematization	+	+0.3611 (0.2933)	-0.18094 (0.05677)	+	+0.4066 (0.2530)	-0.21743 (*) (0.05459)
EU(log€)	+	+ 0.03757 (0.11801)	0.32363 (*) (0.03853)	+	+ 0.01254 (0.10281)	0.29160 (*) (0.03799)
PhDs/ total employment	+	+ 0.01431 (0.03404)	0.015709 (0.008898)	+	+ 0.01150 (0.03090)	1.708e-02 (8.937e-03)

Source: Own elaboration. Data from EUSTAT.

8.4 RESULTS FROM FIRMS' INTERVIEWS

In addition to quantitative research carried out by different techniques, we have conducted some interviews with the firms that received R&D funding from the Intek programme between 2001 and 2004. The objective of these interviews was to better understand the programmes dynamics in firms and consequently to complete the results obtained from the quantitative analysis.

The main characteristics of the firms we interviewed are summarized in the following table:

8-26: Main characteristics of the interviewed firms

FIRM	TECHNOLOGY AND KNOWLEDGE GROUPS	SIZE	INTERNATIONAL PARTICIPATION IN FIRM'S CAPITAL	PARTICIPATION IN THE INTEK PROGRAMME DURING 2001-2004	PARTICIPATION IN COLLABORATIVE INTEK'S PROJECTS DURING 2001-2004	PATENTS REGISTERED (BEFORE 2004/ AFTERWARDS)	PARTICIPATION IN EU FUNDED PROJECTS (BEFORE 2004/ AFTERWARDS)	Legal form
FIRM 1	High Technology	More than 500 employees	Yes	Every year	Yes, every year.	Yes/Yes	No/Yes	S.A.
FIRM 2	Medium-High Technology	Between 11 and 50 employees	No	Yes, in 2001 and 2002	No	Yes/Yes	No/Yes	S.A.
FIRM 3	Medium-Low Technology	Between 151 and 250 employees	No	Every year	No	Yes/No	Yes/Yes	S.A.
FIRM 4	Low technology	Between 51 and 150	No	From 2002 to 2004	Yes, most of the years	Yes/No	No/No	Cooperative
FIRM 5	Medium-Low technology	Between 11 and 50 employees	No	Almost every year (except 2003)	Yes, every project	No/No	Yes/Yes	Cooperative
FIRM 6	High Technology	More than 500 employees	No	Every year	Yes, every year	Yes/Yes	Yes/Yes	Corporative group (S.A.) with R&D Unit
FIRM 7	Knowledge-intensive services	Less than 10 employees	No	2003 and 2004	No	No/Yes	No/No	S.L. New Technology-Based Firm

Source: Own elaboration

As the table above shows, we tried to interview firms from different technology and knowledge intensive groups, different sizes and also different legal forms. This was in order to capture the diversity of firms that participated in the Intek Programme during the analysed period. The results of the interviews cannot be analysed using the same approach as the quantitative analysis. However, we will summarize the main findings following a scheme that includes the main aspects reflected in the quantitative analysis. Thus, we give an overview of interviews findings in this section. For that purpose we will support this overview with some tables that summarize firms' strengths and weaknesses.

The strengths and weaknesses exposed are classified according to their contribution to the additional role of public interventions, especially to the Intek Programme. That is to say, for an additional role of public subsidies, they do not have to substitute what firms could achieve without them but to generate an additional effect on firms. This is the only case when public funding should be implemented. If firms had carried out the same projects (in terms of quantity, scope, etc.) in the absence of policy, there would not have been an additional programme effect. Therefore, if firms continued to carry out the same projects without funding (in terms of inputs, outputs and behaviour), a crowding-out effect would take place, and therefore we would not be able to justify public intervention.

The first table (Table 8-27) shows a summary of the interviews findings related to input additionality. In this table we also summarize some evidence regarding the innovation dynamics and systematization of R&D activities in the interviewed firms.

Table 8-27: Key findings with regards to innovation dynamics and funding programmes in firms

Strengths	Weaknesses
FIRM 1: • Carries out product and process innovation projects, some of these projects are subsidized by public funding. • More than 50% of a projects budget comes from the firm's own resources. • If public funding is not reached, the scope of R&D projects might be modified (reduced).	**FIRM 1:** • They try to complement one project with different funding programmes, even if they have private funds to carry it out. Consequently, more than 50% of project's budget comes from public funding. • Carries out R&D projects independent of their public funding.
FIRM 2: • Carries out product innovation projects, normally, 3 or 4 at the same time. • It has been applying for subsidies for many years. • More than 50% of the projects' budget comes from the firm's own resources. • Firms R&D human resources are growing.	**FIRM 2:** • They try to complement one project with different funding programmes, trying to avoid investing their own resources. • They would have carried out the same number of projects without public funding.

Strengths	Weaknesses
• If public funding is not reached the scope or quantity of R&D projects might be scaled down (reduced). • Firms R&D is dependent from public funding, trying to subsidize the overall projects' portfolio.	
FIRM 3: • Firm carries out systematic R&D activities, normally, 2 or 3 projects per year.	**FIRM 3:** • More than 50% of the project's budget is financed by public funding. • Firm tries to complement regional subsidies with national ones and also with tax incentives. • They try to subsidize the overall projects portfolio, even if they have enough resources to carry some of them out, without public funding.
FIRM 4: • Firm carries out systematic R&D activities, with an R&D organisational structure. • More than 50% of projects' budget comes from the firm's own resources. • Sometimes they did not create a project without public funding.	**FIRM 4:** • Most of the R&D projects are not dependent of public funding.
FIRM 5: • Firm carries out systematic R&D activities, with an R&D organisational structure. • Without public subsidies, the firm would have not carried out R&D activities. • Firm has to support more than 50% of project's budget. • Without public funding the scope of the project and the subcontracting activities would be reduced.	**FIRM 5:** • No weaknesses related to input additionality were perceived.
FIRM 6: • Public funding has an additional effect on the overall projects portfolio. Without public funding some of these projects would not have taken place. • Firm has to support more than 50% of R&D projects' budget.	**FIRM 6:** • Firm has its own R&D unit belonging to the Basque Science and Technology Network they receive subsidies in both the headquarters and in the R&D unit (as subcontractor). • Projects' scope would have been the same without project funding. • Due to subsidies' size in the Intek programme there is no additional effect on firm.
FIRM 7: • They would not have achieved their goals in R&D activities without public funding. • Firm's origin is a patent and it is by origin, R&D oriented.	**FIRM 7:** • They invest 1/3 of project's budget, getting 2/3 from public administrations. • Firm complements R&D projects with several programme applications.

According to the results shown above, most of the interviewed firms carry out systematic R&D activities and projects and most of them are subsidized. They recognise that most of Intek's projects would have been carried out without public funding, although the scope of these projects would have been reduced. Therefore, this downscaling is a sign of the input additionality of the programme. Some of the interviewed firms also support this programmes additionality by supporting it with internal sources of more than 50% of each projects budget.

However, during the analysed period it was possible to combine public funding for the same project. Some of the firms interviewed recognised that most of the time they gained external and public funding from different programmes (national, regional and local) and for the same project, this led to a situation where they received funding for the same project more than once. This supports the idea of the crowding-out effect of the Intek Programme. Even though there are slim possibilities to complement Intek projects with national ones, firms receive an indirect public funding in the form of tax incentives. Therefore, taking into account the overall funding system it seems that the additionality of the Intek programme could not be attributed to the firms' project portfolio, as they complement these funds with other public ones. The fact that most of the projects would have been carried out without public funding would support the idea of crowding-out effect of the Intek programme in some cases (in those that downscaling would not be accomplished).

In the next table (Table 8-28) we can find the summary of firms' opinions with regards to the effect of the Intek Programme and R&D public funding on their results, including innovation as well as economic results. These opinions have been classified according to their support of the programme's output additionality. That is to say that the programme would have an additional effect on firms' outputs in case they had not reached the same results in the absence of policy.

Table 8-28: Key findings with regards to impact of funding (Intek) programmes on firms' outputs

Strengths	Weaknesses
FIRM 1: • Subsidies have helped to develop new technology with a Research Centre and to share the commercial results with this centre. • Subsidized projects have a direct impact on new developments (new products). • There is also a direct impact of subsidized projects in firm's sales.	**FIRM 1:** • No weaknesses were perceived in terms of output additionality.
FIRM 2: • Most of the registered patents result from subsidized projects	**FIRM 2:** • No weaknesses were perceived in terms of output additionality
FIRM 3: • No strengths in terms of output additionality were perceived in the firms interview.	**FIRM 3:** • Best results in terms of patents, new products, etc. are developed in internal (non-subsidized) projects.
FIRM 4: • No strengths in terms of output additionality were perceived in the firms interview.	**FIRM 4:** • They consider that the same impact in the firms would be achieved without Intek's projects.
FIRM 5: • Subsidized projects support new product developments. • These developments have big impacts in terms of marketing and sales for the firm.	**FIRM 5:** • No weaknesses were perceived in terms of output additionality.

Strengths	Weaknesses
FIRM 6: • The Intek programme is oriented to obtaining innovation outputs	**FIRM 6:** • In big projects the subsidy size is so small that there is no additional effect in terms of outputs. • Results for us are new products and not patents. We reach the same results in absence of policy.
FIRM 7: • Subsidies are oriented to firms' economic results.	**FIRM 7:** • Programmes are sometimes oriented to innovative results that are not linked to economic results (i.e. not commercial patents).

The table above shows that there is not a consensus regarding output additionality of the Intek Programme. Around half of the interviewed firms recognised that the Intek programme is oriented to results (innovation and economic results) and the obtained results would have not been reached without the Intek programme. However, around the other half of interviewed firms consider that same or even better results would have been achieved without Intek funding. Even a firm suggests that the Intek's subsidy size is not large enough to impact on the firm's results. Therefore, output additionality of the Intek programme is not clear for all the interviewed firms.

Moreover, the Intek programme might also lead to behavioural changes in firms. These behavioural changes are not easy to evaluate as a consequence of the programme. However, interviews are a good source of evidence of the additional effect of the programme on firm's behaviour. These changes or additional effects are summarized in Table 8-29. It is also important to highlight that collaboration patterns are also measures of behavioural additionality of the programme, although for quantitative purposes we have analysed both concepts separately in the previous sections.

Table 8-29: Key findings with regards to changes in firms' behaviour due to R&D funding projects from the Intek Programme

Strengths	Weaknesses
FIRM 1: • Regional experience and collaboration with Technological Centres lead the firm to participate in national and European projects. • Firm had to learn how to apply for subsidies. They have structured their R&D management according to these requirements. • Collaboration in research projects are durable (they continue after subsidized projects have been finalised) • Being part of a cluster association promotes cooperation with other partners or with the	**FIRM 1:** • Firm normally collaborate in funding projects with its clients, not establishing a new partnership due to external subsidized projects. • Partnerships with Technological Centres in external funded projects are originated in previous relationships, and not necessarily due to these projects.

Strengths	Weaknesses
association itself.	
FIRM 2: • Results from collaborative projects are better than outputs from individual projects. • Experience in regional programmes facilitates firms participation in national and European programmes. • Collaborative partnerships usually continue after the project has finished. • Collaborations in subsidized projects lead to better innovation outputs as patents.	**FIRM 2:** • Firm participates in collaborative projects only because they are highly subsidized. (Evaluation favours collaborative projects). • They would collaborate with Technological Centres although they do not reach subsidized projects. • Collaborative projects do not lead to a greater learning in the firm. Technology Centres do not transfer knowledge to the firm.
FIRM 3: • Experience in regional programmes facilitates firms participation in national and European programmes. This participation usually comes from a prior relationship with a Basque Technology Centre. • Collaborative projects transfer knowledge and facilitate learning processes in the firm. • Without public funding they would not cooperate with Technology Centres. • Systematic R&D has been fostered through R&D subsidies although is not currently funding-dependent.	**FIRM 3:** • Collaborative projects are effective but the best outputs are not a result of collaborative projects. • Firm does not usually collaborate with other firms in R&D projects although they participate in sectoral associations.
FIRM 4: • Collaborative partnerships usually continue after the project has finished. • Collaborative projects transfer knowledge and facilitate learning processes in the firm.	**FIRM 4:** • Participation in collaborative and subsidized projects with Technology Centres is due to their success in public funding programmes and not due to their technological expertise.
FIRM 5: • Collaborative partnerships usually continue after project has finished. • Experience in regional programmes facilitates firms participation in national and European programmes. • Collaborative projects transfer knowledge and facilitate learning processes in the firm. • Collaboration gives the firm contacts with potential clients as well as with Technology Centres. • Firm could not achieve the same results without the collaboration with Technology Centres and universities.	**FIRM 5:** • No weaknesses were noted in the firm's interview.
FIRM 6: • They sometimes collaborate with Technology Centres and Universities due to the funding programme's requirements.	**FIRM 6:** • As they have their own R&D unit they collaborate between the headquarters and their own R&D unit but not usually with other external partners. • They would collaborate with universities and Technology Centres without public subsidies. • They do not consider the existence of an experience effect that led firms to participate in European projects after participating in regional ones. • Collaborative projects do not lead to a higher learning effect on firm.
FIRM 7: • Collaborative partnerships lead to a greater and better learning in the firm.	**FIRM 7:** • They consider that participation in regional programmes such as Intek do not foster participation in national or European projects.

According to the table above we can distinguish different conclusions regarding firms' behavioural additionality. First of all, among the firms that have participated in EU funding programmes, almost all of the firms we interviewed believe that participating in regional projects led them to participate in national or European ones. In most cases firms propose that Technology Centres urge firms to participate in other programmes after the regional experience. Furthermore, some firms have highlighted that participating in the Intek programme has lead to a better learning in the application process for subsidies. Some of the firms have also pointed out that R&D funding has supported their R&D systematization. Regarding collaborative issues, we can highlight that most of the collaborations established during an Intek project have continued after projects.

In the Intek programme, collaboration with agents from the Basque Network of Science and Technology is fostered through collaborative projects but also through individual ones by the subcontracting formula. The main actors within the Network are Technology Centres. Some of the interviewed firms highlight that they have collaborated with Technology Centres due to the requirements of the programme and these collaborations led to a higher learning and better outputs in firms. From this regard we can conclude that behavioural additionality is reached within the programme. However, all the firms do not share this opinion.

Finally, we can highlight some specific issues regarding the overall R&D funding system and not specifically related to the Intek programme or to regional R&D subsidies. In addition, we summarize some strengths and weaknesses related to the characteristics of the public R&D programmes, including the Intek programme.

Table 8-30: Key findings with regards to the overall R&D funding system

Strengths	Weaknesses
FIRM 1: • The Intek programme is an applied programme very useful for firms. They prefer this kind of programme because the results are new products or prototypes. Programmes like Etortek are more research-oriented and their main result is new theoretical knowledge. • Firm considers that the mix of regional, national and European projects is fundamental in order to reach innovation and economic results.	**FIRM 1:** • In the beginning they had some problems with the Intek programmes, especially with regard to justify their projects in terms of innovation. • They consider that regional programmes such as Intek should promote collaboration among firms and scientific agents wherever they are, and not only foster collaboration among Basque regional agents.
FIRM 2: • The Intek programme and regional programmes are easier to apply for.	**FIRM 2:** • The administrative costs of applying for subsidies in different programmes are very

Strengths	Weaknesses
	high for the firm. • Administrations should foster innovative projects (individuals or in collaboration) instead of fostering the collaboration per se.
FIRM 3: • Participation in R&D funding programmes has supported firm's organizational structure, incorporation of R&D personnel and R&D externalization.	**FIRM 3:** • They mix three different funding approaches for the same project (regional subsidies, national subsidies and tax incentives).
FIRM 4: • Tax incentives are an important way (although indirect) of supporting firm's R&D.	**FIRM 4:** • Sometimes they do not get R&D funding as the programme's examiners do not consider their projects as innovative.
FIRM 5: • Participation in R&D funding programmes has supported firms organizational structure, incorporation of R&D personnel and new products. • Regional programmes are easier to apply for than national ones as their managers are closer to firms.	**FIRM 5:** • Some R&D programmes are more generous with Technology Centres and Universities than with firms (i.e. reimbursable loans vs. non-reimbursable subsidies).
FIRM 6: • The additionality effect perceived in the firm is due to the whole R&D funding system and not from an individual programme. • They consider large programmes, in terms of subsidy size and long-term projects, as the most interesting ones.	**FIRM 6:** • Tax incentives are sometimes reduced due to the approved budget of a programme's manager. • Sometimes projects' budgets are over-scaled due to the programme's requirements. • Programmes should evaluate project activities instead of the kind of organisation participating in it.
FIRM 7: • There are some programmes in which the evaluation is more objective and close to firms. • Reimbursable loans are a good formula for promoting efficiency in the funding system.	**FIRM 7:** • Collaborative projects are, most of the time, a way to reach a public subsidy instead of a true collaboration. • Programmes should evaluate project activities instead of the kind of organisation is participating in it. • Sometimes they do not get R&D funding as the programmes examiners do not consider their projects as innovative.

The Intek programme supports R&D in the Basque Country and is considered fundamental for most of the firms, although they recognise that the additional effect of R&D subsidies cannot be attributed to the Intek programme in isolation, but to the overall subsidies system.

Furthermore, and related to the main characteristics of R&D programmes, firms consider that programmes supporting large projects on a long-term basis are more interesting for developing R&D activities rather than annual based projects as the ones supported by the Intek programme. They also consider that the evaluation system should be reviewed in order to better understand firms' innovative activities. In the firm's opinion, fostering collaboration should not be limited to the Basque agents or to the ones in the Basque Network. According to them, the best projects should be subsidized even if they are individuals.

Finally, and although the additional effect relies on the system, tax incentives and complementary subsidies should be reviewed in order to provoke and additional effect in terms of private funding and not to concentrate all the public funding in only a few firms.

8.5 BRINGING QUANTITATIVE AND QUALITATIVE RESEARCH TOGETHER INTO AN INTEGRATED FRAMEWORK

After a detailed quantitative and qualitative analysis of the Intek programme's effect on firms we have the necessary elements to extract conclusions regarding input, output and behavioural additionality and some other elements that can contribute to a better understanding of the R&D funding system and its effect on firms. Taking all these elements into consideration we formulate some reflections that will shed light on the conclusions.

First of all and regarding to the input additionality of the Intek programme, both the quantitative and the qualitative results highlight a positive effect of the Intek programme on R&D employees in firms but a crowding-out effect in terms of total R&D expenditure. In general terms, firms recognize that subsidies received from the Intek programme do not cover more than 50% of the projects budgets, but they usually try to reach higher budget coverage with other funding programmes or tax incentives. Some of the interview statements support this conclusion: "*with a mix of compatible subsidies we reach more than 50% of projects budget", we apply for subsidies in every project, sometimes we stopped implementing a project because of not getting external funding, but this is not the common situation".*

Furthermore, we found that considering the whole funding system (other national or local programmes) the effect on firms is positive, that is to say, there is an input additionality on firms. This is also reflected in some firms' opinions. As one of them states: "*the additional effect on the firms R&D investment is due to the set of funds we receive".*

To sum up, in terms of input additionality of the Intek programme, there seems to be a crowding-out effect on R&D expenditure but a positive effect on R&D personnel, while the overall funding system leads to a positive input additionality.

With regards to output additionality, from the quantitative perspective we found an output additionality of both the Intek Programme and the rest of the R&D programmes on firms. This output additionality can be seen in terms of productivity and patents, but not in terms of R&D

intensity, which can be understood as a result of the crowding-out effect perceived in terms of R&D expenditure. Around half of interviewed firms highlight a positive effect of the Intek programme on their results, which would not have been achieved in the absence of policy. This issue is supported by these statements: *"Subsidies are oriented to firms' economic performance… patents without licensing have no sense", "without public funding we would not be able to achieve the same results, especially those with regards to new products to the firm".*

However, some of the firms interviewed stated that the same results would have been achieved without subsidies, which is a sign of a crowding-out effect in terms of output additionality. This statement supports this idea: *"the most innovative results come from internal (non-subsidized) and individual projects".*

In summary, although some firms did not agree that there was an output additionality from the R&D programmes, especially with respect to Intek, quantitative results and some interviewed firms support the idea of an output additionality measured in terms of productivity, patents and new products.

Behavioural additionality is one of the more difficult concepts to measure by using quantitative techniques and for this reason interviews were more focused on this aspect. Behavioural additionality is therefore measured through different features, which can be summarized by systematization of firms R&D activities, encouraging participation in European Programmes, human resources specialization and collaborative patterns with other firms or other agents in the innovation system.

First of all, regarding R&D systematization, the results obtained from the quantitative analyses show that R&D funding does not lead to a systematization of R&D activities in firms. However, some of the interviewed firms pointed out that the Intek programme jointly with other R&D funding programmes contributed to R&D systematization, to the extent that it was even described as being the core basis of the firm's R&D activities. This can be supported by these statements: *"without the overall set of subsidies we would not have been able to carry out R&D activities every year", "the whole funding system has an additional effect on the whole project's portfolio of the firm".*

Secondly, with regards to firms' participation in European funded projects, and specifically in the Framework programme, we found a positive effect of the Intek programme and the rest of

R&D funding programmes in facilitating this firms internationalization. According to the firms' opinions, regional R&D programmes, such as Intek, create a learning process in projects that then lead to an involvement in larger projects at different administrative levels. Some firms also point out that Technology Centres are the ones that promote European participation among firms and therefore, they recognize a Technology Centre's role in this respect.

Thirdly, quantitative analysis shows a positive effect of the Intek programme and the whole R&D funding system in firms' personnel specialization, especially in the proportion of PhDs in firms compared to the total number of employees. However, interviewed firms recognized that R&D subsidies are relevant for hiring new personnel for R&D activities, and PhDs are not as important: *"we hire people without giving importance to PhDs although they are important to get some funding"*; *"thanks to regional subsidies we have been able to hire new people for our R&D department".*

With regard to collaborative patterns, the analyses carried out point to several conclusions. First of all, and regarding collaborative partners among subsidized firms, we found out that most of the projects collaborations are established with Technology Centres and Universities as opposed to with different firms, this is due to external funding. Therefore, there is an effect of the Intek programme on firms' collaboration patterns. These patterns have been fostered through the programmes terms of reference or requirements, in which collaboration with agents from the Basque Technology Network was promoted. It is important to highlight that some firms only participate in collaborative projects because these are highly subsidized: *"although we collaborate with other firms we know collaborative projects are highly subsidized so we try to define projects in such a framework as we will have more successful possibilities".*

There are also firms that have created their own R&D unit and register it in the Basque Technology Network so they can participate in collaborative projects both as firm and as an agent from the Basque Technology Network. "*We sometimes apply to projects both the headquarters and the R&D unit together, so the headquarters benefit from the activity of the R&D unit"*. One aspect that can be positively highlighted is the fact that most of the firms maintain collaboration with firms or other agents after projects have finished. This reveals behavioural additionality of the Intek programme. However, some of the firms interviewed also pointed out that most of the collaborations were established before getting external funds for them, which denotes that behavioural additionality is not achieved for every firm: *"we participate in subsidized R&D projects with Technological Centres but we were previously* *collaborating with them, independently from the subsidies"*. Another weakness that it is perceived can be summarized in one firm's opinion, which highlights that sometimes seeking funding through collaboration has become a main issue for firms, without taking into account whether R&D activities are strategic for the firm or not: *"if the project consists in travelling to the moon, even if we do not have anything to do there, if the trip is free, we go for sure"*. Therefore, we can conclude that there are some "false partnerships" promoted by these kind of collaborative projects.

Furthermore, we analysed collaborative projects in comparison to individual projects in order to point out whether these projects are more efficient in terms of input, output and behavioural additionality. First of all, in relation to collaboration and input additionality we found through quantitative analysis that there was a positive but non-significant effect on firms' input variables. However, the results highlight that the Intek programme and other R&D funding programmes could lead to a positive effect on firms' input in the case of collaborative projects. This might be a consequence of the size of subsidies, due both to bigger consortia and to programmes prioritization of collaborative projects.

In relation to collaborative projects and output additionality, the quantitative analyses showed a positive but non-significant effect on firms' outputs, which is also supported by the lack of consensus reached within the interviews. Some of the interviewed firms stated that the best outputs are not a result of collaborative projects, while other firms stated that they would not had reached the same results without collaborating with Technology Centres or Universities. *"Most disruptive projects' outputs are those carrying out in isolation and not in cooperation with other firms or research institutions"; "results obtained from collaborative projects would not have been obtained through individual ones. We need knowledge from research institutions that we don't have in our company for developing new products or prototypes".*

Nevertheless, learning through collaborative projects has been seen as one of the main advantages of these kinds of schemes from almost all the firms we interviewed. That is why learning as a result of an intervention is important as it can be considered a key element of behavioural additionality. Behavioural additionality within collaborative projects is a concept that could be analysed through different elements, although we can also consider collaboration itself as a change in firms' behaviour, which is also a sign of the programme's behavioural additionality. However, in order to simplify this conceptualization we have analysed the programmes' effect on some variables that can be understood as changes in a firm's behaviour. These are systematization in R&D activities, participation in European funded projects and human resources specialization. With regard to systematization of R&D activities, we found that collaborative R&D projects (from the Intek programme or other programmes) do not lead to systematization in firms compared to individual projects. This can be a consequence of collaborative projects. Secondly, with regard to participation in European projects we found that firms participating in regional or national collaborative schemes are more likely to participate in European projects. This finding is supported by firms' opinions, which state that collaborative regional partnerships promote participation in European projects, although this participation is normally fostered by Technological Centres: *"participating in regional partnerships facilitates participation in European projects", "normally we do not search for European projects, Technology Centres usually come with the idea and we join the consortium".* Finally, with regard to human resources specialization, we found a positive effect of the R&D programmes on collaborative firms but it was not significant. Moreover, in the interviews carried out we came to some conclusions with regards to collaborative projects which were not previously analysed. Some firms consider that collaborative projects should not be promoted by R&D programmes, as they should foster the best project ideas independently of their consortium. Indeed, collaboration should be 'real' and not, for example, limited exclusively to organizations located in the Basque Region (those belonging to the Basque Technology Network). Finally, some firms consider that Technology Centres and Universities are favoured by some programmes as they act as subcontractors and they get the entire subsidy. Sometimes they get subsidies when firms are funded under a reimbursable-loan form: *"we sometimes do not have the possibility to apply for a subsidy and we receive a reimbursable-loan whereas universities and research centres are receiving a subsidy for their participation in the same project".*

Another issue reflected on interviews was the fact that tax incentives for R&D constitute another form of public funding for the same subsidized projects. In these cases, there is a crowding-out effect between different public instruments: *"we try to complement projects with different sources and instruments of funding so we can fund 100% of project's budget".* Nevertheless, as some firms pointed out, receiving a regional subsidy from the Basque Government also guarantees eligibility for receiving tax incentives, which limits, in some cases, the amount of tax incentives, as subsidized projects sometimes get limited budgets *"One of the problems that regional R&D subsidies have is that they limit the projects' budget which are then mandatory for tax reductions. Therefore we are not able to ask for the tax reduction of the whole budget and only for the budget that has been limited by public funding".*

In addition, both the quantitative and qualitative results highlight the role of the funding system or mix of programmes at different levels to support R&D and innovation in firms. Therefore, it is more important to reach a good policy-mix, taking into account the multi-level approach to gain an effective impact on firms *"the whole funding system has an additionality impact on our R&D activity", "regional R&D funds are important to our R&D activities but not in isolation, complemented by national funds".*

Finally, some important issues arose in the interviews concerning the Intek programme's (and other programmes') design. These included: the adequacy of certain instruments (grants, reimbursable loans...) depending on the programmes rationales; the adequacy of fostering collaboration between firms and a limited group of other agents; and the projects time-frame, which sometimes may be a barrier for developing R&D based projects. In the words of interviewees: *"sometimes we are limited by the funding programmes timeframe and budgets and we need more long-term instruments to develop strategic R&D projects"; "sometimes the best partner is not located in the Basque Country and regional programmes limit collaboration with other agents from other regions, so we lose a good collaboration".*

In conclusion, the case study described in this chapter, and the results from an dual-methodology (combined quantitative and qualitative techniques) evaluation of a Science and Technology programme in a region that is considered a Regional Innovation System, give an extended overview of the policy's impact in terms of input, output and behavioural additionalities. Furthermore, the findings demonstrate the need for considering the overall funding system following a multi-level approach that might change current funding configuration. All these issues will be elaborated upon and analysed following theoretical considerations in the next chapter.

9 CONCLUSIONS AND FURTHER RESEARCH

One of the main aims of this thesis has been to contribute to the understanding of regional Science and Technology Policy following an evolutionary perspective that considers policy itself as part of a system, where different instruments interact in a multi-level context. In order to better understand this regional policy, a case study has been analysed, with a concrete science and technology programme evaluated following both quantitative and qualitative approaches. The evaluation findings have contributed to understanding policy from both neoclassical and evolutionary sides, as the evaluation carried out has integrated both perspectives. Therefore the thesis has contributed to policy learning through the understanding of a specific regional policy and its interactions with other policy instruments. Such a systemic view of policy also contributes to shed light on evaluation processes and how these processes should be planned and implemented in order to deliver an overall view of policy's impacts on firms. Additionally, specific findings of the policy evaluation contribute to understanding some specific failures and the effect of intervention on them.

Taking all these points into consideration, the main conclusions we can highlight can be classified in the following items, which will be further developed in the next sections:

1- Conclusions with regards additionality of regional S&T policy following a integrated perspective;
2- Conclusions regarding evaluation methodology in a systemic context: triangulation of techniques;
3- Conclusions regarding evaluation in a systemic and multi-level perspective;
4- Conclusions regarding policy rationales and their interaction; and
5- Conclusions regarding policy-learning.

9.1 Additionality of regional S&T policy: can input, output and behavioural additionality be found in the same context?

The main rationales that justify Science and Technology Policy correspond to two main economic theories that are usually presented as opposite or complementary: these are neoclassical and evolutionary theories. Each theory justifies the need for public intervention due to some failures that government should correct through public policies. The main differences between these two approaches rely precisely on the nature of the failures. In particular, neoclassical theory justifies policy intervention due to market failures, whereas evolutionary policy aims to correct system failures. It is clear enough from theory that policys' aims differ from one approach to another, but in reality the approaches are not separate and may coexist (Flanagan et al. 2011) in public policy. Therefore regional S&T policies are not purely neoclassical or evolutionary as they combine both types of rationales. Programmes and instruments involved in regional S&T policy have evolved in order to incorporate evolutionary rationales to their final aims. Indeed, sometimes policy rationales are far from theoretical rationales, as they are usually not well-adapted by policy-makers (Laranja et al. 2008, Mytelka and Smith, 2002). Path-dependency is therefore an important issue in public policies as it leads to combinations of rationales that do not correspond to theory. Consequently, when adopting a perspective of evaluation it is important to take into account this rationale mix, in order to provide an overall evaluation.

Evaluation has followed the same evolution as policy rationales and has moved from a neoclassical towards a more systemic approach. This can be seen following the evolution of the concept of additionality. The concept of additionality refers to the complementary role of the government; a government intervention can be only justified if that intervention originates a complementary effect, which would not have taken place without policy. This concept is explained in the literature by different authors: Georghiou (1994, 2002), Bach and Matt (2002), David et al. (2000), Heijs (2001), Herrera and Heijs (2003, 2007), Ebersberger (2005), Georghiou and Clarysse (2006), Autio et al. (2008), Clarysse et al. (2009).

Within neoclassical theory the concepts of input and output additionality are the most commonly used in policy evaluation (Clarysse et al. 2009). Input additionality refers to the additional amount of resources subsidized firms invest in the innovation process, whereas output additionality measures the additional outputs achieved as a consequence of policy intervention. These additionalities are therefore responding to market failures. In recent years a complementary concept has emerged in the literature: behavioural additionality. Behavioural additionality is linked to a systemic or evolutionary view of the economy and refers to changes in firms' behaviour as a result of policy support (Bach and Matt, 2002). These effects are perceived in a longer term than in the other types of additionalities, and according to Geourghiou (2002) they are closer to system failures. More precisely, behavioural additionality includes those behavioural changes that lead firms to collaborative patterns, to continue with R&D investments after the subsidized project has finalized, to internationalize their R&D activities, etc. All of them are related to the organizational learning achieved by the firm after public intervention (Clarysse et al. 2009).

Following the same assumption as in terms of rationales, behavioural additionality does not necessary substitute input and output additionality, but might be a complementary effect to those. Indeed, there are programmes in regional S&T policy that evolve from a neoclassical framework and incorporate systemic rationales to them (i.e. fostering collaboration). Therefore, input, output and behavioural additionality can be found in the same programme. This implies that public policy design, implementation and evaluation should be oriented towards the achievement of these three types of additionality, which gives more complexity to policy-making. Indeed, it is difficult to effectively combine these three types of additionalities within the same programme and instrument, as it is difficult to avoid crowding-out effects between different types of additionality. It is therefore more consistent to implement an appropriate mix of programmes and instruments that combine the three additionality effects when necessary.

In the case study, we have analysed for a concrete programme these three effects separately, but also the interaction between different types of additionality. With regard to input additionality the empirical results show that there is a crowding-out effect in terms of total private R&D expenditures, which is mainly due to the fact that most firms would be able to carry out the R&D projects the programmes are subsidizing without public funding, and also due to the fact that they try to complement external funding so somehow they are duplicating funding sources. In these terms, the analysed programme does not lead to an input additionality.

However, output additionality is achieved by the regional programme, especially in terms of patent or product results and productivity. With regard to behavioural additionality we found that the regional programme fosters collaboration and interaction among firms and agents within a regional innovation system. It also promotes other changes in firms' behaviour, such as participation in European R&D funding programmes. That is to say, this precise regional programme has achieved two different types of additionalities, which raises the important question of whether these additionalities are interacting in order to achieve an even larger additionality effect? In other words, will changes in behaviour lead to larger input and output additionality effects?

Regarding the evaluated programme we found that this collaboration did not necessarily lead to a higher additionality in terms of input or output, although collaboration was in most of the cases only established due to the programme's requirements. Therefore although in theory collaboration within a regional innovation system leads to better results, successful partnerships in these terms depend not only on public funding, but also on trust relationships and complementary competences. Thus it would be very useful to analyse all the possible policy instruments to better address successful collaboration partnerships within the system in order to obtain better innovation results. However, it is also important to point out that these interactive projects have provoked changes in firms' behaviour such as participation in European programmes. Therefore, it is important to make clear the rationale of implemented programmes and instruments, as one can be useful for obtaining results whereas others are directed to trigger learning processes in firms.

9.2 Evaluation methods in a systemic and multi-level context: how to effectively evaluate a policy following an evolutionary approach?

Apart from the concrete evaluation results we have achieved from the case analysis and their implications, some conclusions regarding evaluation methods can be also extracted from the analysis.

First of all, the analysis of a case study has provided the opportunity to analyse in depth all of the policy implications in a particular context. In addition, the case study has been analysed through an integral methodology that combines quantitative with qualitative methods, following the triangulation approach as argued by Turok (1991), Papaconstantinou and Polt, (1997), Williams, (1999), Diez (2002), among others. This approach has provided an overall view of the case study, specifically of the programme's impacts on firms in the region analysed. Indeed, the main advantages of combining different types of techniques have been demonstrated in this research.

The quantitative approach has provided a precise view of the programme's effects in terms of the indicators defined to measure input, output and behavioural additionalities. It is important to highlight that this approach has been based on an official database with data from all the population of firms that have carried out R&D activities, which gives robustness and consistency to all of the results found. This quantitative approach has also facilitated some findings that were previously not expected, such as identifying and measuring interactions through different programmes at different administrative levels. In consequence, the quantitative approach, and specifically the matching technique, has allowed greater understanding of how different policy instruments interact and how some effects are achieved only by the systemic interaction of funding programmes. These findings have some relevant policy implications, supporting an evolutionary view of the economy and also the conception of policy as systemic. This technique might therefore be a good method for evaluating policy within a multi-level approach.

The qualitative approach carried out during the analysis, which consisted of interviews with some of the programmes' beneficiaries, has complemented the quantitative analysis. This qualitative approach has been particularly useful for understanding the reasons underlying firms' behaviour. It has therefore been crucial for analysing behavioural additionality, but also for understanding some of the results obtained in the evaluation of input and output additionalities. In particular the interviews have helped in the contextualization of the programme's evaluation, allowing the researcher to reflect and understand the quantitative results and even to obtain some new evidence for the evaluation itself.

In conclusion, the thesis demonstrates that a mixed-approach that combines quantitative and qualitative methods is an appropriate way for evaluating a policy following an evolutionary and a systemic view in a multi-level context.

9.3 Evaluation in a systemic and multi-level perspective: towards an integrated evaluation

Policy has evolved from a linear conception to a more complex view in which different policies interact at different levels following an evolutionary perspective. In regional policy these interactions are even higher than with respect to national policy. As we have highlighted in previous sections, regions can be considered as policy spaces in which different policies impact; they are overlapping spaces in which different policies from various level of implementation interact (Uyarra and Flanagan, 2010). This policy complexity should be followed by a new approach for capturing these effects in regions. That is to say, a new evaluation approach should be defined in order to cope with these challenges.

In the evaluation literature there is a consensus about the need for systemic evaluations (Arnold, 2004) that incorporate evaluation of the different programmes interacting through the same policy domain. Moreover, it is not only a case of bringing together evaluations of the various programmes or instruments that have similar aims or overlaps in the same policy domain, but there is also a need to evaluate the added value or the additive effects of their interactions. Indeed policy mixes from multiple levels should lead to indirect effects that together are more positive than the simple aggregation of the effects achieved by the programmes in isolation. This means that systemic evaluation should consider not only the evaluation of all the programmes aiming to foster innovation in firms, for example, but should also measure the effects achieved in firms by the interaction of different policies at different administrative levels. Therefore there is a need for new evaluation approaches that include this integral view of policy impacts.

In this research we have provided an evaluation framework that has taken multi-level considerations into account alongside a broad view of policy-mixes. Through this approach we have found different effects depending on whether an individual or systemic evaluation approach is adopted. Indeed, some crowding-out effects are avoided when considering the whole policy system. This implies that there is a risk of implementing policy decisions following the results of individual evaluations rather than a systemic one. This latter type of evaluation could demonstrate complementary policy effects that would not have been achieved considering each policy in isolation.

In addition, the evaluation purposes should be taken into account when making arguments for a systemic evaluation instead of a traditional one. Traditional evaluations might accomplish different purposes, as was explained in Section 5.3. As mentioned, two types of evaluations can be mainly distinguished: the summative evaluation, in which the policy's effects on beneficiaries and economy are measured; and a formative evaluation, aiming to improve policy learning through evaluation. Systemic evaluations have as a main advantage the combination of these two types of evaluations. On one hand, an evaluation of the policy's effects following a systemic perspective provides an input on the effectiveness of policies that have been implemented, and is therefore useful in order to redefine programmes and instruments. On the other hand, a systemic evaluation provides understanding about policies and their interaction supporting policy learning processes. These two evaluation purposes are overlapped in this research supporting the assumption that these two evaluations can and should coexist (Arnold, 2004).

Furthermore, a multi-level evaluation provides an integral view of the suitability of some instruments at different policy levels. Therefore, as Koschatzky and Kroll (2007) argue, there are some policies that should be better implemented at national level as major effects can be produced with this scale and scope. On the contrary, there are some policies more appropriate for regional level due their characteristics. These are programmes aiming at fostering cooperation among regional agents and firms, for example, rather than those mainly based on resources such as the establishment of a physical infrastructure for Science and Technology, for example. Nevertheless, in any case regions should develop regional governance capacities to effectively implement S&T policies at regional level. According to Walendowski et al. (2011), regional governance capacities are those referring not only to sufficient autonomy and resources, but also to sufficient human resources and competences to effectively implement policies.

In this research we found that some additionalities, such as input additionality, that are more dependent on resources are not achieved by the regional policy but by the combination of policies at different levels. Therefore, there might be a minimum budget required or a minimum subsidy size for generating an additionality effect. On the other hand, effects such as those with regards to behavioural additionality or collaborative and interactive patterns seemed to be effectively achieved by a regional policy as it involves mobilizing regional agents and creating social capital that is more easily reached in lower territorial levels due to proximity effects.

Summarizing, there are policy measures more suitable for implementation at regional level and others that should be implemented only at other administrative levels or at least at various levels at the same time, looking for complementary effects. The success of this implementation will depend on the governance capacities regions have developed.

9.4 Evidence of neoclassical and evolutionary rationales: is co-existence possible in a policy system?

Policies are becoming more complex as a result of both the need to adequate policies to reality and the path dependency these policies show due to the fact that current decisions are dependent on those taken in the past. In addition, as was mentioned before, policy-makers do not directly translate theoretical rationales into practice (Mytelka and Smith, 2002; Laranja et al. 2009, Flanagan et al., 2011). Therefore, theoretical policy rationales might be distinguished from policy rationales in practice.

When considering an (national or regional) innovation system it is important to understand this system as a policy system. That implies that it is not an isolated system and multiple policies can be implemented and therefore coexist within this system. Policy systems and innovation systems might not be consistent in terms of administrative boundaries, making it even more important to distinguish between these two units of analysis in order to correctly evaluate them.

Furthermore, following OECD (2010), both market and systemic failures can occur at the same time; that is to say, neoclassical and evolutionary rationales are not mutually exclusive, at least in STI policy. This is a consequence of a broadening view of innovation, which has originated a co-existence of market failures in R&D investments and systemic failures with regards innovation systems. This rationales mix should be managed by policy-makers in order to obtain the best results in terms of innovation performance and competitiveness, which should be the aim of STI policy. The management of this mix basically implies coordination between policies and instruments defined in the framework of each rationale. In practice, this definition is not clear enough and there are not well-established boundaries to categorise each policy in one clear rationale. There are systemic policies that clearly respond to a system failure, such as those aiming at fostering networks per se, but there are other policies that clearly respond to a rationale mix by implementing also a mix of instruments. This is clearly the case that we have analysed in this research.

The programme analysed responds to both neoclassical and system failures by using the same instrument. On one hand it is a programme that seeks to foster R&D expenditures and outputs following a neoclassical rationale, but on the other hand the programme fosters collaboration and interaction through different agents in the regional innovation system. This situation might be a consequence of an intended rationale mix or a consequence of the programme's path dependency. In the first case policy assessment should be a tool for evaluating the programme's effectiveness, following both rationales to evaluate the suitability of maintaining both rationales in the same programme. In the second case rationales should be clarified and instruments better separated in order not to provoke a government failure. The main difference of these two approaches relies on the government's consciousness when defining the policies. Whereas a deliberate rationale mix could be more or less effective depending on the context, a rationale mix by chance or past-dependency could lead to less effective situations than those in the absence of the policy or policies following separate rationales, as it might lead to government failures and crowding-out effects in terms of public funding.

Therefore it is necessary that policy-making evolves along with theory-making in a consistent manner. This development implies the need to clearly identify which are the main failures government has to cope with and which instruments should be implemented in consequence. An evolution does not necessarily imply a substitution of past policies. Some of them are modified in order to deal with new challenges but others stay as they were, as some past failures still exist in a system. Therefore, neoclassical and evolutionary rationales can coexist in the same policy system and even in the same policy. In this context, the most important task for policy makers should be to effectively coordinate these mixes in order to avoid government failures.

9.5 Towards a policy-learning approach

Finally, while the thesis contributes to shed light on the evaluation of Science and Technology Policies embedded in a regional innovation system, it also contributes to the understanding of regional policies and their interaction in a multi-level perspective. This last contribution constitutes part of the policy-learning process.

As mentioned before, evaluation purposes have evolved from a summative to a formative role in which the main aim of the assessment is to contribute to the understanding of public policies and thus to policy learning. Policy learning has become a key issue in the economic and public policy literature, but also a key issue for policy-makers. As Nauwelaers and Wintjes (2008) state, policy learning has become an important field for innovation policy due to the uncertainties innovation and innovation policy-making themselves demonstrate as a consequence of lack of information and communication. There is not an optimal innovation system, and in consequence there is not an optimal innovation policy. This is the main reason that underlies the importance of policy learning for policy definition and implementation. Evaluation has been considered an important activity to provide information to policy-makers. Traditional evaluations were focused on the programmes' effectiveness, whereas for policy-learning purposes the process of policy implementation itself is the most interesting in terms of learning and identifying good and bad practices. This is why evaluations carried out during the policy implementation stage contribute to policy learning in a greater perspective, as policy-makers learn during the process.

One of the main advantages of this research is that while the analysis carried out appears to be an ex-post analysis, not so useful for policy-learning purposes, it is in fact a programme that it is still running. Although some specific results of the evaluation might vary over time, the evaluation carried out at this stage has led to more interesting results in terms of policy learning as the interviews have extracted interesting issues with regards to the programme's functioning, complementarities with other programmes, and real effectiveness for firms. Therefore it is very important to take into account when conducting an evaluation that not only policy effectiveness should be measured, but that there is also a learning component in the evaluation that constitutes a critical element for policy-making.

9.6 Further research

In this research we have demonstrated that regional Science and Technology Policies might have different effects responding to different failures; both neoclassical, and evolutionary or systemic. During this research a number of interesting issues for further research have been aroused and we enumerate in the following paragraphs the most important ones.

First of all, we have defined a systemic evaluation approach that considers different administrative levels for policy, and a broad view of policy mix which considers other instruments in terms of potential complementarities. A more integral evaluation approach that considers both the multi-level focus but also a more complete policy-mix in terms of domains, programmes and instruments should be a challenge for further research.

Secondly, with regards to methods and data availability, we have considered science and technology policy as the main target of analysis and we have focused the research on some specific variables (with regards inputs and outputs of the innovation process) that were available for measuring. Although we have tried to cover other variables of interest with qualitative approaches, to complete the analysis it would be really interesting to have available some other indicators regarding innovation outputs, for example, or with regards to intangible inputs and outputs of the innovation process. A further interesting complementary analysis could also consider other policies interlinked with S&T policies, such as cluster policy, in order to better analyse the interactions among these policies.

Thirdly, in order to better contribute to policy learning purposes, further research could involve the participation in the evaluation process not only of the programme's beneficiaries, but also of other agents in the innovation system and policy-makers themselves. This implication does not necessary mean the elimination of quantitative methods in the research, but building a more participatory process.

In addition, this research has been focused on policies and their evaluation and it has introduced governance of policies only in response to a reality rather than a questioning of the effective governance of S&T policies *per se*. Further research could be focused on the analysis of the effectiveness of certain policies and instruments that overlap in a policy space depending on their level of implementation, including the supra-national level. This would contribute to an important debate about the need for coordination instruments.

9.7 Final remarks

The research in this thesis has demonstrated that a complex method for evaluating policies in a complex world is not necessary. It is more important to better understand the purpose of policy evaluation, the boundaries of a policy-system, and the rationales underlying the definition of a policy, than to define a complex evaluation method.

However, methods and data have their specific role in every research. This analysis has been built on a robust and official database but limited by the number and the nature of the variables studied. These limitations have been mitigated by combining qualitative with qualitative techniques, although data regarding some direct innovative results of firms (new products or processes, for example) and other intangible assets such as those related to learning processes in firms, should have been an important input for this research. We have also considered Science, Technology and Innovation programmes originating from other administrative levels as a whole for this research purposes, but a more detailed analysis of different programmes at different levels could be undertaken.

In addition, it is important to remark that in this specific region, the Basque Country, there is at this moment no single evaluation of STI policies, although they have been running for the last 30 years. According to an oral communication given by Edorta Larrauri, Technology Manager of the Basque Government on 22nd March 2011, all the evaluations that have been implemented in the Basque Country with regards S&T policy have been ex-ante or some specific performance measures in ex-post evaluations, but none of them have analysed policy impacts. As such this thesis contributes to a first evaluation stage in this region and to a better understanding of this regional innovation system.

Finally, it is important to point out that an assessment of policy effectiveness is always important, but it is even more crucial in these days in which the financial crisis is restricting public budgets. Policies and instruments should evolve to adapt to this reality and to the constraints this context nowadays holds.

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ANNEX 1: GUIDE FOR FIRMS' INTERVIEWS

1. - How long have your been participating in the Intek Programme?

2. - How many projects or subsidies have you reached in the last 10 years?

3. - Are they usually in collaboration or individual projects? With which organizations do you collaborate? Do you always collaborate with the same organizations?

4. - Before applying for subsidies, did you carry out R&D projects in your company? Were they funding by the company or by external funds?

5. - Would you have carried out the same projects without subsidies? How do you usually generate the ideas for the projects? Are they strategic projects for the company?

6. - Do you think the amount received per project is enough? Which percentage of the total project's budget is it? Do you normally invest your own resources in subsidized projects? In which percentage?

7. - Do you carry out R&D activities systematically? Since when? Is this independent of receiving subsidies?

8. - Do you employ R&D personnel? Full or part time personnel? Have you hired them thanks to the Intek programme? Thanks to other subsidies? And PhDs?

9. - Which was the direct impact of Intek's projects in the firm? New products, increased sales, increased productivity, new patents?

10. - Do you think that the Intek programme is oriented to innovation outputs?

11. - Participating in regional programmes as the Intek, have originated a learning process about R&D subsidies in the firm? Have you participated before in this type of programmes?

12. - Participating in the Intek programme has helped the company to acquire experience and to participate in European projects?

13. - Participating in the Intek programme, have helped you to develop your human resources' capacities?

14. - One of the types of the Intek programme is collaborative projects, which are the advantages and disadvantages of this type of projects?

15. - Are these projects useful to establish long-term cooperations?

16. - Do you usually collaborate more with Technology Centres or Universities? Through the Intek programme or other programmes? Which programmes are the ones that foster R&D collaboration?

17. - Do you usually collaborate with institutions and organization you were previously collaborating?

18. - ¿ Do you usually collaborate with other firms in R&D projects? Within the Intek programme? Within other national or international programmes?

19. - Are the collaborations promoted by public funding effective?

20. - Do you believe that with these collaborative projects you reach better innovation results?

21. - Do you believe that you learn more with collaborative projects than with individual ones?

22. - Do you belong to any cluster association? Do you participate with other affiliate in collaborative funded projects? And in collaborative non-funded projects?

22. - Which are the main advantages or disadvantages of regional R&D projects versus local, national and European ones?

24. - How do you assess the current access barriers to R&D or innovation regional funding (requirements, bureaucracy)?

ANNEX 2: LIST OF INDUSTRIES AND THEIR CORRESPONDING TECHNOLOGY AND KNOWLEDGE-BASED SERVICES GROUPS

1. - OECD's classification

High-technology	**NACE Revision 1.1**	**ISIC Revision 2**
1. Aerospace	35.3	3845
2. Computers, office machinery	30	3825
3. Electronics-communications	32	3832
4. Pharmaceuticals	24.4	3522
5. Scientific instruments	33	385
Medium-high-technology		
6. Motor vehicles	34	3843
7. Electrical machinery	31	383-3832
8. Chemicals	24-24.4	351+352-3522
9. Other transport equipment	35.2+35.4+35.5	3842+3844+3849
10.Non-electrical machinery	29	382-3825
Medium-low-technology		
11. Rubber and plastic products	25	355+356
12. Shipbuilding	35.1	3841
13. Other manufacturing	36.2 through 36.6	39
14. Non-ferrous metals	27.4+27.53/54	372
15. Non-metallic mineral products	26	36
16. Fabricated metal products	28	381
17. Petroleum refining	23	351+354
18. Ferrous metals	27.1 through 27.3+27.51/52	371
Low-technology		
19. Paper printing	21+22	34
20. Textile and clothing	17 through 19	32
21. Food, beverages, and tobacco	15+16	31
22. Wood and furniture	20+36.1	33

2. – Eurostat's classification

Manufacturing Industries	NACE Rev. 2 codes – 3-digit level
High-technology	21 Manufacture of basic pharmaceutical products and pharmaceutical preparations 26 Manufacture of computer, electronic and optical products 30.3 Manufacture of air and spacecraft and related machinery
Medium-high-technology	20 Manufacture of chemicals and chemical products 25.4 Manufacture of weapons and ammunition 27 to 29 Manufacture of electrical equipment, Manufacture of machinery and equipment n.e.c., Manufacture of motor vehicles, trailers and semi-trailers 30 Manufacture of other transport equipment excluding 30.1 Building of ships and boats, and excluding 30.3 Manufacture of air and spacecraft and related machinery 32.5 Manufacture of medical and dental instruments and supplies
Medium-low-technology	18.2 Reproduction of recorded media 19 Manufacture of coke and refined petroleum products 22 to 24 Manufacture of rubber and plastic products, Manufacture of other non-metallic mineral products, Manufacture of basic metals 25 Manufacture of fabricated metal products, except machinery and equipment excluding 25.4 Manufacture of weapons and ammunition 30.1 Building of ships and boats 33 Repair and installation of machinery and equipment
Low-technology	10 to 17 Manufacture of food products, beverages, tobacco products, textiles, wearing apparel, leather and related products, wood and of products of wood, paper and paper products 18 Printing and reproduction of recorded media excluding 18.2 Reproduction of recorded media 31 Manufacture of furniture 32 Other manufacturing excluding 32.5 Manufacture of medical and dental instruments and supplies

Knowledge based services	NACE Rev. 2 codes – 3-digit level
Knowledge-intensive services (KIS)	50 to 51 Water transport, Air transport 58 to 63 Publishing activities, Motion picture, video and television programme production, sound recording and music publishing activities, Programming and broadcasting activities, Telecommunications, Computer programming, consultancy and related activities, Information service activities (section J) 64 to 66 Financial and insurance activities (section K) 69 to 75 Legal and accounting activities, Activities of head offices; management consultancy activities, Architectural and engineering activities; technical testing and analysis, Scientific research and development, Advertising and market research, Other professional, scientific and technical activities, Veterinary activities (section M) 78 Employment activities 80 Security and investigation activities 84 to 93 Public administration and defence, compulsory social security (section O), Education (section P), Human health and social work activities (section Q), Arts, entertainment and recreation (section R)
Knowledge-intensive market services (excluding high-tech and financial services)	50 to 51 Water transport, Air transport 69 to 71 Legal and accounting activities, Activities of head offices; management consultancy activities, Architectural and engineering activities; technical testing and analysis 73 to 74 Advertising and market research, Other professional, scientific and technical activities 78 Employment activities 80 Security and investigation activities
High-tech knowledge-intensive services	59 to 63 Motion picture, video and television programme production, sound recording and music publishing activities, Programming and broadcasting activities, Telecommunications, Computer programming, consultancy and related activities, Information service activities 72 Scientific research and development
Knowledge-intensive financial services	64 to 66 Financial and insurance activities (section K)
Other knowledge-intensive services	58 Publishing activities 75 Veterinary activities 84 to 93 Public administration and defence, compulsory social security (section O), Education (section P), Human health and social work activities (section Q), Arts, entertainment and

	recreation (section R)
Less knowledge-intensive services (LKIS)	45 to 47 Wholesale and retail trade; repair of motor vehicles and motorcycles (section G) 49 Land transport and transport via pipelines 52 to 53 Warehousing and support activities for transportation, Postal and courier activities 55 to 56 Accommodation and food service activities (section I) 68 Real estate activities (section L) 77 Rental and leasing activities 79 Travel agency, tour operator reservation service and related activities 81 Services to buildings and landscape activities 82 Office administrative, office support and other business support activities 94 to 96 Activities of membership organisations, Repair of computers and personal and household goods, Other personal service activities (section S) 97 to 99 Activities of households as employers of domestic personnel; Undifferentiated goods- and services-producing activities of private households for own use (section T), Activities of extraterritorial organisations and bodies (section U)
Less knowledge-intensive market services	45 to 47 Wholesale and retail trade; repair of motor vehicles and motorcycles (section G) 49 Land transport and transport via pipelines 52 Warehousing and support activities for transportation 55 to 56 Accommodation and food service activities (Section I) 68 Real estate activities 77 Rental and leasing activities 79 Travel agency, tour operator reservation service and related activities 81 Services to buildings and landscape activities 82 Office administrative, office support and other business support activities 95 Repair of computers and personal and household goods
Other less knowledge-intensive services	53 Postal and courier activities 94 Activities of membership organisations 96 Other personal service activities 97 to 99 Activities of households as employers of domestic personnel; Undifferentiated goods- and services-producing activities of private households for own use (section T), Activities of extraterritorial organisations and bodies (section U)

ANNEX 3: SKEWNESS AND KURTOSIS ANALYSIS OF CONTINUOUS VARIABLES

In this annex we present skewness and kurtosis coefficients for the set of continuous variables employed in this research. In addition, we show the same coefficients after applying neperian logarithms to correct these coefficients.

a) Skewness and kurtosis in control variables

	Employment	Ln Employment	External funding	Ln external funding
Skewness	14.15596509	0.039579313	19.1277769	0.54497712
Kurtosis	283.5367062	-0.184665426	454.7967	-1.02753502

b) Skewness and kurtosis in variables for measuring input additionality

	Total private R&D Expenditure	LN Total private R&D Expenditure	R&D employees in the Basque Country (FTE)	LN R&D employees in the Basque Country (FTE)	Number of PhDs in the firm	LN Number of PhDs in the firm
Skewness	16.65648339	-0.390773934	10.2281753	0.67859502	10.8441129	5.98760116
Kurtosis	343.0728734	-1.151895659	143.598936	0.63154419	139.629732	40.5942133

c) Skewness and kurtosis in variables for measuring output additionality

	R&D Intensity	LN R&D Intensity	Productivity	LN Productivity	Patents(num)	LN Patents(num)
Skewness	10.21113106	-0.248572517	34.2880208	-0.63751354	8.76526678	4.33390916
Kurtosis	160.7142606	-0.937032774	1200.78634	-1.12399157	90.8839702	16.8094903

d) Skewness and kurtosis in variables for measuring behavioural additionality

	Participation in UE funded projects	LN Participation in UE funded projects	PhD employment	LN PhD employment
Skewness	14.36188848	4.371602266	8.72813803	-3.69587399
Kurtosis	15.18766148	4.43914375	31.1583269	-3.70537229

e) Skewness and kurtosis in variables for measuring collaboration

	Total external expenditure	LN Total external expenditure	External expenditure in technological centres	LN External expenditure in technological centres	External expenditure in other firms	LN External expenditure in other firms	External expenditure in Public Administrations	LN External expenditure in Public Administrations
Skewness	20.62859626	0.296894026	14.1431247	0.68111777	12.6308109	1.27550575	14.8440917	7.05959057
Kurtosis	485.6645391	-1.15633042	251.041758	-1.00641572	179.710051	0.31764043	258.392216	50.6027824

	External expenditure in private institutions	LN External expenditure in private institutions	External expenditure in foreign firms	LN External expenditure in foreign firms	External expenditure in universities	External expenditure in universities (log)
Skewness	24.47112763	5.060558459	25.5455552	3.91026264	17.2099118	2.56039933
Kurtosis	625.4093323	27.15723417	672.407506	15.4400534	347.129438	5.68390804

ANNEX 4: CORRELATION MATRIXES

In this annex we show the correlation matrixes for all the variables introduced in the thesis. These matrixes are divided according to the different analyses carried out.

a) Correlation matrix for the variables measuring input additionality

	GROUP_TEC010	GROUP_TEC020	GROUP_TEC040	GROUP_TEC060	GROUP_TEC080	GROUP_TEC100	GROUP_TEC120	GROUP_TEC140	EMPLOYMENT	FOREIGN OWNERSHIP	R&D SYSTEMATIC	EXTERNAL FUNDING	INTEK SUBSIDY	R&D EMPLOYEES IN THE BASQUE COUNTRY (FTE)	NUMBER OF PHDS IN THE FIRMS	TOTAL PRIVATE R&D EXPENDITURE
GROUP_TEC010	1	-0.045927137	-0.115841745	-0.112852154	-0.063289449	-0.11833172	-0.031251768	-0.054766122	0.022479404	-0.068472676	-0.07843003	-0.064521842	-0.018198896	-0.026479927	-0.022004563	-0.009450268
GROUP_TEC020	-0.045927137	1	-0.128537958	-0.12522071	-0.07022595	-0.13130083	-0.034676951	-0.06076847	-0.009252893	0.009711232	0.10852281	0.12852634	0.040072333	0.036819007	0.054723932	0.021644729
GROUP_TEC040	-0.115841745	-0.128537958	1	-0.31584345	-0.177130495	-0.3311793	-0.087465466	-0.153275949	0.221828488	0.132460118	0.07355135	0.026664489	0.047743275	0.048051937	0.036120995	0.069963579
GROUP_TEC060	-0.112852154	-0.12522071	-0.31584345	1	-0.172559193	-0.32263238	-0.085208197	-0.149320273	0.204353741	0.079854287	-0.06261474	-0.103351248	-0.008540498	-0.071569571	-0.068504611	-0.049861218
GROUP_TEC080	-0.063289449	-0.07022595	-0.177130495	-0.172559193	1	-0.18093785	-0.047786238	-0.083741404	0.039609621	-0.03053742	-0.02672899	-0.122924766	-0.102025829	-0.070136718	-0.037070556	-0.048624133
GROUP_TEC100	-0.118331718	-0.131300831	-0.331179304	-0.322632381	-0.180937845	1	-0.089345501	-0.156570555	-0.360823916	-0.147355743	0.03705879	0.13837354	0.051649574	0.090248001	0.039565232	0.029388537
GROUP_TEC120	-0.031251768	-0.034676951	-0.087465466	-0.085208197	-0.047786238	-0.0893455	1	-0.041350762	-0.061546052	-0.051699795	-0.06014024	0.033525798	0.007583667	-0.011822577	0.049475446	-0.01776377
GROUP_TEC140	-0.054766122	-0.06076847	-0.153275949	-0.149320273	-0.083741404	-0.15657055	-0.041350762	1	-0.118137825	0.003680608	-0.05001525	-0.051518271	-0.066156808	-0.04220512	-0.032009568	-0.032076835
EMPLOYMENT	0.022479404	-0.009252893	0.221828488	0.204353741	0.039609621	-0.36082392	-0.061546052	-0.118137825	1	0.227870619	0.14838465	0.166208963	0.120993848	0.201653874	0.105398214	0.229769821
FOREIGN OWNERSHIP	-0.068472676	0.009711232	0.132460118	0.079854287	-0.03053742	-0.14735574	-0.051699795	0.003680608	0.227870619	1	0.03871909	-0.038154046	-0.014703623	-0.027565366	0.013023228	-0.009014604
R&D SYSTEMATIC	-0.078430033	0.108522814	0.073551346	-0.062614736	-0.026728988	0.03705879	-0.060140243	-0.050015251	0.148384648	0.038719088	1	0.213657997	0.073619651	0.12870303	0.075732658	0.106531881
EXTERNAL FUNDING	-0.064521842	0.12852634	0.026664489	-0.103351248	-0.122924766	0.13837354	0.033525798	-0.051518271	0.166208963	-0.038154046	0.213658	1	0.377907903	0.514942047	0.253408757	0.313243366
INTEK SUBSIDY	-0.018198896	0.040072333	0.04774327	-0.008540498	-0.10202583	0.051649574	0.007583667	-0.066156808	0.120993848	-0.014703623	0.07361965	0.377907903	1	0.183123742	0.081452972	0.127123804

R&D EMPLOYEES IN THE BASQUE COUNTRY (FTE)	-0.026479927	0.036819007	0.04805194	-0.071569571	-0.07013672	0.090248001	-0.011822577	-0.04220512	0.201653874	-0.027565366	0.12870303	0.514942047	0.183123742	1	0.351442115	0.711656944
NUMBER OF PHDS IN THE FIRMS	-0.022004563	0.054723932	0.03612099	-0.068504611	-0.03707056	0.039565232	0.049475446	-0.032009568	0.105398214	0.013023228	0.07573266	0.253408757	0.081452972	0.351442115	1	0.203436591
TOTAL PRIVATE R&D EXPENDITURE	-0.009450268	0.021644729	0.069963579	-0.049861218	-0.048624133	0.029388537	-0.01776377	-0.032076835	0.229769821	-0.009014604	0.106531881	0.313243366	0.127123804	0.711656944	0.203436591	1

b) Correlation matrix for the variables measuring output additionality

	GROUP_TEC010	GROUP_TEC020	GROUP_TEC040	GROUP_TEC060	GROUP_TEC080	GROUP_TEC100	GROUP_TEC120	GROUP_TEC140	EMPLOYMENT	FOREIGN OWNERSHIP	R&D SYSTEMATIC	EXTERNAL FUNDING	TOTAL PRIVATE R&D EXPENDITURE	FIRM SALES	NUMBER OF PATENTS	PATENT PROB	R&D INTENSITY	PRODUCTIV
GROUP_TEC010	1	-0.045927137	-0.115841745	-0.112852154	-0.063289449	-0.11833172	-0.031251768	-0.054766122	0.022479404	-0.068472676	-0.07843003	-0.064521842	-0.009450268	0.096328091	-0.020062185	-0.005922542	-0.03905785	-0.001948667
GROUP_TEC020	-0.045927137	1	-0.128537958	-0.12522071	-0.07022595	-0.13130083	-0.034676951	-0.06076847	-0.009252893	0.009711232	0.10852281	0.12852634	0.021644729	-0.019713576	0.0559982	0.091544121	0.006949674	-0.009342785
GROUP_TEC040	-0.115841745	-0.128537958	1	-0.31584345	-0.177130495	-0.3311793	-0.087465466	-0.153275949	0.221828488	0.132460118	0.07355135	0.026664489	0.069963579	-0.002834462	0.039345192	0.015864801	-0.075003893	-0.011729826
GROUP_TEC060	-0.112852154	-0.12522071	-0.31584345	1	-0.172559193	-0.32263238	-0.085208197	-0.149320273	0.204353741	0.079854287	-0.06261474	-0.103351248	-0.049861218	0.030568661	0.021529473	0.021025857	-0.111942147	0.05089417
GROUP_TEC080	-0.063289449	-0.07022595	-0.177130495	-0.172559193	1	-0.18093785	-0.047786238	-0.083741404	0.039609621	-0.03053742	-0.02672899	-0.122924766	-0.048624133	-0.027275634	-0.037471352	-0.041663886	-0.079447569	-0.009779142
GROUP_TEC100	-0.118331718	-0.131300831	-0.331179304	-0.322632381	-0.180937845	1	-0.089345501	-0.156570555	-0.360823916	-0.147355743	0.03705879	0.13837354	0.029388537	-0.038698304	-0.047254906	-0.04937645	0.241374169	-0.026178278
GROUP_TEC120	-0.031251768	-0.034676951	-0.087465466	-0.085208197	-0.047786238	-0.0893455	1	-0.041350762	-0.061546052	-0.051699795	-0.06014024	0.033525798	-0.01776377	-0.016336348	-0.025493051	-0.033771195	0.044427419	-0.010512155
GROUP_TEC140	-0.054766122	-0.06076847	-0.153275949	-0.149320273	-0.083741404	-0.15657055	-0.041350762	1	-0.118137825	0.003680608	-0.05001525	-0.051518271	-0.032076835	0.002686514	0.003314556	0.016325851	-0.012603956	0.006260226
EMPLOYMENT	0.022479404	-0.009252893	0.221828488	0.204353741	0.039609621	-0.36082392	-0.061546052	-0.118137825	1	0.227870619	0.14838465	0.166208963	0.229769821	0.189943099	0.168634006	0.168031663	-0.19701098	0.040236612
FOREIGN OWNERSHIP	-0.068472676	0.009711232	0.132460118	0.079854287	-0.03053742	-0.14735574	-0.051699795	0.003680608	0.227870619	1	0.03871909	-0.038154046	-0.009014604	0.040013457	-0.00273083	0.00123587	-0.079728073	-0.003854801
R&D SYSTEMATIC	-0.078430033	0.108522814	0.073551346	-0.062614736	-0.026728988	0.03705879	-0.060140243	-0.050015251	0.148384648	0.038719088	1	0.213657997	0.106531881	0.063079809	0.088997043	0.111908954	0.089017065	0.033255073
EXTERNAL FUNDING	-0.064521842	0.12852634	0.026664489	-0.103351248	-0.122924766	0.13837354	0.033525798	-0.051518271	0.166208963	-0.038154046	0.213658	1	0.313243366	0.117046418	0.159894721	0.165974265	0.244369941	0.03770451

TOTAL PRIVATE R&D EXPENDITURE	-0.009450268	0.021644729	0.069963579	-0.049861218	-0.048624133	0.02938854	-0.01776377	-0.032076835	0.229769821	-0.009014604	0.10653188	0.313243366	1	0.141525667	0.17894437	0.250126928	0.094108645	0.007937513
FIRM SALES	0.096328091	-0.019713576	-0.002834462	0.030568661	-0.027275634	-0.0386983	-0.016336348	0.002686514	0.189943099	0.040013457	0.06307981	0.117046418	0.141525667	1	0.053605651	0.037375744	-0.030852772	0.766375929
NUMBER OF PATENTS	-0.020062185	0.0559982	0.039345192	0.021529473	-0.037471352	-0.04725491	-0.025493051	0.003314556	0.168634006	-0.00273083	0.08899704	0.159894721	0.17894437	0.053605651	1	0.754875601	-0.01449947	0.000542879
PATENT PROB	-0.005922542	0.091544121	0.015864801	0.021025857	-0.041663886	-0.04937645	-0.033771195	0.016325851	0.168031663	0.00123587	0.11190895	0.165974265	0.250126928	0.037375744	0.754875601	1	-0.005470926	0.001350565
R&D INTENSITY	-0.03905785	0.006949674	-0.075003893	-0.111942147	-0.079447569	0.24137417	0.044427419	-0.012603956	-0.19701098	-0.079728073	0.08901706	0.244369941	0.094108645	-0.030852772	-0.01449947	-0.005470926	1	-0.017942251
PRODUCTIV	-0.001948667	-0.009342785	-0.011729826	0.05089417	-0.009779142	-0.02617828	-0.010512154	0.006260226	0.040236611	-0.0038548	0.03325507	0.03770451	0.007937513	0.766375929	0.000542879	0.001350565	-0.017942251	1

c) Correlation matrix for the variables measuring behavioural additionality

	GROUP_TEC010	GROUP_TEC020	GROUP_TEC040	GROUP_TEC060	GROUP_TEC080	GROUP_TEC100	GROUP_TEC120	GROUP_TEC140	EMPLOYMENT	FOREIGN OWNERSHIP	R&D SYSTEMATIC	EXTERNAL FUNDING	CHANGE IN R&D SYSTEMATIC	PARTICIPATION IN UE FUNDING PROJECTS	PHD EMPLOYMENT
GRUP_TEC010	1	-0.045927137	-0.115841745	-0.112852154	-0.063289449	-0.11833172	-0.031251768	-0.054766122	0.022479404	-0.068472676	-0.07843003	-0.064521842	0.054747974	0.007872985	-0.03842759
GRUP_TEC020	-0.045927137	1	-0.128537958	-0.12522071	-0.07022595	-0.13130083	-0.034676951	-0.06076847	-0.009252893	0.009711232	0.10852281	0.12852634	-0.047681335	-0.025481753	0.02931198
GRUP_TEC040	-0.115841745	-0.128537958	1	-0.31584345	-0.177130495	-0.3311793	-0.087465466	-0.153275949	0.221828488	0.132460118	0.07355135	0.026664489	-0.040471941	-0.000612701	-0.0395582
GRUP_TEC060	-0.112852154	-0.12522071	-0.31584345	1	-0.172559193	-0.32263238	-0.085208197	-0.149320273	0.204353741	0.079854287	-0.06261474	-0.103351248	0.00088331	-0.036065554	-0.06618385
GRUP_TEC080	-0.063289449	-0.07022595	-0.177130495	-0.172559193	1	-0.18093785	-0.047786238	-0.083741404	0.039609621	-0.03053742	-0.02672899	-0.122924766	0.012576293	-0.032121098	-0.05099775
GRUP_TEC100	-0.118331718	-0.131300831	-0.331179304	-0.322632381	-0.180937845	1	-0.089345501	-0.156570555	-0.360823916	-0.147355743	0.03705879	0.13837354	0.020134233	0.082788854	0.08213885
GRUP_TEC120	-0.031251768	-0.034676951	-0.087465466	-0.085208197	-0.047786238	-0.0893455	1	-0.041350762	-0.061546052	-0.051699795	-0.06014024	0.033525798	0.063689729	-0.02001632	0.15560435
GRUP_TEC140	-0.054766122	-0.06076847	-0.153275949	-0.149320273	-0.083741404	-0.15657055	-0.041350762	1	-0.118137825	0.003680608	-0.05001525	-0.051518271	-0.020635946	-0.025640386	-0.01102696
EMPLOYMENT	0.022479404	-0.009252893	0.221828488	0.204353741	0.039609621	-0.36082392	-0.061546052	-0.118137825	1	0.227870619	0.14838465	0.166208963	-0.078646603	0.143368458	-0.22533966
FOREIGN OWNERSHIP	-0.068472676	0.009711232	0.132460118	0.079854287	-0.03053742	-0.14735574	-0.051699795	0.003680608	0.227870619	1	0.03871909	-0.038154046	-0.032961828	-0.033305017	-0.06068505
R&D SYSTEMATIC	-0.078430033	0.108522814	0.073551346	-0.062614736	-0.026728988	0.03705879	-0.060140243	-0.050015251	0.148384648	0.038719088	1	0.213657997	-0.127643941	0.069308715	0.01380568
EXTERNAL FUNDING	-0.064521842	0.12852634	0.026664489	-0.103351248	-0.122924766	0.13837354	0.033525798	-0.051518271	0.166208963	-0.038154046	0.213658	1	-0.143361938	0.259690543	0.04565122

CHANGE IN R&D SYSTEMATIC	0.054747974	-0.047681335	-0.040471941	0.00088331	0.01257629	0.02013423	0.06368973	-0.02063595	-0.078646603	-0.032961828	-0.12764394	-0.14336194	1	-0.055406731	-0.02040764
PARTICIPATION IN UE FUNDING PROJECTS	0.007872985	-0.025481753	-0.000612701	-0.036065554	-0.0321211	0.08278885	-0.02001632	-0.02564039	0.143368458	-0.033305017	0.06930871	0.25969054	-0.055406731	1	0.05115958
PHD EMPLOYMENT	-0.038427594	0.02931198	-0.039558204	-0.066183852	-0.05099775	0.08213885	0.15560435	-0.01102696	-0.225339656	-0.060685052	0.01380568	0.04565122	-0.020407643	0.051159581	1

d) Correlation matrix for the variables measuring collaboration

	GROUP_TEC010	GROUP_TEC020	GROUP_TEC040	GROUP_TEC060	GROUP_TEC080	GROUP_TEC100	GROUP_TEC120	GROUP_TEC140	EMPLOYMENT	FOREIGN OWNERSHIP	R&D SYSTEMATIC	EXTERNAL FUNDING	COLLABORATION	INTEK SUBSIDY	TOTAL EXTERNAL EXPENDITURE	EXTERNAL EXPENDITURE IN TECHNOLOGY CENTRES	EXTERNAL EXPENDITURE IN OTHER FIRMS	EXTERNAL EXPENDITURE IN PUBLIC ADMINISTRATIONS	EXTERNAL EXPENDITURE IN PRIVATE INSTITUTIONS	EXTERNAL EXPENDITURE IN FOREIGN FIRMS	EXTERNAL EXPENDITURE IN UNIVERSITIES
GROUP_TEC010	1	-0.045927137	-0.115841745	-0.112852154	-0.063289449	-0.11833172	-0.031251768	-0.054766122	0.022479404	-0.068472676	-0.07843003	-0.064521842	0.08571933	-0.075940084	0.0164357	0.00272799	0.04327132	0.21286038	0.000207	-0.0015696	0.0676708
GROUP_TEC020	-0.045927137	1	-0.128537958	-0.12522071	-0.07022595	-0.13130083	-0.034676951	-0.06076847	-0.009252893	0.009711232	0.10852281	0.12852634	0.024857	0.091078301	-0.000724257	0.017772503	0.01701246	-0.004207231	0.005289341	-0.012695671	0.002610742
GROUP_TEC040	-0.115841745	-0.128537958	1	-0.31584345	-0.177130495	-0.3311793	-0.087465466	-0.153275949	0.221828488	0.132460118	0.07355135	0.026664489	-0.16417418	0.116956474	0.105056881	0.148030526	0.07669918	0.049681103	0.057157838	0.080319611	0.076271809
GROUP_TEC060	-0.112852154	-0.12522071	-0.31584345	1	-0.172559193	-0.32263238	-0.085208197	-0.149320273	0.204353741	0.079854287	-0.06261474	-0.103351248	-0.04872028	-0.047664229	-0.041120036	-0.041111526	-0.04324878	-0.055779766	-0.031376371	-0.026647898	-0.037726467
GROUP_TEC080	-0.063289449	-0.07022595	-0.177130495	-0.172559193	1	-0.18093785	-0.047786238	-0.083741404	0.039609621	-0.030537422	-0.02672899	-0.122924766	0.06751173	-0.090289609	-0.030197442	-0.040606136	-0.03913735	-0.026676602	-0.014202936	-0.01508066	-0.026994148
GROUP_TEC100	-0.118331718	-0.131300831	-0.331179304	-0.322632381	-0.180937845	1	-0.089345501	-0.156570555	-0.360823916	-0.147355743	0.03705879	0.13837354	0.12076248	0.037569732	-0.034357794	-0.066494696	-0.01604769	-0.052490563	-0.011425497	-0.027644407	-0.035307363
GROUP_TEC120	-0.031251768	-0.034676951	-0.087465466	-0.085208197	-0.047786238	-0.0893455	1	-0.041350762	-0.061546052	-0.051699795	-0.06014024	0.033525798	0.05212229	-0.106432336	-0.017915258	-0.027181975	-0.02078798	-0.016697617	-0.009672556	-0.009332554	-0.020171511
GROUP_TEC140	-0.054766122	-0.06076847	-0.153275949	-0.149320273	-0.083741404	-0.15657055	-0.041350762	1	-0.118137825	0.003680608	-0.05001525	-0.051518271	-0.03689706	-0.061978905	-0.025689416	-0.034336957	-0.03148008	-0.023868129	-0.012115409	-0.013714059	-0.023394504
EMPLOYMENT	0.022479404	-0.009252893	0.221828488	0.204353741	0.039609621	-0.36082392	-0.061546052	-0.118137825	1	0.227870619	0.14838465	0.166208963	-0.01605454	0.335265931	0.167555547	0.200669277	0.20576279	0.097382184	0.123242478	0.089952921	0.148425134
FOREIGN OWNERSHIP	-0.068472676	0.009711232	0.132460118	0.079854287	-0.03053742	-0.14735574	-0.051699795	0.003680608	0.227870619	1	0.03871909	-0.038154046	-0.07417866	0.014258981	0.00036858	0.014256009	-0.03088643	-0.013592504	-0.014130233	0.015567385	-0.031589999
R&D SYSTEMATIC	-0.078430033	0.108522814	0.073551346	-0.062614736	-0.026728988	0.03705879	-0.060140243	-0.050015251	0.148384648	0.038719088	1	0.213657997	-0.06358045	0.243211154	0.054067746	0.066144494	0.07874514	0.055523461	0.03411232	0.023190565	0.048024228
EXTERNAL FUNDING	-0.064521842	0.12852634	0.026664489	-0.103351248	-0.122924766	0.13837354	0.033525798	-0.051518271	0.166208963	-0.038154046	0.213658	1	0.08325278	0.483742202	0.18534988	0.249605445	0.22657963	0.111969968	0.093133546	0.097723886	0.191885522
COLLABORATION	0.085719332	0.024857004	-0.16417418	-0.048720277	0.06751173	0.120762477	0.052122289	-0.036897059	-0.016054537	-0.074178655	-0.06358045	0.08325278	1	0.284398106	0.056116424	0.091997065	0.07393282	0.016036908	0.011255262	0.025840918	0.055238369
INTEK SUBSIDY	-0.075940084	0.091078301	0.11695647	-0.047664229	-0.09028961	0.037569732	-0.106432336	-0.061978905	0.335265931	0.014258981	0.24321115	0.4837422	0.28439811	1	0.174210918	0.244099983	0.20714591	0.046877148	0.117416354	0.091761643	0.160259453
TOTAL EXTERNAL EXPENDITURE	0.0164357	-0.000724257	0.10505688	-0.041120036	-0.03019744	-0.034357794	-0.017915258	-0.025689416	0.167555547	0.00036858	0.05406775	0.18534988	0.05611642	0.174210918	1	0.298144928	0.84970157	0.077928135	0.109888966	0.942176495	0.357609084

EXTERNAL EXPENDITURE IN TECHNOLOGY CENTRES	0.00272799	0.017772503	0.14803053	-0.041111526	-0.04060614	-0.066494696	-0.027181975	-0.034336957	0.200669277	0.014256009	0.06614449	0.24960545	0.09199706	0.244099983	0.298144928	1	0.26400705	0.0165393	-0.001809046	0.124571974	0.185330784
EXTERNAL EXPENDITURE IN OTHER FIRMS	0.043271319	0.017012463	0.07669918	-0.043248777	-0.03913735	-0.01604769	-0.020787977	-0.031480084	0.205762792	-0.030886435	0.07874514	0.22657963	0.07393282	0.20714591	0.84970157	0.264007054	1	0.154701527	0.097500834	0.653836792	0.548014027
EXTERNAL EXPENDITURE IN PUBLIC ADMINISTRATIONS	0.21286038	-0.004207231	0.0496811	-0.055779766	-0.0266766	-0.052490563	-0.016697617	-0.023868129	0.097382184	-0.013592504	0.05552346	0.11196997	0.01603691	0.046877148	0.077928136	0.0165393	0.15470153	1	0.009950741	0.021106127	0.189126454
EXTERNAL EXPENDITURE IN PRIVATE INSTITUTIONS	0.000207	0.005289341	0.05715784	-0.031376371	-0.01420294	-0.011425497	-0.009672556	-0.012115409	0.123242478	-0.014130233	0.03411232	0.09313355	0.01125526	0.117416354	0.109888966	-0.001809046	0.09750083	0.009950741	1	0.012952599	0.40629107
EXTERNAL EXPENDITURE IN FORREIGN FIRMS	-0.001569629	-0.012695671	0.08031961	-0.026647898	-0.01508066	-0.027644407	-0.009332554	-0.013714059	0.089952921	0.015567385	0.02319057	0.09772389	0.02584092	0.091761643	0.942176495	0.124571974	0.65383679	0.021106127	0.012952599	1	0.139850688
EXTERNAL EXPENDITURE IN UNIVERSITIES	0.067670824	0.002610742	0.07627181	-0.037726467	-0.02699415	-0.035307363	-0.020171511	-0.023394504	0.148425134	-0.031589999	0.04802423	0.19188552	0.05523837	0.160259453	0.357609084	0.185330784	0.54801403	0.189126454	0.40629107	0.139850688	1

ANNEX 5: MATCHING RESULTS FOR ALL THE POPULATION

In this annex we show the matching results for all the subsidized firms. Concretely, the matching procedure is carried out between all the subsidized firms and firms that, although carry out R&D projects, have not received any Intek subsidy.

Summary of balance for all data:

	Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
distance	0.625	0.517	0.141	0.107	0.085	0.107	0.231
FOREIGN OWNERSHIP	0.097	0.108	0.310	-0.010	0.000	0.011	1,000
GROUP_TEC010	0.038	0.042	0.200	-0.003	0.000	0.004	1,000
GROUP_TEC020	0.053	0.042	0.200	0.012	0.000	0.011	1,000
GROUP_TEC040	0.257	0.229	0.420	0.028	0.000	0.026	1,000
GROUP_TEC060	0.235	0.236	0.425	-0.002	0.000	0.002	1,000
GROUP_TEC080	0.066	0.119	0.324	-0.053	0.000	0.053	1,000
GROUP_TEC100	0.270	0.229	0.420	0.041	0.000	0.042	1,000
GROUP_TEC120	0.026	0.019	0.136	0.007	0.000	0.008	1,000
EXTERNAL FUNDING	1,385	0.639	0.977	0.746	0.751	0.743	2,058
R&D SIST	0.713	0.675	0.469	0.038	0.000	0.038	1,000
SIZE	1,608	1,515	0.568	0.093	0.112	0.118	0.660

Summary of balance for matched data:

	Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
distance	0.700	0.517	0.141	0.183	0.187	0.183	0.271
FOREIGN OWNERSHIP	0.079	0.108	0.310	-0.028	0.000	0.028	1,000
GROUP_TEC010	0.042	0.042	0.200	0.000	0.000	0.000	0.000
GROUP_TEC020	0.064	0.042	0.200	0.023	0.000	0.023	1,000
GROUP_TEC040	0.278	0.229	0.420	0.049	0.000	0.049	1,000
GROUP_TEC060	0.229	0.236	0.425	-0.008	0.000	0.008	1,000
GROUP_TEC080	0.051	0.119	0.324	-0.068	0.000	0.068	1,000
GROUP_TEC100	0.263	0.229	0.420	0.034	0.000	0.034	1,000
GROUP_TEC120	0.032	0.019	0.136	0.013	0.000	0.013	1,000
EXTERNAL FUNDING	1,906	0.639	0.977	1267	1306	1267	2,364
R&D SIST	0.701	0.675	0.469	0.026	0.000	0.026	1,000
SIZE	1,685	1,515	0.568	0.170	0.171	0.173	0.766

Percent Balance Improvement:

	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
distance	-70.39	-119.65	-71.01	-17.58
FOREIGN OWNERSHIP	-173.79	0.00	-150.00	0.00
GROUP_TEC010	100.00	0.00	100.00	100.00
GROUP_TEC020	-90.46	0.00	-100.00	0.00
GROUP_TEC040	-76.91	0.00	-85.71	0.00
GROUP_TEC060	-337.84	0.00	-300.00	0.00
GROUP_TEC080	-27.80	0.00	-28.57	0.00
GROUP_TEC100	18.01	0.00	18.18	0.00
GROUP_TEC120	-84.82	0.00	-75.00	0.00
EXTERNAL FUNDING	-69.90	-73.81	-70.45	-14.85
R&D SIST	31.17	0.00	30.00	0.00
SIZE	-83.46	-52.28	-45.96	-16.09

Sample sizes:	Control	Treated
All	529	729
Matched	529	529
Unmatched	0	200
Discarded	0	0

ANNEX 6: MATCHING RESULTS FOR COLLABORATIVE FIRMS

In this annex we show the matching results for all the subsidized firms. Concretely, the matching procedure is carried out between the subsidized and collaborative firms and firms that, although carry out R&D subsidized projects, they have carried out subsidized and individual projects.

Summary of balance for all data:

	Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
distance	0.715	0.650	0.113	0.065	0.067	0.065	0.101
FOREIGN OWNERSHIP	0.083	0.131	0.338	-0.048	0.000	0.050	1000
GROUP_TEC010	0.049	0.014	0.116	0.036	0.000	0.036	1000
GROUP_TEC020	0.057	0.045	0.208	0.012	0.000	0.014	1000
GROUP_TEC040	0.209	0.365	0.482	-0.156	0.000	0.158	1000
GROUP_TEC060	0.221	0.266	0.443	-0.045	0.000	0.045	1000
GROUP_TEC080	0.077	0.041	0.198	0.036	0.000	0.036	1000
GROUP_TEC100	0.306	0.189	0.393	0.117	0.000	0.117	1000
GROUP_TEC120	0.032	0.014	0.116	0.018	0.000	0.018	1000
R&D SYSTEMATIC	1,306	1243	0.430	0.062	0.000	0.063	1000
SIZE	1601	1624	0.583	-0.023	0.128	0.130	0.322
EXTERNAL FUNDING	1451	1234	1110	0.217	0.167	0.215	1369

Summary of balance for matched data:							
	Means Treated	**Means Control**	**SD Control**	**Mean Diff**	**eQQ Med**	**eQQ Mean**	**eQQ Max**
distance	0.820	0.650	0.113	0.170	0.176	0.170	0.336
FOREIGN OWNERSHIP	0.032	0.131	0.338	-0.099	0.000	0.099	1000
GROUP_TEC010	0.113	0.014	0.116	0.099	0.000	0.099	1000
GROUP_TEC020	0.068	0.045	0.208	0.023	0.000	0.023	1000
GROUP_TEC040	0.005	0.365	0.482	-0.360	0.000	0.360	1000
GROUP_TEC060	0.041	0.266	0.443	-0.225	0.000	0.225	1000
GROUP_TEC080	0.162	0.041	0.198	0.122	0.000	0.122	1000
GROUP_TEC100	0.532	0.189	0.393	0.342	0.000	0.342	1000
GROUP_TEC120	0.072	0.014	0.116	0.059	0.000	0.059	1000
R&D SYSTEMATIC	1,401	1243	0.430	0.158	0.000	0.158	1000
SIZE	1518	1624	0.583	-0.106	0.160	0.161	0.354
EXTERNAL FUNDING	1792	1234	1110	0.558	0.513	0.558	1673

Percent Balance Improvement

	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
distance	-161.3	-164.09	-161.82	-234451
FOREIGN OWNERSHIP	-107.4	0.00	-100.00	0.000
GROUP_TEC010	-176.8	0.00	-175.00	0.000
GROUP_TEC020	-85.3	0.00	-66.67	0.000
GROUP_TEC040	-131.3	0.00	-128.57	0.000
GROUP_TEC060	-402.1	0.00	-400.00	0.000
GROUP_TEC080	-234.3	0.00	-237.50	0.000
GROUP_TEC100	-193.8	0.00	-192.31	0.000
GROUP_TEC120	-224.5	0.00	-225.00	0.000
R&D SYSTEMATIC	-152.3	0.00	-150.00	0.000
SIZE	-359.4	-24.63	-23.80	-9941
EXTERNAL FUNDING	-157.5	-206.53	-159.36	-22187

Sample sizes:

	Control	Treated
All	222	507
Matched	222	222
Unmatched	0	285
Discarded	0	0

Eustat
EUSKAL ESTATISTIKA ERAKUNDEA
INSTITUTO VASCO DE ESTADISTICA

IKERKETA ZIENTIFIKO ETA GARAPEN TEKNOLOGIKOKO (I+Gko) JARDUEREI BURUZKO ESTATISTIKA

ESTADÍSTICA SOBRE ACTIVIDADES DE INVESTIGACIÓN CIENTÍFICA Y DESARROLLO TECNOLÓGICO (I+D)

2009

Erakunde Autonomiaduna
Organismo Autónomo del

EUSKO JAURLARITZA
GOBIERNO VASCO

ENPRESAREN GALDEKETA
CUESTIONARIO DE EMPRESA

ENPRESAREN JARDUERAK FAKTURAZIO-BOLUMENAREN ARABERA ACTIVIDAD PRINCIPAL DE LA EMPRESA SEGÚN VOLUMEN DE FACTURACIÓN	**BATEZ BESTEKO ENPLEGUA** EMPLEO MEDIO
....	**Euskal AEn** En la C.A. de Euskadi
....	**Enpresan** En la empresa

IDENTIFIKAZIO-ALDAKETA / MODIFICACIÓN EN LA IDENTIFICACIÓN

IFZren letra Letra CIF | **IFZ/NAN** - CIF/DNI | **NANen letra** Letra DNI

JABEA EDO IZEN SOZIALA:
PROPIETARIO O DENOMINACIÓN SOCIAL: ....

HELBIDEA:
DIRECCIÓN: ....

UDALERRIA:
MUNICIPIO: ....

LURRALDE HISTORIKOA:
TERRITORIO HISTÓRICO: ....

POSTA-KODEA:
CÓDIGO POSTAL:

TELEFONOA:
TELÉFONO:

FAXA:
FAX:

Webgunearen helbidea / Dirección del sitio Web **http://** ....

JARRAIBIDE OROKORRAK / INSTRUCCIONES GENERALES

Edozein informaziotarako, zure eskura gaituzu / Para cualquier consulta estamos a su disposición:

Doako telefonoa
Teléfono gratuíto: 900 840 040

BULEGOA:
OFICINA: BILBAO: Máximo Aguirre, 18 bis-3º

Faxa:
Fax: 944 031 378

e-mail: i+d@eustat.es

ESTATISTIKA SEKRETUPEKO INFORMAZIOA
INFORMACION SUJETA A SECRETO ESTADISTICO

Galdesorta hau beteta lortuko ditugun datuak "Ikerkuntza zientifikoko eta garapen teknologikoko jarduerei buruzko estatistika" egiteko erabiliko dira eta datu horiek tratatzeko, fitxategi automatizatu batean sartuko dira. Estatistika-eragiketa hori 043201 zenbakiarekin arautzen du otsailaren 17ko Euskal Estatistika Planaren 2/2005 Legeak.
EUSKAL AUTONOMIA ERKIDEGOKO ESTATISTIKA LEGEA:
-9tik 16ra bitarteko artikuluak: Euskal Estatistika Planaren Legearen arabera, behartuta zaude eskatzen zaizun estatistika-informazioa ematera.
-19tik 23ra bitarteko artikuluak: emandako datu guztiak estatistika-sekretupean babestuko dira.
Nahi izanez gero, datuetara heltzeko, zuzentzeko eta ezabatzeko eskubideak erabil ditzakezu Eustaten Zuzendaritza Nagusian: Donostia-San Sebastian kalea, 1. 01010 Vitoria-Gasteiz

Los datos obtenidos mediante este cuestionario se utilizarán para la "Estadística sobre actividades de investigación científica y desarrollo tecnológico", operación estadística regulada con el número 043201 en la Ley 2/2005, de 17 de febrero, del Plan Vasco de Estadística, y a tal fin, se incorporarán a un fichero automatizado para su tratamiento.
LEY DE ESTADÍSTICA DE LA COMUNIDAD AUTÓNOMA DE EUSKADI:
- Artículos 9 al 16: en relación con la Ley del Plan Vasco de Estadística, Vd. está obligado a suministrar la información estadística que se le requiere.
- Artículos 19 al 23: todos los datos suministrados quedan amparados por el secreto estadístico.
Si lo desea, tiene la posibilidad de ejercitar los derechos de acceso, rectificación y cancelación ante la Dirección General de Eustat, C/ Donostia-San Sebastián 1, 01010 Vitoria-Gasteiz.

1. ENPRESAREN DATU OROKORRAK
DATOS GENERALES DE LA EMPRESA

Euro / Euros

1.1. NEGOZIO-ZIFRA 2009AN (Ez sartu BEZa eta Baliokidetasun-Errekargua).
CIFRA DE NEGOCIOS EN 2009 (Excluir el IVA y el Recargo de Equivalencia).

1.2. ENPRESA-MOTA / CLASE DE EMPRESA
(**Adierazi X batez /** Señale con una X)

Publikoa / Pública . . . .

Pribatua / Privada . . . .

Pribatu multinazionala (atzerri-kapitalak gutxienez %50eko parte hartzea duena)
Privada multinacional (con participación de al menos un 50% de capital extranjero) . . . .

Ikerketa-elkartea eta ikerketako beste erakunde batzuk
Centros tecnológicos o asociaciones de investigación . . . .

1.3. I+GKO JARDUERAK HASI ZIREN URTEA / AÑO EN EL QUE SE INICIARON LAS ACTIVIDADES DE I+D

1.4. I+GKO BARRUKO JARDUEREN IZAERA / CARÁCTER DE LAS ACTIVIDADES INTERNAS DE I+D

Enpresako I+Gko barruko jardueren izaera jarraia edota sistematikoa izango da, enpresak, gutxienez, pertsona bat urte osoko dedikazioan erabiltzen duenean, eta bide horretan jarraitzeko asmoa duenean. (Adierazi X batez)
Las actividades internas de I+D de la empresa tendrán carácter sistemático o continuo cuando ésta venga empleando, al menos, a una persona en equivalencia a dedicación plena y tenga previsto continuar en esta línea. (Señale con una X)

I+Gko jarduerak sistematikoak edo jarraiak dira / Las actividades de I+D son sistemáticas o continuas

I+Gko jarduerak noizbehinkakoak dira / Las actividades de I+D son ocasionales . . . .

2. I+Gko JARDUERETAN ENPLEGATUTAKO PERTSONALA 2009an
PERSONAL EMPLEADO EN ACTIVIDADES I+D EN 2009

2.1. IKERKETAKO BEKADUNAK, KOKAPEN GEOGRAFIKOEN ARABERA
BECARIOS DE INVESTIGACIÓN SEGÚN SU UBICACIÓN GEOGRÁFICA

Aurreko galderetan idatzitako ikertzaileen guztizkotik, xehekatu sexuka ikerketako bekadunak direnak, nolako beka duten eta beka zein erakundek eman dien kontuan hartu gabe.
Del total de investigadores de la empresa, indique los que sean becarios de investigación, independientemente del tipo de beca concedida y del organismo que la conceda.

		GUZTIRA / TOTAL		**Euskal AE** / C.A. de Euskadi	
		Guztira Total	**Emakumezkoak** Mujeres	**Guztira** Total	**Emakumezkoak** Mujeres
Bekadunak Becarios	**Pertsona kop.** Nº Personas				
	DOB / E.D.P.*				

* **Dedikazio osoaren baliokidetza. Hamartar batekin idatziko da.** / Equivalencia dedicación plena. Se consignará con 1 decimal.

2.2. IKERKETAKO BEKAK
BECAS DE INVESTIGACIÓN

Kalkulatu 2009. urtean emandako ikerketako beken zenbateko osoa, nolako bekak diren eta beka zein erakundek eman duen kontuan hartu gabe. Zenbaki hori ondorengo 3.1.1. galderaren atalari (*ikertzaileen ordainsariak*) erantsi beharko zaio.
Estime el importe total de las becas de investigación concedidas para el año 2009, independientemente del tipo de beca concedida y del organismo que la haya concedido. Esta cifra deberá incluirse en la partida de retribución a investigadores del apartado 3.1.1.

Euro / Euros

Ikerketako beken zenbatekoa
Importe de las becas de investigación . . . .

2.3. I+Gn ENPLEGATUTAKO LANGILEAK, OKUPAZIOAREN ETA KOKAPEN GREOGAFIKOAREN ARABERA
PERSONAL EMPLEADO EN I+D, SEGÚN SU OCUPACIÓN Y UBICACIÓN GEOGRÁFICA

Ikertzaileetan sartu behar dituzu 2.1. atalean aipatutako ikerketako bekadunak.
Debe incluir en investigadores los becarios de investigación reseñados en el apartado 2.1.

		GUZTIRA / TOTAL		**Ikertzaileak** / Investigadores		**Teknikariak** / Técnicos		**Laguntzaileak** / Auxiliares	
		Guztira Total	**Emakumezkoak** Mujeres	**Guztira** Total	**Emakumezkoak** Mujeres	**Guztira** Total	**Emakumezkoak** Mujeres	**Guztira** Total	**Emakumezkoak** Mujeres
Euskal AE C.A. de Euskadi	**Pertsona Kop.** Nº Personas								
	DOB / E.D.P.*								
Araba Álava	**Pertsona Kop.** Nº Personas								
	DOB / E.D.P.*								
Bizkaia	**Pertsona Kop.** Nº Personas								
	DOB / E.D.P.*								
Gipuzkoa	**Pertsona Kop.** Nº Personas								
	DOB / E.D.P.*								
Estatuko gainerakoak Resto del Estado	**Pertsona Kop.** Nº Personas								
	DOB / E.D.P.*								
GUZTIRA TOTAL	**Pertsona Kop.** Nº Personas								
	DOB / E.D.P.*								

*** Dedikazio osoaren baliokidetza. Hamartar batekin idatziko da.** / Equivalencia dedicación plena. Se consignará con 1 decimal.

2.4. I+Gn ENPLEGATUTAKO PERTSONALA, OKUPAZIOAREN ETA TITULAZIOAREN ARABERA
PERSONAL EMPLEADO EN I+D, SEGÚN SU OCUPACIÓN Y TITULACIÓN

	GUZTIRA / TOTAL		**Ikertzaileak** / Investigadores		**Teknikariak** / Técnicos		**Laguntzaileak** / Auxiliares	
	Guztira Total	**Emakumezkoak** Mujeres	**Guztira** Total	**Emakumezkoak** Mujeres	**Guztira** Total	**Emakumezkoak** Mujeres	**Guztira** Total	**Emakumezkoak** Mujeres
Unibertsitate-doktoreak Doctores universitarios								
Unibertsitate-lizenziatuak, arkitektoak, ingeniariak eta antzekoak Licenciados universitarios, arquitectos, ingenieros y similares								
Unibertsitate-diplomatuak, arkitektoak, ingeniari teknikoak eta antzekoak Diplomados universitarios, arquitectos e ingenieros técnicos y similares								
Goi-mailako Batxilergoa, LH eta bigarren mailako beste ikasketak Bachiller Superior, F.P. y otros estudios secundarios								
Bestelako ikasketak Otros estudios								
GUZTIRA TOTAL								

3. GASTUAK I+Gko JARDUERETAN 2009an
GASTOS EN ACTIVIDADES I+D EN 2009

3.1. BARNEKO GASTUAK, IZAERAREN ARABERA / GASTOS INTERNOS POR NATURALEZA

Enpresa barnean egiten direnak dira, funtsen jatorria edozein delarik.
Son los realizados dentro de la empresa, cualquiera que sea el origen de los fondos.

	Euro / Euros
BARNEKO GASTUAK GUZTIRA / TOTAL GASTOS INTERNOS	
3.1.1. Gastu arruntak (BEZik eta amortizaziorik gabe) Gastos corrientes (sin IVA ni amortizaciones)	
Ikertzaileen ordainsariak (ikerketako bekak barne direla) Retribución a investigadores (incluidas las becas de investigación)	
Teknikarien eta laguntzaileen ordainsariak Retribución a técnicos y auxiliares	
Bestelako gastu arruntak / Otros gastos corrientes	
3.1.2. Kapital-gastuak (BEZik gabe) / Gastos de capital (sin IVA)	
Lurrak eta eraikinak / Terrenos y edificios	
Tresnak eta instrumentuak / Equipos e instrumentos	
I+Gko berariazko softwarea (baimenak barne) Software específico para I+D (incluye licencias)	

3.2. BARNEKO GASTU ARRUNTAK, IKERKETA-MOTAREN ARABERA
GASTOS INTERNOS CORRIENTES POR TIPO DE INVESTIGACIÓN

Guztizkoa 3.1.1. atalarekin bat etorri behar da.
El total debe coincidir con el apartado 3.1.1.

	Euro / Euros
Gastu arruntak guztira / Total gastos corrientes	
Funtsezko edo oinarrizko ikerketa / Investigación fundamental o básica	
Ikerketa aplikatua / Investigación aplicada	
Garapen teknologikoa / Desarrollo tecnológico	

3.3. I+Gko BARNEKO GASTUAK, KOKAPEN GEOGRAFIKOAREN ARABERA
GASTOS INTERNOS SEGÚN UBICACIÓN GEOGRÁFICA

Xehekatu, ehunekotan, 3.1.1. atalean adierazitako gastu arruntak eta 3.1.2. atalean adierazitako kapital-gastuak (ez idatzi hamartarrik eta egiaztatu Euskal Aeko eta Estatuko gainerakoen ehunekoen batura %100ekoa dela).
Distribuya, en porcentaje, los gastos corrientes del apartado 3.1.1. y los gastos de capital del apartado 3.1.2. (no escriba decimales y compruebe que la suma de los porcentajes de la C.A. de Euskadi y del resto del Estado es 100%).

Autonomia-erkidegoa Comunidad Autónoma	**I+Gko barneko gastu arrunten %** Gastos internos corrientes en I+D	**I+Gko barneko kapital--gastuen %** Gastos internos de capital en I+D
Euskal AE / C.A. de Euskadi		
Araba / Álava		
Bizkaia		
Gipuzkoa		
Estatuko gainerakoak / Resto del Estado		
GUZTIRA TOTAL	100	100

3.4. BARNEKO GASTUEN FINANTZAKETA
FINANCIACIÓN DE LOS GASTOS INTERNOS

Xehekatu 3.1. puntuko I+Gko barneko gastuen guztizkoa, I+Grako jasotako funtsen jatorrizko iturburuaren arabera. Funts publikoen kasuan, diru-laguntzak, funts galdura emandako maileguak eta Administrazioarekiko kontratuak sartu beharko dira. I+G egiteko mailegu itzulgarriak enpresaren funts gisa agertuko dira.
Desglose el total de gastos internos del apartado 3.1., según la fuente original de los fondos recibidos.
Los fondos públicos incluyen subvenciones, préstamos a fondo perdido y contratos con la administración. Los préstamos reembolsables se incluirán como fondos propios.

	Euro / Euros
BARNEKO GASTUAK GUZTIRA / TOTAL GASTOS INTERNOS	
3.4.1. Funts propioak (erakunde-izaerako maileguak eta kuotak barne) Fondos propios (incluidos préstamos y cuotas de carácter institucional)	
3.4.2. Kanpoko funtsak / Fondos ajenos	
3.4.2.1. Finantzaketa publikoa / Financiación pública	
Estatuko Administrazio Zentrala Administración Central del Estado	
Administrazio Autonomoa / Administración Autónoma	
Aldundiak eta beste administrazio lokal batzuk Diputaciones y otras Administraciones Locales	
3.4.2.2. Enpresak / Empresas	
Enpresa publikoak / Empresas públicas	
Enpresa pribatuak / Empresas privadas	
Teknologia-zentroak edo ikerketa-elkarteak Centros tecnológicos o asociaciones de investigación	
3.4.2.3. Unibertsitateak / Universidades	
Publikoak / Públicas	
Pribatuak / Privadas	
3.4.2.4. Irabazi-asmorik gabeko erakunde pribatuak Instituciones privadas sin fines de lucro	
3.4.2.5. Atzerritik etorriak / Procedentes del extranjero	
EB (programa komunitarioak) / U.E. (programas comunitarios)	
Agentziak eta beste antolakunde internazionalak Agencias y otras organizaciones internacionales	
Bestelakoak / Otros	

3.5. KANPOKO GASTUAK / GASTOS EXTERNOS

I+Gko zerbitzuak enpresatik kanpo erosteak eragiten dituenak (kontratu, hitzarmen, etab.en bidez) Ez sartu enpresa, ikerketa-elkarte etab. Finantzatzeko kuota instituzionalak, I+Gko erosketa zuzenekoa ez badakarte.
Son los motivados por la adquisición de servicios de I+D fuera de la empresa mediante contrato, convenio, … No incluya las cuotas institucionales para financiar a otras empresas, asociaciones de investigación, ... que no supongan una compra directa de I+D.

	Euro / Euros
KANPOKO GASTUAK GUZTIRA / TOTAL GASTOS EXTERNOS	
Teknologia-zentroetan edo ikerketa-elkarteetan En centros tecnológicos o asociaciones de investigación	
Beste enpresetan / En otras empresas	
Administrazio publikoetan / En Administraciones Públicas	
Irabazi-asmorik gabeko erakunde pribatuetan En Instituciones privadas sin fines de lucro	
Unibertsitateetan / En universidades	
Atzerrian / En el extranjero	

4. I+Gko JARDUERAK 2009an / ACTIVIDADES I+D EN 2009

4.1. IKERTUTAKO PRODUKTUA / PRODUCTO INVESTIGADO

Xehekatu, ehunekotan, 3.1.1. barneko gastu ARRUNTAK, eta adierazi zein jarduera-adarretan erabiliko diren enpresak ikertzen dituen produktuak, materialak, gailuak, prozesuak, sistemak edo zerbitzuak, (ez idatzi hamartarrik, eta egiaztatu zutabearen batura %100ekoa dela).

Adierazi ikertutako den produktua, prozesua, etab... Ikerketa hori erabiliko duen adarrean.

Desglose, en porcentaje, los gastos internos CORRIENTES del apartado 3.1.1., según la rama de actividad que va a utilizar los productos, materiales, dispositivos, procesos, sistemas o servicios en que investiga la empresa (no escriba decimales y compruebe que la suma de la columna es 100%).

Especifique el producto, proceso, ... investigado en la rama que utilizará esa investigación.

	Jarduera-adarra Rama de actividad	**Ikertutako produktua, prozesua edo zerbitzua** Producto, proceso o servicio investigado	%
1.	**NEKAZARITZA** AGRICULTURA		
2.	**ATERATZE-INDUSTRIAK** EXTRACTIVAS		
	MANUFAKTURA-INDUSTRIA INDUSTRIA MANUFACTURERA		
	Elikagaiak, edariak eta tabakoa Alimentación, bebidas y tabaco		
3.	**Elikagaiak, edariak** Alimentación, bebidas		
4.	**Tabakoa** Tabaco		
	Ehunak, jantziak, larrua eta larrukia Textiles, vestidos, pieles y cuero		
5.	**Ehunak** Textiles		
6.	**Jantzigintza eta larrugintza** Confección y peletería		
7.	**Larrukia eta oinetakoak** Cuero y calzado		
	Zura, papera, inprimaketa eta argitalpenak Madera, papel, impresión, edición		
8.	**Zura eta kortxoa (altzariak izan ezik)** Madera y corcho (excepto muebles)		
9.	**Papera eta kartoia** Cartón y papel		
10.	**Argitalpenak, inprimaketa eta aldakiak** Edición, impresión y reproducción		
	Kokea, petrolioa, kimika, kautxua eta plastikoa Coque, petróleo, química, caucho y plástico		
11.	**Kokea, petrolioa fintzea eta erregai nuklearrak** Coque, refino de petróleo y combustible nuclear		
12.	**Kimika (farmazi gaiak izan ezik)** Química (excepto farmacia)		
13.	**Farmazi gaiak** Productos farmacéuticos		
14.	**Kautxua eta plastikoa** Caucho y plástico		
15.	**Metalezkoak ez diren mea-ekoizkinak** Productos minerales no metálicos		
	Oinarrizko metalurgi ekoizkinak Productos metalúrgicos básicos		
16.	**Burdinazko metalurgi ekoizkinak** Productos metalúrgicos férreos		
17.	**Burdinazkoak ez diren metalurgi ekoizkinak** Productos metalúrgicos no férreos		

Jarduera-adarra Rama de actividad	Ikertutako produktua, prozesua edo zerbitzua Producto, proceso o servicio investigado	%
18. **Metalezko manufakturak (makineria eta tresneria izan ezik)** Manufacturas metálicas (excepto maquinaria y equipo)		
Makinak, ordenagailuak, garraioko tresnak eta materialak Máquinas, ordenadores, instrumentos y material de transporte		
19. **Metalezko makineria eta tresneria** Maquinaria y equipo mecánico		
20. **Bulegoko eta kalkuluko makinak, ordenagailuak** Máquinas de oficina, cálculo y ordenadores		
21. **Makineria elektrikoa** Maquinaria eléctrica		
22. **Osagai elektronikoak** Componentes electrónicos		
23. **Irratiko, telebistako eta komunikazioko aparatuak** Aparatos de radio, TV y comunicación		
24. **Optikako eta erlojugintzako tresneria** Instrumentos, óptica y relojería		
25. **Ibilgailu motordunak** Vehículos de motor		
26. **Ontzigintza** Construcción naval		
27. **Aireontziak eta espaziontziak egitea** Construcción aeronáutica y espacial		
28. **Garraioko bestelako gaiak** Otro equipo de transporte		
Altzariak, bestelako gaiak egitea Muebles, otras actividades de fabricación		
29. **Altzariak** Muebles		
30. **Bestelako gaiak egitea** Otras actividades de fabricación		
31. **Birziklapena** Reciclaje		
32. **ELEKTRIZITATEA, GASA ETA URA EKOIZTU ETA BANATZEA** PRODUCCIÓN Y DISTRIBUCIÓN DE ELECTRICIDAD, GAS Y AGUA		
33. **ERAIKUNTZA** CONSTRUCCIÓN		
ZERBITZUEN SEKTOREA SECTOR SERVICIOS		
34. **Merkataritza, ibilgailuen konponketa, etab.** Comercio, reparación de vehículos, …		
35. **Ostalaritza eta sukaldaritza** Hostelería y restauración		
36. **Garraioak, bilketa** Transportes, almacenamiento		
Komunikazioak Comunicaciones		
37. **Posta-zerbitzuak, posta** Servicios postales, correos		
38. **Telekomunikazioak** Telecomunicaciones		
39. **Finantza-bitartekaritza (aseguruak barne)** Intermediación financiera (incluidos seguros)		
Onibar-jarduerak, alokairuak eta enpresentzako zerbitzuak Inmobiliarias, alquileres y servicios a empresas		
40. **Ordenagailu-programak (softwarea)** Programas de ordenador (software)		
41. **Informatikako bestelako jarduerak** Otras actividades informáticas		
42. **I+Gko jarduerak** Servicios de I+D		
43. **Bestelako onibar-jarduerak, alokairuak eta enpresentzako zerbitzuak** Otras actividades inmobiliarias, alquileres y servicios a empresas		
44. **Herri-administrazioa, gizarte- eta herri-zerbitzuak, etab.** Administración Pública, servicios sociales y colectivos, …		
GUZTIRA / TOTAL		**100**

4.2. ZIENTZI ARLOA EDO DIZIPLINA / CAMPO O DISCIPLINA CIENTÍFICA

Xehekatu, ehunekotan, 3.1. ataleko barneko gastuak, eta adierazi zein zientzi arlotan edo diziplinatan egiten den ikerketa (ez idatzi hamartarrik, eta egiaztatu zutabearen batura %100ekoa dela).
Desglose, en porcentaje, los gastos internos del apartado 3.1., según el campo o la disciplina científica en los que se realiza la investigación (no escriba decimales y compruebe que la suma de la columna es 100%).

	%
Zientzia Zehatzak eta Natur Zientziak / Ciencias Exactas y Naturales	
Ingeniaritza eta Teknologia / Ingeniería y Tecnología	
Zientzia Medikoak (Farmazia barne) / Ciencias Médicas (incluida Farmacia)	
Nekazaritza-Zientziak (Abeltzaintza, Basogintza eta Arrantza barne) Ciencias Agrarias (incluidas Ganadería, Selvicultura y Pesca)	
Gizarte-Zientziak / Ciencias Sociales	
Giza Zientziak / Humanidades	
GUZTIRA / TOTAL	100

4.3. HELBURU SOZIOEKONOMIKOA / OBJETIVO SOCIO-ECONÓMICO

Xehekatu, ehunekotan, 3.1 ataleko barneko gastuak, eta adierazi zein izan den ikerketaren xede edo helburu sozioekonomikoa (ez idatzi hamartarrik, eta egiaztatu zutabearen batura %100ekoa dela).
Desglose, en porcentaje, los gastos internos del apartado 3.1., según la finalidad o el objetivo socio-económico de la investigación (no escriba decimales y compruebe que la suma de la columna es 100%).

	%
Lurraren azterketa eta ustiakuntza / Exploración y explotación de la Tierra	
Azpiegiturak eta lurraldearen antolamendua / Infraestructuras y ordenación del territorio	
Ingurumenaren kontrola eta babesa / Control y protección del medio ambiente	
Giza osasunaren babesa eta hobekuntza / Protección y mejora de la salud humana	
Energiaren produkzioa, banaketa eta erabilera arrazionala Producción, distribución y utilización racional de la energía	
Nekazaritzako produkzioa eta teknologia / Producción y tecnología agrícola	
Industriako produkzioa eta teknologia / Producción y tecnología industrial	
Gizarte-egiturak eta -harremanak / Estructuras y relaciones sociales	
Espazioaren azterketa eta ustiakuntza / Exploración y explotación del espacio	
Ikerketa ez-orientatua / Investigación no orientada	
Bestelako ikerketa zibilak / Otras investigaciones civiles	
Defentsa / Defensa	
GUZTIRA / TOTAL	100

4.4. BARNEKO GASTUAK BIOTEKNOLOGIAN
GASTOS INTERNOS EN BIOTECNOLOGÍA

Bioteknoloa da farmakoak, elikagaiak edo bestelako ondasun zerbitzu eta prozesuak egiteko erabiltzen den zientziaren eta teknologiaren aplikazioa organismo bizien (edo euretako batzuen) erabileran.
La Biotecnología es la aplicación de la ciencia y la tecnología en el uso de organismos vivos (o parte de ellos) para producir fármacos, alimentos u otros bienes, servicios y procesos.

	%
Adierazi zein ehuneko hartu duen bioteknologiak I+Gko guztizko barneko gastuetan (ez idatzi hamartarrik) Indique el porcentaje que representa la Biotecnología en los gastos internos en I+D (no escriba decimales)	

5. I+G JARDUERETAKO 2010ean AURREIKUSI DIREN BALIABIDEAK
RECURSOS PREVISTOS PARA ACTIVIDADES DE I+D EN 2010

	DOBeko langileak guztira Total de personal en E.D.P.	**I+Dko barneko gastuak guztira** Total de gastos INTERNOS en I+D
Adierazi zein izango den DOBn egongo diren langileak eta zure enpresak I+G jarduteretarako egingo duen barne-gastua 2010. urtean. Indique la previsión de personal en E.D.P. y el gasto interno que su empresa dedicará a actividades de I+D en el año 2010.		

OHARRAK / OBSERVACIONES:

. . . .

Harremanetarako pertsona, galdeketa honi buruz galdetzeko edo argibideak emateko
Persona a quien dirigirse para consultas o aclaraciones sobre este cuestionario

. . . .

Enpresan duen kargua / Cargo en la empresa

Tel. / Tfno.

E-mail: . . . .

Sinadura eta enpresako zigilua:
Firma y sello de la empresa:

...., **2010eko** .... **ren** ....
.... a .... de .... de 2010

BETETZEKO ESKULIBURUA

OHARPEN OROKORRAK

1. Inkesta hau enpresek ekonomiaren sektore guztietan egiten dituzten ikerketa eta garapen teknologikoko jardueretara (I+G) zabaltzen da. **Enpresatzat** jotzen da ondasun eta zerbitzuen produkzioko antolaketa-unitate bat eratzen duen unitate juridiko oro, erabakitzeko nolabaiteko autonomia duena, batez ere dituen baliabide arruntak erabiltzeko orduan. Ikuspegi praktiko batetik, eta kasurik orokorrenean, enpresaren kontzeptua bat dator unitate juridiko edo legezkoarekin, hau da, legeak ezagututako jarduera duen pertsona fisiko edo juridikoarekin (sozietateak, kooperatibak, etab.). Unitate hori dagokion Identifikazio Fiskaleko Zenbakiaren bidez (IFZ) identifikatuta egoten da.

2. Inkesta honen ondorioetarako, I+Gko jardueratzat hartzen dira: "Batetik, jakintzak gizakiaren, kulturaren eta gizartearen jakintza barne gehitzeko sistematikoki egiten den sorkuntza-lana; eta, bestetik, jakintza horiek aplikazio berriak sortzeko erabiltzea". Jarduera horren baitan sartuta daude oinarrizko ikerketa, ikerketa aplikatua eta garapen teknologikoa.

3. I+Gtik kanpo dauden jarduerak: Irakaskuntza eta heziketa, informazio zientifiko eta teknikorako zerbitzuak, interes orokorreko datuen bilketa, saiakerak eta normalizazioa, bideragarritasun-azterketak, mediku-laguntza espezializatua, patente eta lizentzietako lanak, politikari lotutako azterlanak, softwarea garatzeko ohiko jarduerak, antzeko berrikuntza-, produkzio-eta teknika-jarduerak, eta I+G finantzatzeko baino ez diren jarduerak. I+G definitzeko irizpidea da berritasun eta sorkuntza elementu nabaria izatea.

2. ATALA BETETZEKO JARRAIBIDEAK
I+G jardueretan enplegatutako langileak.

I+Gn zuzenean enplegatutako pertsona guztiak sartuko dira, bai eta jarduera horiei zuzenean lotutako zerbitzuak ematen dituzten pertsonak ere, hala nola zuzendariak, administratzaileak eta bulegoko langileak. Kanpoan geratzen dira zeharkako zerbitzuak ematen dituztenak, hala nola jantokietako eta segurtasuneko langileak, nahiz eta haien soldata eta alokairuak gastu orokortzat kontabilizatzen diren I+Gko barne-gastua neurtzean.

Arduraldi Osoaren Baliokidetza (DOB)

Langileek I+Gko jardueretan ematen duten denbora-zatiak batuz kalkulatzen da. DOB bat pertsona batek urtebetez lan egitearen baliokide da. Horrenbestez, bere denboraren %30 I+Gko jardueretan eta gainerakoa bestelako jardueretan ematen duen pertsona bat 0,3 DOB dela kontabilizatuko da. Orobat, jardunaldi osoz I+Gn diharduen langile bat sei hilabetez baino ez badago enplegatuta, 0,5 DOB dela kontabilizatuko da.

Okupazioaren araberako sailkapena

Ikertzaileak. Jakintza, produktu, prozesu, metodo eta sistema berriak asmatzen edo sortzen, edota dagozkien proiektuak kudeatzen, diharduten profesionalak dira. Hor sartuta daude ikertzaileen laneko zientzia-eta teknika-alderdiak planifikatu eta kudeatzeko jarduerak egiten dituzten kudeatzaile eta administratzaileak, bai eta I+Gko lanetan parte hartzen duten doktoretza-mailako graduatuondoko ikasleak ere.

Teknikariak. Euren zeregin nagusietarako ingeniaritzako, fisikako, zientzia biomedikoetako edo giza nahiz gizarte-zientzietako arlo bat edo gehiagoko jakintza teknikoak eta esperientzia behar dituzten pertsonak dira. Kontzeptu eta metodo operatiboak aplikatzea eskatzen duten lan zientifiko eta teknikoak egiten dituzte, oro har ikertzaileek ikuskatuta.
Besteak beste, zeregin hauek dituzte: bilaketa bibliografikoak egitea; programa informatikoak garatzea; esperimentuak, probak eta analisiak egitea; esperimentu, proba eta analisietarako beharrezko materialak eta ekipoa prestatzea; grafikoetan oharrak jasotzea, kalkuluak egitea, eta taula nahiz grafikoak prestatzea; estatistika-inkestak eta elkarrizketak egitea.

Laguntzaileak. Laguntzen diharduten gainerako langileak. Hor sartuta daude lanbideetako langileak kualifikatua nahiz kualifikatugabea, bulegokoak eta idazkaritzakoak, I+Gko proiektuetan parte hartzen dutenak.

MANUAL DE CUMPLIMENTACIÓN

CONSIDERACIONES GENERALES

1. La encuesta se extiende a las actividades en investigación y desarrollo tecnológico (I+D) que realicen las empresas en todos los sectores de la economía. Se entiende por **empresa** toda unidad jurídica que constituye una unidad organizativa de producción de bienes y servicios, y que disfruta de una cierta autonomía de decisión, principalmente a la hora de emplear los recursos corrientes de que dispone. Desde un punto de vista práctico, y en su caso más general, el concepto de empresa se corresponde con el de una unidad jurídica o legal, es decir, con toda persona física o jurídica (sociedades, cooperativas, etc.) cuya actividad está reconocida por la ley, y que viene identificada por su correspondiente Número de Identificación Fiscal (NIF).

2. A efectos de esta encuesta se entiende como actividades de I+D: "El trabajo creativo llevado a cabo de forma sistemática para incrementar el volumen de conocimientos, incluido el conocimiento del hombre, la cultura y la sociedad, y el uso de esos conocimientos para crear nuevas aplicaciones". Esta actividad comprende la investigación fundamental, la investigación aplicada y el desarrollo tecnológico.

3. Actividades excluidas de la I+D: Enseñanza y formación, servicios de información científica y técnica, recogida de datos de interés general, ensayos y normalización, estudios de viabilidad, asistencia médica especializada, trabajos de patentes y licencias, estudios relacionados con la política, actividades rutinarias de desarrollo de software, otras actividades de innovación, producción y actividades técnicas afines y actividades solamente de financiación de I+D. El criterio que define la I+D es la existencia de un elemento apreciable de novedad y creatividad.

INSTRUCCIONES PARA CUMPLIMENTAR EL APARTADO 2.
Personal empleado en actividades I+D.

Se incluirán todas las personas empleadas directamente en I+D, así como las personas que proporcionan servicios directamente relacionados con dichas actividades, como los directores, administradores y personal de oficina. Se excluyen las personas que proporcionan servicios indirectos como el personal de los comedores y de seguridad, aunque sus sueldos y salarios se contabilicen como gastos generales para la medida del gasto interno en I+D.

Equivalencia Dedicación Plena (E.D.P.)

Se obtiene sumando las fracciones de tiempo que el personal dedica a actividades de I+D. Un E.D.P. debe considerarse como una persona/año. Por lo tanto, una persona que normalmente dedica un 30% de su tiempo a I+D y el resto a otras actividades ha de ser contabilizado como 0,3 E.D.P.. Del mismo modo, si un trabajador de I+D a jornada completa está empleado durante solo seis meses, se le contabilizará como 0,5 E.D.P..

Clasificación según la ocupación

Investigadores. Son los profesionales que se dedican a la concepción o creación de nuevos conocimientos, productos, procesos, métodos y sistemas, y también a la gestión de los proyectos respectivos. Están incluidos los gestores y administradores que desarrollan actividades de planificación y gestión de los aspectos científicos y técnicos del trabajo de los investigadores, así como los estudiantes de postgrado a nivel de doctorado que participan en tareas de I+D.

Técnicos. Son personas cuyas tareas principales requieren conocimientos técnicos y experiencia en uno o varios campos de la ingeniería, la física, las ciencias biomédicas o las ciencias sociales y las humanidades. Ejecutan tareas científicas y técnicas que requieren la aplicación de conceptos y métodos operativos, generalmente bajo la supervisión de los investigadores.
Sus tareas incluyen: realizar búsquedas bibliográficas; desarrollar programas informáticos; realizar experimentos, pruebas y análisis; preparar los materiales y el equipo necesarios para los experimentos, pruebas y análisis; anotar los gráficos, hacer cálculos y preparar tablas y gráficos; llevar a cabo encuestas estadísticas y entrevistas.

Auxiliares. Es el restante personal de apoyo que incluye al personal de oficios, cualificado o no, de oficina y de secretaría que participa en los proyectos de I+D.

Kokagune geografikoaren araberako sailkapena

Ikerketa-unitateek guztien artean dituzten kudeatzaileak, zuzendariak edo bestelako langileak geografikoki banatuko dira, enpresak kalkulatzen duen ehunekoaren arabera. Euskal AEko langileen guztizkoa lurralde historikoen batura izango da. Era berean, enpresako langileen guztizkoa Euskal AEaren eta Estatuko gainerako erkidegoen batura izango da.

3. ATALA BETETZEKO JARRAIBIDEAK
I+Gko jardueretako gastuak

3.1. Barne-gastuak
Urte horretan enpresan egindako I+Gko jardueren multzoa estaltzen duten gastu guztiak sartzen dira, funtsen jatorria edozein izanda ere. Hor sartuko dira zentrotik at baina I+Gko barne-zereginei laguntzeko egiten diren gastuak, hala nola hornidurena.

3.1.1. Gastu arruntak
Ordainsariak. Langileen ordainketa eta gastu osagarriak dira, hala nola primak, opor ordainduak, pentsio-funtsak, Gizarte Segurantzarako ordainketak, soldaten gaineko zergak, eta abar. Ikerketako bekadunen “soldata”/bekak eta antzeko gastuak ere sartuko dira.

Bestelako gastu arruntak. Hor sartuta daude I+Gri laguntzeko materialak, hornidurak eta ekipoak erosteko egindako gastuak, kapital-gastuez kanpokoak. Adibideak: ura eta erregaiak (gasa, argindarra); kontsultarako dokumentuak eta liburutegietako nahiz elkarte zientifikoetako harpidetzak; laborategiko materialak; bulegoko, postako, telekomunikazioetako, aseguruetako… gastuak; zeharkako zerbitzuak, hala nola eraikinen edo ekipoen segurtasuna, biltegiratzea, konponketa eta kontserbazioa; informatika-zerbitzuak; eta I+Gko txostenak inprimatzearen kostuak. Kanpoan utziko dira interesek, BEZak eta antzeko zergek eragindako gastuak.

3.1.2. Kapital-gastuak
Aztergai den aldian I+Gko programetan erabilitako kapital finkoko elementuei dagozkien gastu gordinak dira. Kapital-gastuetan sartuta daude:

Lurrak eta eraikinak. I+Grako lurrak (konparazio batera, probetarako lurrak, laborategietarako eta planta pilotuetarako orubeak) erosteko eta eraikinak egin edo erosteko egindako gastuak dira. Hor sartuta daude hobetzeko, aldatzeko edo konpontzeko lan garrantzitsuen ondorioz egindako gastuak ere.

Ekipoak eta tresnak. I+Gko jardueretarako beharrezko ekipo eta tresnak horiek dakarten softwarea barne erosteko gastuak dira.

Softwarea. I+Grako erabiltzeko softwarea, bereiz daitekeena, erostea. Hor sartuta daude programen deskribapenak, bai eta sistema eta aplikazioetako softwarearekin batera doan dokumentazioa ere. Orobat, hor sartuta daude erositako softwarearen urteroko erabilera-lizentzietako kuotak.

3.2. Barne-gastu arruntak, ikerketa-motaren arabera
Oinarrizko ikerketa. Beha dakiekeen fenomenoen funtsei buruzko jakintza berriak eskuratzeko, aplikazio edo erabilera zehatzik ematean pentsatu gabe, abiarazten diren lan esperimental edo teorikoak dira.

Ikerketa aplikatua. Orobat jakintza berriak egiteko lan originalak dira, baina helburu praktiko zehatz baterantz zuzenduta.

Garapen esperimentala. Ikerketaz edo esperientzia praktikoaz lehendik eskuratuta dauden jakintzetan oinarritutako lan sistematikoak dira, helburu hauetakoren bat dutenak: material, produktu edo gailu berriak fabrikatzea; prozedura, sistema eta zerbitzu berriak ezartzea; edota lehendik daudenak nabarmen hobetzea.

3.5. Kanpo-gastuak
Kanpo-gastuak dira kontratuen, hitzarmenen eta abarren bidez enpresako ikertegitik at egiten diren I+G jarduerek eragindako gastuak. Hor sartuta daude beste erakunde batzuek egindako I+G erostea eta beste batzuei I+G egiteko emandako finantza-laguntzak.

Clasificación según ubicación geográfica

Los gerentes, directores u otro personal que pueda ser común a las distintas unidades de investigación, se distribuirán geográficamente según el porcentaje que la empresa estime. El total del personal de la C.A. de Euskadi corresponderá a la suma de los territorios históricos, así mismo, el total del personal de la empresa será la suma de la C.A. de Euskadi y del resto del Estado.

INSTRUCCIONES PARA CUMPLIMENTAR EL APARTADO 3
Gastos en actividades de I+D

3.1. Gastos internos
Se incluyen todos aquellos gastos que cubren el conjunto de las actividades de I+D realizadas en la empresa durante el año de referencia, cualquiera que sea el origen de los fondos. Se incluirán los gastos llevados a cabo fuera del centro pero en apoyo de las tareas de I+D internas, como por ejemplo, los suministros.

3.1.1. Gastos corrientes
Retribuciones. Son las remuneraciones y gastos complementarios del personal como primas, vacaciones pagadas, fondos de pensiones, pagos a la Seguridad Social, impuestos salariales, etc. También se incluirán los “salarios”/becas y otros gastos similares de los becarios de investigación.

Otros gastos corrientes. Comprenden los gastos producidos por la compra de materiales, suministros y equipos de apoyo a I+D que no forman parte de los gastos de capital. Ejemplos: agua y combustibles (gas, electricidad); documentos de consulta y suscripciones a bibliotecas y sociedades científicas; materiales de laboratorio; gastos de oficina, correos, telecomunicaciones, seguros, etc.; servicios indirectos tales como seguridad, almacenamiento, reparación y conservación de edificios o equipos; los servicios informáticos y los costes de impresión de informes de I+D. Se excluirán los gastos originados por intereses, el IVA y demás impuestos análogos.

3.1.2. Gastos de capital
Son los gastos brutos correspondientes a los elementos del capital fijo utilizados en los programas de I+D en el periodo de referencia. Los gastos de capital comprenden:

Terrenos y edificios. Son los gastos producidos por la adquisición de terrenos para I+D (por ejemplo, terrenos de pruebas, solares para laboratorios y plantas piloto) y para la construcción o compra de edificios, incluidos los gastos que se producen como consecuencia de trabajos importantes de mejora, modificación o reparación.

Equipos e instrumentos. Son los gastos ocasionados por la adquisición de los equipos e instrumentos necesarios para las actividades de I+D incluyendo el software incorporado.

Software. Comprende la adquisición de software identificable por separado para su utilización en la realización de I+D, incluyendo las descripciones de los programas y la documentación que acompaña al software de sistemas y de aplicaciones. También se incluyen las cuotas de licencias de uso anuales del software adquirido.

3.2. Gastos internos corrientes por tipo de investigación
Investigación básica. Consiste en trabajos experimentales o teóricos que se emprenden para obtener nuevos conocimientos acerca de los fundamentos de fenómenos y hechos observables, sin pensar en darles ninguna aplicación o utilización determinada.

Investigación aplicada. Consiste igualmente en trabajos originales realizados para adquirir nuevos conocimientos, sin embargo, está dirigida hacia un objetivo práctico específico.

Desarrollo experimental. Consiste en trabajos sistemáticos fundamentados en los conocimientos existentes obtenidos por la investigación o la experiencia práctica, que se dirigen a la fabricación de nuevos materiales, productos o dispositivos, a establecer nuevos procedimientos, sistemas y servicios, o a mejorar considerablemente los que ya existen.

3.5. Gastos externos
Gastos externos son los ocasionados por las actividades de I+D realizadas fuera del centro investigador de la empresa, mediante contratos, convenios, etc. Incluye la adquisición de la I+D realizada por otras entidades y las ayudas financieras concedidas a otros para la realización de I+D.

Eustat
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