Fostering innovation through R&D cooperation: an empirical research on government sponsored alliances

Alba Sánchez Navas

TESI DOCTORAL

FOSTERING INNOVATION THROUGH R&D COOPERATION: AN EMPIRICAL RESEARCH ON GOVERNMENT SPONSORED ALLIANCES

Alba Sánchez Navas

Doctorat en Empresa

Facultat d'Economia i Empresa

Universitat de Barcelona

Director: Jaume Valls Pasola

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1. Introduction

1.1. Context

Since the beginning of the 21st century innovation has been one of the fundamental aspects of industrial and economic development policies in Western countries. The political agenda in most advanced economies always includes programs aimed to improving innovation capabilities of companies in order to create different products and services. In part, this institutional trend has been spurred by the traditional academic support to innovation as a key capability for the long-term sustainability of companies.

Schumpeter (1934) pointed early in the 20th century at the importance of innovation as a driver for economic growth. Later, Porter (1980) proposed that the competitiveness of nations depended on the ability of an industry to innovate and improve, and that companies achieve competitive advantage through innovation. Thus innovation has proved to be important at the company level as well as on a national level. The theoretical and empirical analysis accumulated over the last few decades about the impact of innovation management on performance, however, have brought only a few conclusive results, especially at the single-company level (Tidd, 2006).

Hult et al. (2004) defines innovation as "The way to change the organization, as a response to external or internal changes or as a proactive attempt to change this environment." Hult further states that, "As the environment is changing, firms must adopt innovations along the time, and, what is more important, innovations are those activities that let the company gain competitive advantages, contributing thus to its effectiveness and business success." Hence, innovation is considered one of the key strategic "processes" that may help companies adapt to their environment.

Damanpour (1991), Henard & Szymaski (2001), and Grant (2005) arrive at similar conclusions. However, the conceptual link between innovation practices and performance is not yet well understood, as the different terminologies and models make it difficult to establish the relationship between different concepts (Adams et al, 2006).

Nevertheless, it is not clear what impact innovation management practices have on a company's performance over a long period of time. One of these practices is collaboration for developing innovation activities, which has become a special area of interest for both academic and practitioners because of its specific characteristics and relationships that are established between partners.

In traditional strategy literature, firms were considered to be individual, self-fulfilling units (Williamson, 1991) that favored going alone over cooperative agreements (Contractor and Lorange, 1988). Alliances were viewed as separated business cases that were to be studied primarily from a dyadic perspective (Greenhalgh, 2001).

With the spurt in alliance activity occurring since the 80s, many firms found themselves in a constant flux of cooperative agreement and abandonment (Barney, 1997; Doz and Hamel, 1998) in order to get access to the desired resources and achieve sustainable competitive advantage. In line with these developments, scholars suggested that alliance capability could be viewed as a rare, valuable and difficult to imitate resource at the company level (e.g. Gulati, 1998).

From this point of view, alliance capability consists of firm-specific resources or micro-level mechanisms, which not only help companies to raise the performance of its entire alliance portfolio, but also provide a candidate explanation for the fixed-firm differences in alliance performance. In order to investigate the influence of alliance mechanisms on alliance performance, a firm's alliance portfolio can be used as a unit of analysis. This logic has been both explicitly suggested (Duysters et al., 1999; De Man, 2001) and implicitly applied by various scholars (Kale et al., 2000; Kale et al., 2002).

According to alliance perspective literature, there can be several reasons for collaboration for a firm (Leverick and Littler, 1993) such as to reduce cost of technological development, to facilitate entry in new markets, to reduce risk of development, to reduce time taken to develop and commercialize new products or to promote shared learning.

This kind of cooperation present unique coordination challenges, since some sharing or transfer of knowledge over firm boundaries is usually required (Sampson, 2007). Successful knowledge transfer is not assured, particularly where knowledge is tacit or complex. Beyond the ability to share knowledge among partners is the need to preserve incentives to share such knowledge, given the substantial moral hazard problems that typically accompany knowledge-based alliances.

Specific studies analyzing factors explaining alliance performance have been manifold and can be categorized in two groups. First, studies analyzing the dyadic relationship in specific relationship characteristics are found to positively influence alliance performance (e.g. Doz, 1996; Dyer et al., 2001; Dyer and Singh, 1998; Kale et al., 2000; Mohr and Spekman, 1994; Parkhe, 1993; Young-Ybarra and Wiersema, 1999). Although empirical evidence confirms that these factors of collaboration quality can create relational-specific rents (Kale et al., 2000; Khanna et al., 1998), this evidence remains scattered and cannot explain the differences in individual firms alliance performance (Park and Ungson, 2001).

Second, other studies suggest that alliance capability influences alliance performance and its antecedent success factors. Moreover, they propose that alliance experience and micro-level mechanisms explain the considerable fixed-firm effects in individual firm's alliance performance (Nault and Tyagi, 2001; Kale et al., 2002; Simonin, 1997).

1.2. Objectives

The general objective of this research is to investigate the relationship between innovation and performance at firm level. Concretely, the main contribution of this PhD research is the exploration of how R&D collaboration, a particular innovation practice, generates positive outcomes for both firms that collaborate and their environment. Finally, this research proposes an evaluation model of how public agencies should assign budget to R&D collaborative projects.

More specifically, the research objectives are:

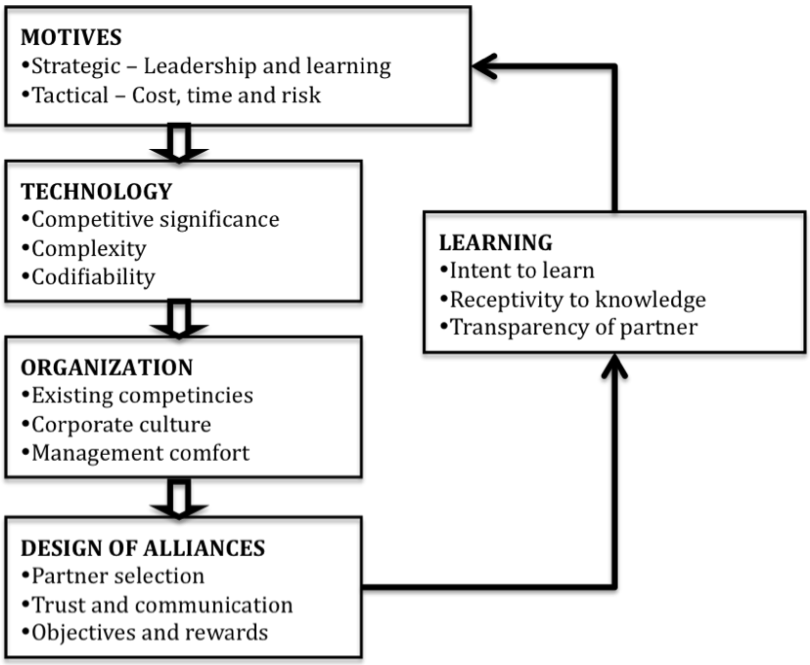
- To classify innovation practices based on previous literature review;
- To empirically test which of these innovation practices have an effect on the firms' long–term financial performance;
- To analyze the relationship between the type of partners that collaborate in R&D alliances and different alliance performance outcomes: acquisition of technical knowledge, new technological opportunities and new commercial opportunities;
- To examine how trust, conflict, commitment and communication affect R&D alliance performance, the individual's satisfaction with the alliance and their intention to collaborate with the same partners in the future;

- To propose a model of evaluation to co-finance large collaborative R&D alliances by governments.

The first phase of this research (Chapter 2) analyzes innovation management practices and the relationship with firms' financial results. Beginning with several models of innovation audit proposed (Chiesa et al., 1996; Yam et al., 2004; AT Kearney, 2006) we have classified nine innovation dimensions and, afterward, we have studied their relationship with firms' performance. Results of this research have motivated a further study in the area of R&D collaboration, as these have not shown the positive effect of R&D collaboration in firms' performance.

In order to do that, Chapters 3 and 4 contain the second phase of this research that is based on a previous model for collaboration (Tidd et al., 1997) (Figure 1), where partner selection, objectives and rewards of the alliance are considered part of the design of the alliance.

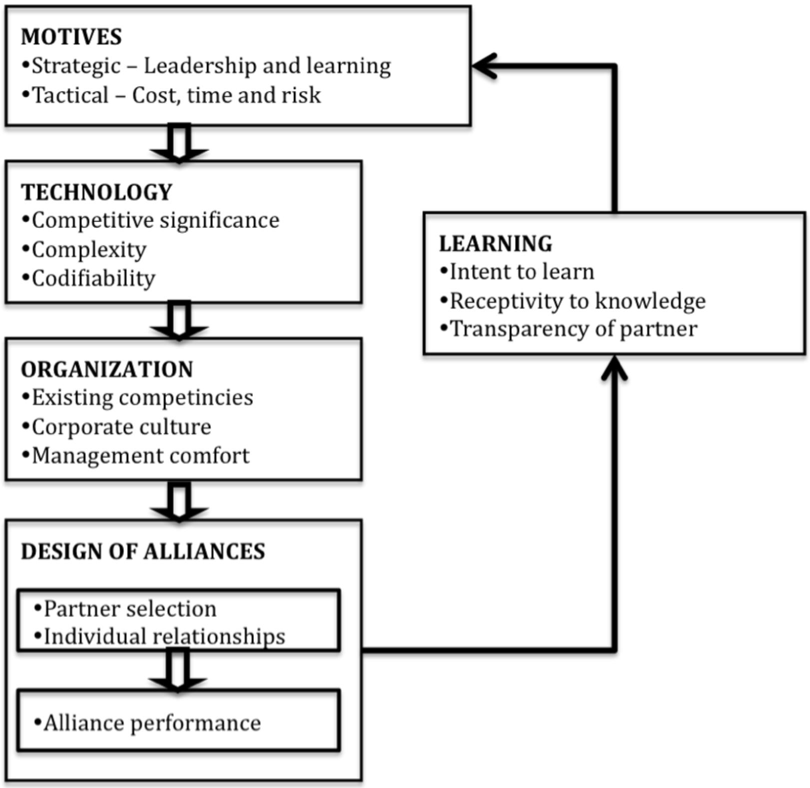
Figure 1: Model for collaboration without modifications



As objectives and rewards are part of alliance performance, I propose to modify the model. Design of alliances could be better explained if "objectives and rewards" is expanded and include "alliance performance" as a whole to get a complete overview of design of alliances.

This research proposes a new model for collaboration (Figure 2) that takes into account partners' selection and individual relationships (not only trust and communication) as determinants of alliance performance.

Figure 2: Model for collaboration with proposed modifications



Finally, in Chapter 5 the investigation is focused on how governments should sponsor R&D alliances taking into account that they have two types of outcomes generation: positive outcomes for companies that participate in the alliances (which is necessary but not sufficient to be publicly granted) and externalities that are the reason why awarding is desirable because of market failures.

1.3. Structure

This PhD thesis is divided into four main chapters where empirical research is used in order to achieve the objectives mentioned above. The chapters that will investigate in depth the research objectives are:

- Analysis of which innovation management practices improve business results
- Exploring R&D alliance outcomes and the relationship with partner selection
- The establishment of individual relationships through R&D alliances
- An evaluation model of government sponsored R&D alliances

Each chapter is composed of the literature review related to its specific objective followed by the research question and/or hypotheses resulted from this literature review. Later on, there is a presentation of the sample and variables used in each case. Finally, results and conclusion are presented.

In order to summarize and easily present the overall results of the whole research, at the end of this work there is a chapter with the main conclusions obtained along the research, limitations of the work, and a proposal of future research lines to continue with investigations carried out in this PhD thesis.

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2. Analysis of which innovation management practices improve business results[1]

This research contributes to the understanding of how different practices of innovation management are related to mid- and long-term growth and profitability. Governments and regional development agencies invest relevant budgets to foster innovation in small and medium enterprises (SMEs) and improve their innovation management practices to make them more competitive. Nevertheless, it is not clear the impact these practices have on a company's performance over a long period of time. We propose a classification of innovation practices and empirically test the impact of innovation practices on the firms' long–term financial performance, using a broad sample of companies in the electronics sector. Our empirical results show that, within a regional context, companies that are similar in terms of size, position in the value chain, and ownership structure follow similar innovative practices. Furthermore, the use of a systematic approach for innovation leads to revenue growth but does not necessarily increase profit or productivity.

Keywords: Innovation management, business results, technology management, product management

[1] An adaptation of this chapter has been published in: Sánchez, A., Lago, A., Ferràs, X., & Ribera, J. (2011). Innovation management practices, strategic adaptation, and business results: evidence from the electronics industry. Journal of technology management & innovation, 6(2), 14-39.

2.1. Introduction

The ability to innovate has been widely considered one key success factor of business survival and performance (Schumpeter, 1934; Burns & Stalker, 1961; Porter, 1990). As such, different measures have been proposed and tested empirically to assess the degree of a company's innovative ability (Barclay, 1992; Kim and Oh, 2002), and the relationship between innovative ability and business performance has been widely analyzed at the industry level (Huff, 1990; Cooper and Kleinschmidt, 1991; Sorescu, Chandy, and Prabhu, 2003; Guan et al., 2009).

This stream of research, however, has mainly focused on measuring innovative ability as the monetary input to a process (e.g., R&D spending) or as the immediate output or results (e.g., number of new products, new products' percentage of sales, number of patents approved). This approach focuses only on technological aspects and neglects the actual processes that turn spending into results. Hence, it does not explicitly consider the medium- and long-term effects of innovation.

In particular, it neglects the processes that are derived from internal capabilities and good innovation management practices (e.g. project management practices). These innovation processes are, needless to say, multidimensional and complex and, as such, there are several ways to measure the innovation capacities of a company, but to our knowledge no comprehensive approach has been proposed to define adequate measures that capture how companies adopt adequate and systematic innovation practices at the company level (Adams et al., 2006), nor is there conclusive knowledge about the relationship between innovation practices and company success in the mid- and long-term (Hult et al., 2004).

This paper proposes a classification of innovation management practices based on previous literature review and factor analysis, and secondly, empirically test which ones influence business results in the companies in terms of sales growth, average profit per employee and return on assets.

2.2. Literature review

Innovation is often referred as the specific set of activities that offer competitive advantages to a company. As such, an increased interest has been placed on understanding which practices affect more substantially the innovation capability of a company (Adler et alt, 1992; Verhaeghe and Kfir, 2002). Innovation can be identified directly with the concept of strategic adaptation (Eunni et al, 2005).

The importance of having mechanisms for systematic management of innovation has been widely recognized and investigated (Burns and Stalker, 1961; Parker, 1982; Kanter, 1983; Leonard-Barton, 1992; Christensen, 1997). Adler et al. (1990) anticipate the need for four kinds of capabilities to sustain technological innovation at the company level (product development, advanced manufacturing capability, process innovation, and organizational flexibility).

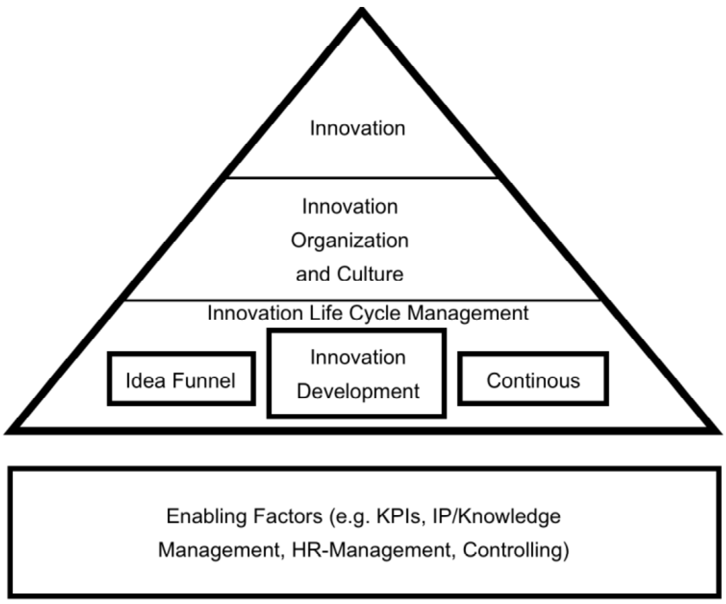
Christensen (1995) classifies technological innovation capabilities into scientific research assets, process innovation assets, product innovation assets or design assets. Burgelman et al. (2004) explores in depth the technological innovation capabilities or TICs (the set of organizational features and practices that support the company's technological innovation strategy). For Yam et al. (2004), "The technological innovation success depends not only on the technological capabilities of the firm, but also on other critical capabilities in marketing, organization, manufacturing, strategic planning and resource allocation."

Chiesa et al. (1996) develop an innovation audit model. This model tests a set of organizational innovation management good practices, in order to determine the firm's innovation capabilities. This model is based in the exploration of "key" innovation processes (new concept generation, new product development, process redefinition, technology acquisition), plus other "support" activities (market focus, leadership and culture, resource allocation, organizational systems). This and similar models were extensively used to foster SME innovation in countries like the United Kingdom (by DTI, the Department of Trade and Industry) and Catalonia (by CIDEM, the Center for Innovation and Business Development) from 1998 to 2002.

More recently, Yam et al. (2004) use an audit model of functional analysis, grouping the different dimensions of innovation capabilities into seven functional groups (corresponding departments) and a further dimension of learning, while Adams et al. (2006) perform an exhaustive analysis of previous innovation management models and establish common denominators based on constructs present in most models: input, knowledge management, strategy, organization and culture, portfolios, and project management and marketing.

Finally, and in order to accomplish the Lisbon EU summit proposal of "converting the EU into the most competitive, knowledge-based, economy in the world by 2010," the European Commission launched an extensive program to improve SME innovation capabilities based on the AT Kearney "Innovation House" model (AT Kearney, 2006), which can be traced back to the Chiesa et al. model (1996). This model, which is one of the latest contributions about innovation management, and the start point of our research, tests innovation practices according to four main foci: innovation strategy, innovation organization and culture, innovation life cycle management, and enabling factors (Figure 3):

Figure 3: The AT Kearney House of Innovation structures Innovation Management into four dimensions enabling success



- Innovation strategy. Also present in models built by Terre (1999), Cooper and Kleinschmidt (1995), Cormican and O'Sullivan (2004), Goffin and Pfeiffer (1999), and Burgelman et al. (2004). Chiesa (1996) identifies it partially under the heading of "leadership." This dimension means the highest level of innovative practices, and includes the creation of an innovative vision, the alignment of same with business strategy, communication and dissemination of the strategy at all organizational levels, the existence of mechanisms for competitive analysis (market trends, technologies, and competitors' moves), and objectives' measurement.

- Innovation organization and culture. A level of organization and culture, also present in models created by Cooper and Kleinschmidt (1995), Chiesa et al. (1996), Cormican and O'Sullivan (2004), and Burgelman et al. (2004). This area includes all those practices related to the systematization and evaluation of innovation, as well as tolerance to failure and risk propensity.
- A field of "Innovation life cycle management," explicitly or implicitly present in other models. This area includes creativity processes, product lifecycle and process planning (Miltenburg, 1995), product and process innovation (Blindenbach-Driessen and Ende, 2006), and continuous improvement.
- Finally, a focus of "enabling factors" that includes activities related to technological innovation, support for the product or process innovation, knowledge management (Coombs and Hull, 1998), information and communication technology tools, and human resources management.

Following the several models of innovation audit proposed (Chiesa et alt, 1996; Yam et al., 2004; AT Kearney, 2006), innovative management practices can be grouped around the following nine dimensions to describe the company's practices:

- innovation strategy (Cooper and Kleinschmidt, 1995; Goffin and Pfeiffer, 2004),
- management systems (Burns & Stalker, 1961; Parker, 1982; Kanter, 1983; Leonard-Barton, 1992; Christensen, 1997),
- innovation culture (Cooper and Kleinschmidt, 1995; Chiesa et al., 1996; Burgelman et al., 2004),
- creativity (Miltenburg, 1995),
- project management (Coombs and Hull, 1998),
- product innovation (Miltenburg, 1995; Blindenbach-Driessen and Ende, 2006),
- process innovation (Blindenbach-Driessen and Ende, 2006),
- commercial innovation (Yam et al., 2004),
- technological innovation, both internally and externally (Christensen, 1995; Hamel and Prahalad, 1994).

The innovative behavior (measured in terms of innovation management practices) should be related to business results (Avlonitis et al., 2001; Bayus et al., 2003; Pauwels et al., 2004), so in this research we want to empirically test which innovation management practices influence business results.

2.3. Methodology

2.3.1. Sample and survey instruments

We chose the high-technology electronics industry to empirically test our model. We chose this industry because it is generally considered a “high-velocity environment, where demand, competition and technology are in constant and accelerated change” (Wirtz et al,, 2007).

Using the “Sistema de Análisis de Balances Ibéricos” database (SABI) – database that collects financial statement and profit and loss accounts of all the Spanish and Portuguese firms registered in the Mercantile Register - we selected a sample of 221 companies in the electronics, communications, and precision equipment groups (corresponding to groups 32 and 33 of the National Classification of Economic Activities). To be chosen for this sample group, companies had to be active before December 1999 and have from 10 to 200 employees.

Data on innovation practices was collected through face-to-face interviews. The face-to-face interview methodology has been shown to be especially effective when there is a high degree of technical complexity in the questions, and when the interviewer is a specialist in the matter (Doyle, 2006). During these visits extended interviews were conducted with the managing director of each company. Each case company received approximately two hours of interviewing and telephone contact. In addition to the interviews, tours of factories, offices, warehouses, and stores were taken in all cases.

An initial questionnaire was designed and pre-tested with an initial subsample of 10 companies, in order to clarify and improve the questions. Finally, a total of 101 companies acceded to the interview, of which 91 we considered valid. Of the surveys, 49.5% were carried out with the company’s General Manager, 19.7% with the R&D Manager, 16.4% with the Engineering Manager, 8.8% with Business Development managers, 3.3% with Production Managers, and 2.19% with Quality Managers.

2.3.2. Variables

Innovation behavior variables. Through the interview process, we captured the innovation behavior of companies through 93 questions that measure the degree of involvement of the companies in key activities, using a Likert scale from 1 to 7. The interviewer guided the company to answer each question and assured a consistent enquiry procedure. Each interview generally followed the structure shown until we received answers for every question. A simplified outline is shown in Table 1 below.

Table 1: Survey structure

Innovation Management Dimensions	**Main topics**
Innovation Strategy	Innovation strategy
Management systems	Innovation systematization
	Human resources management
Innovation culture	Tolerance to change and error
	Cooperative culture
Creativity	Sources of ideas
Project management	Innovation projects management
	Project’s portfolio
	Knowledge management
Product innovation	Product’s lifecycle
	New product development
	Design
Process innovation	Process engineering
	Process management tools
Commercial innovation	Brand management
	New commercial practices

Technological innovation	Technology watch
	R&D department
	R&D public incentives/grants
	External technology sources
	Intellectual property management

Business performance (results) variables. We selected three business results measures: sales growth, profit per employee, and return on assets. We used the SABI database to collect data of business results from 6 consecutive years, which was deemed a sufficient time span to ensure that they reflect the effect of innovation management practices carried out during that period. We obtained data of the three financial figures for each company in our sample and calculated the sales growth rate, average profit per employee, and return on assets during the research period.

2.4. Empirical analysis

2.4.1. Innovation behavior of companies: exploratory factor analysis

We initially speculated that the behavior of companies could be explained around the nine main innovation dimensions proposed in the conceptual model. For that purpose, an exploratory factor analysis was performed of the variables. Through the exploratory factor analysis of data, we found that these 93 questions proposed by literature could be reduced to 19 factors.

Consequently, we recognize that some of the nine dimensions of innovation traditionally considered in the literature could be further subdivided into more refined elements; i.e., when talking about innovation strategy, our analysis shows that it may worthwhile to separately consider the overall strategic planning of the new product development planning, or that management systems innovation could be further subdivided into the control of quality systematization, project management systematization, or the systematization of innovation itself. In Table 2, we map our 19 factors to each of the nine relevant dimensions in our model.

Table 2: Main innovation management patterns

Dimensions	**Factors**
Innovation strategy	Existence of a strategy planning in the mid- and long-term, according to external and internal factors
	Planning of new product developments in the short term
Management systems	Innovation systematization
	Quality systematization
	Project management: portfolio, risk, and continuity of innovation projects
	Capturing high-level professional profiles
Innovation culture	Having an open-minded culture in the organization
Creativity	Development of professional careers, rotation between areas and mechanisms to encourage new ideas among employees
Project management	Knowledge management
Product innovation	Relationship with suppliers as a source of ideas
	Design
Process Innovation	Advanced methods and ICT in product development and production
	Advanced productivity tools in processes
	Operative flexibility
Commercial Innovation	Brand management
	New commercial practices
Technological innovation	Internal R&D
	Collaborative R&D and subsidies
	Use of local technology suppliers

2.4.2. Innovation behavior and firm structure: clusterization of innovative behavior

In order to determine if there are innovation practices related to different industrial environments, we conducted a cluster analysis to classify companies according to their similar innovation practices, using each of the variables (innovation management practices). We used the complete-linkage method, where similarity between clusters is the smallest (minimum diameter) sphere that can enclose all observations in both clusters and assigns each observation (a 60-dimensional vector) to a cluster. The observation (company) is assigned to minimize the Euclidean distance.

Five clusters were found. Looking at the companies forming each cluster, we see that these five clusters corresponded to five different kinds of electronics companies. These results show relevant relationships between the company typology and environment (size, structure, range of products, and position in the value chain) and innovation management practices, such as companies with similar typologies and environments also having similar innovative behaviors (Table 3).

Table 3: Relationship between company typology and environment

Cluster	Innovation management practices	Type of company/Industrial context
1	Higher scores in all innovation management practices, especially in innovation systematization. The worst behavior was found in capturing high-level professional profiles.	Size: Medium enterprises Range of products: Manufacturing medical devices or telecommunications products/services Position in the value chain: Own product
2	Low scores in the majority of variables. This is the cluster where a better product design takes place.	Size: Small companies (fewer than 20 employees) Structure: Strong role of the CEO or director

		Range of products: Very limited range, generally with specific applications where design is a key factor Position in the value chain: Own product
3	Low scores in all practices, important differences found in project management, much lower than in the rest of clusters.	Size: Medium enterprises Structure: Traditional management without professionalization Position in the value chain: Own product. They do not develop technology and use local suppliers to get it
4	Good scores in product design and operative flexibility, although branding is not very relevant.	Size: Medium enterprises Range of products: Control and verification devices and tools, including for industrial processes Position in the value chain: Suppliers
5	High level of quality and branding. This cluster does not show product design and commercial innovation.	Size: Medium-large enterprises Structure: Professionalized Position in the value chain: Big industry suppliers

2.4.3. Link between innovation and results

<u>Cluster comparison</u>

In order to determine if innovation patterns related to different business performance in the mid- and long-term, we performed the following test:

Companies were ranked according to their positions concerning each of the three measures parameters (sales growth, profit per employee, and return on assets). In each case, ranks were divided in quartiles; each company was assigned to a quartile, from 1 to 4. Additionally, we compared the average of each cluster to find which ones had better business performance.

Sales Growth: 50% of companies from Cluster 1 and 42.86% from Cluster 5 belong to Quartile 1 (best performers) in sales growth, and only one of them (from Cluster 5) was ranked as a worst-performer (Quartile 4). On the other hand, 50% of companies belonging to Cluster 2 showed the lowest results in turnover growth (Table 4). However, the chi-square test of independence showed no relationship between cluster membership and quartile distribution (asymp. sign. 2-sided= .196). We found statistical significance showing that companies from Cluster 1 have higher results than Clusters 2, 3, and 4 in terms of turnover variation (Table 5).

Table 4: Cluster distribution by quartiles according to sales growth

	Quartile 4 (less competitive)	Quartile 3	Quartile 2	Quartile 1 (most competitive)	Total
Cluster 1	0% (0)	14.29% (2)	35.71% (5)	50% (7)	100% (14)
Cluster 2	50% (7)	21.43% (3)	7.14% (1)	21.43% (3)	100% (14)
Cluster 3	30% (12)	27.50% (11)	25% (10)	17.50% (7)	100% (40)
Cluster 4	22.22% (2)	22.22% (2)	33.33% (3)	22.22% (2)	100% (9)
Cluster 5	14.29% (1)	28.57% (2)	14.29% (1)	42.86% (3)	100% (7)

Table 5: T-test comparing cluster average of sales growth

Cluster	1	2	3	4	5
1 – Average 1.6	-	0.001**	0.002**	0.052*	0.255
2 – Average 2.7		-	0.397	0.531	0.226
3 – Average 3			-	0.291	0.149
4 – Average 2.4				-	0.616
5 – Average 2.1					-

Profit per employee: Clusters 1 and 4 showed the best performance with 42.86% and 55.56% of the companies, respectively, in Quartile 1, while Clusters 2 and 3 contain the 85.72% of the worst performers in terms of profit per employee (Quartile 4, Table 6). A Chi-square of 19.94 (asymp. sig. 2-sided= .068) confirms this relationship between clusters and their distribution.

We found that Clusters 1, 4, and 5, which showed more innovative behavior, were generally better than Clusters 2 and 3, with a significant difference in their profit per employee media (Table 7).

Table 6: Cluster distribution by quartiles according to profit per employee

	Quartile 4 (less competitive)	Quartile 3	Quartile 2	Quartile 1 (most competitive)	Total
Cluster 1	7.14% (1)	21.43% (3)	28.57% (4)	42.86% (6)	100% (14)
Cluster 2	28.57% (4)	42.86% (6)	21.43% (3)	7.14% (1)	100% (14)
Cluster 3	35% (14)	22.50% (9)	30% (12)	12.50% (5)	100% (40)
Cluster 4	22.22% (2)	11.11% (1)	11.11% (1)	55.56% (5)	100% (9)
Cluster 5	0% (0)	28.57% (2)	42.86% (3)	28.57% (2)	100% (7)

Table 7: T-test comparing cluster average for profit per employee

Cluster	1	2	3	4	5
1 – Average 1.9	-	0.01**	0.01**	0.884	0.872
2 – Average 2.8		-	0.69	0.058*	0.066*
3 – Average 2.9			-	0.059*	0.036**
4 – Average 2				-	1
5 – Average 2					-

Return on assets (ROA): The analysis relating clusters to their position on quartiles measured according to their return on assets media showed that Clusters 1 and 5 were statistically better than 2 and 3 (Table 9), with 57.14% and 33.33% of the companies, respectively, in Quartile 1 (Table 8), confirmed by the chi-square independence test ($\chi 2$=23.09, asym. sign. 2-sided= .027).

Table 8: Cluster distribution by quartiles according to return on assets

	Quartile 4 (less competitive)	Quartile 3	Quartile 2	Quartile 1 (most competitive)	Total
Cluster 1	7.14% (1)	14.29% (2)	21.43% (3)	57.14% (8)	100% (14)
Cluster 2	35.71% (5)	42.86% (6)	7.14% (1)	14.29% (2)	100% (14)
Cluster 3	32.50% (13)	27.50% (11)	27.50% (11)	12.50% (5)	100% (40)
Cluster 4	22.22% (2)	11.11% (1)	33.33% (3)	33.33% (3)	100% (9)
Cluster 5	0% (0)	14.29% (1)	57.14% (4)	28.57% (2)	100% (7)

Table 9: T-test comparing cluster average of return on assets

Cluster	1	2	3	4	5
1 – Average 1.7	-	0.001**	0.0021**	0.283	0.738
2 – Average 2.8		-	0.539	0.15	0.026**
3 – Average 3			-	0.114	0.017**
4 – Average 2.2				-	0.487
5 – Average 1.8					-

Average rank: A final test was carried out with an integrated ranking. In order to capture the relative performance position of the company along multiple dimensions and also in an aggregate construct, we followed a methodology similar to the approach recommended by Rouse & Daellenbach (1999) and Eunni (2005). Data for each dependent variable (performance measure) was separately tabulated in a descending order, and all of the companies were ranked. The ranks were averaged to obtain a mean rank score, then the companies were arranged in descending order of these mean scores. Finally, the companies in the panel were the divided into four final quartiles, to measure overall performance based on the mean quartile scores.

All the results found by the analysis demonstrate that Clusters 1, 4, and 5 - especially 1 and 5 - are better performers than 2 and 3 (Tables 10 and 11, $\chi 2$=23.69, asym. sign. 2-sided= .022), but we can't determine which variables fix these differences, as there is also a relationship between innovation practices and the company context.

Table 10: Cluster distribution by quartiles according to the average rank

	Quartile 4 (less competitive)	Quartile 3	Quartile 2	Quartile 1 (most competitive)	Total
Cluster 1	0% (0)	14.29% (2)	28.57% (4)	57.14% (8)	100% (14)
Cluster 2	50% (7)	14.29% (2)	21.43% (3)	14.29% (2)	100% (14)
Cluster 3	30% (12)	35% (14)	22.50% (9)	12.50% (5)	100% (40)
Cluster 4	22.22% (2)	11.11% (1)	33.33% (3)	33.33% (3)	100% (9)
Cluster 5	0% (0)	28.57% (2)	42.86% (3)	28.57% (2)	100% (7)

Table 11: T-test comparing cluster average rank

Cluster	1	2	3	4	5
1 – Average 1.5	-	0.000**	0.001**	0.124	0.247
2 – Average 2.8		-	0.595	0.125	0.047**
3 – Average 3			-	0.14	0.059*
4 – Average 2.2				-	0.682
5 – Average 2					-

Linear regression model

In order to find which innovation practices are most related to business performance, we built a lineal regression model according to our model, where business performance is the dependent variable and a function of innovation management practices (independent variables).

Three regressions have been run with the three business results indicators. Models where profit per employee and return on assets as independent variables explained by innovation management practices did not show an acceptable R-coefficient and F-test, so there is no significant evidence that some innovation management practices influence these business results indicators.

We show results of the regression where turnover variation is the dependent variable explained by innovation management practices (Table 12).

There is significant evidence that some innovation management practices influence business turnover (the model adjusted R-square was 0.227, with an F-test significance of 0.007).

Two innovation practices are strongly supported: companies with high innovation systematization tend to increase their turnover, and those who use advanced methods and ICT in product development and production exhibit a higher propensity for improvement in their sales.

Innovation practices like design management, capturing high-level professional profiles, collaborative R&D projects, using public subsidies, and the use of local technology suppliers is negatively related to turnover levels, which could show the immature technology level of suppliers or difficulties in technology transfer. Further research is needed to clarify this point.

Table 12: Regression results with turnover as a dependent variable

	Non-standardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	-18.591	87.612		-.212	.833
Innovation strategy	7.976	8.701	.125	.917	.363
Innovation systematization	3.765	13.819	.039	.272	.786
Product lifecycle planning	**28.401**	**13.265**	**.377**	**2.141**	**.036****
Quality systematization	-12.114	8.489	-.182	-1.427	.158
Project management	-9.145	10.960	-.122	-.834	.407
Advanced methods and ICT	**26.969**	**11.060**	**.356**	**2.438**	**.018****
Process management tools	10.395	10.937	.147	.951	.345
Process engineering	7.466	6.554	.121	1.139	.259
Brand management	11.055	9.982	.120	1.107	.272
Design	**-16.410**	**8.797**	**-.239**	**-1.866**	**.067***
New commercial practices	12.833	10.376	.160	1.237	.221
Professional development	-13.355	12.032	-.155	-1.110	.271
Knowledge management	-11.532	9.398	-.157	-1.227	.224
High-level professional profiles	-23.241	11.047	-,271	-2.104	.039**
Tolerance to change and error	10.787	9.364	.146	1.152	.254
Technological innovation	13.387	13.247	.168	1.011	.316
Collaborative R&D, subsidies	**-24.194**	**8.461**	**-.398**	**-2.859**	**.006****
Relationship with suppliers	11.554	9.486	.139	1.218	.228
Local technology suppliers	**-14.951**	**8.630**	**-.202**	**-1.732**	**.088***

* $p \leq .10$

** $p \leq .05$

2.5. Conclusion

Our empirical analysis reveals that, depending on the industrial environment, companies use different innovation management practices. Nevertheless, for the entire sample, the systematization of innovation is the main factor positively related to improvements in business performance.

This is in agreement with some previous results in other contexts. For instance, Battisti and Iona (2009) found that establishment size, ownership structure, and product market concentration are important determinants of the intensity of management practices in the British establishment. Our research shows that something similar may happen in the high-technology sector.

Each of the five clusters of companies corresponds to a particular industrial environment and, at the same time, seems to be related to a different degree of innovation management. For instance, the first cluster formed by companies with a high level of innovation management corresponds to medium-sized companies in the subsector of medical devices and telecommunications. On the other hand, companies in the second cluster tend to be smaller companies with strong leadership (i.e., traditional family-type business) and a limited range of products and, commonly, show low levels of innovation management. The third cluster contains medium-sized companies with little professionalization in the management team and with poor skills in innovation project management. The fourth one is also formed by medium-sized companies - suppliers of control and verification devices - that showed strong design management and operative flexibility, but no capabilities for branding. Finally, the last cluster belongs to medium and large companies that are professionalized, are suppliers for multinational companies, and have high levels of quality of branding but low levels of design and commercial innovation.

Concerning the relationship between clusters and business performance, our research concludes that Clusters 1, 4, and 5 are better performers than 2 and 3 when looking at the three dependent variables - sales growth, profit per employee and ROA - during the period of study.

We found significant statistical evidence of a relationship between different innovation management practices and business results. Our results demonstrate that companies with poor innovation management practices and without innovation project management skills perform worse than the rest of the sector.

Based on the examination of innovation practices and business performance through a lineal regression model, it appears that innovation practices can explain sales growth but not improvements in profit per employee and ROA.

Regarding the negative impact of collaborative R&D projects and the of use public subsidies, our result are surprising. In some mature sectors, previous research shows that companies that experience continuous reduction in turnover seek cooperation in R&D activities to research new markets and opportunities, but that this late reaction seldom leads to improved results in the long term (Hagedoorn, 1993). As such, our results may be biased regarding this problem and further research is needed to solve these issues.

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3. Exploring R&D alliance outcomes and the relationship with partner selection

Developing in-house R&D is still a strategic decision that many firms make in order to achieve competitive advantages. However, collaboration with other firms, universities or research entities through R&D alliances has become in many cases the only solution to get resources that, otherwise, firms would not have or would have higher costs. The aim of this research is to analyze the relationship between the type of partners that collaborate in R&D alliances and different alliance performance outcomes: acquisition of technical knowledge, new technological opportunities and new commercial opportunities. We have found that alliances between companies are the ones that tend to generate more commercial opportunities. Secondly, we confirm a negative effect of the participation of technological centers for the three types of outcomes. And finally, we cannot confirm a positive relationship between including a university partner in the alliance and acquiring new technical knowledge.

Keywords: R&D alliances, collaboration, partner selection, outcomes, performance

3.1. Introduction

Firms are engaged in joint R&D because it allows the utilization of external resources for their own purposes directly and systematically. The benefits of R&D cooperation (Becker and Peters, 1998; Camagni, 1993; Robertson and Langlois, 1995) can be described as follows: joint financing of R&D; reducing uncertainty; realizing cost-savings; and realizing economies of scale and scope.

There is a large body of literature in the management domain that study the motives that initiate firms to collaborate on R&D (Contractor and Lorange, 2002; Nooteboom, 1999) and the selection of partners for this collaboration (Miotti and Sachwald, 2003; Li and Ferreira, 2008; Holmberg and Cummings, 2009). Firms can be engaged in inter-industry agreements (Hagedoorn, 2002; Katz and Ordover, 1990; Mowery, 1989; Plunket et al., 2001) and/or collaborate with institutions outside the industrial sector; especially universities and public research institutes (Beise and Stahl, 1999; Lee, 1996; Leyden and Link, 1999; Schartinger et al., 2002).

On the other side, alliance performance has been recognized as one of the most interesting and also one of the most vexing questions of the strategic alliances literature (Gulati, 1998). However, many factors make the study of alliance performance difficult, such as the lack of consensus around a typology of collaborative agreements, diversity in firms' strategic intents in pursuing alliances, and the lack of objective performance data (Anderson, 1990; Geringer and Hebert, 1991; Kogut, 1988).

As alliances are acknowledged to provide access to specific resources of partner firms enabling them to leverage competitive advantages, performance measurement in alliances need to be adjusted accordingly. Recent studies focus on a firm's ability to acquire partner resources through the alliance (Das and Teng, 2000; Hamel, 1991; Hamel et al., 1989; Khanna et al., 1998; Koot, 1988; Madhok and Tallman, 1998), thereby assessing the achievement of objectives by individual partners (Jap, 2001; Kale et al., 2000).

The theoretical and practical relevance of identifying antecedents of alliance performance provides strong motivation for research that moves beyond firms' initial partners choices or indirect proxies such as alliance survival to study collaborators' specific alliance outcomes. So far, research that analyzes antecedents of alliance performance have produced scattered results (Park and Ungson, 2001) and the relationship between partner's selection and alliance performance has been left almost untouched.

In this research we analyze 81 R&D alliances subsidized between 2007 and 2008 in Catalonia (Spain) that were led by companies with the collaboration of at least another entity (company, technological center or university) and their performance in terms of technical knowledge acquired, new technological opportunities and new commercial opportunities. Therefore, the objective of this research is to investigate the relationship between the typology of partners that collaborate in R&D alliances and alliance outcomes.

3.2. Literature review

3.2.1. Partner selection and alliance performance

The choice of a partner is an important factor affecting alliance performance. Finding the right partner requires careful screening and can be a time-consuming process. Developing an understanding of partners' expectations and objectives can also take time. However, many alliances are formed by chance meetings or through previous experience with the partner.

Selection of partners and measurement of cooperation are some of the main large areas of interest in alliance literature (Parkhe, 1996). It is recognised that high diversity in the membership of an alliance increases the likelihood of the presence of novel information, knowledge and perspectives, which all raise the potential for novelty and innovation (Conway and Steward, 2009). Two main lines of research have been developed on this topic: first, the role of inter-firm value-chain relationships in R&D collaboration, and secondly, the characteristics of industry-university interactions; although there isn't a clarified explanation yet.

In the context of R&D alliances, highly diverse partner capabilities may actually reduce the innovative benefits a firm reaps from collaborative R&D, since firms can only assimilate capabilities that are sufficiently similar to their own. However, partners that are very similar may also experience reduced benefits from R&D collaboration. If innovation arises out of new combinations of existing capabilities (Schumpeter, 1934), then beyond a critical minimum level of R&D activities, the addition of similar capabilities does not increase innovation, since possible new combinations of existing capabilities have been exhausted.

Partners with diverse capabilities have more to learn from each other than partners with very similar capabilities do. Pooling distinct perspectives and capabilities, or technological diversity between partners, encourages creativity and novel solutions to existing problems that improve the performance of the alliance (Saxton, 1997).

Empirical research has been done in order to test the relationship between selection of partners with results, benefits and general performance of alliance, although they have been limited because of lack of data (Feller et al., 1996; Cozzarin, 2008; Santamaría et al., 2010).

First contributions, which started to integrate the partner and relationship characteristics perspectives, tried to examine alliances in different contexts mainly through satisfaction measures as a proxy of alliance performance. Results confirmed that there was a positive relationship between partners' benefits from the alliance and partner reputation, strategic similarities between partners, and partner-specific experience (e.g. Saxton, 1997; Zollo et al., 2002; Kale et al., 2002; Draulans et al., 2003).

At that point, some authors studied the phenomenon in a theoretical way. Das and Teng (2002) propose an integrated process model of alliances that is based on alliance conditions, alliance developmental stages, and an alliance system comprising co-evolutionary elements, that after was developed to present a theoretical framework for understanding alliance performance in terms of its key antecedents (Das and Teng, 2003).

Size and organizational form were found to affect the probability of technical success and duration to commercialization (Bizan, 2003; Arranz and Fdez. De Arroyabe, 2008), and cooperative R&D was more successful, the higher the quality and quantity of external resources available through cooperation, and the lower the transaction and coordination costs required for such arrangements (Okamuro, 2007).

Recent contributions have expanded theoretical frameworks with the inclusion of new partner selection processes and evaluating several firm and sector characteristics that may influence partners' benefits and the overall alliance performance (Holmberg and Cummings, 2009; Deitz et al., 2010; Eom and Lee, 2010; De Faria et al., 2010).

However, some studies arrived to different conclusions and did not find evidence of a clear match between alliance form, partners, and alliance performance. For example, Murray and Kotabe (2005) found an appropriate match between alliance forms and attributes and alliance performance, but did not with alliance attributes or alliance form alone; and Hoang and Rothaermel (2005), contrary to predictions, concluded that partner-specific experience had a negative, marginally significant effect on joint project performance.

3.2.2. Typology of partners

As alliances provide access to specific resources of partner firms enabling firms to leverage competitive advantages, performance measurement in alliances needed to be adjusted accordingly. Consequently, some studies focus on a firm's ability to acquire partner resources through the alliance (Das and Teng, 2000; Hamel, 1991; Hamel et al., 1989; Khanna et al., 1998; Koot, 1988; Madhok and Tallman, 1998), thereby assessing the achievement of objectives by individual partners (Jap, 2001; Kale et al., 2000). Since, with the latter approach, each partner can evaluate the performance of an alliance differently, still others used the alliance per se as unit of analysis and measured performance in terms of e.g. new products developed, product innovativeness or combined indices of profitability and qualitative measures (Deeds and Hill, 1996; Kotabe and Swan, 1995; Parkhe, 1993).

From a resourced-based view, several authors have investigated the role of partners employing a mixture of theoretical and methodological perspective, but there is few research of an empirical character to support the theoretical studies because of the difficulty of obtaining valid data.

Empirical research started at the beginning of the 21st century and they were focused on sectoral patterns of R&D cooperation (Sakakibara, 2001; Malerba, 2002; Schartinger et al., 2002; Miotti and Sachwals, 2003) and the relationship between partners' choice and motivations for cooperative R&D (Bayona et al., 2001; Belderbos et al., 2004; Santamaria and Rialp, 2007).

As introduced before, firms can be engaged in inter-industry agreements (Hagedoorn, 2002; Katz and Ordover, 1990; Mowery, 1989; Plunket et al., 2001) and/or collaborate with institutions outside the industrial sector; especially universities and public research institutes (Beise and Stahl, 1999; Lee, 1996; Leyden and Link, 1999; Schartinger et al., 2002).

This kind of cooperation present unique coordination challenges, since some sharing or transfer of knowledge over firm boundaries is usually required (Sampson, 2007). Successful knowledge transfer is not assured, particularly where knowledge is tacit or complex. Beyond the ability to share knowledge among partners is the need to preserve incentives to share such knowledge, given the substantial moral hazard problems that typically accompany knowledge-based alliances. Concerns over unintended transfer of knowledge to a partner and, ultimately, erosion of the value of a firm's knowledge resources may prevent the firm from contributing adequately to an alliance. The form that alliance organization takes may affect how much firms reap from such collaborations, since organization can influence both the ability and willingness of partners to share knowledge-based capabilities.

Other lines of research analyze value-chain relationships and motivation for R&D cooperation, for example Belderbos at al. (2004), affirm that competitor and supplier cooperation focus on incremental innovations and improves the productivity of firms; while university and competitor cooperation creates innovation sales of products that are novel to the market and improve the growth of firms. Finally, customers and universities are important sources of knowledge for firms pursuing radical innovations, which facilitate growth in innovative sales in the absence of formal R&D cooperation.

By contrast, Miotti and Sachwald (2003) arrive to different results affirming that the share of innovative products in turnover is only increased by vertical integration, not by cooperation with university and competitors; and cooperating with public institutions would increase patenting. Also Santamaría and Rialp (2007) find that vertical cooperation takes place when partners have marketing goals and competitors are an alternative to get financial sources for research projects, while Aschoff and Smidt (2008) affirm that cooperation with competitors leads to cost reductions.

Regarding R&D cooperation between firms and universities, Veugelers and Cassiman (2005) confirm that these agreements are formed whenever risk is not an important obstacle to innovation and typically to share costs and they are embedded in a wider strategy of the firm. According to them, given the specific characteristics of scientific knowledge, R&D cooperation between universities and industry is characterized by high uncertainty, high information asymmetries between partners, high transaction costs for knowledge exchange requiring the presence of absorptive capacity, high spillovers to other market actors (i.e. a low level of appropriation of benefits out of the knowledge acquired), and, restrictions for financing knowledge production and exchange activities due to risk-averse and short-term oriented financial markets.

Later, Santamaría and Rialp (2007) point out vertical cooperation as the preferred one when the firm is pursuing commercials goals, as well as the completion of innovation process. Public funding and technological capabilities are important motivations for selecting universities and technological centers.

Finally and regarding technology centers, there are two main motives for cooperating with them. The first one is that this kind of institution contributes to increase the research capabilities of the company (Miotti and Schawald, 2003; Izushi, 2003). The second reason is that, thorugh this cooperation agreements, companies can benefit of spillovers and public knowledge generated by these institutions (Mohnen and Hoareau, 2003). Consequently, companies could have interest in collaborating with them in order to capture new technological opportunities of their basic research (Mohnen and Hoareau)

As we have seen in the literature, most of the articles concerning R&D alliances explore benefits and disadvantages of R&D alliances, but surprisingly, there are many few works that analyze how alliances are formed and their performance. This last topic will be our main issue of this study and after reviewing the existing literature about partners and its relationship with alliance performance, we propose the next hypotheses:

H1: Alliances with others firms foster new commercial opportunities

H2: Alliances with universities foster acquisition of new technical knowledge

H3: Alliances with technology centers foster new technological opportunities

3.3. Methodology

3.3.1. Sample

This research analyzes R&D alliances of companies in Catalonia that have applied for public subsidies to the regional government. They can be either groups with their own legal status and an operational base in Catalonia that were founded on the date the application was submitted, or any other group of public or private legal entities governed by a contractual agreement.

Public incentives for R&D are provided by ACC1Ó, the Catalan agency for innovation and internationalization. ACCIÓ has supported collaborative R&D projects and provides support to R&D alliances on the basis of the following co-financing model: up to 50% outright grant for research expenses and up to 25% outright grant for experimental development expenses, the maximum established by the European Union. ACCIÓ scores all the projects and gives the maximum grant allowed to every project, starting from the best scored one, and finishing when the budget has run over.

The process changes slightly every year (table 13). We study the data for 2008 and 2009. In 2008, there were 2 calls for R&D projects that had to have a minimum cost of 500.000 euros and ACCIÓ's budget for grants was 19 million euro. In 2009, there was one call with a budget of 17,5 million euros and projects had to be bigger, at least a cost of 600.000 euros.

Table 13: Process characteristics in 2008 and 2009

	Year 2008	**Year 2009**
Budget for grants	19 M€	17.5 M€
Minimum cost of projects	500,000 €	600,000 €
Number of calls	2, evaluated separetely	1 call
Evaluators	ACCIÓ & AIDIT	ACCIÓ & AIDIT
AIDIT evaluation	Only projects submitted as a consortium	All projects submitted

Projects can apply in two different ways: as a consortium where all the companies involved in the project apply for the grant, or in an individual way, where the company that leads the project applies for the grant and the rest of companies are considered subcontracted parties.

Projects submitted by R&D alliances start a double process: the administrative evaluation to see if the project has all the requirements to be granted in terms of legal conditions and formation of alliances (e.g. number and type of participants and costs of the project); and the technical evaluation.

The technical evaluation consists of a double process, an internal process, where the externalities of the projects are examined, and an external one, where the technological compound is assessed.

In the internal process, ACCIÓ considers two kinds of externalities, those that take into account the economic impact that the project could have in the region and over other companies; and those externalities related to the generation and diffusion of new knowledge.

In the external process, the evaluation is made by an external consultant, the Agency for Accreditation of Research, Development and Technological Innovation (AIDIT), on the basis of technological criteria. AIDIT is a public company accredited for certification of R&D in Spain that gives a qualified and independent technical opinion about R&D projects.

AIDIT classifies the R&D projects according to their novelty and riskiness based on a set of quantitative and qualitative criteria: Quality of technical activities developed in projects, capacity of consortia to achieve the goals and possibilities of the joint project, both in the application of knowledge and the correct orientation to success.

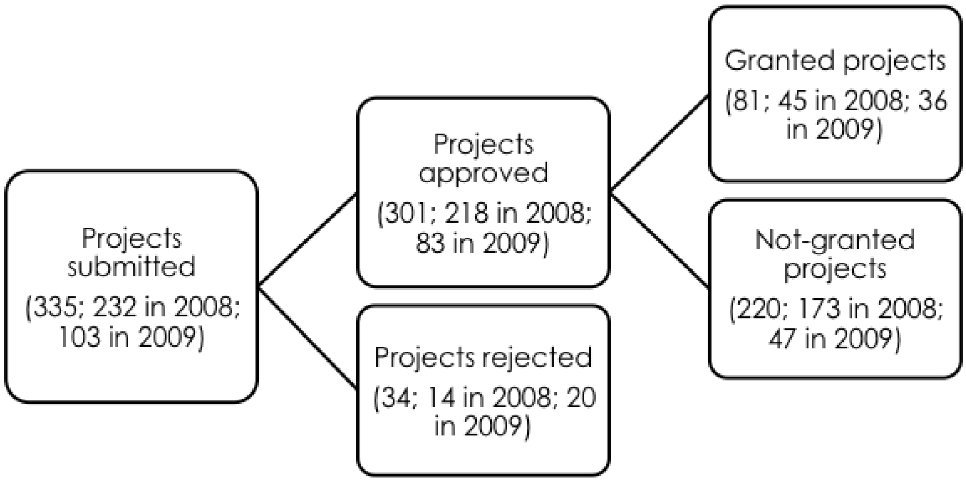
The result of the application of these criteria is a final score ranking of the technological interest degree of the project - A, B, C, D and E - sorted from highest to lowest interest:

Score	Technological Interest degree
A	Very high
B	High
C	Medium
D	Low
E	Very low

In 2008, as a pilot measure, only projects that applied like a consortium were evaluated by AIDIT, and in 2009, the methodology was extended to all the projects submitted.

The process followed by ACCIÓ to decide which projects receive a grant is represented in Figure 4.

Figure 4: ACC1O's decision process



In a first stage, projects were rejected if they did not pass the administrative evaluation or if they were graded with a D or E by the external consultant. 10.1% did not pass the first stage. The rest of the projects were technically approved and ACCIÓ graded them with a score that came from weighting the external consultant evaluation and the degree of externalities generated by the project.

Due to budget constraints, ACCIÓ issued a final decision only for a subset of all the projects that were technically approved. Only the best graded projects were finally granted and financed with the maximum quantity allowed (50% for research and 25% for experimental development activities). Out of the 335 submitted projects, 24.2% were granted financing.

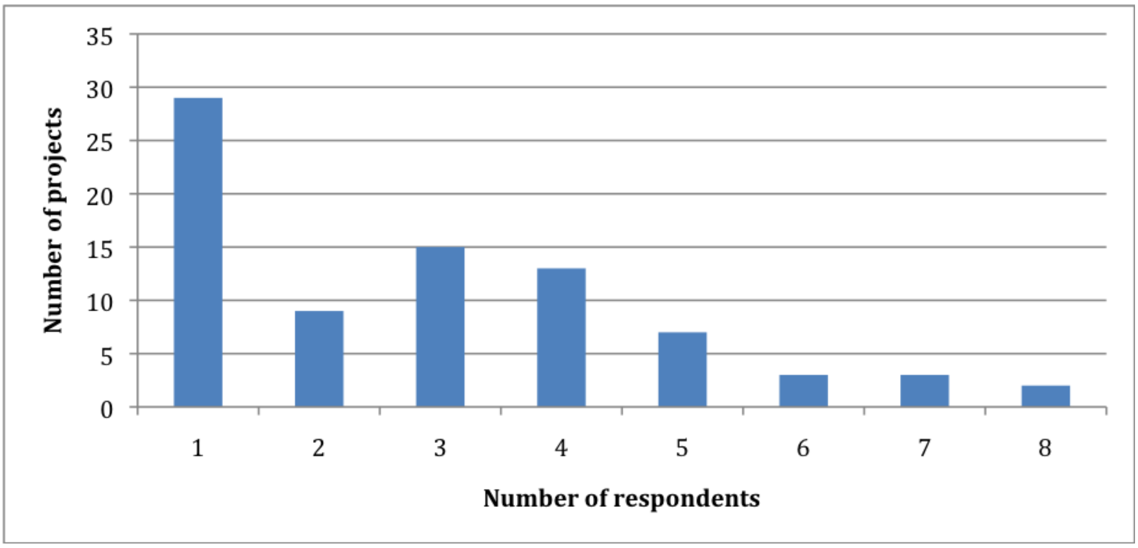
3.3.2. Data

We combine 2 data sources. All the variables of the evaluation process came from ACCIÓ database that includes cost and technical evaluation scores of all projects (n=335) that applied for research and development funding in 2008 and 2009. Unfortunately, the specific criteria used to score projects in 2008 and 2009 were not completely the same as was the cut-off on the size of the projects.

The second source of data is a survey (Appendix 1) performed in 2011 with the companies of granted R&D alliances under this program in 2008 and 2009. The survey allows for a large-sample analysis of cross-sectional qualitative data, such as the firms' stated motives for participation, firms' evaluation of their partners and the outcomes of the collaboration. The questionnaire was pre-tested with several managers in industry and government officials who have coordinated the R&D consortia. Consortia participants were identified from the list of regional government-sponsored R&D consortia.

This survey was sent to the companies participating in the ACCIÓ program in 2008 and 2009, so we can compare outcomes. However, we should be careful in comparisons across years in the selection stage. The final sample of the survey included 236 companies participating in 81 alliances (Figure 5). The number of respondents varied from one to eight depending on the project. In 36% of the alliances only one company answered the survey, in 11% was answered by two companies, 19% by three, 16% by four and higher number of respondents up to eight were 9%, 4%, 4% and 2%, respectively.

Figure 5: Number of respondent companies by project



3.3.3. Variables

Variables used to investigate the relationship between type of partners and outcomes of the alliances, are detailed in Table 14:

Table 14: variables from the survey used in this research

Variable	**Definition**	**Range / value**
Cost	Cost of the project approved by ACCIÓ	Euros
Commercial viability	ACCIÓ's evaluation criteria about the marketable perspectives of the project	Std value (mean 0 and variance 1)
A Project	Technological interest degree. Binary variable if project is scored with an A	[0 (no), 1 (yes)]
B Project	Technological interest degree. Binary variable if project is scored with an B	[0 (no), 1 (yes)]
C Project	Technological interest degree. Binary variable if project is scored with an C	[0 (no), 1 (yes)]
Acquired technological knowledge	Companies' valuation in the survey of the technological knowledge acquired thanks to the participation in the project.	[1 (low) - 5 (high)]
New technological opportunities	Companies' valuation in the survey of the new technological opportunities created thanks to the participation in the project.	[1 (low) - 5 (high)]
New commercial opportunities	Companies' valuation in the survey of the new commercial opportunities generated thanks to the participation in the project.	[1 (low) - 5 (high)]
University partner	Binary variable if companies collaborated with university	[0 (no), 1 (yes)]
Technological center partner	Binary variable if companies collaborated with technological centers	[0 (no), 1 (yes)]
Company partner	Binary variable if companies collaborated with other companies	[0 (no), 1 (yes)]

Moreover, with the aim of analyzing the outcomes of the collaborations, we distinguished 4 types of alliances and created new variables with this information (Table 15): alliances where companies collaborated with university and technological centers (type 1), alliances where companies collaborated only with university (type 2), alliances with collaborations between companies and technological centers (type 3), and finally, alliances where only companies collaborated between them, without any university or technological center within the project (type 4).

Table 15: Types of projects by partners involved

Type	**Partners**
1	Companies + University + Technological center
2	Companies + University
3	Companies + Technological center
4	Companies

Each type of collaboration is expected to produce different outcomes such as new technical knowledge, new technological opportunities or new commercial opportunities as we have presented previously in our hypotheses.

3.4. Results

Looking at the descriptive statistics of outcomes for each type of collaboration (Table 16), we observe that both years type 2 projects (companies and university) are those where companies obtained more technical knowledge and more technological opportunities, while type 3 collaborations (with technological centers) are those where companies obtained less of these two outcomes. Regarding new commercial opportunities, collaborations only between companies (type 4) were the ones that got more of this outcome at the end of the project.

Table 16: Descriptive statistics for types of collaboration and outcomes

	2008				2009			
	Obs.	**Acquired tech. knowledge**	**New tech. Opport.**	**New comer. Opport.**	**Obs.**	**Acquired tech. knowledge**	**New tech. Opport.**	**New comer. Opport.**
Type 1	18	4.09 (0.399)	3.88 (0.611)	3.37 (0.891)	17	3.82 (0.630)	3.84 (0.810)	3.32 (0.553)
Type 2	5	4.50 (0.500)	4.50 (0.500)	4.00 (0.707)	3	4.25 (0.661)	4.56 (0.509)	3.53 (0.709)
Type 3	11	3.86 (0.697)	3.70 (0.821)	3.35 (1.204)	10	3.89 (0.455)	3.94 (0.465)	3.43 (0.584)
Type 4	2	4.50 (0.707)	4.00 (1.414)	5.00 (0.000)	4	3.75 (0.957)	3.50 (0.577)	4.25 (0.957)

We also analyze outcomes depending on the technical evaluation. Results show that in 2008, projects evaluated with a C (medium technological interest degree) performed worse in the three kinds of outcomes, while in 2009 the situation was completely inverse and projects evaluated with an A (very high technological interest degree) are the ones that obtained the worst outcomes (Table 17).

Table 17: Descriptive statistics projects according the technological interest degree and outcomes

	2008				2009			
	Obs.	**Acquired tech. knowledge**	**New tech. Opport.**	**New comer. Opport.**	**Obs.**	**Acquired tech. knowledge**	**New tech. Opport.**	**New comer. Opport.**
A project	15	4.14 (0.387)	3.90 (0.587)	3.65 (0.961)	13	3.59 (0.501)	3.60 (0.717)	3.33 (0.731)
B project	5	4.29 (0.575)	3.99 (1.017)	3.65 (1.275)	16	4.04 (0.635)	4.10 (0.656)	3.63 (0.596)
C project	9	3.75 (0.569)	3.62 (0.745)	3.24 (0.977)	5	4.03 (0.655)	4.01 (0.598)	3.42 (0.731)

About the valuation of partners, in 2008 C projects scored better university, technological centers and companies than A and B projects did. Nevertheless, in 2009 C projects only valued better university partners and B projects had a higher score for technological centers and companies (Table 18)

Table 18: Descriptive on valuation partners

	2008			2009		
	University partner	**Technology center partner**	**Firm partner**	**University partner**	**Technology center partner**	**Firm partner**
A project	3.86 (15)	3.95 (13)	3.44 (12)	3.59 (10)	3.89 (11)	3.7 (12)
B project	3.11 (3)	4.25 (5)	3.85 (5)	4.01 (10)	4.43 (12)	4.15 (14)
C project	3.98 (5)	4.36 (8)	4.23 (7)	4.67 (2)	4.35 (5)	4.09 (5)

Finally, OLS regressions are used to test the proposed hypotheses. We regress the project's performance variables (acquired technological knowledge, new technological opportunities and new commercial opportunities) based on cost, commercial viability, A Project, A project in 2008 and fixed effects to control for year and kind of partners within the collaboration, on the explanatory variables. Table 19 presents the results of the analysis.

One of the things that we clearly appreciate when we look at the models is that results show that the participation of technology centers in the alliances strongly and negatively affects the performance of the alliance for the three measured outcomes: acquired technological knowledge (b = -0.343), new technological opportunities (b = -0.453) and new commercial opportunities (b = -0.896).

Contrary to what we predicted, we have to reject Hypothesis 3 as there is not a positive effect between the participation of technology centers and performance of the R&D alliance.

The findings on the participation of more companies in the alliance support our prediction. Their participation in the alliance is positively and strongly related obtain more commercial opportunities for the other companies involved in the project (b = 0.87), so we can confirm Hypothesis 1.

Finally it is found that there is positive but not significant effect of the participation of universities on acquiring technological knowledge and obtaining new commercial opportunities (Hypothesis 2).

Table 19: OLS Regressions results to explain outcomes of the collaborations

	Acquiring Technical Knowledge	**New Technological Opportunities**	**New Commercial Opportunities**
Cost	-0.083 (0.5)	-0.346 (0.59)	0.722 (0.66)
Commercial viability (CV)	-0.003 (0.08)	0.135 (0.098)	-0.008 (0.11)
A Project	-0.551** (0.21)	-0.67** (0.25)	-0.286 (0.28)
A Project in 2008	0.623** (0.29)	0.602* (0.339)	0.67* (0.38)
2008	0.003 (0.18)	-0.127 (0.215)	-0.134 (0.24)
University Partner	0.144 (0.17)	0.273 (0.202)	-0.526** (0.22)
Technology Center Partner	-0.343* (0.185)	-0.453** (0.22)	-0.896*** (0.243)
Firm Partner	0.007 (0.25)	0.158 (0.29)	0.87*** (0.323)
R^2	0.2331	0.2531	0.2062

*p < .05

**p < .01

3.5. Conclusion

Our findings show strong support that the collaboration in R&D alliances between companies increases the number of commercial opportunities for them. We have found that alliances with the participation of companies only (type 4) are those that manifest having more new commercial opportunities. Moreover, our regression confirms this finding with a high and positive correlation between the variable “firm partner” and “new commercial opportunities”. This is consistent with the findings by Santamaría and

Rialp (2007) and Aschoff and Smidt (2008) that also conclude that cooperation with other companies allow partners to share marketing and other cost reductions that facilitate entry in new markets.

However, we have not been able to distinguish between different types of companies (e.g. suppliers, customers, competitors) because the size of our sample was not large enough to do this segmentation. Perhaps the role of other companies in R&D alliances is not limited to share costs, but in the present sample, we do not have enough number of every kind of companies to explicitly test other propositions that analyze the mechanisms that facilitate new commercial opportunities.

On the other hand, alliances with participation of technology centers are the ones that worse performed in all the possible alliance outcomes when we look at the descriptive statistics. We confirm these results thanks to the regression that shows that the participation of a technology center in the alliance is negatively related to acquiring technological knowledge and finding technology opportunities. These findings reject Hypothesis 3 and may suggest that there are other motivations for companies to establish this type of collaboration, for example, because it facilitates the access to public financing (Santamaría and Rialp, 2007).

Concretely, in Catalonia most of the technology centers develop their activities under the brand TECNIO. TECNIO has been strongly fostered and financed by the regional government the last decade with the objective of turning them into technology transfer centers and experts from a range of associated sectors. They also claim to provide companies with support in securing funding and in-project management, and searching technological partners as well.

According to our analysis, our results could be aligned with the activities of securing funding and in-project management (although we have not investigated it), while we cannot affirm that technology centers had provided new technological opportunities or technology knowledge (hypothesis 3) to the companies that had collaborated with them in granted-projects in 2008 and 2009 in Catalonia.

Finally, when we analyze alliances with the participation of universities, we observe that alliances formed by companies and university (type 2) have higher levels of the outcomes “acquire technical knowledge” and “new technological opportunities” than the rest of alliances (types 1, 3 and 4).

However, we cannot confirm a significant effect of the participation of universities and any of the outcomes (hypothesis 2) in our regression. In fact, in our alliance classification by types, university is present in type 1 and type 2, and performance is only better in type 2, not in type 1 where there is also a technological center participating in the alliance. So, we should do further research to investigate if there is a negative effect caused by the participation of a technological centers that may affect general results of the alliances that also count with the participation of university.

We should also take into account that in industry–science collaboration, given the early stage of technology development, financial barriers to innovation may be strong given the imperfections of the financial markets for these early stage ventures. This is often a motive why governments provide additional funding for industry–science collaboration. Although higher risk associated with high technological uncertainty induces risk-sharing benefits from cooperation, at the same time it invokes higher transaction costs for cooperation, resulting in an ambiguous effect on the probability of success when cooperating with science.

Besides that, this fact may be explained because of a temporal issue of the research, maybe when we collected data with our survey, alliances had already developed their R&D activities (including universities) but this does not ensure that technology transfer had been completed. Knowledge could need extra time beyond the alliance to be internalized by companies, but this relationship is not specifically financed and controlled by the regional government. It does not have to finish necessarily at the same time that the project according the formal agreement signed at the beginning of the alliance.

Moreover, we could investigate deeply about the relationship between companies and university because, as Veugelers and Cassiman (2005) affirm, this kind of agreements are formed whenever risk is not an important obstacle to innovation and typically to share costs and they are embedded in a wider strategy of the firm.

There are limitations to this study. The generalization of the results based on the data of government-sponsored R&D alliances requires some caution. Also, due to data constraints, variables in this analysis are available only for 2 particular years. This study, however, incorporates new variables, which have not been taken into account in the analysis of alliance performance, so we hope to stimulate future research in this line.

Nevertheless, by using R&D alliances granted, we are able to obtain new insights. Government can be an intermediary and a facilitator of alliance formation, so in the setting of government-sponsored alliances, it is likely that the role of technology centers is related to special objectives of the regional government.

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4. The establishment of individual relationships through R&D alliances[2][3]

The purpose of this research is to examine how trust, conflict, commitment and communication affect R&D alliance performance, the individual's satisfaction with the alliance and the intention to collaborate with the same partners in the future.

Through empirical research we find that trust, conflict, commitment and communication are positively related to alliance performance, although trust and communication are the characteristics with the strongest fit. In addition, successful alliances influence positively on individual satisfaction and raise the willingness to reform the alliance with the existing alliance members.

Keywords: R&D alliances, performance, individual relations, reformation, satisfaction, trust, conflict, commitment, communication

[2] An adaptation of this chapter has been presented in the Strategic Management Society (SMS) 32nd Annual International Conference, October 7-9, 2012 in Prague, Czech Republic

[3] An adaptation of this chapter has been accepted by Journal of Industrial Engineering and Management and will be published in 2015

4.1. Introduction

There are strong theoretical streams dealing with alliance building and trying to explain the motivation behind cooperative behavior. Williamson (1985), but also Porter (1990) or Hamel, Doz and Prahalad (1989) analyze the sensemaking of cooperation and alliances regarding competitiveness and cost effects.

From a broad review of the innovation literature, we can distinguish two different waves of academic interest in alliances. The first wave of studies drew upon the network approach emerging from anthropology and sociology, and it is focused on the communicative interactions between individuals. There are three research areas that continue to resonate in the literature today related to this wave. The first area, centered on the communication networks of scientists (Price and Beaver, 1966; Crane, 1969); the second, focused on the interaction of researchers in R&D departments (Allen, 1970; Lin, Wu, Chang; Wang and Lee, 2012); and the third one, concerning the diffusion, adoption, and adaptation of innovation by individuals (Rogers, 1995).

From the late 1980s, a second wave of research appeared. This second wave embraces a resurgence of the interests of the first wave, which is concerned on the interactions and relationships between individuals, but it is characterized by its focus on the exchanges and linkages between organizations (Powell, Koput and Smith-Doerr, 1996; Håkansson, 1987; Burt, 1980). Last years, part of this trend has also looked at the effect of individual relationships such as trust, commitment or conflict on the strategic goals on alliance performance in a separate way (Cullen, Johnson and Sakano, 2000; Luo, 2008; Perry, Sengupta and Krapfel, 2004, Das and Teng, 1998, Nielsen and Nielsen, 2009; Jiang, Jiang, Cai and Liu, 2015).

The object of study in this research is focused in a particular form of alliance, R&D alliances. There has been an increasing number of studies about these alliances because of their specific features and their unique coordination challenges. (Hagedoorm, 2002; Tyler and Steensma, 1995; Belderbos, Carree and Lokshin, 2004). R&D alliances usually require some sharing or transfer of knowledge over firm boundaries (Sampton, 2007), and moreover, they are rigid structures of collaboration that may suffer dynamic inefficiencies during the development of novel technologies, products or processes. These unique conditions in R&D alliances may result in an increase of importance of individual relationships, which take an important role in the achievement of goals of the alliance.

Regarding the effect of relationships in R&D alliances, literature provides conceptual models focused on relationships between organizations (e.g. Lin et al., 2012), and some authors such as Gulati (1998) or Heimeriks (2002) mention the impact of embedded ties on alliance performance and defines embeddedness as a matter of trust building, conflict management, personal responsibility and communication, but they are not applied empirically to the individual level in an integrated way.

The objective of the present research is to study how individual relationships (in terms of trust, commitment, conflict and communication) explain alliance performance, satisfaction and the intention to reform the R&D alliance in the future. We take up samples in R&D alliances to empirically test the model and hypotheses through a questionnaire survey taken by 261 individuals participating in these alliances. These results will enrich current understanding of the relationship among individual relations, alliance performance and reformation in R&D alliances.

4.2. Theory foundation and research hypotheses

4.2.1. Trust and alliance performance

Management literature shows the discussion of relationships in alliances frequently reduced to the role of trust (e.g. Das and Teng, 1998; Krishnan, Martin and Noorderhaven, 2006; Suseno and Ratten, 2007; Jiang et al., 2015) and affirm that trust and trust building is based on positive expectations regarding other people intentions and behaviors in vulnerable situations like R&D alliance where uncertainty is high (Clegg, Unsworth, Epitropaki and Parker, 2002; De Jong, Klein and Woolthuis, 2008; Das and Teng, 2000).

Trust as a behavioral construct to deal with risk has been investigated in several studies dealing with interfirm innovation alliances (De Jong and Woolthuis, 2008; Clegg et al., 2002; Cumbers, Mackinnon and Chapman, 2003; Panayides and Venus, 2009; Wang and Chen, 2007). Moreover, some results show that cooperation by itself, but even more in innovation alliances, requires trust as a relational asset that keeps the interfirm network together (Cumbers et al., 2003).

In spite of empirical evidence between trust and innovation alliances, some authors make their point on the intensity of trustful relationships arguing that "too much trust is death to innovation" (Bidault and Castello, 2010). Based on the findings Levin, Cross and Abrams (2002) research confirms that strong ties encouraged by trust generates knowledge transfer, but that actually weak tie relationships delivered the most useful knowledge.

Taking into account the role of trust in vulnerable situations, the impact of trustful relations on innovation processes should be positive. This is also confirmed by Maurer (2010), who sees a positive effect of trust on knowledge acquisition and therefore on product innovation also. Nielsen and Nielsen (2009) had similar results when analyzing the impact of trust on learning and tacit knowledge sharing on innovation in strategic alliances. In the same direction go Panayides and Venus (2009) who analyzed trust benefits on innovation and supply chain performance. On the basis of the above rationale, we propose:

Hypothesis 1: Trust between partners in R&D alliances is positively associated with alliance performance.

4.2.2. Conflict and alliance performance

Conflict can be defined as an awareness on the part of the parties involved of discrepancies, incompatible wishes, or irreconcilable desires (Boulding, 1963). One of the first approaches to study conflict was made by authors that distinguished functional and dysfunctional conflict (Anderson and Narus 1990; Reve and Stern 1979, Morris and Cadogan, 2001) and have considered conflict as an unhealthy behaviour between partners that decrease teams' performance.

Later on, Jehn and Mannix (2001) propose that conflict in work groups can be categorized into three types—relationship, task, and process conflict. Relationship conflict involves personal issues such as dislike among group members and feelings such as annoyance, frustration, and irritation; task conflict pertains to conflict about ideas and differences of opinion about the task (Amason and Sapienza, 1997), and finally, more recent studies have proposed a third kind of conflict, process conflict (Jehn, 1997; Jehn, Northcraft and Neale, 1999) that refers to controversies about aspects of how task accomplishment will proceed. All this literature about conflict concludes that is a decreasing factor for groups' performance (e.g. Yi, Lee and Dubinsky, 2010). Focusing on these studies we predict that:

Hypothesis 2: Conflict between partners in R&D alliances is negatively associated with alliance performance.

4.2.3. Commitment and alliance performance

Many authors have analyzed commitment from several perspectives: its influence on customers' satisfaction (Ganesan and Hess, 1997), the role of commitment as an indicator of "relationship quality" together with trust and satisfaction measures (Walter, Muller, Helfert and Ritter, 2003), a result of strategic purposes together with asset specificity (Sheth and Parvatiyar, 1992), and from a resource-based view, commitment allows the continuity and long-term results of alliances (Gundlach, Achrol and Mentzer, 1995; Wu and Cavusgil, 2006; Nakos and Brouthers, 2008).

Considering that competitive alliances and collaborative ventures, like R&D alliances, demand a high degree of commitment because of the high entry barriers and, typically, low exit barriers (Sheth and Parvatiyar, 1992) and is required to ensure successful relationships (Morgan and Hunt, 1994), we propose that:

Hypothesis 3: Commitment between partners in R&D alliances is positively associated with alliance performance.

4.2.4. Communication and alliance performance

Communication behavior can be divided into three main aspects: communication quality, information sharing, and participation (Mohr and Spekman, 1994). Communication quality is a key aspect of information transmission (Jablin, Putnam, Roberts and Porter, 1987) and includes aspects such as the accuracy, timeliness, adequacy, and credibility of information exchanged (Lengel and Daft, 1988; Stohl and Redding, 1987). Information sharing includes the extent to which critical information is communicated to partners and it is related to the degree of effectiveness, satisfaction and success in a relationship (Guetzkow, 1965; Schuler, 1979; Devlin and Bleackley, 1988). Finally, participation means the degree to which partners engage jointly in planning and goal setting, and it is also related to partnership's success (Anderson, Lodish and Weitz, 1987; Dwyer, Schurr and Oh, 1988).

Later on, Butler (2010) discovered that the quality of communication may differ within the firm as well as between the alliance partners, and that this will have an impact on the decision-making process in the alliance. Therefore, we predict that:

Hypothesis 4: Communication between partners in R&D alliances is positively associated with alliance performance.

4.2.5. Alliance performance and satisfaction

As an emotional state of being, satisfaction has different facets depending on the contextual framework. Management research on satisfaction emphasizes strongly on employee-employer relationships (Malik, Ahmad, Saif and Safwan, 2010; Singh and Dubey, 2011; Shipton, West, Parkes, Dawson and Patterson, 2006; Sharma, Bajpai and Holani, 2011) and from the marketing area where customer satisfaction is the key concern of research (Fornell, Rust and Dekimpe 2010; Luo, Homburg and Wieseke 2010).

Satisfaction is "a post-decision evaluation of a product or an experience" (Oliver, 1996), which shows that satisfaction is a backward oriented construct, which affects the strength of a relationship, and, in our case, it will be directly related to the experience of getting or not satisfactory alliance performance. In fact, most of the empirical research in the field uses satisfaction as an observable variable to measure alliance performance due to the lack of other valid data (Saxton, 1997; Zollo, Reuer and Singh, 2002). Therefore, we propose that:

Hypothesis 5: Alliance performance is positively associated with partners' satisfaction with the R&D alliance.

4.2.6. Satisfaction and reformation

There are four possible outcomes for an alliance: stabilization, reformation, decline, and termination (Das and Teng, 2002). Our object of study is analyzing the effect of alliance performance and partners' satisfaction on the decision of reforming the alliance for future R&D projects.

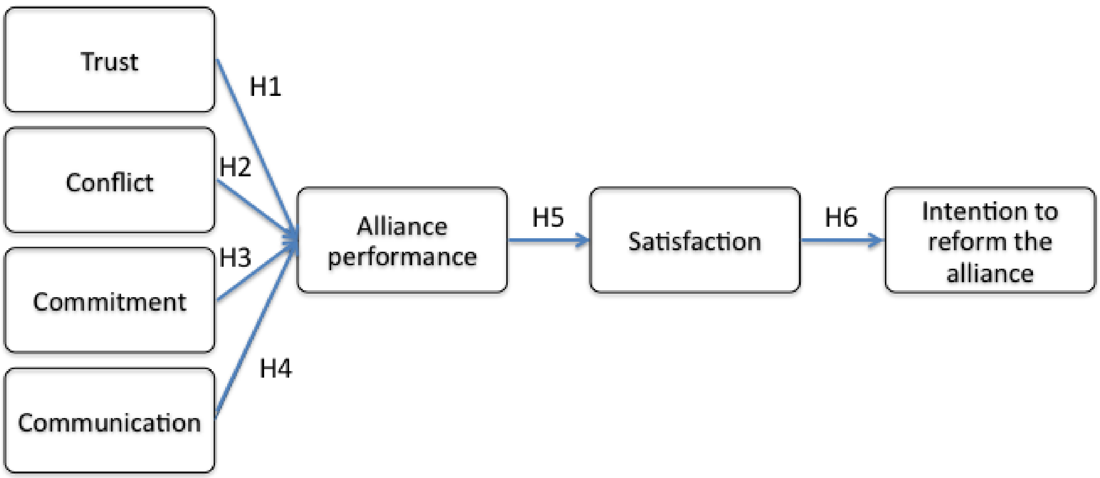
According to the theoretical model of Das and Teng (2002), when alliance performance matches expectations, partners become more satisfied with the alliance, and thus, if partners continue having goals in common and the initial match between the partners is still sustainable, they may decide to reform the alliance. Therefore, we predict that:

Hypothesis 6: Satisfaction is positively associated with the intention of reforming the R&D alliance.

4.2.7. Research framework

In this chapter, we develop a comprehensive research model based on a series of literature review. Based on the research framework, the hypotheses are developed to describe and verify the relationship among individual relationships, alliance performance, satisfaction and the intention of reform the alliance. The research framework is shown in Figure 6.

Figure 6. The research model



4.3. Methods

4.3.1. Variable definitions

Dependent variables

We measured three dependent constructs with a 5-point Likert scale system with 5 equaling the highest extent or degree. Constructs measured were alliance performance, satisfaction and reformation.

Alliance performance was measured through five items that have been adapted from existing articles of alliance performance studies, some measures that consider that the company achieves learning objectives (Geringer and Hebert, 1991; Saxton, 1997; Lane and Lubatkin, 1998; Dyer, Kale and Singh, 2001; Kale, Dyer and Singh, 2002); and some measures based on market gains (Anand and Khanna, 2000; Merchant and Schendel, 2000). Concretely, items measured are: “Technological knowledge acquired”, “Creation of new technological opportunities”, “Creation of new marketing opportunities”, “New relationships and contacts” and “Achievement of initial objectives”.

The second dependent variable, individual alliance participants’ satisfaction with the R&D project, was measured with a five-item scale (Van der Vegt, Emans and Van de Vliert, 2001; Jehn et al., 1999): “I am satisfied with my present colleagues”, “I am pleased with the way my colleagues and I work together”, “I am very satisfied with working in this team”, “How well do you think your group performs” and “How effective is your work unit?”

Finally, the intention to reform the alliance again in the future (reformation) with partners in the alliance with the question: “Would you like to collaborate in the future with any of the alliance partners?”.

Independent variables

Four exogenous items have been taken into account to predict our dependent variables: trust, conflict, commitment and communication. Also for independent variable a 5-point Likert scale system was used in the survey.

To get trust measures, we used questions adapted from McAllister (1995):" I can talk freely to my team about difficulties I am having at work and know that my team will want to listen", "I would feel a sense of loss if one of us was transferred and we could no longer work together", "If I shared my problems with my team I know she would respond constructively and caringly", "I would have to say that we (my alliance) have made considerable emotional investments in our working relationships", "Most of my partners approach his/her job with professionalism and dedication", "I see no reason to doubt my partners´ competence and preparation for the job", "I can rely on other partners not to make my job more difficult by careless work" and "Most of my partners can be relied upon to do as they say they will do". These items all loaded on one factor, and the Cronbach's coefficient alpha for this scale was .813.

Following Jehn and Mannix (2001), we measured conflict at the alliances covering the three conflict categories. Items included "How much relationship tension is there in your work group?", "How often do people get angry while working in your group?", "How much emotional conflict is there in your work group?", "How much conflict of ideas is there in your work group?", "How frequently do you have disagreements within your group about the task of the project you are working on?", "How often do people in your work group have conflicting opinions about the project you are working on?", "How often are there disagreements about who should do what in your work group?", "How much conflict is there in your group about task responsibilities?" and "How often do you disagree about resource allocation in your work groups?". The Cronbach's alpha for this scale was .909.

The construct commitment consists on 5 items adapted from measures of commitment between suppliers and customers by Walter et al. (2003): "We focus on long-term goals in this relationship", "We are willing to invest time and other resources into the relationship with these partners", "We put the long-term cooperation with this partner before our short-term profit", "We expand our business with these partners in the future" and "We defend these partners when outsider criticizes the company". The factor analysis shown a one-factor resolution, and the reliability of this scale was .825.

Finally, to assess communication behavior, we followed a procedure of Mohr and Spekman (1994), who used 5 items to measure the extent do you feel that your communication with partners was: "Timely/untimely", "Accurate/inaccurate", “Adequate/inadequate”, “Complete/incomplete” and “Credible/ not credible”. Cronbach’s coefficient alpha for communication was .918.

4.3.2. Research sample and measurement

The object of the study is individuals that participe in 81 R&D alliances (described in Chapter 3) in the region of Catalonia (Spain) and with 2 years of duration regulated by a collaboration contract.

Most of these R&D alliances are concentrated in 3 technological sectors: 32.8% mobility (automotive, railway and aeronautical), 16.0% health, and 15.8% energy or environment as well. The 81 alliances had the participation of 408 companies and 852 people directly involved in the R&D alliances.

In our study, we used data from a survey among the individuals involved in these R&D alliances that we conducted during 2011, when they had already finished. This approach was chosen to allow for a large-sample analysis of cross-sectional qualitative data. In order to minimize misinterpretation of questions, the questionnaire was pre-examined by several managers in industry and government officials who have coordinated R&D alliances.

The final sample included 261 individuals out of 852 participating in alliances, for a final response rate of 30.6 percent.

4.4. Results

The model was tested using EQS. Constructs trust, commitment, conflict and communication are treated as exogenous, while alliance performance, satisfaction and reformation were endogenous.

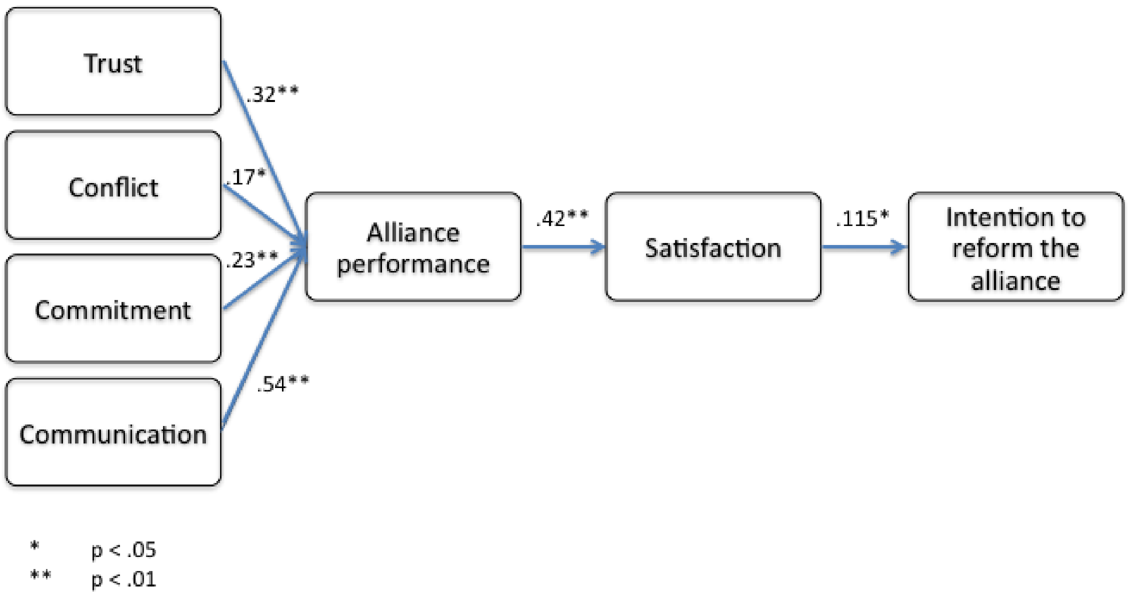
The overall fit of the model was good [$\chi 2$ (647) = 1541.559, p = .000]. Even though the probability was not greater than 0.10, applying conventional guidelines, the chi-square index was less than twice the degrees of freedom, indicating a reasonable good fit. The chi-square statistics is based on the assumption that the model holds exactly in the population, which would be unrealistic in most empirical research (Joreskog, 1993).

Therefore, it is important to also assess a model using root mean square error of approximation (RMSEA), which is a measure of discrepancy per degree of freedom and is useful in assessing the degree of approximation in the population (Joreskog, 1993). A RMSEA of 0.079 indicates a close fit. Also the comparative fit index (CFI) was 0.822 and indicates a good fit. The goodness-of-fit index and the adjusted goodness-of-fit were 0.739 and 0.701, respectively. Finally, the standardized root mean square residual was 0.076.

The Bentler-Bonett normed fit index (NFI) was .831 and the Bentler-Bonett not-normed fit index (NNFI) was .807, both indicate a good estimation of our model.

Results of our structural equation model (SEM) are presented in Figure 7:

Figure 7. Effect of individual relationship on alliance performance, satisfaction and reformation of the alliance



Recall that in hypotheses 1, 3 and 4 we predicted that trust, commitment and communication would be positive related to alliance performance. The SEM result results support these hypotheses. The three constructs were positively associated with alliance performance. The effect on alliance performance is especially high in trust (b = 0.32, p < 0.001) and communication (b = 0.54, p < 0.001), although commitment has a positive effect as well ($b = 0.17$, $p < 0.05$). However, hypothesis 2 was rejected as we found that conflict was also positively related to alliance performance ($b = 0.23$, $p < 0.001$).

Finally, our model supports the relationships between alliance performance, satisfaction and reformation. The model shows a positive effect from alliance performance to satisfaction ($b = 0.42$, $p < 0.001$), which supports hypothesis 5, while satisfaction have a modest effect on reformation ($b = 0.115$, $p < 0.05$). Thus, hypotheses 5 and 6 are supported by SEM results.

4.5. Conclusions and implication

In extension to already existing research on the quality of relationships in alliances, the present study has a clear focus on R&D alliances. In doing so, we empirically analyze the pathology of relations by applying a complex model of relationship constructs and measure their impact on performance and alliance reformation. Until now research in this field lacks empirical evidence (Gulati, 1998; Heimericks, 2002; Dans and Teng, 2002).

Existing research on partners' relationships has used items for measuring trust, commitment, conflict and communication (McAllister, 1995; Walter et al., 2003; Jehn and Mannix, 2001; Mohr and Spekman, 1994) with different samples and environments, but there is no evidence of the validity of those measures in R&D alliances. Our study has shown that measures and factors can be valid for these alliances.

Regarding relationship structure, each construct results from existing literature and has shown high viability within the context of our research and we found that when trust, commitment, conflict and communication are higher, alliance performance reaches higher levels too.

Our findings add that communication is the most relevant factor for predicting alliance performance. This positive effect was predicted and confirmed as R&D alliances are a kind of cooperation that usually requires transfer of knowledge (Sampton, 2007) and successful knowledge is not assured, even more when it is tacit or complex. Past research had shown that the communication behavior is related to partnership's success (Mohr and Spekman, 1994; Anderson et al., 1987; Dwyer et al., 1987), and our study has confirmed the important role as the main predictor of alliance performance in R&D alliances.

Contrary to what we expected, our model found that conflict management is an important capability in R&D alliances, taking into account that conflicts exist and that these conflicts affects the alliance performance positively. What seems to be contradictory at the first glimpse may have its origin in the diverse structure of the alliances. Different backgrounds and experiences lead to different opinions. In its positive sense, these conflicts generate new ideas, reflect creativity and contribute to the development of innovation.

To more thoroughly explicate our model, we examine factors related to alliance performance, satisfaction and reformation. Developing hypotheses from the literature on alliance performance and alliance outcomes (e.g. Das and Teng, 2002; Kale et al., 2002, Reuer and Zollo, 2005), we predict and find that, in general, alliances with better performance influence in the individual satisfaction and raise the willingness to continue or to repeat the alliance experience with the existing alliance members. Therefore, satisfaction is a predictor for alliance reformation.

Some lessons can be extracted and used in management practice, as well. From the firm's point of view, this research shows the need to reinforce specific communication processes to maximize the performance and future expectations of R&D alliances. Taking into account that R&D activities are inherently risky (even more when they are undertaken with third parties), communication quality, information sharing, and participation (dimensions that include aspects such as the accuracy, timeliness, adequacy, and credibility of information exchanged, the extent to which critical information is communicated to partners, and the degree to which partners engage jointly in planning and goal setting) become critical for alliance organizational success. Formal common planning, joint project scheduling, and formal (systematic) communication processes among the partners are required in complex alliance such as R&D alliances.

From the policymaker point of view, practical implications are even more important. To be able to maximize the success probabilities of such complex alliances, it's a key factor to enhance their social dimensions. Building trust or commitment, improving the communication and managing conflicts among partners are social challenges. In this sense, previous social work may improve the starting conditions of the alliances. Cluster public policies, for instance, are programs aimed to strength the links and build trust between local partners.

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5. An evaluation model of government sponsored R&D alliances[4]

The objective of this chapter is to evaluate the decision to co-finance large collaborative R&D alliances by analysing 335 R&D alliances that applied for public subsidies to the regional government in Catalonia (Spain). This research proposes a model for subsidizing R&D alliances that takes into account risk and novelty of projects, both technological and commercial viability, and externalities.

The analysis shows that projects with high commercial viability and high externalities are prioritized and that the technological interest degree appears to have a strong and positive explanatory effect on grant award.

Keywords: R&D alliances, collaboration, public policy, project selection, budget constraint, subsidies

[4] An adaptation of this chapter have been presented in MOVE Workshop on “University-Industry Collaboration” November 9, 2012 in Barcelona, Spain

5.1. Introduction

The broad consensus on the value of public support for R&D is rooted in the existence of market failures (Arrow, 1962; Klette et al., 2000), but there is no consensus about the way collaborative R&D projects should be financed and according to which specific characteristics, to optimise their effect and avoid competitive problems. Because despite all their benefits, partnerships have the negative potential to block competition and create various kind of static and dynamic monopolies (Hagedoorn et al., 2000; Escorsa and Valls, 2003).

Cooperation generates externalities for society as a whole conceptualized in the notion of collective learning (Heijs, 2005). Moreover, research funding is an uncertain business and the outputs of R&D are uncertain and skewed (Molas-Gallart and Salter, 2002) which may cause private investment in R&D cooperation to be less than the social optimal.

One of the main problems for research policy is how distribute research funds to satisfy multiple objectives. Empirical evaluation of R&D policies effects is an important issue on the research agenda, especially because programs may fail to reach their goals if many potentially targeted firms do not apply (Blanes and Busom, 2004; Heijs, 2005).

There are empirical articles that describe subsidy programmes, although few of them have been subjected to rigorous empirical analysis because of data limitation. Some of the empirical studies are focused on how public funds or subsidies are allocated to different R&D projects or industries, for example, analysing the effect of subsidies on R&D investment and cooperation (Fölster, 1995; Wallsten, 2000; David et al., 2000; Lach, 2002; Hussinger, 2003; González and Pazó, 2008; Kleer, 2010), analysing how R&D subsidies affect firms' R&D cooperation strategies (González et al., 2005; Busom and Fernández, 2008) or studying the effect of subsidies on university-industry technology transfer (Ballesteros and Rico, 2001; Blanes and Busom, 2004; Santamaría et al., 2010).

Many of these articles use game theory to analyze the effect of public subsidies, while others simply make statistical description of public programs. Most of these articles, which study which projects participate in R&D programs or obtain public subsidies, specify probit models where participating in programs or receiving subsidies are independent variables, and firm, project and agency's characteristics are the explanatory variables.

The main objective of this research is to evaluate the decision to co-finance large collaborative R&D alliances. This research takes into account risk and novelty of projects (both technological and commercial viability) and externalities that firms cannot appropriate, a gap that has not been covered until now because of lack of data (Cozzarin, 2008; Santamaría et al., 2010) and budget constraint conditions that public organisms have to deal with during recent years.

5.2. Literature review

5.2.1. Why subsidize R&D alliances?

Alliances can be viewed as opportunities for one partner to internalize the skills or competencies of the other(s) to create next-generation competencies (Hamel, 1991). But there is also an additional benefit of sharing complementary knowledge, such sharing can correct market failures in the R&D input market.

The market for R&D inputs such as research personnel and previous R&D results is imperfect and subject to asymmetric information and opportunism (Arrow, 1962; Katz, 1986). Mergers and acquisitions for the purpose of obtaining such inputs tend to be cumbersome. In this case, cooperative R&D may reduce the costs of obtaining necessary R&D inputs.

Moreover, cooperative R&D is also helpful to shorten research time as compared to the firms setting up their own research efforts from scratch, as alliances may be a particularly fast way to pull resources together (Contractor and Lorange, 1988).

But despite expected benefits of R&D cooperation, public policies and government-sponsored alliances becomes necessary because of the existence of market failure (Arrow, 1962), as cooperative R&D alliances generate externalities that may be taken into account for financing their projects.

Spence (1984) argued that the existence of R&D spillovers makes it difficult for innovators to capture the full social benefits of their innovative activity, which depresses the incentives to conduct R&D. Through R&D cooperation, firms internalize the externality created through spillovers, thus restoring the incentive to conduct R&D.

Also positive was the effect found by Cohen and Levinthal (1989), whose research showed that a high spillover rate in R&D among competitors could provide a positive incentive to conduct R&D when a company's own R&D increases its learning capabilities. Cooperative R&D becomes then a "forced" spillover scheme. This implies that spillover rate among consortia participants increases if they cooperate, which gives participants more incentive to conduct more R&D.

Sakakibara (1997) analyzed government-sponsored R&D consortia and found evidence that these consortia worked as a complement of private R&D and, moreover, participants perceived benefits such as researcher training and increased awareness of R&D in general.

David, Hall and Toole (2000) found similar results in their research that investigated if public R&D spending was complementary and thus "additional" to private R&D spending, or if it was substitute for and tended to "crowd out" private R&D.

Additionality of public subsidies R&D has been also studied by other authors such as Zúñiga-Vicente, Alonso-Borrego, Forcadell and Galan (2012) and Takalo, Tanayama and Toivanen (2012) that have studied the relationship between public R&D subsidies and private R&D investment.

Finally and regarding the positive effect of R&D subsidies, Busom and Fernández-Ribas (2008) confirmed that receiving public R&D subsidies increases the probability that a firm will set up an R&D partnership with a public research organization or with other firms. Their results suggest that public R&D programmes trigger a behavioural change in firms' R&D partnerships, alleviating barriers to cooperation's.

So after all the literature that confirms the additionality of R&D subsidization and the absence of crowding-out effect between public and private spending (González, Jaumandreu and Pazó, 2005; González and Pazó, 2008), the challenge consists on establishing which decision-process should public agencies follow to award grants for R&D alliances.

5.2.2. Which projects should be subsidized?

Public financing of R&D projects has been studied from different perspectives. On one hand some research investigates how public financing should be. Santamaría, Barge-Gil and Modrego (2010) compared credit versus subsidy funding in R&D collaborative project calls under the Spanish PROFIT initiative. They found that some projects close to the market are well supported through credits, while basic research projects receive only selective support in the form of subsidies.

More recently Grossman, Steger and Trimborn (2013) characterized the optimal time path of R&D and capital subsidization starting from the R&D subsidization in the US where R&D should jump upwards and then slightly decrease over time. They concluded results in projects did not depend on the financing scheme and that the optimal capital subsidy is time-varying under factor income taxation, but time-invariant when subsidies are financed by lump sum taxes.

Finally Romero-Jordán, Delgado-Rodríguez, Álvarez-Ayuso, I., and de Lucas-Santos (2014) identified the potential determinants of firm R&D to understand the effectiveness of public policies. Their results suggest a considerably low impact of tax credits and public grants on the R&D investment of the Spanish manufacturing firms. Tax credits are mainly considered by large firms that use them as a reduction in the tax burden in the corporate tax, while SMEs use public grants to alleviate financial constraints.

On the other hand, there are several analysis about the decision-making within public sector on the financing of precompetitive R&D projects (Sakakibara, 1997; Acosta and Modrego, 2001; Giebe, Grebe and Wolfstetter, 2006)

Blanes and Busom (2004) investigated factors that affect a firm’s participation status in different R&D subsidy programs. They observed that firm characteristics differ among agencies and industries, which may indicate that public agencies have different goals and face different difficulties in reaching the desired population of firms.

Also Marín and Siotis (2008) found differences between agencies looking at policies in Research Joint Venture (RJV). In the European Union Framework Program were consistent with a “top-down” and mission oriented research policy, while Eureka RJV appeared more market-drive and “bottom-up”.

However, there is scarce literature about how public awarding should be. One of the main contributions is the proposal by Giebe et al. (2006) that evaluates the typically applied rules for awarding R&D subsidies. But they also propose mechanisms to correct inefficiencies that include some form of an auction in which applicants bid for subsidies. Their proposal consists on basing the selection of projects on a ranking of allocations, and to embed that selection rule in a simple auction mechanism, and, therefore selection committee should think in terms of complete allocations, not in single projects.

However, in practical application of this procedure may be complex for two reasons: first because the number of allocations increases exponentially with the number of projects, and second due to legal procedures that agencies should follow for awarding subsidies.

Very often, agencies have to communicate scores to applicants for R&D subsidies after evaluating all the projects together with the amount of grant received. After this, there is a legal period where applicants can ask for further information or ask a re-evaluation if they don't agree with the resolution because they think that their project should be subsidised.

Public agencies usually must have an objective and unquestionable argument to deny a grant to a company and a unique possible resolution is needed. With the proposal of Giebe et al. (2006), multiple allocations are possible and there could be conflicts with the resolution. Thus, we propose another model for awarding grants to R&D projects.

5.2.3. Proposed model

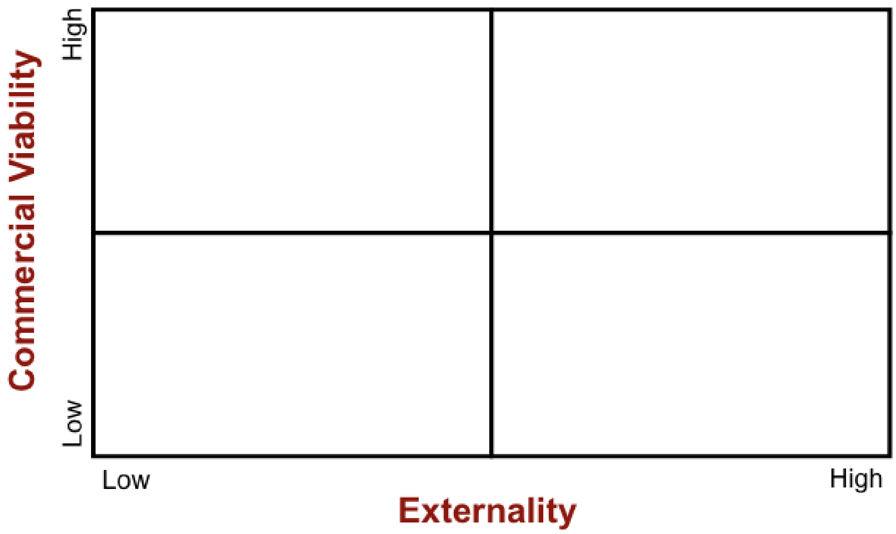
So, in order to answer the question that we face about how public awarding should be taking into account the applicability of the procedure by public agencies, we propose a model with two main dimensions of projects: commercial viability and externalities.

As a result of the documentation facilitated by applicants, public agencies should evaluate projects trying to figure out which are the expected commercial viability and expected positive externalities of the alliance if the R&D project is developed.

We consider that these two variables are the ones that respond to both private and public interests. First, it is supposed that public policies will look for generating wealth in the economy and ensure that the project can make it to market. But this condition is not enough to give financial support to companies (as it could infringe upon competition), so it very important to quantify externalities of projects that justify subsidized R&D alliances as explained previously (point 2.1)

Every project should have punctuation in both variables “commercial viability” and “externalities” and placed in a matrix as shown in Figure 8:

Figure 8: Variables punctuated in the evaluation of R&D alliances

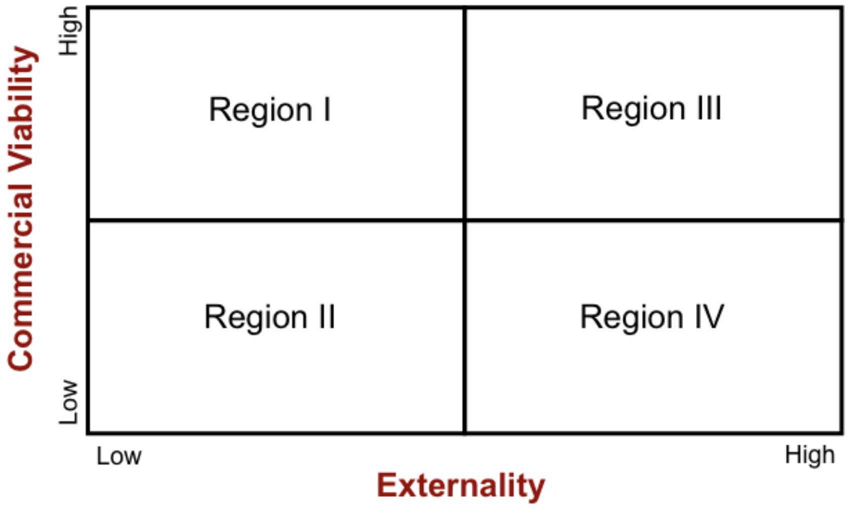


Public agencies intend to subsidized projects with high-expected externalities so they are initiated, but also projects with high-expected commercial viability, although they should not subsidized projects that firms will initiate without subsidy anyway.

So, if we divide the matrix into four regions (see this categorization in Figure 9), projects could be placed and assigned to one region (I, II, III or IV).

Region I and Region II include those projects with a total externality below or equal the mean of all projects, while Region III and Region IV include projects with a total externality above the mean. Analogously, those projects with a commercial viability value below or equal the mean are classified in Region II or Region IV, while those above are in Region I or Region III.

Figure 9: Categorization of regions according to commercial viability and total externality



The objective of this research is to evaluate the decision to co-finance large collaborative R&D alliances that applied for public grants in Catalonia (Spain) through this model.

And after reviewing literature about financing R&D and R&D alliances, we propose the following hypotheses:

H1: No projects with low commercial viability and low externalities should be subsidized (Region II)

H2: Projects with high commercial viability and high externalities should be subsidized (Region III)

H3: Only good technological projects should be subsidized in Region I and IV

5.3. Methods and data

5.3.1. Sample and data

For this research we have used the same sample than in Chapter 3. The sample is 81 R&D alliances, which were co-financed by the regional government of Catalonia (Spain). These alliances developed their R&D activities between 2008 and 2011. They are led by companies and could subcontract other companies, universities and/or technology centers for some activities of the project.

We collected data through a survey sent by email to individuals participating in the R&D alliances. The survey is the same that we explained in Chapter 3. Nevertheless, only individuals of companies belong to our database, as they were the applicants for the grant, so we have information about the role of university and technology centers from their point of view.

5.3.2. Variable definitions

In order to conduct the first analysis, we use as dependent variable grant and independent variables cost, commercial viability, total externality and technological interest degree (see variables description in Table 20). It is important to note that the externalities of each project were slightly different for 2008 and 2009.

In the second analysis about the outcomes of collaborations, we include the companies' valuation of the project's performance through three variables: Acquired technological knowledge, new technological opportunities and new commercial opportunities. Moreover, we introduce fixed effects to control for year and kind of partners within the collaboration (university, technological centers and other companies).

Table 20: Variables description

Variable	**Definition**	**Range / value**
Grant	Binary variable	[0 (no), 1 (yes)]
Cost	Cost of the project approved by ACCIÓ	Euros
Commercial viability	ACCIÓ's evaluation criteria about the marketable perspectives of the project	Std value (mean 0 and variance 1)
A Project	Technological interest degree. Binary variable if project is scored with an A	[0 (no), 1 (yes)]
BC Project	Technological interest degree. Binary variable if project is scored with a B or C	[0 (no), 1 (yes)]
Total externality	Sum of ACCIÓ's evaluation criteria about project's externalities	Std (economic externality + knowledge externality)

Economic externality 08	Investment + Clusters + Employment	[0 (low) - 15 (high)]
Knowledge externality 08	Knowledge diffusion + Start R&D + EU	[0 (low) - 15 (high)]
Economic externality 09	Investment + Clusters + Employment + Local companies	[0 (low) - 20 (high)]
Knowledge externality 09	EU + TECNIO + SMEs, Start-up, AEI	[0 (low) - 15 (high)]
Investment	Industrial investment originated by the project	[0 (low) - 5 (high)]
Clusters	Relationship with clusters in the territory	[0 (low) - 5 (high)]
Employment	Occupation created by the project	[0 (low) - 5 (high)]
Knowledge diffusion	Diffusion of technological knowledge to other companies and sectors	[0 (low) - 5 (high)]
Start R&D	First R&D project for the company	[0 (low) - 5 (high)]
EU	Alignment with European Union (EU) technological platforms	[0 (low) - 5 (high)]
Local companies	Reinforcement of regional companies	[0 (low) - 5 (high)]
TECNIO	Participation of TECNIO centers in the project	[0 (low) - 5 (high)]
SMEs, Start-up, AEI	Participation of Small and Medium Enterprises (SMEs), Start-ups and Innovative Business Groups (AEIs) in the project	[0 (low) - 5 (high)]
Acquired technological knowledge	Companies' valuation in the survey of the technological knowledge acquired thanks to the participation in the project.	[1 (low) - 5 (high)]
New	Companies' valuation in the survey of the	[1 (low) - 5 (high)]

technological opportunities	new technological opportunities created thanks to the participation in the project.	
New commercial opportunities	Companies' valuation in the survey of the new commercial opportunities generated thanks to the participation in the project.	[1 (low) - 5 (high)]
University partner	Binary variable if companies collaborated with university	[0 (no), 1 (yes)]
Technological center partner	Binary variable if companies collaborated with technological centers	[0 (no), 1 (yes)]
Company partner	Binary variable if companies collaborated with other companies	[0 (no), 1 (yes)]

5.3.3. Descriptive statistics

Grant and No-grant decision

The first statistical analysis shows significant differences between projects granted and not granted both in 2008 and in 2009. In 2008, those projects granted by ACCIÓ present commercial viability (mean: 2.84), total externality (mean: 13.62) and cost (mean: 1,801,407 euros) significantly higher ($p<0.001$) than non-granted projects (mean: 1.96; 9.93; 1,112,576 euros; respectively). Table 21 shows the characteristics of projects in 2008.

Table 21: Projects' characteristics granted and not-granted in 2008

2008	Granted		Non Granted		Ttest (p-value)
	Mean	std	Mean	std	
Commercial viability	2.84	1.59	1.96	1.56	-3.39*** (0.0008)
Total externality	13.62	4.75	9.93	5.1	-5.25*** (0.0000)
Cost (euro)	1,801,407	1,892,695	1,112,576	787,947	-3.78*** (0.0002)

In 2009, projects granted by ACCIÓ present commercial viability (mean: 4.11) and total externality (mean: 17.58) significantly higher ($p<0.001$) than non-granted projects (mean: 3.28; 13.45; respectively).

However, that year there are no significant differences in the mean cost of projects. Table 22 shows the characteristics of projects in 2009.

Table 22: Projects' characteristics granted and not-granted in 2009

2009	**Granted**		**Non Granted**		**Ttest (p-value)**
	Mean	**std**	**Mean**	**std**	
Commercial viability	4.11	0.89	3.28	1.22	-3.59*** (0.0005)
Total externality	17.58	6.28	13.45	5.68	-3.39*** (0.0010)
Cost (euro)	1,477,383	492,063	1,360,276	775,421	-0.82 (0.4138)

Distribution of projects by regions

In order to perform a first statistical analysis of our data, we categorized the projects in 4 regions according to their commercial viability and total externality.

As explained before, projects were scored from A (very high) to E (very low) in the evaluation process, then we exploit these score categories of technological interest degree to see which kinds of projects are in each region (see distribution of projects by regions in Figures 10, 11, 12 and 13). Due to the mention slightly different calculation of total externality in 2008 and 2009, the analysis is performed by year.

Figure 10: Distribution of submitted projects by regions in 2008

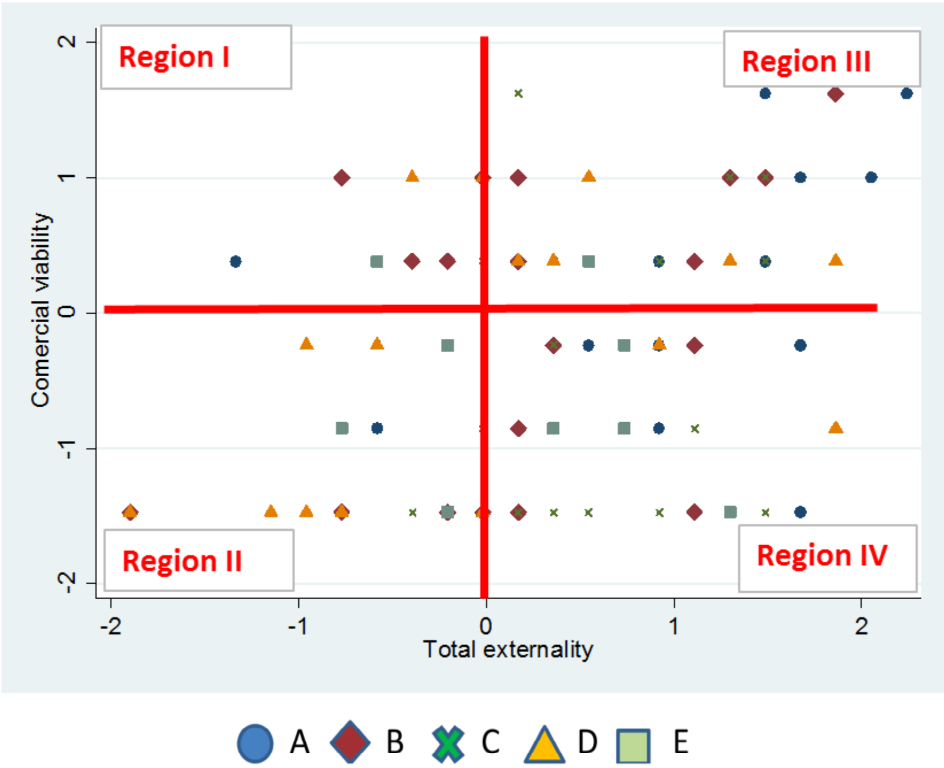


Figure 11: Distribution of granted projects by regions in 2008

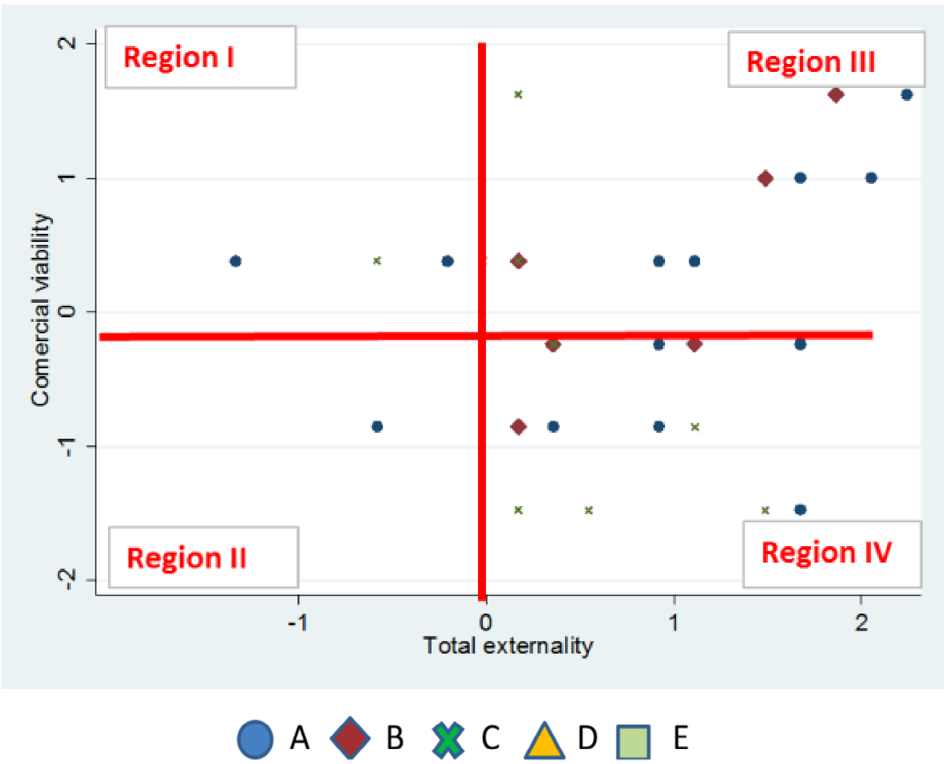


Figure 12: Distribution of submitted projects by regions in 2009

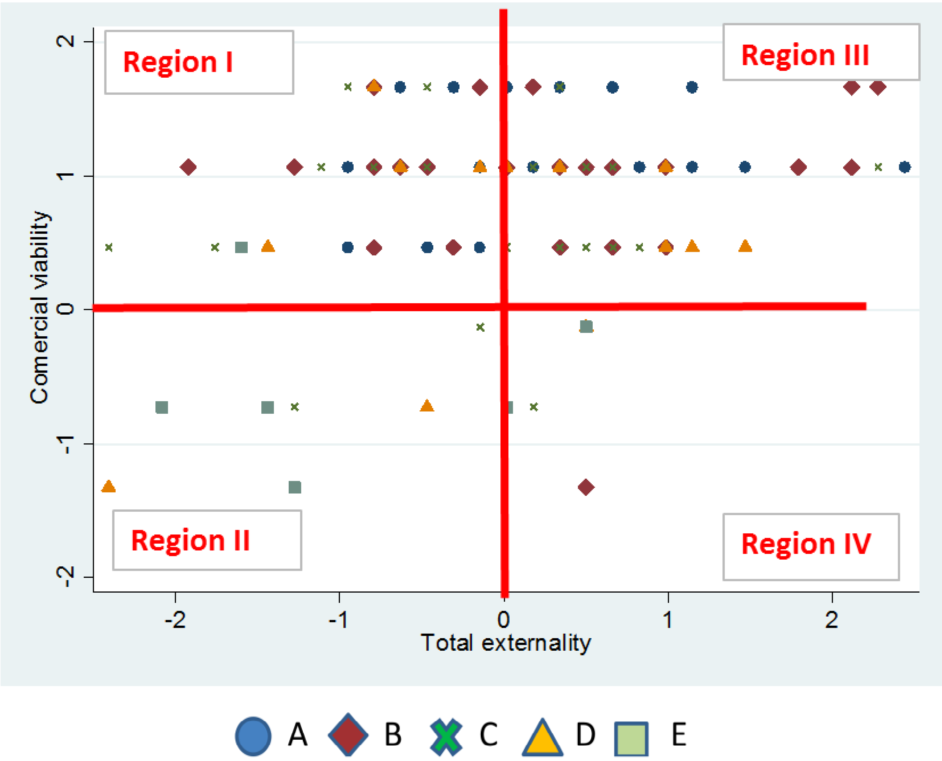
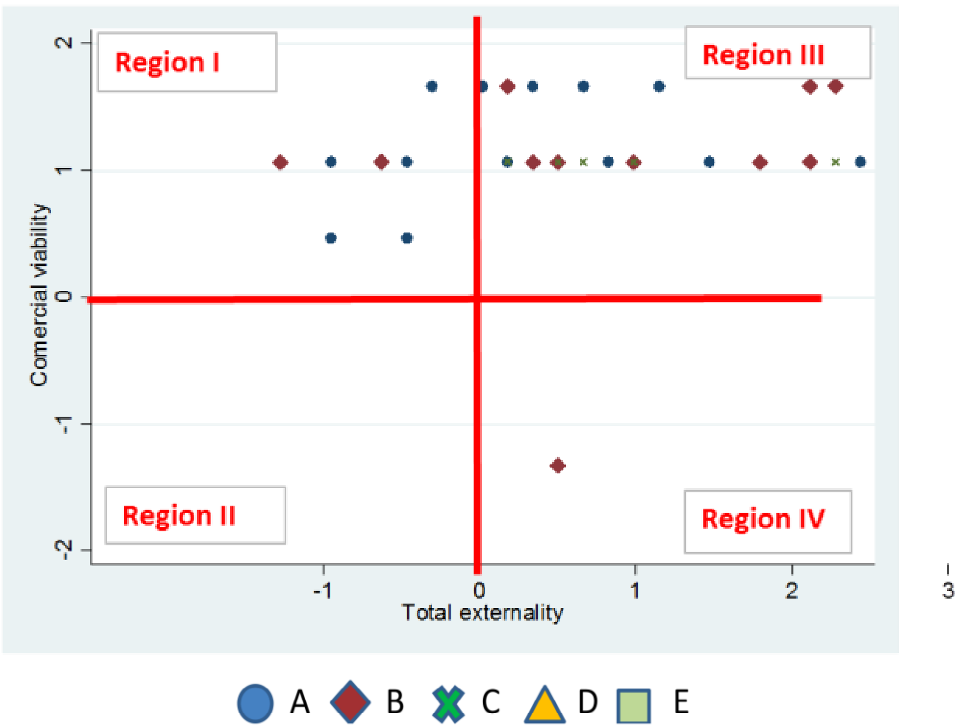


Figure 13: Distribution of granted projects by regions in 2009



Out of all submitted projects in 2008, 12 projects belonged to Region I. Although almost half of the projects were scored as B (42%) only the A and C projects were granted. Therefore, 33% of total projects were granted, almost the same percentage than in Region III. If we look at the descriptive statistics (Appendix 2), in Region I the only significant difference ($p<0.05$) between granted and non-granted projects was the cost.

Regarding Region II, as predicted in hypothesis 1, almost any project (1 out of 23 submitted projects) was granted, and this project was scored as A. Due to the fact that just one project was granted, we could not compute the standard deviation and to perform the descriptive statistics.

Region III encompassed the highest number of projects, listed 35. Out of them, A, B and C projects represented approximately 30% each. Those with higher technological score were more likely to be granted but 64% of A projects, 43% of B ones and 20% of C were approved to get a grant. These projects were characterized by higher commercial viability ($p<0.05$), higher total externality ($p<0.05$) and higher cost ($p<0.001$)

In the remaining region, Region IV, a surprising high number of projects (15 out of 35) were approved. Moreover, the ratio of granted projects were higher (75%) for those whose technological score was evaluated as medium (C) than for those whose score were high (B), granted 57% of projects, or very high (A), granted 50%. As a consequence, there is no surprising to find that there was not any significant difference in the descriptive statistics between granted and non-granted projects.

Regarding 2009, we can see how the majority of the projects were concentrated on the upper regions suggesting they performed relatively well in commercial viability. In Region I, we found 38 projects but only one third were granted, most of them were A projects (64%) and the rest B projects. In this region, there were not significant differences on commercial viability, total externality and cost between granted and non-granted projects.

About the 7 projects located in Region II, none of them was granted. It is remarkable than any of them was scored as A or B project.

In relation to Region III, 24 out of 50 projects were granted. 82% of A projects were granted while 63% of B ones got the grant and none of those graded with a C did. There were significant differences in the commercial viability ($p<0.001$) and the externality cost ($p<0.01$) of those project which were granted and those which were not.

Finally, in Region IV only one project, scored as B, was granted out of the 6 submitted ones.

If we compare between years, at first sight it seems to be important differences between 2008 and 2009. In 2009, most of the projects which were granted (66%) belonged to Region III, while in 2008 this number was below the 40%.

Without any further control, it seems that projects had relative better commercial viability in 2009 than in 2008. In this sense, projects in 2009 were relatively more placed in the upper part of the graph (Region I and Region III) than in 2008. This difference is even more accused if we look at granted projects, where only one was at the bottom part of the graph (Region IV) in 2009 but 16 out of 32 were in Regions II or Region IV.

Ceteris Paribus, we predicted that majority of projects should be in Region III, none in Region II and some in Region I and Region IV. Year 2009 seems to confirm that the majority of projects were located in Region III (hypothesis 2) but year 2008 seems not to adjust so well to this behavior, as there were more granted projects in Region IV (15) than in Region III (12). Hypothesis 1 appears to be confirmed considering that any project was awarded in Region II in 2009, and only one did in 2008.

Regarding the technological interest degree of the granted projects, both years near 45% were scored with an A. In 2008 there were surprisingly more C projects granted (31%) than B projects (22%), by contrast, in 2009 B projects accounted for 42% of the granted projects and C just 15%.

Moreover, in 2008 there were many projects in Regions I and IV with medium technological interest degree, despite the hypothesis 3 states that only the best technological projects should be granted. By contrast, and in line with our hypothesis 3, most of the granted projects in Regions I and IV (58%) in 2009 were A projects.

If we look at the distribution among regions, Region I and IV accounted for 12 out of 26 granted projects in 2009 and X out X in 2008. Of these granted projects, % were A in 2009 while only % were A in 2008 (see details in Appendix 3).

5.4. Results

To investigate the determinants of being awarded with a grant in 2008 and 2009, we looked at the cost, the total externality of the project, the commercial viability, the technological interest degree and the interactions between the externality, the commercial viability and the technological interest degree.

We estimate linear regressions (OLS) for 4 alternative models. In model 1, the dependent variable grant is explained by the cost, the total externality of the project and the commercial viability. Model 2 includes variables of model 1 plus the interaction between the externality and the commercial viability. Model 3 adds the technological interest degree to variables of model 2. Finally, model 4 encompasses all the variables and interactions. Results obtained after estimating the 4 models with the full sample for each year (N = 229 in 2008 and N = 103 in 2009) are shown in Table 23.

Table 23: OLS Regressions results to explain variable grant

Dependent variable: grant	**(1)**		**(2)**		**(3)**		**(4)**	
	2008	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**
Cost	0.77*** (0.000)	0.10 (0.883)	0.77*** (0.000)	0.02 (0.979)	0.59*** (0.001)	0.33 (0.632)	0.61*** (0.000)	0.25 (0.717)
Externality (EXT)	0.11*** (0.000)	0.12*** (0.005)	0.11*** (0.005)	-0.15 (0.234)	0.06* (0.076)	-0.17 (0.103)	0.04 (0.169)	-0.08 (0.438)
Commercial viability (CV)	0.04 (0.123)	0.13*** (0.006)	0.04 (0.403)	-0.05 (0.364)	0.05 (0.259)	0.13*** (0.006)	0.04 (0.354)	-0.06 (0.182)
EXT*CV			0.003 (0.890)	0.09** (0.020)	0.003 (0.875)	0.09*** (0.006)	0.02 (0.439)	0.04 (0.245)
A Project					0.43*** (0.000)	0.65*** (0.000)	0.50*** (0.002)	0.75*** (0.004)
BC Project					0.22*** (0.002)	0.27*** (0.000)	0.32*** (0.001)	-0.01 (0.932)
Aproj*EXT*CV							-0.02 (0.487)	-0.0004 (0.983)
BCproj*EXT*CV							-0.03 (0.209)	0.04*** (0.001)
N	229	103	229	103	229	103	229	103
R^2	0.1679	0.1734	0.1679	0.2161	0.2881	0.3773	0.2982	0.3997

Model 1 captures the positive effects of cost, commercial viability and total externality on grant. This model is significant at the $p < .001$ level in 2008 (F = 22.71, R2 = 0.16) and 2009 (F = 11.50, R2 = 0.17). Coefficients for total externality are significant ($p < .001$) both years, cost is significant only in 2008 ($p < .001$) and commercial viability in 2009 ($p < .001$).

The interaction between the externality and the commercial viability (EXT*CV) is included in Model 2 but it has not explanatory power in 2008 (F = 19.46, R2 = 0.16), where cost and total externality remain significant with the same coefficients than in Model 1 ($p < .001$). However, in 2009 the variable EXT*CV is significant and positively related to grant ($p < .05$) so model 2 improves respect Model 1 this year (F = 11.40, R2 = 0.21).

In order to include the effect of the technological interest degree, we use Model 3 that is significant in 2008 and 2009 (F = 16.43, R2 = 0.28; F = 20.79, R2 = 0.37, respectively). Both years, A Project and BC Project appear to have a strong and positive explanatory effect on grant ($p < .001$). In 2008 coefficients for cost and total externality are significant ($p < .001$, $p < .01$), while in 2009 they are not. In 2009 the variable EXT*CV continues having a positive effect on grant ($p < .001$) although commercial viability without interaction is negatively related to it ($p < .001$).

Model 4 is the full model with all independent variables. This model incorporates the interactions between technological interest degree, total externality and commercial viability (AProj*EXT*CV and BCProj*EXT*CV) to Model 3 and both years is significant, as well (F = 13.65, R2 = 0.30; F = 19.66, R2 = 0.40). Among these new variables, only BCProj*EXT*CV coefficient appears to be positive and significant ($p < .001$) in 2009, together with a very strong and positive effect of A Project ($p < .001$). In 2008 variables cost, A Project and BC Project remain positively related to grant ($p < .001$).

If we use a restricted sample in Model 4 (Table 24) in which we only include projects scored with an A, B and C technological interest degree (N = 73 in 2008 and N = 81 in 2009), we obtain slightly different results respect to the regressions with the full sample. In 2008 only cost and total externality coefficients are positive and significant ($p < .001$). In 2009, EXT*CV and A Project coefficients are positive and significant ($p < .01$; $p < .001$) while Aproj*EXT*CV becomes negative ($p < 0.01$).

Table 24: OLS Regressions results only with A, B and C scored projects

Dependent variable: Grant	(3)	
	2008	2009
Cost	0.87*** (0.002)	0.33 (0.85)
Externality (EXT)	0.17*** (0.006)	-0.20 (0.21)
Commercial viability (CV)	0.06 (0.13)	-0.16 (0.11)
EXT*CV	-0.05 (0.62)	0.11* (0.06)
A Project	0.15 (0.19)	0.76*** (0.005)
A Project*EXT*CV	0.017 (0.14)	-0.043* (0.064)
N	73	81
R^2	0.1701	0.3014

5.5. Conclusion

The decision about how to finance R&D is hard because of there are high levels of uncertainty and these activities produce spillovers, which are characterized by lack of appropriation and are ease to imitate. Hence motives like these ones leave little incentive to private enterprise to finance R&D expenditures, especially for more basic knowledge, where collaboration might be necessary but makes appropriation more complicated.

The aim of this research is to evaluate the decision to co-finance large collaborative R&D alliances. This research takes into account risk and novelty of projects (both technological and commercial viability) and externalities that firms cannot appropriate, a gap that has not been covered until now because of lack of data (Cozzarin, 2008; Santamaría et al., 2010) and budget constraint conditions that public organisms have to deal with during recent years.

Despite there are some proposals in the literature about the appropriate mechanisms to evaluate and award R&D projects (e.g. Giebe et al., 2006), they have limitations to be implemented, such as multiple possible allocation of funds, which make these proposals suitable only in the academic world.

Consequently, in this research we have proposed an evaluation model for awarding R&D grants that considers two main decision variables: commercial viability of projects, which should reflect the expected benefits in the market if the project is developed; and externalities, which contemplate the expected benefits that the project would provide to the economy such as creation of new employment, support to start-up or belonging to a cluster, among others.

By means of the proposed model for awarding R&D alliances, we have evaluated the public policy performed in Catalonia (Spain) during 2008 and 2009 for granting R&D alliances. Although there are slight differences between public calls these two years, we do not consider them as important as that they cannot be analyzed in our study. Despite everything, we have decided to separate years to avoid possible negative influences in results.

A first analysis of the statistics shows preliminary results. We observe that for granted projects, commercial viability and externalities are higher than for non-granted project both years, which seams aligned with our hypotheses.

Besides, when we have graphically distributed projects in the model, at first sight we already realise that in Region II there is only one project granted in 2008 and any project granted at all in 2009. So also here we have found evidence that could confirm hypothesis 1 and few projects are granted with low commercial viability and low externalities. Especially in 2009, we can also observe that in Region III the proportion of granted projects is higher than in the rest of regions.

In order to statistically confirm the hypotheses, we have estimated several OLS regressions. Results show that there is a strong and positive effect of “A project” in receiving a grant.

However there are differences between 2008 and 2009, and 2009 grants seem closer to what we expected from theory, while in 2008 we do not confirm the relationship between commercial viability and receiving a grant.

In 2008, cost and externalities are the explanatory variables that are statistically significant to explain obtaining the grant. By contrast, in 2009 we do confirm that both externalities and commercial viability are positive related to receiving a grant for the R&D project.

To sum up, we have found results that confirm hypothesis 1, as the public agency has not subsidized R&D projects with low externalities and commercial viability. Regarding hypothesis 2, there is some evidence in statistics that support expected results from theory but they cannot be confirmed by regressions in 2008, only in 2009. Finally, there is a clear positive effect of having the grade "A" during the evaluation on the probability of receiving a grant, so it gives us support to confirm hypothesis 3, as in Region III and IV, there are granted projects because of their high level of technological interest.

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6. Concluding remarks

Since the beginning of the 21st century innovation has been one of the fundamental aspects of industrial and economic development policies in Western countries. The political agenda in most advanced economies always includes programs aimed to improve innovation capabilities of companies in order to create different products and services. In part, this institutional trend has been spurred by the traditional academic support to innovation as a key capability for the long-term sustainability of companies.

However, some form of collaboration is normally necessary where the technology is novel, complex or scarce, mainly because “make or buy” a technology becomes difficult due to transaction costs and strategic implications. Any form of alliance is optimal in any generic sense, technological and market characteristics will constrain options, and company culture and strategic considerations will determine what is possible and what is desirable.

The general objective of this research is to investigate the relationship between innovation and performance at firm level. Concretely, the main contribution of this PhD research is the exploration of how R&D collaboration, a particular innovation practice, generates positive outcomes for both firms that collaborate and their environment. Finally, this research proposes an evaluation model of how public agencies should assign budget to R&D collaborative projects. Specific objectives have been studied through the different chapters of this PhD research.

6.1. Empirical findings

The main empirical findings are chapter specific and were summarized within the respective empirical chapters. This section will synthesize the empirical findings to investigate the relationship between innovation and performance at the firm level, and more concretely, the outcomes of R&D collaboration.

In Chapter 2 the aim has been to classify innovation practices based on previous literature review and empirically test which of these innovation practices have an effect on the firms’ long–term financial performance.

Based on previous innovation management models, we propose a classification of innovation management practices based on previous literature review and factor analysis.

Afterwards, we test which ones influence business results in the companies in terms of sales growth, average profit per employee and return on assets and we conclude that systematization of innovation is positively related to improvements in business performance. Our results demonstrate that companies with poor innovation management practices and without innovation project management skills perform worse than the rest of the sector.

Nevertheless, based on the examination of innovation practices and business performance through a lineal regression model, it appears that innovation practices can explain sales growth but not improvements in profit per employee and ROA.

If we look at specific innovation management practices that are related to variations in firms' turnover, we see that four of them have a negatively effect on it. One of these practices is collaborative R&D and subsidies, which seams contradict to theoretical positive effect that collaboration in R&D activities should have on firms. This surprising result has motivated further research about the benefits of collaborative R&D and subsidies.

In order to do that, several analyzes about the topic have been developed in Chapters 3 and. The research in both chapters has used data facilitated by ACCIÓ (Government of Catalonia), which has co-financed R&D alliances with a specific grant program since 2007.

Chapters 3 and 4 have been focused on analysing theoretical positive outcomes of R&D collaboration and subsidies: acquisition of technical knowledge, new technological opportunities, new commercial opportunities and the improvement of individual relationships.

First, Chapter 3 centers the attention in investigating the performance of these R&D alliances in terms of technical knowledge acquired, new technological opportunities and new commercial opportunities. Therefore, the objective of this research is to investigate the relationship between the typology of partners that collaborate in R&D alliances and alliance outcomes.

We have distinguished 4 types of R&D alliances in our sample: alliances where companies collaborated with university and technological centers, alliances where companies collaborated only with university, alliances with collaborations between companies and technological centers, and finally, alliances where only companies collaborated between them, without any university or technological center within the project. This distribution has been made because each type of collaboration was expected to produce different outcomes.

Results obtained show strong confirmation that collaboration in R&D alliances between companies increases the number of commercial opportunities for them. By contrast, R&D alliances with participation of technology centers are the ones that worse performed in all the possible alliance outcomes. Finally, when we analyze R&D alliances with the participation of universities, we observe that they have higher levels of the outcomes “acquire technical knowledge” and “new technological opportunities” than the rest of alliances.

Thus, in Chapter 3 we have confirmed that there are positive outcomes when firms collaborate in R&D activities and, moreover, we have found evidence about how partner selection can affect the type of outcome obtain thanks to this collaboration.

Regarding Chapter 4, the second part of the analysis about R&D alliance outcomes, we have examined the establishment of individual relationships through R&D alliances. In particular how trust, conflict, commitment and communication affect R&D alliance performance, the individual’s satisfaction with the alliance and their intention to collaborate with the same partners in the future.

A model has been proposed and tested using EQS where trust, commitment, conflict and communication are treated as exogenous variables, and alliance performance, satisfaction and reformation as the endogenous ones. We have found that when trust, commitment, conflict and communication are higher, alliance performance reaches higher levels too.

Our findings add that communication is the most relevant factor for predicting alliance performance. Contrary to what we expected, our model found that conflict management is an important capability in R&D alliances, taking into account that conflicts exist and that these conflicts affects the alliance performance positively.

In the last part of the model we predicted and found that, in general, alliances with better performance influence in the individual satisfaction and raise the willingness to continue or to repeat the alliance experience with the existing alliance members. Therefore, satisfaction is a predictor for alliance reformation.

Thus, once it has been analyzed which are the necessary conditions in order to obtain positive outcomes for firms participating in R&D alliances, in Chapter 5 this research proposes a model of evaluation to co-finance large collaborative R&D alliances by governments.

The decision about how to finance R&D is hard because of there are high levels of uncertainty and these activities produce spillovers, which are characterized by lack of appropriation and ease to imitate.

This research proposes a model for public granting where public agencies should evaluate projects according to two concepts: the expected commercial viability and the expected positive externalities of the alliance if the R&D project is developed. Moreover, a third variable with the degree of technological interest should be taken into account in some cases. This model tries to solve the problems of existing models in the literature that are difficult to implement.

After that, we have evaluated the decision process of awarding R&D alliances in Catalonia in 2008 and 2009. In this evaluation we have observed that for granted projects, the variables commercial viability and externalities are higher than for non-granted project both years, which seams aligned with our proposed model.

We have estimated several OLS regressions and well, which show differences between 2008 and 2009. In 2009 grants seem closer to what we expected from theory, while in 2008 we do not confirm the relationship between commercial viability and receiving a grant. In 2008, cost and externalities are the explanatory variables that are statistically significant to explain obtaining the grant. By contrast, in 2009 we do confirm that both externalities and commercial viability are positive related to receiving the grant for the R&D project.

6.2. Theoretical implication

The main objective of this PhD thesis is to investigate the relationship between innovation and performance at firm level considering that there is not conclusive knowledge about the relationship between innovation practices and company success in the mid- and long-term (Hult et al., 2004).

At the beginning of the research, innovation management practices have been classified into 19 factors corresponding to 9 key dimensions of innovation management: innovation strategy, management systems, innovation culture, creativity, project management, product innovation, process innovation, commercial innovation and technological innovation.

Results of the OLS regression confirm the positive relationship between firms' turnover and two of these dimensions: product lifecycle planning, and advanced method and ICT in product and production, which is aligned with studies from Miltenburg (1995), Blindenbach-Driessen and Ende (2006) and Coombs and Hull (1998).

On the other side, innovation management practices such as design, collaborative R&D and local technology suppliers are negatively related to firms' turnover variation. This evidence seems to contradict Ahire and Dreyfus (2000), who state that to attain superior outcomes, firms need to balance their design and process management efforts and persevere with long-term implementation of these efforts. But few studies have quantified the contribution that design makes to company performance.

One of them is the one by Chiva and Alegre (2009) that analyze the relationship between design and performance and conclude that design by itself is not positively related to firms' performance. According to them, good design does not emerge by chance or by simply investing in design but rather as the result of a managed process, and its design management that enhances firm performance. Hence, this research does not contradict Chiva and Alegre (2009) since we have measured the inclusion of design in firm products, but design management has not been included in the survey. Even so, such a negative effect of design in firms within the electronic industry seems to suggest that maybe these firms do not include design management in their activities.

Finally, regarding R&D collaboration and its negative effect on firms' turnover contradicts existing literature, such as Belderbos et al. (2004) that found evidence that cooperation with universities and research institutes and again competitor positively affects growth in sales per employee of products and services new to the market. This is why I have decided to investigate deeper in chapters 3 and 4.

In chapter 3, I analyze the relationship between the type of partners that collaborate in R&D alliances and different alliance performance outcomes: acquisition of technical knowledge, new technological opportunities and new commercial opportunities. Results show that alliances between companies are the ones that tend to generate more commercial opportunities. This pattern is consistent with that presented by Belderbos at al. (2004) and Miotti and Sachwald (2003).

Secondly, we confirm a negative effect of the participation of technological centers for the three types of outcomes which seems to confirm that there are other motivations for companies to establish this type of collaboration, for example, because it facilitates the access to public financing (Santamaría and Rialp, 2007)

And finally, we cannot confirm a positive relationship between the including a university partner in the alliance and acquiring new technical knowledge that is coherent with results presented by Veugelers and Cassiman (2005) who affirm that these agreements R&D cooperation between universities and industry is characterized by high uncertainty. This uncertainty may cause that a direct relationship between this kind of R&D cooperation and performance cannot be demonstrated this way. Although Mohnen and Hoareau (2003) already affirm that companies could have interest in collaborating with them in order to capture new technological opportunities of their basic research.

Concerning the establishment of individual relationships through R&D alliances (Chapter 4), literature provides conceptual models focused on relationships between organizations, and some authors mention the impact of embedded ties on alliance performance as a matter of trust building, conflict management, personal responsibility and communication, but they are not applied empirically to the individual level in an integrated way. It is however noted from the structural equation model in this study that trust, conflict, commitment and communication are positively related to alliance performance. This research supports with empirical evidence previous theories in the literature (e.g. Gulati, 1998; Heimeriks, 2002; Lin et al., 2012).

At the last chapter part of this PhD thesis (Chapter 5) we propose a model to improve the current literature about research policy, whose one of its main problems is how distribute research funds to satisfy multiple objectives. The main contribution of this research is to define a model for awarding R&D alliances under budget constraint that is aligned with the theoretical proposal of Giebe et al. (2006). Moreover, this research takes into account risk and novelty of projects (both technological and commercial viability) and externalities that firms cannot appropriate, a gap that has not been covered until now because of lack of data (Cozzarin, 2008; Santamaría et al., 2010).

6.3. Policy implication

Support to innovation and R&D activities has become habitual in most economic programs worldwide. The need for policy support for these activities is widely demonstrated in the literature, but some firms may perform innovation activities and do not perceive the benefits of such innovation.

This study has used empirical findings to show that innovation management, as a systematic process, is necessary to improve financial results. Many firms associate innovation to the creation and launching of new products and services, or the implementation of new processes, for instance, nevertheless not all of them has incorporated innovation as a continuous activity and not isolated actions.

Thus, theoretical arguments suggest the need for fostering innovation management skills among firms. Innovation needs to be understood and used as other management skills (e.g. marketing, finances, strategy and human resources), even if nowadays few management degrees include innovation management in its core studies. Promoting this training is necessary to ensure that most companies end up by innovating systematically. Local entities for promoting the economic growth in firms could take into account this recommendation to include training programs in their agendas, as well.

On the other hand, it is interesting to note that collaborative R&D could have negative effects in firms' turnover. Therefore, results of this research show that efforts can be made so that R&D alliances maximize firms' performance.

First, in individual relationships should be particularly cared. As shown in chapter 4, communication between individuals participating in R&D alliances can become a key success factor of R&D alliances. Hence, although it could seam an overrun for R&D projects in many firms, it could be positive to assign at least one person to ensure that the relationship with the rest of alliance partners has the suitable communication, trust, conflict and commitment levels during the development of the project. Secondly, we have seen in Chapter 3 that the selection of partners is crucial depending on which are the expected results that a firm aims to achieve thanks to the R&D alliance.

From the policymaker point of view, the practical implications are even more important. The importance of partner selection is relevant for the design of public policies together with the proposed model for awarding R&D alliances in Chapter 5.

To be able to launch additional R&D alliances, and to maximize the success probabilities of such complex alliances, it's a key factor to enhance their social dimensions. Building trust or commitment, improving the communication and avoiding conflicts among the partners are social challenges. In this sense, a previous social work may improve the starting conditions of the alliances. Cluster public policies, for instance, are programs aimed to strength the links and build trust between local partners.

Finally, one of the most noteworthy issues to consider is that evaluation of R&D alliances should take into account the expected commercial viability, externalities and the technological interest degree. The methodology of using a single addition of these concepts to rank projects and assign grants, which is at the present time one of the most used methods by public agencies, can be improved by classifying projects into four regions according to our model.

6.4. Limitation of the study and recommendation for future research

The study has offered an evaluative perspective on the relationship between innovation activities and firm performance, and was conducted in a regional level through two different databases: one has been used in Chapter 2 to study innovation management practices among firms the electronics industry in Catalonia, and the other one has been used in Chapters 3, 4 and 5 and includes data of R&D alliances. As a direct consequence of this methodology, the study encountered a number of limitations, which need to be considered.

Moreover, during the study of R&D alliances, it has been possible to collect data only once at the end of the R&D projects. A deeper study could have been made with a second survey that should have included more questions about performance of these alliances in a longer term.

Considering the fact that the study of R&D alliances analyzes a new database that we collected from R&D alliances on the group level (i.e. alliance performance), but addresses to individuals embedded in these alliances, multilevel research could be another statistical tool in order to address to the research topic. The contribution of multilevel research lies in a stronger consideration of the individual´s environment. In other words, individual-level perceptions can be averaged to represent higher group-level situations (James and Jones, 1976)

It could be also an interesting contribution to study, from a knowledge management perspective, if alliances that effectively reform, also have higher levels of behavior factors (trust, commitment, conflict and communication) than in previous alliances. If this case, we would empirically test a loop for alliance relationships that can drive relations upwards.

Future research on R&D alliance relationships and performance should also look more closely at the effect of communication directly on satisfaction and reformation of the alliances, as it has been shown that it is the behavior that more increases R&D alliance performance.

Finally, our research would be improved if we could test our model with R&D alliance in other regions or countries to avoid that specific characteristics of the region affect the results of the study.

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APPENDIX 1. Survey

Questionnaire about collaborative R&D projects (ACC1Ó - Competitivitat per l'Empresa)

In your opinion, which are the main difficulties to tackle R&D projects in your company?	**1 = Totally desagree**	**2**	**3**	**4**	**5 = Totally agree**	
The finantial return period is too high	1	2	3	4	5	
Lack of funding	1	2	3	4	5	
The technological risk is too high	1	2	3	4	5	
Ignorance of other markets	1	2	3	4	5	
R&D project management is very complex	1	2	3	4	5	

In your opinion, which are the benefits of collaborating in this alliance?	**1 = Totally desagree**	**2**	**3**	**4**	**5 = Totally agree**	
The R&D project finishes sooner	1	2	3	4	5	
Improvement of new product development	1	2	3	4	5	
Improvement of operational processes	1	2	3	4	5	
New technical knowledge	1	2	3	4	5	
Increase of market share where we are already present	1	2	3	4	5	
Access to new markets	1	2	3	4	5	
Reduction of costs	1	2	3	4	5	
To get new technology for the market	1	2	3	4	5	
To get new technology for the company, although not necessary for the market	1	2	3	4	5	
To get innovations that represent an important technological improvement and leave obsolete present technologies and processes	1	2	3	4	5	
It is a strategic project for the company	1	2	3	4	5	
With the expected results, it is not clear if the improvement or new product will arrive to the market	1	2	3	4	5	
Other:	1	2	3	4	5	

COLLABORATIONS WITHIN THE PROJECT	**Suppliers**	**Customers**	**Competitors**	**University**	**Technological centre**	**Companies from other sectors**
Who do you collaborate with within the project? Choose with an X						
Evaluate these collaborations. From 1 (very negative) to 5 (very positive)	1 to 5	1 to 5	1 to 5	1 to 5	1 to 5	1 to 5
Before this project, have you collaborate with these partners? If so, choose it with an X						
Which partners give you technical knowledge? Choose with an X						
Which partners give you knoledge about other markets? Choose with an X						
Which partners give you experience in collaborative project management? Choose with an X						
Which partners give you new contacts? Choose with an X						
Would you like to collaborate with these partners in the future? From 1 (totally desagree) to 5 (totally agree)	1 to 5	1 to 5	1 to 5	1 to 5	1 to 5	1 to 5

Rate the results obtained until the present because of the participation in this alliance. From 1 (very negative) to 5 (very positive)	**Valoration**	**Not applicable**
Technological knowledge obtained	1 to 5	
Creation of new technological opportunities	1 to 5	
Creation of new commertial opportunities	1 to 5	
New contacts and relationships	1 to 5	
Compliance of initial objectives	1 to 5	
Other:	1 to 5	

	Suppliers	**Customers**	**Competitors**	**University**	**Technological centre**	**Companies from other sectors**
Rate your level of satisfaction with different partners in the alliance. Rate from 1 (very negative) to 5 (very positive)	1 to 5	1 to 5	1 to 5	1 to 5	1 to 5	1 to 5

RESULTS	**1 = very bad**	**2**	**3**	**4**	**5 = very good**	
How well do you think your group performs?	1	2	3	4	5	
How effective is your work unit?	1	2	3	4	5	

APPENDIX 2. Descriptive statistics of regions

Regions in 2008

- Region 1

Region I	Granted (9 obs)		Non granted (38 obs)		Ttest (p-value)
	Mean	**(sd)**	**Mean**	**(sd)**	
Commercial viability	3.67	0.87	3.45	0.69	-0.82 (0.4163)
Total externality	7.33	2.60	6.87	2.68	-0.47 (0.6406)
Cost	1.44M	0.62M	1.05M	0.62M	-1.73* (0.0913)

- Region 2

Region II	Granted (1 obs)		Non granted (73 obs)		Ttest (p-value)
	Mean	**(sd)**	**Mean**	**(sd)**	
Commercial viability	1	-	0.67	0.85	-
Total externality	7	-	5.41	3.38	-
Cost	1.98M	-	1.11M	1.02M	-

- Region 3

Region III	Granted (20 obs)		Non granted (46 obs)		Ttest (p-value)
	Mean	**(sd)**	**Mean**	**(sd)**	
Commercial viability	3.9	0.91	3.41	0.62	-2.53** (0.0137)
Total externality	16.3	3.83	14.28	2.84	-2.3790** (0.0204)
Cost	2.22M	2.75M	1.09M	0.55M	-2.69*** (0.0092)

- Region 4

Region IV	**Granted (15 obs)**		**Non granted (27 obs)**		**Ttest (p-value)**
	Mean	**(sd)**	**Mean**	**(sd)**	
Commercial viability	1.07	0.88	0.89	0.93	-0.60 (0.5503)
Total externality	14.27	2.81	14.26	2.55	-0.01 (0.9931)
Cost	1.44M	0.54M	1.23M	0.63M	-1.07 (0.2923)

<u>Regions in 2009</u>

- Region 1

Region I	**Granted (11 obs)**		**Non granted (29 obs)**		**Ttest (p-value)**
	Mean	**(sd)**	**Mean**	**(sd)**	
Commercial viability	3.91	0.54	3.97	0.73	0.23 (0.8175)
Total externality	10.64	1.69	9.86	3.79	-0.65 (0.5205)
Cost	1.28M	0.53M	1.17M	0.62M	-0.49 (0.6297)

- Region 3

Region III	**Granted (24 obs)**		**Non granted (26 obs)**		**Ttest (p-value)**
	Mean	**(sd)**	**Mean**	**(sd)**	
Commercial viability	4.38	0.49	3. 5	0.58	-5.69*** (0.0000)
Total externality	20.75	5.02	18.54	2.49	-1.20* (0.0516)
Cost	1.55M	0.46M	1.59M	0.99M	0.18 (0.8555)

- Region 4

Region IV	**Granted (1 obs)**		**Non granted (5 obs)**		**Ttest (p-value)**
	Mean	**(sd)**	**Mean**	**(sd)**	
Commercial viability	0	-	1.6	0.55	-
Total externality	18	-	17	1.41	-
Cost	2.05M	-	1.26M	0.36M	-

APPENDIX 3. Detail of granted projects by region and by grade

Regions in 2008

- Region I

	Total			Granted		
	Number	% (out of total)		Number	% (out of total granted)	% (out of grade)
A	2	17%		2	50%	100%
B	5	42%		0	0%	0%
C	2	17%		2	50%	100%
Total	12	100%		4	100%	33%

- Region II

	Total			Granted		
	Number	% (out of total)		Number	% (out of total granted)	% (out of grade)
A	2	9%		1	100%	50%
B	4	17%		0	0%	0%
C	5	22%		0	0%	0%
Total	23	100%		1	100%	4%

- Region III

	Total			Granted		
	Number	% (out of total)		Number	% (out of total granted)	% (out of grade)
A	11	31%		7	58%	64%
B	7	20%		3	25%	43%
C	10	29%		2	17%	20%
Total	35	100%		12	100%	34%

- Region IV

	Total			Granted		
	Number	% (out of total)		Number	% (out of total granted)	% (out of grade)
A	10	32%		5	33%	50%
B	7	23%		4	27%	57%
C	8	26%		6	40%	75%
Total	31	100%		15	100%	48%

Regions in 2009

- Region I

	Total			Granted		
	Number	% (out of total)		Number	% (out of total granted)	% (out of grade)
A	10	26%		7	64%	70%
B	13	34%		4	36%	31%
C	9	24%		0	0%	0%
Total	38	100%		11	100%	29%

- Region II: no projects granted
- Region III

	Total			Granted		
	Number	% (out of total)		Number	% (out of total granted)	% (out of grade)
A	11	22%		9	38%	82%
B	16	32%		10	42%	63%
C	17	34%		5	21%	0%
Total	50	100%		24	100%	48%

- Region IV

	Total			Granted		
	Number	% (out of total)		Number	% (out of total granted)	% (out of grade)
A	0	0%		0	0%	0%
B	1	17%		1	100%	100%
C	2	33%		0	0%	0%
Total	6	100%		1	100%	17%